The impact of macroeconomic factors on stock market prices in United Kingdom

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I hereby declare that the work submitted is mine and that where I have made use of another’s work, I have attributed the source(s) according to the Regulations set in the Student’s Handbook.

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Abstract

This dissertation was written as part of the MSc in International Accounting, Auditing and Financial Management at the International Hellenic University. The objective of this study is to analyze the relationship between the stock market prices of FTSE 100 index and macroeconomic factors in United Kingdom for the period 2002-2016. The key macroeconomic factors studied are Consumer price index, Exchange Rate, Treasury bills rate, Unemployment rate, Oil prices and Industrial production. An Ordinary Least Squares regression will be produced in order to show if there is any link between those variables and also a lagged model, as an extension of the main model, to examine whether past values of the predictors could cause the Stock prices. The results showed a positive impact of exchange rate, Oil prices and Industrial production on Stock prices of FTSE 100 index. In addition, the study examines how another economic indicator such as Gross domestic product could be affect the FTSE all-share index by running an OLS regression and applying a Granger causality test.

Keywords: Macroeconomic variables, stock prices, FTSE 100, UK, OLS.

Styliani Avgerinopoulou

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1. Introduction

Establishing the relationships between macroeconomic variables and stock market prices are imperative to investors and understanding the stock market dynamics in any country. Macroeconomic indicators play an important role in the performance of the share market’s returns. It appears in many studies that there is a link between stock market performance and macroeconomic determinants. Several studies are pointing out this relationship in both emerging and the developed economies. Macroeconomic indicators are compositions of data which frequently used by the policy makers and investors for gathering information of current and upcoming investment priority.

A stock exchange constitutes a network of financial transactions where the demands of buyers and sellers of securities meet at an arranged price. Furthermore, share market plays a key role in the evolution of the capital markets in all over the world, leading to the growth of several industries and transactions of the economy. Many factors can influence those who take part in economic activities and transactions, either to expect a higher or lower return when investing in stock market and one of these factors are macroeconomic variables. Any changes in some of these variables can significantly impact stock prices which also mean the returns of an investment portfolio. Over the years, economic theory suggests that there should be a strong link between financial activity and security prices, given that the stock price is the discounted present value of the firm’s payout.

New York stock exchange, NASDAQ, Shanghai, Japan and London stock exchange are some of the leading exchanges in the world. They include hundreds of firms and their performance can affect the entire global economy. This study focuses on London stock exchange and particularly in the Financial Times Stock Exchange 100 Index, also called the FTSE 100 Index, which is a share index of the 100 companies listed on the London Stock Exchange with the highest market capitalization. The objective is to investigate the impact of macroeconomic variables
on the stock market prices of the London stock exchange during the period 2002-2016. It is based on academic papers well acknowledged in the literature of economics and finance.

It is worth pointing out that the data which will be under examination, come from a period of time when many economic and political events occurred. The official introduction of the physical euro coins and banknotes that entered into circulation on 1 January 2002 by many E.U countries, caused fluctuations to other currencies including the British pound (or sterling). In the late 2007, the global financial crisis had already started. Since mid-2008, the UK economy has faced an unusual series of large adverse shocks that have led companies and the whole market to become more uncertain about future economic prospects. This period was defined as the Great Recession of the UK’s economy. It lasted from the second quarter of 2008 until the second quarter of 2009. It was characterized as the deepest recession since the WWII. Additionally, another major event that brought a wave of uncertainty and economic changes was the announcement of the United Kingdom European Union membership referendum of 2016. It would be interesting to see how those events affected the real economic variables and by extension the Stock market performance of London stock exchange’s index, FTSE100.

In Section 2, there is a review of the relevant literature related to macroeconomic indicators and their relationship with the stock prices in various share markets around the world.

2. Literature review
The London Stock Exchange, established in 1801, is one of the world’s oldest stock exchanges. It has a market capitalization of £6.06 trillion making it Europe’s largest stock exchange and third-largest in the world by this measurement. This dissertation will examine the stock index of the 100 companies listed on the London Stock Exchange with the highest market capitalization, the Financial Times Stock Exchange 100 index and also known as FTSE 100. FTSE 100 index was created on January 1984. The index weight is calculated based on the free-float market capitalizations of the constituents. The constituents of the FTSE are reviewed and updated four times a year.

![Figure 1. Stock market prices of FTSE 100 index for the period 1984-2014](source: YAHOO FINANCE)

Empirically, there are number of studies and theories that indicate a link between the market returns and macroeconomic nature variables.

Fama (1981) and Chen (1986) examined the long-term relationship between the stock market variations and the real economic variables in the United States of America. Their main results showed that there is indeed a link between the share market and macroeconomic variables in the long run. In Fama’s (1981) study, the correlation between the stock returns and specific variables had a positive sign. These variables consisted of real GNP, capital expenditures, lagged inflation, industrial production and interest rates. For Chen et al. (1986), the economic

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1 Source: YAHOO FINANCE
variables that affect the returns are the maturity risk premium, the default risk premium, inflation and the short term interest rates. Additionally, a study from Mukherjee and Naka (1995) for the US stock market also found a strong link between money supply, exchange rate, inflation, industrial production and market returns.

Hondroyiannis and Papapetrou (2001) tested and presented how a number of indicators of economic activity affect the movements of the stock market in Greece. Their main findings proved that the macroeconomic activity has indeed an impact on the stock returns but the results are different from studies of other stock markets. In this case, there is a negative correlation between the market fluctuations and the oil prices, interest rates and industrial production. Another research from Papapetrou (2001) showed that oil prices shocks and CPI cause a negative effect on the Greek stock market, while industrial production index causes a positive effect.

Rangvid, Rapach, and Wohar, (2005) developed a model to examine the predictability of market returns of 12 industrial countries by using macroeconomic variables. The variables that have been used such as CPI, money supply, different interest rates, exchange rate and industrial production, helped to come to the conclusion that interest rates are helpful in predicting stock returns in a number of countries.

Another study developed by Abugri (2008), examined how real economy factors, domestic and global, have any kind of significance on the stock market returns of Latin America countries. It has been found that Chile, Argentina, Brazil and Mexico market returns experienced various changes when domestic factors, like industrial production, exchange rate, money supply as well as global factor such as US three month treasury bills yields, changed. However, it is quite usual for those four countries to be economically influenced by the shocks and changes of worldwide financial factors.

Morelli (2002), by using ARCH and GARCH models, tried to test whether the volatility of the market is affected by the volatility of specific economic determinants in UK for the period 1967-1995. He came to the conclusion that the fluctuations of variables such as industrial production, real retail sales, money supply, inflation, and exchange
rate do not explain any changes on the stock returns. On the other hand, Nasseh and Strauss (2000) had produced different outcomes regarding the UK market. They found a positive relation between CPI and industrial production and the share prices.

Masuduzzaman, (2012) studied two of the biggest indices FTSE100 and S&P500. In the first model, the stock market returns of the London stock exchange’s biggest index depended on industrial production index, interest rates and consumer price index in the long-run while the unemployment rates link to the market returns only through industrial production index. Furthermore, in the index of S&P500 the results indicate the prices are influenced in the long-run by interest rates, exchange rates, unemployment rates industrial production index and consumer price index. Interesting finding is the fact that an increase in industrial production index resulted in a decline in stock market returns in United Kingdom in the long-run.

Alagidede and Panagiotidis (2010) examined the relationship between the South African stock market index and a selected macroeconomic indicator which is inflation. They used CPI as a proxy of inflation. The results revealed that the beta coefficient has a positive sign meaning that there is positive relationship between the stock prices and CPI in the long run. However, in the short the study showed a negative link. Therefore, stocks response differently to inflation movements in the long run and short run.

Regarding the Asian markets, Hosseini, Ahmad and Lai (2011) investigated the relationship between stock market indices and four macroeconomic factors in China and India. The findings showed that there is indeed a link between crude oil price, money supply, industrial production and inflation rate with share price movements in the long run as well as in the short run. In the long run, crude oil prices and money supply impact negatively stock prices in India while in China the effect of the those factors is positive on share prices. As for inflation, the outcomes suggest a positive link in both countries whereas the industrial production is negative only in China.
Subeniotis (2011) studied the relationship between the EU-12 stock market price indices and four macroeconomic factors, such as market capitalization, industrial production, the economic sentiment indicator, and inflation. The twelve countries selected are those which have adopted the euro. The study indicates that both industrial production and inflation have a negative effect on stock market prices. As far as the other two economic indicators are concerned, the empirical results imply a positive link between the stock market and the variables.

It should be noticed that several studies and some of those mentioned above, generate different outcomes in comparison to this study which can be explained due to the different model specifications, different methodology and variable approach.

3. Theoretical Background

A fundamental principle in finance is the trade-off between risk and return. This means that a riskier the portfolio that an investor holds results to a higher expected return. Currently, the best two theories that can explain the groundwork of this trade-off between risk and return are the Capital Asset Pricing Model and the Arbitrage Pricing Theory. In this section, we will discuss these theories and our focus is on the APT and especially on the factors affecting returns.

The link between macroeconomic fundamentals and stock market returns has been a major topic of engagement within the financial economics circus. This correlation is an object of on-going interest of investors, academics and policymakers. Several theories and empirical evidence alike have shown much detail on this subject of concern to economies.

3.1 Capital Asset Pricing Model

The Capital Asset Pricing Model (generally known as CAPM) was developed in the 1960s by Sharpe (1964) and Lintner (1965) and it is based on the portfolio theory
introduced by Markowitz (1952). According to Sharpe, diversification gives the investor the opportunity to minimize all portfolio risk, except the risk deriving from fluctuations in economic activity. This risk, the systematic risk, grows with the addition of an individual stock and depends on the response to the economic and political environment. Additionally, systematic risk remains even in the most efficient portfolios and cannot be avoided by diversification in contrast to the unsystematic risk which can be diversified away. For this reason, the Capital Asset Pricing Model only measures the response to the degree of economic activity when assessing the risk of an asset’s rate of return. Moreover, we should not forget that CAPM is based on only in one factor, an independent variable, which is the risk premium of the market.

The equation of CAPM is demonstrated below

\[ R_i = R_f + \beta_i \times (R_m - R_f) \]

Where:

- \( R_i \) = Expected return on security i
- \( R_f \) = Risk-free rate
- \( \beta_i \) = Beta of security i
- \( R_m \) = Expected return on the market

In another research developed by Fama and French (2004), based on the CAPM and other empirical work, they proved that the link between beta and average return is more leveled than predicted in this asset model version. CAPM estimates of the cost of equity for high beta stocks are too high (relative to historical average returns) and estimates for low beta stocks are too low. Similarly, if the high average returns on value stocks (with high book-to-market ratios) imply high expected returns, CAPM cost of equity estimates for such stocks are too low.
3.2 Arbitrage Pricing Theory

Another framework to the Capital Asset Pricing model is the Arbitrage pricing theory. It is an asset pricing model that created in 1976 by Stephen Ross, and forecasts a connection between the market returns of a portfolio and the returns of a single asset through a linear combination of various independent macroeconomic variables. The model assumes that investors take advantage of arbitrage opportunities in the broader market. Thus, an asset’s rate of return is a function of the return on alternative investments and other risk factors. The APT, unlike to CAPM, recognizes various causes of risk that could affect the expected return of an investment. The model ascribes a capital asset’s expected return to various risk factors, and also measures the risk premiums associated with each of these risk determinants. According to Ross, if equilibrium prices have no arbitrage opportunities, then the capital assets’ expected returns are nearly related to the factor burdening.

Chen and Ross (1986) concluded that stocks depend on anticipated and unanticipated factors. The returns realized by the equity holders are influence by those anticipated factors linked to economic conditions. In contrast to CAPM, Ross proposes a multifactor approach to deal with explaining capital asset through the arbitrage pricing hypothesis. For Ross, various economic forces are those which have a direct impact on stock returns. In many empirical studies, a number of macroeconomic factors have been used in econometric models, based on the arbitrage pricing theory, and it has been proven to affect the market returns. For instance, Chen et al. (1986) in his analysis chose a set of relevant variables and came to the conclusion that economic factors such as industrial production, inflation, risk premium and term structure of interest rates could affect equities’ returns.

APT states that the expected return on a stock or other security must adhere to the following relationship:
\[ R_i = r_f + b_1 x r_{p1} + b_2 x r_{p2} + ... + b_n x r_{pn} \]  

Where,

- \( R_i \) = expected return
- \( r_f \) = the risk-free interest rate
- \( r_p \) = the risk premium associated with the particular factor
- \( b \) = the sensitivity of the asset to the particular factor

The arbitrage pricing theory (APT) describes the price where a mispriced asset is expected and it is often viewed, as an alternative to the capital asset pricing model (CAPM), since the APT has more flexible assumption requirements. While the CAPM formula requires the market's expected return, APT uses the risky asset's expected return and the risk premium of a number of macroeconomic factors. Those who adopt the APT model, they expect to profit by taking advantage of mispriced securities, which have prices that differ from the theoretical price predicted by the model. By shorting an overpriced security, while concurrently going long in the portfolio the APT calculations were based on, the arbitrageur is in a position to make a theoretically risk-free profit.

### 4. Data and Methodology

The present research considers six macroeconomic indicators as the explanatory variables such as Unemployment rate (UN), Consumer Price Index (CPI) as proxy for inflation rate, Exchange Rate (EXC), Treasury bills rate (TBR), Industrial production (IP) and Oil prices (OP). Stock prices of FTSE 100 index will play the role of the dependent variable. In the study, the Ordinary Least Square (OLS) is used in order to

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2 Source: Investopedia
investigate the impact of macroeconomic variables on London Stock Exchange’s Index. Table 1 demonstrates all the variables examined to this study.

<table>
<thead>
<tr>
<th>VARIABLE NAME</th>
<th>ABBREVIATION</th>
<th>INTERPRETATION</th>
<th>SOURCE OF DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOCK PRICES (FTSE 100)</td>
<td>SP</td>
<td>FTSE 100 is a stock market index of London Stock Exchange</td>
<td>FTSE 100 Jan/2002 - Dec/2016 monthly.</td>
</tr>
<tr>
<td>UNEMPLOYMENT RATE</td>
<td>UN</td>
<td>Unemployment rate is a measure of the prevalence of unemployment</td>
<td>Office for National Statistics, UK Jan/2002 - Dec/2016 monthly.</td>
</tr>
<tr>
<td>CONSUMER PRICE INDEX</td>
<td>CPI</td>
<td>Consumer Price Index is commonly used to measure inflation</td>
<td>Office for National Statistics, UK Jan/2002 - Dec/2016 monthly.</td>
</tr>
<tr>
<td>TREASURY BILLS RATE</td>
<td>TRB</td>
<td>Treasury bill rate is a short-term obligation with a maturity of less than a year</td>
<td>Bank of England, Jan/2002 - Dec/2016 monthly.</td>
</tr>
<tr>
<td>EXCHANGE RATE</td>
<td>EXC</td>
<td>Exchange rate refers to British pound (£) against one euro (€)</td>
<td>European Central Bank, Jan/2002 - Dec/2016 monthly.</td>
</tr>
<tr>
<td>INDUSTRIAL PRODUCTION INDEX</td>
<td>IP</td>
<td>Industrial production refers to the volume of output generated by industrial sectors</td>
<td>Office for National Statistics, UK Jan/2002 - Dec/2016 monthly.</td>
</tr>
</tbody>
</table>

4.1 Unemployment rate

Another very strong macroeconomic indicator that affects the stock markets is the unemployment rate. It shows the development and effectiveness of the economy overall. Investors follow the movements of this rate since it can predict future level of economic activity. Boyd (2005) argued that when the unemployment rates are announced, the stock markets respond differently to the news. According
to the study, the market’s reaction depends on either the economy has an upward march or a downward. In average, when the rates of unemployment are rising that have a positive impact on stock market when the economy is expanding, but it is bad news during economic recession. Stock market analysts argue that stock prices rebound after an unemployment rate increase announcement. However, in the literature there is no clear academic consensus on the impact of unemployment announcement on stock market returns. This study focuses on the monthly Unemployment rates (UN) since these figures are viewed as the most influential announcement and there are frequently cited to move the markets. The reason is that the Unemployment rate is the first monthly indicator issued from statistical agencies providing evidence on the economy as a whole. Generally speaking, employment reports matter to the overall economic picture because jobs growth is an important stimulus for economic growth. Job growth is highly correlated with improvements in consumer confidence, which often presage increases in spending. Since spending accounts for over two-thirds of economic activity, it can be understood why analysts monitor the labor market closely.

4.2 Consumer price index

Another economic indicator which will be used in this dissertation is Consumer price index (CPI). It is also called the Harmonized Index of Consumer Prices (HICP) in United Kingdom. The Consumer price index is a measure that examines the changes in the general level of prices of consumer goods and services, such as transportation and food. Many experts consider CPI as the best measure of inflation available to investors and others. Over the years, researchers came to the conclusion that expected and unexpected inflation can influence the stock market movements in a positive or negative manner, and also it can us the direction of this relationship, the market’s and inflation’s. In economy when demand exceeds supply the prices go up. Subsequently, this would increase the earnings of corporations and retained earnings as well, resulting in a rise the firm’s share value. That is how expected inflation. As far as the unexpected inflation is concerned, an increase in prices leads
to higher cost of living, which will reduce investments and relocate people’s resources to consumption. Moreover, nominal interest rates will also increase with the result of decrease of income. Nasseh and Strauss (2000) argued that there is a strong, integrating relationship between stock prices and domestic and international macroeconomic variables in selected European countries. Their findings demonstrate that there is indeed a connection between changes in stock prices and activities of macroeconomic nature in European countries in the long-run. Hence, share prices are grounded in economic fundamentals including the Consumer Price Index.

4.3 Exchange rate

Many factors, such as exchange rates, interest rates, money supply and unemployment have an impact on stock prices. More specific, exchange rates have been one of the major determinants in international businesses and equity prices due to the ongoing rising in the global trade and capital movements. In this thesis, FTSE 100 index stock prices is under examination, so the British pound (or sterling) against Euro is the exchange rate that will be one the independent variables that will be reviewed.

Various studies based on monthly data have found either little relation can be established between the two markets or exchange rate market leads stock market. According to Granger, (2000) most markets show either changes in stock prices lead that in exchange rates or either market can take the lead.

Researchers and economists argued that the link between share market prices and currency is substantial for a few reasons. More specific, Gavin (1989) showed that this link may affect monetary and fiscal policies because when the stock market is booming that influence positively the aggregate demand. Additionally, in order to further economically the exporting sector, it is usual for policy-makers to encourage for less expensive currency. Besides, they should know if that kind of policy might
push down the financial market. Another reason to consider this relationship important is the fact that the link between the two markets may be used to foresee the progress and evolution of the exchange rate. For example, multinational corporations are dealing every day with the exposure to foreign contracts and exchange rate risk, so that link of the markets helps to manage that exposure and stabilize corporate earnings. Lastly, it is a common thing to include the currency as an asset in an investment portfolio. The investor should know about how exchange rates can impact the assets of the portfolio because is crucial for the performance of the portfolio’s assets. An estimate of the correlation between stock prices and exchange rates is quite important for an investment decision.

Nieh and Leeb (2001) tested the relationship between stock prices and exchange rates for the G-7 countries. The outcomes indicated that the exchange rates have a significant relationship with the stock prices only in a short run period. Particularly, in specific G-7 countries the link between the rates and the prices happens only for one day. For example, a decrease in the currency led to a decline in prices in German market but there was an upward trend in Canadian and British markets the next day.

4.4 Treasury bills rate

Over the years financial analysts and investors have been concerned about the impact of Treasury bills rate on the behavior of stock returns. Institutions that issue Treasury bills and stocks are competing for investor’s funds. Correct choice ensures that the investors are able to reduce their risk and enhance returns by recognizing the underlying direction of the markets and taking positions accordingly. This is in line with the assumption that rational investors only assume risk if they will be adequately compensated. Therefore investors have to rank assets on a risk-return perspective then select the assets to invest in according to their individual risk preferences as noted by Markowitz (1952) in his mean variance paradigm. Treasury bills are the least risky, Elton and Gruber (1995), but play a special role in financial
theory because they have no risk of default in addition to very short term maturities. Ordinary shares issued by private entities represent an ownership claim on the earnings and assets of the firm that issued them, Elton and Gruber (1995). Even with the limited liability that ordinary shares come with, the residual nature of claims (on a firm’s assets and earnings accruing to shareholders, this class of investment is considered the riskiest. However money to productive sector in the form of subscription for stocks in corporations could contribute much more desired economic growth than money invested in Treasury bills.

4.5 Industrial production

Industrial production (IP) is a measure of output of the industrial sector of the economy. It measures the volume of production at base year prices for the manufacturing, mining and quarrying and energy supply industries. The industrial sector includes manufacturing, mining, and utilities. Although these sectors contribute only a small portion of Gross domestic product (GDP), they are highly sensitive to interest rates and consumer demand. This makes industrial production an important tool for forecasting future GDP and by extension the whole economic performance. Another use of Industrial production figures is by central banks to measure the levels of inflation, since high levels of industrial production can lead to unrestrained consumption numbers and rapid inflation as well. In contrast to high levels, the reduced consumer spending drives demand at a low level. Subsequently, the production is slowing down. Low industrial production means lower corporate sales and profits, which directly affects stock prices.

The IP time series data used for this study are seasonally adjusted figures on the index of output of the production industries. A continuous fall in overall IP data may lead to many fundamentally strong stocks being undervalued. This gives you the perfect opportunity to invest in fundamentally strong companies at discount price.
4.6 Crude oil prices

Many researchers studied the movements and shocks of oil price and how those fluctuations are related to stock market prices. They discovered that there is indeed a correlation between the two. It is quite usual to link the fluctuations of economic indicators, such as oil, and the performance of major stock market indexes like FTSE 100 in this case. It is generally known and understood that an increase in oil prices will raise input costs for most businesses. Higher crude oil prices directly affect the cost of gasoline, home heating oil, manufacturing and electric power generation.

The price of oil influences the costs of production and manufacturing. For example, there is the direct correlation between the costs of gasoline or airplane fuel to the price of transporting goods. As many industries are refined from oil, lower oil prices benefit the manufacturing sector. High oil prices have an impact on other economic factors like inflation. In contrast, drops in the price of oil were largely viewed as positive because it lowers the price of importing oil and reduces costs for the manufacturing and transport sectors. This reduction of costs could be passed on to consumer and thereby the whole economy as well. Oil price shocks due to the fact that are caused by fluctuations in the global business cycle are expected to influence all stock markets in the same manner.

Filis, Degiannakis and Floros (2011) in their study examined the relationship between oil shocks that influences oil-importing and oil-exporting countries and stock market prices. They found that oil price shocks tend to affect oil-importing and oil-exporting countries in the same way. One reason is the fact that those shocks are caused by global economic, business and other incidents that will affect all stock market worldwide. A second reason can be attributed to the oil sector that in some oil importing countries is rather small that the effects of any uncertainty is bare minimum. They came to the conclusion that non-economic uncertainties provoke a stronger negative link between oil prices and stock markets. However, if the crisis originates from financial activities, that triggers a stronger positive link between oil prices and stock markets. It is important to mention that United Kingdom is mainly an oil importing country.
4.7 Gross domestic product

This variable is not included in the main model but in the alternate where the Gross domestic product is the predictor and FTSE all-share index the dependent one. Generally, Gross domestic product (GDP) and the stock market link to each other through several financial conditions as well as consumer preferences. When stock market is booming, it tends to derive a mood of a great deal of optimism surrounding the economy and the prospects of the performance of various stocks. When institutes valuate firms positively, that allows them to obtain loan at lower rates, allowing them to expand their operations, invest in new projects, and try to find new financial opportunities. Subsequently, this environment will generate new jobs and consumers will purchase more, either goods or services. All of these activities can boost GDP and by extension the entire economy. The confidence that prevail from the positive performance of the share market in bull mode, only optimistic results and prospects could bring. However, when share market is experiencing downturns, it negatively affects GDP through the same channels. All the beneficial effects that discussed above will have adverse sign in a bear market. In this situation, companies are forced to cut costs and jobs too. Businesses will struggle to find new sources of financing, and existing debt will grow even more. Due to these conditions and the pessimistic climate, investing in new projects is highly unlikely. These will have a negative impact on GDP. Economic growth is impacted by other indicators like unemployment, inflation, interest rates and more others. That is also one of the reasons why this factor is not included in the main regression model with the rest of the selected macroeconomic factors.

There are many studies regarding the performance of the economy and the capital market. It was discussed before, in simple terms, how GDP and bull or bear markets link to one another. But do empirical studies of researchers find that indeed these two can link to each other? Many academic papers, based on real data, concluded different outputs on this matter and two of them are reviewed in this section.
Arestis, Demetriadis and Luintel (2001), after examining United States and United Kingdom’s economy, came to the conclusion that stock market volatility have a negative link to financial development. Furthermore, the results showed that financial development and economic growth have a weak relationship in the long run.

Duca (2007) in his study examined the causality direction of stock market prices and GDP in developed market economies including United Kingdom. He concluded that there is an unidirectional relationship between GDP and stock prices, implying that the level of economic activity in a country, can potentially depend on the stock market amongst other variables.

5. Empirical Results

The empirical examination is based on a share index of London Stock Exchange and five economic factors. It was mentioned above that the main econometric model to be used is the Ordinary Least Squares (OLS) for testing the relationship between selected macroeconomic variables and the stock market index (FTSE100). First, the appliance of a unit root test is crucial for this time series model. After running the model, we have to assure that the results of the OLS various econometric tests are carried out. As an extension to the main model, a lagged regression is produced to see if past values of the significant predictors could predict any changes in the present value of the dependent variable. Thereafter, the second model of FTSE all-share index and GDP will display us whether there is a link between them and if the one can predict the other with the Granger causality test.

5.1 Unit Root Test (Augmented Dickey-Fuller test)

The first step in the analysis, before running the regression, is to carry out an Augmented Dickey-Fuller (ADF) test, which is an extension of the Dickey-Fuller test,
for stationarity of the variables. In cases where time series data are used an ADF test is necessary to avoid non-reliable results. We can run the data before applying the unit root test and obtain satisfying results, like a high R-squared, and yet we do not have clear and precise outcomes. Many economic and financial time series exhibit trending behavior or non-stationarity in the mean. Models that contain non-stationary variables will often lead to a problem of spurious regression whereby the results obtained, suggest that there are statistically significant relationships between the variables in the regression model when in fact there is evidence of contemporaneous correlations rather than meaningful causal relations.

The unit root test will be applied in the dependent and independent variables. The null and alternative hypotheses are as follows:

- $H_0$: time series has a unit root (non-stationary)
- $H_1$: time series does not have a unit root (stationary)

In order to reject the null hypothesis the test statistic has to be more negative than the critical value in a selected level of confidence or the p-value is less than or equal to a specified significance level like 0.01(1%), 0.05(5%) or 0.1(10%).

After running the test and looking at the results, we can see that most the variables that have been under examination have a root. In more details, the dependent variable $SP$ has a unit root for the 5% confidence level since the critical value is more negative than the test statistic which means $SP$ is non-stationary. For the dependent variables, such as CPI, UN, EXC, IP and OP, the results are similar. Only the test statistic of TRB exceeds the critical value in 5% confidence level that makes the time series variable stationary. In the following table, we see by numbers the results of the test of stationarity.
As we see from ADF’s outcomes, the problem with the unit root exists in almost every variable selected in this study. For this reason, a solution to this issue would be to take the first differences of the non-stationary variables before running the OLS regression. With the help of STATA, new variables created which represent the first difference of SP, UN, CPI, EXC, IP and OP. The ADF test is applied again, now for the new variables. In case where the null hypothesis is not again rejected, then we have to take the second difference of each variable which includes a unit root in the first difference level. Following the results, the p-values of all the examined variables are greater (more negative) than the critical value in 95% confidence level. There are also more negative in the 1% and 10% confidence level. Table 3 demonstrates the results.

Table 2. Augmented Dickey-Fuller test outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>P-value</th>
<th>Null hypothesis</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>0.7065</td>
<td>Do not reject</td>
<td>SP is non-stationary</td>
</tr>
<tr>
<td>UN</td>
<td>0.9297</td>
<td>Do not reject</td>
<td>UN is non-stationary</td>
</tr>
<tr>
<td>CPI</td>
<td>0.9440</td>
<td>Do not reject</td>
<td>CPI is non-stationary</td>
</tr>
<tr>
<td>TRB</td>
<td>0.0026</td>
<td>Reject</td>
<td>TRB is stationary</td>
</tr>
<tr>
<td>EXC</td>
<td>0.3444</td>
<td>Do not reject</td>
<td>EXC is non-stationary</td>
</tr>
<tr>
<td>IP</td>
<td>0.5188</td>
<td>Do not reject</td>
<td>IP is non-stationary</td>
</tr>
<tr>
<td>OP</td>
<td>0.3949</td>
<td>Do not reject</td>
<td>OP is non-stationary</td>
</tr>
</tbody>
</table>
Table 3. Augmented Dickey-Fuller test outcomes after 1\textsuperscript{st} differences

<table>
<thead>
<tr>
<th>Variable</th>
<th>P-value</th>
<th>Null hypothesis</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP_diff</td>
<td>0.0000</td>
<td>Reject</td>
<td>SP_diff is stationary</td>
</tr>
<tr>
<td>UN_diff</td>
<td>0.0000</td>
<td>Reject</td>
<td>UN_diff is stationary</td>
</tr>
<tr>
<td>CPI_diff</td>
<td>0.0000</td>
<td>Reject</td>
<td>CPI_diff is stationary</td>
</tr>
<tr>
<td>EXC_diff</td>
<td>0.0000</td>
<td>Reject</td>
<td>EXC_diff is stationary</td>
</tr>
<tr>
<td>IP_diff</td>
<td>0.0000</td>
<td>Reject</td>
<td>IP_diff is stationary</td>
</tr>
<tr>
<td>OP_diff</td>
<td>0.0000</td>
<td>Reject</td>
<td>OP_diff is stationary</td>
</tr>
</tbody>
</table>

5.2 Ordinary Least Squares method (OLS)

Once the variables, dependent and independents, are stationary, with the use of first differences, next step is to run the OLS regression.

The equation comes as follows:

\[
(SP\_diff)_t = \alpha + \theta_1 (CPI\_diff)_t + \theta_2 (UN\_diff)_t + \theta_3 (TRB)_t + \theta_4 (IP\_diff)_t + \theta_5 (EXC\_diff)_t + \theta_6 (OP\_diff)_t + \epsilon_t
\]

Where:

- \( \theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6 \) are the coefficients of each independent variable
- \( \alpha \) is the intercept term
- \( \epsilon_t \) is the error term

After running the OLS model, we see the results that are displayed in the table below
From a quick look at the output, half of the predicted variables have a significant relationship with the dependent variable DSP. In more details, exchange rate’s p-value is lower that 5% (0.000<0.05) which means the variable is statistical significant in 95% confidence level. As for the coefficient, the figure has a positive sign that indicates a positive correlation between the two variables. For instance, an increase in the exchange rate of British pound to Euro will lead to a rise in the Stock prices of the index. In addition, another predicted variable that indicates a positive correlation with Stock prices is Industrial production index. That could be seen if we look at the beta coefficient which is 36.05. There is a significant relationship between the two variables since its p-value is quite lower than 5% (0.012<0.05). Moreover, Oil prices variable is the third predictor that is positively correlated to share prices of FTSE 100 index. This relation means that an increase of 1% in oil prices will cause stock prices to rise by 6.04%. In the case where some of the statistical significant variables hold a negative sign in their coefficient figures, a rise by a certain amount of the independent variable will lead to a decrease for the dependent. Overall, after carrying out the OLS regression the results signify that three of the six macroeconomic factors, which were selected to this study, explain and have an impact on the Stock prices index in United Kingdom.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>P-value</th>
<th>IP_diff</th>
<th>OP_diff</th>
<th>Cons</th>
<th>R-squared</th>
<th>Adjusted R-squared</th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN_diff</td>
<td>-172.4</td>
<td>-1.20</td>
<td>0.231</td>
<td>36.05</td>
<td>6.04</td>
<td>16.97</td>
<td>0.1574</td>
<td>0.128</td>
<td>5.35</td>
</tr>
<tr>
<td>CPI_diff</td>
<td>56.67</td>
<td>1.12</td>
<td>0.262</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRB</td>
<td>-1.02</td>
<td>-1.50</td>
<td>0.136</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXC_diff</td>
<td>3.17</td>
<td>4.08</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Ordinary Least square (OLS) outcome
In a financial environment, when it comes to investment decisions, macroeconomic indicators have an important role to play in the process. Corporations and private investors aim to maximize their profits. Therefore, it is essential to monitor the developments and changes of the economy in any level; either is in the production, in labor or in capital market. From the results that are displayed above, industrial production, crude oil prices and exchange rate influence the share market movements of FTSE 100 index. So paying attention to production industries, like manufacturing or energy, can show if a financial decision, regarding those sectors, will be carried out or not. The currency of GBP against Euro is positively linked to stock prices. Any movement in monetary policy, caused by an incident, will affect exchange rates and by extension the prices of shares. Although the study examines this specific currency, other studies showed that different currencies could impact the stock market. Another critical indicator that influences the economy in a general matter is the price oil. The study proved a positive relationship between them. Oil prices have a dynamic influence on the economy as a whole, once a large percentage of corporations and households are depending on them. So following the movements of oil prices is important for corporations and investors in order to take decisions concerning the stock market.

The other three variables that were under examination showed no sign of relation with the dependent variable. However, we have to keep in mind that even though theses economic indicators did not affect share market activities, economy depends on their changes. For example, a growing or shrinking consumer demand should be an investor’s concern as well as unemployment rate. Maybe they do not have an immediate impact on stock returns but they do have an indirect significance through other economic forces. Same applies for Treasury bill rate which do not have the predicted power on stock market returns but it influences interest rates. In other words, macroeconomic factors are linked in various ways and that should be taken into consideration before any financial transactions regarding the stock market.

As it was mentioned earlier, the data used for this study derive from a period of time where many economic and financial fluctuations occurred. For instance, unemployment rate reached its highest level since 1994 in the Great Recession of
the late 2000s. Additionally, changes in interest rates and yields influenced other economic factors like Treasure Bills rate. Inflation rose significantly and the industry of manufacturing declined by 7%. Thus, we could say that those incidents may be the reason why those three explanatory variables do not give us a clear picture regarding the performance of the stock market index of FTSE 100 in United Kingdom. In addition to economic incidents, the companies which constitute the index of FTSE 100 are updated four times a year, so in a fifteen year period many alterations had took place. Hence, these changes can be taken into account concerning the behavior of some independent variables.

5.2.1 OLS model in lags

As an extent to the main OLS regression, the lagged model will be produced. It is a model for time series data in which the regression equation is used to predict current values of a dependent variable based on both current and past values of the explanatory variables. As we saw in section 5.2, the current values of the independent variables were used to explain the current values of the dependent one. Based on this equation, we add two lagged variables for each predictor. The selection of two lag weights was made to avoid multicollinearity effects among the various lagged values of the independent variables and also, the prediction can be more reliable when the predictor’s values come from two time periods before. Now the new equation, demonstrated below, includes both present and previous values of the explanatory variables and the dependent’s as well.

\[
(SP\text{\_diff})_t = \alpha + \beta_0 (UN\text{\_diff})_t + \beta_1 (UN\text{\_diff})_{t-1} + \beta_2 (UN\text{\_diff})_{t-2} + \gamma_0 (CPI\text{\_diff})_t + \\
\gamma_1 (CPI\text{\_diff})_{t-1} + \gamma_2 (CPI\text{\_diff})_{t-2} + \delta_0 (EXC\text{\_diff})_t + \delta_1 (EXC\text{\_diff})_{t-1} + \delta_2 (EXC\text{\_diff})_{t-2} + \\
\eta_0 (TRB)_t + \eta_1 (TRB)_{t-1} + \eta_2 (TRB)_{t-2} + \zeta_0 (IP\text{\_diff}) + \zeta_1 (IP\text{\_diff})_{t-1} + \zeta_2 (IP\text{\_diff})_{t-2} + \delta_0 (OP\text{\_diff}) + \\
\delta_1 (OP\text{\_diff})_{t-1} + \delta_2 (OP\text{\_diff})_{t-2} + \kappa_1 (SP\text{\_diff})_{t-1} + \kappa_2 (SP\text{\_diff})_{t-2} + \epsilon_i_t
\]

Where \( t-1, t-2 \) refer to first and second lag respectively.
After realizing the OLS model extension in STATA, we can observe that the lagged variables of the three statistical significant predictors cannot, all of them, predict the current value of FTSE 100 index prices. For instance, the Exchange rate can impact positively the stock prices in its present value but that does not apply to the two previous values (L1.EXC and L2.EXC). Same behavior is noticed from the first and second lagged values of Oil Prices (L1.OP and L2.OP). Although, Industrial Production’s first lagged value appears to impact the present value of Stock prices significantly, in the second past value there is no influence on the dependent variable. Overall, we can conclude that past values of the statistical significant explanatory variables do not explain the current value of the examined dependent variable at the most part.

In the following sections, various tests will be produced in order to check the reliability and effectiveness of the OLS regression model outcomes. A detection of multicollinearity within the explanatory variables, a heteroscedasticity test, a white noise and autocorrelation test as well as a normality test are essential to prove the efficiency of this analysis. To avoid any confusion, the tests are carried out for main OLS regression results and not for the lagged model.

5.2.2 Multicollinearity detection

Multicollinearity (or collinearity) is a phenomenon that occurs when the regression model includes multiple factors that are correlated not just to the response variable, but also to each other. Although multicollinearity does not reduce the predictive power or reliability of the model as a whole, it is important to check if there is any sign of it within the predictors.

Using the STATA demand of VIF, which stands for variance inflation factor, the results are the following:
The results and be able to rely on them. The null hypothesis and Correlation matrix of coefficients of regress model

<table>
<thead>
<tr>
<th></th>
<th>VIF</th>
<th>1/VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP_diff</td>
<td>1.10</td>
<td>0.909075</td>
</tr>
<tr>
<td>CPI_diff</td>
<td>1.09</td>
<td>0.920618</td>
</tr>
<tr>
<td>EXC_diff</td>
<td>1.03</td>
<td>0.964218</td>
</tr>
<tr>
<td>UN_diff</td>
<td>1.03</td>
<td>0.967452</td>
</tr>
<tr>
<td>IP_diff</td>
<td>1.03</td>
<td>0.968913</td>
</tr>
<tr>
<td>TRB</td>
<td>1.03</td>
<td>0.971241</td>
</tr>
</tbody>
</table>

Mean VIF 1.05

\[
VIF = \frac{1}{\text{tolerance}} \quad \text{where} \quad \text{tolerance} = 1 - R^2
\]

A tolerance of less than 0.20 or 0.10 and/or a VIF of 5 or 10 and above indicates a multicollinearity problem. In this case, tolerance exceeds those values, so does VIF. So, there is no indication of collinearity.

**5.2.3 Heteroscedasticity test**

In this part, a heteroscedasticity test will be occurred in order to examine the efficiency of the OLS outcomes. The presence of Homoscedasticity is crucial in a Linear Regression model. In other words, homoscedasticity means that the variance of residuals should not increase with fitted values of response variable. The test is needed to assure the results and be able to rely on them. The null hypothesis and the alternative are:

- \( H_0 = \text{Homoscedasticity (Constant variance)} \)
- \( H_1 = \text{Heteroscedasticity (non-constant variance)} \)
The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity will be used. The STATA output is summarized in the table below.

<table>
<thead>
<tr>
<th>Table 5. Heteroscedasticity test results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi2 (6)</td>
</tr>
<tr>
<td>Prob&gt;chi2</td>
</tr>
</tbody>
</table>

According to test results, the p-value does not exceed the 0.05 which means we cannot reject the null hypothesis, indicating there is homoscedasticity and the OLS regression can be trusted.

5.2.4 White noise and Autocorrelation test

Another test will be realized in order to examine if the residuals are White noise which means there is no serial correlation, residuals are homoscedastic and the mean of the residual is zero. The purpose of this test, as it was mentioned before, is to confirm the reliability and accuracy of the OLS outcomes.

An autocorrelations and partial correlation graph is displayed below.
Additionally, a Breusch-Godfrey Serial Correlation LM test will be carried out in this section for more detailed outcomes.

The null hypothesis and the alternative are:

- $H_0$ = no serial correlation
- $H_1$ = serial correlation

After looking at the results, we can conclude that there is no serial correlation since the p-value surpasses the 5%. Same output comes from the Durbin’s alternative test for autocorrelation, where the probability value is 0.1609 lower than 0.05, so we cannot again reject the null hypothesis of no autocorrelation.

**5.2.5 Normality test**

This test examines if the residuals are normally distributed. By displaying a histogram of residuals, we can visually understand how the residuals are distributed. Moreover, a Jarque-Bera test of normality can give us more details in figures.
From a quick look at the histogram, it is obvious that the residuals are not normally distributed.

The Jarque–Bera test checks whether sample data have the skewness and kurtosis matching a normal distribution. The hypotheses are as follow:

- $H_0$: Normality
- $H_1$: non-Normality

The table below demonstrates the JB test results:

<table>
<thead>
<tr>
<th>Pr(Skewness)</th>
<th>Pr (Kurtosis)</th>
<th>adj chi2 (2)</th>
<th>Prob&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0020</td>
<td>0.3626</td>
<td>9.29</td>
<td>0.0096</td>
</tr>
</tbody>
</table>

It is also confirmed by the JB test that the errors are not normally distributed since the value of 0.0096 does not exceed the 0.05. This non-normality in the distribution could be explained considering that some of the predictor variables increased more than the rest. We cannot forget the fact that the times series variables are from 2002 until 2016 which means that through those years many events mediated that
affected the variables. For example, the global economic crisis of 2008 that influenced many macroeconomic factors as well as the Referendum for E.U, were crucial determinants in the British economy.

5.3 FTSE all-share and GDP model

In this part of the dissertation, another model is studied. This time, another economic indicator, GDP, will again play the role of the predictor. The dependent variable will be FTSE all-share index. The purpose of this test is to see if there is a cause of Gross Domestic Product of the British economy on stock market movements in the index of FTSE all-share. The main reason establishing this model is that GDP does considered as a very strong macroeconomic factor where impacts other economic indicators, so a problem with collinear relationship between the rest variables, in the first model, could have been possible. In addition, FTSE all-share index includes a considerable amount of firms; therefore, it can be a more representative sample when we want to study how an important economic determinant like GDP could link to the index’s performance and vice versa.

The FTSE All-Share Index, originally known as the FTSE Actuaries All Share Index, is a capitalization-weighted index, comprising around 600 of more than 2,000 companies traded on the London Stock Exchange. It is considered as a good market index indicator for examining the activity, increases or decreases, of stock prices of almost one third of total LSE listed companies.
For this examination, two econometric models are conducted. First the OLS regression model to see if FTSE all-share index can be significantly affected by GDP and second a Granger causality test to examine if the predictor variable can forecast the dependent and vice versa. Due to the fact that this model works as an auxiliary for the whole study, only the main output is displayed for OLS and Granger tests. The time period examined is 2002-2016 and the tests are based on quarterly data. The source of the data is the Office of National Statistics of UK, like some of the other examined variables, and they are seasonally adjusted prices.

The OLS’ model equation is demonstrated below:

\[(\text{GDP}_t) = a_1 + \beta_1 (\text{FTSE})_t + u_1\]

The results are summarized in table 7.
Table 7. Ordinary Least square (OLS) outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>0.011537</td>
<td>7.78</td>
<td>0.000</td>
</tr>
<tr>
<td>Cons</td>
<td>-2,028</td>
<td>3.21</td>
<td>0.002</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.4786</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.4707</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>60.58</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the regression output, FTSE all share stock prices have a significant relationship with the Gross domestic product since the p-value of 0.000 does not exceed the 5% significance level. In addition, the beta coefficient of GDP have a positive sign meaning that an increase in stock prices of the market index will lead to an increase of the level of GDP as well. An increase of 1% in GDP level will cause a rise at stock prices of the index by 1.15%. As it was mentioned before, GDP is an indicator of economic growth so it is interesting to see how the share market movements could be impacted by its level and by extension the progress and development of the stock market as a whole. Levine and Zervos (1996) in their research found a positive correlation between economic growth and the performance of stock market in the long run.

Regarding the second diagnosis, the Granger Causality test examines whether a times series variable can predict another or not. Thus, this test determines if the past values of a selected variable can predict changes in another one. It is commonly used for forecasting economic variables, so it could be useful in this particular case that macroeconomic variables are examined.

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

- \( H_0 = \) GDP does not Granger Cause FTSE all-share
- \( H_1 = \) GDP does Granger Cause FTSE all-share
As much as the Granger causality test results are concerned, the p-value of 0.268 is greater than 0.05 (appendix 8.4), so we cannot reject the null hypothesis that GDP does not Granger Cause FTSE all-share. However, we can observe that FTSE all-share “Granger causes” Gross Domestic Product (0.004<0.05) meaning that the movements of the entire index of London stock exchange can forecast the economic growth of United Kingdom.

There are other studies mentioning that GDP and the market performance have a weak relationship or they actually link but in a negative way. Economic growth in UK was affected from the global economic crisis of the late 2000s, so we have to take into consideration this kind of parameters could easily affect the results of any study.

6. Summary and Conclusions

The dissertation aims to provide empirical evidence of the impact of macroeconomic variables on stock market performance of FTSE 100 index in United Kingdom from the period of 2002 until 2016. The main model included six independent variables such as Consumer Price Index, Exchange Rate, Treasury bills rate, Unemployment rate, Oil prices and Industrial production and the dependent one, Stock prices. Based on the OLS outcomes, half of them showed a significant relationship with the main variable. Exchange rate, Industrial production and Oil prices can positively affect the movements of stock prices of the examined share market index. However, the other half of the predictor variables like Unemployment rate, CPI and Treasury bill rate did not appear to influence FTSE 100 index. As much as the extension of the OLS model is concerned, the output of the extended OLS model revealed that the past values of two of the three statistical significant predictors do not influence the current value of the examined dependent variable. Only first-lagged Industrial Production variable have the ability to impact the prices of the index.

Another hypothesis tested in the study was whether the Gross domestic product of UK can affect the performance of FTSE all-share index, which acts as an alternate of the main hypothesis. The results indicated that growth or downturns of economic growth of the British economy could lead to additional increases or decreases to
share prices of the examined index, respectively. Additionally, the Granger causality test that was carried out for this model showed that share price movements can predict GDP and by extension the performance and growth of the economy as a whole. However, Gross domestic product cannot forecast the performance of stock prices. The dissertation’s empirical results are consistent with other similar studies made by researchers regarding both hypotheses. To sum up, we could say that economic indicators can impact the stock market movements, positively or negatively, with direct or indirect influence. The entire economy can be characterized as a chain which is composed of those factors mentioned above, and many others, and they operate in the same environment. Although this study cannot be a guide on investment decisions, for the reasons mentioned above, corporations, investors or policy makers when it comes to financial or investment decisions, they should pay attention on macroeconomic indicators frequently.

7. References


www.finance.yahoo.com

www.investopedia.com

www.wikipedia.com
8. Appendices

8.1 Augmented Dickey-Fuller test results

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Z(t) )</td>
<td>-1.121</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for \( Z(t) = 0.7065 \)

<table>
<thead>
<tr>
<th>Test Statistic</th>
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<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Z(t) )</td>
<td>-0.152</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for \( Z(t) = 0.9440 \)

<table>
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<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Z(t) )</td>
<td>-0.270</td>
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<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for \( Z(t) = 0.9297 \)

<table>
<thead>
<tr>
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<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Z(t) )</td>
<td>-3.827</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for \( Z(t) = 0.8026 \)

<table>
<thead>
<tr>
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<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Z(t) )</td>
<td>-1.874</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for \( Z(t) = 0.3444 \)
8.1.1 Data graphs set at level

Graph 1. Stock prices (SP)  
Graph 2. Unemployment rate (UN)  
Graph 3. Consumer price index (CPI)  
Graph 4. Treasury bills rate (TRB)
8.2 ADF with 1st differences

. dfuller SP_diff, lags(0)

Dickey-Fuller test for unit root

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-13.690</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller UN_diff, lags(0)

Dickey-Fuller test for unit root

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-8.638</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller CPI_diff, lags(0)

Dickey-Fuller test for unit root

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-14.700</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

MacKinnon approximate p-value for Z(t) = 0.0000
. dfuller EXC_diff, lags(0)

Dickey-Fuller test for unit root

<table>
<thead>
<tr>
<th>Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-14.048</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

Mackinnon approximate p-value for Z(t) = 0.0000

. dfuller IP_diff, lags(0)

Dickey-Fuller test for unit root

<table>
<thead>
<tr>
<th>Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-15.914</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

Mackinnon approximate p-value for Z(t) = 0.0000

. dfuller OP_diff, lags(0)

Dickey-Fuller test for unit root

<table>
<thead>
<tr>
<th>Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z(t)</td>
<td>-8.738</td>
<td>-3.484</td>
<td>-2.885</td>
</tr>
</tbody>
</table>

Mackinnon approximate p-value for Z(t) = 0.0000

### 8.2.1 Data graphs set at first difference

**Graph 8. Stock prices (SP_diff)**

**Graph 9. Unemployment rate (UN_diff)**
8.3 OLS regression results

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 179</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1255046.79</td>
<td>6</td>
<td>209174.466</td>
<td>F(  6,   172) = 5.36</td>
</tr>
<tr>
<td>Residual</td>
<td>6716678.54</td>
<td>172</td>
<td>39050.4567</td>
<td>Prob &gt; F = 0.0000</td>
</tr>
<tr>
<td>Total</td>
<td>7971725.34</td>
<td>178</td>
<td>44784.9738</td>
<td>R-squared = 0.1574</td>
</tr>
</tbody>
</table>

| SP_diff | Coef.  | Std. Err. | t     | P>|t|   | [95% Conf. Interval] |
|---------|--------|-----------|-------|-------|---------------------|
| UN_diff | -172.4109 | 143.5388 | -1.20 | 0.231 | -455.7353 - 110.9135 |
| CPI_diff| 56.67493 | 50.40225 | 1.12  | 0.262 | -42.81166 - 156.1615 |
| TRB     | -1.018741 | .6794542 | -1.50 | 0.136 | -2.359884 - .3224009 |
| EXC_diff| 31.67035 | 7.76512  | 4.08  | 0.000 | 16.34315  46.99755  |
| IP_diff | 36.05692 | 14.1522  | 2.55  | 0.012 | 8.122572 - 63.99126  |
| OP_diff | 6.039259 | 2.555973 | 2.36  | 0.019 | .994158 - 11.08437  |
| _cons   | 16.9756  | 21.03354 | 0.81  | 0.421 | -24.54149 - 58.49269 |

8.3.1 OLS model in lags results
8.3.2 Heteroscedasticity test results

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: UN_diff CPI_diff TRB EXC_diff IP_diff OP_diff

\[
\begin{align*}
\chi^2(6) & = 8.42 \\
\text{Prob} > \chi^2 & = 0.2087 \\
\end{align*}
\]

Breusch-Godfrey LM test for autocorrelation

\[
\begin{array}{c|cc|c}
\text{lags(p)} & \chi^2 & \text{df} & \text{Prob} > \chi^2 \\
\hline
1 & 2.034 & 1 & 0.1538 \\
\end{array}
\]

Ho: no serial correlation

8.3.3 Autocorrelation results
8.3.4 Normality test results

Skewness/Kurtosis tests for Normality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Pr(Skewness)</th>
<th>Pr(Kurtosis)</th>
<th>adj chi2(2)</th>
<th>Prob&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>myResiduals</td>
<td>178</td>
<td>0.0020</td>
<td>0.3626</td>
<td>9.29</td>
<td>0.0096</td>
</tr>
</tbody>
</table>

8.4 FTSE all-share and GDP model

8.4.1 OLS regression model results
8.4.2 Granger causality test output

Granger causality Wald tests

<table>
<thead>
<tr>
<th>Equation</th>
<th>Excluded</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTSEAllShare</td>
<td>GDP</td>
<td>11.271</td>
<td>2</td>
<td>0.004</td>
</tr>
<tr>
<td>FTSEAllShare</td>
<td>ALL</td>
<td>11.271</td>
<td>2</td>
<td>0.004</td>
</tr>
<tr>
<td>GDP</td>
<td>FTSEAllShare</td>
<td>2.6347</td>
<td>2</td>
<td>0.268</td>
</tr>
<tr>
<td>GDP</td>
<td>ALL</td>
<td>2.6347</td>
<td>2</td>
<td>0.268</td>
</tr>
</tbody>
</table>