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# The impact of macroeconomic variables on Stock Market returns. The case of Athens stock exchange

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**School of Economics, Business and Computer Science**

**The impact of macroeconomic variables on Stock Market returns  
The case of Athens stock exchange**

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**Department of Accounting and Finance**

**2019/2021**



**School of Economics, Business and Computer Science**

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The case of Athens stock exchange**

**By Bekiaridou Ioanna**

**Submitted at the School of Economics, Business and Computer Science in partial fulfillment of the requirements for obtaining the Degree of MSc in Banking, Investments and Finance.**

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# Master's thesis in Finance, Banking and Investments

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*Date: 18 January 2021*

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*Academic year: 2019/2021*

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## Declaration

This dissertation is all my own work and all other works discussed or referred to have been cited.

Signature: Bekiaridou Ioanna

Date: 18 January 2021

## Acknowledgements

This dissertation is a milestone in my academic as well as in my professional life since it has enhanced my theoretical and practical knowledge in conjunction with the one year of great effort of studying. It gave me the opportunity to comprehend deeply the concept of Stock Exchange from all its aspects. Saying that, I would like to thank my supervisor, Prof. Giannopoulos who supports me during this difficult period by its directions and advice in terms of completing this demanding dissertation.

Finally, I would like to thank my family for the psychological support and the power that gave to me to continue this long and complicated project.

## Abstract

This study investigates the relationship between the macroeconomic variables and the Greek Stock Market. From the opening of Greek stock market and specifically from 1876, it can be observed that the returns of Athens stock exchange presented many fluctuations. This can be explained by many factors. One of them is the law of demand and supply that determines the prices of stock returns. To clarify, when investors buy en masse a specific stock then its price increases and respectively when investors sell en masse a stock, its price declined. However, this factor is significant, it cannot support the historical sharp changes in the stock prices. By studying the findings of many researches about the correlation between macroeconomic variables and stock markets in other countries, it was clear that macroeconomic variables play a key role to the profits of the listed companies and thus to their dividends that determine the present value of their shares. For example, the increase of oil price in USA in 1974 had a negative impact on companies whose operations and production costs based on oil. This happened due to the fact that their production cost rose, affecting directly and adversely their profits and dividends. Therefore, their low dividends did not attract many investors and resulted in a low present value of their stock price according to the dividend discount model. In addition, we found that the big changes in the exchanges rates of strong currencies can be linked to the substantial changes of stock returns of exporting and importing firms. To exemplify, when Brexit had been announced in 2016, Euro against GBP appreciated, led to the strengthening of European exported firms. Finally, the global financial crisis that started in USA in 2007 evoked the fall of the global markets. Root of financial crisis in 2007 was the increasing home values and low interest rates on mortgage loans. Taking into consideration all the above examples, we can consider that macroeconomic variables such as interest rates, gross domestic product, inflation, foreign markets can determine the stock prices as it has been indicated from the history. Finally, one more representative example is that the stock market of Greece had the best performance in 2019 when the capital controls were cancelled and the lenders could repackage bad loans. These implications resulted in the increase of the market value of the big four banks of Greece, fact that indicates that also banking sector can have a significant impact on stock prices. Inspiring of these examples and motivating from the difficult economic conditions on the Greece and its economic uncertainty, we trigger to find through this study if the macroeconomic

variables such as the industrial production, the exchange rate of usd/ euro, the oil prices, the banking activity and the money supply have a strong relationship with the prices of ASE index. Therefore, the aim of this study is to find the correlation between these factors and ASE index, presenting results that will be useful for the investing community. More specifically, investors and corporate businesses are interested to be aware about the factors that affect the value of listed companies since they affect directly their profitability.

The data that have been used for this study are the prices of ASE (Athens Stock Exchange General Index) index that have been extracted from Capital.gr from the period of 01/01/2010 to 01/08/2020 and the prices of the aforementioned macroeconomic variables for the same period. The relationship between ASE index and macroeconomic predictors has been tested through the regression analysis and specific through the Ordinary Least Squares. This statistic model has been chosen since it is considered that produces accurate and valuable results while many popular theorists and professional analysts have used it. It is a simply model that can be fit to many variables. In addition, for purposes of extended this study, Granger Causality tests are performed to explore if the past prices of the examined independents variables can predict the prices of ASE index or the reverse. To boot this research, banking activity index of Greece that is a very significant sector has been used to run Granger Causality test with ASE index. Finally, the index of Gross Domestic Product has been tested in respect of its causality relationship with ASE index.

The main hypothesis that used to this model is that there is significant relationship between these variables and stock prices. More analytically, the expected outcome was that the macroeconomic factors have a dominant role in the stock prices since they can transform company's assets (right of use assets, value of properties, value of investments, financial instruments) and liabilities (loans, bonds). This outcome was derived from the changes in rates of these factors (interest, property, inflation, foreign markets, unexpected events) and resulting in the increase or decrease of the company's stock price in Greek Stock Market.

The findings from the empirical analysis suggest a positive link between ASE index and crude oil prices but a negative correlation among the ASE index and money supply for Euro area. The fluctuations in exchange rate usd/euro with prices of ASE index concluded also in a negative relationship. It is interesting to note that a causality connection was found between crude oil



prices and ASE index in terms of that the past values of ASE index can forecast the oil prices and also a unidirectional relationship identified between banking activity and ASE index. In short details, we found that ASE index can influence the banking activities. Finally, a causality relationship was found between Gross Domestic Product and ASE index. To explain, results from Granger Causality test indicated that past values of ASE index can predict the GDP.

Based on the above results, we concluded to the fact that the most significant macroeconomic variables of Greek economy have a direct relationship with the Greek stock market as expected. However, we identified that it depends on the composition of index that is examined as well as to the economic conditions of the country that is examined.

Key words: ASE index, Macroeconomic variables, OLS analysis, Granger Causality test

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# Chapter 1

## Introduction

The financial sector in Greece, especially the stock exchange has dramatically expanded in current years since more and more people boost their funds investing in stocks of Greek Stock Exchange that is the stock exchange that we analyze on this research. As this sector is growing rapidly, every change in the economy can have a significant impact on the stock prices and the reverse. It is a fact that the most common factors than can evoke an increase or decrease in stock prices are the macroeconomic factors such as money supply, industrial production, crude oil prices and the foreign markets as it analyzed widespread in the below paragraphs. Saying that, many investors request a perceptive analysis of how these factors can affect their investing decisions. In terms of this concern, this study seeks the relationship of these macroeconomic factors with stock prices of Greek stock market.

At this point, a short description of the history of Greek Stock Exchange is stated to help readers to understand the key role of Greek stock exchange to the development of the economy. Greek stock exchange was established by Prime Minister Koumoundouros on 30 September 1876 in Athens. In the beginning, only merchants, masters, collimators and brokers were allowed to take place for limited transactions such as negotiations and transactions were held on the bonds of the national loans. When the spread of equity securities all over the world was one of the most important issues, the Greek stock exchange started to enter more significant transactions, creating the unofficial Stock Exchange. After some years the official Greek Stock Exchange established in Piraeus and it was a mixed market of goods and securities. It is important to mention that in the beginning only few transactions took place which were not enough to create a stock market atmosphere. But after the founding of the Lavrio Company, the gatherings in the cafe and in the area in front of it became more and more frequent. The atmosphere, as mentioned, began to warm up in May 1873, when 100,000 shares of the Lavrio Company were issued and were the exclusively the subject of sales. The main object of trading in the "unofficial" stock market of Athens was the bonds of the National Loans. However, shares of the National Bank and the National Steamship Company of Greece were also traded. After 1873, the shares of the "Lavrio Metallurgy Company", the insurance companies "Phoenix" and "Ankara"

and the "Athens Gas Lighting Societe Anonyme" began to be traded. Then, with the rise of "metallurgy and the establishment of many mining companies, negotiations took place between the mining companies "Hellenic Mining Company", "Lavreotikos Olympus", "Nikias", "Pericles" and "Karystos". In 1999 was one of the best times of ASE stock exchange when a great amount of international funds invested on listed firms, soaring the returns of them. After that, the value of these firms was amounting to 184,000 million Euros. However, after few years and particularly during 2002 and 2003 the value of stocks listed in ASE index dropped significantly at around 70% and the majority of investors failed to keep their portfolio and went bankrupt. In the beginning of 2004 and until 2007, ASE stock exchange performed a peak period with high returns due to the fact that USA and UK capital markets have been developed dramatically. In 2004, the ASE Stock Exchange was composed of 350 companies. Despite this growth, the outbreak of mortgage loan crisis in 2007 affected negatively all the global stock markets. As a step to this harsh crisis, capital market commission imply protective measures for keeping the investors interests stable. In addition, ASE applied an alternative capital market which includes mutual funds, pension and institutional investors and addressed to smaller capitalized companies. Moreover, ETF funds added to the ASE stock market that helped many investors with low risks to be developed and to be profitable. However, these implications the number of companies declined during the big recession in Greece and particularly in 2009 when the recorded total amount of companies was 285 in sharp contrast with 2019 when only 219 firms were listed to the Greek Stock Exchange. This happened due to the difficult economic conditions in that period when many companies went bankrupt or they could not satisfy the appropriate requirements for entering the stock market. Therefore, it can be clearly seen that the economic challenge that Greek economy faced from 2009 until 2015 had strongly effects in the stock exchange.

Analyzing the reasons of recession, it is apparent that the big public debt of Greece affected the results of most companies since banks has no funds to lend, unemployment rate was too high, taxes and vat were at higher levels and therefore companies could not deal with all these and as a result investors had no motivation to trade in Greek stock market that presented the lowest return.

Following the highest and lowest returns of ASE index from 1987 until 2020. In 1987, the return of ASE was 272,47 and it was gradually increased reaching the 932 in 1990. From 1990 to 1996

it was remained between 670 to 933 with some fluctuations. However, in 1999 it reached its peak to 5,535 and for eight years it moved in a range between 1,748 and 5,178. After 2007, when the financial crisis started and the global market fall, the ASE index also dropped to 1,786 with a slight increase in 2009 of about 23% and again declined to 680.42 in 2011. During 2012 and 2013, the level of return increase to 907,90 and 1,162.28 respectively. In 2014 and 2015, the return of ASE went down to 826,18 and 631,35 respectively due to the fact that the debt crisis in Greece was in its peak. After that, the returns remained stable to levels between 610 and 800. Finally, in 2019 the return of ASE index increased from 613,30 to 916,67, however with the outbreak of Covid 19 the returns fell at 808,99 in 2020. However, now Athens Stock Exchange has 28 indices from which the most integral are: The Athens General Composite and FTSE/ Athex 20. Specifically, as at 1 January 2021 on the Athens Exchange 170 companies are represented with 176 stocks. The Securities Market has 166 stocks. (from 160 companies) and the Alternative Market has 10 stocks (10 companies).

At this point of the study, we will present below the most significant seasons of Greek stock exchange that consist the main motivation and the significance of this research. This analysis took place in order to comprehend deeper the importance of economic development to stock exchange and also the connection of stock exchange with the economy such as the macroeconomic factors that were mentioned before. Also, we pointed out significant events in history of Greek stock exchange that proved that there is a strong relationship between them.

As one of our macroeconomic variables that we will examine is the foreign markets such the exchange rate usd/euro, we will state one example of how foreign markets have affected the returns of Greek Stock market. To clarify, we will explain how the referendum on 23 June 2016 for the Brexit has positively affected the prices of Greek market. Particularly, when the voting for withdrawal of United Kingdom in 2016 passed by 51.9%, the pound sterling declined due to the global and domestic uncertainty. However, the depreciation of British currency against to Euro, improved the ASE stock market since the composition of Greek stock market is sixty percent (60%) exported companies and forty percent finance companies. To exemplify, Greek exports increased during this period and thus profits for exporting companies also soared to a



high level since they sold products to UK, receiving pounds and after converting them to Euro that was in appreciation. More specifically, the Pound dropped substantially in value against the Euro at around 16% four months after the outcome of referendum, including 6% on the day of decision. On the other hand, the returns of exporting firms in Greece experienced high profits and general the exports growth rate in Greece has developed in 2016 that stood at 2.3 compared to low level of -9.3 in 2015. This event and its contribution to Greek stock market returns was one of the motivations to investigate the relationship between foreign markets and ASE returns.

In addition, on other significant event that turned our interesting to search and find the relationship between economic factors and Athens Stock exchange is that in year 2019, the Greek main index was considered one of the indices with the highest performance in Europe and all over the world with a return of 43%. This was derived from the fact that government spending declined, investments strengthen and exports increased significantly. Therefore, it is obvious that stock market directly affected by macroeconomic factors. Moreover, in year 2019, shares of four big banks has also soared such as Piraeus's bank share increased more than 250%, National's Bank share of Greece climbed to 171%, meanwhile Alpha's and Euro bank's shares rose to 71% and 67% respectively. It can be said that it came from the cancellation of capital controls and the implementation of Hercules based on which lenders can repackage bad loans. Based on the above and mainly to the last information, we consider significant to analyze the effect of banking sector in stock market during the last decade in order to identify if there was a positive correlation between them or 2019 case is an isolated case.

Furthermore, GDP is one of the most significant indicators that shown the change in economic growth of a country from one year to the next. This variable takes into consideration the personal consumption, the private investments, the government spending's and the export less the imports. In other words, it includes the value of all finished goods and services that have been produced for one year in a specific country. If this variable has positive value and it is high, then it means that the health of economy is in a good level and that the prices of stocks are high also, there are investors that are active giving rise in the economy, improving the employment rates, the value of the business and generally the economy is growth, creating opportunities for all and increasing the wealth. Regarding the investing community, GDP is a significant factor that can alter the prices of stocks as they depend on the growth of economy since the company's value

affected by the GDP that is a combination of all the basic components of a country's economy. The Greek GDP presented an increase up to 1.6% year-on-year in the fourth quarter of 2018 that is a satisfied level above the average 0.90% from 1996 until 2018, well above the record low of -10.20% in the first quarter of 2011. This increase derives from the rise of exports which recorded 3144,50 euro million in October of 2018 and the tourism revenues which reached 3601,30euro million in August 2018. Also, the decline of unemployment rate down to 18% in December 2018 from 18.3% in the previous month, was a hopeful sign compared to the low level of 27,90 in 2013. All these parameters caused the increase of Greece's surplus to 0,80 of GDP in sharp contrast with -15,10 deficit of GDP in 2017. Undoubtedly is that this stable growth of Greece attracts more investors due to the empowerment of Greek firms and subsequently the stock market.

In addition, as oil prices have presented much volatility during the years is a reason to test its correlation with stock prices since the determination of the stock price depends on their expected cash flows discounted with a discount rate. To clarify, this discount rate affected by multiple economic variables such as the inflation, interest rates, oil prices, unemployment rate and others. Therefore, oil prices will be the object of examination due to its high volatility. It important to mention that oil prices can have different impact on companies that revenue based on oil and companies that use oil as input for its operations. Noteworthy is the fluctuation of oil prices during the years was very high. For example, Brent oil prices increased to \$145 from a low level around at \$60 and after dropped dramatically to \$30 between 2007 and 2009. In 2014 and 2014, oil prices devalued at approximately 75% of their value. These movements have concerned the investing community for a deeper research between these variables. It is remarkable that the sharp increases of oil prices in 1974 put an end on the growth of Greek economy since the inflation rocketed to a high of 25% from the low level of 5% and after stood above 10% for the next 20 years. High inflation rates make the discount rate higher and therefore the present value of stock prices declined as happened to the stock market until 1996 that presented low returns. For this reason, we would like to investigate the last decade performance of ASE index with the relevant performance of oil prices.

In addition, one of the best year for the Greek stock market as for the most markets in world was the period of 1997 and 1999, where the interest rates declined, the inflation dropped and the

exchange rate stabilization could improve the growth of economy. More specifically, banking sectors was the most profitable sector due to the reduction of interest rates fact that led to the integration of Greece into EMU. However, this upward trend of stock exchange affected many small investors to invest their savings and finally after the bubble of 1999 they lose everything as well as a majority of companies ruined. This condition indicates the strong correlation between interest rates, growth of economy and stock returns and for that reason we will examine the relationship of abovementioned macroeconomic factors with ASE stock returns the last decade.

Taking into consideration the above description of the connection between significant macroeconomic variables and returns of stock exchange in Greece in the previous years we have been motivated and interested to make an empirical research in respect of the impact of economic variables in the returns of stock exchange for the last decade which is the main objective and question of this study. Particularly, we have chosen the exchange rate usd/euro, money supply, industrial production, oil price and bank activity as the main predictor indicators of Greek stock exchange. Through this empirical research, we would like to find their positive or negative relationship and also to examine if there is causality between the past prices of these variables and the current prices of ASE index.

At this point it is essential to indicate the significance of this research. Initially, this research will assist the beginner's investors to enrich their theoretical background through the outcomes that will performed in this master thesis. This is the contribution with the regards to the practitioner's peers. On the other hand, in respect of the professional audience, it will encourage them to reconsider their attitude on the valuation of stock returns, showing them a different way to follow. Furthermore, many implications can be extracted from this analytical research that can be used to other researches or educational interventions.

Regarding the chosen method of this research which is the Regression analysis and particularly the method of Ordinary Least Squares, it is vital to mention that we studied and other statistic models that can be used for examining such correlations such as the Pearson, Kendall and Spearman coefficients, the ANOVA model, the Bayesian Interactive Model and the Principal Component Analysis. However, we found that these models are not appropriate for our research

since we try to fit our data and we cannot extract significant results. Therefore, we conclude that the most appropriate method is Linear regression analysis, Ordinary Least Squares from which we extracted important outcomes for the majority of our variables. In addition, the OLS has been used in the most researches and considered more accurate for its results as it can be confirmed by many other tests such as heteroscedasticity, normality and autocorrelation test that have been conducted in empirical section.

In respect of the data that have been selected for this study, we have extracted data from 01 January 2010 to 01 August 2020 of ASE index (Athens Stock Exchange General Index) and data for the above mentioned factors for the same period in order to examine the effect of macroeconomics factors on this index that is a benchmark for Greek market. These data help us to prove that the statement ‘‘Macroeconomic factors have an impact on stock returns in Greek Stock Exchange’’ is valid through statistic models and extract very important results that will be used by investing community.

Finally, we have selected to examine the last decade since many researches have already done for the prior period and it is considered a very significant period for Greece since many substantial events like the debt crisis during 2010 – 2017 had happened. Hence, it will be interesting to find the empirical results of macroeconomic variables and stock returns for this period due to the big and sharp changes in these predictors. Moreover, many professionals, theorists and researchers have studied the impact of macroeconomic variables in other countries and this has motivated me to investigate it for Greece that is a country with a relevant small scale stock exchange but with an uncertainty economy during this period. Such investigations have been done for U.S.A and specifically for the S P 500 that is one of the benchmark indices that can affect the global stock market and therefore these studies were very important for investors. Also, similar researches have been completed for South Africa, London, India and the results were very different and exciting for each case. Encouraging from the above researchers, this dissertation will be conducted in order to answer the main research question that is if finally, the returns of stock market can be affected by the economic variables.

A brief overview of the following dissertation is followed in this paragraph to help the readers building an organized structure in their mind. Firstly, an introduction of the topic is presented in Chapter 1, giving emphasis on the significance of the topic in the financial world and the relevant literature is discussed in the Chapter 2. Chapter 3 is intended to mention the theoretical framework that has been used in the study and Chapter 4 the methodology that has been followed in order to provide all the required results. The empirical results are reported in Chapter 5 and discussed in Chapter 6 pointing out the main conclusions. Continuing the Chapter 7 mentions a further analysis that should be recommended for a better analysis of the topic. Finally, all the references and tables that have been used in the dissertation summarized in Chapter 8 and Chapter 9 respectively.

## Chapter 2

### Literature review

After many researches around the world, it is apparent that there is a strong relationship between the macroeconomics variables and the stock market returns and therefore the trading behavior of investors in Greek stock markets and in other market over the world. Some of these variables are the industrial production, money supply, foreign markets, crude oil and banking activity. The below findings shows that this relationship is the main cause of the variance that is observed to the shares of stock markets. Therefore, we mention some researches that have been completed on this area.

Beltratti, et, al (2002) conducted a survey on how the macroeconomic factors can affect the stock market volatility, applying the Garch and structural breaks in the data of S&P500 index for a 31 year time period (1970-2001). The features, that were inserted into these models, were the money supply, interest rate, inflation and industrial production. The results from the above research was that there was no significant impact in volatility for each structural change, however a double effect happened in stock market when there were uncertain conditions in economy.

Kuang-Liang Chang (2009) also executed a research on the relationship of stock returns variations with the fluctuations of various macroeconomics elements such as interest rate, dividend yield and default premium from the period of January 1965 to July 2007 using the GJR-GARCH model. From this testing, Kuang found that these variables can change returns and volatility but with not stable degree. He also noticed that the ramifications of these factors were dependent on the time as well as to the volatility of stocks. Finally, he explored that the projection of conditional variance connected with the interest yield and dividend yield but no with the projection of transition probabilities,

Sariannidis, et, al, (2010), analyze the variance of Dow Jones Wilshire 5000 indexes and Dow Jones Sustainability that derived from various components applying the Garch Model and taking data from eight years (2000 to 2008). Some of the results were the following. The relationship of

crude oil prices with the returns of stock market was negative in sharp contrast with the correlation of 10-year bond prices that was positive, however the two of them could change the price of Dow Jones Wilshire indexes. Another non beneficial factor of returns of U.S non-farm payroll is the unpredictability of exchange rates and therefore stock market can reinforce the returns of Dow Jones Wilshire indexes.

Hamrita and Trifi (2011) took governments bonds with 3 months' duration and S&P 500 index in order to make a wavelet analysis. The analysis was based on 18 years' data and specifically they were prices from 1990 to 2008 resulting in the following sentence:

Exchange rates can effect both negative and effective the stock returns but on the other hand interest rates have no correlation with stock returns.

Gertler and Grinols (1982) decided to examine the effects of changes in unemployment and inflation rates to common stock returns for a ten-year period (1970 to 1980). They used datasets of 712 companies that have initial public offer and the returns in market portfolio, the unemployed and inflation rates. The outcome of the above investigation was that the return on market in connection with the returns of two aforementioned significant macroeconomic factors had a material effect on the stock returns according to the regression analysis.

Masduzzaman, (2012) assessed the stock Market of London and particularly the FTSE100 in relation with industrial production, inflation using the consumer price index as a measurement and the interest rates in the long term and find that this linkage exists. However, his results in respect of correlation between the market and the percentage of unemployed rates showed that they are connected via the industrial section. Moving on the research of same case study of S&P500, he brought out that there is significant connection with this index and exchange rates, unemployment rate, industrial production, consumer price index and interest rates. An uncommon outcome was that price stock of FTSE 100 dropped when, the industrial production rises in long-term.

Alagidede and Panagiotidis (2010) explores that there was a positive association among inflation and index of South Africa in long run in sharp contrast with the negative relation in short term.

In addition, a positive link identified between the crude oil prices and money supply rates with the stock index in China with comparison with India this connection was positive in long term. Turning on the inflation, it was stated that it can positively affect the stock returns of two countries while the opposite found for industrial production in China's Market. This study was conducted by Hosseini, Ahmad and Lai (2011).

To conclude, the different types of empirical studies present different results. Some of them support the strong relationship of fundamental macroeconomic factors and the returns on stock market whereas others showed a weaker relationship between these variables. Important is to mention that a crucial factor to this results is the method (Quantitative Model) that has been used in order the study to conducted as well as the types of variables and the examined time period. However, it is appropriate to examine the effect size of this relationship. In other words, to investigate how much is the variation on stock returns in respect of the changes in macroeconomic factors.



## Chapter 3

### Theoretical framework

Many theories have been tried to explain the correlation between the macroeconomic factors and stock returns and to find if they are interconnected positively or negatively under specific terms and conditions. Each theory has used different assumptions and methodology in order to capture the real data in one statistic model, proving its results. Some of them presented some eliminations and difficulties in their application, however it is rational since the real economy and specifically the stock market and all the macroeconomics variables that exist in the finance life are not perfect. Saying that, in this master thesis we investigate in two significant theories in order to analyze our empirical research and findings, the Capital Asset Pricing Theory and the Dividend Discount Model.

### 3.1 Capital Asset Pricing Theory

CAPM has firstly introduced by Jack Treynor (1961, 1962), William F. Sharpe (1964), John Lintner (1965) and Jan Mossin (1966) independently, based on the theory of Harry Markowitz on diversification and modern portfolio theory. A shortly description of CAPM will be followed in order to be easily understandable for readers.

The main hypothesis in which the theory of CAPM was established is the existence of a portfolio without specific risk or in other words a portfolio that includes a variety of assets with different risks that managed to pass away the risk derived from the companies' environment of the multiple assets. Since this portfolio does not involve unsystematic risk, it includes only market risk.

Therefore, CAPM investigates mainly on the beta which links the systematic risk of the market with the systematic risk of the assets that are included in the portfolio. More specifically, beta operates as a benchmark between market return and return of assets. To clarify, if beta is equal to

1 then the return of the asset has the same direction and movement with the market return. In any other case, beta will be multiplied with the percentage of decrease or increase of market return in order to identify the percentage of change of assets' return.

Significant is to mention that this systematic risk that constituted in the above type of portfolio has a reward to the holder of the portfolio that called equity risk premium. To exemplify, equity risk premium derived from the summation of risk free rate and the subtraction of risk free rate from the market rate of return. That is to say that investors of such portfolio will have extra return for their choice to allocate their funds to the assets of the total market and not only to the assets that do not bear any risk. Risk free rate usually refers to government debt or the yield of treasury bills.

Based on the above description of CAPM, it is subsequent to state the equation (1.1) of CAPM:

$$R_f = \beta (E_{R_m} - R_f) \quad (1.1)$$

where:  $E_R$  = expected return of investment,  $R_f$  = risk-free rate  $\beta$  =beta of the investment and  $(E_{R_m} - R_f)$  = market risk premium

Method of CAPM is very known for pricing securities through the determination of the expected returns of the abovementioned types of portfolio. In this way, investors can use this formula for evaluating the fair value of assets and comparing it with their current price, finding if they are overvalued or undervalued. If the fair value extracting from CAPM is higher than the current price, then it means that asset price is undervalued and the reverse. As a result, investors can arbitrage through buying the undervalued assets and selling the overvalued.

At this point, it is consistent to mention that CAPM is directly associated with our research. To clarify, considering that our hypothesis that macroeconomic variables can affect the price of ASE index is valid, it is apparent that interest rates, oil prices, GDP, foreign markets can determine the return of market and the risk free rate. Thus, it indicates that pricing can be affected from the macroeconomic variables as they determine the discount factor and the market return.

On the other hand, although there is a connection between CAPM and our research, there are many opponents of this theory that support the below limitations of CAPM.

First and foremost, it is vital to mention that CAPM assumes that recent information of the business world is reflected in the stock prices make the market very efficient. This assumption is not satisfied by the market since sometimes market cannot adjust immediately every information such as political news, company announcements and other in the stock prices. Secondly, on other characteristic of the market that is opposite with the assumption of CAPM is that there are many investment decisions that are based on the emotions, and not to the logic that supports the CAPM. Finally, CAPM advocates that the total risk of a stock derived from its high volatility something that is not always absolute since it can be evoke opposite results.

Although there are these criticisms, CAPM continues to remain one of the most useful and easy model that a great majority of investors and analysts use for the valuation and comparison of various investments. To summarize, CAPM is a useful tool for finding if the assets have been fairly valued comparing to its risk, time value and their expected returns.

## 3.2 Dividend Discount Model

In order to introduce the Dividend Discount Model, it is essential to present its mathematical equation (1.2) that is stated below:

$$\text{Present value} = \text{Future Value} / (1 + r) \quad (1.2)$$

More analytically, dividend discount model considers that the present value of an asset is equal to the sum of future dividends that have been discounted to their present value using the required return of the asset. In other words, it finds the net present value of the future cash flows of the company applying the time value of money. The rate of return represents the compensation that is requested by the holder of asset in respect of the possibility that the value of the asset will be decreased through the future.

One type of this model is the Gordon Growth Model that introduced by Myron J. Gordon. This model is based on the DDM and its equation ( 1.3) presented below:

$$\text{Stock value} = \text{Dividend per share} / (\text{Required Rate of Return} - \text{Dividend Growth Rate}) \quad (1.3)$$

A short explanation of this model is that it uses the dividends and the rate of their growth in order to find the price of assets. The dividends assumed that have a stable rate of increasing during the years.

This model is considered effective for the pricing and valuation of stock assets since dividends can play a role to the determination of the stock price. To exemplify, when a company pays a satisfied dividend then more investors will be attractive by buying this stock in order to be benefited from its income dividend. In this way, the price of a stock will be increased. Moreover, this model is considered fair since it takes into consideration the actual results of the company in order to find the estimated cash flows, the growth rate and the cost of equity.

However, it is one of the most valuable models since it has a strong mathematical equation, it indicates some disadvantages that derived from the below reasons.

Firstly, the assumption that the rate of dividend growth is stable is very difficult to be hold since the economic condition is very unstable. This fact affects the sustainability of companies and their profits since they cannot guarantee a fixed dividend growth rate. Furthermore, in respect of the estimated dividends that used in the equation ( 1.3) , there is probability of the wrong estimations since many companies may use debt to distribute dividends that can interfere the present value of an asset. Finally, it can result in mistaken outcomes for new companies as well as for companies that present their higher performance. To clarify, it is not fair for new startup companies since they will be undervalued due to their small profits while the high developed companies will be overvalued due to the fact that they maybe appear a peak of success only at that moment.

To recapitulate, this model can be considered one of the fundamental theories of the basic research question of this study due to the fact that this theory supports that the value of a stock based on the company's dividends that depend on the profits of company. Therefore, it can be correlated with the hypothesis that macroeconomic variables can affect the dividends through the profits and therefore the final stock price. To explain, profitability of companies can be affected by the macroeconomic variables such as the interest rate if a company holds borrowings and has interest liability, crude oil prices that associated with the production cost of many companies that related with oil price, foreign markets that affect mainly the results of exporting and importing companies, and many others. The relationship of each variable may be different to the results (negative or positive), however this model can strongly support our hypothesis that there is strong connection between macroeconomic variables and stock prices.

## Chapter 4

### 4.1 Data and Methodology

The main objective of this study is to take one of the most popular indexes in Greece, the Athens Stock Exchange General Index as a dependent variable and also some of the key macroeconomics variables such as Money Supply for Euro Area, Industrial production of Greece, oil prices and exchange rates of USD/EURO as the independents variables and find the link between them. These are the main data of the first analysis of this study and we state below the necessary information for them in order to introduce to our data.

Athens stock exchange General index will be presented as ASE index and it has been extracted from Capital.gr, Money supply for Euro area (M1) that measures the total stock of money and Industrial production index in Greece (IP) which measures the total output in total industry are seasonally adjusted and they have been extracted from Federal Reserve Economic Data. Finally, crude oil prices per barrel and exchange rate usd/euro have been extracted from yahoo. Finance.com. It is important to mention that all the observations are in a monthly basis and the number of data for each variable is 128. The period that will be examined is 01 January 2010 to 01 August 2020.

## ANALYSIS OF VARIABLES

### **DEPENDENT VARIABLE**

#### 4.1.1 ASE Index (Athens Stock Exchange General Index)

The Athens Stock General Index is an integral stock market index which records the behavior of Greek stocks listed on the Athens Stock Exchange. It is an index that its components – securities are measured based on their total market capitalization. In other words, the shares of index that are held by other institutions and individuals multiplied with their current market price in order to find its market capitalization. As a result, it can be said that the shares are priced at their fair value since almost all the unexpected events as well as the changes in macroeconomics factors

have been taken into consideration. The ASE General Index has a base value of 100 as of December 31, 1980. Saying that we can state that this index will enrich our research in order to find the connection of macroeconomic factors and stock returns.

This index is the dependent variable that represents the returns of Greek Stock Exchange. We will extract data for a ten-year period and eight months with the purpose of including in our research different seasons and also periods over the history that significant events have taken place affecting the total outlook of the economy and mainly the market returns. The chart below represents our independent variable better.

### 1. Chart of ASE INDEX

**Source:** Capital.gr

**Observations:** Monthly

**Period:** 01/01/2010 to 01/08/2020



It is observed from the below graph that there is a downward trend of Index after 2010 and until the beginning of 2012 and it derived from the ramifications of financial crisis 2007-2008 in the worldwide economy. Also, the index presented an increase from the middle of 2012 until 2014

that there were some developments in economy, however after that the index dropped dramatically and presented very low levels since the debt crisis in Greece came. Since ASE Index is a benchmark of Greek stock exchange while includes the stocks of the 60 biggest companies in Greece, we can say clearly that the market in Greece had a downward trend that period.

At this point of the study, we turn our attention to the independents factors that play a significant role to the attitude of the total market. We chose some of the most important indicators in order to extract satisfied results and findings that can make sense in our research. Below we present analytically the four integral factors that we will investigate on this study. An introduction of each of them will take place in the next paragraphs so as to mention the significance of them in the economy.

#### 4.1.2 Money Supply for Euro Area (M1)

Money supply (M1) includes the currency of a country than can be easily converted into cash such as deposits, checks coins and physical currency. To elaborate, M1 is needed for exchange purposes that can be occurred through deposits and checks, but it does not consist of financial assets. Many economists support that M1 shows the flow of money in a country. For this reason, M1 is considered a very determined economic variable that can affect the stock markets. To clarify, monetary policy of central bank plays a key role to the business world and to the economy. Therefore, it is crucial to comprehend that outcomes of Monetary policy can affect the stock market and as a result money supply. According to the theorists, an increase in M1 has a positive impact on stock returns. This is why when the money stock increases, banks can lend more money to firms and individuals that leads to expand of production or wealth respectively and finally it can be result in higher profits, dividends and earnings. All the aforementioned can evoke increase in price stocks. On the other hand, other believe that money supply and stock market has a negative relationship. To explain, increase of money supply can directly associate with inflation which evokes rise to the risk free rates. This high risk free lead to a high discount rate and thus to lower returns. Taking consideration, the above arguments, the expectations of the below tests is that money supply affect stock market positively.



The chart states below give a clear picture for the movement of this variable in the selected period.

## 2. Chart of Money supply in Euro Area (M1)

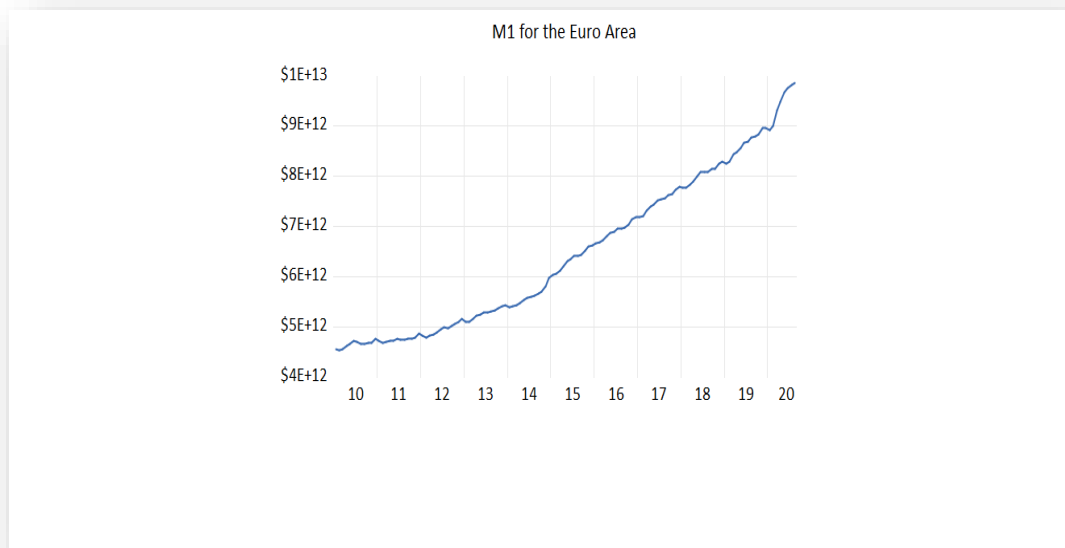
Source: Federal Reserve Economic Data- Federal Reserve Bank of St. Louis

Link: <https://fred.stlouisfed.org>

Units in National currency

Period: 01/01/2010 to 01/08/2020

Monthly observations



The graph above illustrates the money supply in Euro Area and shows that M1 had an upward trend for the selected period and it is derived from the fact that governments borrowed in a great extent from the central banks and thus these loans are considered as liquid assets for bank. In addition, bank loans to private sector have been dramatically increased during this period and the liquid ratio that allows the bank to lend money has been reduced, increasing the number of loans. All these factors led to rise of money supply during the years.

#### 4.1.3 Industrial Production for total industry in Greece

Industrial production counts the volume of production in the sector of manufacturing, mining and quarrying and energy supply industries at base years' prices. Even though, these sectors have not a significant allocation in GDP, they are linked with the interest rates and their changes.

Therefore, the level of industrial production can predict the GDP as well as the inflation. To clarify, high level of industrial production can lead to high inflation due to high volume of consumption and thus to higher profits for companies that affects the stock prices. In contrast, the low level of industrial production reduces the demand of spending and it is directly linked with losses for companies and low stock prices. Saying that, it is vital to include this macroeconomic variable in our analysis in order to identify its effect on Greek stock market.

Chart of this index during the last decent presented below.

#### 3.Chart of Index of Production of total industry in Greece

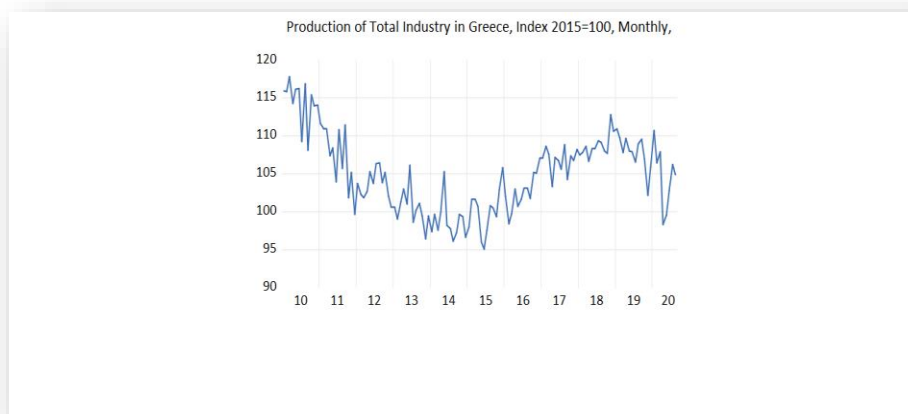
Source : Federal Reserve Economic Data

Link: <https://fred.stlouisfed.org>

Unit: Index 2015=100

Period: 01/01/2010 to 01/08/2020

Monthly observations



Graph above demonstrates the Industrial Production in Greece. Observing this graph, it is apparent that there was a drop during 2010 to 2017 due to the debt crisis in Greece. To clarify, the debt restructuring in Greece in 2009 affected the industrial sector since the business could not borrow funds to expand their activities and to pay their employees. More specifically, the building sector went down as well as the retail sector. In addition, the taxes and interest rates increased in order to cover the debt led a great number of businesses into bankruptcy. During 2017, the industrial production went on but it remained in low levels until 2020.

#### 4.1.4 Oil Prices

Oil prices is a significant indicator for the economy since the fluctuations in oil prices can directly affect the cost of the most businesses and consequently their earnings. To exemplify, higher crude oil prices means higher cost for gasoline, manufacturing sectors, electric power generation and thus for the cost of production. Therefore, the profits lowered, meaning a low performance of stock prices. On the hand, the correlation between low oil prices and stock prices is positive since it reduces the cost of importing oil as well as the cost of transport that is beneficial for the earnings. As a consequence, the businesses with lower costs can achieve higher profits and dividends, leading to higher stock prices. As oil is an appropriate product for the operations of all businesses, we can say clearly that affects all the global economy. Based on the above analysis, we expect to find a negative relationship between oil prices and stock prices. It is vital to mention that Greece based on imports in respect of the crude oil.

According to a past research of Filis, Degiannakis and Floros in 2011 for the connection of oil shock and the returns of stock in countries that import and export oil, they suggest that both type of countries affected with similar way due to the fact that the fluctuations in oil prices derived from the changes in global economic that affect the stock market in all the world. Also, they found that in some countries in which the oil sector is no significant and therefore there is no correlation between them. Finally, they conclude that only the changes in financial activities can lead to a louder positive link between finance economy and oil prices.

We state the graph of crude oil prices for a better comprehension.

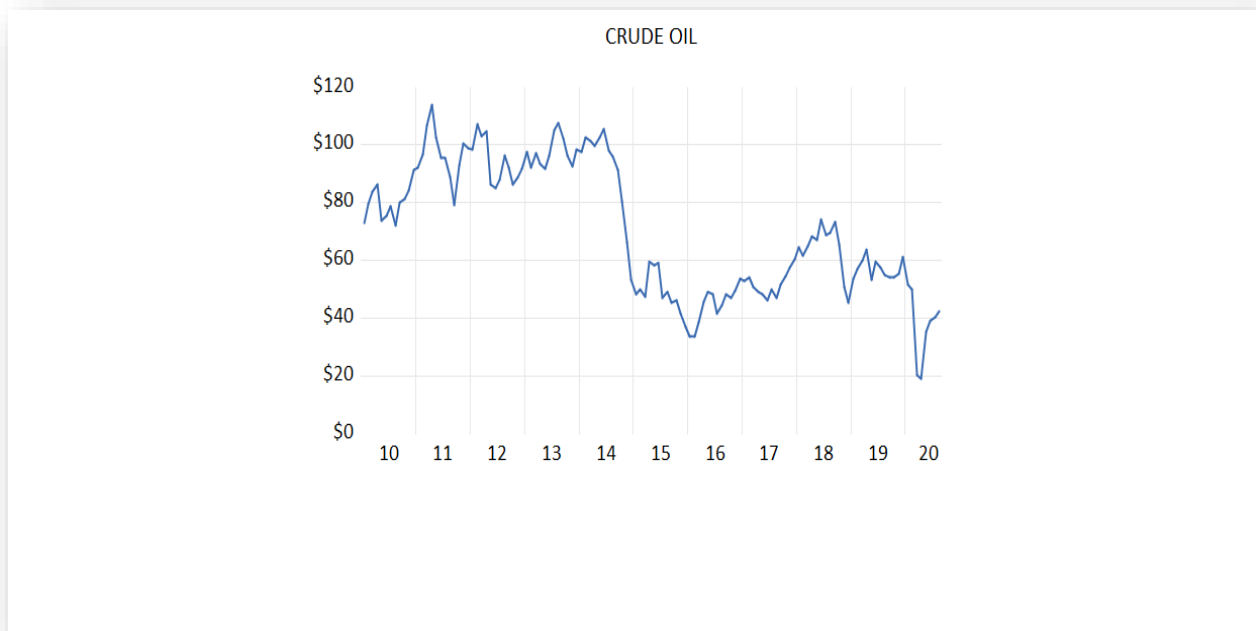
#### 4. Chart of Crude Oil prices

Source: Yahoo. Finance

Link: [www.yahoo.finance.com](http://www.yahoo.finance.com)

Units in USD per barrel

Period: 01/01/2010 to 01/08/2020



Graph below demonstrates the fluctuations in oil prices from 2010 to August 2020. From the graph two main trends can be observed. From the beginning of the period until mid of 2014, an upward trend in crude oil prices can be observed, however from mid - 2014 to 2016 there was a collapse in oil prices that derived from the continually growing supply in US oil production.

#### 4.1.5 Exchange rates

Exchange rate is a macroeconomic factor for which many researches have been occurred in order to find its relationship with stock returns. The result is that this factor is controversial since various results taken in different countries. In other words, many academics found that exchange rate correlated with the appreciation and depreciation of the currency of each country. When a currency depreciates the imports are more expensive and the domestics motivate the exports. Depreciation of exchange rate meanwhile means that interest rate level is low and therefore there are no many investing transactions in this country as no satisfactory returns are expected. This attitude leads to the fact that more stocks are sold than these that are bought. On the other hand, appreciation of currency has better results in respect of the stock returns since if someone invest in forex market with domestic currency they earn more money. Taking into consideration, the above example, it means that the relationship between exchange rates and stock returns is positive and an increase in exchange rates can bring increase in stock returns.

However other academics support that a decrease in exchange rates derived from a decrease in interest rates meaning that people can spend more money since borrowing in lower interest rates and consequently they can invest more money. When more and more people buy stocks and other financial assets, the stock returns increase. Based on this aspect, there is a negative link between stock returns and exchange rates. It is easily understandable that the results are contentious as we mentioned before. For this reason, a further investigation will be conducted in order to extract a clearer outcome.

The following chart show us the movement of Exchange rate usd/ euro in the last decade.

## 5. Chart of Exchange Rate USD/EURO

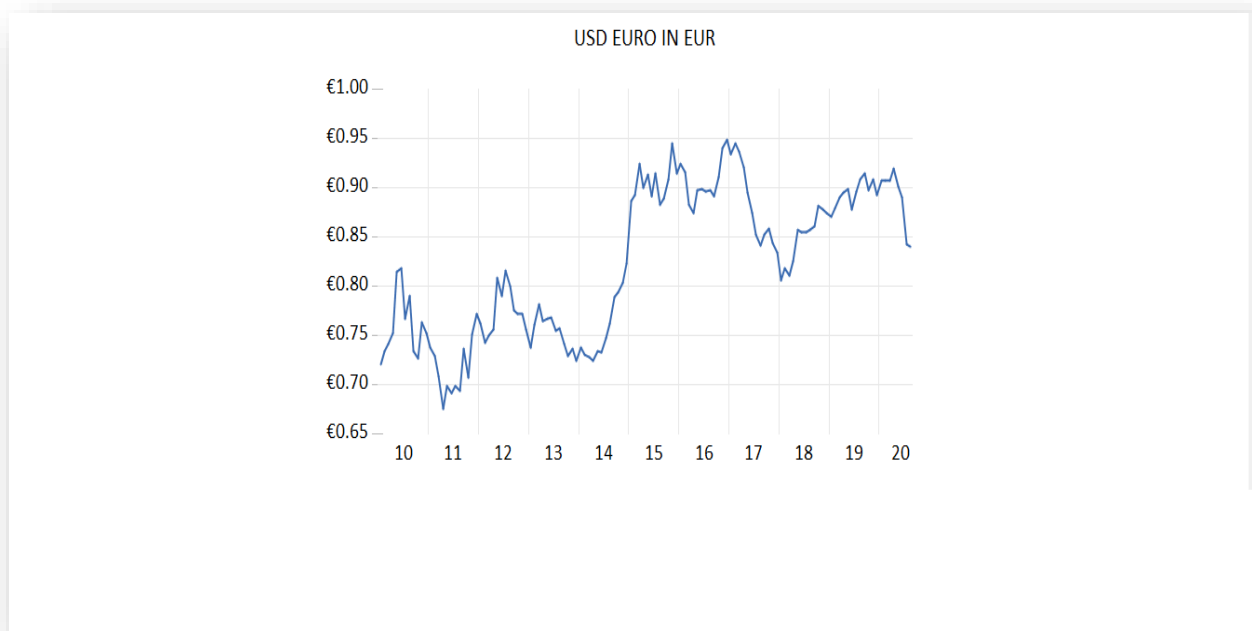
Source: Yahoo. Finance

Link: [yahoo.finance.com](https://yahoo.finance.com)

Units in Euro

Period from 01/01/2010 to 01/08/2020

Monthly observations



Graph below shows the movement of exchange rate of usd/euro during the examined period and we can observe clearly that there were sharp changes in this rate. Also, the rate usd/ euro increased the last five years compared to the first years that was very high. This extreme movement can be considered reasonable due to the fact that it affected from two economies, New York and Europe and there are many changes every year in the conditions of each one affected this rate.

## 4.2 Methodology

In this study, we use Eviews statistic software in order to apply our data and extract the relevant results. While our examined time series corresponds to 10 years and 8 months, we should test if our data are stationery. In other words, we need to test if our data have a constant mean, variance and autocorrelation over time, otherwise we should add in our equation residuals in order to extract more reliable results. This test will be conducting by unit root test for all of our data. After that, the macroeconomic factors have been checked through Eviews software in order to understand their relationship with ASE index for the selected years. The model that has been applied is Ordinary Least Squares that is a regression type of analysis which help us to define the relationship between macroeconomic factors and ASE Index. Furthermore, residual diagnosis has been executed for the results of OLS regression analysis with the purpose of identifying if the residuals are serial correlated or not. To clarify, the results of OLS regression can be trusted only if there is no heteroscedasticity in residuals. Secondly, the Granger causality test has been used in order to look if there is a relationship between the ASE index and the independent variables as well as if they can predict the each other. Finally, for purposes of extended our study analysis, we have taken the index of banking activity in Greece for the selected years with a view to achieve if it is reflected in the stock market returns in Greece since it is a significant sector that can be considered that has an impact on the stock market prices.

Moreover, it is important to mention that we have used monthly data for our tests due to the fact that monthly data are usually normally distributed in contrast with the daily data. In other words, we can say that the assumption of normality is much less crazy for monthly data than that for daily data. A furthermore advantage of using monthly data is that they are easily implied in the econometrics models and they can define better the diversity between the dataset indicating the trend and the variation over the examined period.

## Chapter 5

### 5.1 Empirical Findings

The empirical analysis has been conducted with the assistance of Eviews software and specifically the application of some statistics models in order to input our data and extract the results. Firstly, the unit root test has been applied to check the stationarity of our data. After that, the OLS regression analysis has been conducting to identify the relationship of the macroeconomics variables with the ASE index (Athens Stock Exchange General Index). Taking the output of OLS regression, we should test the results for their robustness through the normality, heteroscedasticity and correlation test. In addition, the Granger Causality test has been run to test if the economic variables can predict the prices of Index and vice versa. Furthermore, as an extension to this study, the index of the banking activity in Greece has been taken for the selected period and the Granger Causality test has been applied to check whether there is a causality connection between ASE and banking activity. Banking activity is considered as a very determined factor in total economy that can change policies of businesses and general the economy. Therefore, we believe that there is a causality relationship with the stock market and bank activity.

At this point, we will mention some of the most significant reasons for which we choose the Ordinary Least Squares and not another statistic model. First of all, OLS is one of the most frequent strategy used for linear models if the assumptions are fulfilled and it can scrutinize all the numerous variables, answering our basic research question that is if there is strong relationship between macroeconomic variables and ASE stock market. As we have checked these assumptions in our empirical research through the residual diagnosis, we can consider that the model gave us the best coefficients and the best results for our equation. More analytically, the assumptions that are covered are:

The coefficients should be realistic and close to the actual values. In other words, the differences between the estimates and the actual values should be small in order to accept the model.



According to the Gauss-Markov theorem, OLS produces estimates that are better than estimates from all other linear model estimation methods when the assumptions hold true.

Hypothesis in respect of coefficients and linear hypothesis satisfied if all the terms in the model are either the constant or a parameter multiplied by an independent variable.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon \quad (1.4)$$

In the equation ( 1.4 ), the betas ( $\beta$ s) are the parameters that OLS estimates. Epsilon ( $\varepsilon$ ) is the random error. To satisfy this assumption, the correctly specified model must fit the linear pattern.

The assumptions of this equation are described below:

The first OLS assumption is that the error term should have a population mean of zero and we can see that this assumption is covered by the normality test that has been conducted in section 5.4.3, table 9. Specifically, the mean of residuals is approximately zero and therefore we can use this model.

The second OLS assumption is that the observations of the error term should be uncorrelated with each other, meaning that the one observation should not forecast the other. In order to check this assumption, we have conducted the serial autocorrelation test in section 5.4.2 and we found that there is no correlation between residuals since the probability was higher of 0,05 that is the critical value in the significance level 95%.

The third assumption of no heteroscedasticity of error term has also been satisfied through the heteroscedasticity test in section 5.4.1 and from which we have extracted that there is homoscedasticity in residuals from the fact that the probabilities of F test is greater than 5% and thus null hypothesis of homoscedasticity cannot be rejected.

As the second and third assumption are satisfied, the residuals considered that are independent and identically distributed (IID).

The fourth assumption of OLS is that the error term should be normally distributed. It has been satisfied by the normality test in section 5.4.3. where it can be seen that the probability of Jarque Bera test is greater than 0,05 and thus the null hypothesis that there is normality can be supported.

Taking into consideration all the above arguments, it can be said that the OLS regression model fit well our variables since they satisfy these assumptions and therefore it is an appropriate model to give us the best estimates. To exemplify, our residuals have a mean of zero, have a constant variance, and are not correlated with themselves or other variables, creating an efficient environment for our variables.

It is sure that there are various statistic models that can be used for our empirical research such as the Quantreg procedure that uses quantile regression to model the effects of covariates on the conditional quantiles of a response variable. Quantile regression was introduced by Koenker and Bassett (1978) as an extension of ordinary least squares (OLS) regression, which models the relationship between one or more covariates  $X$  and the conditional mean of the response variable  $Y$  given  $X = x$ . Quantile regression extends the OLS regression to model the conditional quantiles of the response variable, such as the median or the 90th percentile. Quantile regression is particularly useful when the rate of change in the conditional quantile, expressed by the regression coefficients, depends on the quantile.

Quantile regression generalizes the concept of a univariate quantile to a conditional quantile given one or more covariates.

For a random variable  $Y$  with probability distribution function

$$F(y) = \text{Prob}(Y \leq y) \quad (1.5)$$

the  $\tau$  quantile of  $Y$  is defined as the inverse function

$$Q(\tau) = \inf \{y: F(y) \geq \tau\} \quad (1.6)$$

where the quantile level  $\tau$  ranges between 0 and 1.

It is important to say that quantile regression is an extension of linear regression used when the conditions of linear regression are not met and in our research the assumption of linear regression are satisfied and therefore the OLS model which is simplest is preferred for our empirical analysis.

In respect of the selection of our variables, it is vital to say that we have examined more than four variables before we conclude to the most important and significant for our dependent variable, ASE index. Below, we will state the results of the OLS regression test of the dependent variable ASE index with the independent variables Gross domestic product, consumer index price and unemployment rate. Although, these variables are considered some of the most significant in the economy, according to the OLS regression they cannot fit the model and they are not significant and therefore we cannot continue our research with these variables. Below, the table of results shows that probabilities of t-statistics for all the variables are not significant since they are greater than 5% which is the critical value of 95% significance level.

Before we proceed with the presentation of results of OLS regression, we will define below all the variables that have been used to the below analysis.

1. DLNASE: First difference of logarithm ASE index (Athens Stock Exchange index)
2. DLNCIP: First difference of logarithm of Consumer Index Price (CIP)
3. DDLNGDP: Second difference of logarithm of Gross Domestic Product (GDP)
4. DDLNUNRATE: Second difference of logarithm of Unemployment Rate (UNRATE)
5. DLNCO: First difference of logarithm of Crude oil prices (CO)
6. DLNUSDEURO: First difference of logarithm of exchange rate usd / euro (USD/EURO)
7. DDLNM1: Second difference of logarithm of Money supply for Euro (M1)
8. DLNINDUS: First difference of logarithm of Industrial Production in Greece (IP)
9. DDLNBANL: Second difference of logarithm of Banking activity index

The Estimation Equation is

$$\underline{\underline{DLNASE = C(1) + C(2)*DLNCIP + C(3)*DDLNGDP + C(4)*DDLNUNRATE}} \quad (1.7)$$

And if we applied the coefficients the equation will be modified as below:

$$\underline{\underline{DLNASE = -0.0120043158001 - 0.016642175177*DLNCIP + 25.1591961847*DDLNGDP - 0.893987896221*DDLNUNRATE}} \quad (1.8)$$

**Table 1 Outcome for Ordinary Least Squares of ASE with CIP, GDP and Unemployment rate**

<b>Dependent Variable: DLNASE</b>				
<b>Method: Least Squares</b>				
<b>Date: 01/31/21 Time: 17:30</b>				
<b>Sample (adjusted): 2010M03 2020M02</b>				
<b>Included observations: 63 after adjustments</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
C	-0.012004	0.012552	-0.956386	<b>0.3428</b>
DLNCIP	-0.016642	0.016269	-1.022967	<b>0.3105</b>
DDLNGDP	25.1592	70.85398	0.355085	<b>0.7238</b>
DDLNUNRATE	-0.893988	1.058878	-0.844279	<b>0.4019</b>
R-squared	0.02466			
Adjusted R-squared	-0.024933			
S.E. of regression	0.097931			
Sum squared resid	0.565835			
Log likelihood	59.05336			
F-statistic	0.497249			
Prob(F-statistic)	0.685604			

## 5.2 Unit Root Test (Augmented Dickey –Fuller test)

At this point, we test the time series of the above variables for their stationarity. In other words, we have examined if the variables have a unit root or not. If they are not stationary, it means that they presented as related variables but actually they are not and they do not have a constant mean and variance. To clarify, a majority of financial time series indicate a trend or non-stationarity in the mean. Therefore, the models that include such data give wrong results, demonstrating that the variables have a considerable relationship whereas they show a simultaneous correlation rather than significant causal relationship. It is appropriate to examine this factor before we proceed to the linear regression test in order to find the relationship between the macroeconomics variables and the dependent index.

At this point, we will describe the procedures that have been followed through Eviews software in order to conduct the appropriate tests for identifying the stationary of our data. This procedure has been conducted by the Unit Root Test and specifically the Augmented Dickey –Fuller test which helps us to identify if the time series have a constant mean and variance and meanwhile whether they are time invariant or if they are time varying, presenting many fluctuations during the examined period. The desirable result would be to have stationary data in order to extract more accurate results without many residuals.

The equation of unit root test is stated below:

Consider a discrete-time stochastic process  $y_t, t=1,2,3,\dots$  and suppose that it can be written as an autoregressive process of order  $p$ :

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_p y_{t-p} + e_t \quad (1.9)$$

Here,  $e_t, t=0,1,2,\dots$  is a serially uncorrelated, zero-mean stochastic process with constant variance  $\sigma^2$ . For convenience, assume  $y_0=0$ . If  $m=1$  is a root of the characteristic equation, of multiplicity 1:

$$m^p - m^{p-1} a_1 - m^{p-2} a_2 - \dots - a_p = 0 \quad (1.10)$$

then the stochastic process has a unit root or, alternatively, is integrated of order one, denoted  $I(1)$ . If  $m = 1$  is a root of multiplicity  $r$ , then the stochastic process is integrated of order  $r$ , denoted  $I(r)$ .

After stating the mathematical equation of unit root test it is important to mention that the data have been transformed into logarithm form in order to make the distribution of our data less skewed and as a consequence to present better and more representative results.

In this test, the procedure that has been followed described below:

We entered our time series in Eviews and through the Quick function, we transformed the data in their logarithm form. After that the Unit Root test has been conducted at first level of observations to identify if our data are stationary or not. We choose the specifications for our test which are the choice of constant mean and the adjustment of max 12 lags that is a very representative number for our monthly data.

The Augmented Dickey-Fuller (ADF) test includes the null and alternative hypothesis as follows:

$H_0$ : Null hypothesis: Unit root- Variable is not stationary

$H_1$ : Alternative hypothesis: No unit root – Variable is stationary

If the p value that will be occurred from the above test will be less or equal to 0,05 that is the critical value in 95% level of significance, then our data are stationary and there is a constant variance and mean between the observations and therefore we can reject the null hypothesis. Otherwise, we cannot reject the null hypothesis and hence our data include a unit root, characterizing them as not stationary. In the previous section, we have plotted each of our variables and we observed that there is no a specific trend in the variables. Therefore, we run the test with no trend since these variables are not presenting a trend during the examined period.

Moving on the table 2 that shows the results, we can say clearly that for all variables that the p-value of ADF test is greater than 0,05 which is the critical value (5%) and thus we cannot reject the null hypothesis and therefore we accept that there is a unit root in the time series and as a result the data are not stationary. While our data is not stationary at first levels, we will investigate the first differences through the Unit root test in order to find if our data are stationary at first differences.

See in Appendix 9.1 the results from the Unit Root test at first levels as they have been extracted from Eviews.

In the following Table 2, the results of Unit root test at first levels presented:

**Table 2. ADF TEST AT FIRST LEVEL, NO TREND, INTERCEPT**

ADF Test Result at level, no trend , intercept			
<u>Variable</u>	<u>p-value</u>	<u>Null hypothesis</u>	<u>Outcome</u>
ASE INDEX	0,09	NOT REJECTED	ASE INDEX is not stationary
M1 for Euro	0,99	NOT REJECTED	M1 is not stationary
Industrial Production - IP	0,064	NOT REJECTED	IP is not stationary
Crude oil prices-CO	0,35	NOT REJECTED	CO is not stationary
Exchange rate usd/euro - USD/EURO	0,35	NOT REJECTED	Exchange rate is not stationary

While running Unit root test at first level has not brought out satisfactory results, we have transformed the time series data through Eviews to first differences before conducting the OLS regression in order to check again the Unit root test in the transformed data. The ADF test is applied below for the new time series data. If the null hypothesis is not again rejected, then we should transform our data in second difference and run the unit root test again.

Following the results, the p-values of all the examined variables except of Money Supply are less than 0,05 that is the critical value in 5% confidence level. Therefore, we can reject the null hypothesis and we can consider that there is no a unit root and that the variables are stationary. As a result, we can use these variables in our regression model. However, we have changed the time series data of Money supply in second differences to check if the stationarity is valid.

See the results of unit root test as they have been extracted from Eviews in Appendix 9.2.

Table 3 demonstrates the results

**Table 3 ADF TEST RESULTS AT FIRST DIFFERENCE, NO TREND, INTERCEPT**

<b>ADF Test Result at first differences, no trend , intercept</b>			
<b><u>Variable</u></b>	<b><u>p-value</u></b>	<b><u>Null hypothesis</u></b>	<b><u>Outcome</u></b>
ASE INDEX	0,0	REJECTED	ASE INDEX is stationary
M1 for Euro	0,32	NOT REJECTED	M1 is not stationary
Industrial Production - IP	0,0	REJECTED	IP is stationary
Crude oil prices-CO	0,0	REJECTED	CO is stationary
Exchange rate usd/euro - USD/EURO	0,0	REJECTED	Exchange rate is stationary

Finally, we run the Unit root test for the M1 for Euro Area at second difference to test if it covers the criteria of stationarity.

Based on the table of results below, we can observe that the p – value is zero and therefore the null hypothesis can be rejected, considering that the time series of M1 in second differences is stationary. Consequently, the time series of M1 at second differences will be used in the regression model.

In Appendix 9.3 the results as extracted from Eviews can be found.

Table 4 illustrates the results of Unit root test for M1 at second differences



**Table 4 Unit Root Results for M1 at second differences**

<b>ADF Test Result at second differences, no trend , intercept</b>			
<b><u>Variable</u></b>	<b><u>p-value</u></b>	<b><u>Null hypothesis</u></b>	<b><u>Outcome</u></b>
M1 for Euro	0,0	REJECTED	M1 is stationary

### 5.3 Ordinary Least Squares method (OLS)

For conducting the regression analysis –OLS, we have used the first differences for ASE INDEX, IP (Industrial Production), CO (Crude oil prices) and USD/EURO (Exchange rate usd/euro in Euro) and the second differences for M1 for Euro Area since they are stationary at these levels.

The equation of OLS regression comes as follows:

$$\underline{Y = \beta_0 + \sum_{j=1 \dots p} \beta_j X_j + \varepsilon} \quad ( 1.11 )$$

where Y is the dependent variable,  $\beta_0$ , is the intercept of the model,  $X_j$  corresponds to the jth explanatory variable of the model ( $j= 1$  to  $p$ ), and  $\varepsilon$  is the random error with expectation 0 and variance  $\sigma^2$ .

Estimation Equation for our variables;

$$\underline{DLNASE = C_{(1)} + C_{(2)}*DLNCO + C_{(3)}*DLNUSDEURO + C_{(4)}*DDLNM1 + C_{(5)}*DLNINDUS + e_{it}} \quad ( 1.12 )$$

Where:

- ✚  $C_2, C_3, C_4, C_4$ , are the coefficients of each independent variable
- ✚  $C_1$  is the intercept term
- ✚  $\varepsilon_i$  is the error term

Where:

- ✚ DLNASE: logarithm first difference of ASE INDEX
- ✚ DLNCO: logarithm first difference of CRUDE OIL
- ✚ DLNUSDEURO: logarithm first difference of USD/EURO
- ✚ DDLNM1: logarithm second difference of Money supply for Euro Area
- ✚ DLNINDUS: logarithm first difference of Industrial Production in Greece

After running the OLS model, we see the results that are displayed in the table 5

In the Appendix 9.4.1 the results for OLS regression as extracted from the Eviews software can be found.

**Table 5 Outcome from Ordinary Least Squares**

<b>Dependent Variable: DLNASE</b>				
<b>Method: Least Squares</b>				
<b>Date: 01/09/21 Time: 10:23</b>				
<b>Sample (adjusted): 2010M03 2020M08</b>				
<b>Included observations: 126 after adjustments</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
C	-0.006745	0.007353	-0.917378	<b>0.3608</b>
DLNCO	0.140336	0.060685	2.312553	<b>0.0224</b>
DLNUSDEURO	-1.231716	0.309241	-3.983025	<b>0.0001</b>
DDLNM1	-1.726291	0.875218	-1.972412	<b>0.0508</b>
DLNINDUS	-0.125997	0.247335	-0.509418	<b>0.6114</b>
R-squared	0.246844			
Adjusted R-squared	0.221947			
Sum squared resid	0.821003			
Log likelihood	138.3249			
F-statistic	9.914343			
Prob(F-statistic)	0.000001			

**In addition, the equations transformed as below after the application of coefficients:**

**Substituted Coefficients:**

$$\begin{aligned} \text{DLNASE} = & -0.00674510394385 + 0.140336474573 * \text{DLNCO} - \\ & 1.23171570907 * \text{DLNUSDEURO} - 1.72629051791 * \text{DDLNM1} - \\ & 0.125996910033 * \text{DLNINDUS} + e_i \quad (1.13) \end{aligned}$$

We can see clearly from the above table that the majority of independent variables have a significant relationship with dependent variable ASE INDEX. More specifically p-value is significant for CO (crude oil price) since p value is lower than 5% (p value = 0,02) meaning that the variable is statistical significant in 95% confidence level. Also p-value for usd/euro (Exchange rate usd/euro in Euro) is almost zero 0,0001 and therefore it is much lower than 0,05. Furthermore, p- value of M1 for Euro Area (Money supply) is equal to 0,05 and therefore it is considered significant in 95% confidence level.

The only variable that has not significant p – value is Index of Industrial Production that according to outcome of OLS regression has p- value 0,61 that is much greater than the 0,05 and therefore it cannot be considered that has a significant relationship with ASE INDEX.

Since the index of industrial production is not significant, we run the OLS regression again without this variable because it affects the coefficients of the significant variables. After running the model again, the results are presented below in the table 6 as well as the relevant equation and coefficients. The table as extracted from E-views presented in the Appendix 9.4.2.

**Table 6 Outcome from Ordinary Least Squares without Industrial Production**

<b>Dependent Variable: DLNASE</b>				
<b>Method: Least Squares</b>				
<b>Date: 01/31/21 Time: 12:22</b>				
<b>Sample (adjusted): 2010M03 2020M08</b>				
<b>Included observations: 126 after adjustments</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
C	-0.006605	0.007325	-0.901691	<b>0.369</b>
DLNCRUDE	0.142174	0.060393	2.354139	<b>0.0202</b>
DLNUSD	-1.264693	0.301471	-4.195078	<b>0.0001</b>
DDLNM1	-1.662492	0.863579	-1.92512	<b>0.0565</b>
R-squared	0.245229			
Adjusted R-squared	0.226669			
S.E. of regression	0.082122			
Sum squared Log likelihood	0.822764			
F-statistic	138.1899			
Prob(F-statistic)	13.21282			
	0			

**In addition, the equations transformed as below after the application of coefficients:**

Estimation Equation:

$$\text{DLNASE} = \text{C}(1) + \text{C}(2)*\text{DLNCRUDE} + \text{C}(3)*\text{DLNUSD} + \text{C}(4)*\text{DDLNM1} \quad (1.14)$$

**Substituted Coefficients:**

$$\text{DLNASE} = -0.006604989679 + 0.142174015983*\text{DLNCRUDE} - 1.26469281845*\text{DLNUSD} - 1.66249189494*\text{DDLNM1} \quad (1.15)$$

From the new regression outcome, we can see that the R-squared of the regression is 0.24 that is a quite high number and show that there is linear relationship in the data of our model, so we can consider that model fits to our data. In addition, log likelihood is 138 that is also a good indication that the model match to our data and we can trust them.

Further to the above analysis, it is essential to mention that when the coefficients are positive, it means that there is positive relationship whereas when the coefficients are negative, the relationship is negative. Therefore, the regression analysis indicates that there is a positive relationship between ASE Index and CO (Crude oil prices) whilst a negative relationship between M1(Money supply for Euro Area) and ASE INDEX. The relationship of exchange rate usd/euro with ASE index follows similar patterns with M1 and therefore has a negative relationship.

In order to explain better the above relationships, we will state the below statements for each variable.

1. 1% increase in prices of crude oil evoke 0,14% increase in stock price of ASE index.
2. 1% increase in exchange rate of usd/euro evoke 1,26% decrease in stock price of ASE index.

3. 1% increase in Money supply in Euro Area evoke 1,66% decrease in the stock price of ASE index.

Taking into consideration, all the above results, the OLS model demonstrates that three of the four studied independent variables are significant and have an integral impact to the stock returns of Greek Stock Exchange.

At this point an extended analysis will be stated for the significant variables as well as a comparison of the expected results with the final results in order to identify if the literature researches rejected.

### **1. Positive relationship between CO (crude oil) and ASE INDEX**

Based on the literature research about the relationship of crude oil prices and stock market returns, we found that a negative relationship is expected due to the fact that higher oil prices led to higher production costs and therefore to reduced profits that directly affect the paid dividends and as a result the stock price. However, the results of OLS regression analysis shows that there is a positive correlation between the two variables and therefore it is interesting to bring out the factors that have resulted in this outcome. At this point it is essential to mention that ASE INDEX constitutes mainly by banks, holding companies, leasing and insurance companies, companies of household goods, furnishing, clothing, technology and telecommunications companies rather than retail companies. Saying that we can clearly say that the high oil prices cannot affect the cost production of these type of companies since they have no related costs. On the other hand, the ASE index includes two of the biggest oil companies in Greece which are the Hellenic Petroleum and Motor Oil Hellas and also some energy companies such as Terna Energy and Public Power corporation that are affected positively from the increase in oil prices while their revenues based on oil and therefore they benefit from this high shocks of oil prices because they can sale their products in higher prices, gaining more profits and thereafter paying higher dividends that lead to a higher stock price. Taking all the aforementioned arguments into consideration, we can conclude that the components of each index plays a key role in the relationship of the oil prices and the return of index as we analyzed above.

## **2. Negative relationship between ASE INDEX and exchange rate usd/euro**

As we have mentioned in chapter 3, the expected relationship between exchange rate usd/euro and ASE index was negative in some cases and OLS regression analysis bring out the same outcome. To clarify, the currency of Euro against dollar is negatively correlated with stock price of ASE index. This means that an appreciation of Euro against USD may derives from high interest rates in Greece. Thus, companies that based on debt have a negative impact on their performance in respect of their debt ratio and their cover debt ratio. These high ratios affect the decisions of potential investors and finally they do not prefer to invest on them. As a result of this attitude the stock prices drop. One other example for proving this negative relationship is the ramifications of changes in exchange rate to retails exporting companies. To elaborate, if the examined index constitutes of most retail companies then appreciation of Euro against USD can have a negative impact to these companies since the exports reduced and the imports increased, meaning that the income of exports will be less than the cost of imports. Therefore, the profits for the exporting retail companies will decline, lead to lower stock price.

Moreover, an increase in exchange rate of usd/euro will lead the investors to invest their money in New York stock exchange since the cost will be lower and thereafter to convert their profits / returns to Euro that worth more. In this way, the stock prices in Greek Stock Market will drop since there will be no demand from investors.

## **3. Negative relationship between money supply and ASE INDEX**

Money supply as we mentioned above can directly associated with high inflation and therefore with high interest rates. As a result, when there is inflation, there is an uncertainty in economy in respect of investments and in the production level. To exemplify, the risk free rate increases lead to the increase of discount factor and therefore to lower the future earnings. In addition, high interest rates mean high costs in respect of taxes and interest expenses of companies that lead to lower profits. Saying that and from the extracted results of OLS regression, we can conclude that increase of M1 in Euro had negative results in the stock prices of ASE index.



#### **4. No significant relationship between Industrial Production in Greece and ASE INDEX for the selected years.**

This result may have occurred from the fact that the examined period includes period of recessions in Greece when the industrial sector declined significant. Therefore, this factor cannot affect the Athens stock market. Period from 2009 to 2015, Greece has experienced the worst financial crisis and all the industrial sectors failed. Since Greece has small industrial sector and the examined index does not include many manufacturing companies, no significant relationship can be found.

To recapitulate, it is significant for all investors individuals, mutual funds companies or corporations to analyze the relationship of significant macroeconomic variables with the stock prices or indexes that they tend to invest on them. As the final aim of investor is to gain more profits and maximized their returns, they should take into consideration any change in the money supply, in the prices of crude oil and in the exchange rates of usd/ euro that are some of the most integral variables that can change the policies, the interest rates and the economy at any level. From the results above, these three factors can influence the prices of stock Market in Athens and specifically the returns of General ASE Index. Therefore, the carefully studying of oil prices can change may decisions that related to companies that have operational cost or revenues based on oil.

In addition, the changes in currency usd / euro consists one of the most serious factors since euro as well as usd are strong currencies that can change monetary policies and interest rates and as a result they can affect dramatically the returns of stock markets and especially of Athens that includes many exporting and importing companies. Needless to say that, money supply is associated with inflation and interest rates that affect the returns of companies listed in Athens stock market and thus it can evoke fluctuations to the returns of stock markets. This study proved that these factors can have an impact on stock returns either negatively or positively.

In that point is significant to mention that the regression analysis has also been run with lagged values of the independent variables in order to identify if the extracted results are better with

more accuracy, however no significant results occurred from this procedure. Therefore, we consider that it is not important to state this analysis in our study due to the poor results that have been extracted. Regression of lagged values means to find the connection of the current value of dependent variable with the past values of macroeconomic variables. For example, to examine the t-value of Index with the t-1 value, t-2 and t-3 values of macroeconomic factors. T is the examined period and in our case is the month.

## 5.4 Residual Diagnosis for accuracy of OLS method

In order to ensure the results of the OLS regression analysis, we will run the residuals analysis with the view to identify if the residuals follow a normal distribution, presenting homoscedasticity or if the residuals are serial correlated with heteroscedasticity. If the residuals are normally distributed, the results are considered more accurate since less residuals appeared in our regression analysis.

Below the tests for residual diagnosis presented:

### 5.4.1 Heteroscedasticity test

Heteroscedasticity test can help us to find if heteroscedasticity is presence in our linear regression. If there is indication that the variance of residuals is not constant, then the above results cannot be trusted since many errors occurred. On the other, the desirable result is if homoscedasticity exists in regression. This means that there is no serial correlation between the variance of residuals and the variance of variables.

The two hypothesis of this test are:

- ❖ The null hypothesis = Homoscedasticity (constant variance)
- ❖ The alternative hypothesis: Heteroscedasticity (not constant variance)

The table 7 below represents the results of heteroscedasticity test. As we can see the p value of F-statistics is much greater than 0,05 that is the critical value in 95% significance and therefore the null hypothesis cannot be rejected. Therefore, homoscedasticity exists in the distribution of residuals and thus the results of OLS regression are considered reliable and the outcome can be accepted.

In Appendix 9.5 the results as they have been extracted from Eviews software can be found.

**Table 7 Results of Heteroscedasticity test for Residuals**

<b>Heteroskedasticity Test: Breusch-Pagan-Godfrey</b>			
<b>Null hypothesis: Homoskedasticity</b>			
<b>F-statistic</b>	1.06752	Prob. F(4,121)	0.3757
<b>Obs*R-squared</b>	4.29497	Prob. Chi-Square(4)	0.3676
<b>Scaled explained SS</b>	4.66456	Prob. Chi-Square(4)	0.3235
Test Equation: Dependent Variable: RESID^2 Method: Least Squares Date: 01/09/21 Time: 10:25 Sample: 2010M03 2020M08 Included observations: 126			

### 5.4.2 White noise and Autocorrelation test

At this point, we will state the table 8 of the residuals tests for autocorrelation and partial autocorrelation for the residuals.

This test also will be examined if the residuals are white noise meaning that they have no correlations with zero mean. The execution of this test is also for the purpose of proving the accuracy of our results.

The two hypothesis are:

Ho: No serial autocorrelation

H1: Serial autocorrelation

It is observed from the below table that the p values of Q –statistics are higher than 0,05 and therefore the null hypothesis that there is no serial correlation cannot be rejected. Consequently, there is no Autocorrelation and partial autocorrelation for residuals and outcome of OLS can be trusted.

**Table 8 Autocorrelation and partial autocorrelation for residuals**

Date: 01/09/21 Time: 10:27

Sample (adjusted): 2010M03 2020M08

Included observations: 126 after adjustments

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
. .	. .	1 -0.057	-0.057	0.4254	0.514
* .	* .	2 -0.101	-0.105	1.7594	0.415
. .	. .	3 -0.018	-0.031	1.8041	0.614
. *	. *	4 0.106	0.094	3.3018	0.509
. .	. .	5 -0.040	-0.033	3.5201	0.620
. .	. .	6 0.021	0.037	3.5802	0.733
* .	* .	7 -0.067	-0.068	4.1861	0.758
. .	* .	8 -0.061	-0.077	4.6909	0.790
. *	. *	9 0.092	0.082	5.8532	0.755

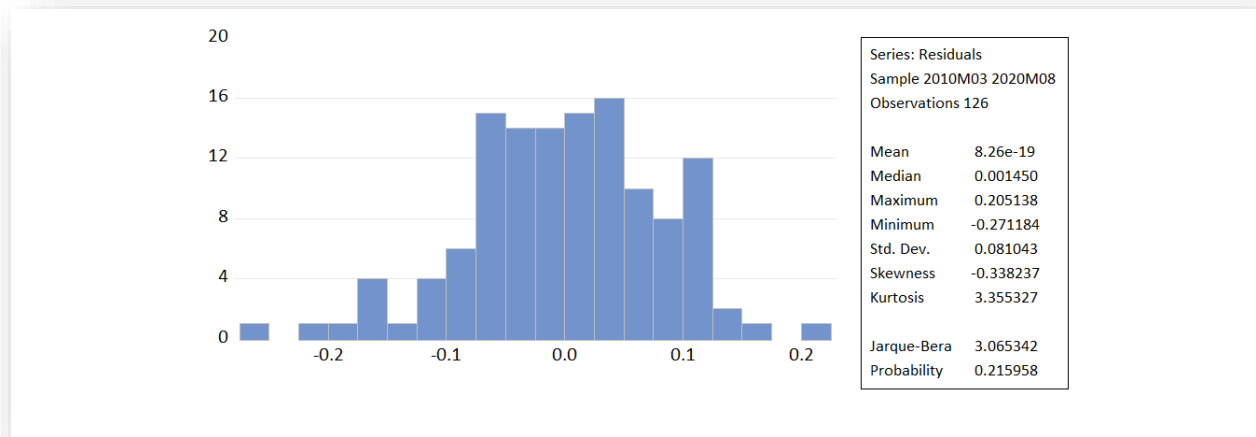
. *		. *		10	0.126	0.118	8.0640	0.623
. .		. .		11	0.008	0.056	8.0732	0.707
. .		. .		12	-0.013	0.026	8.0968	0.778
. .		. .		13	0.034	0.025	8.2624	0.826
. .		. .		14	-0.044	-0.062	8.5389	0.859
* .		* .		15	-0.098	-0.115	9.9281	0.824
. *		. *		16	0.136	0.127	12.651	0.698
. .		. .		17	0.040	0.066	12.888	0.744
* .		. .		18	-0.071	-0.021	13.641	0.752
* .		* .		19	-0.072	-0.075	14.425	0.758
. *		. .		20	0.135	0.071	17.210	0.639
* .		* .		21	-0.071	-0.091	17.974	0.651
. *		. *		22	0.129	0.132	20.568	0.548
. .		. .		23	-0.024	0.008	20.660	0.602
. .		. .		24	-0.043	0.002	20.956	0.641
* .		. .		25	-0.070	-0.059	21.742	0.651
. *		. .		26	0.103	0.007	23.439	0.608
* .		* .		27	-0.082	-0.090	24.522	0.601
. .		. .		28	-0.036	-0.006	24.735	0.642
. .		. .		29	-0.026	-0.032	24.851	0.686
. .		. .		30	-0.015	-0.030	24.890	0.730
* .		. .		31	-0.070	-0.064	25.734	0.734
. .		. .		32	0.065	0.012	26.459	0.743
. .		. .		33	0.036	-0.001	26.682	0.773
* .		* .		34	-0.114	-0.089	28.959	0.713
* .		* .		35	-0.091	-0.071	30.431	0.688
. .		. .		36	-0.001	-0.064	30.431	0.730

---

### 5.4.3 Normality test

Normality test can show the histogram of residuals and also can identify if they follow normal distribution or not. Therefore, the histogram can visually help us to recognize our residual distribution. Moreover, the statistics that have been extracted for the test such as the descriptive statistics and the results of Jarque Bera test will give us deeper analysis for the distribution.

Table 9 presents the graph illustration of Histogram and the main descriptive statistics



Analyzing the results of the above table, we can say that the kurtosis is very close to 3. It is important to mention that when kurtosis is equal to 3, the distribution is normal. However, in this case there is a small deviation from 3. Even though this small difference, the histogram can be considered as normal distributed. In addition, the probability of Jarque Bera test is greater than 0,05 and thus the null hypothesis that there is normality can be supported. Furthermore, we can see that mean is approximately equal to median that is a strong indication that there is normality. Based on the above arguments, we can conclude that there are many indications that the distribution of residuals is normal and hence the results are considered reliable.

## 5.5 Granger Causality test for dependent and independent variables

In this section one further test will be tested for the dependent and independent variables with the purpose of checking if each of the examined independent variables can predict the dependent variable, ASE index and vice versa. In other words, how the past values of macroeconomic factors can forecast the values of ASE index and vice versa. In addition, GDP variable has been added to this test since it is considered one of the most significant variables in the economy that can affect other economic variables. Also, we would like the possibility to result in a causality relationship although in the regression analysis the GDP variables were not significant, indicating that there was no relationship between it and ASE index in similar time. In this way, we check if the past values of GDP can forecast the prices of ASE index or vice versa.

This procedure will be conducted through the Granger Causality test.

The formula of G- Causality test is performed below:

G-causality is normally tested in the context of linear regression models.

Let  $y$  and  $x$  be stationary time series. To test the null hypothesis that  $x$  does not Granger-cause  $y$ , one first finds the proper lagged values of  $y$  to include in a univariate autoregression of  $y$ :

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_m y_{t-m} + \text{error}_t \quad (1.16)$$

Next, the autoregression is augmented by including lagged values of  $x$ :

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_m y_{t-m} + b_1 x_{t-1} + b_q x_{t-q} + \text{error}_t \quad (1.17)$$

One retains in this regression all lagged values of  $x$  that are individually significant according to their  $t$ -statistics, provided that collectively they add explanatory power to the regression according to an  $F$ -test (whose null hypothesis is no explanatory power jointly added by the  $x$ 's).

In the notation of the above augmented regression,  $p$  is the shortest, and  $q$  is the longest, lag length for which the lagged value of  $x$  is significant.

The null hypothesis that  $x$  does not Granger-cause  $y$  is accepted if and only if no lagged values of  $x$  are retained in the regression.

The results state below in the following tables for each variable with ASE index.

To summarize the following results, the only causality relationship that was identifying running the Granger Causality tests for data in their first difference for ASE Index, usd/euro, Crude oil price and index of industrial production whereas in second differences for Money supply for Euro Area, was between ASE index and crude oil prices. To clarify, there was a unidirectional relationship between crude oil and ASE index, meaning that ASE INDEX Granger cause the crude oil prices.

This result is in accordance with the empirical researches of Jones and Kaul (1996), Sadorsky (1999) who found that there is significant relationship between crude oil prices and Athens stock index. More specifically, we can explain the fact that Athens Stock Market can predict the oil prices from the concern that two of biggest oil companies joined in ASE and therefore the high yields of these companies and the strong balance sheets act on the companies or banks that have acquired shares on these oil companies. As a result, the high profits of these companies as well as the effective ratios can have a positive impact on oil prices movements. Finally, it is significant to mention that Greek stock market depends on oil related companies and therefore this is strong relationship can be justified. In sharp contrast, the findings of the rest of variables for the causal effects between them and ASE index shows that there was any causal effect that make sense leading to the conclusion that may the composition of Athens stock is not sensitive and vulnerable to the other economic variables such as industrial production, Money supply and exchange rate of usd/ euro due to the lower percentage of these types of companies that exists in Athens Stock Market.

In addition, the results of Granger causality test for Gross Domestic Product and ASE index was that there is a causality relationship between them. In other words, past values of ASE index can forecast the Gross Domestic Product, meaning that the stock prices movements of ASE index can have an impact to the formulation of GDP in Greece. It can be explained from the fact that ASE index includes many major firms such as banks, trading ,energy, food, metal , oil , airline , electric power real estate's companies like Viohalco, Coca-Cola HBC AG, EYDAP, Terna Energy, Hellenic Petroleum, GEK Terna, Titan Cement, Mytilineos



Holdings, OTE, OPAP, Motor Oil Hellas, Alpha Bank, National Bank of Greece, Piraeus Bank, ., Aegean Airlines. The huge revenues and activities of these companies and as consequence their big market capitalization affect the Gross Domestic Product to be shaped since it includes the investments, the private and public consumption and the foreign balance of trade. Therefore, it is apparent that these companies contributed to the increase of all of the components of GDP, affecting it positively or negatively based on the profits or loss of the companies included in the ASE index.

On the other hand, the Granger causality test indicates that the past values of GDP cannot predict the performance of ASE index. It can be considered reasonable since the future prices of ASE cannot be affected from the past prices of GDP as the changes in GDP have already adjusted in its value.

#### 1. Granger causality test for ASE index and Crude oil price (CO)

Pairwise Granger Causality Tests			
Date: 01/09/21 Time: 10:57			
Sample: 2010M01 2020M08			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DLNASE does not Granger Cause DLNCO	125	3.42308	0.0358
DLNCO does not Granger Cause DLNASE		0.04313	0.9578

The null hypothesis for the first statement can be rejected since the p-value is less than 0,05 which is the critical value at 95% significance.

Therefore, we can conclude that past prices of ASE INDEX can predict the values of crude oils and thus there is causality.

On the other hand, the price of crude oil cannot estimate the price of ASE INDEX since the p value of F-statistic is much greater than 0,05 and null hypothesis cannot be rejected.

## 2. Granger causality test for ASE index and USDEURO

Pairwise Granger Causality Tests			
Date: 01/09/21 Time: 11:00			
Sample: 2010M01 2020M08			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DLNUSDEURO does not Granger Cause DLNASE	125	0.46051	0.6321
DLNASE does not Granger Cause DLNUSDEURO		0.32455	0.7235

Null hypothesis for causality test between ASE index and usd/euro cannot be rejected and therefore no causality relationship exists between them. Therefore, the past prices of usd/euro cannot forecast the values of ASE index and vice versa.

## 3. Granger causality test for ASE INDEX and M1 for Euro (Money supply)

Pairwise Granger Causality Tests			
Date: 01/09/21 Time: 11:01			
Sample: 2010M01 2020M08			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DLNASE does not Granger Cause DDLNM1	124	1.33341	0.2675
DDLNM1 does not Granger Cause DLNASE		0.58275	0.5599

Null hypothesis for causality test between the examined variables cannot be rejected and therefore no causality relationship exists between M1 for Euro Area and ASE index. In details, past values of Money supply cannot predict the prices of ASE index and vice versa.

#### 4. Granger causality test for ASE index and IP (Industrial Production)

<b>Pairwise Granger Causality Tests</b>			
<b>Date: 01/09/21 Time: 11:03</b>			
<b>Sample: 2010M01 2020M08</b>			
<b>Lags: 2</b>			
Null Hypothesis:	Obs	F-Statistic	Prob.
DLNINDUS does not Granger Cause DLNASE	125	0.37068	0.6911
DLNASE does not Granger Cause DLNINDUS		1.53303	0.2201

Null hypothesis for causality test between Industrial production and ASE index cannot be rejected and therefore no causality relationship exists between them. In other words, past values of industrial production cannot affect the ASE index and vice versa.

5. Granger causality test for ASE index and GDP

Pairwise Granger Causality Tests			
Date: 01/31/21 Time: 18:18			
Sample: 2010M01 2020M08			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DLNASE does not Granger Cause DDLNGDP	124	4.69764	0.0109
DDLNGDP does not Granger Cause DLNASE		0.08344	0.92

Null hypothesis for causality test between Gross Domestic Product and ASE index can be rejected since probability of F- test is lower than 0,05 that is the critical value of 95% level of significance and therefore causality relationship exists between them. In other words, past values of ASE index can affect the Gross Domestic product. However, Gross Domestic Product cannot predict the performance of ASE index based on the results of Granger Causality test (probability of F-statistic is much greater than 5% and therefore the null hypothesis cannot be rejected).

## 5.6 Granger Causality test for ASE index and banking activity index

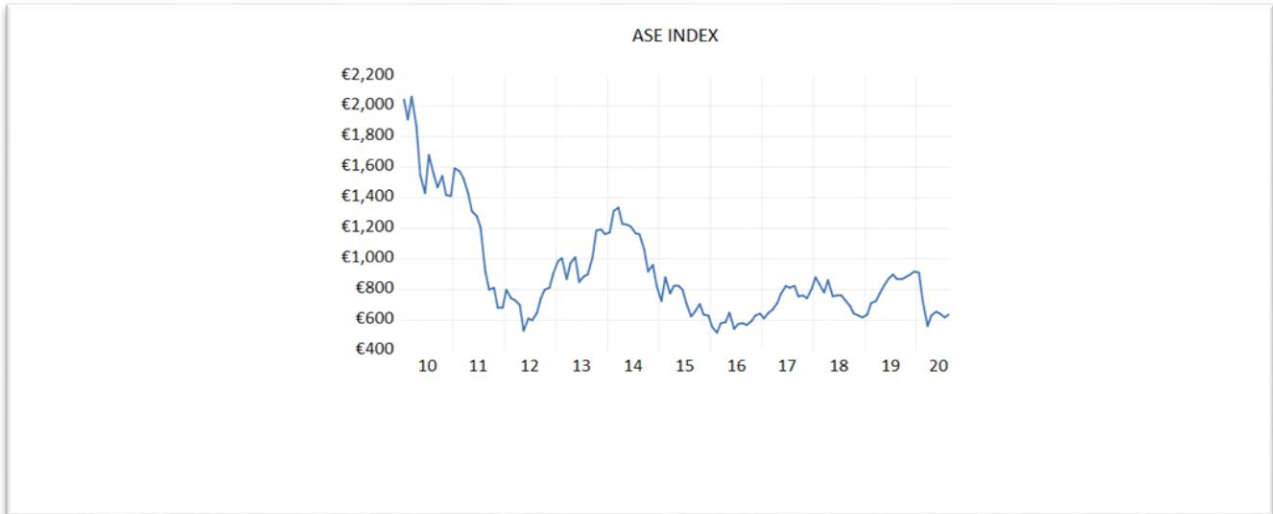
As an extension in our study analysis, an another substantial macroeconomic variable which is the banking activity index has been taken into consideration in order to investigate its relation with the Athens Stock price and specifically with one also huge index of Greek Stock Market, the ASE index. Banking activity is a sector that can evoke changes in many sectors and finally it can strongly affect the finance of national economy according to the literature researches. To clarify, ASE index includes many banks and also some of the biggest companies in respect of their capitalization. For this reason, it will be interesting to examine the relationship of banking sector in Greece that has been impacted by many events during the examined period and its impact on stock returns in Greek Stock Market.

For conducting the above analysis, a Granger Causality test have been performed for purposes of exploring if the two variables can predict each other or more analytically if past values of one can forecast the other.

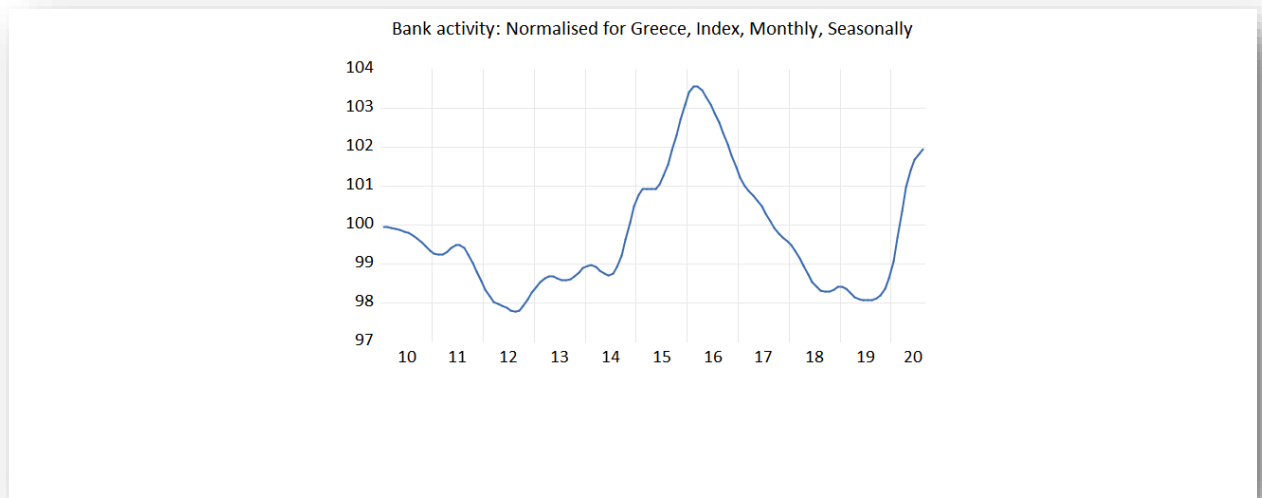
It is significant to mention that the dependent variable is the ASE index as before and the independent the index of banking activity in Greece. Also, the examined period for the two tests is from 01/01/ 2010 to 01/08/2020.

In the following graphs the data of ASE index and the index of banking activity in Greece as well as their data in excel will be stated.

Graph 5.6.1 ASE INDEX for period 01/01/2010 to 01/08/2020



Graph 5.6.2. Index of banking activity in Greece



After the illustration of graphs in which it can be easily observed that there was a downward trend for both during the examined period, it is crucial to extract their descriptive statistics in order to have a clearer picture for their distributions. At this point, it is useful to mention that Greece faced the biggest debt crisis during 2009 and 2015 that picked in 2015 with the new

measures of restriction that implied to Greek banks in order to keep the liquidity ratio stable. Banks dealt with a huge crisis and they tried to be sustainable since there were no liquid assets and no funds from the Federal bank. This situation has an impact on the index as it can be seen. In addition, the debt and bank crisis of 2015 affected dramatically the stock market in Greece since in July 2015 the Greek stock market closed and many companies went bankrupt. If we observed the graph of ASE Index is visible that in 2015 the index dropped substantially and thereafter followed a stable but in very low levels movement.

Despite the unexpected events that have been occurred during the examined period, we will test our data to conclude in a general result that determine the relationship of these two variables. Furthermore, a unit root test will be conducted as the section 1 in order to identify the stationary of banking index according to the procedures that have been followed in the section 1. It is significant to point out that unit root test for Index has been already conducted and therefore only banking index activities will be tested for stationarity.

The results of the unit root test and particularly the Augmented Dickey test for the banking index at level, first and second differences will be presented in the below summarized table.

Following the table, it is clear that the index of banking activity is stationary in second differences since the p – value is significant ( $0,00 < 0,05$ ) and therefore the null hypothesis can be rejected. Thus the transformed data in second differences will be used in the Granger Causality test for checking the cause effects of each other.

In Appendix 9.6 the results as they have been extracted from the Eviews software are stated.

**Table 10 Unit root results, Level, First differences and second differences of Banking activity index**

Index of Banking activity			
	UNIT ROOT TEST -LEVEL	UNIT ROOT TEST -FIRST DIFFERENCES	UNIT ROOT TEST -FIRST DIFFERENCES
P-VALUE	0,23	0,0522	0,0
Null hypothesis	Index of Banking activity is not stationary	Index of Banking activity is not stationary	Index of Banking activity is not stationary
Outcome	NOT REJECTED	NOT REJECTED	REJECTED-INDEX OF BANKING ACTIVITY IS STATIONARY

At this point the results of the Granger Causality test is followed in order to analyze the causation relationship of these two variables.

For Granger causality test, the null hypothesis and the alternative are:

$H_0$ = DLNASE INDEX does not Granger Cause DDLNBANK

$H_1$ = DDLNBANK does not Granger Cause DLNASE



**Table 11 Results from Granger Causality test of Banking activity index and ASE index**

Pairwise Granger Causality Tests			
Date: 01/09/21 Time: 12:30			
Sample: 2010M01 2020M08			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DLNASE does not Granger Cause	124	5.30956	0.0062
DDLNBANK does not Granger Cause		0.74999	0.4746

As we can see from the above table, the null hypothesis for the statement that ASE index cannot predict Bank activity index can be rejected. This means that ASE index can forecast the values of banking index in Greece and an extended analysis for this relationship has been stated at this chapter. In sharp contrast, the results of the Granger Causality test for the second statement interpret that Bank activity index's prices cannot predict the values of ASE index since the p-value is greater than 0,05 (p – value should be lower than 0,05 to reject) and thus it is not significant.

As mentioned before and based on the results, it was expected that a causality relationship will be occurred from these two variables. At this point, it is appropriate to notice that this result derived from the fact that 20% of the Greek index are covered from bank shares and hence ASE index is directly associated with banking sectors. Moreover, it is known that banking activity is related with many huge Greek corporations that are listed on the Greek Stock Exchange. To elaborate, if the activities and financial outlook of these companies are not in high level, offering funds in the banks or getting loans by bank in order to strengthen its commercial and investing activity, it can evoke a reverse reflect in the bank, reducing its index and appearing low levels. As a result, this indicates a strong causality relationship between banks and stock market. Bank

depends on a great extend in the transactions of such companies that are the key role in the finance world. It is interesting to mention that in 2015, during the debt crisis in Greece and the capital controls in banks the Athens stock exchange went down 16,2% while the banks dropped 30% due to the fact that investors sell their shares. As a consequence, banking sector has been dramatically hit in that period since Athens stock exchange closed and investors sold all their shares. To exemplify, overall banking index FTATBNK was down to its 30 percent daily limit. Additionally, the index of National Bank, Alpha Bank, Piraeus Bank, Attica and Euro bank have no buyers and therefore they closed. The bank had emergency need for recapitalization to repay their obligations (bonds and loans to central banks). Consequently, these negative ramifications were resulted by the failure of Greek stock market, confirming their strong causation.

## Chapter 6

### Conclusions and Discussion

The scope of this dissertation is to produce empirical outcomes in respect of the linkage between Greek stock market and five sensational and weighty macroeconomic variables for the period of 01 January 2010 to 01 August 2020. The execution of this analysis is considered meaningful for the finance world since the whole economy based on the funds that utilized by investors. To this effect, it was intense for investing community to be aware of the changes that macroeconomic factors can have on the stock market for the purpose of making their policies, avoiding losses and achieving the highest profits. The empirical study uses the regression analysis and the Granger causality tests to investigate these correlations. The basic economic variables that have been taken into considerations are the prices of crude oil, the industrial production, money supply in Euro area, the exchange rate of usd/ euro expressing in Euro and the index of banking activity in Greece. The selection of these variables associated with the examined period and their estimated influencing in the market of Greece. That is to say, that the examined period includes the huge debt crisis of Greece and the fail of Stock Market in July 2015 and also the outbreak of Covid 19 at the end of this period that is a worldwide pandemic that has affect all stock markets. These two remarkable events affect meanwhile the aforementioned macroeconomics variables and they are expected to have a significant impact to the market. According to the results extracted from the OLS regression and Granger Causality test, we found that only Industrial production in Greece cannot alter Athens stock exchange since the results of the tests are not enough significant to prove this relationship. The justification of this can be supported by the fact that the General Index of Athens does not include big industrial companies and therefore it has no serious impact by this index. On the contrary, a material impact pointed out for the rest of variables. More explicitly, positive relationship was identified for the movements of crude oil price and Athens General stock index for the reasons that will be stated below. Nevertheless, the other two predictors like Exchange rate usd/ euro and money supply for Euro area seems to

control Athens stock index negatively since the coefficients that occurred from the OLS regression has a negative signal. These outputs will also be analyzed in the following paragraph. As far as the evidences of Granger causality test, we discovered that the only causality relationship that exists is that between ASE index and price of crude oil. In other words, we found that the past values of Athens General Stock Index (ASE) can forecast the prices of crude oil and it is based on the fact that the main components of Athens stock exchange are oil based companies that has a crucial impact on this sector. Finally, the same outcome with index of bank activity extracted for the past values of ASE index and index of Gross Domestic Product. To clarify, we found that the past value of ASE index can predict the value of GDP. This outcome derived from the fact that companies that included in ASE index affect significantly the investments and the consumption of government as well as of individuals which are the main components of GDP. Therefore, all these factors determined from the operations of big firms and mainly their profits, the individuals' and corporations' investments. As a consequence, it is reasonable that there is a causality connection between them since they are directly linked.

In the extension of our study analysis, we examined the link between the index of bank activity in Greece and the Athens General Stock exchange through the Granger Causality test because banking sector is considered that can strongly affect the finance activities of an economy. Especially, in Greece the banking sector has impacted by many unexpected events during the examined period and meanwhile it faced development but and many periods of crisis. Therefore, as far we concerned it will extract appealing results for investing community. The Granger causality test that was carried out resulted in the fact that only the past prices of ASE index can predict the movement and changes in Banking index. This result executed since the p- value of null hypothesis that ASE index does not Granger cause the Bank index was significant and hence we rejected the null hypothesis and accepted the alternative.

In conclusion, we can say that the high oil prices benefit the profits and the dividends of oil – based companies and the related companies of these that dominated in the Athens stock market. Saying that the price of stock prices soared to a high level, increasing the General index of Athens stock market, encouraging the investors to allocate their funds to these stocks. In respect of the money supply that is macroeconomic predictor for Europe, we can support its negative

relationship with Greek stock market due to fact that money supply is directly associated with inflation and therefore higher costs of companies as well as less spending for individual investors, Based on these justifications, the investing corporations as well as the individuals have no enough funds to buy shares and as a result the profits and dividends of listed companies decreased, leading to lower prices of Athens General stock index.

Finally, regarding the negative linkage of exchange rate usd/ euro and Greek stock market, it is important to say that there is a controversial relationship between these factors since it depends on the type of companies that we examine. For example, exporting companies can be profited by the appreciation of Euro against the dollar whereas importing companies experience losses in the same case. In additional, Greek investors that hold foreign investments and exchange their profits in Euro can also have high benefits from appreciation in sharp contrast with investors that hold Greek investments in other currency. As a consequence, we can say that Greek stock market is influenced negatively since it includes more importing companies than exporting in its composition and therefore they experienced losses and hence lower stock prices in the market in case that exchange rate of usd/euro increases.

Furthermore, the findings of the last analysis of Granger causality test for the causation between ASE Index and index of bank activity can be explained from the fact that the growth of the Greek stock market means development of listed companies and thus more financial and investing activities that affect the revenues and activities of bank. To clarify, banks has investing and financing activities except of their commercial use that can also be affected since the interest income will be greater than the interest expense since greater number of loans will be asked from well established companies for expectation and developments purposes. To summarize, the past values of ASE index can predict the values of banking index.

Comparing the dissertation's evidence with the empirical results from other researches that have been mentioned in the Chapter 2, we can conclude that we have extracted similar results with some researchers and some against to them. At this point, it is vital to say that it is reasonable since the results depends on each country, on the period selected and on the kind of companies that includes the examined index in the relevant study. In conclusion, although the results are not in agreement with all the empirical results of previous researchers, we can say clearly that macroeconomic factors can have an impact on the Greek stock market with small or high power

while all the economy acts and employs in a strong linked environment with these integral factors than can change continually the financing activities. However, there are opponent's theorists that support the opinion that the stock prices affected more by the law of demand and supply of investing community. However, it should be taken into consideration that the short terms investors also are affected by these variables and therefore they are directly or indirectly linked with financing activities. The most integral result exported by this dissertation is that a very analytically investigation of macroeconomic variables should be conducted before any investment.

## Chapter 7

### Further research

Except of the concept that macroeconomic variables can influence the flow of the stock market, other analysts such as Warren Buffet has adopted another strategy after studying many years in which he supports the investing model. According to this the value of business and its continued growth are the most serious factors for the long term investors and not the changes in the economic factors. The basic idea of Warren Buffet Investing Theory is that investments should be evaluated in their intrinsic value that is the sum of future cash flow discounted by the time factor. This method according to the Buffet is the fairest and give a true picture of the return of the potential investment. If an investor buys an investment in lower or higher price, then it means that the investment will be under valued or overestimated, giving inaccurate picture to the investors and to the investing community. In addition, it is significant to mention that Buffet is an opponent of Efficient Market Hypothesis since he considers that not all the information can be perfectly adjusted to the market prices and therefore investors that have similar aspects can beat the market, succeeding high returns when the folk behave mass impetuously. As a result of the aforementioned opinion of Buffet Warren, it is apparent that he does not support the law of supply and demand from which the majority of investment community and mainly the short term investors hunt low and quick returns from the stock price fluctuations. Thus, his theory focus on the analysis of financial outlook of the companies and not to the trading activities of the stock market. Taking into consideration, the above arguments of Warren Buffet, it is easily understandable that long term investments are more effective than short terms. Therefore, a deeply analysis should be done on the theory of Warren Buffet in order more sufficient and accurate results to be extracted in respect of the factors that finally affect the stock prices.

## Chapter 8

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## Chapter 9

### Appendices

#### 9.1 Unit root test at first levels

##### **a) ASE INDEX**

Null Hypothesis: LNASE has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.627949	0.0900
Test critical values: 1% level	-3.482453	
5% level	-2.884291	
10% level	-2.578981	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNASE)

Method: Least Squares

Date: 01/08/21 Time: 21:20

Sample (adjusted): 2010M02 2020M08

Included observations: 127 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNASE(-1)	-0.065384	0.024880	-2.627949	0.0097
C	0.432928	0.168448	2.570104	0.0113
R-squared	0.052356	Mean dependent var	-0.009234	
Adjusted R-squared	0.044775	S.D. dependent var	0.093163	
S.E. of regression	0.091053	Akaike info criterion	-1.939119	
Sum squared resid	1.036340	Schwarz criterion	-1.894328	
Log likelihood	125.1340	Hannan-Quinn criter.	-1.920921	
F-statistic	6.906116	Durbin-Watson stat	1.921975	
Prob(F-statistic)	0.009666			

##### **b) M1 for Euro Area**

Null Hypothesis: LNM1 has a unit root

Exogenous: Constant

Lag Length: 6 (Automatic - based on SIC, maxlag=12)

t-Statistic Prob.\*

Augmented Dickey-Fuller test statistic	1.650404	0.9996
Test critical values: 1% level	-3.485115	
5% level	-2.885450	
10% level	-2.579598	

\*MacKinnon (1996) one-sided p-values.

### Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNM1)

Method: Least Squares

Date: 01/08/21 Time: 23:58

Sample (adjusted): 2010M08 2020M

Included observations: 121 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNM1(-1)	0.004654	0.002820	1.650404	0.1016
D(LNM1(-1))	0.214214	0.087400	2.450956	0.0158
D(LNM1(-2))	-0.207584	0.088527	-2.344877	0.0208
D(LNM1(-3))	0.091265	0.089979	1.014284	0.3126
D(LNM1(-4))	-0.098689	0.090227	-1.093782	0.2764
D(LNM1(-5))	0.064552	0.087097	0.741155	0.4601
D(LNM1(-6))	0.402138	0.092315	4.356163	0.0000
C	-0.133729	0.082474	-1.621467	0.1077
R-squared	0.309035	Mean dependent var	0.006127	
Adjusted R-squared	0.266232	S.D. dependent var	0.006946	
S.E. of regression	0.005950	Akaike info criterion	-7.347038	
Sum squared resid	0.004000	Schwarz criterion	-7.162192	
Log likelihood	452.4958	Hannan-Quinn criter.	-7.271965	
F-statistic	7.219930	Durbin-Watson stat	1.904734	
Prob(F-statistic)	0.000000			

### **c) Industrial Production (IP)**

Null Hypothesis: LNINDUS has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.781700	0.0638
Test critical values: 1% level	-3.482879	
5% level	-2.884477	
10% level	-2.579080	

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\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
Dependent Variable: D(LNINDUS)  
Method: Least Squares  
Date: 01/09/21 Time: 09:33  
Sample (adjusted): 2010M03 2020M08  
Included observations: 126 after adjustments

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNINDUS(-1)	-0.141452	0.050851	-2.781700	0.0063
D(LNINDUS(-1))	-0.416527	0.080188	-5.194385	0.0000
C	0.657030	0.236613	2.776812	0.0063

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R-squared	0.276918	Mean dependent var	-0.000791
Adjusted R-squared	0.265160	S.D. dependent var	0.030890
S.E. of regression	0.026480	Akaike info criterion	-4.401367
Sum squared resid	0.086243	Schwarz criterion	-4.333836
Log likelihood	280.2861	Hannan-Quinn criter.	-4.373931
F-statistic	23.55257	Durbin-Watson stat	2.033685
Prob(F-statistic)	0.000000		

#### **d) Crude oil price**

Null Hypothesis: LNCO has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

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	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.861470	0.3495
Test critical values: 1% level	-3.482453	
5% level	-2.884291	
10% level	-2.578981	

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\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
Dependent Variable: D(LNCO)  
Method: Least Squares  
Date: 01/08/21 Time: 22:11  
Sample (adjusted): 2010M02 2020M08  
Included observations: 127 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCO(-1)	-0.059288	0.031850	-1.861470	0.0650
C	0.244761	0.134241	1.823292	0.0706
R-squared	0.026973	Mean dependent var	-0.004227	
Adjusted R-squared	0.019189	S.D. dependent var	0.129372	
S.E. of regression	0.128125	Akaike info criterion	-1.256003	
Sum squared resid	2.051992	Schwarz criterion	-1.211212	
Log likelihood	81.75617	Hannan-Quinn criter.	-1.237805	
F-statistic	3.465071	Durbin-Watson stat	1.726790	
Prob(F-statistic)	0.065027			

### **e) Exchange rate USD/EURO in Euro**

Null Hypothesis: LNUSDEURO has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.868805	0.3461
Test critical values: 1% level	-3.482453	
5% level	-2.884291	
10% level	-2.578981	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNUSDEURO)

Method: Least Squares

Date: 01/08/21 Time: 22:26

Sample (adjusted): 2010M02 2020M08

Included observations: 127 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNUSDEURO(-1)	-0.045314	0.024248	-1.868805	0.0640
C	-0.007792	0.005307	-1.468204	0.1446
R-squared	0.027180	Mean dependent var	0.001198	
Adjusted R-squared	0.019397	S.D. dependent var	0.025507	

S.E. of regression	0.025258	Akaike info criterion	-4.503729
Sum squared resid	0.079745	Schwarz criterion	-4.458939
Log likelihood	287.9868	Hannan-Quinn criter.	-4.485531
F-statistic	3.492431	Durbin-Watson stat	2.098506
Prob(F-statistic)	0.063991		

## 9.2 Unit root test at first differences

### a) ASE INDEX

Null Hypothesis: D(LNASE) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-10.86437	0.0000
Test critical values: 1% level	-3.482879	
5% level	-2.884477	
10% level	-2.579080	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNASE,2)

Method: Least Squares

Date: 01/08/21 Time: 21:24

Sample (adjusted): 2010M03 2020M08

Included observations: 126 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNASE(-1))	-0.974322	0.089680	-10.86437	0.0000
C	-0.008521	0.008394	-1.015242	0.3120
R-squared	0.487677	Mean dependent var	0.000749	
Adjusted R-squared	0.483545	S.D. dependent var	0.130425	
S.E. of regression	0.093729	Akaike info criterion	-1.881065	
Sum squared resid	1.089364	Schwarz criterion	-1.836044	
Log likelihood	120.5071	Hannan-Quinn criter.	-1.862774	
F-statistic	118.0346	Durbin-Watson stat	1.978901	
Prob(F-statistic)	0.000000			

### b) M1 for Euro Area

Null Hypothesis: D(LNM1) has a unit root  
 Exogenous: Constant  
 Lag Length: 5 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.931291	0.3171
Test critical values:		
1% level	-3.485115	
5% level	-2.885450	
10% level	-2.579598	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(LNM1,2)  
 Method: Least Squares  
 Date: 01/08/21 Time: 23:59  
 Sample (adjusted): 2010M08 2020M08  
 Included observations: 121 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNM1(-1))	-0.348178	0.180283	-1.931291	0.0559
D(LNM1(-1),2)	-0.399598	0.173435	-2.304021	0.0230
D(LNM1(-2),2)	-0.576727	0.151782	-3.799710	0.0002
D(LNM1(-3),2)	-0.450446	0.141031	-3.193951	0.0018
D(LNM1(-4),2)	-0.521065	0.108184	-4.816452	0.0000
D(LNM1(-5),2)	-0.428393	0.091619	-4.675820	0.0000
C	0.002372	0.001206	1.966666	0.0517
R-squared	0.535102	Mean dependent var	6.65E-05	
Adjusted R-squared	0.510634	S.D. dependent var	0.008570	
S.E. of regression	0.005995	Akaike info criterion	-7.339748	
Sum squared resid	0.004097	Schwarz criterion	-7.178008	
Log likelihood	451.0548	Hannan-Quinn criter.	-7.274059	
F-statistic	21.86919	Durbin-Watson stat	1.919790	
Prob(F-statistic)	0.000000			

### **c) Industrial Production (IP)**

Null Hypothesis: D(LNINDUS) has a unit root  
 Exogenous: Constant  
 Lag Length: 2 (Automatic - based on SIC, maxlag=12)



	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-9.599467	0.0000
Test critical values: 1% level	-3.483751	
5% level	-2.884856	
10% level	-2.579282	

\*MacKinnon (1996) one-sided p-values.

#### Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNINDUS,2)

Method: Least Squares

Date: 01/09/21 Time: 09:34

Sample (adjusted): 2010M05 2020M08

Included observations: 124 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNINDUS(-1))	-2.006073	0.208978	-9.599467	0.0000
D(LNINDUS(-1),2)	0.471713	0.162933	2.895139	0.0045
D(LNINDUS(-2),2)	0.259524	0.089579	2.897147	0.0045
C	-0.001668	0.002392	-0.697285	0.4870
R-squared	0.758917	Mean dependent var	0.000136	
Adjusted R-squared	0.752890	S.D. dependent var	0.053383	
S.E. of regression	0.026537	Akaike info criterion	-4.388849	
Sum squared resid	0.084504	Schwarz criterion	-4.297872	
Log likelihood	276.1086	Hannan-Quinn criter.	-4.351892	
F-statistic	125.9182	Durbin-Watson stat	2.104676	
Prob(F-statistic)	0.000000			

#### **d) Crude oil price**

Null Hypothesis: D(LNCO) has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-9.031090	0.0000
Test critical values: 1% level	-3.483312	
5% level	-2.884665	
10% level	-2.579180	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(LNCO,2)  
 Method: Least Squares  
 Date: 01/08/21 Time: 22:11  
 Sample (adjusted): 2010M04 2020M08  
 Included observations: 125 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCO(-1))	-1.071691	0.118667	-9.031090	0.0000
D(LNCO(-1),2)	0.196364	0.088629	2.215562	0.0286
C	-0.005698	0.011452	-0.497567	0.6197
R-squared	0.469291	Mean dependent var	5.04E-05	
Adjusted R-squared	0.460591	S.D. dependent var	0.174078	
S.E. of regression	0.127851	Akaike info criterion	-1.252196	
Sum squared resid	1.994195	Schwarz criterion	-1.184317	
Log likelihood	81.26228	Hannan-Quinn criter.	-1.224621	
F-statistic	53.94068	Durbin-Watson stat	2.035483	
Prob(F-statistic)	0.000000			

### **e) Exchange rate usd/euro in Euro**

Null Hypothesis: D(LNUSDEURO) has a unit root  
 Exogenous: Constant  
 Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-11.96124	0.0000
Test critical values: 1% level	-3.482879	
5% level	-2.884477	
10% level	-2.579080	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(LNUSDEURO,2)  
 Method: Least Squares  
 Date: 01/08/21 Time: 22:27  
 Sample (adjusted): 2010M03 2020M08  
 Included observations: 126 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
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D(LNUSDEURO(-1))	-1.069955	0.089452	-11.96124	0.0000
C	0.001156	0.002284	0.506291	0.6136

R-squared	0.535704	Mean dependent var	-0.000169
Adjusted R-squared	0.531960	S.D. dependent var	0.037430
S.E. of regression	0.025607	Akaike info criterion	-4.476160
Sum squared resid	0.081309	Schwarz criterion	-4.431140
Log likelihood	283.9981	Hannan-Quinn criter.	-4.457870
F-statistic	143.0712	Durbin-Watson stat	1.989541
Prob(F-statistic)	0.000000		

### 9.3 Unit root test at second differences

#### a) M1 for Euro Area

Null Hypothesis: D(LNM1,2) has a unit root

Exogenous: Constant

Lag Length: 10 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.765110	0.0000
Test critical values: 1% level	-3.488063	
5% level	-2.886732	
10% level	-2.580281	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNM1,3)

Method: Least Squares

Date: 01/08/21 Time: 23:59

Sample (adjusted): 2011M02 2020M08

Included observations: 115 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNM1(-1),2)	-7.054492	1.042776	-6.765110	0.0000
D(LNM1(-1),3)	5.359231	1.008191	5.315692	0.0000
D(LNM1(-2),3)	4.573388	0.966552	4.731652	0.0000
D(LNM1(-3),3)	3.852357	0.903004	4.266156	0.0000
D(LNM1(-4),3)	3.229386	0.820607	3.935364	0.0002
D(LNM1(-5),3)	2.592910	0.724335	3.579710	0.0005
D(LNM1(-6),3)	2.229618	0.589684	3.781036	0.0003
D(LNM1(-7),3)	1.766580	0.454497	3.886887	0.0002

D(LNM1(-8),3)	1.294710	0.320178	4.043721	0.0001
D(LNM1(-9),3)	0.920411	0.197382	4.663095	0.0000
D(LNM1(-10),3)	0.337644	0.100737	3.351725	0.0011
C	0.000503	0.000514	0.978789	0.3300

---

R-squared	0.856384	Mean dependent var	0.000200
Adjusted R-squared	0.841047	S.D. dependent var	0.013628
S.E. of regression	0.005433	Akaike info criterion	-7.494050
Sum squared resid	0.003041	Schwarz criterion	-7.207623
Log likelihood	442.9079	Hannan-Quinn criter.	-7.377791
F-statistic	55.83559	Durbin-Watson stat	1.913954
Prob(F-statistic)	0.000000		

### 9.4.1 OLS Regression Analysis

Dependent Variable: DLNASE  
Method: Least Squares  
Date: 01/09/21 Time: 10:23  
Sample (adjusted): 2010M03 2020M08  
Included observations: 126 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006745	0.007353	-0.917378	0.3608
DLNCO	0.140336	0.060685	2.312553	0.0224
DLNUSDEURO	-1.231716	0.309241	-3.983025	0.0001
DDLNM1	-1.726291	0.875218	-1.972412	0.0508
DLNINDUS	-0.125997	0.247335	-0.509418	0.6114

---

R-squared	0.246844	Mean dependent var	-0.008766
Adjusted R-squared	0.221947	S.D. dependent var	0.093385
S.E. of regression	0.082372	Akaike info criterion	-2.116268
Sum squared resid	0.821003	Schwarz criterion	-2.003717
Log likelihood	138.3249	Hannan-Quinn criter.	-2.070542
F-statistic	9.914343	Durbin-Watson stat	2.064087
Prob(F-statistic)	0.000001		

Estimation Command:

```
=====
LS DLNASE C DLNCO DLNUSDEURO DDLNM1 DLNINDUS
```

Estimation Equation:

```
=====
DLNASE = C(1) + C(2)*DLNCO + C(3)*DLNUSDEURO + C(4)*DDLNM1 +
C(5)*DLNINDUS
```

Substituted Coefficients:

=====

$$\text{DLNASE} = -0.00674510394385 + 0.140336474573*\text{DLNCO} - 1.23171570907*\text{DLNUSDEURO} - 1.72629051791*\text{DDLNM1} - 0.125996910033*\text{DLNINDUS}$$

#### 9.4.2 OLS Regression Analysis without Industrial production

Dependent Variable: DLNASE

Method: Least Squares

Date: 01/31/21 Time: 12:22

Sample (adjusted): 2010M03 2020M08

Included observations: 126 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006605	0.007325	-0.901691	0.3690
DLNCRUDE	0.142174	0.060393	2.354139	0.0202
DLNUSD	-1.264693	0.301471	-4.195078	0.0001
DDLNM1	-1.662492	0.863579	-1.925120	0.0565

R-squared	0.245229	Mean dependent var	-0.008766
Adjusted R-squared	0.226669	S.D. dependent var	0.093385
S.E. of regression	0.082122	Akaike info criterion	-2.129999
Sum squared resid	0.822764	Schwarz criterion	-2.039958
Log likelihood	138.1899	Hannan-Quinn criter.	-2.093418
F-statistic	13.21282	Durbin-Watson stat	2.062113
Prob(F-statistic)	0.000000		

Estimation Command:

=====

LS DLNASE C DLNCRUDE DLNUSD DDLNM1

Estimation Equation:

=====

$$\text{DLNASE} = \text{C}(1) + \text{C}(2)*\text{DLNCRUDE} + \text{C}(3)*\text{DLNUSD} + \text{C}(4)*\text{DDLNM1}$$

Substituted Coefficients:

=====

$$\text{DLNASE} = -0.006604989679 + 0.142174015983*\text{DLNCRUDE} - 1.26469281845*\text{DLNUSD} - 1.66249189494*\text{DDLNM1}$$

## 9.5 Heteroscedasticity test – Residual Analysis

Heteroskedasticity Test: Breusch-Pagan-Godfrey

Null hypothesis: Homoskedasticity

F-statistic	1.067522	Prob. F(4,121)	0.3757
Obs*R-squared	4.294969	Prob. Chi-Square(4)	0.3676
Scaled explained SS	4.664562	Prob. Chi-Square(4)	0.3235

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 01/09/21 Time: 10:25

Sample: 2010M03 2020M08

Included observations: 126

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.006497	0.000895	7.257807	0.0000
DLNCO	-0.006684	0.007389	-0.904645	0.3675
DLNUSDEURO	-0.038252	0.037651	-1.015958	0.3117
DDLNM1	0.123716	0.106561	1.160986	0.2479
DLNINDUS	-0.023798	0.030114	-0.790254	0.4309
R-squared	0.034087	Mean dependent var	0.006516	
Adjusted R-squared	0.002156	S.D. dependent var	0.010040	
S.E. of regression	0.010029	Akaike info criterion	-6.327780	
Sum squared resid	0.012170	Schwarz criterion	-6.215229	
Log likelihood	403.6502	Hannan-Quinn criter.	-6.282054	
F-statistic	1.067522	Durbin-Watson stat	2.060724	
Prob(F-statistic)	0.375657			

## 9.6 Unit root test at first level, first differences and second differences for banking activity index

Null Hypothesis: D(LNBANK) has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
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Augmented Dickey-Fuller test statistic	-2.867278	0.0522
Test critical values: 1% level	-3.484198	
5% level	-2.885051	
10% level	-2.579386	

\*MacKinnon (1996) one-sided p-values.

#### Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNBANK,2)

Method: Least Squares

Date: 01/09/21 Time: 12:28

Sample (adjusted): 2010M06 2020M08

Included observations: 123 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNBANK(-1))	-0.029091	0.010146	-2.867278	0.0049
D(LNBANK(-1),2)	1.815472	0.086086	21.08894	0.0000
D(LNBANK(-2),2)	-1.381190	0.142090	-9.720521	0.0000
D(LNBANK(-3),2)	0.409159	0.094746	4.318466	0.0000
C	5.52E-06	1.61E-05	0.343260	0.7320

R-squared	0.926206	Mean dependent var	1.17E-05
Adjusted R-squared	0.923704	S.D. dependent var	0.000642
S.E. of regression	0.000177	Akaike info criterion	-14.39785
Sum squared resid	3.71E-06	Schwarz criterion	-14.28354
Log likelihood	890.4680	Hannan-Quinn criter.	-14.35142
F-statistic	370.2602	Durbin-Watson stat	1.895764
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNBANK,2) has a unit root

Exogenous: Constant

Lag Length: 2 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.282951	0.0000
Test critical values: 1% level	-3.484198	
5% level	-2.885051	
10% level	-2.579386	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(LNBANK,3)  
 Method: Least Squares  
 Date: 01/09/21 Time: 12:29  
 Sample (adjusted): 2010M06 2020M08  
 Included observations: 123 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNBANK(-1),2)	-0.214491	0.040601	-5.282951	0.0000
D(LNBANK(-1),3)	1.023698	0.065246	15.68977	0.0000
D(LNBANK(-2),3)	-0.326700	0.092975	-3.513844	0.0006
C	3.37E-06	1.65E-05	0.203795	0.8389
R-squared	0.767238	Mean dependent var	-2.33E-06	
Adjusted R-squared	0.761370	S.D. dependent var	0.000374	
S.E. of regression	0.000183	Akaike info criterion	-14.34676	
Sum squared resid	3.97E-06	Schwarz criterion	-14.25531	
Log likelihood	886.3259	Hannan-Quinn criter.	-14.30961	
F-statistic	130.7509	Durbin-Watson stat	1.839704	
Prob(F-statistic)	0.000000			