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# An Empirical Analysis of the Impacts of LIBOR Changes on the Volumes of Global Seaborne Trade and the Growth of World Gross Domestic Product - Cointegration and Causal Nexuses -

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*Abstract-* Ship finance (SF), global seaborne trade (WST), world gross domestic product (WGDP) and, the London Interbank Offered Rate (LIBOR) really are the fascinating issues to the ship owners, financial institutes, bankers, banking risk managers and, maritime researchers. The remarkable developments of global shipbuilding and sea transportation are important and significantly created more productivities and businesses to the world economy today compared to last 20th century, special in the containerization, oil tankers, liquefied petroleum gas (LPG), liquefied natural gas (LNG), dry bulk carriers and others. The ship investors normally require the large amount of capital and always seek for the suitable financial sources. The research is aimed at empirical analysis examining the distinguished and internally causal nexuses of the WST, WGDP, LIBOR and the world merchant fleets (WMF) when these four separate factors are jointly acted into one synchronous linear autoregressive model during the 1980-2015 period. We could see how the real active powers of each factor are and, how the internal relationships of maritime supply and demand and how the activities of long run and short run equilibrium relationships in the model by employing Johansen and Juselius (1990) cointegration, vector error correction models (VECM) and Granger causality tests.

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## I. Introduction

As globally statistical recorded, over 90% of world trade (WT) is carried by the international maritime fleets with low and decreasing ocean freight costs. Global seaborne trade (WST) is expected to be expanded continually to bring the benefits for international consumers. There are more than 90,000 merchant ships which are registered in over 150 nations and trading internationally and transporting every kind of cargoes. In maritime industrial fields, most of the shipping companies, the cargo owners, the shipbuilders the port authorities are very concerned to seek for the healthy and stable sources of cash flows and how to successfully establish the regularly profitable charter routines in order to have the higher returns of gigantic amounts invested into their fleets, or to develop the modern ports to attract cargoes by offering the advanced cargo handling facilities to the vessels. The sources of ship finance loans are a large required funds which are normally derived and needed from joint stock limited companies, from the individuals who own and control it (individuals are legally shared), from equity capitals, from public issuing of corporate bonds or from funds are loaned by merchant banks, from sales and lease-back, from sales to another flag, from 2nd hand vessels considerations and also from saving taxations. Among the sources of shipping finance, borrowings from commercial banks shows more than 50%.

The ship investors normally require the sources of large amount of capital – sometimes accounts for up to 80% of the costs of acquiring and operation of a bulk carrier - from the financial institutes or from the bankers who always like very much the predictable earnings, transparent corporate accounts and, consistent growth and high yields of that shipping company. However there are no many shipping companies which are fully qualified with these critical requirement. Each of new building vessels could cost more than thirty to few hundred millions US dollars and its time life is utilized around 15 economic years thus, the ship investors are very much concerned how they can fully utilize their profitably operating fleets which are heavily dependent on the regularly routine charters and combined full trading volumes of cargoes on boards. The crucial issues that the ship investors, bankers, and port operators may expect to see whether there are any interactional causal nexuses between the WGDP to the WST, to the WMF, and to the LIBOR and vice versa? Are all of these separate factors endogenously or exogenously impacted each other? If WST is increased, then would this be the reason to the increasing WMF, and then transforming to the volatilities of WLIR and, if they are so how do they work? The empirical analysis of those issues is ingeniously deciphered by Johansen

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cointegrating equations, VECM and Granger causality tests and if the findings which are resulted from plausible deciphers, hopefully would be satisfied and contributed anything to the future strategies of the ship-owners, port authorities and bankers.

The remainder of this research is divided into: section (2) briefly reviews all the literatures on the Johansen cointegrating equations, VECM in long run and short run and, Granger causality tests, section (3) presents all data and applied methodologies, section (4) will analyze and explain the empirical findings through examining how those factors are dealt and impacted with and conclusion in section (5).

## II. Literature Reviews

*a) Ship finance loans to maritime fleets*

For the development of maritime industries, the requirement of ship finance is the crucial condition and is related to its capital costs in their sizes because a container ship represents an initial capital outlay of more than US$ 80 million while others like LNG tankers or new technological designs are more expensive. The ship finance is prominently playing the crucial roles that are contributed to maritime industries. It could be stated as shipyard credits, leasing agreement, and special national funds set up for shipping or shipbuilding development. In the study of Minsky's financial instability hypothesis and the leverage cycle, by linear modeling of financial institutions and banks for fund raising, Tsomocos et al., (2011) found that in the initial period banks do not choose to invest any capital in the risky project, and the same holds for the intermediate period when a bad state realize. However once expectations are updated upwards, say, the economy moves to the good state in the intermediate period, then bank starts investing into riskier projects. That is meant when the expectations are boosted and financial institutions find it profitable, then the creditors are willing to provide ship-owners with funds and bank portfolios consists of relatively riskier projects. Currey (2004), in his note exploration on ongoing Marco-level changes at the WB, denoted that the World Bank Group (WBG) funding to support the private sector has increased dramatically, both in absolute terms and relative to overall spending, and in 2013, the International Finance Corporation (IFC) accounted for 35% of WBG commitments, compared with 18% in 2009 and only 13% in 2000.

Wijnbergen (1988) applied the general equilibrium models through financial variables of revenue, expenditure, relative prices, interest, and data of OECD and LIBOR etc. for period 1979-1982, and 1982 onwards to test for the debt neutrality, fiscal deficits, interest rates, and the global effects on the inter-temporal and intra-temporal trade of various fiscal policy measure and interventions in commodity trade. He showed that almost all of the increase in real interest rates can be ascribed to the pressure on world saving exerted by increased fiscal expenditure and the fact that increase was deficit financed, and an increase in the world interest rate to restore global current account balance. In the crisis period the ship-owner should be much care of margin conditions and cost of capital when getting the loan from financial institutions. Coffey et al. (2009) empirically analyzed the data of LIBOR and other currencies for supplying dollars in their studying of capital constraints, counterparty risk and deviation from covered interest rate parity (CIP) by using linear regression model, saying that the proxy for margin conditions and cost of capital are significant determinants of the basic, especially during the crisis period. According to the study of Gratsos (2013), the cost efficiency of shipping is related to the dry bulk shipping's cost efficiency improved about 33% over the last 31 years through larger, more cost efficient ships, and the average size of the fleet grew from 35,500 DWT in 1981 to 70,600 DWT in 2012, in order to improve cost efficiency, ship sizes are constantly increasing. All ship categories suffer bracket creep and parcel trade in bigger bulk carriers improves cost competitiveness, the smaller, more flexible ships attain a measure of cost efficiency by reducing the ballast leg (triangulation).

Regarding to the loan supplying to the maritime fleets, Heiberg (2012) proved that bank commitments are probably in the region of US$ 400 to US$450 billion, as an aggregate value of the world fleet including specialized ships such as chemical tankers, gas tankers, and offshore units and it is likely that this is shrinking because some banks wish to reduce exposure, and also over the next couple of years loan repayment will probably be in the range of US$ 70 billion per annum of which US$ 40 billion is likely to be committed by the banks to the new business, and however export credit agencies are expected to be part of the funding equation, although they will probably have a greater impact on the offshore side than the shipping side. Between 2010 and 2012, increased financial constraints was highlighted as one of the most significant changes to the business by 40% of the shipping respondents and overcapacity of supply was also highlighted by shipping respondents and London was selected as the financial center best to meet the needs by 40% of shipping respondents with New York and Singapore joint second. There are 36% of shipping respondents are using or considering new sources of finance, and structured finance was most favored (26%), new private equity (23%), and export credit (20%), (www.shippingresearch.worldpress.com).

Concerning to the bank's strategies for ship financing, as reported in Stopford (2009), the shipping has distinctive characteristics which make financing different from other asset-based industries such as real estate and aircraft whereas bankers like predictable earnings, well-defined corporate structures, high levels

of disclosure and well-defined ownership, whilst investors look for consistent growth and high yields, however many shipping companies do not meet those criteria. Providing finances to the borrowers, high risks are always occurred even though the banks normally play a critical role in international trade by providing trade financial products that reduce the risk of exporting, however to the situation of surplus new shipbuilding when the market are down, the high risk are still the crucial issues and seriously concerned. However, in the KMPG's research (2011) it was asserted that German banks have taken a leading role in the financing of global shipping, even in the recent years of the crisis German banks have provided equity interim financing up to 10% loan financing for ordered ships and working capital financing and financing of operation cost (OPEX), the fundamentally finance changed shipping financing conditions require action by shipping companies and they must develop individual tailored solutions to secure new capital and to fund new builds.

Niepmann, et al. (2014) employed double residual estimators into linear regression testing models with all joint variables of documentary collection (DC), letter of credit (LC), expected profits from cash in advance, open account, destination country risk, transaction size, log GDP per capita, log financial development, long distance, and log exports denoted that increasing in the cost of trade finance that may come from increased due diligence requirement and new rules on capital and leverage have the potential to impact real economic activity not only in the United States but also abroad, and policymakers have interpreted the low usage of trade finance for shipments to less-developed economies as evidence of a gap in the provision of trade finance by commercial banks. The sources of ship finance and other relevant expenditures of shipping activities are the crucial issues, and for most ship investors' forecasting is not optional.

As Stopford (2009) reckons that in order to earn better, the more anticipate in to the future the more profit they can make, thus the ship investors should have the accurate forecasting model through the forecasting steps of economic assumptions, the seaborne trade, the average haul, the ship demand, the ship productivity, the shipping supply, the balance of supply and demand, and the freight rates by employing linear regression relationship models. For instant, employing the linear relationship regression models for testing the moving together in a linear way between seaborne trade (ST) and gross domestic product (GDP) from 1995-2005, based on the actual result of 1982-1995, he predicted that there exist the casual nexuses between two variables of ST and GDP with the result of R2 = 99%, whereas R2 = 98.9% in cargo trade, and R2=94.3% in oil trade. However, standing on the different point of views when empirically analyzes the causal effects between the trade volume (seaborne trade) and volatility in the shipping forward freight market of dry bulk vessels of Capesize (172K metric tons DWT), Panamax (74K metric tons DWT) and, Supramax (52K metric tons DWT) by using vector autoregressive (VAR) model, exponential GARCH model, and EGARCH-X model, Alizadeh (2012) denoted that there is no evidence of causality from volume to price changes, and result from the asymmetric conditional volatility models indicate the asymmetric response of forward freight agreement (FFA) price volatility to shocks in the market and there is a positive relationship between trading volume (seaborne) and price volatility only.

Bulut (2011) using vector autoregressive modelling, unit root and Granger casualty tests for the analysis of the causal nexuses of freight rate and dry bulk carriers of Handymax (HM) and Panama (PM) sizes ships to affect the profits of ship-owners and shipping companies in period from 2000- 2009 in the WMF and WST, he proved the trends of maritime industry, as a key effect of economic globalization is the continuing increase in maritime trade and traffic and in the near future, global port operators are seen to continue to expand to new geographic areas and will maximize the use of technology to create worldwide port networks that can offer consistent levels of services and modes of operation, since capital investment into marine will be high thus only the most powerful enterprises with significant financial resources will remain in these alliances.

*b) World merchant fleets (WMF) to WST and WGDP*

The maritime industry and maritime merchant fleet which is a subsector of the transport sector - dominated by North America, Europe and Asia - globally accounts for over 90% of transportation requirement of the world, and the roles of WMF to the development of WST, as Selen (2009), trade is a vehicle of growth, and maritime transport is an instrument for bridging markets and is a catalyst of world trade and this has been lasted for thousands of years. The significant contribution of WMF to the WST, between 2010 and 2012 by 40% of the shipping respondents and overcapacity of supply was also highlighted by shipping respondents as OECD report. The development of global trade is a specific driver of maritime and air freight transport volumes and in which maritime transport is the backbone of international trade with over 90% of world cargo by volume transported by sea, the WST measured in tons loaded grew 4% to 9.2 billion tons in 2013, or 11% above the pre-crisis peak in 2008 (UNTACD). And in ton-miles, maritime transport grew by 4% reaching 46 billion ton-miles; the total amount of goods unloaded (in tons) in developing countries reached 28% above pre-crisis 2008 peak in 2012 while in the developed economies volumes were still 8% below their 2008 peak. Container volumes continued to grow at all ports except for Hong Kong where traffic fell for the second

consecutive year as a result of increasing competition from rival ports in southern China and the Pearl River Delta area and shift in ocean carrier alliances (OECD, 2015). The tankers, bulk carriers and container ships are the most important means of maritime transportation and carry billions of tons cargoes and bringing vast improvements in efficiency.

From 1950 – 2005, Stopford (2009) denoted that the seaborne trade had the central place in the twenty first century and grew from 0.55 billion tons to 7.2 billion tons, showing average 4.8% per annum. Det Norske Veritas AS (DNV, 2012) had predicted the trends of oil tanker from 2012-2020 which is dependent heavily on oil prices, then 7-8% that is equivalent to 8-33 million tons of LNG new building will be able to run on, the bulk carrier will be grown less than 5% per year and still be under pressure for several years to come as the result of the current oversupply. The container ship is seen as "the closets to the consumer" and demand is strongly driven by the GDP growth and, not least, changes in per capita income in regions and large countries and the number of 4,000-8,000 TEU vessel will be increased while vessels smaller than 1,000TEU are likely to represent a smaller share of the market in 2020 than they do today. The maritime sector is of critical significance to any economy and is the main means for transporting goods internationally, and many cities rely on their ports as a major source of revenue. Maritime activities are expanding, for example, the European Union's (EU's) maritime regions accounting for about 40% its GDP. (www.myfinancialintelligence.com).

Huang et al. (2015) using two models of linear regressions, one for trip generation and one for gravity for trip distribution between exported countries and imported countries to test and found that, it captured up to 72% of variation in trade volumes while the gravity model achieved an accuracy of 84%, and also revealed that socio-economic and demographic indicators that affect import and export containerized trade volumes were identified with R2 = 79.80%. Corbett (2008) asserted the global goods movement is a critical element in the global freight transportation system that includes ocean and coastal routes, a primary example is containerized short-sea shipping where the shipper or logistics provider has some degree of choice how to move freight between locations. Talking to the crucial roles of MF as facilitator of WT and WST, Heiberg (2012) critically analyzed that if just compares with 1950s, the WST comprised about 0.5 billion metric tons whereas today it has expanded to about 9 billion metric tons, thus ST has ground about 18-fold while GDP has grown roughly eight or nine-fold in the same period. In value terms, ST accounts for about 60% of WT, and the value of all of WT today is about US$ 15 trillion, of which US$ 9 trillion by sea. Also as Heiberg, over last 60 years the seaborne container trade has grown from zero (0) to about 1.5 billion metric tons, and in 2010 the global value of seaborne container trade is estimated about US$ 5.6 trillion which is about 60% of the WST. Rua (2014) using the econometric models for the period 1956 to 2008 - consisted of the adoption year for 145 countries and data on containerized and general cargo trade for 684 ports in 127 countries to see the crucial impacts and diffusion of containerization - adoption and usage to the firm's fixed costs, empirical investigation and finding that the usage of containerization increases with firm's fixed costs and the size and average income of the container network, and the adoption depends on expected future usage, adoptions costs, and trade with United States, the first and largest user of containerization. Analyzing the types of cargoes (dry bulk cargo, liquid bulk cargo, and general cargo), types of ships (dry bulk carrier, tanker, LNG/LPG, combined carrier, container, RO/RO, and reefer), trade routes (Mediterranean Sea, Caribbean Sea, etc.), and type and duration of charters (voyage, time, bareboat and contract of affreightment charter) by using the spearman rank correlation coefficient to measure the degree of association between ST (in million ton) and freight rate, Anyanwu (2013) showed that there is a positive association between freight rate and fleet size with the correlation coefficient of 0.660 and this is implied as seaborne volume grows thus, the ship-owners need to adjust their fleet size to meet the market demand.

In maritime industries, containerization is getting more important than decade years in sizes and increased deadweight (DWT) to meet the rapid growth of international trade. Gosasang et al. (2012) deployed the parameters multilayer perceptrons (MLP) neutral network models, root mean squared error (RMSE), mean absolute error (MAE) together with linear regression models to test the correlation coefficients of containerization output at four major Thai land ports (Bangkok, Private Wharves along the Chap Pharaya River, Laem Chabang and, Songkhla) for the period 2001-2011. Gosasang et al. found that despite of other related factors of industrial production, inflation rate, interest rate, exchange rate, oil prices, etc. the containerization situation now is significantly contributed to the import and export of cargoes in and out Thailand. According to the research of Rodrigue (2016), as of 200, the seaborne trade accounted for 89.6% of global trade in terms of volume and 70.1% in terms of value. Wignall et al. (2014) examined and found that the international trade by volume in South Asia, Southeast Asia is transported by sea in three forms of container, dry bulk, and liquid bulk and sea transport has a large cost per ton kilometer advantage over the other modes of transport and will not be eroded significantly over next 20 years.

## III. Data Collections and Methodologies

*a) Data collection*

This research employs the time series from 1980- 2015 period for the numbers of merchant fleets by flag or registration by the type of merchant ships such as bulk carrier, container ships, oil tankers, general cargo, other ships, total ships in deadweight tons volumes (DWT) from UNTACD. The data of WGDP and WST from 1980- 2014 period are derived from World Bank (WB), the interest rates of period from 1986-2015 are employed from London Interbank Offered Rate (LIBOR). Those separate factors will be applied together as the joined variables in one synchronic model.

*b) Methodologies*

i. *Co-integration and Unit root Tests*

As Johansen (1988), Johansen and Juselius (1990) maximum likelihood method is a procedure for testing cointegration of several, say k, *I*(1) time series to obtain the number of cointegrating vector and this test permits more than one cointegrating relationship so is more generally applicable than Engle and Granger (1987) test which is based on Dickey and Fuller (1979) test for unit roots in the residuals from a single (estimated) cointegrating relationship. It provides two different types likelihood ratio tests, one is trace and other on the max eigenvalue, and the inferences might be a little bit different. The Johansen and Juselius cointegrating model is given below:

$$\Delta X_t = \sum_{i=1}^{p=1} \Gamma_j \Delta X_{t-1} + \Pi X_{t-1} + \varepsilon_{t,} \ldots \quad (1)$$

In the cointegrating tests, vector error correction model has information about the existence of short and long run equilibrium relationships and their adjustments to change into *X*t via the estimated parameters $\Gamma$ j and $\Pi$ respectively, whereas *X*t is (*2x1*) vector of jointly variables respectively, and Δ is stood for symbol of different operators whilst $\varepsilon$t is stood for (*2x1*) vector of residuals. The expression of $\Pi X_{t-1}$ is the error correction term and $\Pi$ can be factored into separate matrices $\alpha$ and $\beta$ such as $\Pi = (\alpha\beta)'$, where $\beta'$ is denoted for the vector of cointegrating parameters then $\alpha'$ is for the vector correction coefficient measuring the speed of convergence to the long run steady states. When the multi-variables are jointly in the linear synchronic model, we could find the cointegrating relationships after being run by Johansen-Juselius test, they will share a common stochastic trends and will grow proportionally together in the long-run relationships. The joint variables are theoretically cointegrated in the linear autoregressive synchronicity just imply the existence of internally casual nexuses of variables only, but it fails to show the directions of causal relationships.

To establish the order of integration of the jointly variables, the conventional unit root test as augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, and normally a variable is considered to be integrated of order *d*, is written as *I*(d) is turned out to be stationary after differencing at *d* times, and when being cointegrated, it is order at *1* (Asteriou and Hall, 2007), and is demoted as below for the time series *Y*t ($H_0$: $\vartheta$=0):

$$\Delta Y_t = \beta_0 + \vartheta Y_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta Y_{t-i} + \varepsilon_t \quad (2)$$

ii. *Granger causality test*

The Granger causality test is defined as the core meanings of directions of causal relationships which will be a short run exogeneity as shown by the significance of $\Delta Y_{t-1}$, and in the long run exogeneity as shown by the significance of error correction term. The results are then felt in one of the following cases, if $\boldsymbol{\delta i} \neq 0$ and gets significant meanings, but $\boldsymbol{\rho i}$ is negatively significant meanings, then we could conclude that the active moving of variable *X* is just causing of causal moving of *Y* (uni-directional causality), if $\boldsymbol{\delta i}$ is negatively significant meanings, but $\boldsymbol{\rho i} \neq 0$ with actively significant meanings then the conclusion is being said the variable *X* is impacted by the active changing of variable *Y* (uni-directional causality), if $\boldsymbol{\delta i}$ and $\boldsymbol{\rho i}$ are all$\neq$ 0 but get significant meanings then the conclusion is being told there is occurrence of the internally active causality vice versa of both variables of *X* and *Y* (bi-directional causality), and if $\boldsymbol{\delta i}$ and $\boldsymbol{\rho i}$ are all negatively significant meanings then the saying that both variables of *X* and *Y* are independent is finally given result (Vu et al. 2016). Hiemstra et al. (1994) suggest that the research should consider nonlinear theoretical mechanisms and empirical regularities when devising and evaluating models of the joint dynamics stock prices and trading volume. Neither this variable internally and directly impacts nor other, but both of variables are all moving and possibly impacted by the external variables. The testing are generally denoted as:

$$\begin{cases} \Delta Y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i \Delta Y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta X_{t-1} + \varepsilon_t & (3) \\ \Delta X_t = \alpha_1 + \sum_{i=1}^{k} \phi_i \Delta X_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-1} + \nu_t & (4) \end{cases}$$

Where $\alpha^0$, $\alpha^1$, $\beta^i$, $\phi^i$, $\delta^i$ and $\rho^i$ are coefficients, $\varepsilon^t$ and $\nu^t$ are residuals and $\Delta X_t$, $\Delta Y_t$ are dependent and explanatory variables at *t,* $\Delta Y_{t-1}$ and $\Delta X_{t-1}$ are variables at one period time. The selected number of lags are usually chosen when using an information criterion, such as the Akaike information criterion (AIC) or Schwarz Bayesian criterion (SBC). Any particular lagged value of one of the variables is retained in the regression if the cause happens prior to its effect, it is significant according to a *t*-test, and if the cause has unique information about the future values of its effect and the other lagged values of the variable jointly add explanatory power to the model according to an *F*-test.

iii. *Vector error correction model (VECM)*

Ericsson et al (2000) asked for the attention to the distribution of error correction tests of cointegration in the long-run relationship is regarded as a steady-state equilibrium, whereas the short-run relationship is evaluated by the magnitude of the deviation from equilibrium. The VECM is just a special case of vector autoregressive (VAR) for variables that are stationary in their differences (i.e., *I*(i)) and VEC can also take into account any cointegrating relationships among the jointly variables.

The VECM can avoid the shortcoming of the VAR based model in distinguishing between a long run and short run relationship among the jointly variables. When the joint variables of a VAR are cointegrated, VECM can be then commonly denoted as:

$$\Delta Y_t = \beta_{y0} + \beta_{y1}\Delta Y_{t-1} + \ldots + \beta_{yp}\Delta Y_{t-p} + \lambda_{y1}\Delta X_{t-1} + \ldots + \lambda_{yp}\Delta X_{t-p} - \lambda_y(y_{t-1} - \alpha_0 - \alpha_1 x_{t-1}) + \nu_t^y \ldots.(5)$$

$$\Delta X_t = \beta_{x0} + \beta_{x1}\Delta Y_{t-1} + \ldots + \beta_{xp}\Delta Y_{t-p} + \lambda_{x1}\Delta X_{t-1} + \ldots + \lambda_{xp}\Delta X_{t-p} - \lambda_x(y_{t-1} - \alpha_0 - \alpha_1 x_{t-1}) + \nu_t^x \ldots.(6)$$

$$\Delta Y_t = \sum_{i=1}^{p=1} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{p=1} \alpha_i \Delta X_{t-i} + Z1 * EC1_{t-1} + \varepsilon_{1t} \ldots(7)$$

$$\Delta X_t = \sum_{i=1}^{p=1} \varphi_i \Delta X_{t-i} + \sum_{i=1}^{p=1} \pi_i \Delta Y_{t-i} + Z2 * EC2_{t-1} + \varepsilon_{2t} \ldots(8)$$

Where in (5), (6), $y_t = \alpha_0 + \alpha_1 x_1$ is the long run cointegrating relationship between two variables and $\lambda_y$ and $\lambda_x$ are the error correction parameters that measure how *y* and *x* react to deviation from long run equilibrium. If in (7), (8) $\beta_i$, $\varphi_i$, $\alpha_i$, and $\pi_i$ are short run coefficients, $Z_1$ and $Z_2$ are error correction coefficients whereas $EC1_{t-1}$ & $EC2_{t-1}$ are denoted as the equilibrium error lagged values one period derived from residuals of threshold conintegrating equations regression of jointed variable vectors, and same time the procedures of optimum lag length criteria of VAR model based on the AIC or SC are specified as well.

When VECM has more than two variables, it is considered to the possibility that more than one cointegrating relationship is existed among the joint variables and with VECM, then we can examine the relationship of this joint variable is weak Granger causality compared with others and vice versa. When the short run relationship between this variable to other counter variable is found which is based on the normal *F* Wald test of the joint significant coefficients, on the lagged terms in the unrestricted models as the null hypothesis and its alternative, then it is considered as weak Granger causality. The long run relationship is tested by the speed of adjustment of coefficients and based on the *t* statistic of the error correction terms.

iv. *Selected Joint Variables Model*

In this paper, the examining of all joint multi-variables is tested on the denoting of cointegration equations by Johansen and Juselius, VECM models and Granger causality in a linear regressive synchronic models are deployed respectively, as:

$$\Delta WST_t = \sum_{i=1}^{k=1} \alpha_i \Delta WST_{t-1} + \sum_{i=1}^{k=1} \beta_i \Delta WGDP_{t-1} + \sum_{i=1}^{k=1} \phi_i \Delta LIBOR_{t-1} + \sum_{i=1}^{k=1} \gamma_i \Delta WMF_{t-1} + Z1 * EC1_{t-1} + \varepsilon_{1t} \ldots (9)$$

$$\Delta WGDP_t = \sum_{i=1}^{k=1} \lambda_i \Delta WGDP_{t-1} + \sum_{i=1}^{k=1} \varphi_i \Delta WST_{t-1} + \sum_{i=1}^{k=1} \delta_i \Delta LIBOR_{t-1} + \sum_{i=1}^{k=1} \vartheta_i \Delta WMF_{t-1} + Z2 * EC2_{t-1} + \varepsilon_{2t} \ldots (10)$$

$$\Delta LIBOR_t = \sum_{i=1}^{k=1} \mu_i \Delta LIBOR_{t-1} + \sum_{i=1}^{k=1} \nu_i \Delta WST_{t-1} + \sum_{i=1}^{k=1} \varsigma_i \Delta WGDP_{t-1} + \sum_{i=1}^{k=1} \omega_i \Delta WMF_{t-1} + Z3 * EC3_{t-1} + \varepsilon_{3t} \ldots (11)$$

$$\Delta WMF_t = \sum_{i=1}^{k=1} \tau_i \Delta WMF_{t-1} + \sum_{i=1}^{k=1} \xi_i \Delta WST_{t-1} + \sum_{i=1}^{k=1} \psi_i \Delta WGDP_{t-1} + \sum_{i=1}^{k=1} \tau_i \Delta LIBOR_{t-1} + Z4 * EC4_{t-1} + \varepsilon_{4t} \ldots (12)$$

When WST, WGDP, LIBOR and WMF are denoted for global seaborne trade, world gross domestic product, London Interbank Offered Rate and, world maritime fleet respectively. The symbols of $(\alpha_i),(\beta_i),(\phi_i),(\gamma_i),(\lambda_i),(\varphi_i),(\delta_i),(\vartheta_i),(\mu_i),(\nu_i),(\zeta_i),(\upsilon_i),(\omega_i),(\xi_i),(\psi_i),(\tau_i)$ are depicted for the short run coefficients, and $\varepsilon 1t$, $\varepsilon_{2t},\varepsilon_{3t},\varepsilon_{4t}$ stand for the residuals of the jointed variables whilst the $EC1_{t-1}$, $EC2_{t-1}$, $EC3_{t-1}$, $EC4_{t-1}$ are derived from the long run cointegration relationship and measure the magnitude of the past disequilibrium and denoted as lagged values of residual cointegrating regression models.

## IV. Empirical Results

*a) Unit root test*

Johansen and Juselius, and Granger argues that the fundamental condition for cointegration of each of variables in the joint synchronic model has to be integrated of the same order thus, the selected joint variables have to be stationary absolutely thus the joint variables WST, WGDP, LIBOR and, WMF for the period 1980-2015 are tested by Dickey and Fuller (ADF), and Phillip Perrons (PP) in the different levels at level, trend and intercept at 1%, 5% and 10% respectively for all joint variables such as WST, WGDP, LIBOR, WMF and, resid in the selected synchronic models and obtained results unit root tests depicted the values of all joint variables are stationary included residual as threshold co-integration is at level, in Table 1:

*Table 1:* Unit root test by ADF and PP

| Variables | ADF | | | | PP | | | |
|---|---|---|---|---|---|---|---|---|
| | 1% | 5% | 10% | P | 1% | 5% | 10% | P |
| WST1** | -4.262735 | -3.552973 | -3.209642 | 0.0002 | -4.262735 | -3.552973 | -3.209642 | 0.0000 |
| WGDP* | -4.262735 | -3.552973 | -3.209642 | 0.0000 | -4.262735 | -3.552973 | -3.209642 | 0.0000 |
| LIBOR1** | -4.467895 | -3.644963 | -3.261452 | 0.0046 | -4.323979 | -3.580623 | -3.225334 | 0.0040 |
| WMF1** | -4.252879 | -3.548490 | -3.207094 | 0.0000 | -4.252879 | -3.548490 | -3.207094 | 0.0000 |
| εt*** | -3.689194 | -2.971853 | -2.625121 | 0.0017 | -3.689194 | -2.971853 | -2.625121 | 0.0017 |

*(*) At level, trend and intercept, (**) at 1st difference, trend and intercept, (***) Resid at level*

*b) Johansen and Juselius cointegration test*

Johansen and Juselius cointegrating test requests all the joint variables such as WST1, WGDP1, LIBOR1 and WMF1 are at level, or first differences when they are in the trace values and max-eigenvalue tests with the results of null hypothesis $H_0$ are not cointegrated and the alternatives is $H_1$. The AIC is used to determine the optimum lag length and the number of cointegrating vectors are denoted by $r_0$ with the trace test is calculated as the null hypothesis $H_0$: $r_0 \leq r$, and the alternative hypothesis $H_1$: $r_0 > r$. The max-eigenvalue test is proved the null hypothesis $H_0$: $r_0 = r$. The Johansen and Juselius cointegrating tests for all joint variables in three models (*model 2, 3 and, 4*) of rank tests, trace and max-eigenvalue and are presented in Table 2.

*Table 2 :* Johansen & Juselius cointegration results of joint variables in synchronic model

| | Unrestriced cointegration Trace | | | Unrestricted cointegration Max-eigenvalue | | |
|---|---|---|---|---|---|---|
| ***Model 2- Intercept (no trend) in CE, no intercept in VAR*** | | | | | | |
| Cointegration | Eigenvalue | Trace statistic | 5% critical value | Eigenvalue | Max-eigen statistic | 5% criticcal value |
| None | 0.651151 | 74.23390 | 54.07904 | 0.651151 | 28.43416 | 28.58808 |
| At most 1 | 0.559985 | 45.79975 | 35.19275 | 0.559985 | 22.16557 | 22.29962 |
| At most 2 | 0.473129 | 23.63417 | 20.26184 | 0.473129 | 17.30158 | 15.89210 |
| At most 3 | 0.209066 | 6.332591 | 9.164546 | 0.209066 | 6.332591 | 9.164546 |
| ***Model 3 - Intercept in CE/VAR, no trend in CE/VAR*** | | | | | | |
| None | 0.649072 | 56.92611 | 47.85613 | 0.649072 | 28.27370 | 27.58434 |
| At most 1 | 0.503590 | 28.65241 | 29.79707 | 0.503590 | 18.90952 | 21.13162 |
| At most 2 | 0.210171 | 9.742888 | 15.49471 | 0.210171 | 6.370361 | 14.26460 |
| At most 3 | 0.117422 | 3.373527 | 3.841466 | 0.117422 | 3.372527 | 3.841466 |
| ***Model 4 - Intercept and trend in CE- no intercept in VAR*** | | | | | | |
| None | 0.681706 | 82.15314 | 63.8761 | 0.681706 | 30.90904 | 32.11832 |
| At most 1 | 0.635778 | 51.24411 | 42.91525 | 0.625778 | 27.26979 | 25.82321 |
| At most 2 | 0.491479 | 23.97432 | 25.87211 | 0.491479 | 18.25871 | 19.38704 |
| At most 3 | 0.190784 | 5.715614 | 12.51798 | 0.190784 | 5.715614 | 12.51798 |

The above results from tests indicate the null hypotheses for trace and max-eigenvalue statistics could be rejected at the 5% level of significance when $r_0 \leq 0$ and $r_0 = 0$, respectively and accept the alternative. In model 2, as results at 5% critical values are very much significant in *none*, *at most 1, 2* in trace statistic, means that denotes rejection of the hypothesis at the 0.05 level thus we can reject the null hypothesis but accept the alternative whilst the null hypothesis in max-eigenvalue of *none*, *at most* 1, 2 are cointegrated whilst *at most 3* indicates no cointegration at the 5% level thus, it is available to reject hypothesis with the meaning that there are cointegrated equations in the model with the long run causalities of these joint variables between WST1 to LIBOR1 and ,WMF1 whilst to WGDP1 is a short run relationship.

The obtained results in *model 3*, *model 4* at 5% critical value are significant at *none, at most 1, 2* hence, it is allowed to reject H0 and accept the alternative hypothesis. In other words the obtained results of the joint variables in selected synchronic models are tested by Johansen & Juselius to be cointegrated for WST1, LIBOR1 and WMF1 and it is believed that they share a common stochastic trend and will grow proportionally as moving together in the long run causalities, except the appearance of short run causalities between WST1 and WGDP1.

*c) Granger causality test*

This advantageous test is crystalliferous to indicate the directions of causal relationship of all joint variables as unidirectional or bidirectional causality. The selected synchronic model with jointed multi-variables must be in stationary before Granger casualty test, the unit root test resulted on variable WGDP at level is significant and stationary and better in AIC (*3.4512*), however in order to have same order in this synchronicity, WGDP is intentionally changed to *1st* differences (WGDP1) as other joint variables with higher *R* square value and more significant than at level (*P: 0.0000, R2=63.97*%). Besides it is assumed that residuals are correlated and do not lead to spurious issue is appeared if those are stationary too. The $H_0$ of test is no causal nexuses among the joint variables, and $H_1$ is the alternative to $H_0$. The obtainable Granger causality tests are seen on the table (3) taking us to the conclusion of long run relationship between WST1 to LIBOR1 for all the times series of the studied period, however it is short run with WMF1 at lag 3, whilst WGDP1 seems to be short run for all the times when joints with WST1, LIBOR1 and WMF1 variables in the synchronic model. On the contrary, every WGDP1 or WMF1 does not cause WST1, LIBOR1, WMF1, WST1, WGDP1 and LIBOR1 respectively but only the appearances of short run relationships are seen, for instant when WGDP1 is joined with WST1, LIBOR1 and WMF1 respectively, and in lag 3 it is seen as weakest.

*Table 3 :* Granger causality test

| Casual relationship | Lag | WST1 | | | WGDP1 | | | LIBOR1 | | | WMF1 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *WGDP1* | *LIBOR1* | *WMF1* | *WST1* | *LIBOR1* | *WMF1* | *WST1* | *WGDP1* | *WMF1* | *WST1* | *WGDP1* | *LIBOR1* |
| ***F* - Stat.** | 1 | 1.008 | 5.382 | 12.402 | 0.475 | 1.397 | 0.129 | 0.817 | 0.074 | 2.661 | 0.001 | 0.760 | 1.344 |
| | | [0.3231] | [0.0288] | [0.0014] | [0.4956] | [0.2483] | [0.7216] | [0.3744] | [0.7868] | [0.1149] | [0.9672] | [0.3897] | [0.2569] |
| | 2 | 0.647 | 7.624 | 3.564 | 0.403 | 0.283 | 0.168 | 3.775 | 3.879 | 1.026 | 0.075 | 0.605 | 3.364 |
| | | [0.5311] | [0.0030] | [0.0418] | [0.6720] | [0.7561] | [0.8459] | [0.0389] | [0.0360] | [0.373] | [0.9279] | [0.5528] | [0.0523] |
| | 3 | 1.130 | 6.699 | 1.788 | 0.355 | 0.248 | 0.126 | 2.128 | 1.767 | 0.764 | 2.388 | 0.764 | 1.641 |
| | | [0.3556] | [0.0028] | [0.175] | [0.7858] | [0.8617] | 0.9437] | [0.1304] | [0.1876] | [0.5249] | [0.0928] | [0.5249] | [0.2115] |

*Note: Numbers in [.] are P-values*

*d) Vector Error Correction Model (VECM)*

When use VECMs, we should consider two critical alternatives, firstly it is acknowledged if the first differences of the joint variables in the synchronicity exhibits deterministic trend and, secondly it is specified the optimum and criteria lag length of the VAR model. In the selected synchronic model with all joint variables of WST1, WGDP1, LIBOR1 and WMF1, the status of dependent and independent are intentionally changed firstly by WST1, then turn to WGDP1, LIBOR1 and finally by WMF1 respectively by employing VAR models, error correction mechanism and system equations in Table (4). The tests of the realities and responses of every variables in the synchronicity to any deviation of long run equilibrium or short run disequilibrium for the $t_{-1}$ period to other variables are depicted.

*Table 4 :* VECM and Error correction terms employed VAR, system eq.

| VECM/EC | WST1 | | | WGDP1 | | | LIBOR1 | | | WMF1 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *WGDP1* | *LIBOR1* | *WMF1* | *WST1* | *LIBOR1* | *WMF1* | *WST1* | *WGDP1* | *WMF1* | *WST1* | *WGDP1* | *LIBOR1* |
| Coef. | -0.000296 | -0.000291 | 13.392490 | -169.6712 | -0.463085 | 21315.68 | -268.2309 | -0.743843 | 33697.67 | 0.000130 | 3.62E-07 | 3.56E-07 |
| t-Stat | -2.852080 | -4.411540 | 0.434410 | -1.726730 | -4.411540 | 0.434410 | -1.726730 | -2.852080 | 0.434410 | 1.726730 | 2.852080 | 4.411540 |
| Prob. | 0.1035 | | | 0.0115 | | | 0.0004 | | | 0.6500 | | |
| $R^2$ | 50.35% | | | 61.83% | | | 68.97% | | | 37.93% | | |
| DW | 2.0035 | | | 2.1462 | | | 1.7284 | | | 2.0821 | | |
| Result* | Joint variables WGDP1, LIBOR1, WMF1 have weak relationships to WST1 | | | Joint variables WGDP1, LIBOR1, WMF1 have reasonable relationships to WST1 | | | Joint variables WGDP1, LIBOR1, WMF1 have strong relationships to WST1 | | | Joint variables WGDP1, LIBOR1 and WMF1 are negative to WST1 | | |

From the above obtained results, it is asserted there exists the long-run relationship between cointegrated variables such as LIBOR1 and WST1, WGDP1 and WMF1 is strong and better selected model. This frankly refuses debates or justifications of global seaborne trade strongly led growth hypothesis of world GDP, Libor interest rates and world merchant fleets as well. It is clearly shown there is no long run relationship from global seaborne trade, world GDP and Libor to world merchant fleets. Standing on the reality and also theory, we can acknowledge how the financial roles and sounds of Libor interest rate is strongly affected to global seaborne trade, to merchant fleets and creates the better development of world GDP for all the times. The important equations of having the accurate appraisals on the causal relationships of every variables in the synchronicity when they are in the long run exogenity or short run exogeneity to others by viewing the disturbances of residual error correlation. The statuses of these are tested by Wald, Breusch-Godfrey at lag (2), Breusch-Pagan-Godfrey, and histogram to determine as if any disturbing activities of residual error if short run and long run relationships are derived from the cointegration and VECM tests are in table (5).

*Table 5 :* Residual errors equations in long run and short run relationships tests

| Residual error tests | | WST1 | | | WGDP1 | | | LIBOR1 | | | WMF1 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *WGDP1* | *LIBOR1* | *WMF1* | *WST1* | *LIBOR1* | *WMF1* | *WST1* | *WGPD1* | *WMF1* | *WST1* | *WGDP1* | *LIBOR1* |
| Wald | $\chi$ 2 | 0.7995 | 5.9482 | 9.6127 | 0.7826 | 6.4503 | 0.1326 | 9.4254 | 3.7396 | 0.5916 | 0.0690 | 0.2918 | 3.1192 |
| | Pro. | 0.6705 | 0.0511 | 0.0082 | 0.6762 | 0.0397 | 0.9358 | 0.0090 | 0.1541 | 0.7439 | 0.9661 | 0.8642 | 0.2102 |
| Breusch-Godfrey (lag2) | Obs*R2 | 0.553365 | | | 0.80413 | | | 2.4053 | | | 1.4766 | | |
| | P($\chi$ 2) | 0.7583 | | | 0.6689 | | | 0.3004 | | | 0.4779 | | |
| Breusch-Pagan-Godfrey | Obs*R2 | 8.595803 | | | 16.07091 | | | 10.81975 | | | 10.74824 | | |
| | P($\chi$ 2) | 0.7370 | | | 0.1880 | | | 0.5444 | | | 0.5506 | | |
| Histogram | J.B | 2.729 | | | 1.664 | | | 0.689 | | | 30.066 | | |
| | Pro. | 0.2555 | | | 0.4351 | | | 0.7083 | | | 0.0000 | | |

As the residual unit root test is early asserted that it is stationary thus the spurious is not concerned in this synchronic model. Then in above table (5) only the activities of residuals in the cointegrated joint variables are concerned and proactively detected in Wald tests which are strongly determined the prominent functions of long run relationships of world merchant fleets to global seaborne trade as $\chi^2$ (9.6127) and *P-value* (0.0082), and the roles of world merchant fleets to global seaborne trade, the Libor interest rates to world GDP and global seaborne trade to Libor as $\chi^2$ and *P-values* (as 9.6127, 0.0082; 6.4503, 0.0397; 9.4254, 0.0090) respectively, and beyond these cases are depicted as the short-run relationships. The Breusch-Godfrey (BG) is run at lag 2 tells that there is no serial correlation in those selected synchronic models thus null hypothesis is rejected and models are acceptable. Incorporating with the BG, Breusch-Pagan- Godfrey (BPG) and histogram normality tests are employed to determine the disturbances of heteroskedascity and normal distributions of joint variables in the VAR models, if any. The obtainable results from the above tests are declined the disturbing roles of heteroskedasticity activities whereas denote only the synchronic model in which joint variables such as global seaborne trade, world GDP and Libor interest rate to world merchant fleets is not normal distribution (JB=30.066) which is really not desirable.

## V. Conclusion

According to Stopford (2009), the merchant shipping accounts for roughly a third of the total maritime activity and owner-ship is a major commercial issue in the shipping market and besides, the seaborne commodity trades have been fallen into short-term and long-term in which short-term volatility as seasonality which has a disproportionate effect on spot market whereas the long-term trends is identified by economic characteristics of the industries which produce and consume the traded commodities.

The creditors such as bankers, financial institutions, the banking risk managers, financial policymakers, chief finance officers (CFO) are ready to move and provide financial leverage to ship-owners with high risks and expect to get higher returns, however the debates of how to make the accurate appraisals and how to mitigate the risky projects in the current market volatility are still not determined yet and hung on, because the biggest concerns of which the interactional effectiveness and realities between the causal nexuses of global seaborne trade, world GDP, Libor (just standing as one of the representative symbol to other banks) and world merchant fleets in the international maritime transports are, prior to spreading out their sources of finances. This research investigates the causal long-run and short-run relationships of global seaborne trade, world GPD, Libor interest rates and, world merchant fleets when those are jointly cointegrated in linear regression of the selected synchronic models during the 1980-2015 period. The various cointegration testing approaches are applied and the empirical findings suggest the existences of the long run and short run causalities of every variables in the ship finances and maritime fields. The findings from the research could hopefully be utilized by the financial organizations, the financial policymakers, ship-owners, seaport authorities, and risk managers for their future making financing strategies.

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