The Negative Relationship Between Inflation and Maltese Stock Returns: An Analysis

by

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A dissertation submitted in partial fulfilment of the requirements for the award of the Master in Accountancy degree in the Department of Accountancy at the Faculty of Economics, Management and Accountancy at the University of Malta

May 2020

20MACC043

Abstract

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PURPOSE: This study sought to analyse the relationship between inflation and Maltese stock returns and identify causes of such relationship using monthly data comprising of 139 observations. Additionally, the study sought to compare the results of the Maltese stock market with previous empirical evidence from developed and developing economies.

DESIGN: A mixed-research design was adopted to attain the objectives of the study. The quantitative method involved a series of statistical tests so that the final multivariate time series model – a vector error correction model, was fitted to the data. Research efforts were corroborated through the findings from the qualitative method which involved 8-semi-structured interviews with local experts on the subject matter.

FINDINGS: Stock returns are positively influenced by stock returns of the previous month and negatively influenced by inflation where the inflation factor takes 3 to 4 months to impact stock returns. Additionally, short-term interest rates and money supply seem to contribute indirectly to the negative inflation-stock returns relationship since both variables are statistically significant in explaining inflation. Long-term interest rates and industrial production variables are statistically insignificant in explaining both inflation and stock returns. The key message from the interviews, the Maltese investors' mentality of high dividend pay-out and capital preservation was stressed by all interviewees.

CONCLUSIONS: Investors should incorporate inflation, short-term interest rates and money supply when making an investment decision. Additionally, policy makers should exert smooth and positive influences on the economy so as to reduce volatility in the Maltese stock market and in turn increase investors' confidence.

VALUE: The study contributed in enriching the current limited literature on the Maltese stock market and hence adding value to local financial advisors when giving investment recommendations. Moreover, the study gave additional value to macroeconomics finance literature by providing several recommendations to investors and policy makers.

KEYWORDS: *Maltese stock market, stock returns, multivariate time series model, macroeconomic finance literature*

Dedicated to Mum & Dad

and

my sisters, Kristina & Francesca

Acknowledgements

My sincere gratitude goes to my dissertation supervisor, Mr Konrad Farrugia, for his constant assistance, guidance and dedication throughout the development of this dissertation.

Special thanks go to Dr. David Suda to whom I am deeply grateful for his patience and help in the statistical and econometric analysis of this study.

I wish to thank all those who in some way contributed to my study, especially to all the participants who accepted my request for an interview.

Last but not least, my appreciation goes to my family and friends for their constant support, encouragement and for always believing in me throughout the compiling of this study. This dissertation would certainly have not been accomplished without their input.

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List of Abbreviations

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
AR	Autoregressive
CLRM	Classical Linear Regression Models
CPI	Consumer Price Index
DCF	Discounted Cash Flows
DF	Dickey-Fuller
EMH	Efficient Market Hypothesis
EU	European Union
FPE	Akaike's Final Prediction Error
GDP	Gross Domestic Product
HICP	Harmonised Index of Consumer Prices
HQ	Hannan-Quinn Information Criterion
IP	Index of Industrial Production
MFSA	Malta Financial Services Authority
MS-DR	Markov-Switching Dynamic Regression
MSE	Malta Stock Exchange
MSETRX	Malta Stock Exchange Equity Total Return Index
NSO	National Statistics Office
OLS	Ordinary Least Squares
RPI	Retail Price Index
SC	Schwarz-Bayes Information Criterion
SPSS	Statistical Package for Social Sciences
VAR	Vector Autoregressive
VECM	Vector Error-Correction Model

Chapter 1

Introduction

1.0 Introduction

Inflation imposes a threat to investors since it takes away real savings and investment returns. Generally, investors strive to raise their long-term purchasing power. However, inflation restrains such objective since for real purchasing power to increase, investment returns must first sustain the rate of inflation. Treasury inflation protected securities, inflation-linked bonds are all inflation-linked instruments which offer a protection against inflation. In spite of this, real returns on assets are usually low. Therefore, investing in stocks becomes more attractive for investors since they will enjoy the equity premium, but the drawback is that stocks are subject to inflation risk. For this reason, identifying and understanding the relationship between inflation and stock returns is crucial.

This chapter is intended to lay out the basis of the dissertation. Section 1.1 provides a definition of inflation and gives an overview of the inflation in Malta. Section 1.2 gives a brief description of the local stock market while section 1.3 provides a definition of stock returns and gives a general idea of the stock returns in Malta. Section 1.4 gives a brief description of the Efficient Market Hypothesis and the concept of arbitrage. Section 1.5 explains the need for the study while section 1.6 outlines the research objectives of this dissertation. Section 1.7 comprises the scope and limitations inherent to the study and finally section 1.8 provides an outline of the structure of this dissertation.

1.1 Defining Inflation

"Inflation refers to a general rise in the level of prices throughout the economy" (Sloman, Wride 2009, p.6). If aggregate demand increases significantly, businesses are expected to react by increasing their prices. Nevertheless, if there is a high demand for a particular product, firms can presumably still sell the same as before and hence make more profits. Thus, the increase in prices by businesses in general will cause inflation (Sloman, Wride 2009).

Inflation is normally driven by a surge in money supply or increases in the cost of production. It contributes in expansion of the economy because if inflation for the next year is expected to increase, then individuals are motivated to purchase sooner. However, when inflation increases, it can be detrimental to an economy because it generates low growth and greater unemployment (Stanlake, Grant 2000). Generally, the rate of inflation is measured by using consumer prices which can be defined by equation 1.1 (Sloman, Wride 2009).

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100 \qquad \textbf{(1.1)}$$

Where;

π_t = Rate of inflation,

P_t = Price index for year t,

P_{t-1} = Price index for the preceding year.

This measure is used throughout the European Union (EU) and is more commonly known as the harmonised index of consumer prices (HICP). The HICP provides for 100 per cent of consumer spending and applies specific weights for every component (Sloman, Wride 2009).

1.1.1 Inflation in Malta

Even though one can observe significant fluctuations in inflation in Malta, statistics depict that long-term trend inflation has followed a slow-moving descending path over the past 11 years, from slightly below 4% in 2008 to around 1% by 2019 (National Statistics Office [NSO] 2019).

1.2 The Maltese Stock Market

The Malta Stock Exchange (MSE) was set up in 1990, consequent to the enactment of the Malta Stock Exchange Act, and trading operations started on 8th January 1992. The MSE is the only stock exchange in Malta. It is a regulated market which acts as its own market operator with the principal role being to provide a structure for the admission of a variety of financial instruments such as equities, bonds, treasury bills and collective investment schemes. The MSE is authorised and supervised by the Malta Financial Services Authority (MFSA). Currently, the MSE has 24 Maltese equities listed which are all registered in Malta. In 2018, total market capitalisation stood at €12.1 billion with around €4.4 billion relating to equities, whereas annual equity market turnover stood at €86.3 million (Malta Stock Exchange [MSE] 2019).

Smith (2012) studied the efficiency of European emerging stock markets and concludes that the MSE is amongst the least efficient stock markets. A possible reason being that in general the Maltese investor is a buy-and-hold-investor (Sammut 2002). Furthermore, Zahra (2018) showed that the MSE has some deficiencies through the results of statistical tests conducted as well as through the questionnaires where the majority of the participants considered the MSE to be inefficient. The participants of the questionnaire suggested that such deficiencies might be due to the fact that most investors are passive, or due to the small size of the Maltese stock market which restricts the number participants (Zahra 2018). Sammut (2002) concludes that inefficiency in the Maltese stock market arose due to market attributes such as small size of the Maltese stock market and illiquidity.

1.3 Stock Returns

Stock return measures how well an individual does by holding equity over a specific period which can be defined by the equation below:

$$Total\ Stock\ Return = \frac{P_{t+1} - P_t + D}{P_t} \qquad \textbf{(1.2)}$$

Where;

P_t = Stock price at time 't',

P_{t+1} = Stock price at time 't+1',

D = Dividends.

Therefore, stock returns quantify the worth that shareholders gain against the amount paid for the initial equity investment. Stock returns are influenced by each and every element that affects the total demand and total supply of an economy. These elements consist of inflation, real interest rates and real activity level amongst others (Mishkin et al. 2013). From the daily data published by the MSE, it could be denoted that total equity returns in Malta have on average increased in the past eleven and a half years, that is, from an index of 7,179.745 on 4th January 2008 to an index of 9,769.838 on 30th August 2019 (MSE 2019).

1.4 The Efficient Market Hypothesis and the Concept of Arbitrage

1.4.1 The Efficient Market Hypothesis

In an efficient market (Fama 1965), the price of an equity is presumed to be equivalent to the aggregate of its discounted expected future cash flows. The Efficient Market Hypothesis (EMH) maintains that in an efficient market, the price of a security should reflect all available information. This can be defined through the following equation which states that "current prices in a financial market will be set so that the optimal forecast of a security's return, using all available information, equals the security's equilibrium return" (Mishkin et al. 2013, p.138).

$$R^{of} = R^{*} \qquad \textbf{(1.3)}$$

Where;

R^{of}= optimal forecast of the return,

R^{*}= equilibrium return.

Additionally, the EMH states that all prices are always precise and “reflect market fundamentals” in an efficient market (Mishkin et al. 2013, p.139).

1.4.2 The Concept of Arbitrage

The rationale behind the EMH can be explained through the concept of arbitrage, where the arbitrageurs remove unexploited profit opportunities (Mishkin et al. 2013).

1.5 Need for the Study

The scope for analysing the relationship between inflation and Maltese stock returns is twofold.

The first reason being that there is lack of congruence in the literature regarding whether inflation and stock returns are positively or negatively correlated. This lack of agreement is evident both in relation to theory and also empirically. The extended Fisher (1930) hypothesis states that a rise in inflation should be equivalent to a one-to-one rise in the inflationary element of the asset’s return and also in the total return of the asset concerned. Hence, in this regard, the inflation-stock returns relation can be presumed to be absolutely positive. Correspondingly, Yuhn et al. (2018) state that stock returns and expected inflation should be positively correlated given that investors retain stocks as a hedge against inflation. Contrastingly, the study by Fama (1981) contradicts the Fisher (1930) hypothesis because of “proxy effects”. This implies that stock returns are driven by predictions of more closely related real variables and the negative inflation-stock returns relation is generated by the adverse correlation between inflation and real activity (Fama 1981). Modigliani and Cohn (1979) also found a negative relationship, they deduced that it arises because investors in the stock market undergo inflation illusion and so reduce stock prices due to high inflation and vice versa. Moreover, Li et al. (2010) established that the relationship between inflation and stock returns varies according to whether inflation is expected or unexpected. As a result, examining this relationship using Maltese data can provide an understanding of this relationship.

Secondly, no previous studies on this subject matter have been undertaken in Malta with the exception of Buhagiar (2017) who investigated the relationship between Maltese stock returns and seven macroeconomic indicators, amongst which was inflation. Buhagiar (2017) found that not only inflation and stock returns are inversely related but that the relationship is highly significant. The other macroeconomic indicators studied were interest rates, industrial production, term spread, German DAX index, EUR/USD exchange rate and oil prices (Buhagiar 2017).

As a result, this dissertation aims to provide a justification for the negative relationship between inflation and stock returns. Furthermore, prior studies tend to focus on the Maltese stock market, more specifically on identifying whether it is efficient or not and pinpointing its inefficiencies (Vella 2012, Tabone 2016, Zahra 2018). Therefore, this study will aim to establish a relationship between these two variables in the Maltese market and investigate the causes of such relationship.

Ultimately, the inflation-stock returns relation is an area of concern both for investors as well as for policymakers. Starting from the former, a better understanding of such relationship will help investors identify whether stock returns could provide protection against inflation (positive relationship) or not (negative relationship). With respect to the latter, even though policymakers usually will not mediate in the stock market, with better understanding they can implement strategies to limit inflation and enhance economic growth. Therefore, overall, this research should give additional value to macroeconomics finance literature.

1.6 Research Objectives

The objectives of this research are:

(i) to identify links between inflation and stock returns from previous literature and assess if these can be applied to the Maltese economic scenario;

(ii) to evaluate the relationship between stock returns and inflation in Malta between January 2008 and July 2019 with the purpose of establishing the origin of the negative relationship; and

(iii) to interpret the inverse relationship between inflation and Maltese stock returns with previous empirical evidence from developed and developing economies.

1.7 Scope and Limitations of the Study

Primarily, the literature reviewed in Chapter 2, is quite dated. Nonetheless, this does not imply that such literature is irrelevant but rather that because the Maltese stock market is still primitive, before one can apply today's latest research to the Maltese scenario, it is important that one understands the basics in which developed markets were established (that is during the 1970s to the 1990s). Furthermore, the Maltese market is not profound in the sense that there are very few instruments on the local market and so trading is limited. Therefore, certain expectations on how the market functions will not necessarily apply to the Maltese scenario.

In addition, this study uses secondary data, which is already in existence as opposed to primary data which is collected from the field. Hence, the choice of the data was restricted by data availability. For instance, gross domestic product (GDP) could not be used as a real activity variable since monthly data on such variable was unavailable. Nevertheless, this study tried to compensate this limitation by incorporating primary data through semi-structured interviews with various experts on the subject matter.

This study concentrated on the Malta Stock Exchange Index only, in preference to testing various portfolios because of the small size of the Maltese stock market. The study incorporates four variables in addition to the stock returns and inflation variables so as to enhance the accuracy of the model and also to be able to identify the cause of such relationship. However, one should keep in mind that no matter how exhaustive the list of variables is, it is very difficult to be able to incorporate all the variables which influence the inflation-stock returns relation.

1.8 Structure of the Dissertation

Chapter 1 has given an overview of the research topic that is investigated in this dissertation by providing background information to the study and a brief description of the local stock market. Additionally, chapter 1 illustrates the need for this study and outlines the study's objectives whilst highlighting its inherent limitations.

Chapter 2 presents a thorough review of the literature on the subject matter being investigated. This review drives the research methodology.

Chapter 3 gives a description of the research methodology. A mixed-research design is adopted whereby publicly available data is obtained in order to fit a time series model which shall be used to analyse such data. In order to support the empirical results obtained from the quantitative study a series of semi-structured interviews are conducted with experts including stockbrokers, financial analysts and economists.

Chapter 4 reports the results obtained and is divided into:

(i) An analysis of the statistical results, and

(ii) An analysis of the data obtained from a series of interviews.

Chapter 5 discusses the findings of this study.

Finally, **Chapter 6** concludes the dissertation by providing a brief overview of the main findings, provides some recommendations and proposes areas for further research (*vide* figure 1.1).

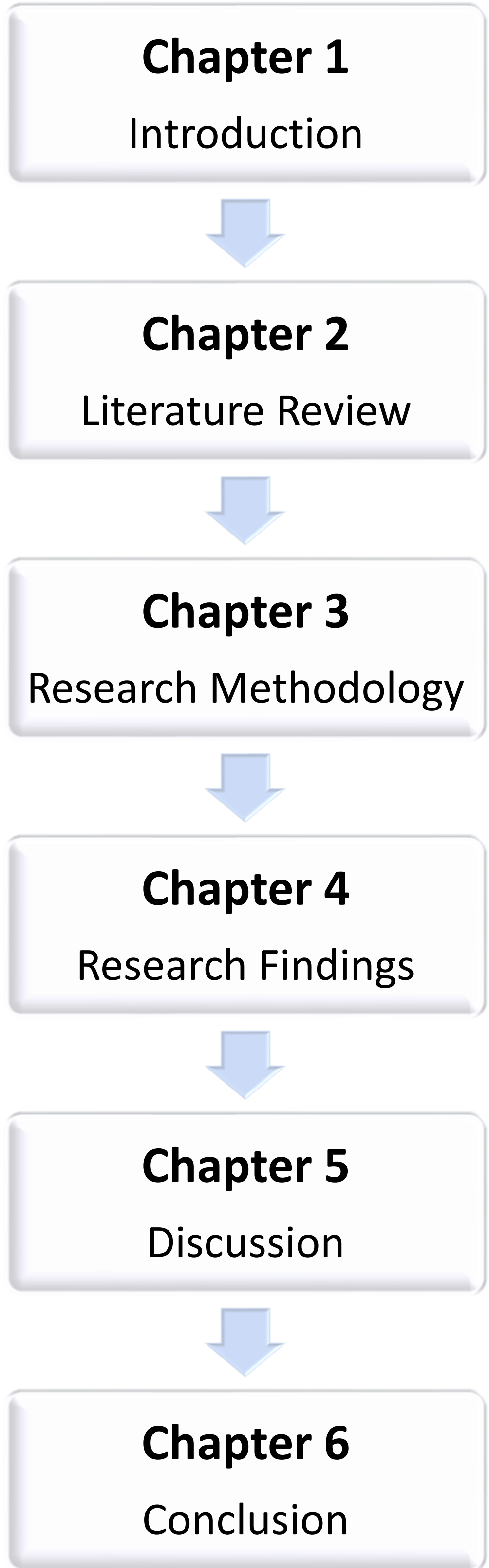

Figure 1.1: Dissertation Structure

Chapter 2

Literature Review

2.0 Introduction

"The inflation–stock returns puzzle is an intriguing phenomenon. While it seems reasonable to assert that returns should compensate for the expected inflation, the results are far from conclusive" (Austin, Dutt 2015, p.939). This phenomenon is created due to the evident discrepancies between the data and one's expectations from economic theory.

This chapter provides an insight of the previous studies so as to acquaint the reader with the theoretical foundations with the main research issues investigated in this study. It starts off by discussing the various hypotheses relating to the stock returns-inflation relationship including the Fisher's hypothesis, Fama's proxy hypothesis, supply and demand shocks and Kaul's monetary argument amongst others. Finally, the last section will give the reader an overview of the relationship between inflation and stock returns citing data and studies from a number of developed and developing economies.

2.1 The Fisher Hypothesis

The main motive for why the Fisher (1930) hypothesis has been cited in various studies is because if the Fisher hypothesis is satisfied, then the asset under consideration is a suitable hedging tool against inflation. This hypothesis which explains the relationship between inflation and both nominal and real interest rates, states that the nominal interest rate, less expected inflation will result in the real interest rate. This is shown by equation 2.1 which expresses that whenever inflation increases, investors will request an additional reward so that their purchasing power remains constant.

$$(1 + i) = (1 + i_r)(1 + \pi)$$

$$\Rightarrow 1 + i = 1 + \pi + i_r + i_r\pi$$

$$\Rightarrow i_r + \ i_r\pi \ = i - \pi$$

Since, both i_r and π are quantitatively very small, then $i_r\pi$ will result in a much smaller number and so it can be ignored.

$$\therefore i_r = i - \pi \qquad \textbf{(2.1)}$$

Where;

i_r = the real interest rate,

i = the nominal interest rate,

π = the expected inflation rate.

2.1.1 Extension of the Fisher Hypothesis

The Fisher (1930) hypothesis was extended further and hence, the theoretical foundation for the positive relationship between stock returns and inflation originated.

The extended Fisher (1930) hypothesis presumes that nominal interest rates consist of a real element along with an inflationary element. Consequently, a rise in expected inflation would bring about a rise in the interest rate given that the real interest rate remains constant (Mishkin et al. 2013). This theory has been prolonged from interest rates to all financial assets. This means that nominal return on an asset (for example: equity), contains an element of inflation and an element of real return. Thus, in principle, a rise in inflation should be equivalent to a one-to-one rise in the inflationary element of the asset's return and also in the asset's concerned total return (Fisher 1930). Therefore, in this regard, the inflation-stock returns relation can be presumed to be absolutely positive.

Several studies have addressed the extended Fisher hypothesis including Nelson (1976), Bodie (1976), Fama, Schwert (1977) and Peel, Pope (1985, 1988). Peel and Pope (1988) give a brief explanation of the extended theory in that ex-post nominal returns of equity shares are dependent on the real rate of return (anticipated and unanticipated) and inflation (anticipated and unanticipated). This is presented by equation 2.2 below.

$$S_t = r_t^a + r_t^u + p_t^a + p_t^u \qquad \textbf{(2.2)}$$

Where;

S_t = ex-post nominal return,

r_t^a = anticipated real rate of return,

r_t^u = unanticipated real rate of return,

p_t^a = anticipated inflation rate,

p_t^u = unanticipated inflation rate.

Thus, if unanticipated inflation is incorporated in the Fisher model, then p_t^u should be equal to p_t^a, and is presumed to be unity implying that there must be a positive relationship between equity returns and inflation. Consequently, equity returns should offer protection against both anticipated and unanticipated inflation (Peel, Pope 1988).

The one-to-one relationship is only justified in the long-run, yet inconclusive in the short-run. The discounted cash flow (DCF) model also offers an explanation to the relationship between unanticipated inflation and stock returns (*vide* equation 2.3). The DCF model states that firms should maintain their fundamental value provided that any fluctuations in the cash flow are offset by fluctuations in the discount rate, so as to compensate stockholders for changes in purchasing power in the discounted rate (Bodie et al. 2014).

$$V = \frac{C^e}{R} \quad \textbf{(2.3)}$$

Where;

V = fundamental value of the firm,

C^e = expected cash flow,

R = discounted rate.

In fact, Campbell and Shiller (1988) illustrate that even though higher unexpected inflation might induce higher discount rates which in turn reduces returns and consequently future dividends increase leading to higher returns, the price elasticity of future cash flows need not be equivalent to 1. This gives rise to the inconclusive unexpected inflation-stock returns correlation in the short-run.

2.1.2 Limitations of the Fisher Hypothesis

A disadvantage of the Fisher hypothesis is the ***elasticity of demand in relation to interest rates***. When the economy is going through periods of boom (rising asset prices), high interest rates might be rendered useless in lowering demand. Therefore, central banks might need to increase the real interest rate (Pettinger 2018).

If people think that the interest rate is not going to decrease further, any increase in money supply will not affect the interest rate. Therefore, any additional money will be kept in idle balances and hence lost in the ***liquidity trap***. The liquidity trap is "the absorption of any additional money supply into idle balances at very low rates of interest, leaving aggregate demand unchanged" (Sloman 2009, p.538). As a result, monetary policy will be rendered ineffective as people will prefer to postpone their purchases in anticipation of higher interest rates in the future. This would in effect lower bond prices (Sloman 2009) and so the return on bonds decreases. Therefore, stockholders tend to accept a lower required rate of return on an investment in equity, leading to lower stock returns (Mishkin et al. 2013).

2.2 Common Stocks as a Hedge against Inflation

Supporting the Fisher (1930) hypothesis, Bodie (1976) described the extent to which common stocks may be used as a hedge against inflation. This study examined the degree to which common stocks may be used to decrease the risk of an investor's real return, which arises from uncertainty on the expected level of consumption prices. The study used a mean-variance[1] model to derive inflation hedging measures for the period 1953 to 1972 and formed a regression with the variables: inflation, risk-free nominal returns and terminal nominal return[2]. The study concluded that in the short-run there is a negative correlation between real return on equity and both expected and unexpected inflation (Bodie 1976).

Academics considered common stocks as a good hedge against inflation since stocks signify ownership of physical capital whose true price is anticipated to be autonomous of the inflation rate. This means that keeping other factors constant, changes in the inflation rate must be followed by equivalent changes in the nominal rate of return on equity, implying a positive relationship between the two. However, Bodie (1976) as mentioned above, deduced that both anticipated and unanticipated inflation impact real return on equity negatively in the short-run, as opposed to the general principle that economists tend to embrace. Furthermore,

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[1] Mean-variance model is the process of weighing risk against expected return.

[2] The return "which an investor would have received had he followed a policy of buying and reinvestigating all receipts in equal dollar amounts of all New York Stock Exchange (NYSE) common stocks at the beginning of each month during the holding period" (Bodie 1976, p.464).

this implies that for common stocks to serve as a good hedge against inflation, they need to be sold short-term to protect them from further reductions in the price of equity (Bodie 1976).

A recent study carried out by Kim and Ryoo (2011) examined whether the long run-relationship between stock prices and goods prices is a requisite for equity shares to provide an effective hedge against inflation. This is a generalised form of the Fisher hypothesis, where a decrease in nominal stock returns is brought about by a proportionate decrease in anticipated inflation and vice versa. By using a two-regime threshold vector error-correction model (VECM)[3], it was concluded that stock price and commodity price possess a one-to-one long-run relation. Thus, it was deduced that "US common stocks have been an effective long-run hedge against inflation" (Kim, Ryoo 2011, p.168) which is contrary to Bodie's (1976) puzzling outcome.

With respect to the Maltese scenario, Buhagiar (2017) who analysed the relationship of Maltese stock returns with several other macroeconomic variables (*vide* section 1.5), concluded that Maltese equities are not an effective hedge against inflation.

[3] It is a specification of the Vector Autoregressive (VAR) model which can be used for non-stationary time series variables, provided that they are cointegrated. If two variables are cointegrated it means that there is a long-run relationship between the two variables (Juselius 2006).

2.3 Positive Vs. Negative Relationship

Prior to the 1950s, there was hardly any evidence against the Fisher hypothesis (Danthine, Donaldson 1986; Kim, Ryoo 2011; Katzur, Spierdijk 2013). In fact, the studies by Nelson (1976) and Fama and Schwert (1977) were amongst the first studies to contradict the Fisher (1930) hypothesis by deducing a negative correlation between inflation and stock returns. Hence, this negative correlation was perceived abnormal since it opposed the traditional view that equities should provide a good hedge against inflation (Marshall 1992). Furthermore, Modigliani and Cohn (1979) said that irrationality and market efficiency are the cause for these inconsistencies between the data and economic theory. As a result, a number of scholars attempted to provide an explanation to this phenomenon.

2.3.1 Proxy Hypothesis

Fama's (1981) study was centred around the fact that the adverse relationship between inflation and real activity is the answer to the factitious negative relationship between stock returns and inflation, given that inflation is triggered by real activity. This is known as the proxy-effect hypothesis meaning that stock returns are established by predictions of variables which are more closely related, and the negative stock returns-inflation correlations are generated by adverse real activity-inflation relations (Fama 1981).

The study found a positive relationship between real stock returns and measures of real activity such as output and capital expenditure. Fama (1981) hypothesised that these reflect the difference between the amount of capital invested and the anticipation of rates of return greater than the costs of capital. Correspondingly, the study provided support for the negative correlation between inflation and real activity which was justified by the theory of money demand and the quantity theory of money (Fama 1981).

These theories were based on several reasons, the first being that a rise in inflation will imply that to purchase the same amount of goods and services more money is needed. This leads to an increase in consumption expenditure, which is associated with a decrease in savings and investment, because limited resources that were intended to be used in investment are directed to consumption. A rise in inflation affects corporate profits negatively due to higher direct costs, higher interest pay-outs and demand constraints, leading to a decline in stock prices as a result of unfavourable corporate performance. Furthermore, an increase in inflation rate, raises the discount rate in the stock valuation method, causing a decline in share prices. This increase would also entice fiscal and monetary policies which would decrease money supply, raise interest rates and restrict aggregate demand, negatively influencing growth rate, business performance and stock returns (Fama 1981).

Balduzzi (1995) who re-examined Fama's (1981) hypothesis by using quarterly data, concluded a negative inflation-stock returns relation (consistent with Fama (1981)) and derived that inflation drives most of the fluctuations in stock returns. However, the study also deduced that interest rates function as a better 'proxy' than real activity in justifying the negative inflation-stock returns relation. Therefore, short-term interest rates might be key in driving the inflation-stock returns relation (Balduzzi 1995).

2.3.2 Demand and Supply Shocks

A number of authors have recognised that the relationship between inflation and stock returns is determined by the source of inflation, that is, whether it arises from demand or supply factors (Geske, Roll 1983; Lee 1989).

In fact, literature shows that based on equilibrium models, the relationship between inflation and stock returns is mainly influenced by two elements:

1. Demand shocks such as monetary (Tobin 1969) and fiscal policy shocks.
2. Supply shocks including shocks in oil price and shocks in productivity.

Thus, it can be deduced that the stock return-inflation relation differs according to the cause of inflation (Hess, Lee 1999; Lee 2010).

Hess and Lee (1999) implemented a structural vector autoregression identification method where permanent and temporary shocks to reflect aggregate demand and aggregate supply shocks, respectively, were imposed in order to be able to pinpoint the two shocks statistically. The study concluded that aggregate supply shocks had a permanent effect on the stock price whilst aggregate demand shocks had a temporary effect (Hess, Lee 1999). Moreover, the findings deduced that a negative inflation-stock returns relationship is generated by the aggregate supply shock whereas a positive relationship is driven by the aggregate demand shock (Hess, Lee 1999; Lee 2010).

Danthine and Donaldson (1986), Stulz (1986) and Marshall (1992) established general equilibrium models that, contrary to the Fisher hypothesis, expect stocks to be unable to provide an effective hedge against inflation particularly when inflation is triggered by non-monetary factors (example: real output shocks). Money is introduced in the model as an asset that offers transaction services and its price is established together with stocks. Anticipation of an increase in the price level, decreases the purchasing power of money and hence wealth decreases. Consecutively, the anticipated real return on stocks declines.

Danthine and Donaldson (1986) created a model where they introduced money by placing deflated money balances in the utility function, with the assumption that money balances offer transaction services only in the following period (i.e. t+1). The findings showed that stocks provide an effective hedge against a purely monetary inflation but are unable to offer protection to reduce the impact of inflation caused by real output shocks.

Stulz (1986) forecasts that real stock returns are negatively influenced by prospects of higher inflation even those caused by the monetary sector. Nevertheless, the effect of a rise in anticipated inflation on stock returns will be larger when it is generated by a reduction in investment rather than a rise in money growth.

Based on simulations, Marshall (1992) deduced that when changes in inflation are brought about by real impulses, the relationship between the ex-ante real equity return[4] and anticipated inflation approximates minus one. Whereas when changes in inflation are brought about by monetary impulses, ex-ante real equity return and anticipated inflation are also adversely related but smaller in magnitude. On the other hand, ex-post equity return and actual inflation are negatively related when brought about by real impulses and positive when inflation was generated by monetary impulses only. Therefore, these findings propose that inflation induced by real economic shocks is the cause for the negative relationship between ex-post equity returns and inflation (Marshall 1992).

The Mundell-Tobin model ascribes a negative link between expected inflation and expected stock returns to the money demand theory, in that, when interest rates and expected inflation are high, the greater the opportunity cost of holding money without interest. As a result, money-holders attempt to transfer to financial assets, such as short-term bonds which give an interest rate that provide protection for expected inflation, leading to lower expected real returns (such as equity). This in turn, decreases the cost-of-capital for investment decisions by companies as well as the public, thus inducing an increase in capital expenditures and real

[4] Real equity return refers to "the one-month value-weighted return on the New York Stock Exchange …, compounded to a quarterly return and deflated by the inflation rate" (Marshall 1992, p.1325).

activity. The Mundell-Tobin effect proposes that nominal interest rates would increase less than one-for-one with inflation since in order to compensate for higher prices, individuals will reduce their holdings in money balances and instead transfer their holdings in other assets, hence lowering interest rates (Mundell 1963; Tobin 1965).

2.3.3 Tax-effects Hypothesis

This was introduced by Feldstein (1980) who claimed that US tax laws, mainly historic cost depreciation and taxation of nominal capital gains, are the cause of the opposing effect of higher inflation on share price. This was corroborated by Geske and Roll (1983) who deduced that a random negative real shock influences stock returns leading to higher unemployment and lower corporate earnings, respectively. Consequently, this will affect personal and corporate tax revenue leading to an increase in the state's funds due to borrowing from the public. Hence, the economy will pay for this debt by expanding or contracting money supply leading to higher inflation. Whereas a positive real shock will have the opposite effect (Geske, Roll 1983).

2.3.4 Monetary Argument

Additionally, Kaul (1987, 1990), based on Fama (1981) and Geske, Roll (1983), argued that the relationship between inflation and stock returns arises from the equilibrium process in the monetary sector. Equilibrium in the monetary sector occurs when "the quantity of money demanded equals the quantity of money supplied" (Mishkin et al. 2013, p.480). Kaul (1987) suggested that inflation stimulates the economy's demand for money, which is met by withdrawing investments, thus resulting in lower stock returns. Moreover, Kaul (1987) stated that such relationship fluctuates over time in an orderly manner subject to the forces of money demand and supply factors (Geske, Roll 1983; Lee 1989). The findings showed that the negative stock returns-inflation relation observed in the post-war phase is explained by the negative correlation between inflation and real activity, supported by counter-cyclical monetary responses. Conversely, data from the 1930's showed either a positive relationship between inflation and stock returns or no relationship at all due to pro-cyclical movements in money, prices and stock returns (Kaul 1987). Kaul (1990) deduced that the negative inflation-stock returns correlation varies across monetary regimes – a stronger negative correlation during interest rate regimes in comparison to money supply regimes. Therefore, there seems to be a close correlation between the monetary policy of the Federal Reserve System and the stock returns-inflation relationship. Park and Ratti (2000) have continued to solidify this significant role of the counter-cyclical monetary policy in justifying the negative inflation-stock returns relation.

2.3.5 Inflation Illusion Hypothesis (or mis-pricing hypothesis)

Modigliani and Cohn (1979) discuss the inflation illusion hypothesis which asserts that in an environment where inflation is increasing, investors tend to allow for this by applying higher discount factors when calculating the present values of expected future earnings and dividends. This is because nominal interest rates are expected to increase. Hence, with expected increases in inflation, the present value of stock prices declines, whereas when inflation is low, expected stock prices have a higher value. This justifies the negative relationship between inflation and stock returns (Modigliani, Cohn 1979; Campbell, Vuolteenaho 2004; Lee 2010). Hence, such findings indicate that when inflation is anticipated to rise considerably, investors should be more cautious when considering investments (Buhagiar 2017). This is because a rise in inflation will decrease an individual's spending power. Hence, in relation to investment, inflation reduces real savings and investment returns. Consequently, the investors' main objective of increasing their long-term purchasing power will be at risk since investment returns must first keep abreast of the rate of inflation so as to increase real purchasing power.

Brown et al. (2016) extended the inflation illusion hypothesis into the cross-sectional asset pricing where the magnitude of inflation-illusion-related mispricing at the stock level was determined by how the earning yield of each stock is related to inflation. This was perpetrated by creating an inflation illusion factor by "buying stocks with large earning yield sensitivities on inflation and selling stocks with small earning yield sensitivities on inflation" (Brown et al. 2016, p.14). The study established a positive relationship between earnings yield and inflation, which indicates that inflation and expected returns are also positively correlated. Additionally, the findings implied that inflation illusion is present in both the long-run and the short-run of asset growth portfolios (Brown et al. 2016). This is consistent with Sharpe (2002) who found a one-to-one relationship between expected inflation and long-run equity returns.

In spite of this, the study carried out by Jones et al. (2017) concluded that real stock returns have a negative influence on inflation, yet it does not really sustain the inflation illusion hypothesis. This is because to the contrary of what one would expect, the study concluded that inflation only explains 3% of the deviation in real stock returns (Jones et al. 2017).

2.3.6 Two-Regime Hypothesis

The two-regime hypothesis was suggested by Hess and Lee (1999) in order to show that Modigliani and Cohn's (1979) inflation illusion hypothesis is incompatible with pre-war data. To explain the stock returns-inflation relationship, aggregate demand and aggregate supply shocks were utilised. It was deduced that in the pre-war phase, aggregate demand shocks took over, whereas in the post-war phase, aggregate supply shocks took over. Furthermore, the aggregate supply shock was concluded to have a long-lasting negative impact on the inflation-stock returns correlation whilst the aggregate demand shock was concluded to have a short-term positive impact on the inflation-stock returns correlation (Hess, Lee 1999).

2.3.7 Two-Regime Hypothesis vs. Inflation Illusion Hypothesis

A revised study of the two-regime hypothesis as well as the concepts of inflation illusion was conducted by Lee (2010). It was established that the inflation illusion concept does not support the pre-war positive correlation, but it provides a good pillar for the post-war negative correlation. This means that a major drawback of the inflation illusion hypothesis is that while mispricing is crucial in defining the relationship between stock returns and inflation in both periods, its function differs under different scenarios. Consequently, if the inflation illusion hypothesis was the underlying theory behind the stock returns-inflation relation, then it seems implausible that it cannot explain both the pre- and the post-war correlation. Therefore, there must be two separate regimes in relation to one whole period, with positive and negative stock return-inflation correlations so as to justify the various functions of mispricing (Lee 2010).

Consequently, Lee (2010) found that in both the pre- and post-war periods there are two separate forces which steer the relationship in opposite directions (i.e. a positive relationship in the pre-war period and a negative relationship in the post-war period). This implies that the inflation-stock returns relation can be time-varying subject to the relationship amongst opposing economic forces, such as aggregate demand versus aggregate supply (Fama 1981). It was also pinpointed that over time players in the stock market become more vulnerable to inflation illusion. This appears contradictory to the inflation illusion hypothesis which only assumes a negative relationship (Lee 2010).

2.3.8 Time-Varying Risk Aversion Hypothesis

This hypothesis, proposed by Brandt and Wang (2003), states that inflation will make investors more risk averse, leading to a rise in equity risk premium and hence a rise in the real discount rate. An inflation shock redistributes wealth from lenders to borrowers by decreasing the real value of nominal assets and liabilities. As a result, an inflation shock will reduce the real wealth of the less risk averse investors more than the real wealth of highly averse investors and so, causing a rise in aggregate risk aversion, given that aggregate risk aversion is influenced by the cross-sectional distribution of real wealth. Eventually, the less risk averse investors recuperate by receiving inflation risk premium and so aggregate risk aversion returns to its equilibrium state (Brandt, Wang 2003).

2.3.9 Expected versus Unexpected Inflation

Al-Zubi and Salameh (2007) illustrated that stock returns are only influenced by two factors namely: expected[5] and unexpected[6] inflation. The study concluded that there is no relationship between unexpected inflation and stock returns in the short-term, but the two variables are related in the long-term. This supports the Fisher's (1930) hypothesis that stocks can be regarded as a good hedge against inflation while opposing Fama's (1981) hypothesis. With regards to expected inflation, the regression revealed a significant positive relationship with stock returns excluding dividends and an insignificant relationship with stock returns including dividends (Al-Zubi, Salameh 2007).

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[5] Al-Zubi and Salameh (2007) defined expected inflation as a change in the price level that is widely foreseeable.
[6] Al-Zubi and Salameh (2007) defined unexpected inflation as a rise in the price level that comes as a shock to the majority of the individuals.

Li et al. (2010) by utilising UK statistics, investigated the inflation-stock returns relation in the short-run and medium-run and also under various inflationary regimes, that is, during periods of high and low inflation. The study concluded that in the short-term a significant negative relationship is evident between unexpected inflation and stock returns whereas with regards to expected inflation the relationship is insignificant. On the other hand, in the medium-term conflicting outcomes were obtained. This implies that stock returns influence expected inflation positively (Fisher 1930) but they influence unexpected inflation negatively (Fama 1981). Lastly, it was found that different inflationary regimes have a considerable impact on the inflation-stock returns relations because they affect investment choices (Li et al. 2010).

In fact, the findings show that the correlation between expected inflation and returns varies in different inflationary regimes for the whole market over the full period under consideration, being from January 1955 to December 2007. In the low inflationary regime, the correlation was statistically insignificant whilst in the high inflationary regime, it was positive and statistically significant. Conversely, with regards to unexpected inflation and returns, a statistically insignificant relationship was established in the low inflationary regime whilst a significant negative relationship was found in the high inflationary regime (Li et al. 2010).

2.3.10 Boom versus Recession Period

Another strand of literature only found an adverse correlation between inflation and stock returns during a recessionary period, whilst in the boom period an insignificant relationship was found. This was deduced through the Markov-Switching Dynamic Regression[7] (MS-DR) model which was used to analyse the impact of both anticipated and unanticipated inflation on real stock returns based on current time period.

Furthermore, the study presumed that inflation might have a different effect on real stock returns in a regime of boom and recession because of the regime-dependent hypothesis. Hence, real stock returns, inflation and real activity dynamics were tested together with Fama's (1981) hypothesis. The results obtained showed that the regime-dependent proxy-effect hypothesis only describes the adverse inflation-stock returns correlation in the recession period. Nonetheless, the findings suggest that the stock returns-inflation relation puzzle can be described by "the regime-dependency between real stock returns, inflation and real activity" (Cifter 2015, p.73).

[7] This method allows several structural breaks in the regression and then the regression coefficients are tested individually in the recession and boom periods.

2.3.11 Volatility of Inflation

Yuhn et al. (2018) attempt to present a solid interpretation for the relationship between inflation and stock returns in an inter-temporal portfolio-choice framework. The study denoted that in a time of less inflation volatility, real stock returns are likely to have a negative correlation with expected inflation; whereas in a time of high inflation volatility, expected stock returns and inflation are positively correlated. Furthermore, it was statistically proven that when the standard deviation of the annual inflation rate is equivalent to 10% or greater, the relationship between expected inflation and stock returns is positive whereas when the standard deviation of the annual inflation rate is below 10%, then the stock returns-inflation relation is negative (Yuhn et al. 2018).

2.4 The Inflation-Stock Returns Relation in Developed and Developing Economies

A study carried out by Gultekin (1983) analysed the stock returns-inflation relation for the post-war phase in 26 countries. The study concluded that most countries do not satisfy the Fisher (1930) hypothesis, stating that only Israel and the UK displayed statistically positive estimates of the inflation coefficient. The findings also indicated that some of the industrialised countries, including Germany, Italy and Switzerland, have a negative relationship between inflation and stock returns. On the contrary, the majority of the other industrialised countries, including Australia, Canada, Denmark, Japan, Spain and the US have a weak negative relationship between the two variables (Gultekin 1983). This was corroborated by Paul and Mallik (2003) for the case of Australia. Additionally, the study found that interest rates affect stock prices negatively whereas GDP growth has a positive effect on stock prices. A possible reason why the results contradict the Fisher (1930) hypothesis is due to measurement error which generates biased coefficient estimates (Fuller 1987).

In the final estimation, the study used Fama's (1975) method by using 3-month Treasury bills to forecast inflation and concluded that fluctuations in short-term interest rates correspond to fluctuations in inflation rate since all regression coefficients were positive and significant for most countries. This is in line with Fama (1975). Hence, expected inflation was estimated by using short-term interest rates, whereas unexpected inflation was estimated by prediction errors. It was deduced that there is a negative relationship between stock returns and expected inflation for all the countries under study. Again, the only difference was in the case of UK where a negative relationship between stock returns and expected inflation was found but when inflation was unexpected a positive relationship was found (Gultekin 1983).

Additionally, Erb et al. (1995) in their study of 41 countries, established that generally, a negative relationship only prevails in a time series analysis. Whereas in a cross-sectional analysis, the Fisher hypothesis is supported across different countries. Similarly, Boyd et al. (2001) identified a negative relationship between inflation and stock returns but only in low-inflation countries. Whilst when analysing high-inflation countries, stock returns were found to increase one-for-one with minor increases in inflation (Boyd et al. 2001).

Ely and Robinson (1997) claimed that in the long-run, stocks keep their values proportionate to goods prices depending on both real and monetary shocks. This is in contrast to Marshall's (1992) and Hess' and Lee's (1999) results which deduced that real and monetary shocks negatively influence the relationship between inflation and stock returns. However, it conforms with their view that one needs to consider the source of inflation (i.e. whether it arises from real output shocks or from monetary shocks) when evaluating whether stock prices keep their values proportionate to goods prices.

By using VECMs to capture the long-run relationships between stock and goods prices for 16 industrialised countries, the study conforms with the Fisher (1930) hypothesis by concluding that stocks are a good hedge against inflation. Moreover, the study showed that money supply influences the inflation-stock returns relation positively in Finland and The Netherlands and negatively in Australia, France and Norway. Whilst the stock returns of most of the countries under study (including Canada, Germany, Japan, Spain, Switzerland and UK) are influenced by real output shocks, that is industrial production and GDP (Ely, Robinson 1997). This was corroborated by Nasseh and Strauss (2000) who studied the long-run correlation between stock prices and economic activity in 6 European economies (including Germany, Italy and UK) and found that stock prices are significantly related to industrial production and short- and long-term interest rates amongst other macroeconomic variables.

Lin (2009) examined the relationship between inflation and stock returns by focusing on 16 industrialised OECD [8] countries, namely Australia, France, Germany, Italy, Japan, Norway, Spain, United Kingdom and United States, amongst others for the period 1957 to 2000. The study found that expected inflation and inflation uncertainty have an insignificant impact on real stock returns in the short-run but a significant and negative impact on real stock returns in long-run. With respect to unexpected inflation, the study concluded that there is a co-existence of a negative long-run impact and a positive short-run impact of unexpected inflation on real stock returns (Lin 2009). Hence, this suggests that in terms of expected inflation, the Fisher (1930) effect seems to hold in the short-run only.

Alagidede (2009) investigated the stock returns-inflation puzzle on six African countries being; Egypt, Kenya, Morocco, Nigeria, South Africa and Tunisia. It was deduced that the stock returns-inflation relationship in African countries seems to be different from that of the other countries since they all supported the Fisher (1930) hypothesis with the exception of Egypt where a negative relationship was established, but was insignificant. Despite this, Kenya, Nigeria and Tunisia,

[8] OECD: Organisation for Economic Co-operation and Development.

ascertained a significant positive correlation between inflation and stock returns in the long-term implying that in these countries, the Fisher (1930) hypothesis is satisfied (Alagidede 2009). Moreover, Omotor (2010) conducted a study on the stock returns-inflation relation in Nigeria and similar to Alagidede (2009), the findings indicate that stock returns provide an adequate hedge against inflation. Furthermore, Omotor (2010) deduced money supply affects inflation positively whilst industrial production affects inflation negatively by using cointegration and Granger-causality[9] tests.

Another strand of literature which studied the relationship between inflation and stock returns in Malaysia concluded that Malaysian common stocks do not provide an adequate hedge against inflation during both the pre- and the post-crisis periods. The study also deduced that there is no long-run relationship between the two variables (Siang et al. 2017). On the contrary, Geetha et al. (2011) found a long-run relationship between stock returns and both expected and unexpected inflation for China, Malaysia and United States. However, there seems to be no short-run relationship between these variables for Malaysia and US as opposed to China (Geetha et al. 2011).

In addition, Siang et al. (2017) also denoted that the two variables are unsuitable indicators to forecast each other in the short-run since they do not Granger-cause

[9] Granger-causality test is a statistical test which analyses if one variable (y) is able to forecast another variable (x) (Hamilton 1994).

each other during all the periods under study except for the post-global financial crisis period. The reason being that investors and policymakers anticipated a stable inflation rate in the future owing to the monetary policy to maintain the price level at a constant rate. However, the fact that inflation Granger-causes stock return during the post-global financial crisis period indicates that investors can exploit past information of inflation to forecast future stock return since investors have learnt from the Asian financial crisis (Siang et al. 2017).

On the contrary, Tripathi and Kumar (2014) who studied the long-term relationship between inflation and stock returns in BRICS[10] countries, found that even though in the short-run inflation and equity returns seem to be correlated, there seems to be an insignificant relationship in Russia, India and South Africa in the long-term. Whilst in Brazil and China a significant long-term correlation was found. However, through further panel cointegration test, it was underlined that there is no long-term cointegration between inflation and equity returns (Tripathi, Kumar 2014).

Furthermore, Khan and Yousuf (2013) investigated the impact of several macroeconomic variables including inflation, interest rates and broad money supply on stock returns in Bangladesh by using co-integration analysis and VECM. The study concluded that inflation does not affect stock prices in the long-

[10] BRICS: Brazil, Russia, India, China and South Africa.

term whilst interest rates and money supply are positively correlated to stock prices (Khan, Yousuf 2013). On the contrary, Rushdi et al. (2012) who studied the long-run correlation between real stock returns and inflation in Australia found a significant relationship between inflation and stock returns when inflation was actual. However, when inflation was expected, this study agrees with Tripathi, Kumar (2014) and Khan, Yousuf (2013) implying that no significant relationship between inflation and stock returns was found. Hence, the latter suggesting that in Australia, common stocks can be adequately used as a hedging tool against expected inflation (Rushdi et al. 2012).

A study by Al Oshaibat (2016) analysed the effect of several principal economic indicators, including inflation and interest rates, on stock returns in the long-run from 1980 to 2014 by fitting a VAR model. The study found a positive relationship between inflation rate and stock returns in Jordan. Moreover, the findings revealed that the relation persisted only for a limited time after which it started declining. Furthermore, it deduced a negative relationship between interest rates and stock returns (Al Oshaibat 2016) which was contradicted by Lee (1992), Fama, Schwert (1977) and Khan, Yousuf (2013) who all found a positive relationship.

Ferrer et al. (2016) who investigated the link between 10-year government bond yields and stock returns for several European countries, found that these two variables differ significantly from one country to another and their relationship varies over time with respect to the time horizon considered. For instance, it was deduced that in the UK there is most interdependence between long-term interest rates and equity returns across time and frequencies where it tends to be stronger in times of uncertainty such as the recent global financial crises in 2007-2009. Furthermore, the significant link between fluctuations in 10-year government bond yields and equity returns is mostly strong at investment horizons from one to two years, whilst for horizons less than a month and a half the link is very weak. The study deduced a negative relationship between long-term interest rates and stock returns until the late-1990s whilst a positive relationship since the early 2000 onwards. Moreover, a positive relationship was found for Germany, France, The Netherlands and Finland. In such countries the link between long-term interest rates and inflation was stronger when the global financial crisis commenced in 2007. This positive relationship highlights that the historically low levels of interest rates in recent years have been unable to stimulate European stock markets. Whilst for other European countries including Portugal, Ireland and Greece, the relationship is much weaker. Ferrer et al. (2016) argued that this weak link may be because the stock markets of these countries are illiquid and have a relatively small capitalisation.

Consistent with the Fisher (1930) hypothesis, Jonsson and Reslow (2015) found a positive relationship between interest rates and inflation in all of the six countries under study being Sweden, US, Euro area, Japan, UK and Canada.

Lee (1992) who used post-war US data, examined the relation between asset returns, real activity and inflation by fitting a multivariate VAR model. The study deduced that stock returns explain little changes in inflation if interest rates are incorporated in the model as opposed to the findings presented by Geske and Roll (1983). Furthermore, the study concluded that interest rates explain fluctuations in inflation which translate to too little change in real activity, contradicting the Fama (1981) proxy hypothesis.

Rahman et al. (2009) who studied the long-run effects of several macroeconomic variables (including money supply, inflation and industrial production) on Malaysia's stock returns using a VECM framework, agreed with Fama's (1981) study. The study deduced that in the long-run industrial production index affects stock returns positively while money supply and interest rates affect stock returns negatively. This was also corroborated by Humpe and Macmillan (2007) for the case of Japan. Additionally, this study investigated the relationship between US stock prices and several macroeconomic variables and it found that US stock returns are positively related to industrial production and negatively related to inflation and long-term interest rates. Whilst an insignificant relationship between US stock prices and money supply was found (Humpe, Macmillan 2007).

In spite of this, Mukherjee and Naka (1995) whose study revolved around the Japanese stock market claimed that a rise in money supply will bring about economic expansion due to increased cash flows, stock prices would profit from economic growth driven by expansionary monetary policy. Hence, implying that money supply and Japanese stock returns are positively related (Mukherjee, Naka 1995). This was also corroborated by Hasan, Nasir (2008) and Khan, Khan

(2018) who analysed the impact of several macroeconomic variables on Japanese stock returns. Despite this, in Japan (Hasan, Nasir 2008; Khan, Khan 2018) and in Pakistan (Hamao 1988) the industrial production variable was found to be insignificant in explaining stock returns.

Adrangi et al. (2000) who analysed the inflation-stock returns relation in Brazil by using Fama's (1981) hypothesis framework, supported the adverse correlation between inflation and stock returns but the findings do not clearly support the proxy-effect. This is because even though the negative relationship between inflation and real activity was eliminated, the negative inflation-stock returns relation in Brazil still persisted. Consequently, stock returns may be negatively influenced by inflation because: inflationary pressures may have a negative impact on future corporate profits, whilst nominal discount rates increase. This leads to a decline in stock returns. In contrast, the study claimed that there is a long-run equilibrium relationship between inflation, stock returns and real activity congruent with the proxy-effect hypothesis. Thus, the findings suggest that the proxy-effect may be true in the long-run but not in the short-run (Adrangi et al. 2000).

A recent study which investigated the inflation-stock returns relation in Brazil, also found a negative relationship between the two. The study deduced that such relationship is caused by the vulnerability of the capital market in Brazil to capital flows. Furthermore, industrial production was found to influence stock returns negatively (Chaves, Silva 2018).

2.5 Conclusion

This chapter outlined the hypotheses and findings from previous studies around the extent of correlation between inflation and stock returns. Findings show that there is a relationship between inflation and stock returns in the long-run however this is not always evident in the short-run. Hence, drawing attention to the fact that both the economy and the stock market are volatile and ultimately driven by human action. Subsequently, this chapter provided an insight of the inflation-stock returns relation in several developing and developed economies. The following chapter shall discuss the manner in which the research questions shall be addressed and how the hypothesis discussed above shall be tested.

Chapter 3

Methodology

3.0 Introduction

This chapter shall inform and acquaint the reader with the study by outlining the research approach employed to determine the relationship between Maltese stock returns and inflation. A mixed research approach shall be adopted. This chapter is divided into four sections:

- Part 1 which will provide an overview of the combined quantitative and qualitative aspects of this mixed research approach.
- Part 2 which will include data gathering, data sources, changes done to the data prior to estimating the multivariate models and some preliminary research considerations.
- Part 3 outlines the quantitative methodology employed for this dissertation namely both in statistical terms as well as the two fitted time series models.
- Part 4 which will be mainly qualitative. Here, a series of semi-structured interviews shall be held with experts including stockbrokers, financial analysts and economists.

Finally, this chapter will conclude by underlying the ethical considerations and safeguards to ensure that confidentiality is preserved.

3.1 Research Design

The methodology of the research taken up in this study consists of a mixed methods research design which makes use of both quantitative and qualitative data collection measures and analytical techniques. More specifically a triangulation design was adopted which comprises of various data collection approaches of quantitative and qualitative natures respectively, to support and verify or question the results acquired from both methods. Hence, since both sets of results can be compared, such method gives a richer and more comprehensive response to the research objectives (Saunders et al. 2016).

The dissertation's objectives are primarily studied through the application of quantitative research with the qualitative component aiming to consolidate and seek views on the results of the former. Therefore, throughout this study, the realism perspective [11] was pursued as existing data was utilised for the quantitative methodology. The study also used a combination of objectivism and subjectivism. The quantitative part of the study portrays objectivism since the data obtained is fact-based and measurable. The qualitative part portrays subjectivism through the interviews which allow the inclusion of opinions and judgement of subject matter experts in the study.

When conducting interviews, the use of semi-structured interviews allowed the researcher to ask additional questions or induce various arguments corresponding to the specific interview context, yet still maintain the same question structure (Saunders et al. 2016).

[11] Realism perspective focuses on establishing reasons that influence observable events with the intention of explaining them (Saunders et al. 2016).

As mentioned previously, the principal aim of this study is to evaluate the interdependency between several explanatory variables with the aim of understanding the relationship between stock returns and inflation in Malta. Hence, arising from a more positivist and realistic research pattern, a quantitative research is the most suitable approach in order to reach the study's objectives. The main research methodology used is a correlational study which enables the researcher to study a situation with the intention of explaining the correlation between the variables through explanatory and predictive correlational studies (Saunders et al. 2016).

3.2 Data Collection

This study made use of secondary data, gathered from the period between January 2008 and July 2019 - comprising of monthly observations of each variable. These add up to a total of 139 observations for each variable used in the models. The use of monthly data, as opposed to lower frequency data (such as yearly data), enables the short-run dynamics of the economy to be studied in more depth. Moreover, this increases the model's practicality since it enables data to be forecasted.

The data used in the study includes primarily inflation and stock returns which are the primary variables in this study. The additional variables used are: money supply, interest rates and real activity which are similar to the study of Fama

(1981) and Kaul (1987). The variables used in the study are covered in the subsequent sections.

3.2.1 Main Variables

The study revolves around two main financial variables which are stock returns and inflation where stock returns shall be the dependent variable and inflation shall be the independent variable.

The data on stock returns was obtained from the MSE Equity Total Return Index (MSETRX) time series data which was collected from the MSE website. Whereas, in relation to inflation, HICP as opposed to Retail Price Index (RPI) was used to source the data. This decision was made since HICP meets the international standards and it was used by the majority of the previous studies mentioned in chapter 2. HICP values were taken from the NSO using 2015 as the base year. This base year was chosen since it is the most recent and so it reflects the structural changes that have occurred within an economy, hence increasing the accuracy of the data.

3.2.2 Explanatory Variables

a. Money Supply

In this study, money supply was represented by Broad Money (M3) which was obtained from the Central Bank of Malta website under the table entitled ‘The Contribution of Resident MFIs to Euro Area Monetary Aggregates’. M3 consists of M2[12] "plus repurchase agreements, money market fund shares/units and debt securities with an original maturity of up to 2 years" (Central Bank of Malta 2020a). M3 was chosen in preference to narrow money so as to reduce the effect of portfolio allocations of money holdings in the private sector on the monetary aggregate. Moreover, M3 is less volatile than narrow money (Wiedmann 2011).

b. Interest Rate

The study used two variables as a measure of the interest rate so as to incorporate both the short-term and the long-term interest rates. The short-term interest rate was represented by the yield on the three-month Treasury bill (TB3m), whilst the long-term interest rate was represented by the yield on the ten-year government bond (GB10y). The long-term interest rate, in the form of GB10y was included as a representation of a competitive investment alternative. Both interest rates were sourced from the Central Bank of Malta website.

c. Real Activity Variable

The Index of Industrial Production (IP) was used in order to include a representation of the real economy. IP is a monthly economic indicator calculating real output in the manufacturing, mining and quarrying, electricity and gas industries in relation to a base year. It is considered as one of the most

[12] M2 (i.e. intermediate money) comprises of "currency issued plus deposits that are withdrawable overnight plus deposits with an original maturity of less than two years or a notice period of less than three months" (Central Bank of Malta 2020a).

significant measures of economic activity since any fluctuations in the business cycle are best explained by changes in this index (NSO 2019). The index was compiled by using monthly data from the Eurostat database under the section "Short-term Statistics" using 2015 as the base year.

An additional real activity variable, GDP, was going to be added to the model. However, data on GDP was only available quarterly and so was considered to be inconsistent with the study's frequency.

3.2.3 Summary of Variables

Table 3.1 presents a summary of all the variables described in sub-sections 3.2.1 and 3.2.2.

Variable	Interpretation
$MSETRX_t$	Malta Stock Exchange Equity Total Return Index level for month t
$HICP_t$	Harmonised Index of Consumer Prices for month t
$TB3m_t$	Three-month Maltese Treasury Bill rate for month t
$GB10y_t$	Ten-year Government Bond Yield for month t
$M3_t$	Broad Money for month t
IP_t	Index of Industrial Production level for month t

Table 3.1: Summary of the Variables Used

3.3 Preliminary Research

Preliminary research enables the researcher to acquaint with, understand more and identify the most appropriate way of answering the research questions.

The starting point was to obtain data on both inflation and stock returns. The historical data was charted to show the most basic correlations and visually identify any fluctuations.

Furthermore, a thorough overview of the literature available was conducted. This was done to get a better understanding of the relationship between inflation and stock returns. It was noted that there were various studies investigating the relationship between inflation and stock returns but there were very few specifically relating to the Maltese scenario. This continues to highlight the need for a study on the Maltese scenario due to the inherent volatile nature of the stock market and it should serve as a tool for investors in their investment decisions.

3.4 Quantitative Research

The principal methodology involved building a multivariate time series model[13]. The model was developed by first testing each variable for stationarity by using

[13] A multivariate time series model is one which considers multi-period values simultaneously (Tsay 2014).

original sequence plots and differencing was applied where necessary. Subsequently, cross-correlation plots against all variables were plotted so to establish whether there is correlation between the variables. This is where the vector autoregression model would eventually fit. Then, the Granger-causality test was implemented so as to establish whether a variable is able to predict another variable. A vector autoregressive (VAR) model was implemented to analyse the stock returns-inflation relation in Malta. In addition to the VAR model, another multivariate model – the Vector Error Correction Model (VECM), was fitted. Prior to fitting the VECM, the time series was checked for cointegration[14] since it is a prerequisite of VECM.

The data collected was analysed by developing a multivariate time series model which was built by using the Statistical Package for Social Sciences (SPSS) analysis software for descriptive statistics and cross-correlation functions and R programming language to carry out the statistical tests and in generating the final models. All the code and output generated, which is not provided in the findings, is presented in appendices 2 and 3.

[14] Cointegration analysis “identifies stationary linear combinations between non-stationary variables so that an I(1) model can be reformulated exclusively in stationary variables” (Juselius 2006, p.82).

3.4.1 Descriptive Statistics

It is essential that when analysing a dataset, one obtains a basic understanding of the nature of the data. Consequently, several descriptive measures such as the measures of central tendency (mean and median), the measures of dispersion (range, variance and standard deviation) and the coefficient of variation (which is the ratio of the standard deviation to the mean i.e. $\frac{\sigma}{\mu}$) were calculated.

From the data collected, each variable was plotted against time so that any patterns and general trends of the dataset could be easily identified. This helped in gaining an understanding of whether the time series is stationary[15]. Furthermore, a bivariate cross-correlation plot of each variable against MSETRX and HICP respectively was plotted. These computations and plots aid to establish 'a priori' expectations when progressing with the study.

It is worth noting that when working with time series variables, cross-correlation instead of the Pearson product-moment correlation coefficient[16] should be used since the latter leads to spurious correlations[17] (Yule 1926). An assumption of Pearson correlation coefficient is that data follows a normal distribution, however,

[15] Stationarity is a statistical property indicating that the time series does not change over time (Gujarati, Porter 2010).
[16] It is "a measure of any linear trend between two variables" (Puth et al. 2014, p.184).
[17] Spurious correlation is when there is correlation but not causation between two or more variables due to either coincidence or the occurence of another unseen factor (Yule 1926).

in time series this may not always be the case, and this is the reason why it may lead to nonsense correlations (Puth et al. 2014).

3.4.2 Stationarity

An issue encountered when using time series data as opposed to when using classical linear regression models (CLRM[18]) is the phenomenon of 'spurious regressions' as suggested by Granger and Newbold (1974). This occurs when the data in the CLRM is non-stationary (i.e. unit root) causing an excessively high coefficient of determination[19] (denoted by R^2) which arises due to the fact that the residuals do not constitute a white-noise process[20] (Granger, Newbold 1974). If this is the case, then one of the CLRM assumptions would be violated (Gujarati, Porter 2010).

As a result, a substantial portion of probability theory of time series is revolved around stationary time series. Therefore, if a time series is non-stationary, the equations are modified to convert it into a stationary one. A time series is weakly stationary if there is no systematic variation in the mean (i.e. no trend) and the

[18] CLRM is an estimation model used to predict unknown parameters (Gujarati, Porter 2010).
[19] R^2 is a statistical measure of how close the data are to the fitted model i.e. how well the model is able to explain and predict the dependent variable (Gujarati, Porter 2010).
[20] "A sequence is a white-noise process if each value in the sequence has a mean of zero, a constant variance, and is uncorrelated with all other realisations" (Enders 2015, p.49).

variance is constant over time. This is explained below by equation 3.1, where μ is the mean and σ^2 is the variance.

$$\mu_t = \mu \ ; \ \sigma_t^2 = \sigma^2 \qquad \textbf{(3.1)}$$

Stationarity is analysed by employing a Unit Root Test which tests whether a time series variable possesses a unit root and is therefore non-stationary. This was tested by using the tau (τ) test whose critical values are based on the Monte Carlo simulations and is more commonly known as the Augmented Dickey-Fuller (ADF) test. The ADF test was chosen in preference to the Dickey-Fuller (DF) test since it takes into consideration higher-order models and therefore serial correlation in the time series is reduced or even eliminated. Additionally, the ADF test has more statistical power implying that it is more capable of distinguishing an actual effect from a probable effect (Dickey, Fuller 1979).

The ADF test contains two tests for stationarity, one which tests for no constant and no trend and the other tests for a constant but no trend. In this study both tests are examined where the null hypothesis is defined as the presence of a unit root and so the variable is non-stationary, whereas the alternative hypothesis implies that there is no unit root and so the variable is stationary (Dickey, Fuller 1979). A thorough explanation of the ADF test can be found in Appendix 1.

This test ensures that the appropriate level of differencing is applied to the time series equation in order to remove autocorrelation. Non-stationary data which becomes stationary at first difference is said to be integrated of order 1 [I(1)]. Correspondingly, for data which becomes stationary at second difference [I(2)] and so forth. Generally, the majority of macroeconomic time series are expected to be I(1) (Tsay 2013).

3.4.3 Granger-causality Test

The Granger-causality test is a statistical hypothesis test which analyses whether one variable (y) is able to predict another variable (x). If it cannot, then it is deduced that y fails to Granger-cause x for all t < 0. On the contrary if, the lagged values of x and y together are better in explaining x as opposed to when using only lagged values of x itself, then, y is assumed to Granger-cause x (Hamilton 1994).

The Granger-causality test is carried out by means of an F-test to compare two regressions of the form shown by equations 3.2a and 3.2b. If at least one lagged value of y is retained in the second regression (equation 3.2b) as having explanatory power, then it could be concluded that y Granger-causes x.

$$x_t = c_0 + a_1 x_{t-1} + \cdots + a_p x_{t-p} + \varepsilon_t \qquad \textbf{(3.2a)}$$

$$x_t = c_0 + a_1 x_{t-1} + \cdots + a_p x_{t-p} + b_1 y_{t-1} + \cdots + b_p y\cancel{x}_{t-p} + \varepsilon_t$$

(3.3b)

Where;

x_t and y_t = variables x and y at time t,

c_0 = constant coefficient

a_1 and b_1 = coefficients for the 1st lag of variables x and y respectively,

p = lag length,

ε_t = error term.

This test determines whether the variables lags are useful in forecasting Maltese stock returns and vice versa. The null hypothesis was set such that the explanatory variables at time t do not Granger-cause MSETRX and so rejection of the null hypothesis indicates Granger-causality between the two time series. Granger-causality is a very simple test in the sense that it can only be one directional or bi-directional, however it is a powerful tool to determine the relation between two time series (Hamilton 1994).

3.4.4 Vector Autoregressive Model

In time series data, very often the assumption that the relationship between the dependent variable (Y) and the explanatory variables (X's) is contemporaneous (i.e. at the same point in time), does not hold. As a result, one needs to test whether there is a non-contemporaneous (i.e. lagged) relationship between Y and the X variables (Gujarati, Porter 2010).

A basic bivariate VAR(1) model has the following form:

$$x_{1t} = d_0 + \phi_1 x_{t-1} + z_t \qquad \textbf{(3.3)}$$

Equation 3.3 can be written in matrix form as follows:

$$\begin{pmatrix} x_{1t} \\ x_{2t} \end{pmatrix} = \begin{pmatrix} d_{10} \\ d_{20} \end{pmatrix} + \begin{pmatrix} \phi_{1,11} & \phi_{1,12} \\ \phi_{1,21} & \phi_{1,22} \end{pmatrix} \begin{pmatrix} x_{1,t-1} \\ x_{2,t-1} \end{pmatrix} + \begin{pmatrix} z_{1t} \\ z_{2t} \end{pmatrix} \qquad \textbf{(3.4)}$$

Where;

x_{1t} = variable 1 at time t,

d_{10} = constant for the equation of variable x_{1t},

d_2 = constant for the equation of variable x_{2t},

$\phi_{1,11}$ = coefficient for variable 1 at lag 1

z_{1t} = white noise error term for the equation of variable x_{1t} (Hamilton, 1994).

Note that the first number in the subscript refers to the variable, while the second number refers to the lag used. Refer to Appendix 1 for a more detailed explanation of the VAR model.

A drawback of the VAR model is that since the variables are represented by a matrix, then one might end up with several parameters which are very small and insignificant. Therefore, a restricted VAR model, which eliminates the insignificant parameters was also generated.

In addition to the VAR model, a VECM model was also fitted since in the error-correction form, the multicollinearity effect[21] (which is generally very strong in time-series data) is decreased significantly implying that differences are much more statistically independent (orthogonal). Moreover, the coefficients can be categorised into short-run and long-run effects. Therefore, estimates can be interpreted more easily (Juselius 2006).

3.4.5 Vector Error Correction Model (VECM)

Due to the limitations of the VAR model, a restricted VAR model known as the VECM was fitted. Such econometric model does not require the time series variables to be stationary but allows non-stationarity provided that the variables are cointegrated (Juselius 2006).

3.4.5.1 Testing for Cointegration

A prerequisite for fitting a VECM is to check whether there are cointegrating relationships in the time series since if not, then the VECM cannot be used. A cointegrating relationship is said to exist when two or more variables move together in the long run because they have a common random probability distribution. Putting it differently, two variables are cointegrated "if the non-stationarity of one variable [i.e. I(1)] corresponds to the non-stationarity of another

[21] Multicollinearity is a common issue in time series data and arises when the explanatory variables are related to one another and as a result a unique estimate of all parameters cannot be obtained leading to unreliable and unstable estimates of coefficients. Therefore, the interpretability of the model is lost (Gujarati, Porter 2010).

variable" resulting in "a linear combination between them that becomes stationary" [i.e. I(0)] (Juselius 2006, p.80).

The theory indicating that error correction models can represent cointegrated series was first stated and proved by Granger (1983). The Engle-Granger cointegration test was used to assess whether there is a cointegrating relationship between each of the variables in the multivariate time series. The null hypothesis indicates that there is no cointegration between two non-stationary variables whilst the alternative hypothesis indicates that two non-stationary variables are cointegrated and hence become stationary (Engle, Granger 1987).

3.4.5.2 Estimating the VECM

If the time series is cointegrated, then a VECM model of the following form will be fitted:

$$\Delta x_t = \Gamma_1^{(m)} \Delta x_{t-1} + \Gamma_2^{(m)} \Delta x_{t-2} + \cdots + \Gamma_{k-1}^{(m)} \Delta x_{t-k+1} + \Pi x_{t-m} + \Phi D_t + \varepsilon_t \qquad \textbf{(3.5)}$$

Where;

Δx_t= the first difference of the variables in vector x at time t,

Γ = a coefficient matrix of the lags of differenced variables of x,

m = an integer between 1 and k defining the lag placement of the ECM term,

$\Pi = \alpha\beta'$; where α is a loading matrix describing the speed at which a dependent variable converges back to its equilibrium value and β' is the cointegration matrix. Hence, Π is a coefficient matrix of cointegrating relationships (r) and represents the cointegrating rank of the VECM (i.e. it influences the number of error correction terms needed).

D_t= a vector of deterministic terms at time t,

Φ= the coefficient matrix of D_t,

ε_t= an error term which is normally distributed with constant covariance.

As can be seen from equation 3.5, the only difference to a VAR model is the error correction term Πx_{t-m} which captures the effect of how the growth rate of a variable in x changes, if one of the variables departs from its equilibrium value (Juselius 2006).

After estimating the model, a robustness check was carried out by conducting misspecification tests which included checking the multivariate normality assumption underlying the model as well as serial correlation of the residuals (ε_t).

3.5 Qualitative Research

The qualitative research approach involved the acquisition of primary qualitative data through 8 semi-structured interviews. These were held with a number of professionals including stockbrokers, financial analysts and economists. The duration of the interview was approximated to last around 45 minutes.

3.6 Ethical Considerations

It is important to highlight that any data or information disclosed during this study was handled with the strictest confidentiality by ensuring that the rights to privacy, anonymity and confidentiality of the participants were safeguarded. A paragraph in the letter of participation included an ethical clause which emphasised confidentiality and the right to withdraw or withhold publication of data for this research.

The researcher ensured that the interviewees were made aware of the objectives of the study and what was expected of them as participants. Additionally, the participants were also informed that there were no potential risks or costs, if at any time, the participants chose to withdraw from the study.

3.7 Conclusion

This chapter has discussed the research methodology adopted in this study with regards to both the qualitative and the quantitative approaches taken. Additionally, a description of the time series models used together with the variables used in the study was provided. Chapters 4 and 5 provide the findings and an analysis of the results obtained from this methodology, respectively.

Chapter 4

Findings

4.0 Introduction

The aim of this chapter is to outline the findings corresponding to the research objectives. This chapter shall be divided into two parts where the first part shall underline the results found from the statistical analysis and the second part shall present the findings obtained from the semi-structured interviews.

Part 1: Quantitative Segment

This section presents the results derived from the two multivariate models developed to establish and analyse the cause of the negative relationship between inflation and Maltese stock returns. The first part gives an overview of the findings obtained from the preliminary analysis and the respective changes done to the data prior to deriving the multivariate models. Subsequently, a presentation of the results derived from the VAR model and the VECM is given.

4.1 Descriptive Statistics

Table 4.1 presents a basic understanding of the variables used in this study by providing several descriptive measures namely the: mean, median, range, variance, standard deviation and the coefficient of variation. These values were used to understand the key metrics from the data. For instance, one could deduce that the data is quite symmetrical since the mean and median are similar. The significantly high standard deviation relative to the mean of MSETRX and M3 indicates a greater spread in the data and hence the values in the dataset are, on average, farther away from the mean. The coefficient of variation shows the level of dispersion around the mean. All coefficients of variation are less than ten and so it can be concluded that the values in the dataset give a precise estimate, with the short-term interest rates being the most volatile.

	MSETRX	HICP	TB3m	GB10y	M3	IP
Mean	6,691.24	1.90	0.81	2.91	13,527.77	103.52
Median	6,053.76	1.40	0.48	3.21	11,834.98	102.20
Minimum	4,137.93	-0.50	-0.38	0.52	8,583.08	89.30
Maximum	9,815.91	5.70	4.94	5.28	20,769.23	126.70
Range	5,677.98	6.20	5.32	4.76	12,186.15	37.40
Variance	2,558,927	1.75	1.62	2.26	17,034,635	49.93
Standard Deviation	1,599.66	1.32	1.27	1.50	4,127.30	7.07
Coefficient of Variation	0.239	0.70	1.56	0.52	0.305	0.068

Table 4.1: Descriptive Statistics

4.1.1 Original Sequence Plots

Figure 4.1 overleaf shows each variable plotted against time where the volatility of MSETRX, HICP and IP is highlighted which is in line with a priori expectations. TB3m and GB10y show a declining path implying that interest rates are decreasing over the years, whilst M3 shows an upward trend over the years. Similar to table 4.1, the original sequence plots also provide an overview of the time series, however, figure 4.1 also illustrates strong evidence of non-stationarity in all of the time series. This will be corroborated via unit root tests in section 4.2.

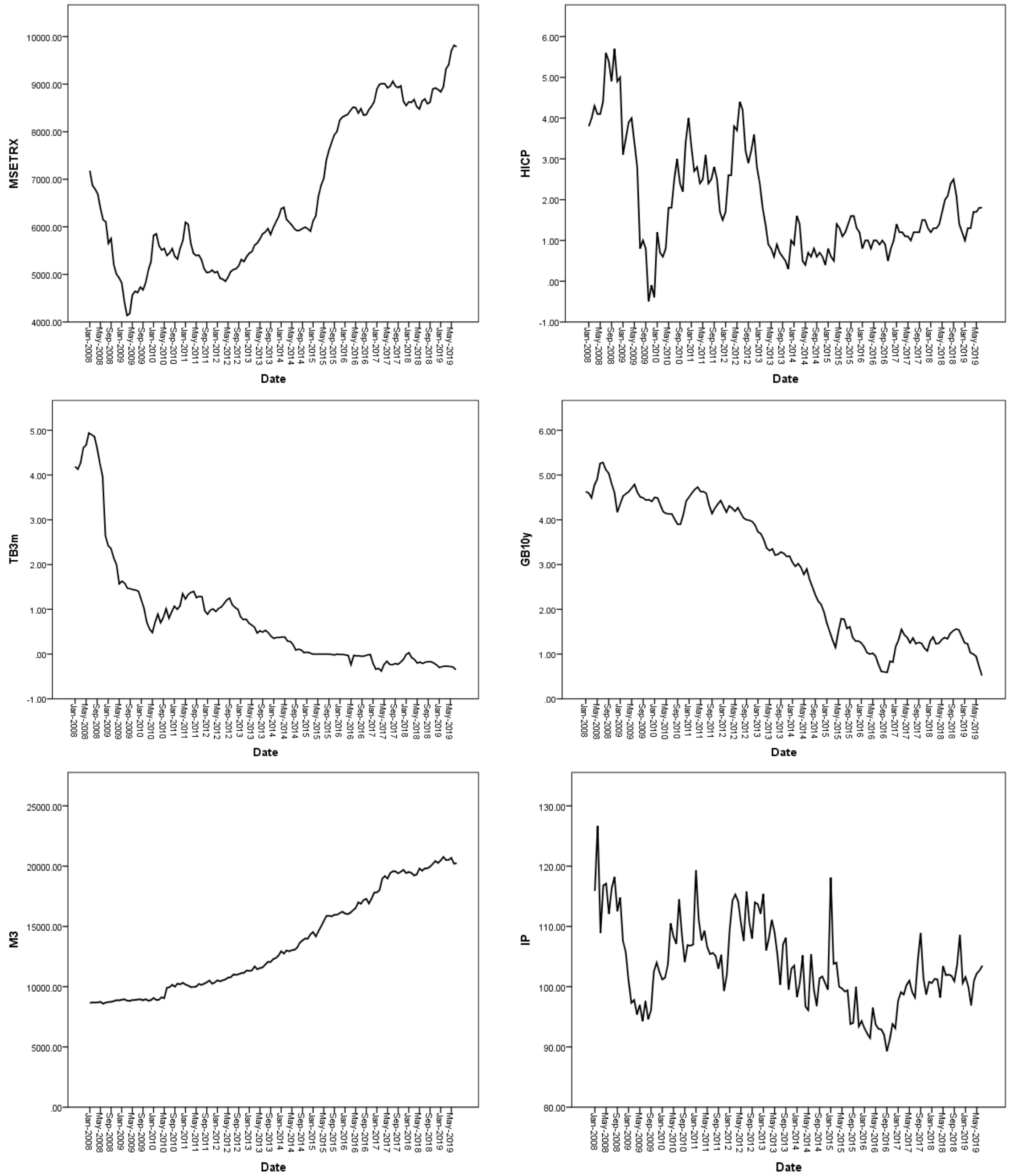
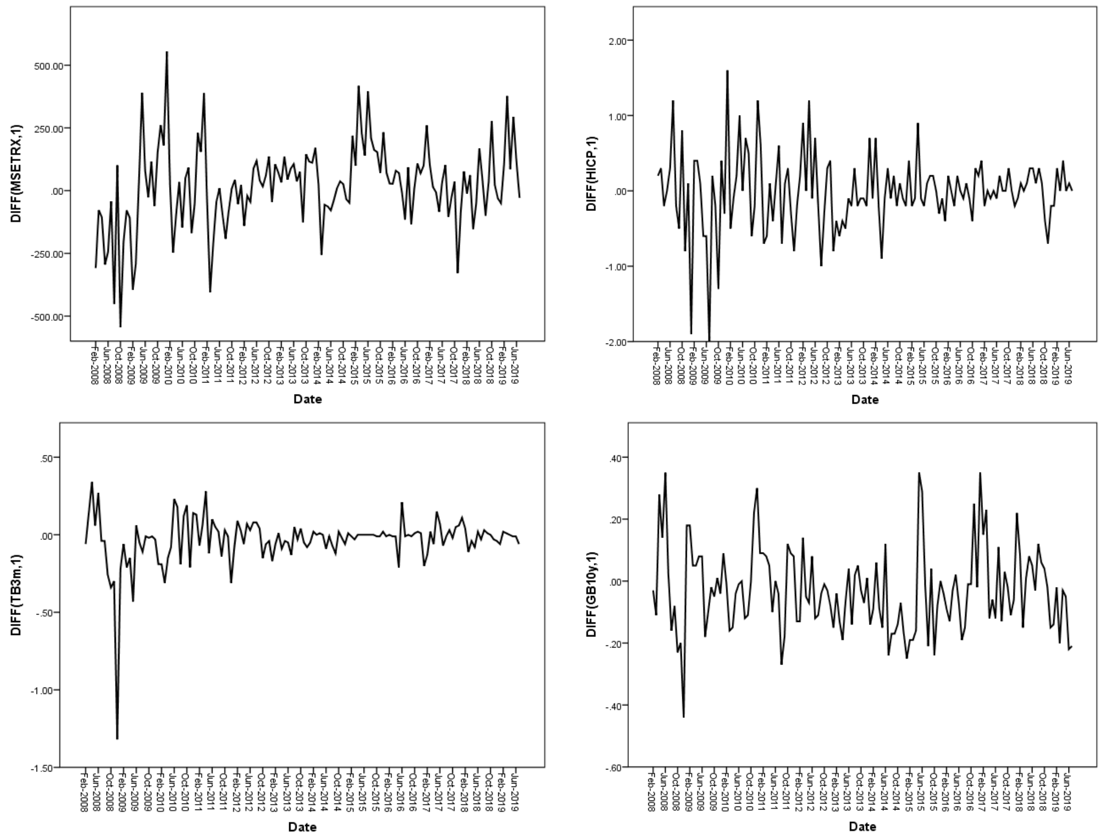


Figure 4.1: Original Sequence Plots

4.1.2 Differenced Sequence Plots

Figure 4.2 shows the first-order differenced sequence plots of each variable. These were plotted in order to be able to generate the cross-correlation functions. From figure 4.2, one can deduce that first order differencing largely eliminates non-stationarity in most of the time series. This was also corroborated via unit root tests.



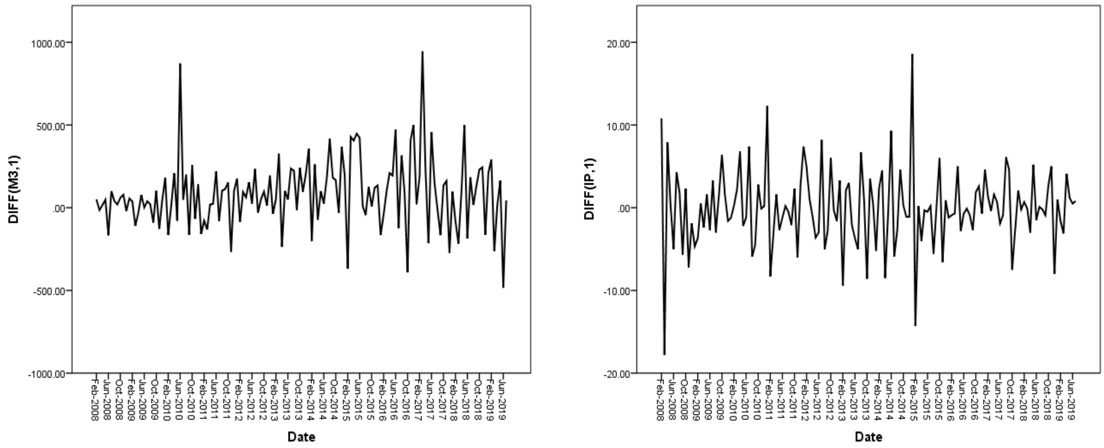
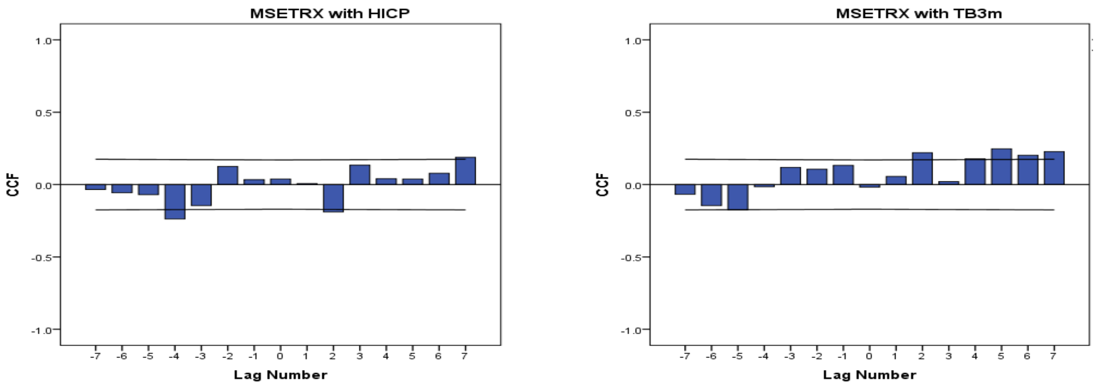


Figure 4.2: Differenced Sequence Plots

4.1.3 Cross-correlation Functions

Lastly, each variable was plotted against MSETRX and HICP respectively to determine the dependencies between the first-order differenced time series. Both actual cross-correlation coefficients and plots were carried out – the plots are shown in the main text of this study (figure 4.3) whilst the cross-correlation coefficients can be found in appendix 2 (table A2.1).



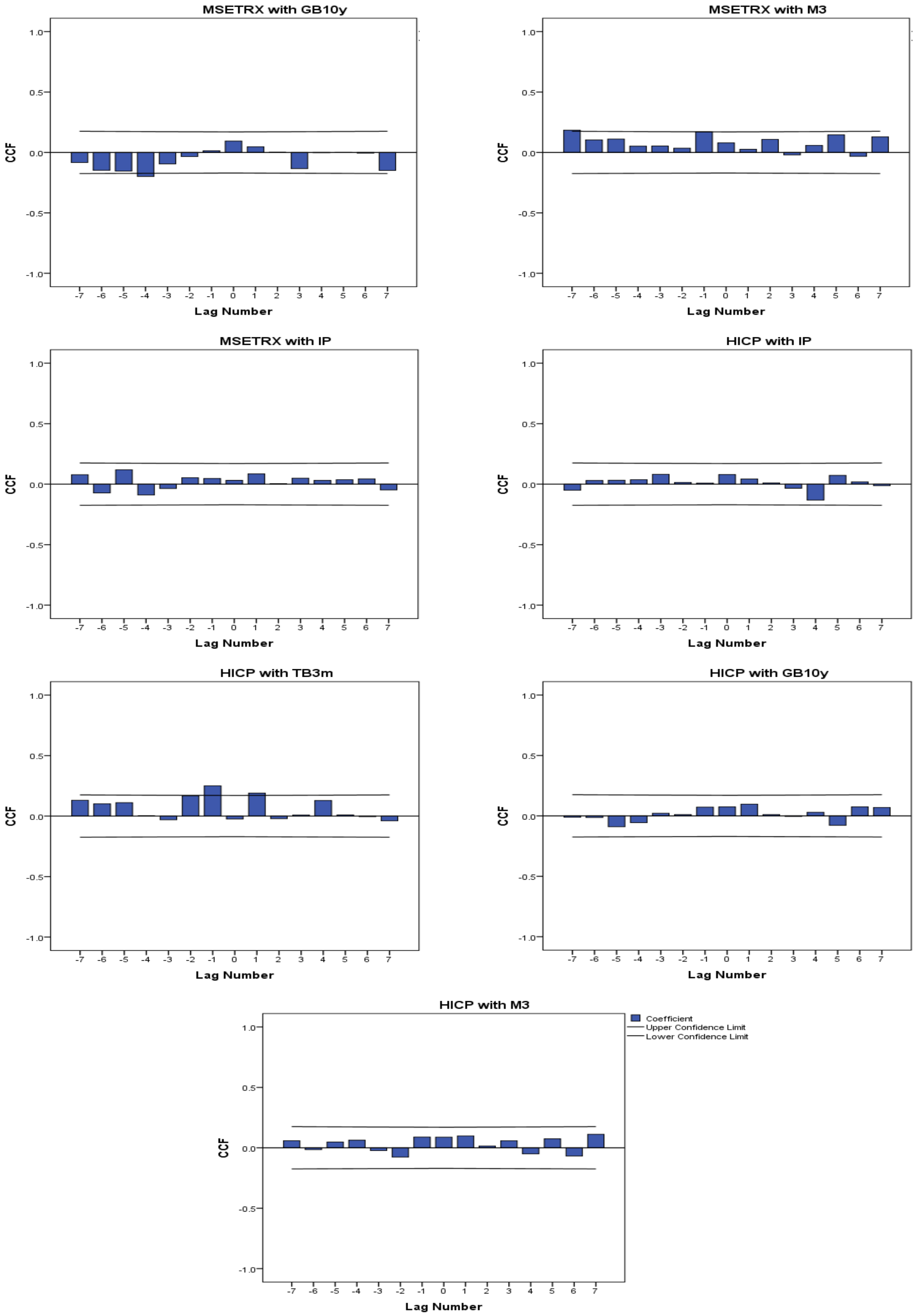


Figure 4.3: Cross-Correlation Plots

The correlations between the variables were obtained by looking at where the confidence limits (i.e. the black horizontal lines in the plots) were crossed on either side or both, hence indicating that the coefficients are significantly correlated. On the other hand, if the confidence limits were not crossed, then the coefficients were said to be insignificantly correlated. Furthermore, if the significant coefficients at the negative lags are larger than the significant coefficients at the positive lags, it indicates that the first variable (i.e. either MSETRX or HICP in the graphs above) is causing[22] the other variable and vice versa if the positive lags are larger than the negative lags.

From figure 4.3, it can be concluded that MSETRX is negatively correlated with HICP and GB10y. With respect to MSETRX and HICP, the significant coefficient at the negative lag is larger, indicating that the impact of MSETRX on HICP is greater, therefore it appears that the volatility in the MSETRX mainly causes changes to HICP and not the other way around. In the case of MSETRX and GB10y, the only significant lag is negative, thus implying that MSETRX causes GB10y with a lag of 4 months.

On the other hand, MSETRX is positively correlated with TB3m and M3. With respect to MSETRX and TB3m, all the significant lags are positive and so it

[22] Causation implies that one event/variable is the result of the occurrence of the other event/variable (Tsay 2014).

appears that movements in TB3m causes MSETRX. Whilst in the case of M3, the significant lags are negative, hence implying that MSETRX causes M3.

Additionally, it is deduced that IP is insignificantly correlated with both MSETRX and HICP at any lag. Therefore, there does not seem to be any causal relationship between MSETRX and IP nor with HICP and IP.

4.2 Stationarity

After acquiring an initial understanding of the variables in the study, the first statistical test was to analyse whether each time series variable is non-stationary (unit root test). Table 4.2 shows the results from the ADF test for each variable. From the above differenced sequence plots, it was demonstrated that with first-order differencing all time series become stationary. As a result, the lag order in the ADF test was set at 1.

Variable	No. of Lags	P-Value (nc)	H_0	P-Value (c)	H_0
MSETRX	1	0.9221	Accepted	0.9667	Accepted
HICP	1	0.07914	Accepted	0.1024	Accepted
TB3m	1	0.01	Rejected	0.08869	Accepted
GB10y	1	0.08292	Accepted	0.9201	Accepted
M3	1	0.99	Accepted	0.99	Accepted
IP	1	0.3661	Accepted	0.01	Rejected

Table 4.2: ADF Test for Stationarity

From table 4.2, it could be deduced that all time series possess a unit root since the null hypothesis either in one case or in both cases was accepted (p-value > 0.05) and hence indicating that the variables are non-stationary. Thus, it could be concluded that all of the time series variables are integrated of order 1, i.e. I(1). This was confirmed by reperforming the ADF test on the first order differenced time series.

4.3 Vector Autoregression (VAR) Model

4.3.1 Granger-causality Test

The Granger-causality test defines the null hypothesis as no Granger-causality between the two variables. Thus, if the p-value is greater than 0.05, then the null hypothesis is accepted implying that there is no Granger-causality. Therefore, it was concluded that MSETRX, HICP and TB3m are the only interrelated series. The results show that GB10y, M3 and IP are not predictors of HICP and MSETRX. For the variable pair M3 and IP, the test found that the variable M3 is a predictor of IP but not vice versa. The results obtained are presented in appendix 3 (Table A3.1).

The Granger-causality test provided some results which were contradictory to the results generated from the cross-correlation functions, thus underlining the statistical maxim that ‘correlation does not imply causation’. An example is where the Granger-causality test deduced that MSETRX is not correlated with neither GB10y nor M3, whereas the cross-correlation functions showed otherwise.

The reason is that the Granger-causality test provides a much more rigid criteria for causation than simply checking correlation across lags. The Granger-causality test is a concept of marginal predictability and so the time dimension of the potential relationship between two variables (e.g. X and Y) is crucial unlike cross-correlation functions which are a measure of linear dependence between two random variables. Furthermore, cross-correlation functions assume symmetry implying that if there is a correlation between X and Y, then there is the same correlation between Y and X. This is in contrast to the Granger-causality test where X can cause Y but not the other way around.

Therefore, in order to adhere to the principle of parsimony – which suggests that the model should be kept as simple as possible, only MSETRX, HICP and TB3m were used to fit the VAR model.

4.3.2 Optimal Lag Order

The next step in the quantitative analysis was to fit a VAR model to identify the optimal lag order for the model. This was done by selecting the VAR model order that minimises one or more information criteria evaluated over a range of VAR models using lag orders from 1 to 10. The information criteria used were the Akaike (AIC), Hannan-Quinn (HQ), Schwarz-Bayes (SC) and Akaike's Final Prediction Error (FPE). Table 4.3 shows the results of the information criteria where the lowest value indicates the optimal lag order according to the criteria. It is important to choose the optimal lag order since if the chosen or assumed lag order is unnecessarily large, the precision of the forecast of the corresponding VAR model will be reduced.

Lag Order	AIC(n)	HQ(n)	SC(n)	FPE(n)
1	4.720590	4.802068*	4.921123*	112.237326
2	4.744232	4.907188	5.145299	114.943247
3	4.700530*	4.944964	5.302130	110.082228*
4	4.723306	5.049217	5.525439	112.726286
5	4.740868	5.148256	5.743534	114.905836
6	4.792390	5.281257	5.995590	121.269931
7	4.860485	5.430830	6.264219	130.250925
8	4.845590	5.497412	6.449857	128.902826
9	4.954016	5.687315	6.758816	144.503609
10	5.036980	5.851758	7.042314	158.160899

Table 4.3: Lag Order Selection

**Optimal lag order as per criterion*

From table 4.3 one could deduce that both AIC and FPE indicate that the optimal lag order is 3 whilst HQ and SC indicate that the optimal lag order is 1.

Given that the above tests provide conflicting results, it was decided to fit two VAR models: one with a lag order of 1 [VAR(1)] and the other with a lag order of 3 [VAR(3)]. Through expert judgement, it was decided that from these two models, VAR(3) is the prevalent model and checked by running two additional models: a VAR with a lag order of 4 [VAR(4)] and one with a lag order of 5

[VAR(5)]. The purpose was to assess the significance of the coefficients and compare the fit with the VAR(3) model. This is because the above tests for the optimal lag order, only assess the likelihood of the relationship between the coefficients and the time series is penalised on the number of parameters that it contains. Consequently, one needs to use a certain level of expert judgement so as to ensure that a parsimonious model is fitted to accurately describe the time series. The reason being that due to this inherent limitation of such tests, high lag orders are rarely optimal since the higher the lags the greater the number of parameters required in the model.

In fact, it was found that a VAR(4) model is better at explaining the relationship between MSETRX and HICP because when a 4th lag was added to the time series, an additional lag of HICP ($HICP_{t-4}$) which is more significant than that of lag 3 (i.e. $HICP_{t-3}$) was produced. This proves a higher correlation between MSETRX and HICP at lag 4. Therefore, implying that a VAR(4) model is more powerful in terms of explaining the time series than a VAR(3) or a VAR(5) model. The results of VAR(3) and VAR(5) are presented in appendix 3. Whilst VAR(4) is presented in the next sub-section.

4.3.3 Vector Autoregressive Model with a lag order of 4

The VAR(4) model generated can be displayed in matrix form as shown overleaf:

$$\begin{pmatrix} MSETRX_t \\ HICP_t \\ TB3m_t \end{pmatrix} = \begin{pmatrix} \mathbf{0.28847} & -3.51863 & 114.62114 \\ 0.000391 & \mathbf{0.01301} & 0.7615 \\ -0.0000208 & 0.02852 & \mathbf{0.3072} \end{pmatrix} \begin{pmatrix} MSETRX_{t-1} \\ HICP_{t-1} \\ TB3m_{t-1} \end{pmatrix} +$$

$$\begin{pmatrix} 0.09612 & 37.43327 & 57.34429 \\ \mathbf{-0.000957} & 0.008801 & 0.3667 \\ \mathbf{0.000231} & -0.03019 & 0.08075 \end{pmatrix} \begin{pmatrix} MSETRX_{t-2} \\ HICP_{t-2} \\ TB3m_{t-2} \end{pmatrix} +$$

$$\begin{pmatrix} 0.07757 & \mathbf{-53.92014} & 70.67527 \\ 0.000503 & -0.07337 & -0.3412 \\ \mathbf{-0.0001638} & 0.006841 & \mathbf{0.165} \end{pmatrix} \begin{pmatrix} MSETRX_{t-3} \\ HICP_{t-3} \\ TB3m_{t-3} \end{pmatrix} +$$

$$\begin{pmatrix} 0.05148 & \mathbf{-79.07609} & -138.90174 \\ -0.00001625 & 0.1365 & -0.126 \\ 0.000107 & 0.02333 & -0.05338 \end{pmatrix} \begin{pmatrix} MSETRX_{t-4} \\ HICP_{t-4} \\ TB3m_{t-4} \end{pmatrix} + \underline{\varepsilon_t}$$

(4.1)

Where the bold figures denote the significant variables (at 10% level) and the vector noise ($\underline{\varepsilon_t}$) is assumed to be normally distributed at mean 0 and a covariance $\underline{\Omega}$ which is denoted as follows:

$$\underline{\varepsilon_t} \sim N(0, \underline{\Omega}) \quad ; \quad \underline{\Omega} = \begin{pmatrix} 21764.344 & 1.212870 & -2.381065 \\ 1.213 & 0.233414 & -0.003219 \\ -2.381 & -0.003219 & 0.020680 \end{pmatrix}$$

From the above equation we can deduce that HICP is affecting MSETRX at the 3rd and 4th lag negatively, implying that an increase in inflation will lower the stock returns. Additionally, it can be concluded that the relationship between inflation and MSETRX is not immediate, but the effect takes place 3/4 months after. In appendix 3, one can find equation 4.1 in one-dimensional form.

4.3.4 Misspecification Tests

These are tests which ensure that the fitted model is adequate and to verify its robustness prior to deciding on the final model. Typically, misspecification tests include: ensuring that stationarity is not compromised, the residuals have no significant serial correlation and the distributions do not violate the normal distribution assumption (Tsay 2014).

a. Testing for Stationarity of the Residuals

Table 4.4 shows that the roots of each VAR model respectively are all considerably less than 1, thus indicating that stationarity is maintained.

Model	Roots
VAR3	0.7515, 0.6551, 0.6481, 0.6481, 0.5651, 0.5651, 0.3645, 0.3645, 0.2746
VAR4	0.7585, 0.7585, 0.6931, 0.6926, 0.6926, 0.6504, 0.6504, 0.6325, 0.6325, 0.6140, 0.3880, 0.3880
VAR5	0.8545, 0.8545, 0.7476, 0.7476, 0.7454, 0.7286, 0.7286, 0.7206, 0.7206, 0.6092, 0.6092, 0.4990, 0.4990, 0.4370, 0.4370

Table 4.4: Testing for Stationarity of the Residuals

b. Testing for Serial Correlation in the Residuals

This was carried out by using the Portmanteau test. Table 4.5 overleaf shows that the p-value in all lag orders is greater than 0.05, implying that there is no serial correlation in all VAR models.

Lag Order	Chi-squared	Degrees of Freedom	p-value
3	132.86	117	0.15
4	121.84	108	0.1713
5	113.98	99	0.1441

Table 4.5: Portmanteau Test for Serial Correlation in the Residuals

c. Testing for Normality of the Residuals

The test for normality of the residuals was rejected for all tests applied since the p-values are all less than 0.05 (*vide* table 4.6). However, non-normality is not an exclusive source for biases and so it was decided that since both previous misspecification tests conducted were satisfactory, the normality assumption assumed in the VAR model is not sufficient to invalidate the results of the VAR model.

Lag Order	Test	Chi-squared	Degrees of Freedom	p-value
	JB-Test	1367.4	6	$<2.2*10^{-16}$
3	Skewness	123.84	3	$<2.2*10^{-16}$
	Kurtosis	1243.6	3	$<2.2*10^{-16}$
	JB-Test	999.78	6	$<2.2*10^{-16}$
4	Skewness	96.495	3	$<2.2*10^{-16}$
	Kurtosis	903.28	3	$<2.2*10^{-16}$
	JB-Test	1464.1	6	$<2.2*10^{-16}$
5	Skewness	132.52	3	$<2.2*10^{-16}$
	Kurtosis	1331.6	3	$<2.2*10^{-16}$

Table 4.6: Normality Test of Residuals

4.3.5 Restricted Vector Autoregressive Model

Equation 4.1 (refer to sub-section 4.3.3) quite evidently shows that the model is suffering from multicollinearity (mentioned in chapter 3) since for instance the presupposed negative relationship between HICP and MSETRX is not always so but in lags 1 and 3 there is a positive relationship. Using a VAR model with a lag order of 4 as the best fitting model (*vide* sub-section 4.3.2), a restricted VAR model with a lag order of 4 was fitted. Expert judgement was used to eliminate the insignificant coefficients at the various lags, so that the final VAR model is able to predict the relationship between the variables more accurately. This is shown by equations 4.2-4.4 where the values in brackets are the p-values.

$$MSETRX_t = \underset{(0.000005)}{0.368MSETRX_{t-1}} + \underset{(0.0497)}{157.246TB3m_{t-1}} - \underset{(0.0132)}{63.544HICP_{t-3}} - \underset{(0.0115)}{65.170HICP_{t-4}} + \underline{\varepsilon_t} \quad ; \quad \underline{\varepsilon_t} \sim N(0,23088.6) \tag{4.2}$$

Adjusted R^2: 0.2139

$$HICP_t = \underset{(0.00587)}{0.736TB3m_{t-1}} - \underset{(0.00154)}{0.00085MSETRX_{t-2}} + \underset{(0.04131)}{0.00056MSETRX_{t-3}} + \underline{\varepsilon_t} \quad ; \quad \underline{\varepsilon_t} \sim N(0,0.245) \tag{4.3}$$

Adjusted R^2: 0.1227

$$TB3m_t = \underset{(0.000315)}{0.031TB3m_{t-1}} + \underset{(0.00690)}{0.00022MSETRX_{t-2}} - \underset{(0.0218)}{0.00021MSETRX_{t-3}} + \underset{(0.0318)}{0.174TB3m_{t-3}} + \underset{(0.0377)}{0.00017MSETRX_{t-4}} + \underline{\varepsilon_t} \quad ; \quad \underline{\varepsilon_t} \sim N(0,0.0215 \tag{4.4}$$

Adjusted R^2: 0.1998

From the above equations, it is clearly highlighted that there exists a negative relationship between inflation and stock returns. Furthermore, as outlined in the unrestricted VAR, the effect of inflation on stock returns is not immediate but takes a couple of months. Hence, implying that a rise in prices, will lead to a decline in Maltese stock returns in 2- or 3-months' time. With respect to short-term interest rates, it is shown that they are more likely to influence both stock returns and inflation in the short-term (typically in one months' time). It is also worth noting that short-term interest rates seem to be affected by previous months' stock returns.

The adjusted R^2 figures indicate the model's ability to explain the dependent variable. Looking at equation 4.2, one could deduce that TB3m and HICP explain 21.4% of the changes in MSETRX. As expected, the adjusted R^2 figures are quite low pertaining to the fact that only 3 out of the 5 independent variables were retained in the model.

Even though the VAR model gives some insight regarding the inflation-stock returns relation, the results might not be fully accurate because in order to make the time series stationary, differencing was required and so increasing the risk of overlooking long-run relationships between the variables. As a result, a VECM model was fitted to allow for both the short-term and the long-term effects within the model. Nonetheless, the VAR model was still referred to in determining the number of lags to be used for the VECM model.

4.4 Vector Error Correction Model

4.4.1 Cointegration Test

This was carried out by using the Engle-Granger cointegration test where the null hypothesis was accepted if the p-value was greater than 0.05 and thus concluding that there is no cointegration between the variables.

From the Engle-Granger test it was concluded that there are a number of cointegrating relationships within the time series: MSETRX is cointegrated with GB10y and M3 and vice versa. Whilst HICP is cointegrated with TB3m & IP and vice versa. A table summarising the output generated from the Engle-Granger cointegration test is presented in appendix 3 (table A3.2).

4.4.2 VECM

Ultimately, a VECM model was fitted since all of the time series variables are I(1) and there is cointegration in the time series. A number of VECM models were generated so that the optimal lag order and the optimal number of cointegrating the relationships (r) was chosen. The optimal model was rendered to be one with a lag order of 4 and r=2, which is presented by equations 4.5 and 4.6. Only the significant coefficients (i.e. 10% level) for $\Delta MSETRX_t$ and $\Delta HICP_t$ are displayed whereas the full results are presented in appendix 3 (table A3.3). *Note that the p-values are the values in the brackets.*

$$\underset{}{\Delta MSETRX_t} = \underset{(0.0284)}{0.2088\Delta MSETRX_{t-1}} - \underset{(0.0513)}{55.9236\Delta HICP_{t-3}} - \underset{(0.0042)}{80.5981\Delta HICP_{t-4}} \quad \textbf{(4.5)}$$

$$\Delta HICP_t = \underset{(0.0783)}{0.000018ECT1} - \underset{(0.0003)}{0.1512ECT2} + \underset{(0.0272)}{0.7217\Delta TB3m_{t-1}}$$

$$\underset{(0.0012)}{-0.0010\Delta MSETRX_{t-2}} - \underset{(0.037)}{0.0004\Delta M3_{t-2}} - \underset{(0.096)}{0.5462\Delta TB3m_{t-3}} + \underset{(0.04)}{0.1826\Delta HICP_{t-4}} \quad \textbf{(4.6)}$$

Where,

ECT1 and ECT2 are the first and second error correction terms respectively,

Δ denotes the first difference of the respective variable, and

Π is given by the error correction terms multiplied by the cointegrating relationships (i.e. r1 and r2) as shown below:

$$\Pi = \begin{pmatrix} 0.023 & 6.66 \\ 0.00002 & -0.15 \\ 0.00001 & 0.019 \\ 0.000005 & -0.004 \\ 0.017 & -59.3 \\ -0.00003 & 0.23 \end{pmatrix} \begin{pmatrix} 0 & 0 & -7433.36 & -5724.82 & -2.82 & 534.0 \\ 2.7 * 10^{20} & 1 & -1.64 & 1.15 & 0.00017 & -0.07 \end{pmatrix}$$

$$\therefore \Pi x_t = \begin{pmatrix} 1.8 * 10^{21} & 6.66 & -181.89 & -124.01 & -0.06 & 11.82 \\ -4.05 * 10^{19} & -0.15 & 0.10 & -0.29 & -8.19 * 10^{-5} & 0.02 \\ 5.13 * 10^{18} & 0.019 & -0.12 & -0.04 & -2.5 * 10^{-5} & 4.01 * 10^{-3} \\ -1.08 * 10^{18} & -0.004 & -0.03 & -0.03 & -1.47 * 10^{-5} & 2.95 * 10^{-3} \\ -1.60 * 10^{22} & -59.3 & 29.12 & 165.52 & -0.06 & 13.23 \\ -6.21 * 10^{19} & 0.23 & -0.15 & 0.44 & 1.24 * 10^{-5} & -0.03 \end{pmatrix} \begin{pmatrix} MSETRX_{t-4} \\ HICP_{t-4} \\ TB3m_{t-4} \\ GB10y_{t-4} \\ M3_{t-4} \\ IP_{t-4} \end{pmatrix}$$

The above matrix (Π) shows that Π is not a full rank matrix which is consistent with the previous findings that x_t is integrated of order one [i.e. $x_t \sim I(1)$] and so all stochastic components are stationary in the fitted VECM.

Similar to the VAR model, the VECM shows that only the lagged HICP and $MSETRX_{t-1}$ have a significant impact on describing MSETRX. Additionally, the expected negative relationship between inflation and Maltese stock returns is depicted clearly in equation 4.5 showing that it takes three to four months for Maltese stock returns to adjust for changes in inflation.

Looking at the HICP equation, one can again see the negative interaction between HICP and MSETRX. Moreover, there is a negative relationship between HICP and M3 whilst a positive relationship between HICP and TB3m (by considering only the most significant TB3m). Therefore, showing that changes in M3 and changes TB3m have a significant impact in explaining HICP.

4.4.3 Misspecification Tests

Similar to the VAR model, the VECM was also checked for its adequacy by testing the serial correlation of the residuals as well as their normality. The LjungBox test for serial correlation was used to assess whether the residuals of the fitted VECM model are correlated. Table 4.7 overleaf, shows that there is no serial correlation between the residuals since the p-values in all lag orders is greater than 0.05.

Lag Order	Test Statistic	Degrees of Freedom	p-value
5	75.41114	180	1.0000000
10	239.49728	360	0.9999998
15	438.83634	540	0.9994700
20	633.46752	720	0.9908853
25	800.05277	900	0.9925179
30	980.38341	1080	0.9860483

Table 4.7: LjungBox Test for Serial Correlation

The Shapiro-Wilk test was used to check whether the normality assumption of the residuals is met. The test gave a p-value of 4.948×10^{12} which is smaller than 0.05 and thus, unfortunately, similar to the VAR model, the normality assumption was also rejected in the VECM indicating that the residuals do not follow a normal distribution.

4.5 Conclusion of Part 1

The first part of this chapter has presented the findings of the two multivariate time series models. Although the model shows similar results, the VECM was able to provide a greater insight with regards to the factors that influence inflation. In the VECM, as the time series is cointegrated, no differentiation is applied to the underlying data. This allows the time series to capture the long-term relationship between the variables more accurately. The next part shall present the findings obtained from the interviews.

Part 2: Qualitative Segment

This section presents the opinions and views of professional experts in the field, through the results acquired from the semi-structured interviews conducted with 2 economists, 3 financial analysts and 3 stockbrokers. This part shall corroborate the findings derived from the quantitative model developed in chapter 4 and aims to achieve the third objective of this study. It shall take a similar format to the interview questions which are presented by figure 4.4 below while Appendix 4 discloses the interview questions.

Investment in Malta

- Investment Culture
- Investment Decisions
- Investment Portfolio

Inflation and Maltese Stock Returns

- Stock Returns
- Inflation
- Money Supply
- Interest Rates
- Real Activity
- Other Significant Shocks

Figure 4.4: Interview Structure

4.6 Investment in Malta

4.6.1 Investment Culture

All interviewees agreed that Maltese investors have a higher propensity to seek higher returns with less consideration to their risk tolerance levels. Having said this however, the interviewees pointed out that most Maltese investors prefer higher rated investments. The interviewees also agreed that local investors have longer term investment objectives known as buy-and-hold – implying that local investors tend to buy shares and retain them indefinitely, which results in less active trading on the Maltese stock market. Interviewees mentioned instances where even after the person holding the shares passes away, whoever inherits them will again retain them indefinitely.

4.6.2 Investment Decisions

When making an investment decision, interviewees mentioned that the economic conditions of the country in which the shares of the company are suggested to be purchased and the geo-political risk should be taken into consideration as they form the basis of business activity. The economic conditions mentioned include economic growth, industrial or services development, pressures in the labour market, inflation, GDP and other economic indices such as the Business Confidence Index (BCI) and the Purchasing Managers' Index (PMI).

In contrast with the majority of the interviewees who seek to look at the macro-economic indicators, two interviewees emphasised the fact that before looking at the macro-economy, they consider a micro-approach (i.e. bottom-up perspective), where initially an assessment of the company itself is first undertaken prior to taking a wider view of understanding the whole sector.

The participants were also asked how much importance they give to inflation when making an investment decision. Only 2 out of 8 interviewees consider inflation to be an important indicator when making an investment decision by stating that a rise in inflation would induce a series of events. For instance, if inflation increases it implies that the central bank is going to tighten the monetary policy leading to a rise in interest rates and a reduction in money supply which would eventually lead to less money circulating in the economy and higher cost of financing for the companies and fewer loans for the public due to higher interest rates. Whereas the other 6 interviewees rank inflation mid-way in their scale because in recent years the inflation rate was low.

When asked which factor they think mostly influences stock returns, 6 interviewees agreed that stock returns are influenced by dividends: 1 interviewee said that it is investors' expectations as well as interest rates which mostly influence stock returns. Whilst the other said that it is quality of the stock[23] which

[23] The quality of the stock refers to the reliability of the company which is determined by high and consistent profits, low debt and alternative methods of sustainable earnings.

is based on the nature of the business activity, quality of board of directors and management as well as governance, strategic plans of the companies and balance sheets.

4.6.3 Investment Portfolio

When considering to acquire financial assets in an investment portfolio, 4 out of 8 interviewees stated that they consider inflation in their proposal. The forecasted inflation rates are included in the estimation of the theoretical share price and ensuring that they are protected for inflation by buying securities for instance.

On the other hand, 3 out of 8 interviewees stated that in a period of low inflation rates, this factor does not influence decisions on an investment portfolio, unless the investment is in real estate.

Additionally, 1 interviewee stated that in addition to inflation, consideration should be given to: interest rate, liquidity, inherent risk (both of the issuing firm and of the countries to which the firm is exposed), financial performance of the issuer, PMIs, GDP and consumer spending amongst others.

4.7 Inflation and Maltese Stock Returns

This section presents interviewees’ responses to questions asked in relation to the findings generated from the quantitative model (see Part 1: Quantitative Segment).

4.7.1 Stock Returns

The interviewees were asked for their views on why the stock returns in any one month are influenced by stock returns of the previous month (i.e. at lag 1) but not the previous 2 months, 3 months and so on. The interviewees stated that in the long-run, a rational investor decision-maker adopts a more forward-looking approach in that the investor considers the quality and the growth prospects of the stock. Hence, there is no need to look at higher lags. Another reason could be that stock returns are generally affected by the "herd instinct" where in the short-run investors act like the majority.

4.7.2 Inflation

All interviewees except 1 do not perceive inflation as a significant contributor to the volatility of stock returns in Malta. This is because local investors lack certain sophistication as to how they interpret economic and financial data.

The interviewees also explained that the reason behind the negative relationship between inflation and stock-returns is the lack of financial sophistication amongst local investors, which leads to excluding inflation changes in their investment decisions. There is a time lag for inflation to filter through Maltese stock returns, due to the period of time required for the inflation factor to filter through the Maltese stock returns. Also, they stated that the lack of liquidity on the Maltese stock market delays for the share price to factor the impact of a number of factors including inflation. Moreover, 3 out of 8 interviewees, claimed that there may be other reasons causing inflation such as the number of foreigners that were coming to Malta either on holiday or for work. This might have led to higher spending and a higher demand for certain sectors or services, thus contributing to higher inflation. Hence, it could be that this growth in certain sectors might have pushed people away from the local investment market. Another reason was because of higher interest rates which will increase competition for returns as the price of bonds is pushed up.

When asked whether there is a specific cause for the origin of the negative relationship between inflation and stock returns in Malta, the interviewees expressed that the Maltese market is still a small market and still at the early stages of its development. Another reason is that unfortunately, inflation is not given the importance that it merits by local investors. Therefore, the interviewees suggested that there may be other factors causing a negative relationship between inflation and stock returns such as ‘herd behaviour’.

4.7.3 Money Supply

The VECM’s findings presented in the previous part of this chapter deduced an anomalous negative relationship between inflation and money supply. The interviewees were asked to give their opinion on whether they think that such negative relationship would influence the relationship between inflation and stock returns.

Interviewees had conflicting opinions on the influence of money supply on stock returns. 2 interviewees were of the view that in Malta money supply does not influence stock returns. They are of the view that other economic factors such as consumer confidence and the general underlying health of the economy impact stock returns. They opined that as stocks are a long-term investment, it is unlikely that short term factors such as the money supply affects their returns. Additionally, the fact that money supply does not affect stock returns reflects that in Malta we are still a high savings community. The other six interviewees said that there is a relationship between money supply and stock returns when the money in circulation is in excess of real economic activity. This creates inflation and hence affects stock returns.

The interviewees also suggested possible reasons pertaining to the anomalous negative relationship between money supply and inflation. These being:

- The current low interest rate scenario that Malta is experiencing and hence money supply seems to be having little influence on inflation. This shows that consumer confidence is still low and there is a lot of uncertainty in the market. Consequently, consumers are not prepared to spend as much as one would expect even if borrowing attracts low interest rates.

- Increases in money supply because the central bank anticipates low inflation. Hence, as inflation declines the central bank is increasing the money supply. However, this scenario only holds for a very short period of time since ultimately as soon as additional money supply is injected into the economy, inflation should recover.

- Whilst another interviewee suggested that even though money supply is injected into the economy, the money is not going into the companies or the companies are not encouraged to borrow, hence, the companies are not investing in new machinery, are not employing people and so on. Correspondingly, it might be that the money supply has increased however, the investors are not encouraged to take a loan or to buy property.

4.7.4 Interest Rates

(a) Short-term Interest Rates

6 out of 8 interviewees agreed that changes in short-term interest rates should affect the relationship between inflation and stock returns. This is because if bank interest rates on deposits are low, investors seek alternative opportunities from banks and hence equity benefits. Inflation pushes interest rates up as banks seek to attract deposits. This usually has the short-term psychological effect of having investors considering returning to bank deposits.

The other 2 interviewees said that investors are not influenced by the level of interest rates in the local market but by considerations of capital safety and yield in their investment decisions.

(b) Long-term Interest Rates

The interviewees were also asked to give their opinion on whether long-term interest rates affect stock returns.

4 interviewees said that long-term interest rates should affect stock returns since they have an impact on investment decisions. Markets do not like high interest rates and stock prices generally fall when interest rates rise and vice versa. However, this relationship might not be reflected in the Maltese scenario since there are other factors at play. Furthermore, one of these 4 interviewees said that long-term interest rates provide an indication of the future economic climate and also determine the cost of borrowing, implying a relationship between long-term interest rates and stock returns.

On the other hand, the other 4 interviewees agreed with the quantitative model that long-term interest rates do not impact stock returns. The reason they cited was that usually the focus is on short-term interest rates. Long-term interest rate changes are considered as ‘old news’ because stock markets anticipate what is going to happen and constantly react to the changes in short-term interest rates. Furthermore, the fact that Maltese investors are short-sighted implies less consideration to longer term impacts on the stock returns. Another reason pointed out by an economist was if the investor is considering returns from equities in the long-term rather than for a short-term gain, then long-term interest rates will not affect stock returns.

4.7.5 Real Activity

As expected from the literature review (Fama 1981; Kaul 1987), the interviewees also agreed that real activity should affect both inflation and stock returns. A possible reason provided by the interviewees for real activity being insignificant to both inflation and stock returns (as deduced from both models developed in the quantitative part of this study), could be due to the lack of sophistication of the Maltese investors. Another reason might be inherent to the fact that currently we are in an environment of very low inflation. However, the interviewees also said that in Malta when news about the performance of the economy comes out, movements in the market generally respond relatively fast.

An interviewee also said that real activity has an indirect effect on stock expectations rather than on stock returns per se and this might be the reason why it is insignificant.

4.7.6 Other Significant Shocks

Lastly, the interviewees were asked whether they think that other significant shocks such as COVID-19, would reduce the impact of inflation on stock returns. All interviewees said that it is very early to be able to estimate its impact on the stock market. Furthermore, the interviewees also highlighted that the impact of COVID-19 was more company specific in that, whether the company is sufficiently solvent and liquid in the short term. Ultimately, the interviewees believe that significant shocks will not reduce the effect that inflation has on stock returns but the whole inflation-stock returns relationship will be affected.

4.8 Conclusion of Part 2

The second part of this chapter outlined the findings from the interviews conducted with several experts in financial markets. The subsequent chapter shall discuss the overall findings in relation to the research objectives with a comparison of the findings in previous studies.

Chapter 5

Discussion

5.0 Introduction

This chapter shall discuss the quantitative and qualitative findings presented in the previous chapter in relation to the research objectives, as well as findings from previous studies as outlined in the literature chapter.

5.1 An Overview of the Data

From the test for stationarity of the time series, it was concluded that all variables used in this study were integrated of order one and hence consistent with Tsay (2013). Similar to other countries, when analysing Maltese economic and equity data, one needs to address the problem of unit root in time series so as to eliminate the issue of spurious regressions (Granger and Newbold, 1974).

The study proceeded to check the causality between the variables. The Granger-causality test showed that MSETRX, HICP and TB3m are all interrelated. This was in line with the findings of Siang et al. (2017) in the post-global financial crisis. Therefore, indicating that Maltese investors can use past information of inflation to forecast future Maltese stock returns. Furthermore, the Engle-Granger cointegration test even though it showed several cointegrating relationships within the time series, there was no cointegration relationship between stock returns and inflation implying that the relationship between inflation and equity returns in Malta is not long-term. This highlights that equity returns do not offer a good protection against inflation in the long run. This result is similar to Russia, India and South Africa (Tripathi, Kumar 2014) and Bangladesh (Khan, Yousuf 2013) who deduced that inflation does not influence stock prices in the long-run.

5.2 Inflation and Maltese Stock Returns

The model in section 4.4.2 described the relationship between inflation and Maltese stock returns with the aim to identify the origin of such relationship. It was deduced that Maltese stock returns are influenced by only two variables: past month stock returns and the three and four inflation lags. Surprisingly, the other variables seemed to have no influence on stock returns per se. However, the model deduced that short-term interest rates and money supply are influencing inflation, implying that short-term interest rates and money supply could have an indirect impact on the relationship between inflation and stock returns as whole. The sections below shall discuss each variable as well as any possible causes and implications on the inflation-stock returns relationship.

5.2.1 Stock Returns

Primarily, the fact that the stock returns variable is influenced only by the previous one month and not by the previous two months or prior months, could be due to the fact that such variable becomes stationary at lag 1 (*vide* section 4.2). Another reason emphasised by all interviewees is that most Maltese investors are forward-looking. Nonetheless, a financial analyst who was interviewed said that investors who have been investing for a long time still give importance to past stock returns and past experience. In fact, there are instances where such investors are reluctant to invest or opt for particular securities due to a negative past experience. Furthermore, it highlights the fact that Maltese stock returns have a short-term impact.

Having said this, one should also consider the likelihood that stock returns are not only influenced by historic changes, but possibly also reflect expectations about the future, including future inflation, future interest rates and the firm's future profitability. Another reason may be co-movement with developments in other markets, especially for firms that are heavily engaged in trade or firms which are presumed to be influenced by the same shocks arising elsewhere (Ando 2019). Stock markets may also react or overreact to statements by high-profile institutions or policy makers, this was referred to as 'herd behaviour' by 3 out of 8 interviewees where after a public announcement is made, people tend to follow what others are doing.

5.2.2 Inflation

The findings with regards to the inflation-stock returns relationship in Malta corroborate with Buhagiar (2017), in that a highly significant negative relationship was identified (refer to equation 4.5[24] in section 4.4.2). Furthermore, this implies that stock returns in Malta do not provide adequate protection against inflation

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[24] An increase in inflation at lag 3 by 1 unit will cause stock returns to decrease by approximately 55.92 units. Furthermore, an increase in inflation at lag 4 will cause stock returns to decrease by approximately 80.60 units.

and hence go against the Fisher (1930) hypothesis but is consistent with the findings of Erb et al. (1995). Nonetheless, numerous studies such as Fama, Schwert (1977), Gultekin (1983), Geetha et al. (2011) and Chaves, Silva (2018), have found a negative relationship in several developed and developing countries including Brazil, Germany, Italy, Malaysia, Switzerland and US. This may be because of the time series methodology used. In fact, Erb et al. (1995) imply that a cross-sectional study will generate results consistent with the Fisher hypothesis unlike time series studies.

In the literature reviewed, several plausible justifications of this negative relationship were established. Fama's (1981) claimed that inflation acts as a proxy for omitted variables and hence the sign on inflation, reflects such variables because of high inflation which implies low growth and low corporate performance. Also due to the fact that there is a positive correlation between economic growth and stock returns, it is evident that inflation and stock returns are negatively correlated. This proxy hypothesis was also supported by Adrangi et al. (2000) who claimed that in Brazil, future companies' profit is affected by inflation and that inflation drives nominal discount rate up. This in turn decreases future profits and stock returns, resulting in a negative relationship between inflation and stock returns.

Danthine and Donaldson (1986), Stulz (1986) and Marshall (1992) deduced that a negative inflation-stock returns relation is present when inflation is generated by non-monetary factors. Furthermore, Hess and Lee (1999) claimed that a negative relationship between inflation and stock returns is generated by aggregate supply shocks.

Modigliani and Cohn's (1979) inflation illusion hypothesis which argued that in an environment where inflation is increasing, interest rates are expected to increase and so investors will apply higher discount factors when calculating the present value of expected future earnings and dividends to compensate for the increase in interest rates. Hence, stock prices decrease. Thus, underlining the negative inflation-stock returns relationship.

Although Jones et al. (2017) deduced an adverse relationship between inflation and stock returns, in the study it was argued that inflation only explains 3% of the change in real stock returns. This might be in relation to the Maltese scenario where from the interviews conducted, 7 out of 8 interviewees believed that most Maltese investors fail to take into account inflation since, Maltese investors give a lot of importance to dividend income and also because in the last couple of years inflation has been relatively low. The remaining interviewee argued that inflation is a significant contributor to the volatility of stock returns in Malta. The listed entities on the Maltese market mainly operate in the retail, hotels and property sectors which are more likely to be influenced by changes in the rate of inflation. For example, with high inflation rates, the value of money will decrease, reducing demand for products or services offered by these companies, with a negative impact on earnings and profitability.

Another inherent limitation of the Maltese market is that unfortunately inflation is not given the importance that it merits by local investors and hence the negative relationship might be due to other factors such as 'herd behaviour' as mentioned in sub-section 5.2.1. In fact, only 2 out of 8 interviewees expressed the importance of considering inflation in an investment decision whilst the others rank inflation mid-way in their scale mostly because currently inflation is under control. Instead, Maltese investors mainly seek high income and dividend pay-outs whilst ensuring a safe investment.

From the study, it was also deduced that in Malta it takes around 3 to 4 months for inflation to have a negative impact on stock returns. Understandably, there is going to be a time lag for the inflation factor to impact the Maltese stock returns. This result shows that the Maltese stock market is highly illiquid, especially when compared to international markets. Hence, this delays the effects of a number of factors including changes in inflation. In fact, Li et al. (2010) who studied the effects of inflation announcements on stock returns in the UK concluded that unexpected changes in inflation rates influence stock returns negatively on announcement day and within 3-days during low inflation periods. This underlines the excessive illiquidity of the Maltese stock market. Moreover, the interviewees suggested that there may be other reasons which are causing inflation, hence leading to a time lag for stock returns to adjust to such fluctuations in inflation for instance the number of foreigners coming to Malta and growth in certain economic sectors (*vide* section 4.2.8).

Furthermore, the interviewees argued that although inflation is a good indicator of economic activity, local investors fail to consider inflation in their investment decisions which interviewees view as a lack of sophistication amongst Maltese investors. However, over the years there has been an improvement in the Maltese stock market since more institutional investors are becoming active in the local market (Rizzo, 2016) and there has also been an increased influence on inflation. Nonetheless, the interviewees believe that it is still less than what can be observed in international markets.

5.2.3 Money Supply

Kaul's (1987) monetary argument suggests that inflation stimulates the economy's demand for money, which is met by withdrawing investments, therefore resulting in lower stock returns. In contrast with Kaul's (1987) monetary argument, money supply seems to have very little influence on the Maltese stock returns-inflation relationship since in the VECM it is only influencing inflation and the coefficient is very small. In fact, the model shows that an increase in money supply by 1 unit, will cause inflation to decrease by 0.0004 units. However, money supply might be influencing Maltese stock returns indirectly through inflation.

This is contradictory to economic theory which states that an increase in money supply leads to an increase in inflation. Indeed, Milton Friedman came up with the well-known statement "Inflation is always and everywhere a monetary phenomenon" (1968, p.39).

However, reality does not always reflect economic theory as in the case of Malta as well as Fama's (1981) findings which showed that higher inflation would instigate the implementation of monetary and fiscal policies, which would result in a decrease of money supply, increasing interest rates and restriction of aggregate demand leading to lower stock returns.

A possible explanation for this negative relationship between inflation and stock returns is that the Maltese investor is mainly characterised as dividend seeking, buy-and-hold investor (Sammut, 2002) with normally long holding periods. This was corroborated by all the interviewees who highlighted the importance that Maltese investors give to capital preservation whilst maintaining high returns.

Additionally, the interviewees suggested possible reasons pertaining to the anomalous negative relationship between money supply and inflation. These included the current low interest rate scenario that Malta is experiencing, uncertainty in the stock market and the fact that even though money is injected into the economy, investors are not encouraged to take a loan (*vide* section 4.8.3).

With regards to stock returns, Tobin (1969) maintained that changes in money supply are a great indicator and a crucial source of information in explaining future stock market returns. However, according to the model presented in section 4.4.2, there seems to be no relationship between money supply and stock returns. This is again surprising since one expects that when money is injected into the economy, it will drive economic growth and so lead to a higher demand for equity. As a result, investors will switch to equity due to higher returns over bonds and hence stock prices will rise (Mukherjee, Naka 1995). Fama (1981), Rahman et al. (2009) and Humpe, Macmillan (2007) also stated that stock prices are negatively influenced by money supply.

The interviewees also argued that money supply should have an impact on stock returns if the money in circulation is in excess of real economic activity, thus fuelling consumer demand when companies have not yet provided enough supply to meet that demand. This creates inflation and triggers the cycle of inflation impact on corporate equity and returns. Furthermore, an interviewee suggested that money supply does not affect stock returns because of same factors that caused a negative relationship between inflation and money supply. Another interviewee said that stock returns are determined by consumer confidence and the general underlying strength of the economy and hence money supply does not affect stock returns.

On the other hand, 2 interviewees agreed that money supply does not influence stock returns directly. 1 interviewee suggested that these two variables are not interrelated which indicates that Malta is still a high savings community. Whilst the other interviewee said that money supply is something which impacts the business in the short-term, whereas stock returns are an expectation in the long-term investment and hence there is no correlation between the two.

5.2.4 Interest Rates

From the VECM presented in section 4.4.2, both short- and long-term interest rates were deemed to be insignificant in explaining stock returns. This was quite unexpected because both economic theory and also prior studies show a positive relationship such as Lee (1992), Fama, Schwert (1977) and Khan, Yousuf (2013). Furthermore, given that long-term interest rates provide an indication of the future economic climate and determine the cost of borrowing, one expects that long-term interest rates should have an impact on stock returns. Ferrer et al. (2016) deduced that the relationship between long-term interest rates and stock returns differs significantly from one country to another and the relationship varies over time with respect to the time horizon considered. This is depicted by the positive relationship between inflation and stock returns which was found to be stronger in times of uncertainty in the UK as opposed to being stronger at the start of the global financial crisis in Germany, France, the Netherlands and Finland in 2007.

The interviewees suggested some possible explanations regarding the insignificance of long-term interest rates in the Maltese scenario. These are listed below:

- 4 interviewees said that the stock market only focuses on short-term interest rates and so as soon as the indications on short-term interest rates change, the markets will react accordingly because short-term interest rates act as an indicator of long-term interest rates. Therefore, long-term interest rates are perceived as “old news”.

- One of the economists interviewed said that the Maltese stock market is too small and hence one cannot generalise and compare it to the foreign market. Contrarily, another economist and one of the financial analysts interviewed claimed that if investors are rational (meaning that investors base their investment decisions on the quality of the stock and its growth prospects rather than short-term gain) then long-term interest rates should not affect stock returns.

Furthermore, a possible reason as argued by Ferrer et al. (2016), is because the relationship between 10-year government bond rates and stock returns is normally observed in one- or two-years' time. Therefore, this suggests that had the study been conducted using yearly data, the results might have been different. However, this would have significantly reduced the number of observations.

Moving on to inflation, only short-term interest rates seem to be significant showing a positive relationship between the two. This is consistent with the Fisher (1930) hypothesis and with Sweden, US, Euro area, Japan, UK and Canada (Jonsson, Reslow 2015). Consequently, it is reasonable that economists advise that inflation is kept low in order to maintain low interest rates. However, since according to the findings of the VECM (*vide* equation 4.6 in section 4.4.2) which show that a rise in the previous month's short-term interest rates by 1% will cause a rise in inflation by approximately 0.72 percentage points, the Mundell-Tobin effect, which proposes that nominal interest rates would increase less than one-for-one with inflation (*vide* section 2.3.2), seems to be more appropriate in explaining the relationship between inflation and interest rates in Malta (Mundell 1963, Tobin 1965).

One should also bear in mind the conclusions derived by Balduzzi (1995) which imply that interest rates function as a better proxy than real activity in analysing the negative inflation-stock returns relation. Therefore, short-term interest rates might be a key driver to the inflation-stock returns relationship. This was in fact corroborated by the interviewees, where 6 out of 8 interviewees claimed that interest rates definitely influence the inflation-stock returns relation.

However, 2 out of 8 interviewees contradicted Balduzzi (1995) with respect to the Maltese scenario by arguing that since local investors are more concerned with capital preservation and returns in their investment decisions rather than by the level of interest rates in the local market. Therefore, the relationship between inflation and short-term interest rates should not affect the inflation-stock returns relation.

5.2.5 Industrial Production

A surprising result was the fact that the industrial production variable was found to be highly insignificant both with stock returns and inflation. This contradicts Fama's (1981) argument which deduced a positive relationship between real stock returns and real activity, and a negative relationship between inflation and real activity, which when both relationships are combined together yield a negative inflation-stock returns relation. These results are also inconsistent with several studies in both developed and developing countries such as in the United States (Fama 1990), Brazil (Chaves, Silva 2018), Malaysia (Rahman et al. 2009), Japan (Humpe, Macmillan 2007), Canada, Spain, Switzerland (Ely, Robinson 1997), Germany, Italy, United Kingdom (Nasseh, Strauss 2000) and Australia (Paul, Mallik 2003). Moreover, economic theory also states that stock returns and real activity should be positively related, implying that as industrial production increases in real terms, their net asset value should increase. In addition, all of the interviewees believe that real activity should influence both inflation and stock returns, in particular if investors consider that a particular shock to economic activity would impact firms' earnings and profitability.

Albeit the findings from this study corroborate with findings in Pakistan (Hasan, Nasir 2008; Khan, Khan 2018) and in Japan (Hamao 1988) where the industrial production variable does not impact stock returns. This insignificant relationship may be explained by the fact that the Maltese economy has been shifting from the industrial sector into the services sector. This can be justified further by the fact that on the Maltese stock exchange only one manufacturing company is listed which is Simonds Farsons Cisk plc.

5.2.6 Other Significant Shocks

Other significant shocks such as COVID-19 represent a negative shock to demand, supply and investors' confidence. Although the impact of these shocks on activity is negative, that on inflation can be negative or positive, depending on how the supply side of the economy reacts. On one hand, the supply side of the economy is not affected by the shock, but on the other hand demand falls, this will result in a downward pressure on prices. However, if the economic capacity is affected more negatively than demand, supply falls and so prices increase. Thus, affecting the relationship between inflation and stock prices and hence the inflation-stock returns relation.

However, as the majority of the interviewees said, it is very early to be able to estimate its impact on the stock market. Furthermore, the interviewees also highlighted that the impact of COVID-19 was more company specific in that, whether the company has enough cash to be able to keep up with the payments. Additionally, as mentioned previously, local investors are unsophisticated and hence during unexpected events, especially when such events have a negative impact, they tend to act irrationally and this might have implications on the inflation-stock returns relationship. However, the interviewees believe that significant shocks will not reduce the impact of inflation on stock returns but such shocks will affect the whole inflation-stock returns relationship.

COVID-19 has been reflected through the instability of financial markets and volatility in returns and hence this makes it difficult to be able to identify the influence of inflation from other factors (for instance earnings' expectations and uncertainty) during this period. However, given that COVID-19 is a temporary shock, as normality is restored and over longer horizons one would expect that the historical relationship between inflation and stock returns would be restored.

5.3 The Implication of the Findings on the Maltese Market Efficiency

The results from the model indicate that the lags of the stock returns variable ($MSETRX_{t-1}$; *vide* equation 4.5 in section 4.4.2) are significant in describing current or future stock returns. This is in contrast to one of the principles of the EMH (Fama 1965) which maintains that in a weak-form efficient market, historical price movements cannot explain future price movements and/or returns. Hence, the results of the study indicate that the Maltese stock market is inefficient. This is supported by finding from previous studies in Malta, which indicate that the Maltese stock market is inefficient due to market attributes including the small size of the Maltese stock market, slow reaction to new information, 'buy-and-hold' mentality and illiquidity (Smith 2012; Sammut 2002; Zahra 2018).

One of the interviewees suggested that in order to make the Maltese stock market efficient, one should consider the introduction of a market maker. A market maker is an individual or a firm that participates in the market by buying and selling large amounts of a certain asset so as to ease liquidity and guarantee smooth running of financial markets. This will also help in reducing volatility in the market.

Additionally, the MSE and members of the MSE should do their best to urge mature companies[25] to pursue a listing on the Official List of the MSE so as to increase the options available to the investors in Malta. The key is to have a deeper and larger stock market so as to ensure continued success of the Maltese economy in a progressively regulated environment (Rizzo 2016).

5.4 Conclusion

This chapter has discussed the findings from both the multivariate time series model as well as the 8 interviews conducted which were compared to the literature review. The implications of the findings on the EMH were also discussed and some suggestions to both investors and policy makers was given so as to enhance the performance of financial markets. The following chapter shall conclude the dissertation and shall include several recommendations for further research.

[25] Mature companies are companies that are well-established in the industry.

Chapter 6

Conclusion

6.0 Introduction

This final chapter concludes the dissertation by giving a brief summary of the findings in relation to the research objectives, outlines a number of recommendations and suggests areas for further research.

6.1 Key Findings

The primary aim of this study was to analyse the relationship between inflation and stock returns in Malta and identify the causes of such relationship. This study was mainly driven due to the lack of congruence in prior research regarding whether stock returns provide a good hedge against inflation or otherwise and also due to the lack of research on this subject matter with respect to the Maltese scenario.

The findings of this study show that Maltese stock returns are influenced by lagged stock returns and inflation at lag 3 and lag 4, indicating that Maltese stock returns take 3 to 4 months to react to changes in inflation. Additionally, there is a strong negative relationship between inflation and Maltese stock returns which implies that Maltese stock returns do not provide adequate protection against inflation. Inflation is influenced by lagged inflation, stock returns, short-term interest rates and money supply.

The first objective (*vide* section 1.6) was addressed primarily through the literature review so as to establish a priori expectations as well as understand the inflation-stock returns relation across both developed and developing countries. This assisted in identifying the additional variables for this study which would not have been possible without the prior execution of an exhaustive literature review. Additionally, this objective was addressed through preliminary research analysis as well as the methodology which helped in the development of a suitable quantitative model that best fits Maltese data.

The second objective was to evaluate the inflation-stock returns relation in Malta for the period January 2008 to July 2019 and identifying a relationship between these two variables. This was established by fitting a time series which found the above-mentioned lagged stock returns and inflation at lag 3 and lag 4 being the only significant variables influencing stock returns. In addition, short-term interest rates and money supply seem to have an indirect impact on Maltese stock returns since inflation was found to be influenced by short-term interest rates and money supply apart from lagged inflation and stock returns.

The third objective was to link the first and the second objectives together by conferring the findings in light of previous empirical evidence from developed and developing economies. Findings show that the Maltese stock market is still very small and at the early stages of its development was clearly highlighted which made it somewhat difficult to be able to compare it with foreign markets. Nonetheless, comparisons with other countries help in setting a benchmark for the Maltese market's future prospects.

Additionally, the quantitative findings were also corroborated with the opinions of several local experts in financial markets. The interviewees emphasised that the Maltese investment culture is dominated by the concept of ‘buy-and-hold’. Moreover, the lack of sophistication of Maltese investors was highlighted, in that although inflation is a good indicator of economic activity, local investor fail to consider inflation in their investment decisions but instead they seek a high dividend pay-out.

6.2 Recommendations

A large number of studies on the relationship between inflation and stock returns have been undertaken. The key finding is that there is a significant divide between the economic theory and the actual relationship of these two variables in different economic scenarios. From the findings and discussion some recommendations for improvement for investors and policy makers were outlined.

The study found that the key economic variables which investors should consider before making an investment decision are: changes in inflation, short-term interest rates, money supply and the previous one-month stock returns variable. This is because even though short-term interest rates and money supply do not affect the stock return variable per se, they ought to have an indirect impact since both are dependant variables for the inflation rate. Furthermore, investors should not consider investing in Maltese equities as a means to hedge against inflation because from the findings, the Fisher hypothesis does not seem to hold for Maltese listed equities.

Although it is crucial to keep updated with changes in foreign markets, local investors should be cautious in applying the theoretical impact of international macroeconomic factors within the Maltese scenario, due to the particular features of the Maltese equity market. However, having said this, the inherent local investors' buy-and-hold and dividend-seeking mentality is anticipated to change in the future as the ECB pushes for further EU capital markets integration.

In setting up policies, policy makers should also be particularly careful to changes in money supply and short-term interest rates since both variables affect inflation and hence could possibly have an indirect effect on stock returns.

Furthermore, policy makers should attempt to exert positive and smooth influence on the economy so that investors would anticipate less volatility in the stock market which would decrease uncertainty and consequently increasing investors' confidence. This would in turn enhance the Maltese stock market as the investors change their mentality.

An additional recommendation, stems from the finding that stock returns are influenced by the previous month's stock returns. Hence, this underlines the inefficiency of the Maltese stock market. Therefore, policy makers should continue to improve the Maltese market's efficiency by promoting the MSE and pushing for more digital access to the stock exchange. Additionally, financial literacy and educational courses regarding financial markets should be encouraged to the public.

6.3 Areas for Further Research

Due to the scope and limitations inherent to the study, the following areas for further study were identified so as to enrich the literature with respect to the inflation-stock returns relation:

- Inflation can be decomposed into expected and unexpected inflation as described in the study by Al-Zubi and Salameh (2007) and Li et al. (2010) who deduced different conclusions with respect to the inflation-stock returns relationship depending on whether inflation is expected or unexpected. This can be applied to the Maltese scenario where one can assess the impact of expected and unexpected inflation on Maltese stock returns.

- A cross-sectional study through a more granular split of listed companies according to their sector – food and beverage, banking, property, insurance and telecommunications, could also aid in elaborating the study within the Maltese scenario context so as to provide further knowledge and insight on the Maltese stock market. Furthermore, this would allow dividends to be incorporated as an additional variable to the study, which was excluded from this study due to the fact that only half yearly and yearly data was available.

Incorporating dividends in assessing the inflation-stock returns relation could provide more insight given that dividends seem to be a major factor affecting local investors' investment decisions as highlighted by the interviewees.

- A research study using primary data i.e. by in-depth questionnaires and interviews carried out with all the listed firms on the MSE, on factors affecting stock market returns could be adopted. This will compliment this study as well as help in providing a better understanding of the Maltese stock market.

6.4 Conclusion

To conclude, this study has contributed in widening the current limited literature on the Maltese stock market by using both statistical methods as well as the opinions of local experts on the subject matter. The findings from the VECM infer that the stock returns variable is influenced only by the previous one month and by inflation at lags 3 and 4, indicating that inflation negatively influences stock returns after 3 to 4 months. Additionally, it was deduced that short-term interest rates and money supply might contribute to the negative inflation-stock returns relationship since both variables were found to be significant in explaining inflation, with interest rates affecting inflation positively and money supply affecting inflation negatively. Fama's proxy hypothesis seems to be irrelevant to the Maltese scenario since the industrial production variable does not influence stock returns nor inflation. Long-term interest rates were also found to be insignificant in explaining both inflation and stock returns in the Maltese scenario.

Moreover, from the qualitative segment of this study, the lack of sophistication of Maltese investors was highlighted, in that although inflation is a good indicator of economic activity, local investors fail to consider inflation in their investment decisions, but instead they seek a high dividend pay-out and capital preservation. The concept of ‘herd behaviour’ surrounding stock markets was also underlined.

Finally, this study has added value to both investors and policy makers in that inflation, short-term interest rates and money supply should be taken into consideration when making investment decisions or in setting policies. Ultimately, this study has shown that there are several factors at play which influence the inflation-stock returns relationship and so it is imperative that all these factors are considered prior to making investment decisions or implementing policies.

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Appendices

Appendix 1: An Explanation of Some Basic Statistical Concepts

A1.1 Augmented Dickey-Fuller (ADF) Test

The ADF test contains two tests for stationarity, one which tests for no constant and no trend and the other which tests for a constant but no trend. These two cases are presented by equations A1.1 and A1.2 below.

Case 1: No constant, no trend (nc): $\Delta y_t = \phi y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t$ **(A1.1)**

Case 2: Constant, no trend (c): $\Delta y_t = a + \phi y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t$ **(A1.2)**

Where;

a = the intercept constant causing the drift term,

ϕ = the co-efficient for the y_{t-1} term (the process root),

β_i = the coefficient for the i^{th} lagged term,

$\Delta y_{t-i} = y_{t-1} - y_{t-2}$,

p = the lag order of the first-differences autoregressive process,

ε_t = error term (which is normally distributed).

In the ADF test, the null hypothesis is defined as the presence of a unit root whereas the alternative hypothesis implies that there is no unit root and so the relevant time series is stationary.

$$H_0: \ Unit\ root \therefore time\ series\ is\ nonstationary$$

$$H_1: No\ unit\ root \therefore time\ series\ is\ stationary$$

In applying the ADF test, if the computed t (tau) value of the estimated coefficient is greater than the critical ADF tau values, then we accept the null hypothesis implying that we accept the unit root and hence the variable is non-stationary (Gujarati, Porter 2010). In this study, instead of tau values, a p-value was generated where if the p-value is greater than 0.05, then the null hypothesis is accepted whilst if the p-value is less than 0.05, then the null hypothesis is rejected.

One must be careful with how many lags to include since too few lags will imply that the residuals do not act like white-noise processes. Whereas if too many lags are included, then the power of the test to reject the null hypothesis is reduced. This is due to the fact that the greater the number of lags, the more parameters to be tested will be required leading to loss in degrees of freedom (Enders 2015). As a rule of thumb, 12 lags should suffice for monthly data (Wooldridge 2016). Irrespective of which method is chosen to determine the number of lags, one must make sure that “residuals act as white-noise processes” (Enders 2015, p.217).

A1.2 Vector Autoregressive (VAR) Model

An autoregressive (AR) model forecasts future behaviour of a variable by looking at past behaviour of the same variable. One of the main parameters in autoregressive models is the lag order, which is, the number of past values incorporated in the model in order be able to predict future values. A basic AR model of lag order p [AR(p)] has the following form:

$$X_t = c_t + \phi_1 X_{t-1} + \cdots + \phi_p X_{t-p} + \varepsilon_t \quad ; \quad t = 1,2, \dots, T \qquad \textbf{(A1.3)}$$

Where;

X_t = the variable under study at time t,

c_t = the constant,

ϕ_p= the estimated coefficient of the pth lag of the variable under study,

ε_t = white noise error term which is normally distributed.

From equation 3.4 above, it is clearly depicted that the AR(p) model is only made up of the lagged values of the variable under study. This model can be broadened further so as to include lagged values of other variables as independent variables. This is known as the VAR model. A pth-order VAR [VAR(p)] has the following form:

$$\underline{X}_t = \underline{d}_t + \Phi_1 \underline{X}_{t-1} + \cdots + \Phi_p \underline{X}_{t-p} + \underline{Z}_t \quad ; \quad t = 1,2, \dots, T \qquad \textbf{(A1.4)}$$

Where;

the underscore denotes a vector,

$\underline{d}_t$ = an $(n \times 1)$ vector of constants

Φ_p = an $(n \times n)$ matrix of autoregressive coefficients for $p > 0$,

$\underline{Z}_t$ = vector generalization of white noise i.e. $\underline{Z}_t \sim N(0, \Omega)$ with Ω denoting an $(n \times n)$ matrix which is known as the covariance matrix of residuals.

As shown above, the VAR model is very similar to the AR model with the difference that x, c and ε become vectors comprising of a number of variables (n) and the coefficients are represented by an $(n \times n)$ matrix which is denoted by Φ.

Therefore, in a VAR model, an equation is created for every variable in the vector x. A basic bivariate VAR(1) model has the following form:

$$x_{1t} = d_0 + \phi_1 x_{t-1} + z_t \qquad \textbf{(A1.5)}$$

Equation A1.5 can be written in matrix form as follows:

$$\begin{pmatrix} x_{1t} \\ x_{2t} \end{pmatrix} = \begin{pmatrix} d_{10} \\ d_{20} \end{pmatrix} + \begin{pmatrix} \phi_{1,11} & \phi_{1,12} \\ \phi_{1,21} & \phi_{1,22} \end{pmatrix} \begin{pmatrix} x_{1,t-1} \\ x_{2,t-1} \end{pmatrix} + \begin{pmatrix} z_{1t} \\ z_{2t} \end{pmatrix}$$

(A1.6)

The above equation can be depicted in one-dimensional form by 2 equations as shown below:

$$x_{1t} = d_{10} + \phi_{1,11} x_{1,t-1} + \phi_{1,12} x_{2,t-1} + z_{1t} \qquad \textbf{(A1.7)}$$

$$x_{2t} = d_{20} + \phi_{1,21} x_{1,t-1} + \phi_{1,22} x_{2,t-1} + z_{2t} \qquad \textbf{(A1.8)}$$

Where;

x_{1t} = variable 1 at time t,

d_{10} = constant for the equation of variable x_{1t},

d_2 = constant for the equation of variable x_{2t},

$\phi_{1,11}$ = coefficient for variable 1 at lag 1

z_{1t} = white noise error term for the equation of variable x_{1t} (Hamilton 1994).

Note that the first number in the subscript refers to the variable, while the second number refers to the lag used.

Appendix 2: Quantitative Segment – IBM-SPSS

A2.1 Cross-Correlation Functions

Below are the actual cross-correlation coefficients of the cross-correlations of each variable against MSETRX and HICP, respectively.

Note that the figures in bold indicate the significant coefficients.

Series Pair: MSETRX with HICP

Lag	Cross Correlation	Std. Error
-7	-.034	.087
-6	-.057	.087
-5	-.069	.087
-4	**-.238**	**.086**
-3	-.145	.086
-2	.125	.086
-1	.034	.085
0	.038	.085
1	.007	.085
2	**-.189**	**.086**
3	.134	.086
4	.040	.086
5	.038	.087
6	.078	.087
7	**.188**	**.087**

Series Pair: MSETRX with TB3m

Lag	Cross Correlation	Std. Error
-7	-.068	.087
-6	-.145	.087
-5	-.175	.087
-4	-.015	.086
-3	.119	.086
-2	.106	.086
-1	.133	.085
0	-.018	.085
1	.056	.085
2	**.220**	**.086**
3	.021	.086
4	**.178**	**.086**
5	**.247**	**.087**
6	**.203**	**.087**
7	**.227**	**.087**

Series Pair: MSETRX with GB10y

Lag	Cross Correlation	Std. Error
-7	-.083	.087
-6	-.148	.087
-5	-.154	.087
-4	**-.199**	**.086**
-3	-.095	.086
-2	-.034	.086
-1	.014	.085
0	.094	.085
1	.046	.085
2	.001	.086
3	-.134	.086
4	-.002	.086
5	-.001	.087
6	-.006	.087
7	-.149	.087

Series Pair: MSETRX with M3

Lag	Cross Correlation	Std. Error
-7	**.184**	**.087**
-6	.104	.087
-5	.111	.087
-4	.052	.086
-3	.053	.086
-2	.035	.086
-1	.171	.085
0	.080	.085
1	.026	.085
2	.108	.086
3	-.021	.086
4	.058	.086
5	.146	.087
6	-.032	.087
7	.129	.087

Series Pair: MSETRX with IP

Lag	Cross Correlation	Std. Error
-7	.078	.087
-6	-.072	.087
-5	.119	.087
-4	-.090	.086
-3	-.036	.086
-2	.053	.086
-1	.046	.085
0	.032	.085
1	.085	.085
2	.004	.086
3	.049	.086
4	.031	.086
5	.037	.087
6	.044	.087
7	-.048	.087

Series Pair: HICP with IP

Lag	Cross Correlation	Std. Error
-7	-.050	.087
-6	.030	.087
-5	.032	.087
-4	.037	.086
-3	.081	.086
-2	.014	.086
-1	.008	.085
0	.079	.085
1	.044	.085
2	.010	.086
3	-.034	.086
4	-.132	.086
5	.073	.087
6	.019	.087
7	-.013	.087

Series Pair: HICP with TB3m

Lag	Cross Correlation	Std. Error
-7	.131	.087
-6	.101	.087
-5	.111	.087
-4	.002	.086
-3	-.031	.086
-2	.167	.086
-1	**.250**	**.085**
0	-.024	.085
1	**.190**	**.085**
2	-.021	.086
3	.009	.086
4	.129	.086
5	.010	.087
6	-.005	.087
7	-.039	.087

Series Pair: HICP with GB10y

Lag	Cross Correlation	Std. Error
-7	-.011	.087
-6	-.013	.087
-5	-.090	.087
-4	-.056	.086
-3	.022	.086
-2	.011	.086
-1	.072	.085
0	.074	.085
1	.097	.085
2	.011	.086
3	-.005	.086
4	.029	.086
5	-.079	.087
6	.075	.087
7	.069	.087

Series Pair: HICP with M3

Lag	Cross Correlation	Std. Error
-7	.059	.087
-6	-.015	.087
-5	.048	.087
-4	.063	.086
-3	-.023	.086
-2	-.076	.086
-1	.089	.085
0	.088	.085
1	.099	.085
2	.014	.086
3	.058	.086
4	-.050	.086
5	.075	.087
6	-.068	.087
7	.112	.087

Table A2.1: Cross-Correlation Functions of MSETRX and HICP with all the variables

Appendix 3: Quantitative Segment - Code and Output

This appendix presents the R script used in order to run the statistical tests described in chapters 3 and 4. In the script, there are notes to explain the reasoning behind the code inputted as well as to refer to certain sections in the main text. Additionally, there are certain breaks in the script to display relevant output which was mentioned but not presented in the main text.

```
#Importing Data
library(readxl)
Data <- read_excel("Desktop/Data.xlsx")
View(Data)

#Install Packages
install.packages("pastecs")
install.packages("fUnitRoots")
install.packages("vars")
install.packages("aTSA")
install.packages("tsDyn")
install.packages("portes")
install.packages("mvShapiroTest")

#Loading the Required Libraries
library(pastecs)
library(fUnitRoots)
library(vars)
library(aTSA)
library(tsDyn)
library(portes)
library(mvShapiroTest)

#Transferring Data into Time Series
Data1<-ts(Data,start=c(2008,1),end=c(2019,7),frequency=12)

#Naming Columns
MSETRX<-Data1[,1]
HICP<-Data1[,2]
TB3m<-Data1[,3]
GB10y<-Data1[,4]
M3<-Data1[,5]
IP<-Data1[,6]

#Descriptive Statistics
stat.desc(Data1)

#Plotting Data
par(mfrow=c(3,2))
plot.ts(Data1[,1], main = "MSETRX",ylab="Average Index",type="l")
```

```
plot.ts(Data1[,2], main = "HICP",ylab="Rate (%)",type="l")
plot.ts(Data1[,3], main = "TB3m",ylab="Rate (%)",type="l")
plot.ts(Data1[,4], main = "GB10y",ylab="Rate (%)",type="l")
plot.ts(Data1[,5], main = "M3",ylab="Euro millions",type="l")
plot.ts(Data1[,6], main = "IP",ylab="Index",type="l")
par(mfrow=c(1,1))

#Stationarity

#Unit Root Test - ADF for both Case 1 (nc) and Case 2 (c)
adfTest(Data1[1:139,1],lags=1,type="nc")
adfTest(Data1[1:139,1],lags=1,type="c")
adfTest(Data1[1:139,2],lags=1,type="nc")
adfTest(Data1[1:139,2],lags=1,type="c")
adfTest(Data1[1:139,3],lags=1,type="nc")
adfTest(Data1[1:139,3],lags=1,type="c")
adfTest(Data1[1:139,4],lags=1,type="nc")
adfTest(Data1[1:139,4],lags=1,type="c")
adfTest(Data1[1:139,5],lags=1,type="nc")
adfTest(Data1[1:139,5],lags=1,type="c")
adfTest(Data1[1:139,6],lags=1,type="nc")
adfTest(Data1[1:139,6],lags=1,type="c")

#First Order Differencing (to make sure that all variables are
stationary)
diffData1<-diff(Data1,lag=1)

#First Order Differencing Plots
par(mfrow=c(3,2))
plot.ts(diffData1[,1], main = "diffMSETRX",ylab="Average
Index",type="l")
plot.ts(diffData1[,2], main = "diffHICP",ylab="Rate (%)",type="l")
plot.ts(diffData1[,3], main = "diffTB3m",ylab="Rate (%)",type="l")
plot.ts(diffData1[,4], main = "diffGB10y",ylab="Rate (%)",type="l")
plot.ts(diffData1[,5], main = "diffM3",ylab="Euro millions",type="l")
plot.ts(diffData1[,6], main = "diffIP",ylab="Index",type="l")

#ADF Test (on first order differencing)
adfTest(diffData1[1:138,1],lags=1,type="nc")
adfTest(diffData1[1:138,1],lags=1,type="c")
adfTest(diffData1[1:138,2],lags=1,type="nc")
adfTest(diffData1[1:138,2],lags=1,type="c")
adfTest(diffData1[1:138,3],lags=1,type="nc")
adfTest(diffData1[1:138,3],lags=1,type="c")
adfTest(diffData1[1:138,4],lags=1,type="nc")
adfTest(diffData1[1:138,4],lags=1,type="c")
adfTest(diffData1[1:138,5],lags=1,type="nc")
adfTest(diffData1[1:138,5],lags=1,type="c")
adfTest(diffData1[1:138,6],lags=1,type="nc")
adfTest(diffData1[1:138,6],lags=1,type="c")

#Bivariate Granger-causality Test
lagselect12<-VARselect(diffData1[1:138,c(1,2)], lag.max = 6, type =
"none")
print(lagselect12)
VAR12<-
VAR(diffData1[1:138,c(1,2)],p=max(lagselect12$selection),type="none")
causality(VAR12,cause="MSETRX")
```

```
causality(VAR12,cause="HICP")

lagselect13<-VARselect(diffData1[1:138,c(1,3)], lag.max = 6, type =
"none")
print(lagselect13)
VAR13<-
VAR(diffData1[1:138,c(1,3)],p=max(lagselect13$selection),type="none")
causality(VAR13,cause="MSETRX")
causality(VAR13,cause="TB3m")

lagselect14<-VARselect(diffData1[1:138,c(1,4)], lag.max = 6, type =
"none")
print(lagselect14)
VAR14<-
VAR(diffData1[1:138,c(1,4)],p=max(lagselect14$selection),type="none")
causality(VAR14,cause="MSETRX")
causality(VAR14,cause="GB10y")

lagselect15<-VARselect(diffData1[1:138,c(1,5)], lag.max = 6, type =
"none")
print(lagselect15)
VAR15<-
VAR(diffData1[1:138,c(1,5)],p=max(lagselect15$selection),type="none")
causality(VAR15,cause="MSETRX")
causality(VAR15,cause="M3")

lagselect16<-VARselect(diffData1[1:138,c(1,6)], lag.max = 6, type =
"none")
print(lagselect16)
VAR16<-
VAR(diffData1[1:138,c(1,6)],p=max(lagselect16$selection),type="none")
causality(VAR16,cause="MSETRX")
causality(VAR16,cause="IP")

lagselect23<-VARselect(diffData1[1:138,c(2,3)], lag.max = 6, type =
"none")
print(lagselect23)
VAR23<-
VAR(diffData1[1:138,c(2,3)],p=max(lagselect23$selection),type="none")
causality(VAR23,cause="HICP")
causality(VAR23,cause="TB3m")

lagselect24<-VARselect(diffData1[1:138,c(2,4)], lag.max = 6, type =
"none")
print(lagselect24)
VAR24<-
VAR(diffData1[1:138,c(2,4)],p=max(lagselect24$selection),type="none")
causality(VAR24,cause="HICP")
causality(VAR24,cause="GB10y")

lagselect25<-VARselect(diffData1[1:138,c(2,5)], lag.max = 6, type =
"none")
print(lagselect25)
VAR25<-
VAR(diffData1[1:138,c(2,5)],p=max(lagselect25$selection),type="none")
causality(VAR25,cause="HICP")
causality(VAR25,cause="M3")
```

```
lagselect26<-VARselect(diffData1[1:138,c(2,6)], lag.max = 6, type =
"none")
print(lagselect26)
VAR26<-
VAR(diffData1[1:138,c(2,6)],p=max(lagselect26$selection),type="none")
causality(VAR26,cause="HICP")
causality(VAR26,cause="IP")

lagselect34<-VARselect(diffData1[1:138,c(3,4)], lag.max = 6, type =
"none")
print(lagselect34)
VAR34<-
VAR(diffData1[1:138,c(3,4)],p=max(lagselect34$selection),type="none")
causality(VAR34,cause="TB3m")
causality(VAR34,cause="GB10y")

lagselect35<-VARselect(diffData1[1:138,c(3,5)], lag.max = 6, type =
"none")
print(lagselect35)
VAR35<-
VAR(diffData1[1:138,c(3,5)],p=max(lagselect35$selection),type="none")
causality(VAR35,cause="TB3m")
causality(VAR35,cause="M3")

lagselect36<-VARselect(diffData1[1:138,c(3,6)], lag.max = 6, type =
"none")
print(lagselect36)
VAR36<-
VAR(diffData1[1:138,c(3,6)],p=max(lagselect36$selection),type="none")
causality(VAR36,cause="TB3m")
causality(VAR36,cause="IP")

lagselect45<-VARselect(diffData1[1:138,c(4,5)], lag.max = 6, type =
"none")
print(lagselect45)
VAR45<-
VAR(diffData1[1:138,c(4,5)],p=max(lagselect45$selection),type="none")
causality(VAR45,cause="GB10y")
causality(VAR45,cause="M3")

lagselect46<-VARselect(diffData1[1:138,c(4,6)], lag.max = 6, type =
"none")
print(lagselect46)
VAR46<-
VAR(diffData1[1:138,c(4,6)],p=max(lagselect46$selection),type="none")
causality(VAR46,cause="GB10y")
causality(VAR46,cause="IP")

lagselect56<-VARselect(diffData1[1:138,c(5,6)], lag.max = 6, type =
"none")
print(lagselect56)
VAR56<-
VAR(diffData1[1:138,c(5,6)],p=max(lagselect56$selection),type="none")
causality(VAR56,cause="M3")
causality(VAR56,cause="IP")

#See table A3.1 overleaf for the output of the Granger-causality test.
```

Null Hypothesis (H_0)	No. of Lags	F-Test	P-value	Accept/ Reject H_0
∆MSETRX do not Granger-cause ∆HICP	4	3.8081	0.00503	Reject
∆HICP do not Granger-cause ∆MSETRX	4	4.2731	0.00231	Reject
∆MSETRX do not Granger-cause ∆TB3m	5	3.1242	0.00940	Reject
∆TB3m do not Granger-cause ∆MSETRX	5	2.5047	0.03103	Reject
∆MSETRX do not Granger-cause ∆GB10y	1	0.0005	0.9832	Accept
∆GB10y do not Granger-cause ∆MSETRX	1	0.2229	0.6373	Accept
∆MSETRX do not Granger-cause ∆M3	3	0.3801	0.7674	Accept
∆M3 do not Granger-cause ∆MSETRX	3	1.2646	0.287	Accept
∆MSETRX do not Granger-cause ∆IP	2	0.5219	0.594	Accept
∆IP do not Granger-cause ∆MSETRX	2	0.2030	0.8164	Accept
∆HICP do not Granger-cause ∆TB3m	1	6.121	0.01397	Reject
∆TB3m do not Granger-cause ∆HICP	1	9.1157	0.00278	Reject
∆HICP do not Granger-cause ∆GB10y	1	0.8494	0.3576	Accept
∆GB10y do not Granger-cause ∆HICP	1	0.8588	0.3549	Accept
∆HICP do not Granger-cause ∆M3	3	0.5726	0.6335	Accept
∆M3 do not Granger-cause ∆HICP	3	0.5955	0.6185	Accept
∆HICP do not Granger-cause ∆IP	2	1.0754	0.3427	Accept
∆IP do not Granger-cause ∆HICP	2	0.0147	0.9854	Accept
∆TB3m do not Granger-cause ∆GB10y	1	0.4039	0.5256	Accept
∆GB10y do not Granger-cause ∆TB3m	1	0.7206	0.3967	Accept
∆TB3m do not Granger-cause ∆M3	3	0.7221	0.5396	Accept
∆M3 do not Granger-cause ∆TB3m	3	0.0261	0.9943	Accept
∆TB3m do not Granger-cause ∆IP	3	1.1323	0.3365	Accept

ΔIP do not Granger-cause ΔTB3m	3	0.4031	0.7509	Accept
ΔGB10y do not Granger-cause ΔM3	3	1.0199	0.3844	Accept
ΔM3 do not Granger-cause ΔGB10y	3	0.7076	0.5483	Accept
ΔGB10y do not Granger-cause ΔIP	2	1.6717	0.1899	Accept
ΔIP do not Granger-cause ΔGB10y	2	0.2121	0.809	Accept
ΔM3 do not Granger-cause ΔIP	6	2.3709	0.03038	Reject
ΔIP do not Granger-cause ΔM3	6	1.7156	0.118	Accept

Table A3.1: Pairwise Granger-causality Test

```
#VAR Model

#Selecting "best" VAR using different criteria
VARselect(diffData1[1:138,1:3], lag.max = 10, type = "none")

 $selection
 AIC(n)  HQ(n)  SC(n) FPE(n) 
      3      1      1      3 

 $criteria
                  1          2          3          4          5          6
 AIC(n)    4.720590   4.744232   4.700530   4.723306   4.740868   4.792390
 HQ(n)     4.802068   4.907188   4.944964   5.049217   5.148256   5.281257
 SC(n)     4.921123   5.145299   5.302130   5.525439   5.743534   5.995590
 FPE(n) 112.237326 114.943247 110.082228 112.726286 114.905836 121.269931
                  7          8          9         10
 AIC(n)    4.860485   4.845590   4.954016   5.036980
 HQ(n)     5.430830   5.497412   5.687315   5.851758
 SC(n)     6.264219   6.449857   6.758816   7.042314
 FPE(n) 130.250925 128.902826 144.503609 158.160899


#Fitting VAR(1) and VAR(3) so as to identify the optimal lag order
VAR1<-VAR(diffData1[1:138,1:3],p=1,type="none")
summary(VAR1)
VAR3<-VAR(diffData1[1:138,1:3],p=3,type="none")
summary(VAR3)
#This yielded best lag at 3

#Fitted VAR(3), VAR(4) and VAR(5)
VAR3<-VAR(diffData1[1:138,1:3],p=3,type="none")
summary(VAR3)
```

```
VAR Estimation Results:
=========================
Endogenous variables: MSETRX, HICP, TB3m
Deterministic variables: none
Sample size: 135
Log Likelihood: -880.411
Roots of the characteristic polynomial:
0.7515 0.6551 0.6481 0.6481 0.5651 0.5651 0.3645 0.3645 0.2746
Call:
VAR(y = diffData1[1:138, 1:3], p = 3, type = "none")


Estimation results for equation MSETRX:
=======================================
MSETRX = MSETRX.l1 + HICP.l1 + TB3m.l1 + MSETRX.l2 + HICP.l2 + TB3m.l2 + MSETRX.l3 +
 HICP.l3 + TB3m.l3

           Estimate Std. Error t value Pr(>|t|)
MSETRX.l1   0.34678    0.08723   3.975 0.000118 ***
HICP.l1    12.02327   27.95148   0.430 0.667823
TB3m.l1    62.41371   91.45361   0.682 0.496199
MSETRX.l2   0.04714    0.09135   0.516 0.606721
HICP.l2    32.54254   27.50946   1.183 0.239053
TB3m.l2    53.74429   95.86079   0.561 0.576032
MSETRX.l3   0.12208    0.08998   1.357 0.177302
HICP.l3   -68.37083   26.83838  -2.548 0.012052 *
TB3m.l3    -3.50983   91.05074  -0.039 0.969312
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 154.1 on 126 degrees of freedom
Multiple R-Squared: 0.2228,     Adjusted R-squared: 0.1673
F-statistic: 4.013 on 9 and 126 DF,  p-value: 0.0001557
Estimation results for equation HICP:
=====================================
HICP = MSETRX.l1 + HICP.l1 + TB3m.l1 + MSETRX.l2 + HICP.l2 + TB3m.l2 + MSETRX.l3 + HI
CP.l3 + TB3m.l3

            Estimate Std. Error t value Pr(>|t|)
MSETRX.l1  0.0002899  0.0002723   1.064  0.28916
HICP.l1    0.0066504  0.0872555   0.076  0.93937
TB3m.l1    0.6972532  0.2854886   2.442  0.01598 *
MSETRX.l2 -0.0008909  0.0002852  -3.124  0.00221 **
HICP.l2   -0.0002195  0.0858756  -0.003  0.99796
TB3m.l2    0.3377819  0.2992464   1.129  0.26114
MSETRX.l3  0.0005199  0.0002809   1.851  0.06654 .
HICP.l3   -0.0821651  0.0837808  -0.981  0.32861
TB3m.l3   -0.2611647  0.2842310  -0.919  0.35993
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.4812 on 126 degrees of freedom
Multiple R-Squared: 0.1657,     Adjusted R-squared: 0.1062
F-statistic: 2.781 on 9 and 126 DF,  p-value: 0.005255
```

```
 Covariance matrix of residuals:
           MSETRX      HICP      TB3m
 MSETRX 23497.151 -0.697998 -2.429678
 HICP      -0.698  0.231401 -0.002059
 TB3m      -2.430 -0.002059  0.020594

 Correlation matrix of residuals:
           MSETRX      HICP     TB3m
 MSETRX  1.000000 -0.009466 -0.11045
 HICP   -0.009466  1.000000 -0.02982
 TB3m   -0.110452 -0.029820  1.00000


VAR4<-VAR(diffData1[1:138,1:3],p=4,type="none")
summary(VAR4)

VAR Estimation Results:
=========================
Endogenous variables: MSETRX, HICP, TB3m
Deterministic variables: none
Sample size: 134
Log Likelihood: -864.83
Roots of the characteristic polynomial:
0.7585 0.7585 0.6931 0.6926 0.6926 0.6504 0.6504 0.6325 0.6325 0.614 0.388 0.388
Call:
VAR(y = diffData1[1:138, 1:3], p = 4, type = "none")


Estimation results for equation MSETRX:
=======================================
MSETRX = MSETRX.l1 + HICP.l1 + TB3m.l1 + MSETRX.l2 + HICP.l2 + TB3m.l2 + MSETRX.l3 +
 HICP.l3 + TB3m.l3 + MSETRX.l4 + HICP.l4 + TB3m.l4

             Estimate Std. Error t value Pr(>|t|)
MSETRX.l1     0.28847    0.08661   3.331  0.00115 **
HICP.l1      -3.51863   27.53504  -0.128  0.89853
TB3m.l1     114.62114   92.18320   1.243  0.21610
MSETRX.l2     0.09612    0.08955   1.073  0.28522
HICP.l2      37.43327   27.15602   1.378  0.17059
TB3m.l2      57.34429   94.19246   0.609  0.54379
MSETRX.l3     0.07757    0.09537   0.813  0.41757
HICP.l3     -53.92014   26.85244  -2.008  0.04685 *
TB3m.l3      70.67527   93.42002   0.757  0.45079
MSETRX.l4     0.05148    0.08898   0.579  0.56393
HICP.l4     -79.07609   26.66744  -2.965  0.00364 **
TB3m.l4    -138.90174   89.43397  -1.553  0.12298
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 148.5 on 122 degrees of freedom
Multiple R-Squared: 0.2853,     Adjusted R-squared: 0.215
F-statistic: 4.059 on 12 and 122 DF,  p-value: 2.636e-05
```

```
Estimation results for equation HICP:
=====================================
HICP = MSETRX.l1 + HICP.l1 + TB3m.l1 + MSETRX.l2 + HICP.l2 + TB3m.l2 + MSETRX.l3 + HI
CP.l3 + TB3m.l3 + MSETRX.l4 + HICP.l4 + TB3m.l4

            Estimate Std. Error t value Pr(>|t|)
MSETRX.l1  3.907e-04  2.818e-04   1.386  0.16822
HICP.l1    1.301e-02  8.960e-02   0.145  0.88478
TB3m.l1    7.615e-01  3.000e-01   2.538  0.01239 *
MSETRX.l2 -9.573e-04  2.914e-04  -3.285  0.00133 **
HICP.l2    8.801e-03  8.837e-02   0.100  0.92083
TB3m.l2    3.667e-01  3.065e-01   1.196  0.23386
MSETRX.l3  5.025e-04  3.103e-04   1.619  0.10800
HICP.l3   -7.337e-02  8.738e-02  -0.840  0.40272
TB3m.l3   -3.412e-01  3.040e-01  -1.122  0.26386
MSETRX.l4 -1.625e-05  2.896e-04  -0.056  0.95532
HICP.l4    1.365e-01  8.678e-02   1.573  0.11831
TB3m.l4   -1.260e-01  2.910e-01  -0.433  0.66576
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.4833 on 122 degrees of freedom
Multiple R-Squared: 0.1852,     Adjusted R-squared: 0.105
F-statistic:  2.31 on 12 and 122 DF,  p-value: 0.01081


Estimation results for equation TB3m:
=====================================
TB3m = MSETRX.l1 + HICP.l1 + TB3m.l1 + MSETRX.l2 + HICP.l2 + TB3m.l2 + MSETRX.l3 + HI
CP.l3 + TB3m.l3 + MSETRX.l4 + HICP.l4 + TB3m.l4

            Estimate Std. Error t value Pr(>|t|)
MSETRX.l1 -2.076e-05  8.499e-05  -0.244 0.807415
HICP.l1    2.852e-02  2.702e-02   1.055 0.293289
TB3m.l1    3.072e-01  9.045e-02   3.396 0.000923 ***
MSETRX.l2  2.308e-04  8.787e-05   2.626 0.009735 **
HICP.l2   -3.019e-02  2.665e-02  -1.133 0.259399
TB3m.l2    8.075e-02  9.243e-02   0.874 0.383995
MSETRX.l3 -1.638e-04  9.358e-05  -1.750 0.082646 .
HICP.l3    6.841e-03  2.635e-02   0.260 0.795592
TB3m.l3    1.650e-01  9.167e-02   1.800 0.074317 .
MSETRX.l4  1.070e-04  8.731e-05   1.225 0.222835
HICP.l4    2.333e-02  2.617e-02   0.891 0.374473
TB3m.l4   -5.338e-02  8.776e-02  -0.608 0.544145
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.1457 on 122 degrees of freedom
Multiple R-Squared: 0.2623,     Adjusted R-squared: 0.1898
F-statistic: 3.616 on 12 and 122 DF,  p-value: 0.0001229
```

```
Covariance matrix of residuals:
           MSETRX      HICP      TB3m
MSETRX 21764.344  1.212870 -2.381065
HICP       1.213  0.233414 -0.003219
TB3m      -2.381 -0.003219  0.020680

Correlation matrix of residuals:
         MSETRX     HICP     TB3m
MSETRX  1.00000  0.01702 -0.11223
HICP    0.01702  1.00000 -0.04634
TB3m   -0.11223 -0.04634  1.00000
```

The VAR(4) model, displayed by equation 4.1, can presented more simply by decomposing it into three equations:

$$MSETRX_t = 0.29MSETRX_{t-1} - 3.52HICP_{t-1} + 114.62TB3m_{t-1} + 0.10MSETRX_{t-2} + 37.43HICP_{t-2} + 57.34TB3m_{t-2} + 0.08MSETRX_{t-3} - 53.92HICP_{t-3} + 70.68TB3m_{t-3} + 0.05MSETRX_{t-4} - 79.08HICP_{t-4} - 138.90TB3m_{t-4} + \underline{\varepsilon_t} \quad ; \quad \underline{\varepsilon_t} \sim N(0,21764.34) \tag{A3.2}$$

$$HICP_t = 0.0004MSETRX_{t-1} + 0.013HICP_{t-1} + 0.76TB3m_{t-1} - 0.001MSETRX_{t-2} + 0.009HICP_{t-2} + 0.37TB3m_{t-2} + 0.0005MSETRX_{t-3} - 0.073HICP_{t-3} - 0.34TB3m_{t-3} - 0.00002MSETRX_{t-4} + 0.14HICP_{t-4} - 0.13TB3m_{t-4} + \underline{\varepsilon_t} \quad ; \quad \underline{\varepsilon_t} \sim N(0,0.233) \tag{A3.3}$$

$$TB3m_t = -0.00002MSETRX_{t-1} + 0.029HICP_{t-1} + 0.31TB3m_{t-1} + 0.0002MSETRX_{t-2} - 0.03HICP_{t-2} + 0.081TB3m_{t-2} - 0.0002MSETRX_{t-3} + 0.007HICP_{t-3} + 0.17TB3m_{t-3} + 0.0001MSETRX_{t-4} + 0.02HICP_{t-4} - 0.05TB3m_{t-4} + \underline{\varepsilon_t} \quad ; \quad \underline{\varepsilon_t} \sim N(0,0.021) \tag{A3.4}$$

```
VAR5<-VAR(diffData1[1:138,1:3],p=5,type="none")
summary(VAR5)

VAR Estimation Results:
=========================
Endogenous variables: MSETRX, HICP, TB3m
Deterministic variables: none
Sample size: 133
Log Likelihood: -852.453
Roots of the characteristic polynomial:
0.8545 0.8545 0.7476 0.7476 0.7454 0.7286 0.7286 0.7206 0.7206 0.6092 0.6092 0.499 0.
499 0.437 0.437
Call:
VAR(y = diffData1[1:138, 1:3], p = 5, type = "none")


Estimation results for equation MSETRX:
=======================================
MSETRX = MSETRX.l1 + HICP.l1 + TB3m.l1 + MSETRX.l2 + HICP.l2 + TB3m.l2 + MSETRX.l3 +
 HICP.l3 + TB3m.l3 + MSETRX.l4 + HICP.l4 + TB3m.l4 + MSETRX.l5 + HICP.l5 + TB3m.l5

            Estimate Std. Error t value Pr(>|t|)
MSETRX.l1  2.477e-01  9.104e-02   2.721   0.0075 **
HICP.l1   -7.029e+00  2.773e+01  -0.253   0.8004
TB3m.l1    8.378e+01  9.315e+01   0.899   0.3703
MSETRX.l2  1.061e-01  9.059e-02   1.171   0.2440
HICP.l2    2.894e+01  2.752e+01   1.052   0.2951
TB3m.l2    1.316e+02  9.959e+01   1.321   0.1889
MSETRX.l3  8.860e-02  9.696e-02   0.914   0.3627
HICP.l3   -4.382e+01  2.734e+01  -1.603   0.1117
TB3m.l3    8.030e+01  9.480e+01   0.847   0.3987
MSETRX.l4  9.813e-03  9.751e-02   0.101   0.9200
HICP.l4   -6.595e+01  2.728e+01  -2.418   0.0172 *
TB3m.l4   -1.056e+02  9.493e+01  -1.112   0.2683
MSETRX.l5  7.893e-02  9.121e-02   0.865   0.3886
HICP.l5   -1.130e+00  2.780e+01  -0.041   0.9676
TB3m.l5   -1.675e+02  9.015e+01  -1.858   0.0656 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 147.7 on 118 degrees of freedom
Multiple R-Squared: 0.3052,     Adjusted R-squared: 0.2169
F-statistic: 3.456 on 15 and 118 DF,  p-value: 7.007e-05
```

```
Estimation results for equation HICP:
=====================================
HICP = MSETRX.l1 + HICP.l1 + TB3m.l1 + MSETRX.l2 + HICP.l2 + TB3m.l2 + MSETRX.l3 + HI
CP.l3 + TB3m.l3 + MSETRX.l4 + HICP.l4 + TB3m.l4 + MSETRX.l5 + HICP.l5 + TB3m.l5

            Estimate Std. Error t value Pr(>|t|)
MSETRX.l1  4.211e-04  2.995e-04   1.406  0.16233
HICP.l1    2.823e-02  9.123e-02   0.309  0.75758
TB3m.l1    8.010e-01  3.064e-01   2.614  0.01012 *
MSETRX.l2 -1.024e-03  2.980e-04  -3.434  0.00082 ***
HICP.l2    1.160e-02  9.052e-02   0.128  0.89826
TB3m.l2    2.385e-01  3.276e-01   0.728  0.46807
MSETRX.l3  5.117e-04  3.190e-04   1.604  0.11137
HICP.l3   -8.023e-02  8.993e-02  -0.892  0.37416
TB3m.l3   -4.132e-01  3.119e-01  -1.325  0.18777
MSETRX.l4 -4.475e-05  3.208e-04  -0.140  0.88928
HICP.l4    1.089e-01  8.974e-02   1.213  0.22743
TB3m.l4   -1.853e-01  3.123e-01  -0.593  0.55404
MSETRX.l5  1.046e-04  3.001e-04   0.348  0.72811
HICP.l5   -4.620e-02  9.145e-02  -0.505  0.61437
TB3m.l5    4.182e-01  2.965e-01   1.410  0.16106
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.4859 on 118 degrees of freedom
Multiple R-Squared: 0.2012,     Adjusted R-squared: 0.09966
F-statistic: 1.981 on 15 and 118 DF,  p-value: 0.02204

Covariance matrix of residuals:
          MSETRX      HICP      TB3m
MSETRX 21551.747  2.991326 -2.420418
HICP       2.991  0.235861 -0.003649
TB3m      -2.420 -0.003649  0.020249

Correlation matrix of residuals:
         MSETRX     HICP    TB3m
MSETRX  1.00000  0.04196 -0.1159
HICP    0.04196  1.00000 -0.0528
TB3m   -0.11586 -0.05280  1.0000


#checking stationarity condition of VAR models - all roots are
considerably less than 1 so stationarity not compromised
roots(VAR3)
roots(VAR4)
roots(VAR5)

#checking for presence of serial correlation in the residuals of the
VAR models - all p-values > 0.05 so no serial correlation
serial.test(VAR3)
serial.test(VAR4)
serial.test(VAR5)
```

```
#checking for multivariate normality of residuals in all models, this
is rejected in all cases
normality.test(VAR3)
normality.test(VAR4)
normality.test(VAR5)

#Restrict
VAR4R<-restrict(VARJ4, method = "ser", thresh = 1.4)
summary(VAR4R)

VAR Estimation Results:
=========================
Endogenous variables: MSETRX, HICP, TB3m
Deterministic variables: none
Sample size: 134
Log Likelihood: -875.719
Roots of the characteristic polynomial:
0.7201 0.7201 0.6766 0.6766 0.663 0.663 0.5706 0.512 0.512 0.4078 2.012e-17     0
Call:
VAR(y = diffData1[1:138, 1:3], p = 4, type = "none")


Estimation results for equation MSETRX:
=======================================
MSETRX = MSETRX.l1 + TB3m.l1 + HICP.l3 + HICP.l4

           Estimate Std. Error t value Pr(>|t|)
MSETRX.l1   0.36760    0.07722   4.760 5.07e-06 ***
TB3m.l1   157.24638   79.36562   1.981   0.0497 *
HICP.l3   -63.54448   25.28879  -2.513   0.0132 *
HICP.l4   -65.16995   25.42173  -2.564   0.0115 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 148.6 on 130 degrees of freedom
Multiple R-Squared: 0.2374,     Adjusted R-squared: 0.2139
F-statistic: 10.12 on 4 and 130 DF,  p-value: 3.673e-07


Estimation results for equation HICP:
=====================================
HICP = TB3m.l1 + MSETRX.l2 + MSETRX.l3

            Estimate Std. Error t value Pr(>|t|)
TB3m.l1    0.7360483  0.2628122   2.801  0.00587 **
MSETRX.l2 -0.0008516  0.0002632  -3.235  0.00154 **
MSETRX.l3  0.0005630  0.0002732   2.061  0.04131 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4785 on 131 degrees of freedom
Multiple R-Squared: 0.1424,     Adjusted R-squared: 0.1227
F-statistic: 7.249 on 3 and 131 DF,  p-value: 0.0001547
```

```
Estimation results for equation TB3m:
=====================================
TB3m = TB3m.l1 + MSETRX.l2 + MSETRX.l3 + TB3m.l3 + MSETRX.l4

             Estimate Std. Error t value Pr(>|t|)
TB3m.l1     3.085e-01  8.332e-02   3.703 0.000315 ***
MSETRX.l2   2.221e-04  8.088e-05   2.746 0.006896 **
MSETRX.l3  -2.066e-04  8.898e-05  -2.322 0.021812 *
TB3m.l3     1.735e-01  7.993e-02   2.171 0.031770 *
MSETRX.l4   1.691e-04  8.053e-05   2.100 0.037690 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.1448 on 129 degrees of freedom
Multiple R-Squared: 0.2297,     Adjusted R-squared: 0.1998
F-statistic: 7.691 on 5 and 129 DF,  p-value: 2.339e-06



Covariance matrix of residuals:
           MSETRX      HICP      TB3m
MSETRX 23088.6436  0.696468 -2.289161
HICP       0.6965  0.245491 -0.001621
TB3m      -2.2892 -0.001621  0.021541

Correlation matrix of residuals:
          MSETRX      HICP     TB3m
MSETRX  1.000000  0.009251 -0.10265
HICP    0.009251  1.000000 -0.02229
TB3m   -0.102647 -0.022293  1.00000


#Testing for Cointegration using Engle-Granger
coint.test(Data1[1:139,1],Data1[1:139,2])
coint.test(Data1[1:139,1],Data1[1:139,3])
coint.test(Data1[1:139,1],Data1[1:139,4])
coint.test(Data1[1:139,1],Data1[1:139,5])
coint.test(Data1[1:139,1],Data1[1:139,6])
coint.test(Data1[1:139,2],Data1[1:139,1])
coint.test(Data1[1:139,2],Data1[1:139,3])
coint.test(Data1[1:139,2],Data1[1:139,4])
coint.test(Data1[1:139,2],Data1[1:139,5])
coint.test(Data1[1:139,2],Data1[1:139,6])
coint.test(Data1[1:139,3],Data1[1:139,1])
coint.test(Data1[1:139,3],Data1[1:139,2])
coint.test(Data1[1:139,3],Data1[1:139,4])
coint.test(Data1[1:139,3],Data1[1:139,5])
coint.test(Data1[1:139,3],Data1[1:139,6])
```

```
coint.test(Data1[1:139,4],Data1[1:139,1])
coint.test(Data1[1:139,4],Data1[1:139,2])
coint.test(Data1[1:139,4],Data1[1:139,3])
coint.test(Data1[1:139,4],Data1[1:139,5])
coint.test(Data1[1:139,4],Data1[1:139,6])
coint.test(Data1[1:139,5],Data1[1:139,1])
coint.test(Data1[1:139,5],Data1[1:139,2])
coint.test(Data1[1:139,5],Data1[1:139,3])
coint.test(Data1[1:139,5],Data1[1:139,4])
coint.test(Data1[1:139,5],Data1[1:139,6])
coint.test(Data1[1:139,6],Data1[1:139,1])
coint.test(Data1[1:139,6],Data1[1:139,2])
coint.test(Data1[1:139,6],Data1[1:139,3])
coint.test(Data1[1:139,6],Data1[1:139,4])
coint.test(Data1[1:139,6],Data1[1:139,5])

#Conclusion: There is cointegration in the time series, therefore VECM
can be fitted - Table A3.2 below presents the condensed output of the
Engle-Granger test.
```

Variables	**EG**	**p-value (type 1 – no trend)**	**Accept/ Reject H_0**
MSETRX,HICP	-0.629	0.1	Accept
MSETRX,TB3m	-2.1	0.1	Accept
MSETRX,GB10y	-3.3198	0.0206	Reject
MSETRX,M3	-3.82	0.01	Reject
MSETRX,IP	-1.03	0.1	Accept
HICP,MSETRX	-2.8329	0.0581	Accept
HICP,TB3m	-3.4084	0.0147	Reject
HICP,GB10y	-2.8141	0.0612	Accept
HICP,M3	-2.7411	0.0732	Accept
HICP,IP	-2.9430	0.0459	Reject
TB3m,MSETRX	-4.88	0.01	Reject
TB3m,HICP	-3.2827	0.0231	Reject
TB3m,GB10y	-3.95	0.01	Reject

TB3m,M3	-4.02	0.01	Reject
TB3m,IP	-2.37	0.1	Accept
GB10y,MSETRX	-3.56	0.01	Reject
GB10y,HICP	-1.03	0.1	Accept
GB10y,TB3m	-1.79	0.1	Accept
GB10y,M3	-2.5	0.1	Accept
GB10y,IP	-1.13	0.1	Accept
M3,MSETRX	-3.99	0.01	Reject
M3,HICP	-0.631	0.1	Accept
M3,TB3m	-1.8	0.1	Accept
M3,GB10y	-2.38	0.1	Accept
M3,IP	-0.519	0.1	Accept
IP,MSETRX	-3.3786	0.0167	Reject
IP,HICP	-3.2169	0.0276	Reject
IP,TB3m	-2.7463	0.0724	Accept
IP,GB10y	-3.2422	0.0259	Reject
IP,M3	-3.0063	0.0417	Reject

Table A3.2: Engle-Granger Test for Cointegration

```
#VECM
VECM4<-VECM(Data1[1:139,1:6], r=2, lag=4, include = "none")
summary(VECM4)

#############
###Model VECM
#############
Full sample size: 139   End sample size: 134
Number of variables: 6  Number of estimated slope parameters 156
AIC 1993.569    BIC 2468.815    SSR 6762748
Cointegrating vector (estimated by ML):
         MSETRX HICP         TB3m         GB10y            M3           IP
r1 1.000000e+00    0 -7433.357426 -5724.824475 -2.8186080521 533.99958774
r2 2.710505e-20    1    -1.642776     1.151694  0.0001736415  -0.06951094
#Table A3.3 below presents the condensed output of the VECM(4) output.
```

	Equation MSETRX	Equation HICP	Equation TB3m	Equation GB10y	Equation M3	Equation IP
ECT1	**0.0023**	**0.000018**	**0.00001**	**0.000005**	**0.0167**	-0.000028
	(0.0032)	(0.00001)	(0.000003)	0.000003	(0.0044)	(0.000089)
ECT2	6.66	**-0.15**	0.019	-0.004	**-59.20**	0.23
	(12.61)	(0.04)	(0.0116)	(0.0115)	(17.16)	(0.35)
$MSETRX_{t-1}$	**0.209**	0.0004	-0.0001	0.0000074	0.1275	0.0008
	(0.094)	(0.0003)	(0.000087)	(0.000086)	(0.1279)	(0.0026)
$HICP_{t-1}$	-11.99	0.0545	0.0062	0.0037	62.6948	0.5908
	(29.143)	(0.0930)	(0.0268)	(0.0266)	(39.656)	(0.8047)
$TB3m_{t-1}$	100.406	**0.7217**	**0.1965**	-0.0524	-209.56	2.7451
	(101.029)	(0.3223)	(0.093)	(0.0922)	(137.47)	(2.7895)
$GB10y_{t-1}$	-38.023	0.4045	0.1419	**0.3831**	**317.323**	1.2498
	(113.602)	(0.3624)	(0.1046)	(0.1036)	(154.58)	(3.1367
$M3_{t-1}$	0.12	-0.00009	-0.000022	-0.000029	-0.1280	0.0023
	(0.067)	(0.0002)	(0.000061)	(0.00006)	(0.0911)	(0.0018)
IP_{t-1}	0.6941	-0.015	-0.001	-0.0047	**-18.8541**	**-0.401**
	(3.8376)	(0.0122)	(0.0035)	(0.0035)	(5.222)	(0.106)
$MSETRX_{t-2}$	0.0868	**-0.001**	0.0001	0.00002	0.0584	0.0006
	(0.0956)	(0.0003)	(0.000088)	(0.000087)	(0.1301)	(0.0026)
$HICP_{t-2}$	29.7146	0.0751	**-0.0539**	0.0027	30.1288	-0.1784
	(28.958)	(0.0924)	(0.0267)	(0.0264)	(39.404)	(0.7996)
$TB3m_{t-2}$	117.776	0.3536	0.046	0.0403	-47.6182	-2.4834
	(102.14)	(0.3258)	(0.094)	(0.0932)	(138.986)	(2.82)
$GB10y_{t-2}$	-55.0976	0.1468	0.1671	0.0551	-15.785	1.7379
	(119.65)	(0.3817)	(0.1101)	(0.1092)	(162.8148)	(3.3037)
$M3_{t-2}$	-0.0088	**-0.0004**	-0.000003	-0.000076	-0.0457	0.000096
	(0.0665)	(0.0002)	(0.000061)	(0.000061)	(0.0904)	(0.0018)
IP_{t-2}	-1.187	-0.0043	-0.0016	-0.0064	-3.6998	**-0.3103**
	(4.1067)	(0.0131)	(0.0038)	(0.0037)	(5.5882)	(0.1134)
$MSETRX_{t-3}$	0.0391	0.0003	-0.0002	-0.0002	-0.207	0.0013
	(0.1001)	(0.0003)	(0.000092)	(0.000091)	(0.1362)	(0.0028)
$HICP_{t-3}$	-55.9236	-0.0132	-0.0042	0.0095	18.1108	-0.3049
	(28.3769)	(0.0905)	(0.0261)	(0.0259)	(38.614)	(0.7835)
$TB3m_{t-3}$	108.1764	-0.5462	**0.2348**	-0.02	-182.141	1.7025
	(101.97)	(0.3253)	(0.0939)	(0.093)	(138.75)	(2.8155)

$GB10y_{t-3}$	-39.6729	0.3907	-0.116	0.0416	265.393	1.5178
	(117.66)	(0.3753)	(0.1083)	(0.1073)	(106.103)	(3.2487)
$M3_{t-3}$	0.0175	-0.0003	-0.000013	-0.000045	**0.1859**	0.0003
	(0.0671)	(0.0002)	(0.000062)	(0.000061)	(0.0913)	(0.0019)
IP_{t-3}	-3.358	0.0077	-0.0009	**-0.007**	-1.4979	0.0403
	(3.804)	(0.121)	(0.0035)	(0.0035)	(5.1763)	(0.105)
$MSETRX_{t-4}$	0.039	-0.0001	-0.000023	0.000018	-0.0926	0.0018
	(0.099)	(0.0003)	(0.000091)	(0.00009)	(0.1347)	(0.0027)
$HICP_{t-4}$	**-80.598**	**0.1826**	0.0104	0.0164	-32.639	**-1.5144**
	(27.530)	(0.0878)	(0.0253)	(0.0251)	(37.462)	(0.7601)
$TB3m_{t-4}$	-67.323	-0.2326	-0.0761	-0.0375	4.5754	2.1156
	(100.704)	(0.3212)	(0.0927)	(0.0919)	(137.018)	(2.7806)
$GB10y_{t-4}$	-151.129	0.0553	**0.2242**	0.0788	197.343	-0.9019
	(117.332)	(0.3743)	(0.108)	(0.107)	(159.658)	(3.2397)
$M3_{t-4}$	0.0294	-0.0001	-0.000018	-0.0001	0.0762	-0.0027
	(0.0652)	(0.0002)	(0.00006)	(0.00006)	(0.0887)	(0.0018)
IP_{t-4}	-4.8303	0.0072	-0.0021	-0.0011	3.2826	-0.0043
	(3.3608)	(0.0107)	(0.0031)	(0.0031)	(4.5731)	(0.0928)

Table A3.3: Vector Error Correction Model with a lag order of 4

Note that the values in brackets show the standard error.

```
#Generating the p-values of the coefficients of the VECM
coefs_all <- summary(VECM4)$coefMat
coefs_all[grep("MSETRX", rownames(coefs_all)),]
coefs_all <- summary(VECM4)$coefMat
coefs_all[grep("HICP", rownames(coefs_all)),]

#Testing for serial correlation between the residuals
LjungBox(VECM4$residuals)

#Testing for normality of the residuals
mvShapiro.Test(VECM4$residuals)
```

Appendix 4: Qualitative Segment - Interview Questions

Section 1: General Information

1. What does the main activity of the organisation consists of?
2. For how long has the entity been established?
3. Can you describe your role within the organisation that you are currently engaged in?

Section 2: Investment in Malta

4. What do you think is the investment culture of the Maltese investor?
5. When making an investment decision what economic factors do you take into account?
6. In order of importance, where do you rank inflation when making an investment decision?
7. In your opinion, which factor mostly influences stock returns?
8. Do you think that inflation influences decisions taken on an investment portfolio? If yes, how?

Section 3: Inflation and Maltese Stock Returns

3.1.1 Stock Returns

9. According to my study, stock returns seem to be only influenced by stock returns at lag 1 (i.e. the previous month). Why do you think stock returns are not affected by higher lags (i.e. the previous 3 months, 6 months, etc.)?

3.1.2 Inflation

10. Is inflation a significant contributor to the volatility of stock returns in Malta?
11. In analysing the relationship between Maltese stock returns and inflation, it was found that stock returns take time to adjust for changes in inflation, why do you think this is so? In your view, how long is the period of adjustment?
12. Do you think that there is a specific cause for the origin of the negative relationship between inflation and stock returns in Malta?

3.1.3 Money Supply

13. Money supply seems to be negatively related to inflation. Do you think that this affects the relationship between inflation and stock returns?
14. Why do you think that money supply does not affect stock returns?

3.1.4 Interest Rates

15. Short-term interest rates seem to have a positive relationship with inflation. Do you think that this affects the relationship between inflation and stock returns?
16. Why do you think that long-term interest rates do not affect stock returns directly?

3.1.5 Real Activity

17. Do you think that real activity affects inflation or stock returns?

3.1.6 Other Significant Shocks

18. Do you think that other significant shocks such as the impact of COVID-19 reduce the inflation impact on stock returns?

End of Interview
