SECTOR GROWTH AND RELATED INDEX RETURNS – AN INTEGRATION ANALYSIS OF THE GROUP OF SEVEN

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For all the people that helped shaped me into who I am today.

ABSTRACT:

This study examines the lagged short run and long-term relationships between output growth and related index returns of the industrial and financial sectors of the G-7 economies. This study examines this relationship using quarterly data for a maximum time period of 22 years ranging from 1994(Q4) to 2017(Q4). The relationship between sector specific output growth and related index returns of the G-7 is investigated within this study, in order to determine whether passive investors should incorporate expected growth prospects into their decision making in order to earn superior returns. In order to examine the relationship between sector specific output growth and the related index returns of the G-7, this study uses correlation, cointegration as well as causality testing. This study finds weak non-lagged correlation relationships between output growth and related index returns of the industrial and financial sectors of the G-7 economies, with the correlation relationships becoming stronger in all cases when lags are incorporated within the correlations analysis. This study also finds cointegrating relationships between financial sector output growth and related index returns of Italy and the United Kingdom and that financial index return data of the United Kingdom serves as a leading indicator for financial sector growth within the United Kingdom. The overall Implication of these results is that investors should not incorporate growth prospects into their decision making of which passive funds to invest in, of which these passive funds examined track the performance of industrial and the financial firms within the G-7 economies.

keywords:

Correlation, Cointegration, Granger causality, sector growth, G-7, Gross domestic product

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ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dicky-Fuller
ADRL	Autoregressive distributed lag
AIC	Akaike information criterion
BRICS	Brazil, Russia, India, China and South Africa
EMH	Efficient market hypothesis
FPE	Final prediction error
G-7	Group of seven (Canada, France, Germany, Italy, Japan, the United Kingdom, the United States)
GDP	Gross domestic product
IPI	Industrial production index
LR	The sequential modified LR test statistic
MSCI	Morgan Stanley Capital International
OECD	Organisation for economic co-operation and development (USA, Canada, Japan, Australia, New Zealand, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, U.K)
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
UK	United Kingdom
US	United States

1. INTRODUCTION

Asset pricing theory stems from the single concept that the price of an asset is equal to it's discounted expected future payoff, where this payoff captures underlying macroeconomic risks that the asset is exposed to (Cochrane, 2009). Macroeconomic variables for which these macroeconomic risks are related to and may hence drive asset prices include inflation, interest rates, and economic growth (Cochrane, 2009).

Conventional wisdom is that economic growth and stock market performance are related to each other and, as a result, forecasts of growth are important in international resource allocation decisions (Gaddka & Pietraszewski, 2016; Ritter, 2012). According to Duca (2007), a strong link between economic activity and stock prices is also suggested by economic theory, as stock prices are the discounted future dividends payable by a firm, which one should expect to be a function of economic activity (Duca, 2007). An important conclusion that can be drawn from the existence of a relationship between economic growth and stock market performance is that, by investing in countries with high economic growth prospects, one can expect higher equity returns than that which could be earned by investing in countries with low growth prospects (Gaddka & Pietraszewski, 2016). The same principle would apply to passive investment in exchange traded funds of high growth economies as opposed to low growth economies.

Prior integration studies that have examined the relationship between output growth and equity returns have found the relationship to be weak or non-existent, suggesting that investors might not unconditionally benefit from higher economic growth prospects within an economy.

Integration studies that have employed correlation testing (Estrada, 2012; Gaddka & Pietraszewski, 2016; Klement, 2015; Ritter, 2005, 2012; Siegel, 1998) have found no strong positive correlation between output growth and stock returns, indicating that growth prospects in general do not have an impact on stock returns. The lack of a significant relationship between output growth and stock returns is further supported by integration studies that have employed cointegration testing to examine the lagged relationship between the variables (Adam, 2015; Binswanger, 2004; Hossain & Hossain, 2015; Kirui, et al., 2014; Madsen, Dzhumashev, & Yao, 2013; Rangvid, 2001; Tripathi & Kumar, 2015).

The direction of the causal relationship between economic growth and equity returns is one of the most contentious issues in economics (see Hossain & Hossain, 2015). The inconclusive findings of previous studies that have examined the lagged causal link in both developed and emerging economies (see Adam, 2015; Duca, 2007; Feridun, 2006; Hossain & Hossain, 2015; Husain & Mahmood, 2007; Ikoku, 2010; Mun, Siong, & Thing, 2008; Olweny & Kimani, 2011; Padhan, 2007) bears testament to this.

The objective of this paper is to examine the relationship between sector specific output growth and the related index returns of industrial and financial sectors of the G-7 economies. Prior research has largely focused on examining the relationship between stock returns and output growth in a specific country at an aggregate level, using gross domestic product and the returns on an all-share index as proxies for the variables used in this relationship (Adam, 2015; Alexius & Spang, 2015; Hossain & Hossain, 2015; Kirui, Wawire, & Onono, 2014; Ritter, 2005; Siegel, 1998; Tripathi & Kumar, 2015). There have only been a few exceptions to this, which include studies by Maysami, Howe and Hamzah (2004) who examined the relationship between stock returns and output growth in Singapore, using the returns on specific sector related indices and the industrial production index as proxies for the variables in the relationship. This study aims to examine the relationship between output growth and equity returns at the sector specific level for the G-7, and will therefore add to the existing literature on the relationship between output growth and equity returns within the G-7, where this relationship has not been documented at the sector specific level.

The results of this study will provide investors with useful information that could influence the type of passive funds in which they invest. This is because the results of this study can inform investors whether, in order to earn superior returns, they should invest in passive funds that track high growth sectors of an economy. There has been an increase in the amount of money dedicated to passive investment strategies in recent times. Thus information that could lead to better decision making with regard to which passive investment funds investors should invest in has become more important (Anadu, Kruttli, Mccabe, Osambela, & Shin, 2018). As this study will incorporate lags in the examination of the relationship between sector specific output growth and related index returns, the results will indicate which period specific output growth and related index return information investors should consider when deciding which passive funds to invest in.

The G-7 is a group consisting of the world's seven largest developed economies (Council on Foreign Relations, 2017). As of 2017, the G-7 had a significantly larger share of passive funds as a proportion of their total value of equity market capitalisation in comparison to emerging economies (Morningstar, 2018; Sushko & Turner, 2018) as well as a much larger percentage of assets in passive funds as a percentage of total assets (Morningstar, 2018; Sushko & Turner, 2018). An examination of the relationship between sector output growth and related index returns within the G-7 economies, as opposed to emerging economies as an alternative, would thus yield more important information for financial decision-making.

Investors would be expected to diversify their portfolios into foreign assets in order to reap the associated benefits of international diversification (Chiou, 2008; Driessen & Laeven, 2007; Nilsson, 2002), and these are likely to include those of the G-7 economies. Should a relationship between output growth and equity returns at the sector specific level thus be found to exist, it will inform passive investors whether they should consider the associated growth of sectors of firms within these G-7 economies when selecting which sector related indices or specific firms within these G-7 economies to invest in in order to yield superior returns.

The relationship between economic growth and equity returns is dependent on the nature of stock markets analysed and the degree to which they conform to the efficient market hypothesis (EMH) (Hossain & Hossain, 2015; Mobarek, Mollah, & Bhuyan, 2008). Depending on the form of market efficiency that stock markets exhibit, share prices would encapsulate a varying amount of information including economic growth expectations (Hossain & Hossain, 2015; Mobarek, Mollah, & Bhuyan, 2008). In this study, the expectation created by the EMH is that there is a more significant relationship between output growth and equity returns within the G-7 economies than in emerging economies. This is because developed economies including that of the US and UK are thought to be efficient in the semi-strong or strong form and, as such, share prices in these markets in terms of the EMH would reflect all new and available information while weak-form efficiency markets would not (Hossain & Hossain, 2015). Consequently, it is expected that share prices of these developed markets would better incorporate and reflect the future growth prospects of the economy than those of emerging markets (Hossain & Hossain, 2015). One would also expect a non-lagged relationship between sector specific output growth and related index returns of the G-7, because for these developed economies share prices would be expected to reflect all new and available output growth information based on the strong or semi-strong form of the EMH.

In order to examine the relationship between sector specific output growth and related index returns within the G-7 economies this study will make use of correlation, cointegration, and causality testing. This study will use quarterly output and index return data for a maximum period of approximately 22 years ranging from 1994(Q4) to 2017(Q4) to examine the relationship between sector specific output growth and the related index returns of the G-7. The period 1994(Q4) to 2017(Q4) is the most recent at the time of this study and is therefore the best proxy for current financial market and economic conditions which investors are currently subject to and which currently impact their investment decisions.

Correlation testing will be conducted in order to examine the extent of the lagged short-term relationship (Sharma, 2005) between output growth and index returns related to the industrial and financial sectors of the G-7 economies. However, correlation testing alone would not provide evidence on the ability to forecast future index performance based upon sector specific growth, as correlation does not imply causality (Gujarati, 2011; Sharma, 2005). Cointegration and causality testing will thus also be conducted to analyse the long-run equilibrium and casual relationship between the variables examined. In examining the correlation between output growth and related index returns of the industrial and financial sectors of the G-7 economies, this study will be extensive in determining which lag length results in the highest correlation between the variables. The optimal lag interval that will be used within the cointegration and causality testing carried out in this study is determined through lag order selection criteria.

This study finds weak non-lagged correlation between output growth and index returns of the industrial and financial sectors of the G-7 economies, with the correlation relationship becoming stronger in all cases when lags are incorporated into the correlation analysis. This is consistent with prior literature (Gaddka & Pietraszewski, 2016; Ritter, 2005, 2012; Siegel, 1998) and does not conform to the efficient market hypothesis. Importantly, this study goes on to find no negative non-lagged correlation relationships between output growth and index returns of the industrial and financial sectors of the G-7, with the exception of Germany, which is in contrast to prior studies (Ritter, 2005; Siegel, 1998).

This study also finds very few lagged cointegrating relationships, with some findings on the existence of a relationship between output growth and related index returns of the industrial and financial sectors of the G-7 contradicting that of prior literature (Alexius & Spang, 2015; Binswanger, 2004; Hossain & Hossain, 2015; Madsen, et al., 2013), albeit being tested at the sector specific level within this study. In terms of the nature of the causal relationship between sector specific output growth and related index returns of the G-7, this study goes on to find that for a single G-7 economy, there exists a cointegrating relationship between financial sector output growth and related index returns, with financial index return data found to serve as a leading indicator of financial sector output growth. For those G-7 economies for which this study finds a cointegrating relationship between sector specific output growth and related index returns, output growth within the industrial and financial sectors of those economies is not found to Granger-cause related index returns. This indicates that, for those G-7 economies where a cointegrating relationship between sector output growth and related index returns is found, investors would not be able to use historical sector specific growth data to predict changes in the returns of the related indexes.

The remainder of this study will be organised as follows: *Section 2* provides a review of the literature relating to the relationship between output growth and equity returns, to give the study the required context and background. *Section 3* provides an overview of the rise in the popularity of passive investment strategies in recent times and how this relates to the Group of Seven. *Sections 4 and 5* deal with the data used in this study and the research approach, respectively. *Section 6* provides an analysis of the results found by this study using the data, and *Section 7* provides the conclusions of this study and suggests areas in which further research could be conducted. *Section 8* provides the reference list to this study and *Section 9* consists of the appendices to this study.

2. REVIEW OF RELATED LITERATURE

The issue of whether macroeconomic variables and stock market returns are related and influence each other has been widely debated for a variety of markets and time horizons, with the stock market having been historically viewed as a reliable instrument to indicate economic processes such as output growth (Pilinkus, 2009).

In the introduction to this study, it was proposed that investors may be inclined to invest in high growth economies because of the belief that through this action they would yield superior returns.

This review of the literature will begin by providing a short overview of how economic growth is assumed to translate into equity returns by supply side economic models. This is done in to provide context into what is required for the relationship between output growth and equity returns to hold, as well as to provide an explanation for why the relationship may be found to not exist within certain economies. The literature review will then provide an overview of the findings of studies that have examined the relationship between output growth and equity returns using different econometric tests. This is done in order to create an expectation for this study's findings based upon prior literature as well as to provide an overview of previous findings on the nature of the relationship within different economies when using different econometric tests.

The econometric tests that prior studies have used to examine the relationship between output growth and equity returns are correlation, cointegration, and causality testing. In this literature review the findings of studies that have examined the relationship between output growth and equity returns using correlation testing are brief, with only the most important studies emphasised. Studies that have used cointegration testing to examine the relationship between output growth and equity returns using cointegration testing are organised within this literature review into those that have examined this relationship in emerging economies and those that have examined this relationship in developed economies. The findings of studies that have examined the causal relationship between output growth and stock performance have been organised into those that have found the casual relationship between output growth and stock performance to be bi-directional, those that have found that there is unidirectional causality running from stock performance to output growth, and those that have found that there is unidirectional causality running from output growth to stock performance.

2.1 The relationship between economic growth and equity returns

The relationship between output growth and equity returns is assumed by supply side economic models of stock returns that have been developed to explain and forecast stock market returns based on macroeconomic performance (as measured by GDP growth). These supply side models are described by Morgan Stanley Capital International (2010) and assume that GDP growth flows to shareholders in three stages. That is, GDP growth translates into aggregate corporate earnings growth which then translates into earnings per share growth and then finally into equity returns. This relationship is weak, however, because of the problems associated with GDP growth translating into stock returns (Morgan Stanley Capital International, 2010) which are discussed below.

A returns decomposition model as discussed by Ibbotson and Chen (2002) and, as indicated below, can be used to explain the problems associated with this translation of GDP growth into equity returns and why these two variables may not be meaningfully related to each other, as indicated by prior research.

$Rt = (1 + gEPS\ t\ )(1 + gE/P,t\ ) - 1$

The model's explanation for a lack of correlation between economic growth and equity returns can be divided into two groups. The first group provides reasons for a lack of correlation between a country's economic growth and aggregate corporate earnings growth ÷ Earning per share growth (g_{EPS}) of companies making up a country's all share index. The second group tries to explain why EPS growth does not necessarily translate into equity returns (Gaddka & Pietraszewski, 2016).

Arguments for the first group of why economic growth does not necessarily translate into aggregate corporate profits growth or earnings per share growth include Siegel's (1998) globalisation argument. In this study Siegel (1998) argues that the largest firms quoted on most country's stock markets are multinationals whose profits depend on worldwide rather than purely domestic economic growth, which leads to a disconnect between the earnings of a company and the economic growth of the country in which it is listed. In addition, because of their wide geographic exposure these multinationals are somewhat protected against downturns in the business cycles of economies in which they operate, whereas the effects of these downturns will be picked up in the GDP growth of that local economy, leading to a disconnect in the relationship (Estrada, 2012).

Another explanation for the disconnect is the existence of a situation whereby companies dilute their earnings by issuing new shares to finance their growth. This may lead to higher aggregate corporate profits through the use of the additional funding raised, but may decrease EPS growth (Gaddka & Pietraszewski, 2016).

Additionally, economic growth results mainly from increases in the usage and efficiency of three main inputs, that is, labour, capital, and technology (Ritter, 2012). Krugman (1994) and Young (1995) argue that much of the real economic growth in emerging markets comes from the infusion of new capital and more efficient utilisation of labour, and neither of these increases necessarily translate into higher profits for the shareholders of existing listed companies. With regard to technological progress, Bernstein and Arnott (2003), Ritter (2012) and Siegel (1998, 1999) argue that much of the benefits of technological change that drives economic growth in a competitive economy ends up accruing to consumers in the form of lower prices and higher quality products instead of to investors, indicating that returns may not be positively affected.

Arguments for the second group are that changes in valuation (P/E ratios) can offset the positive impact of earning's growth on equity returns. According to the returns decomposition model, equity returns increase with a positive growth in earnings unless that growth in earnings is offset by a reverse movement in the valuation (P/E ratio) (Gaddka & Pietraszewski, 2016).

A reverse movement in the valuation occurs from investors' tendency to overpay for the growth prospects of companies in fast-growing economies which is highlighted by Siegel (1998), through a belief that investing in fast-growing economies will translate into higher returns. These growth expectations are impounded into the share prices at the start of the period, causing the initial P/E ratio to rise dramatically. Eventually however, when these companies cannot deliver on these growth expectations that have been imputed into their share prices to justify their high PE ratio's, the share price falls, leading to decreasing/negative growth in returns even though the economy in which the company operates might be experiencing positive economic growth (Gaddka & Pietraszewski, 2016; Siegel, 1998)

From the above, one can see why, the relationship between output growth and equity returns may not hold, as indicated by previous studies.

The extent of the lack of relationship between economic growth and EPS growth and also between EPS growth and equity returns was investigated by Norges Bank Investment Management (2012), using MSCI indices data for 20 developed and 21 emerging economies for a period up to 22 years. The Norges Bank Investment Management (2012) study used correlation tests to determine the extent of the non-lagged relationship between the variables and found that the correlation between EPS growth and equity returns is highly positive and statistically significant for both developed and developing countries included in the sample, with a correlation of 0.8 for the developed countries and 0.76 for the emerging countries. However, Norges Bank Investment Management (2012) found that for the relationship between GDP growth and EPS growth, the correlation was only 0.05 for the developed countries and -0.19 for the emerging market countries. This reveals that it is within this relationship that a disconnect exists which renders the correlation relationship between GDP growth and Equity returns not statistically significant (Gaddka & Pietraszewski, 2016).

2.2 Correlation between output growth and equity returns

The findings of the literature covered that has examined the correlation relationship between output growth and equity returns are brief and are not intended to serve as an exhaustive review, with only seminal studies being emphasised. These studies have not considered possible lags within the correlation relationship, which this study will do.

Siegel (1998) conducted a seminal study on the correlation between output growth, measured by annual GDP growth, and US dollar stock returns using aggregated data for the period 1970 to 1997. This was done for seventeen developed countries and eighteen emerging economies monitored by the Morgan Stanley Capital Markets Indexes. Siegel (1998) found that an aggregate negative correlation existed between these two variables for both sets of developed and emerging economies used in the analysis. This indicated an absence of any positive relationship between the two variables in the short term and that investing in high growth economies as opposed to low growth economies would not lead to higher equity returns.

Ritter (2005), in a study using predominately developed countries, also found the existence of a negative correlation between output growth and stock returns when testing for the relationship using a longer period of 102 years, indicating that no positive long-term relationship existed.

Further consensus on the lack of a statistically significant positive correlation between output growth and stock returns were also found by studies conducted by Estrada (2012), Gaddka and Pietraszewski (2016), Klement, (2015) and Ritter (2012) albeit using slight variations of the variables in their studies.

Ritter (2005) and Siegel (1998) indicated that because they found a negative correlation between output growth and stock returns, on average investors would have been better off investing in companies in countries that ended up experiencing lower output growth than in those that experienced higher output growth, both in the short and long term.

The data from these aforementioned studies did however indicate that the two variables are slightly more correlated when a longer period is used to test the relationship, with Ritter (2005) finding a slightly higher positive correlation when using a period of 102 years. Siegel (1998) and Ritter (2012) found a lower positive correlation in the relationship upon using shorter testing periods.

The lack of a significant correlation between output growth and equity returns revealed by Siegel's (1998) study was attributed by him to economic growth already being factored into stock prices at the start of the period, which lowered future stock returns and created a discrepancy between future economic growth and future stock price growth. Siegel (1998) also attributed this lack of correlation to the explanation provided in his globalisation argument which was discussed in *Section 2.1 The relationship between economic growth and equity returns*.

Estrada (2012) noted that some may question the relevance of evidence provided by previous studies regarding the correlation between output growth and equity returns. This is because a number of these previous studies, including that of Ritter (2005) and Siegel (1998), used output and equity return data from many decades ago and economies and financial markets have changed substantially since then (Estrada, 2012). However, when Estrada investigated the relationship between real output growth and equity returns over the period 1970 to 2011 for South Africa and 21 developed countries, he found a correlation coefficient of -0.04 and a corresponding p-value of 0.87, consistent with the findings of prior literature indicating a lack of significant correlation between output growth and equity returns.

2.3 Cointegration relationship between output growth and equity returns

Fama, in a study conducted in 1990, postulated that the three sources of stock return variations are time-varying expected returns, expected returns shocks, and shocks to expected cash flows.

There has therefore been a significant amount of studies that have examined the cointegration relationship between macroeconomic variables that serve as proxies for these three causes of stock return variations and share price behaviour (Cheung and Ng, 1998).

One of such studies was conducted by Cheung and Ng (1998) who examined the empirical relationship between all share stock index returns and aggregate macroeconomic variable of five countries using the Johansen cointegration test. The five countries for which this relationship was examined were Canada, Germany, Italy, Japan and the United States. The aggregate macroeconomic variables that were used were real consumption, real oil price, real money, and real output. In the study Cheung and Ng (1998) found evidence of long-run cointegration between the countries' stock index returns and the aggregate economic variables, which had varying effects on index returns. Changes in the oil price and money stock were found to have significant effects on stock market movements, whereas changes in output and consumption were found to have weak explanatory power in terms of the cointegrating relationship. (Cheung & Ng, 1998).

Similar studies also found that aggregate macro-economic variables that served as proxies for the three sources of stock return variations proposed by Fama (1990) were cointegrated with equity returns. Such studies included Gan, Lee, Hwa, Yong, and Zhang (2006) and Humpe and Macmillan (2009) although they used slightly different macroeconomic variables as proxies.

Other studies have also examined the relationship between share prices and changes in individual macroeconomic variables such as inflation, real activity, and interest rates (Hossain & Hossain, 2015). These studies more closely align to this study as here we look at the relationship between two variables, that is, output growth as measured by real gross domestic product per sector and index returns of the associated sector**.**

Studies that have examined the relationship between individual macroeconomic variables and output growth in developed economies include those of Fama (1981, 1990) and Patel (2012) while those that studied this relationship in developing markets include Kwon and Shin (1999) and Ibrahim and Aziz (2003) .

The study conducted by Ibrahim and Aziz (2003) found evidence of dynamic linkages between a set of macroeconomic variables and stock prices, when using cointegration techniques indicating long run predictability for Malaysian stock prices. The macroeconomic variables used in the study conducted by Ibrahim and Aziz (2003) were industrial production, money supply, the price level, and the US dollar exchange rate

Some of these studies (Kwon & Shin, 1999; Patel, 2012) have made use of industrial production as a measure of real activity and examined the relationship between industrial production and equity returns, as measured by a countries' all share indexes. This is a similar approach to this study in that they make use of an industry specific measure of output, but the studies are nonetheless not directly comparable, as they fail to then subsequently investigate the relationship of this variable to sector specific index returns.

Section 2.3.1 Findings in emerging markets below provides the findings of prior literature that has examined the relationship between output growth and equity returns in emerging economies. This is done even though our study only examines the relationship in selected developed economies, because this will provide useful information on how the relationship differs depending on whether developed or emerging economies are examined. This also takes into account that an area of further research could be an extension of this study to the examination of the relationship between sector specific output growth and related index returns in emerging economies.

2.3.1 Findings in emerging markets

Osamwonyi and Evbayiro-Osagie, in a 2012 study, attempted to determine the lagged short-run and long-run relationship between the Nigerian stock market index and several macroeconomic variables, of which included Nominal GDP, using annual data for the period 1975 to 2005. To test the relationship cointegration and therefore Error Correction Modelling technique was employed.

The study conducted by Osamwonyi and Evbayiro-Osagie (2012) differs from this study in that the effects of inflation were not removed from the measure of real economic activity. The inflation rate has been found conclusively to have a negative relationship with stock prices, indicating that through the use of a nominal measure of economic activity in the study one would expect a stronger relationship with stock prices (Osamwonyi & Evbayiro-Osagie, 2012).

Osamwonyi and Evbayiro-Osagie (2012) found no significant relationship in the short run but significant cointegration in the long run, at a 10% significance level.

Erdem, et al. (2010) investigated the long-run lagged relationship between stock market performance and real economic growth (as measured by real GDP) for six emerging economies being Malaysia, Turkey, Mexico, Korea, Brazil, and India, selected based on availability of data.

The study conducted by Erdem, et al. (2010) employed the use of the autoregressive distributed lag (ARDL) cointegration method proposed by Pesaran, et al. (2001) to investigate the long run relationship between the two variables and the results provided evidence of a long- run equilibrium relationship in Malaysia, Turkey, Korea and India. In a separate study conducted by Kaplan (2008), the existence of cointegration between stock market performance and real economic activity was confirmed in the case of Turkey, albeit through the use of a shorter testing period.

More recent studies that investigated the lagged relationship between output growth and stock returns in the context of developing markets are those of Kirui, Wawire and Onono (2014), Adam (2015) and Tripathi and Kumar (2015).

Kirui, et al. (2014) investigated the relationship between output growth and equity returns in Kenya using quarterly data for the period 2000(Q2) to 2012(Q2) covering stock market returns per the Nairobi securities exchange, and gross domestic product data. The Engle-Granger cointegration test was used to examine the existence of a cointegrating relationship between the two variables and, after establishing the existence of cointegration among the variables, an Error Correction Model was estimated to test for the short and long run-dynamics of the relationship. Kirui, et al. (2014) found no significant cointegrating relationship between the two variables, indicating no significant long-run relationship between output growth and equity returns in the Kenyan economy.

Adam (2015) tested the existence of the cointegrating relationship in the Indonesian economy using a similar time frame and methodology to that of Kirui, et al. (2014) and found that the two variables were not cointegrated.

The 2015 study conducted by Tripathi and Kumar investigated the long run relationship between selected macroeconomic variables and equity returns in the BRICS (Brazil, Russia, India, China, and South Africa) nations as a group. The macroeconomic variables used were GDP, inflation, interest rate, exchange rate, and money supply. Tripathi and Kumar (2015) used quarterly data that spanned the period 1995 to 2014 and also examined the relationship during two sub-periods, a pre-crises period covering 1995(Q1) to 2007(Q2) and a post crisis period from 2007(Q3) to 2014(Q4). To test the existence of the relationship during these periods the Pedroni's Panel Cointegration Test (Engle-Granger based) and Panel autoregressive distributed lag (ARDL) model was used. It was found that stock prices of the BRICS nations as a panel were cointegrated with GDP in the total period tested as well as GDP, inflation and money supply in the post crisis period specified. The findings according to Tripathi and Kumar (2015) had significant implications for policymakers and regulators because the identified interlinkages between the real economy and the stock market needed to be taken into account in any reforms envisioned or undertaken.

A study that is comparable to this one is that of Rangvid (2001) who investigated the lagged relationship between real activity and share prices for industrial firms in nine emerging economies and examined whether these two variables were cointegrated for the period covering the 1970's to 1999. The nine emerging economies in which this lagged relationship was examined were Chile, Columbia, Greece, Ireland, Korea, Mexico, Poland, Turkey, and Venezuela

The study conducted by Rangvid (2001) differed from those previously discussed, as the measure of real activity used was based on the production of firms in the industrial sector only (the industrial production index) and not production in the economy as a whole. The latter is what GDP attempts to capture, as it represents the total aggregate output of an economy in a specific year and not the output of a specific sector. Additionally, the share prices used in the study conducted by Rangvid (2001) were that of industrial firms only, in the form of an industrial index. The methodology employed by this study will be similar to that of Rangvid (2001) as this study will also look at the relationship between production in certain sectors of the economy, as measured by the gross domestic product per sector, and associated indices that capture equity returns of companies' shares in those sectors.

Rangvid (2001), employing the Johansen cointegration test, found that cointegration existed between output growth and stock returns in four of the nine emerging economies examined (Poland, Turkey, Venezuela, Chile), indicating that in these countries the two variables were driven by the same stochastic trend.

2.3.2 Findings in developed markets

In a study conducted by Binswanger (2004), a cointegration analysis was performed to test the long-run lagged relationship between quarterly data of real stock prices and real GDP growth of the G-7 countries. The period covered by the analysis was 1960 to 1999.

To test for integration between these two variables, Binswanger (2004) made use of both the Johansen and Engle-Granger cointegration tests. Both tests were used in order to achieve as robust results as possible, as the two tests can lead to different results, as for example, outlined in Dickey, Jansen and Thornton (1991), and there is still no agreement on which of the tests are more appropriate (Binswanger, 2004).

The results of the Johansen cointegration test in Binswanger's (2004) study indicated cointegration between equity returns and real GDP growth for France, Italy, and Japan. The Engle-Granger test in Binswanger's (2004) study, however, indicated slightly contrasting results, of cointegration in the relationship for Germany, which the Johansen test rejected and no cointegration in the relationship for Italy, which the Johansen test supported.

The result of this is that for these developed countries the results did not provide a firm basis to decide whether cointegration existed (Binswanger, 2004).

These results largely coincided with the findings of a similar study by Hossain and Hossain (2015) using more recent data, which found a lack of cointegration in the long-run lagged equilibrium relationship between output growth and equity returns for the US, UK, and Japan using the Engle-Granger cointegration test. The finding by Hossain and Hossain (2015) of no cointegrating relationship between output growth and equity returns in Japan, which is in contrast to that of Binswanger (2004), was attributed by Hossain and Hossain (2015) to the fact that the time frame used in the studies differed, and as a result, also the economic environment of the period in which the studies were performed.

In 2013 Madsen, et al. examined the aforementioned relationship for 20 Organisation for Economic Co-operation and Development (OECD) countries, albeit through the use of per capita GDP as the measure of economic activity and not aggregate GDP that was predominately used by previous studies.

Madsen, et al. (2013) tested the relationship using annual data for the period 1870 to 2006, or data covering a shorter period, depending on data availability for the countries tested, and employed a stochastic general equilibrium model to test the long run relationship between the two variables.

Madsen, et al. (2013) found no robust positive relationship between real stock returns and per capita GDP output growth for the countries examined, except for the period 1920 to 1950, during which output growth was dominated by severe output fluctuations, indicating the non-existence of a long run relationship.

Several studies have tested the existence of the relationship between output growth and equity returns in Australia and have offered contradicting results. One such study is that of Tang (2013) which investigated the existence of the long-run lagged relationship using quarterly data for the period 1960 to 2008. To test for a long-run lagged relationship Tang (2013) employed a bounds testing approach to cointegration, which is claimed by Pesaran and Shin (1999) and also Panopoulou and Pittis (2004) to have superior properties over conventional cointegration tests. The study conducted by Tang (2013) found evidence of the existence of cointegration between the two variables in the long-run for Australia.

The finding of a long-run relationship between the two variables in the Australian economy is consistent with that of Mao and Wu (2007). However, it contradicts the findings of Thangavelu, et al. (2004) who found no evidence of cointegration. These two studies, however, used data from different sample periods and of different frequencies which could be the reason for the contradicting results.

Maysami, et al. (2004) examined the long-run lagged equilibrium relationship between three stock market indices in Singapore and the industrial production index which was used as a proxy for real activity. The three indexes used were the finance, hotel, and property index. This closely aligns to this study by looking at the relationship between different sector indices in an economy and related measures of real sector activity. Maysami, et al. (2004) found that the measure of real activity formed significant relationships with only selected indices, that is, the hotel index and the property index, indicating that the real activity measure provided long-run predictability of these indices' returns.

An interesting study was conducted by Alexius and Spang (2015) who investigated the long run lagged equilibrium relationship between the G-7 countries' stock market returns, the domestic GDP of these countries and their trade weighted foreign GDP. By including the trade weighted foreign GDP as a variable to explain stock return variations the study conducted by Alexius and Spang (2015) also investigated Siegel's (1998) globalisation argument, as discussed in *Section 2.1. The relationship between economic growth and equity returns*. The period covered was 1969 (Q1) to 2014 (Q1) and the study employed the Johansen (1988) cointegration procedure to test the relationship.

The study conducted by Alexius and Spang (2015) used quarterly real stock market return data for the G-7 countries, which was collected from MSCI, and real domestic GDP data from the OECD database Main Economic indicators. The country specific foreign GDP data was constructed as a weighted average of real GDP of 16 OECD countries, using the OECD total comparative weights of each country as weights.

Alexius and Spang (2015) found that that stock prices, domestic GDP and foreign GDP are cointegrated in the G-7 countries, with the exception of the United States whereas in terms of a bivariate cointegration relationship, domestic GDP and domestic stock prices were found to be cointegrated for four of the seven G-7 countries. The four countries in which Alexius and Spang (2015) found domestic GDP and domestic stock prices to be cointegrated were Canada, Germany, France and the United Kingdom. This indicates that including trade weighted foreign GDP in the study allows more variations in the stock price returns to be explained and supports Siegel's (1998) globalisation argument, as the relationship is found to be cointegrated for a great number of the countries.

The studies within *Section 2.3.1 and 2.3.2* indicate mixed results concerning the relationship, with no consistent long-run relationship being found for either developed or emerging economies as a set. This indicates that one may not necessarily benefit from greater returns in emerging economies that may experience high growth as opposed to developed economies experiencing lower levels of economic growth due to lack of cointegration. This also indicates that not all share indexes of the countries analysed have long-run predictability (Ibrahim & Aziz, 2003).

2.4 Causality findings between output growth and equity returns

Studies that have found a bidirectional causal relationship between stock performance and output growth

Ikoku, in a 2010 study, found the lagged causal relationship between real output growth and stock performance in Nigeria to be bi-directional for the period 1984 to 2008, using Granger causality tests. This indicated that, while stock prices within Nigeria reflect the expectations of investors, they ultimately must also reflect economic fundamentals. This bi-directional lagged causal relationship between stock prices and output growth was also found by Feridun (2006), Pilinkus (2009) and Padhan (2007) in Canada, Lithuania and India, respectively, also based on Granger causality tests, implying that well-developed stock markets can enhance economic activity and vice-versa (Padhan, 2007).

Studies that have found a unidirectional causal relationship running from stock performance to output growth

Adam, in a 2015 study, examined the dynamic of the lagged causal relationship between stock prices and output growth in Indonesia for the period 2004 to 2013. Their study used the general causal model LVAR proposed by Agung (2009). A lag of two periods was incorporated into the examination of the causal relationship between the stock prices and output growth to take into consideration Adam's (2015) claim that prior research such as that of Stock and Watson (2003) and Croux and Reusens (2013) indicated that share prices serve as a predictor of future economic activity. Adam (2015) found that within Indonesia there was a significant positive causal relationship between stock prices and output growth, with an increase (decrease) in stock prices always being followed by an increase (decrease) in economic growth. This unidirectional causal link running from stock prices to output growth was also found by Mun, et al. (2008), in Malaysia, and Enisan and Olufisayo (2009), in Egypt and South Africa. Comincioli (1996), Duca (2007) and Hossain and Hossain (2015) found this unidirectional causal link for the

United States for the periods 1970 to 1994, 1957 to 2005 and 1991 to 2012 respectively. This contradicts the findings of Feridun (2006) that in the United States output growth Granger-caused stock performance and not the other way around.

Duca (2007) also found that stock performance Granger-caused output growth for the period 1970 to 2004 in the case of the United Kingdom and France, and the period 1957 to 2004 in the case of Japan. Hossain and Hossain (2015) confirmed that in the case of the United Kingdom stock performance Granger-caused output growth, while in the case of Japan he found no causal relationship between stock performance and output growth, which is in contrast to the findings of Duca (2007).

In addition, Erdem, et al. (2010) in investigating the relationship between output growth and stock performance in Malaysia, Turkey, Mexico, Korea, Brazil, and India found a short-term lagged unidirectional causal relationship running from stock market performance to economic growth in four of the six countries examined. The four countries in which this lagged unidirectional causal link was found within Erdem, et al.'s (2010) study was Malaysia, Turkey, Mexico, and Korea.

Empirical research on the nature of the causal relationship between stock performance and output growth in Australia has failed to reach a consensus. Shan, et al. (2001) found a lagged bidirectional causal relationship between stock performance and output growth and Thangavelu, et al. (2004) and Tang (2013) found a unidirectional lagged causal relationship running from stock performance to output growth when using quarterly stock return and output data. Mao and Wu (2007) investigated the lagged causal relationship between stock performance and output growth in Australia using different sample periods and frequency of data (i.e. monthly and quarterly). The sample periods used in Mao and Wu's (2007) study were 1974 to 2004, 1974 to 1983 and 1986 to 2004. Mao and Wu (2007) found that economic growth Granger-caused stock returns whenever quarterly data was used in the causal analysis, regardless of the time period examined, and that the causal relationship between the variables were inconclusive whenever monthly data was utilized, as the nature of the causal relationship varied depending on the time period examined.

Studies that have found a unidirectional causal relationship running from output growth to stock performance

Olweny and Kimani, in a 2011 study, found that in Kenya output growth Granger-caused stock price performance for the period 2001 to 2010 and that the lagged causal relationship was one way. This unidirectional lagged causal relationship running from economic growth to stock price performance was also found by Husain and Mahmood (2007) for Pakistan for the period 1959 to 1999, indicating that the Pakistani market cannot be characterised as a leading indicator of economic activity (Husain & Mahmood, 2007).

The overview of the results of the causality studies above indicate that the nature of the causal relationship between output growth and stock market performance differs depending on the economy and time frame analysed, with no conclusive causal relationship between output growth and stock market performance being able to be drawn for developed and emerging economies as a set.

3. Passive investment in the Group of Seven

Section *3.1 The rise in the popularity of passive investment strategies* will provide background on the extent of the recent rise in passive investment strategies globally and more specifically the United States, which is home to the world's largest stock markets (World Bank, 2011). It will also identify factors that have contributed to this increase in passive investment strategies. This will highlight that, because of the increase in the popularity of passive investment strategies, information that may lead to better decision making with regards to passive investments has become more important. This includes information on the relationship between output growth and equity returns which this study aims to examine. *Section 3.2 The Group of Seven* will then emphasise the size of passive investment within the G-7, and assert that an analysis of the relationship between output growth and equity returns in the G-7 has the potential to yield more relevant information than if the relationship were examined within other economies.

3.1 The rise in the popularity of passive investment strategies

Passive investing has grown inexorably more popular in recent times with the past couple of decades seeing a significant shift in assets from active to passive investment strategies (Anadu, et al., 2018).

Passive funds today represent a significant portion of the global investment fund universe (Sushko & Turner, 2018). Measuring industry size by assets under management showed that passive funds represented about eight trillion dollars or 20 percent of aggregate investment fund assets as of June 2017, up from a mere 8 percent a decade earlier. The growth in passive funds has been rapid for both equity and bond asset classes, although most passive portfolios remain focused on equities (Sushko & Turner, 2018).

In the U.S, which is home to the world's largest stock markets (World Bank, 2011), as at December 2017, passive funds accounted for approximately 37 percent of combined mutual funds (MFs) and exchange traded fund assets under management (AUM). This is from constituting a mere three percent of mutual funds and exchange traded fund AUM in 1995 and 14 percent in 2005 (Anadu, et al., 2018).

In addition, passively managed funds hold an increasing share of total financial assets in the US, with US stocks held in passive MF's and ETFs accounting for almost 14 percent of the US domestic equity market as of December 2017, up from less than four percent in 2005 (Anadu, et al., 2018). The aggregate passive share outside of MFs and ETFs is even larger, with BlackRock (2017) estimating that passive investors owned 18 percent of all global equity at the end of 2016, with most of these holdings outside MFs and ETFs (Anadu, et al., 2018). This huge increase in the popularity of passive funds is not expected to slow down in the near future.

The recent active to passive investment shift highlighted above is attributed to several factors including the development of the efficient market hypothesis in the period 1950 – 1970 which called into question the active selection of securities to "beat the market" and indicated rather than investors should instead hold the market portfolio itself (Bhattacharya & Galpin, 2011). The introduction of the first stock index funds in the 1970's made passive investments in the market portfolio a practical option for investors and facilitated this shift from active stock selection. Another factor contributing to the popularity of passive investment alternatives is the relatively lower costs associated with passive investing compared to active investment strategies. These lower fees are due to fund managers not having to actively select stocks. The evidence of underperformance of many active stock managers has also called into question these higher fees associated with active investment strategies (Anadu, et al., 2018).

Given this increase in the popularity of passive investments, information that could lead to better decision making on which passive investment vehicles investors should invest in, such as exchange traded funds that track an index relating to companies that operate within a specific sector of an economy, has become vastly more important. This has increased the importance of information that can answer questions such as whether there is a relationship between sector specific output growth and the stock returns of a related index, which would assist passive investors to make investment decisions.

3.2 The Group of Seven

The Group of Seven (G-7) is comprised of the world's seven largest developed economies with the aggregate GDP of the G-7 member countries making up nearly 50% of total global output (Council on Foreign Relations, 2017).

As indicated by **Table 1**, as of 2017 passive funds' share of outstanding market volumes as measured by equity market capitalisation was the largest for the United States at 14.7 percent, followed by Japan at 5.5%, and Europe at 3.3%. For emerging market economies on the other hand passive funds' share of outstanding market volumes was only 2.3 percent of these emerging economies taken in aggregate, and including South Africa.

In addition, Morningstar (2018) estimated that for African countries assets in passive funds as a percentage of the total assets within both active and passive funds stood at a mere 4%. Comparatively, for the United states and Europe this figure stands at 32% and 19% respectively. Assets in passive funds as a percentage of total assets for Africa as well as for several other regions is indicated by **Figure 1**.

This highlights the large difference in passive funds' share of the total value of the equity market capitalisation of these G-7 countries in comparison to emerging economies. It also highlights the large difference in the proportion of assets within passive funds for developed economies, some of which are G-7 members, in contrast to emerging economies.

Table 1: Passive funds estimated share of outstanding market volumes[1] in percent

Securities market	2007	2017
Equities[2]		
Europe	2.3	3.3
Japan	2.0	5.5
United States	6.0	14.7
EMEs	1.2	2.3
Bonds[3]		
Europe	1.0	0.9
United States	1.2	4.5

[1] End-June data for each year. [2] Equity market capitalisation (denominator) based on Bloomberg World Market Capitalization indices (WCAUJAPA for Japan, WCAUUS for US, and constituent countries for Europe and EMEs). [3] Bond market capitalisation (denominator) based on Bloomberg Barclays Pan-European Aggregate, Bloomberg Barclays Pan-European High Yield, Bloomberg Barclays US Corporate High Yield and US Aggregate Bond Indices (LP06TREU, LP01TREU, LF98TRUU and LBUSTRUU, respectively).

Sources: Bloomberg; Lipper; authors' calculations.

(Sushko & Turner, 2018)

Figure 1: Percentage of assets in active versus passive funds by region

(Morningstar, 2018)

This study examines the relationship between output growth and equity returns at the sector level for the G-7 economies. Thus, our study investigates this relationship for the world's largest economies who have the largest passive fund share of their equity market capitalisation as well as the highest proportion of their assets in passive funds. This should reveal useful information for passive fund investors as it is within these G-7 economies that passive investment is more popular and accounts for a larger share of total market capitalisation value.

Markowitz (1952) in his seminal study on portfolio selection stated that "diversification is both observed and sensible; a rule of behaviour which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim."

As noted by Nilsson (2002), the diversification of one's portfolio through the incorporation of foreign assets in order to create portfolios with a higher expected return per unit of risk has been specifically discussed since the early words of Grubel (1968), Levy and Sarnat (1970) and Solnik (1974) with studies such as those of Nilsson (2002), Driessen and Laeven (2007) and Chiou (2008) finding that there exists substantial benefits from the international diversification of one's portfolio and that there are substantial costs associated with not diversifying internationally (Driessen & Laeven, 2007). Chiou (2008) found that this holds even though international markets have become more integrated over time, with the benefits of international diversification found to be larger for developing countries than for developed countries when viewed from the perspective of a local investor, even when controlling for currency effects (Chiou, 2008; Driessen & Laeven, 2007; Nilsson, 2002).

From a portfolio diversification perspective, foreign equities are said to provide great international diversification opportunities, with the benefits of diversification often being argued to be a reduction in the variance of one's portfolio rather than an increase in returns (Grubel, 1968; Levy & Sarnat, 1970; Li, Sarkar, & Wang, 2003; Solnik, 1974)

Taking note that the international diversification of one's portfolio provides benefits to investors, one would expect investors in emerging and developed economies to incorporate foreign assets into their portfolios. With regard to passive investors of emerging economies specifically, International diversification is widely pursued, with Bloomberg (2018) reporting that for the period 1 January 2017 to 17 July 2017 the net money flows from emerging economies into and out of US-based exchange traded funds[1] was 29.61 billion US dollars, which indicates the popularity of international based assets among emerging economies. BRICS nations' net flows into and out of US-based exchange traded funds was reported by Bloomberg (2018) to be 46.97 million US dollars. These net flows into and out of US based exchange traded funds[1] are indicated by **Table 2** below.

[1] These US - based exchange traded funds consist of equity, fixed income, currency and other exchange traded funds.

Table 2: Net flows into and out of US – based exchange traded funds[2] in millions of USD for the period 1/01/2017 to 17/07/2017 by region

Region US ETFs by Asset Class				
Asset Class	# Funds	Net Flows (MM)	Beg Mkt Cap (MM)	% Funds Mkt Cap
Asian Pacific Region	21	1 142,11	4 971,06	23,0%
Asian Pacific Region ex Japan	15	1 261,29	4 817,62	26,2%
BRIC	5	46,97	223,30	21,0%
Eastern European Region	1	-	-	-
European Region	62	7 302,18	28 701,33	25,4%
European Union	2	-	-	-
Eurozone	18	6 484,79	11 803,89	54,9%
Global	609	9 198,16	135 081,68	6,8%
International	345	82 309,93	337 162,38	24,4%
Latin American Region	9	(201,84)	1 089,14	(18,5%)
Middle East Region	4	(7,91)	46,16	(17,1%)
Nordic Region	1	1,14	29,59	3,9%
North American Region	7	151,93	840,43	18,1%
Geography	**1 099**	**107 688,75**	**524 766,59**	**20,5%**

(Bloomberg, 2018)

In addition, South Africa as an example, has many exchange trackers available that can be used to track the performance of international assets. Examples of South African based international index trackers include the Satrix S&P 500 ETF, Stanlib MSCI World Index Feeder ETF, Sygnia Itrix S&P 500 as well as the Sygnia FTSE 100 ETF (JSE, 2018). The large number of South African based international index trackers available indicate the popularity of international diversification among South African investors.

The popularity of international diversification among the investors of emerging economies and the fact that international diversification provides benefits, results in the relationship between sector related output growth and associated sector related returns within the G-7 economies being important for all passive fund investors and not only passive fund investors in the G-7 economies themselves.

This is because all investors in passive funds would be expected to diversify their portfolios into foreign assets, given the benefits of international diversification (Chiou, 2008; Driessen & Laeven, 2007; Nilsson, 2002), and these funds are likely to include those of the G-7 economies as the G-7 represents those economies with the largest market capitalisation. Should a relationship between output growth and equity returns at the sector specific level thus be found to exist, it would provide useful information for passive fund investors who should then take into account the associated growth of sectors that firms within these G-7 economies find themselves in, when selecting which sector related indices within these G-7 economies to invest in in order to yield superior returns.

4. DATA

This study uses real quarterly output data and related real index price data for the industrial and financial sectors in the G-7 countries.

The price levels of the MSCI industrial and finance indexes for each of the specific G-7 countries were used as the index price data relating to the industrial and financial sectors of these G-7 economies. This index price data was obtained from Bloomberg and was obtained as nominal price data, thereby including the effects of inflation. To remove the effects of inflation, the finance and industrial index price data for each G-7 country was deflated using a corresponding country specific Consumer Price Index developed by the Organisation for Economic Co-operation and Development (OECD) which was obtained from Bloomberg. The base year for all consumer price indexes for each of the G-7 countries was 2015, at which the consumer price index level was equal to 100.

The output data relating to the industrial and financial sector of each of the G-7 economies was obtained from Bloomberg and comprised real output data in monetary terms. All real output data was obtained as seasonally adjusted data with the exception of the financial output data of Germany, where seasonally adjusted data was not available from Bloomberg. The output data used in this study was chosen as seasonally adjusted because seasonally adjusted output data eliminates seasonal variation and allows one to study the business cycle properties of the macroeconomic time series (Auerbach & Kotlikoff, 1998). Furthermore, if output data is not seasonally adjusted, the seasonal variation in the output data might swamp the variation associated with the business cycle (Auerbach & Kotlikoff, 1998).

The industrial production index of each of the G-7 countries served as a proxy for real industrial sector output, while real gross value added for finance and insurance activities served as a proxy for real output from the financial sectors of these economies. Gross value added is defined by the International Monetary Fund (1993) as the value of output less the value of immediate consumption within an industry. Gross domestic product is then the sum of gross value added of all industries, plus tax and less subsidies on products not included in the valuation of output (International Monetary Fund, 1993).

In this study the real output and index price level data relating to the industrial and financial sectors of the G-7 countries were all measured in a consistent currency. The currencies in which this output and index price data was measured in for each of these countries is shown in **Table 18 of Appendix A.**

The range of the output and index price data used in this study was approximately 22 years, from 1994(Q4) to 2017(Q4). In most instances, the data relating to the output and related index price levels of the industrial and financial sectors of the G-7 economies was for a shorter period, and these time periods are indicated in **Table 19 of Appendix A.** In all cases with the exception of industrial sector growth and related output of the United States, data ranges for output, and index price data were chosen to consist of series of full calendar years with data ranges beginning and ending with Q1 and Q4 of a particular calendar year, respectively.

The real output and related real index price level data for the industrial and financial sectors of the G-7 economies were used for the cointegration test carried out in this study. This is because cointegration testing requires that the datasets be non-stationary. Cointegration tests examine whether, when taken together, these non-stationary datasets become stationary (Engle & Granger, 1987).

For correlation and causality testing, where the data used is required to be stationary (Gujarati, 2011), the growth in the real output and index price levels (index returns) for the industrial and financial sectors of the G-7 economies were calculated.

4.1 Data issues

A data issue encountered during this study was that quarterly financial output and related financial index return data was not available for the same range for all G-7 countries per Bloomberg, with the data range being considerably shorter for Japan and the United States than the other G-7 countries. The data ranges of output growth and related index return data of the financial and industrial sectors of the G-7 economies used within this study are provided in detail in **Table 19 of Appendix A.**

5. RESEARCH APPROACH

Three econometric models are employed to examine the relationship between output growth and related index returns of the industrial and financial sectors of the G-7 economies.

First, correlation tests are applied to examine the short-term relationship between the output growth and related index return data. These correlation tests examine the relationship between lagged and non-lagged values of sector specific output growth and related index returns. The maximum lag considered within this study to examine the correlation relationship between sector specific growth and index return data is 12 periods (three years) in order to be extensive in determining the optimal lag length that results in the highest correlation between sector specific output growth and related index returns.

Secondly, the Johansen Cointegration test is applied to examine the long run-relationship between the variables in their level form (price data). The optimal lag intervals used in the Johansen cointegration test carried out within this study have been determined through the Final Prediction Error (FPE) and Akaike information criterion (AIC) lag order selection criteria. The FPE and AIC criterion are chosen as the deciding criteria for the lag length used within our Johansen cointegration test as Liew (2004) indicates that these criteria should be used with sample sizes of less than 120 observations, which is the case in this study. Liew (2004) indicates that, through using the FPE and AIC criterion, one minimizes the chances of underestimating the optimal lag length and also maximizes the chance of determining the correct lag length.

Finally, for those specific industrial or financial sectors of the G-7 economies where the output and related index price level data is found to be cointegrated, and thus reveals a long run relationship between the variables, a granger causality test is performed to determine the nature of the causality between the variables. The lag length used in the Granger causality test is consistent with that of the associated Johansen cointegration test, which is determined through the FPE and AIC information criterion.

As noted by Thornton and Batten (1985), individuals are able to arrive at different but equally legitimate conclusions concerning the Granger causal relationship between two time series due solely to a difference in their lag-length selection criteria. Thornton and Batten (1985) also indicate that an extensive search of the lag space is required to ensure that causality test results are not "critically dependant on the judicious (or perhaps fortuitous) choice of the lag structure", which include the selection of which lag order selection criteria to implement. Thus, in instances where no Granger causality is found despite cointegration being found to exist between sector output and related index price level data of a specific G-7 country, causality and cointegration testing is also conducted using lag lengths specified as being optimal by other lag order selection criterion.

The optimal lag lengths specified by the various lag order selection criteria are presented in **Appendix D**.

Correlation and causality testing requires that the underlying data be stationary, while cointegration testing requires that the underlying data be non-stationary (Gujarati, 2011). In this study, the stationary nature of the data is examined by firstly applying the Augmented Dicky-Fuller test (ADF) and subsequently the Phillips-Perron unit root test if need be, to determine whether the output growth and related index return data is stationary and to determine whether the output and index price level data is non-stationary and therefore contains a unit root.

5.1 Unit root tests

A unit root test is used to determine whether a time series, such as price data, is stationary or non-stationary for use in further testing. The null hypothesis of a unit root test, otherwise known as the unit root hypothesis, is that the time series under examination is non-stationary and therefore contains a unit root. The alternative hypothesis within a unit root test is that the time series under examination is stationary (Gujarati, 2011).

The unit root hypothesis therefore implies that the time series under examination is integrated of order *'d'* and needs to be differenced '*d'* times in order to make it stationary. A rejection of the null hypothesis implies that a time series is integrated of order zero and is stationary without differencing it (Gujarati, 2011).

It is noted that most non-stationary economic time series, such as output data, generally do not need to be differenced more than one or twice in order to render them stationary (Gujarati, 2011).

The Augmented Dickey-Fuller (ADF) test is carried out in this study to test stationarity of the output and index price level data for the industrial and financial sectors of the G-7 economies.

This data is required to be stationary i.e. I(0), in order to perform correlation and casualty testing (Gujarati, 2011).

For cointegration testing, the output growth and index return data is required to be non-stationary and the Augmented Dickey-Fuller test was carried out to examine this. In testing for non-stationarity to test for cointegration in the time series, where the null hypothesis was rejected at the 5% significance level for a specific time series, the Phillips-Perron unit root test was run as a robustness check. If both tests indicated a rejection of the null hypothesis at the 5% significance level, further unit root tests were run, comprising the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Kwiatkowski, 1999), the Elliott-Rothenberg-Stock DF-GLS test, and the Ng-Perron test (Ng & Perron, 2001).

The Augmented Dickey-Fuller test includes lags to account for the presence of serial correlation, where the lag length is based on the Schwartz info criterion (IHS Global Inc., 2017).

5.2 Correlation

Correlation analysis attempts to determine the degree of relationship between variables, which in terms of this study will be the output growth and equity returns related to the financial and industrial sectors of the G-7 economies (Sharma, 2005). The measure of correlation known as the correlation coefficient summarises the strength as well as the direction of correlation between the two variables examined (Sharma, 2005).

Udny Yule, in his presidential address to the Royal Statistical society in November 1926, stated:

> ‘It is fairly familiar knowledge that we sometimes obtain between quantities varying with the time (time variables) quite high correlations to which we cannot attach any physical significance whatever, although under the ordinary test the correlation would be held to be certainly “significant”.’

The statement advances that when correlation is found between two time-series, even though they may be correlated, there may be no common cause and thus no direct relationship between the two-time series.

This issue is exemplified by Sober (2001) where he used the rise of both the Venetian sea levels and British bread prices as an example of two time-series being very strongly correlated, with the postulation of a common cause among the two simply not being very plausible and that the synchronous increases can be attributed to somewhat isolated endogenous causes (Sober, 2001).

Sober (2001) claimed that these two time-series are truly correlated but not connected by construction, therefore neither causes the other and there can be no common cause.

Therefore, by employing correlation testing alone we cannot determine a true relationship among the two variables tested in this study and could not necessarily provide evidence for forecasting future indices performance based on sector specific growth. This is because the correlation between the variables may be spurious.

In addition Sharma (2005), notes that the coefficient of correlation is one of the most widely abused statistical measures in that it is sometimes overlooked that correlation does not imply causality and that further testing in the form of cointegration and causality tests are needed in order to assess the existence of a true causal relationship between the variables examined (Gujarati, 2011).

Cointegration and causality testing as statistical techniques will thus be employed in this study to overcome these shortfalls in relation to correlation testing.

5.3 Cointegration and causality

Cointegration is a situation in which the regression of two or more nonstationary time series may not result in a spurious regression (Gujarati, 2011). A spurious regression is a situation in which trending variables, when regressed on one another, result in significant t and F statistics and a high R^2 value even though there is no true relationship between the time series (Gujarati, 2011). This is as a result of the standard linear regression procedure assuming that the underlying time series examined are stationary (Gujarati, 2011).

When time series data is found to be cointegrated, it indicates that there exists a long-term or equilibrium relationship between the time series, with the relationship being non-spurious (Gujarati, 2011).

This study employs the Johansen VAR-based cointegration procedure to test for cointegration between the output and index price level data for the financial and industrial sectors of the G-7 economies. The Johansen cointegration procedure is multivariate and uses a Vector Error Correction Model (VECM). A consequence of the use of an error correction model in the Johansen cointegration procedure is that, should time series be found to be cointegrated and thus have an attainable long-run equilibrium, then by definition there must be some causation between the time series in order to provide the necessary dynamics to achieve this equilibrium (Granger, 1988).

Due to the existence of causality between variables that are found to be cointegrated when analysed through the use of Johansen's cointegration procedure, only once sector specific real output and real index price level data is found to be cointegrated for specific G-7 economies is a Granger causality test conducted on the related return data of the variables to determine whether this causal relationship is significant. The Granger causality test indicates the direction of the casual link between the variables and helps us to determine whether past values of one variable helps to predict changes in another variable, with the variables in this study being sector specific output growth and related index returns of the G-7 economies (Hossain & Hossain, 2015).

6. RESULTS

This section details the results of this study, including the results of the unit root, correlation, cointegration, and causality tests that have been run on the quarterly real sector specific output growth and related index return data, which is measured in consistent currencies.

6.1 Unit root and correlation tests on output growth and index returns

In order to test for correlation between the real output growth and related real index returns of the industrial and financial sectors of the G-7 economies, it must first be determined that this data is stationary through unit root tests, as indicated by *Section 5.1 Unit root tests*. We thus first begin by examining the unit root test results for this data in **Table 3** and **Table 4** before proceeding to the correlation test results.

Table 3: Unit root tests results using the ADF unit root test on proxy variables of output growth and index returns relating to the industrial sectors of the G-7

Augmented Dickey-Fuller test (ADF)				
	Industrial production index		MSCI industrial index	
	Full period		Full period	
Country	T-stat	Prob	T-stat	Prob
Canada	-5.7716	0.0000	-11.7438	0.0001
France	-7.2879	0.0000	-8.8098	0.0000
Germany	-6.7721	0.0000	-9.6391	0.0000
Italy	-6.6875	0.0000	-9.5345	0.0000
Japan	-8.4486	0.0000	-8.0768	0.0000
United Kingdom	-6.7104	0.0000	-9.6448	0.0000
United States	-3.9819	0.0023	-9.2032	0.0000

Notes: The variables that serve as proxies for industrial sector output growth and industrial sector index returns consist of real data that is in a country consistent currency, as indicated by Table 18 of Appendix A.

The critical values of ADF are -3.505 at a 1% level, -2.894 at a 5% level and -2.584 at a 10% level (MacKinnon (1996) one sided p values). Lag length for ADF is based on Schwartz information criterion (IHS Global Inc, 2017).

Table 4: Unit root tests results using the ADF unit root test on proxy variables of output growth and index returns relating to the financial sectors of the G-7

Augmented Dickey-Fuller test (ADF)				
	Gross value added by finance and insurance		MSCI financial index	
	Full period		Full period	
Country	T-stat	Prob	T-stat	Prob
Canada	-8.2723	0.0000	-8.3711	0.0000
France	-3.2423	0.0210	-10.2900	0.0000
Germany	-7.7371	0.0000	-5.3475	0.0000
Italy	-10.8331	0.0001	-7.6264	0.0000
Japan	-8.7369	0.0000	-6.3081	0.0000
United Kingdom	-8.7760	0.0000	-8.4866	0.0000
United States	-6.6795	0.0000	-5.7733	0.0000

Notes: The variables that serve as proxies for financial sector output growth and financial sector index returns consists of real data that is in a country consistent currency which is indicated by Table 18 of Appendix A.

The critical values of ADF are -3.50 at a 1% level, -2.89 at a 5% level and -2.59 at a 10% level (MacKinnon (1996) one sided p values). Lag length for ADF is based on Schwartz information criterion (IHS Global Inc, 2017).

The Augmented Dickey-Fuller unit root test results are shown in **Table 3** and **Table 4** and indicate that all output growth and index return data relating to the industrial and financial sectors of the G-7 economies were found to be stationary at the 1% level over the periods tested, with the exception of the financial sector related output data of France, where stationarity was found at the 5% level. Correlation and causality testing was therefore performed on all sector specific output growth and index return data of the G-7 economies.

Figure 2 and Figure 3 of Appendix B depict the correlation coefficients associated with the non-lagged relationship between output growth and related index returns of the industrial and financial sectors of the G-7 economies in a graphical format. **Appendix B** depicts the results of this relationship for the full periods examined, with these periods indicated by **Table 19 of Appendix A**.

The results of the correlation test, where no lags between the variables examined were considered, are provided in detail in **Table 5**.

Table 5. Correlation results for non-lagged relationship between output growth and related index returns of the industrial and financial sectors of the G-7

Country	Industrial output growth and related industrial index returns		Financial output and related financial index returns	
	Correlation coefficient	prob	correlation coefficient	prob
Canada	0.16635	0.115	0.023232	0.8349
France	0.218721	0.0373	0.087018	0.4121
Germany	0.230249	0.0281	-0.025795	0.8082
Italy	0.171577	0.1039	0.128913	0.234
Japan	0.252005	0.016	0.243238	0.0634
United Kingdom	0.213189	0.0425	0.05643	0.5952
United States	0.350643	0.0006	0.109344	0.445

Notes: correlations are tested between variables for the periods outlined in Table 19 of Appendix A. All data is real and in consistent currency terms per currency of which the currencies used are outlined in Table 18 of Appendix A.

The p-value (prob) is the probability of drawing the related t-statistic (not shown) obtained from t-test. It is computed from a t-distribution with T-k degrees of freedom (IHS Global Inc, 2017).

Key:

- indicates significant correlation relationship being found at the 5% significance level.

Table 5 shows little correlation between output growth and index returns of the industrial and financial sectors of the G-7 economies when no lag in the relationship is taken into account. The highest correlation is found between industrial output and related industrial index returns of the United States, with a correlation coefficient of 0.35.

The findings indicate, importantly, that all correlation relationships between financial sector output growth and financial sector index returns of the G-7 economies is statistically insignificant at the 5% significance level. This reveals an absence of any short-term relationship between financial sector output growth and financial sector index returns for all G-7 economies.

The correlation relationship between output growth and index returns related to the industrial sector is found to be statistically insignificant at the 5% significance level for Canada and Italy.

The correlation relationships displayed in **Table 5** are weak, except for the correlation relationship between the industrial output and index returns of the United States. This indicates that, historically, passive fund investors would benefit most (although minimally) from favourable economic growth by investing in passive funds such as exchange tracker funds, that track the performance of firms in the industrial sector of the United States.

This study finds that there are no negatively correlated non-lagged relationships between output growth and index returns of the industrial and financial sectors of the G-7, with the exception of financial output growth and related financial index returns in Germany. This finding is in contrast to those of Siegel (1998) and Ritter (2005), who found an aggregate negative correlation between output growth and equity returns in 17 and 19 developed economies respectively, with testing periods of 27 years and 102 years. Ritter (2005), found that the relationship between aggregate output growth and equity returns are slightly more correlated when shorter testing periods are used. This finding is consistent with this study's findings, which are that there is a largely positive non-lagged correlation relationship between output growth and equity returns when using a maximum data range of approximately 22 years.

The more positive correlation findings could, in addition to the shorter testing period that this study has implemented, also be due to examining the relationship between output growth and equity returns of the financial and industrial sectors of the G-7 only and not aggregate output growth and equity returns. The equity returns of firms in these sectors of the G-7 economies may be more closely related to the corresponding sector's output growth than others, which, when taken into account through the use of aggregate output and equity return variables, results in a smaller positive correlation.

As discussed in *Section 2.1 The relationship between economic growth and equity returns*, Siegel (1998) attributed the lack of correlation between output growth and equity returns to growth expectations being impounded into share prices at the start of a period examined. This comes as a result of an investor's tendency to overpay for the growth prospects of companies in fast-growing economies before these companies can possibly deliver on these growth expectations, causing a lag between output growth and equity returns (Siegel, 1998). This explanation for a lack of correlation between output growth and equity returns is corroborated by the lagged correlation test results depicted in **Table 6** and **Table 7**, where it can be seen that the correlation between output growth and index returns in the industrial and financial sectors of the G-7 economies is stronger in all relationships examined when a lag is incorporated between the variables as opposed to applying a zero lag.

Table 6. Correlation results for lagged relationship between output growth and related index returns of the industrial sectors of the G-7

Country	Industrial output growth and related industrial index returns			
		IPI, Industrial index (-i)	IPI, Industrial index (+i)	Prob. associated with greater of lead/lag correlation
	i resulting in highest correlation coefficient	lag	lead	
Canada	1	-0.0484	0.3383	0.0013
France	1	0.238	0.4092	0.0000
Germany	1	0.079	0.3107	0.0032
Italy	1	0.1105	0.2315	0.0300
Japan	1	-0.0518	0.2996	0.0046
United Kingdom	1	-0.0216	0.2319	0.0297
United States	1	0.15	0.4878	0.0000

Table 7. Correlation results for lagged relationship between output growth and related index returns of the financial sectors of the G-7

Country	Financial output and related financial index returns			
		GVA by Fin. and Ins., Financial index (-i)	GVA by Fin. and Ins., Financial index (+i)	Prob. associated with greater of lead/lag correlation
	i resulting in highest correlation coefficient	lag	lead	
Canada	2	0.1318	0.1973	0.0794
France	4	0.0851	0.151	0.1602
Germany	2	-0.0718	0.2302	0.0310
Italy	3	-0.2318	-0.151	0.0339
Japan	1	0.1345	0.3849	0.0034
United Kingdom	3	0.2749	0.0139	0.0095
United States	1	0.543	-0.286	0.0000

Notes to Table 6 and Table 7: lagged - correlations are tested between variables for the periods outlined in Table 19 of Appendix A. All data is real and in consistent currency terms per currency of which the currencies used are outlined in Table 18 of Appendix A.

The p-value (prob) is the probability of drawing the related t-statistic (not shown) obtained from t-test. It is computed from a t-distribution with T-k degrees of freedom (IHS Global Inc, 2017).

Key:

[yellow highlight] - indicates significant lagged - correlation relationship being found at the 5% significance level.

As can be seen in **Table 6 and Table 7**, all lagged-correlation relationships between output growth and related index returns of the industrial and financial sectors of the G-7 economies are statistically significant at the 5% significance level, with the exception of financial sector output growth and related index returns of Canada and France. This is in contrast to the non-lagged correlation results shown in **Table 5**, which reveal no statistically significant relationship between financial sector output growth and related index returns for any of the G-7 economies at the 5% significance level. This indicates that there is a short-term relationship between financial sector output growth and related index returns for the G-7 economies (except for Canada and France) when a lag is incorporated in the correlation relationship.

The optimal lag length that results in the highest correlation between output growth and index returns for the industrial sectors of the G-7 economies is one period. For the financial sectors of the G-7 economies, the optimal lag length that results in the highest correlation between financial sector output growth and related index returns is greater than zero, as depicted in **Table 7**.

The results indicate that in all G-7 economies output from the industrial and financial sectors serves as a leading indicator for related index returns, with the exception of Italy, the United Kingdom and the United States. For these three countries it was found that financial sector index returns serve as a leading indicator of related sector output growth.

For all G-7 economies the correlation coefficients between lagged output growth and related index returns in the industrial and financial sectors (with the exception of financial output and related index returns of Canada, France and Italy) are all in excess of 0.2. This indicates a sufficient linear relationship between the two variables examined, when noting that these results were derived from investigating a bivariate correlation relationship, and that the inclusion of additional variables in the correlation analysis could increase the correlation coefficients substantially.

The highest correlation is found between industrial output and related index returns of the United States, with a correlation coefficient of 0.49, which is greater than the correlation found between the variables of 0.35 when a lag length of zero is used, as indicated in **Table 5**.

The results thus indicate that, if investors are considering growth prospects when deciding whether to invest in passive funds that track the performance of industrial and industrial firms within the G-7 economies, they should consider the lagged correlation relationship between industrial and financial sector output growth and related index returns.

6.2 Unit root, cointegration and causality tests on output and index price level data

6.2.1 Unit root testing on output and index price level data

Unit root testing is a prerequisite for testing the existence of a cointegrating relationship between sector related output growth and related index returns, because output and index price data is required to be non-stationary, as detailed in *Section 5.1 Unit root tests*. We thus first begin by examining the unit root test results for this data, shown in **Table 8 and Table 9,** followed by the cointegration tests.

Table 8: Unit root tests results using the ADF unit root test on output and index price level data relating to the industrial sectors of the G-7

Augmented Dickey-Fuller test (ADF)				
	Industrial production index		MSCI industrial index	
Country	Full period		Full period	
	T-stat	Prob	T-stat	Prob
Canada	-2.1394	0.2301	-0.0330	0.9524
France	-2.2044	0.2062	-1.2243	0.6611
Germany	-0.9933	0.7529	-2.1525	0.2251
Italy	-1.5930	0.4820	-2.5052	0.1176
Japan	-3.5804	0.0080	-1.1869	0.6774
United Kingdom	-1.3146	0.6200	-1.6923	0.4317
United States	-2.2926	0.1766	-0.7690	0.8228

Notes: The variables that serve as proxies for industrial sector output and industrial sector index price levels consist of real data that is in a country consistent currency which is indicated by Table 18 of Appendix A.

The critical values of ADF are -3.504 at a 1% level, -2.894 at a 5% level and 2.584 at a 10% level (MacKinnon (1996) one sided p values). Lag length for ADF is based on Schwartz information criterion (IHS Global Inc, 2017).

Key: - indicates null hypothesis of non-stationarity rejected at 1% significance level.

Table 9: Unit root tests results using the ADF unit root test on output and index price level data relating to the financial sectors of the G-7

Augmented Dickey-Fuller test (ADF)				
	Gross value added by finance and insurance		MSCI financial index	
	Full period		Full period	
Country	T-stat	Prob	T-stat	Prob
Canada	0.4960	0.9857	-0.9734	0.7594
France	-1.6669	0.4442	-2.3934	0.1464
Germany	-1.2903	0.6313	-1.6547	0.4507
Italy	-1.2718	0.6396	-1.1877	0.6768
Japan	-0.7746	0.8188	-1.7979	0.3780
United Kingdom	-2.6125	0.0942	-1.5093	0.5245
United States	-2.1331	0.2330	-1.5049	0.5230

Notes: The variables that serve as proxies for financial sector output and financial sector index price levels consist of real data that is in a country consistent currency which is indicated by Table 18 of Appendix A.

The critical values of ADF are -3.5 at a 1% level, -2.9 at a 5% level and 2.58 at a 10% level (MacKinnon (1996) one sided p values). Lag length for ADF is based on Schwartz information criterion (IHS Global Inc, 2017).

The Augmented Dickey-Fuller unit root test results depicted in **Table 8 and Table 9** indicate that the null hypothesis of non-stationarity was not rejected at the 5% level for all output and index return data relating to the industrial and financial sectors of the G-7 economies, with the exception of data relating to the industrial output of japan, where the null-hypothesis was rejected at the 1% level.

As the Augmented Dickey-Fuller test indicated stationarity of the industrial output data of Japan at the 1% significance level, a Phillips-Perron unit root test was conducted on this data as a robustness check to conclude whether the data is indeed stationary at a 5% significance level. The results of the Phillips-Perron unit root test are given in **Table 10.**

Table 10. Phillips-Perron unit root test results for industrial output data relating to Japan

		T-Stat	Prob.*
Phillips-Perron test statistic		-3.1593	0.0258
Test critical values:	1% level	-3.5039	
	5% level	-2.8936	
	10% level	-2.5839	

Notes: *MacKinnon (1996) one-sided p-values.
The variable that serves as a proxy for the industrial sector output of Japan consists of real data that is in a country consistent currency which is indicated by Table 18 of Appendix A.

The Phillips-Perron unit root test results indicated by **Table 10** above indicate a rejection of the null-hypothesis of non-stationarity at the 5% significance level. Therefore, further unit root tests comprising the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, the Elliott-Rothenberg-Stock DF-GLS test, and the Ng-Perron test, are conducted on the data. A summary of the results of these additional unit root tests is given in **Table 11.** The full test results of the additional unit root tests are provided in **Appendix C**.

Table 11. Summary of additional unit root tests results for industrial output data of Japan

	Unit root test		
	Kwiatkowski-Phillips-Schmidt-Shin test	the Elliott-Rothenberg-Stock DF-GLS test	Ng-Perron test
Industrial output of Japan	S	S	S

Notes: S - Unit root test found that data exhibited stationarity at 5% significance level.
The variable that serves as a proxy for the industrial sector output of Japan consists of real data that is in a country consistent currency which is indicated by Table 18 of Appendix A.

The additional unit root tests results indicate that the industrial output data of Japan is stationary at the 5% significance level. These findings align with the results of the Augmented Dicky-Fuller unit root test as well as the Phillips-Perron unit root test conducted on the data and provided in **Table 8**. As the industrial output data of Japan is found to be stationary, cointegration testing cannot be conducted on this data and the associated industrial index price level data. Cointegration testing is conducted on all other output and related index price level data of the industrial and financial sectors of the G-7 economies.

6.2.2 Cointegration and causality test results on output and index price level data

As specified in S*ection 5.3 Cointegration and causality*, The Johansen cointegration test is applied in this study to examine the long-run equilibrium relationship between the output and index price level data for the financial and industrial sectors of the G-7 economies, with the exception of the industrial output and related index price data of Japan, where the data was found to be stationary. The stationarity of this data was indicated by the test results discussed in Section *6.2.1 Unit root testing on output and index price level data*. In order to determine whether two time-series are cointegrated in terms of the Johansen cointegration test, one must either compare the Trace or Max-Eigen test statistics to their critical values at a chosen significance level, or determine whether the p-values associated with the Trace and Max-Eigen test statistics result in a rejection of the null hypothesis at a chosen significance level. The null hypotheses of the Johansen cointegration test are that (i) there are no cointegrating equations associated with the time series examined, and (ii) that there is at most one cointegrating equation associated with the time series examined.

Table 12. Johansen cointegration test results relating to the examination of the relationship between industrial output and related index price level data of the G-7

		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Trace statistic**	Prob	rejection of H0	**Trace statistic**	Prob	rejection of H0
Canada	1 - 2	5.8519	0.7130		0.0293	0.8640	
France	1 - 6	14.4390	0.0717		0.0589	0.8082	
Germany	1 - 4	10.6669	0.2328		0.9505	0.3296	
Italy	1 - 2	10.7702	0.2260		3.8919	0.0485	**
Japan	-	-	-		-	-	
UK	1 - 2	9.1607	0.3508		2.5347	0.1114	
US	1 - 2	7.8602	0.4805		0.0236	0.8778	
		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Max-Eigen statistic**	Prob	rejection of H0	**Max-Eigen statistic**	Prob	rejection of H0
Canada	1 - 2	5.8226	0.6361		0.0293	0.8640	
France	1 - 6	14.3801	0.0479	**	0.0589	0.8082	
Germany	1 - 4	9.7164	0.2312		0.9505	0.3296	
Italy	1 - 2	6.8783	0.5036		3.8919	0.0485	**
Japan	-	-	-		-	-	
UK	1 - 2	6.6259	0.5343		2.5347	0.1114	
US	1 - 2	7.8366	0.3955		0.0236	0.8778	

Table 13. Johansen cointegration test results relating to the examination of the relationship between financial output and related index price level data of the G-7

		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Trace statistic**	Prob*	rejection of H0	**Trace statistic**	Prob*	rejection of H0
Canada	1 - 2	9.1639	0.3505		0.1898	0.6631	
France	1 - 6	13.8942	0.0859		2.5916	0.1074	
Germany	1 - 3	14.2281	0.0769		2.0760	0.1496	
Italy	1 - 5	17.6369	0.0234	**	1.0324	0.3096	
Japan	1 - 2	3.5332	0.9375		0.0215	0.8833	
UK	1 - 1	22.7687	0.0034	**	8.3389	0.0039	**
US	1 - 1	15.0476	0.0583		2.4294	0.1191	

		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Max-Eigen statistic**	Prob*	rejection of H0	**Max-Eigen statistic**	Prob*	rejection of H0
Canada	1 - 2	8.9742	0.2883		0.1898	0.6631	
France	1 - 6	11.3026	0.1397		2.5916	0.1074	
Germany	1 - 3	12.1521	0.1050		2.0760	0.1496	
Italy	1 - 5	16.6045	0.0209	**	1.0324	0.3096	
Japan	1 - 2	3.5117	0.9070		0.0215	0.8833	
UK	1 - 1	14.4298	0.0471	**	8.3389	0.0039	**
US	1 - 1	12.6182	0.0896		2.4294	0.1191	

Notes to Table 12 and Table 13:

The 5% critical value that results in a rejection of the null hypothesis of **no** cointegrating equations and **at most one** cointegrating equations through comparison of the trace statistic is 15.4947 and 3.8415 respectively.

The 5% critical value that results in a rejection of the null hypothesis of **no** cointegrating equations and **at most one** cointegrating equations through comparison of the Max-Eigen statistic is 14.2646 and 3.8415 respectively.

* - MacKinnon, Haug, and Michelis (1999) p-values.

** - denotes rejection of the null hypothesis at the 5% significance level.

***The lag interval used has been determined through the use of the FPE and AIC criterion as discussed within *Section 5. Research approach*

United Kingdom abbreviated to UK within results (*see acronyms and abbreviations*)

United States abbreviated to US within results (*see acronyms and abbreviations*)

Table 12 shows that the Trace statistic indicates no cointegration between industrial output and related index price level data for any of the G-7 economies. The Max-Eigen statistic, on the other hand indicates a cointegrating relationship between industrial output and related industrial index price level data for France at the 5% significance level, with one cointegrating equation found between the variables. The Johansen test results per **Table 12** do thus not provide conclusive evidence as to whether there exists a cointegrating relationship between the industrial output and related index price level data of France, as the Trace and Max-Eigen value test statistics provide conflicting evidence on the existence of a cointegrating relationship.

Conflicting evidence is provided by the Trace and Max-Eigen value test statistics as to whether there exists cointegration among time series, when time series consist of small sample sizes.

Serletis and King (1997) noted that when the two test statistics yield different results, one should rely on the Trace statistic to determine the existence of cointegration among time series, as the Trace statistic tends to have more power than the Max-Eigen value test statistic. In thus relying on the Trace test statistic where the Trace and Max-Eigen value tests statistics yield different results, as shown in **Table 12**, it is determined that there exists no cointegrating relationship between the industrial output and the related index price level data of France at the 5% significance level.

The finding of no cointegrating relationships between industrial sector output and related index price levels for any of the G-7 economies is interesting, given that the correlation results depicted in **Table 5** and **Table 6** indicate short term relationships between industrial sector output growth and related index returns for the majority of G-7 economies. This finding thus supports the notion that correlation testing does not provide evidence of a true relationship among variables examined and that any correlation may be spurious (Sober, 2001).

The Trace and Max-Eigen test statistics shown in **Table 13** both indicate that the financial output and related financial index price level data of Italy and the United Kingdom are cointegrated, with one and two cointegrating equations being found between the variables respectively.

The results in **Table 12** and **Table 13** thus indicate that there exists a long-run equilibrium relationship between the financial output and related index price level data of Italy and the United Kingdom, revealing the existence of causation in these two sets of time series.

This finding contradicts that of prior literature (Alexius & Spang, 2015; Binswanger, 2004; Hossain & Hossain, 2015; Madsen, et al., 2013), with Binswanger (2004), Hossain & Hossain (2015) and Madsen, et al. (2013) finding no cointegration between aggregate output growth and equity returns in the UK, whereas this study finds a cointegrating relationship among these variables, albeit within the financial sector only and not at the aggregate level. Alexius and Spang (2015), Binswanger (2004) and Madsen, et al. (2013) also found no cointegrating relationship between aggregate output growth and equity returns within Italy, which this study finds within the financial sector. In addition, contrary to the findings of this study, Alexius and Spang (2015), and Hossain and Hossain (2015) found a cointegrating relationship between aggregate output growth and equity returns in Canada, France and Germany which this study did not find, albeit when testing this relationship at the sector specific level.

Because this study finds that financial output and related index price level data are cointegrated in Italy and the United Kingdom, the Granger causality test is applied to assess the casual relationship between these variables for the two countries.

The null hypotheses of the Granger causality test conducted is that financial sector output growth does not Granger-cause related financial sector index returns (i) and financial sector index returns does not Granger-cause related financial sector output growth (ii). The Granger causality tests were conducted between the variables using the methodology discussed in *Section 5. research approach*.

Table 14. Granger causality test results for the UK and Italy using lag lengths specified by FPE and AIC lag order selection criteria

		Null hypothesis		Null hypothesis	
Countries	*lag length:	Financial sector output growth does not Granger-cause related financial sector index returns		Financial sector index returns does not Granger-cause related financial sector output growth	
		F-statistic	Prob	F-statistic	Prob
UK	1	0.9174	0.3408	0.7812	0.3792
Italy	5	1.4483	0.2178	1.0542	0.3931

Notes: The Granger causality test is conducted within the framework of f-test. If the p-value (prob) of f-test is significant (i.e. α=<0.05) at the 5% significance level, the null hypothesis is rejected within this study.

Granger-causality is tested between the variables for the periods outlined within Table 19 of Appendix A. All data is real and in consistent currency terms per currency of which the currencies used are outlined in Table 18 of Appendix A.

*The lag lengths of one and five were determined by the FPE and AIC lag order selection criterion to be the optimal lag lengths which resulted in a cointegrating relationship being found between financial output and related index price level data of the UK and Italy respectively.

United Kingdom abbreviated to UK within results (*see acronyms and abbreviations*)

The results depicted in **Table 14** indicate no Granger causality between financial sector output growth and related index return data of the UK and Italy at a 5% significance level when using lag lengths of one and five, respectively.

In line with the research approach of this study, cointegration and causality testing was subsequently conducted on the financial sector output and related index return data of the UK and Italy, using lag intervals that are determined as being optimal by other lag order selection criteria. The optimal lag lengths determined by the lag order selection criteria are presented in **Appendix D.**

The sequential modified LR test statistic (LR) result within **Appendix D** indicates that, for the UK, an optimal lag interval of four should be used in the Johansen cointegration test in order to examine the cointegrating relationship between financial sector output growth and related index returns. In reperforming the Johansen cointegration test using a lag interval of four periods, financial sector output growth and related index returns of the UK are shown to be cointegrated. This result is depicted in **Table 15**.

Table 15: Johansen cointegration test results for the UK using LR lag order selection criteria

		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Trace statistic**	Prob*	rejection of H0	**Trace statistic**	Prob*	rejection of H0
UK	1 - 4	23.2389	0.0028	**	8.6133	0.0033	**

		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Max-Eigen statistic**	Prob*	rejection of H0	**Max-Eigen statistic**	Prob*	rejection of H0
UK	1 - 4	14.6256	0.0438	**	8.6133	0.0033	**

Notes to Table 15:

The 5% critical value that results in a rejection of the null hypothesis of no cointegrating equations and at most one cointegrating equations through comparison of the trace statistic is 15.4947 and 3.8415 respectively.

The 5% critical value that results in a rejection of the null hypothesis of **no** cointegrating equations and at most one cointegrating equations through comparison of the Max-Eigen statistic is 14.2646 and 3.8415 respectively.

* - MacKinnon, Haug, and Michelis (1999) p-values.

** - denotes rejection of the null hypothesis at the 5% significance level.

***The lag interval used has been determined through the use of the sequential modified LR test statistic (LR).

United Kingdom abbreviated to UK within results (*see acronyms and abbreviations*)

As depicted within **Appendix D**, the sequential modified LR test statistic (LR) indicates that, for Italy, an optimal lag interval of seven periods should be used in the Johansen cointegration test to examine the cointegrating relationship between financial sector output growth and related index returns. The Hannan-Quinn information criterion and Schwarz information criterion indicate that an optimal lag interval of one period should be used.

In reperforming the Johansen cointegration test using a lag interval of seven periods, it is found that the financial sector output and related index price level data of Italy are cointegrated. Cointegration between the variables is not found when a lag interval of one period is used. These results are shown in **Table 16**.

Table 16: Johansen cointegration test results for Italy using other lag order selection criteria

		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Trace statistic**	Prob*	rejection of H0	**Trace statistic**	Prob*	rejection of H0
Italy	1 – 1 1 - 7	11.5096 16.9372	0.1820 0.0301	 **	0.6350 0.5150	0.4255 0.4730	

		Null Hypothesis: No. of cointegrating equations = none			Null Hypothesis: No. of cointegrating equations = At most 1		
Country	***Optimal lag interval	**Max-Eigen statistic**	Prob*	rejection of H0	**Max-Eigen statistic**	Prob*	rejection of H0
Italy	1 – 1 1 - 7	10.8746 16.4222	0.1606 0.0224	 **	0.6350 0.5150	0.4255 0.4730	

Notes:

The 5% critical value that results in a rejection of the null hypothesis of **no** cointegrating equations and **at most one** cointegrating equations through comparison of the trace statistic is 15.4947 and 3.8415 respectively.

The 5% critical value that results in a rejection of the null hypothesis of **no** cointegrating equations and **at most one** cointegrating equations through comparison of the Max-Eigen statistic is 14.2646 and 3.8415 respectively.

* - MacKinnon, Haug, and Michelis (1999) p-values.

** - denotes rejection of the null hypothesis at the 5% significance level.

***The lag intervals used have been determined through the use of the sequential modified LR test statistic (LR), the Hannan-Quinn information criterion and the Schwarz information criterion.

Because the financial output and related index price level data of the UK and Italy are found to be cointegrated when lag intervals of four and seven are used, respectively, the Granger causality test is applied to assess the casual relationship between the variables using the same lags.

The Granger causality test results represented in **Table 17** indicate a rejection of the null hypothesis (2) at the 5% significance level for the UK when the lag length of four periods is used, indicating a unidirectional causal relationship that financial sector index returns Granger-causes financial sector output growth in the UK. This finding of a unidirectional causal link running from financial sector index returns to financial sector output growth in the UK is consistent with that of prior literature (Duca, 2007; Hossain & Hossain, 2015).

Table 17. Granger causality test results for the UK and Italy using lag lengths specified by other lag order selection criteria

		Null hypothesis		Null hypothesis	
Countries	lag length:	Financial sector output growth does not Granger-cause related financial sector index returns		Financial sector index returns does not Granger-cause related financial sector output growth	
		F-statistic	Prob	F-statistic	Prob
UK	4	1.0204	0.4021	2.8605	0.0288
Italy	7	1.3176	0.2564	1.1276	0.3570

Notes to Table 17: The Granger causality test is conducted within the framework of f-test. If the p-value (prob) of f-test is significant (i.e. α=<0.05) at the 5% significance level, the null hypothesis is rejected within this study.

Granger-causality is tested between the variables for the periods outlined within Table 19 of Appendix A. All data is real and in consistent currency terms per currency of which the currencies used are outlined in Table 18 of Appendix A.

The lag lengths of four and seven were determined by the sequential modified LR test statistic (LR), the Hannan-Quinn information criterion and Schwarz information criterion to be the optimal lag lengths which resulted in a cointegrating relationship being found between financial output and related index price level data in the UK and Italy respectively.

– indicates rejection of the null hypothesis at the 5% significance level.

United Kingdom abbreviated to UK within results (*see acronyms and abbreviations*)

The results shown in **Table 17** indicate that, for the UK, financial sector index returns assist in forecasting financial sector output growth four quarters into the future, given past values of financial sector output growth data. Financial sector index returns in the UK are thus found to hold predictive power and serve as a leading indicator for financial sector output growth in that country.

This result is not surprising, given that stock markets reflect the expectations of investors and market operators regarding the performance of firms and the economy in general, with respect to economic growth and other variables (Ikoku, 2010). In terms of equity valuation models, stock price valuations depend on expected future dividends, and thus the causal link running from stock returns to output growth may result from the fact that expected future dividends are a good proxy for future economic activity as measured by GDP, and growth within specific sectors of an economy comprise part of this measure (Duca, 2007).

The predictive power of stock prices to determine future economic activity and the role of these prices as a leading indicator can also be explained through the impact that stock prices may have on firm investment. Increases in companies' stock prices can have a positive impact on their effective cost of capital, which in turn increases investment and economic activity (Croux & Reusens, 2013).

A consequence of this study's finding that financial sector index returns Granger-causes financial sector output growth in the United Kingdom is that UK policymakers could use financial sector index return data to improve their predictions of GDP growth, which includes growth in the financial sector (Croux & Reusens, 2013). These more accurate predictions could allow UK policymakers to anticipate the direction of future aggregate economic activity and take stabilising actions in advance to improve the country's future economic prospects (Croux & Reusens, 2013).

As the casual link is not found to run from financial sector output growth to financial sector index returns, this indicates that investors would not be able to use historical financial sector growth data to predict changes in the returns of financial indexes of the United Kingdom. Financial sector growth data is thus found to hold no predictive value in the UK in determining whether passive funds that track the performance of financial firms would benefit positively from financial sector growth.

7. CONCLUSION AND AREAS OF FURTHER RESEARCH

7.1 Conclusion

This study examined the short-run and long-run relationships between output growth and related index returns of the industrial and financial sectors of the G-7 economies.

The study found weak non-lagged correlation between output growth and index returns of the industrial and financial sectors of the G-7 economies, with the correlation relationships becoming stronger in all cases when lags are incorporated in the correlation analysis. Importantly, this study found that all non-lagged correlation relationships between financial sector output growth and related index returns are statistically insignificant at the 5% significance level for all G-7 economies, indicating that these correlations cannot be said to be statistically different from zero.

Through cointegration testing, long-run equilibrium relationships were found between output and related index return data of the financial sectors of Italy and the United Kingdom, with the causal link being found to run from financial index returns to financial sector output growth for these economies when examined through Granger causality testing. These findings indicated that investors should not incorporate growth prospects into their decisions regarding which passive funds to invest in, in Italy and the United Kingdom. This result for Italy and the United Kingdom in contrast to the findings of Binswanger (2004) and Madsen, et al. (2013) of no cointegrating relationship between output growth and equity returns for both the UK and Italy. The finding of this study of a cointegrating relationship between output growth and index returns for Italy and the United Kingdom also contradicts that of Hossain and Hossain (2015) and Alexius and Spang (2015) who found no evidence of a cointegrating relationship between the variables in in these countries.

The causality findings indicated that financial index return data serves as a leading indicator of financial sector output growth in the United Kingdom and is consistent with prior literature (Duca, 2007; Hossain & Hossain, 2015). This shows that financial sector index return data can assist in forecasting financial sector output growth, and policymakers in the United Kingdom could use this data to anticipate and influence the direction of future economic activity in the UK (Croux & Reusens, 2013).

7.2 Areas for further research

As briefly noted, the findings of this study may prove invaluable to active investors, as they suggest that, in order to yield superior returns, they should consider the associated sector related growth rate of firms that they are considering investing in. This study, however, examined the relationship between output growth and equity returns using index returns as the proxy for equity returns, and not individual stock returns. Therefore no inference on the relationship between sector output growth and individual stock returns of companies in the associated industry can be drawn from the conclusions of this study, and further research on this is needed.

An additional area of further research that has been alluded to in this study is performing a lagged multivariate correlation analysis between industrial and financial sector index returns, the related sector output growth, and additional variables for the specific G-7 economy examined, such as country specific inflation or interest rates. This may result in a significantly stronger lagged correlation relationship being found between the variables than has been found in this study.

Future research could also focus on the relationship between sector specific output growth and related index returns in emerging economies, as this has not yet been done as of yet.

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9. APPENDICES

Appendix A

Table 18. Currencies in which real output growth and real index return proxy variables are measured in per G-7 country

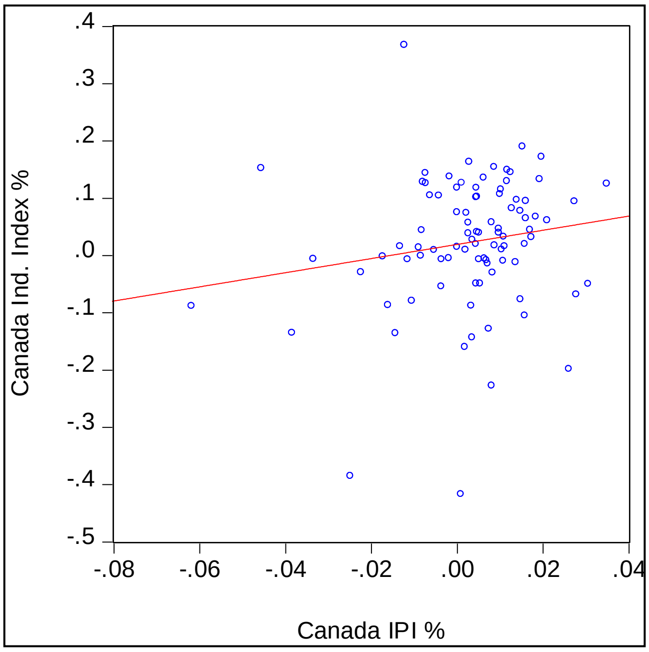
Country	Currency for which real output growth and real index return variables are measured in
Canada	Canadian Dollar
France	Euro
Germany	Euro
Italy	Euro
Japan	Yen
United Kingdom	Pound sterling
United States	US Dollar

Table 19. Time period range of output and index price data used in this study

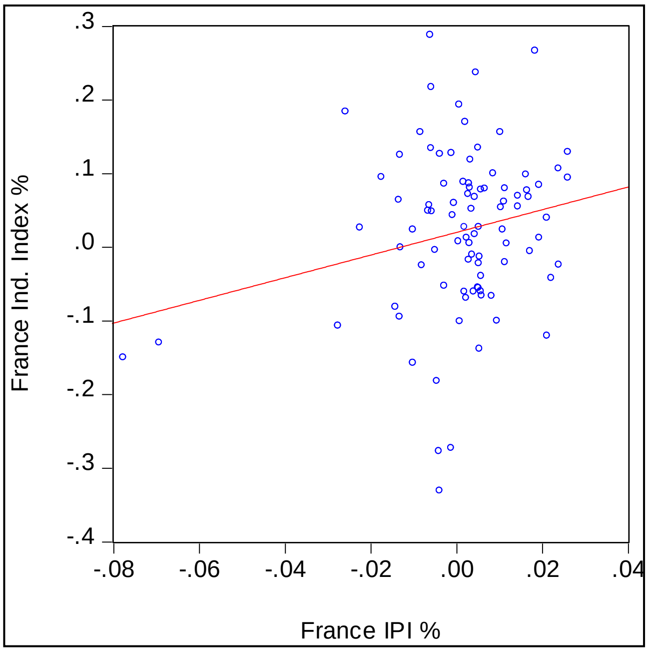
Country	Range of data	
	Industrial output and related industrial index returns	Financial output and related financial index returns
Canada	1995 (Q1) - 2017 (Q4)	1997 (Q1) - 2017 (Q4)
France	1995 (Q1) - 2017 (Q4)	1995 (Q1) - 2017 (Q4)
Germany	1995 (Q1) - 2017 (Q4)	1995 (Q1) - 2017 (Q4)
Italy	1995 (Q1) - 2017 (Q4)	1996 (Q1) - 2017 (Q4)
Japan	1995 (Q1) - 2017 (Q4)	2003 (Q1) - 2017 (Q4)
United Kingdom	1995 (Q1) - 2017 (Q4)	1995 (Q1) - 2017 (Q4)
United States	1994 (Q4) - 2017 (Q4)	2005 (Q1) - 2017 (Q4)

Appendix B

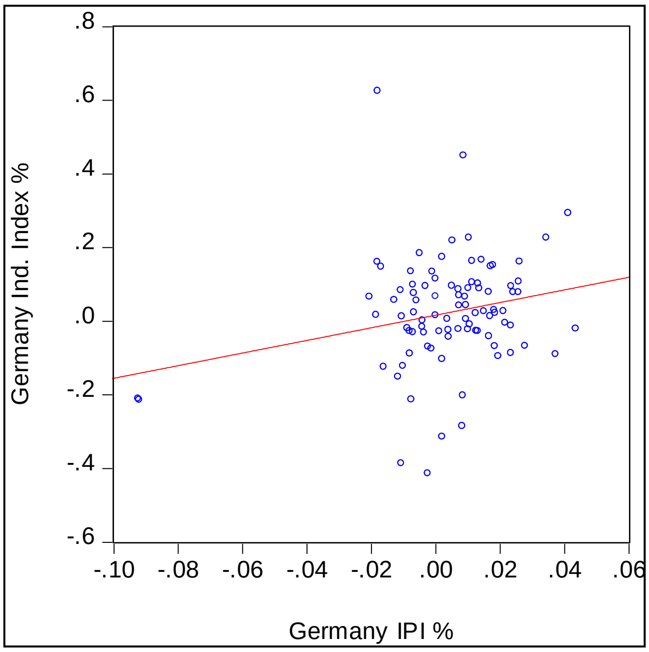
Figure 2: Non-lagged correlation relationship between real output growth and real index returns relating to the industrial sectors of the G-7



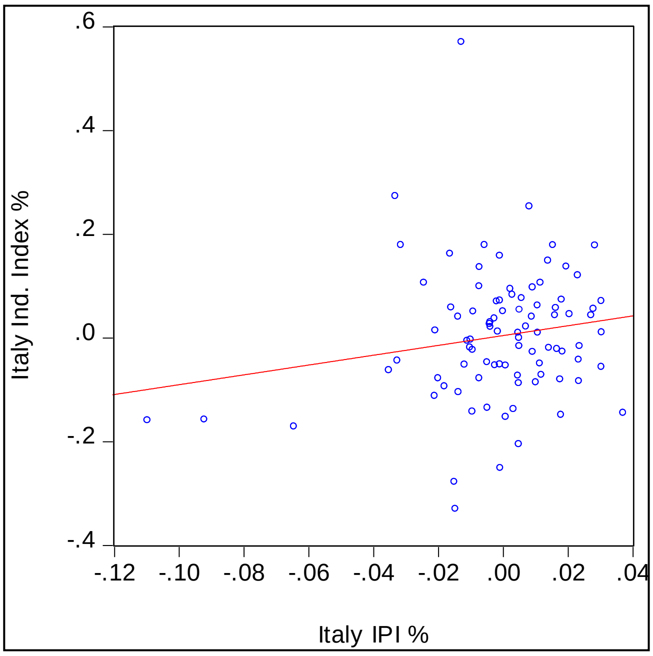
Canada



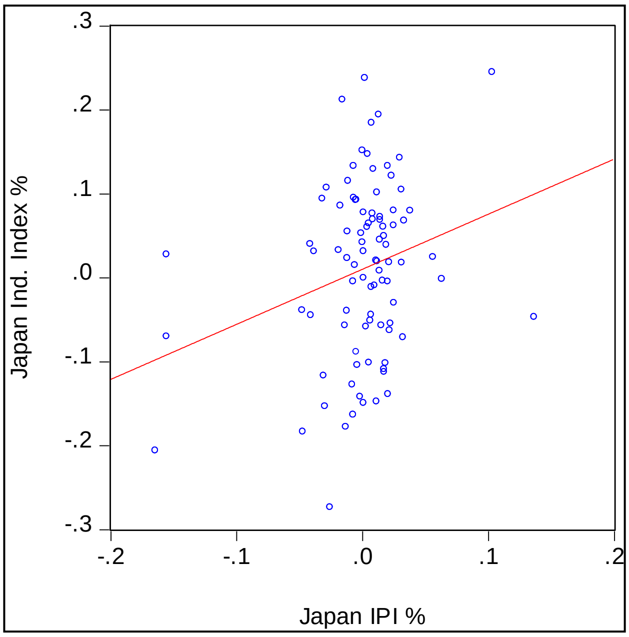
France



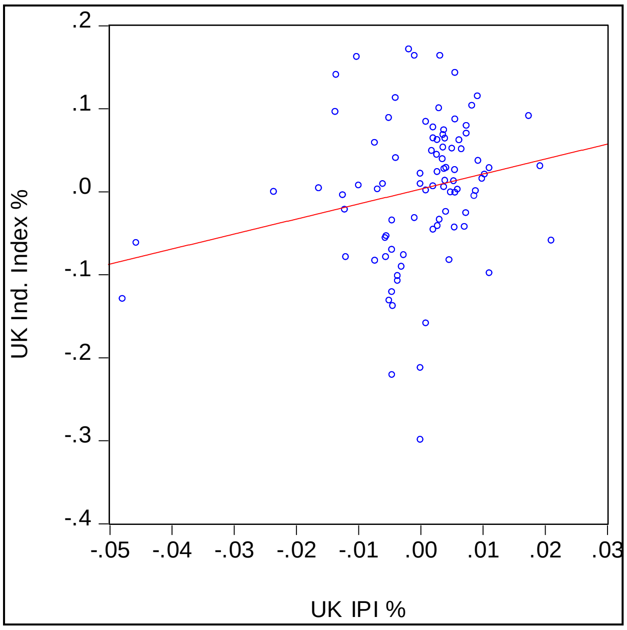
Germany



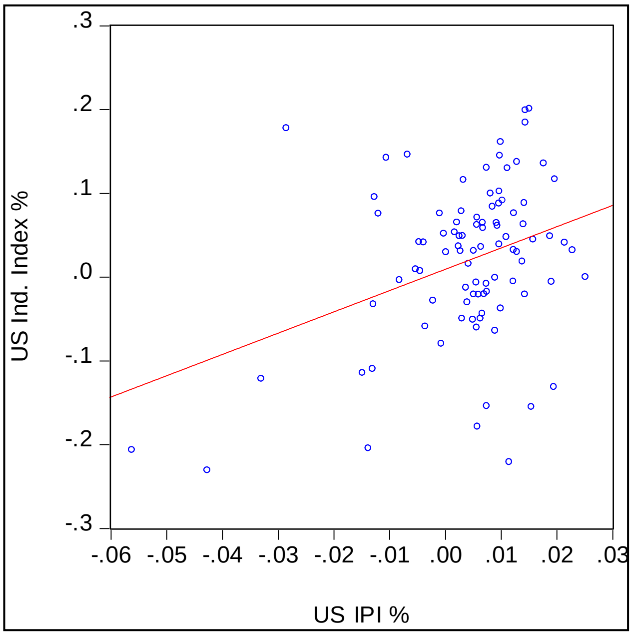
Italy



Japan

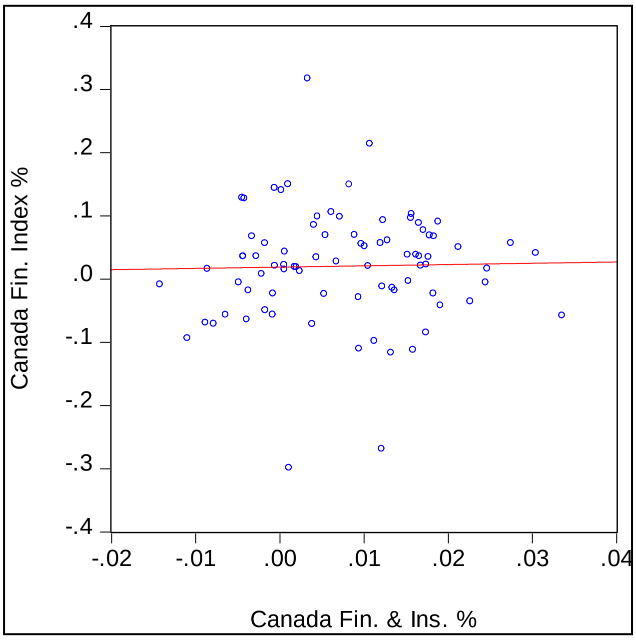


United Kingdom

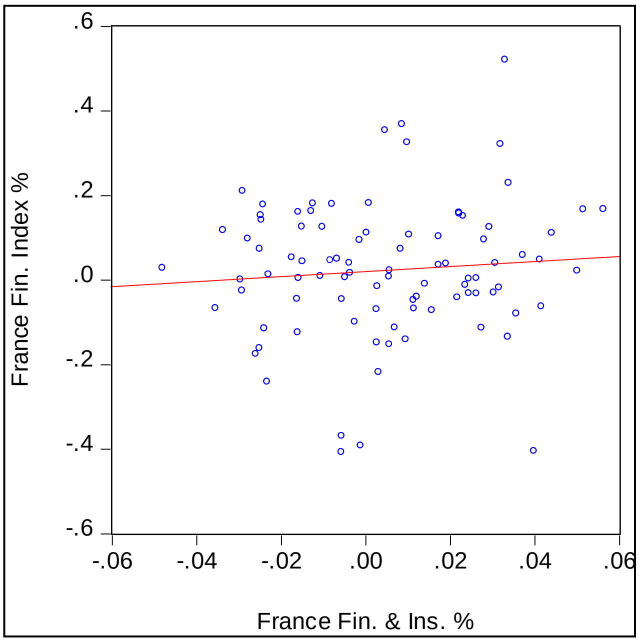


United States

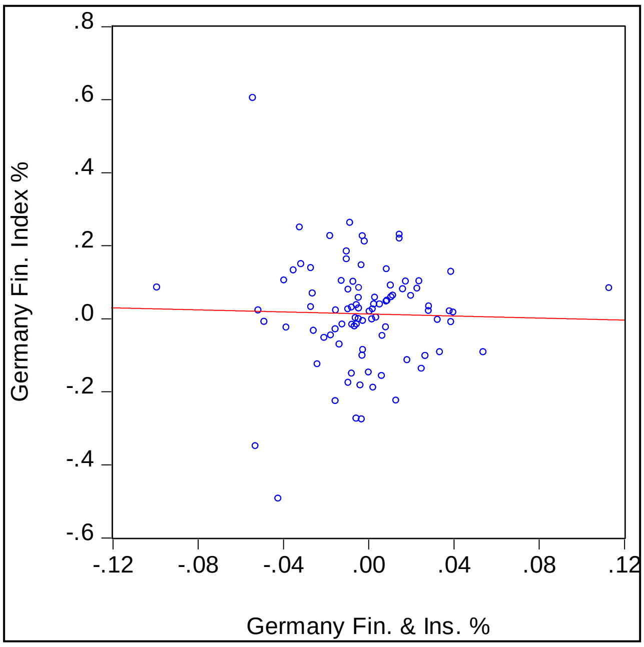
Figure 3: Non-lagged correlation relationship between real output growth and real index returns relating to the financial sectors of the G-7



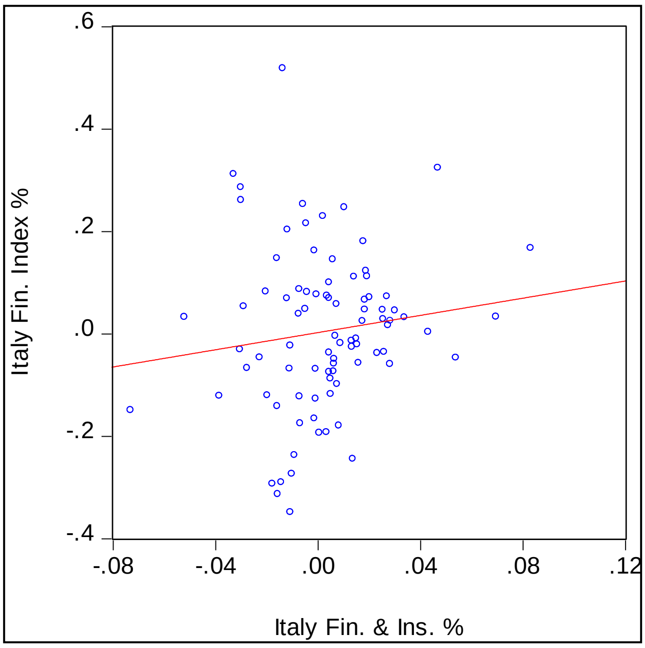
Canada



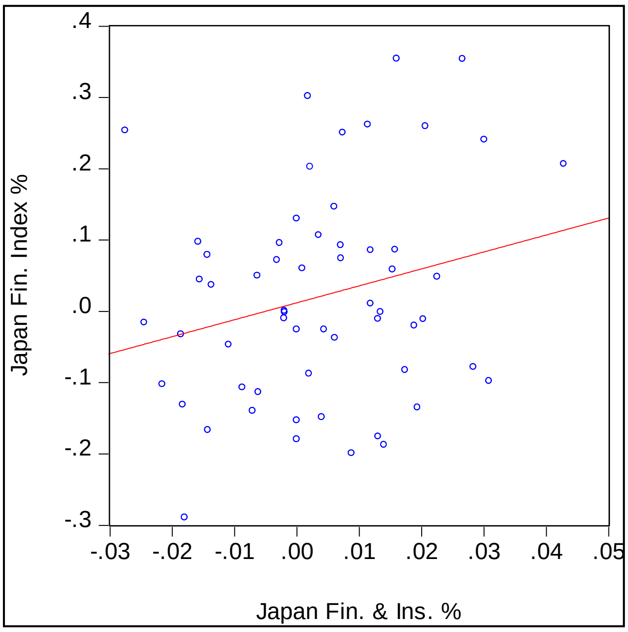
France



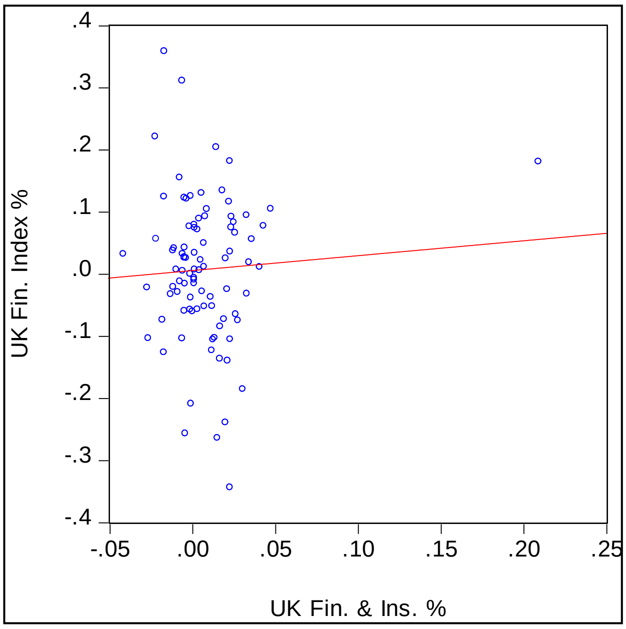
Germany



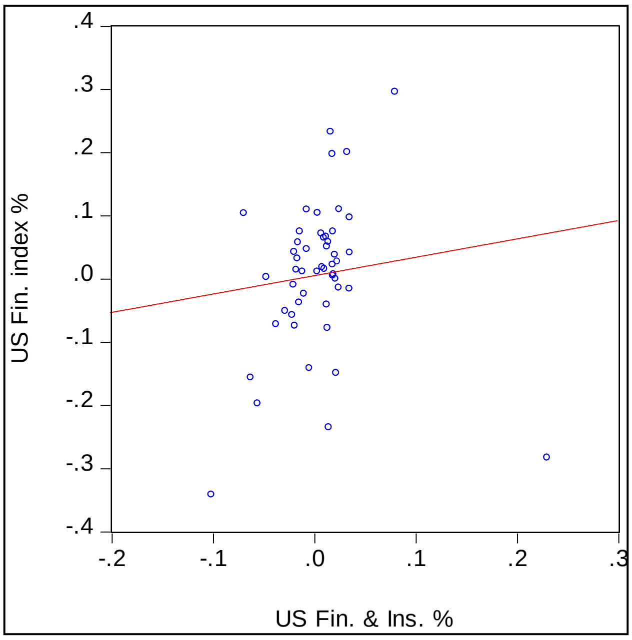
Italy



Japan



United Kingdom



United States

Appendix C

Full test results of additional unit root tests conducted on industrial output data of Japan data

Kwiatkowski-Phillips-Schmidt-Shin test		
		LM-Stat.
		0.234443
Asymptotic critical values*:	1% level 5% level 10% level	0.739 0.463 0.347

*see Kwiatkowski, Phillips, Schmidt and Shin (1992, Table 1)

Elliott-Rothenberg-Stock DF-GLS test		
		t-Statistic
		-3.5990
Test critical values*:	1% level 5% level 10% level	-2.5909 -1.9444 -1.6144

*see MacKinnon (1996)

Ng-Perron test					
		MZa	MZt	MSB	MPT
Ng-Perron test statistics		-24.8009	-3.5192	0.1419	0.9953
Asymptotic critical values*:	1%	-13.8	-2.58	0.174	1.78
	5%	-8.1	-1.98	0.233	3.17
	10%	-5.7	-1.62	0.275	4.45

*see Ng and Perron, 2001 (Table 1)

Appendix D

Optimal lag length specified by lag order selection criteria for G-7 industrial sector output and related index price level data

Canada

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-740.1435	NA	161834.7	17.67008	17.72796	17.69335
1	-527.4601	410.1751	1125.223	12.70143	12.87506	12.77123
2	-514.2428	24.86099*	903.7020*	12.48197*	12.77135*	12.59830*
3	-513.6628	1.063413	980.8507	12.56340	12.96854	12.72626
4	-512.1074	2.777468	1040.547	12.62160	13.14249	12.83100
5	-511.0054	1.915319	1116.414	12.69061	13.32725	12.94653
6	-508.5176	4.205654	1159.645	12.72661	13.47900	13.02907
7	-507.4710	1.719361	1247.524	12.79693	13.66508	13.14592
8	-505.3376	3.403252	1308.910	12.84137	13.82527	13.23689

France

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-717.4957	NA	94381.39	17.13085	17.18873	17.15412
1	-533.0799	355.6592	1286.321	12.83523	13.00886	12.90503
2	-522.3964	20.09515	1097.326	12.67610	12.96549*	12.79243*
3	-520.5044	3.468603	1154.377	12.72630	13.13143	12.88916
4	-513.5466	12.42455	1076.822	12.65587	13.17676	12.86527
5	-511.5712	3.433485	1131.555	12.70408	13.34072	12.96000
6	-503.1282	14.27269*	1019.993*	12.59829*	13.35069	12.90075
7	-501.1721	3.213685	1073.780	12.64695	13.51510	12.99594
8	-500.5036	1.066308	1166.607	12.72628	13.71018	13.12180

Germany

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-717.4831	NA	94353.08	17.13055	17.18843	17.15382
1	-548.8616	325.1988	1872.999	13.21099	13.38462*	13.28079
2	-542.1391	12.64467	1755.829	13.14617	13.43555	13.26250*
3	-540.2989	3.373627	1849.396	13.19759	13.60273	13.36045
4	-534.0575	11.14541*	1754.823*	13.14423*	13.66512	13.35362
5	-530.7872	5.684064	1788.033	13.16160	13.79824	13.41753
6	-529.2877	2.534821	1901.498	13.22114	13.97353	13.52359
7	-528.8554	0.710291	2075.729	13.30608	14.17423	13.65507
8	-526.9541	3.032971	2189.938	13.35605	14.33995	13.75157

Italy

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-690.2032	NA	49280.10	16.48103	16.53890	16.50429
1	-525.7655	317.1297	1080.729	12.66108	12.83471*	12.73088
2	-518.4148	13.82645*	998.0783*	12.58130*	12.87069	12.69763*
3	-515.1929	5.906677	1017.244	12.59983	13.00497	12.76269
4	-513.3838	3.230566	1072.656	12.65200	13.17289	12.86139
5	-509.4656	6.810322	1076.223	12.65394	13.29058	12.90987
6	-508.8795	0.990802	1169.680	12.73523	13.48762	13.03768
7	-507.9984	1.447473	1263.287	12.80949	13.67763	13.15847
8	-507.0074	1.580871	1361.995	12.88113	13.86503	13.27665

Japan

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-688.4677	NA	47285.28	16.43971	16.49758	16.46297
1	-567.9316	232.4624	2949.362	13.66504	13.83867*	13.73484*
2	-562.2558	10.67585*	2834.628*	13.62514*	13.91452	13.74147
3	-560.7510	2.758861	3009.616	13.68455	14.08968	13.84741
4	-558.8020	3.480370	3163.004	13.73338	14.25427	13.94277
5	-553.8194	8.660173	3094.115	13.70999	14.34663	13.96591
6	-551.3664	4.146698	3216.600	13.74682	14.49922	14.04928
7	-548.7213	4.345563	3331.125	13.77908	14.64723	14.12807
8	-546.5105	3.526765	3488.602	13.82168	14.80558	14.21720

United Kingdom

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-650.9626	NA	19360.22	15.54673	15.60460	15.56999
1	-418.8670	447.6128	84.79089	10.11588	10.28951*	10.18568*
2	-413.1086	10.83134*	81.33217*	10.07401*	10.36340	10.19034
3	-410.4283	4.913886	83.96970	10.10544	10.51057	10.26830
4	-409.6082	1.464392	90.65358	10.18115	10.70204	10.39054
5	-407.6682	3.371926	95.34165	10.23020	10.86684	10.48612
6	-404.4977	5.359752	97.43687	10.24994	11.00234	10.55240
7	-401.7340	4.540286	100.6217	10.27938	11.14753	10.62837
8	-400.2370	2.388083	107.1847	10.33898	11.32288	10.73450

United States

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-681.9913	NA	33461.82	16.09391	16.15139	16.11703
1	-468.4491	412.0108	241.7279	11.16351	11.33593	11.23286
2	-433.1059	66.52843*	115.6465*	10.42602*	10.71339*	10.54161*
3	-430.4035	4.959593	119.2888	10.45655	10.85887	10.61838
4	-428.6633	3.112025	125.9095	10.50972	11.02699	10.71778
5	-424.3413	7.525253	125.1251	10.50215	11.13436	10.75644
6	-424.2001	0.239168	137.2808	10.59294	11.34011	10.89347
7	-423.1745	1.689228	147.6204	10.66293	11.52504	11.00970
8	-421.5438	2.609113	156.6251	10.71868	11.69574	11.11168

Optimal lag length specified by lag order selection criteria for G-7 financial sector output and related index price level data

Canada

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1205.907	NA	2.19e+11	31.78703	31.84837	31.81154
1	-950.2778	491.0776*	2.91e+08	25.16520	25.34921*	25.23874*
2	-945.8307	8.309013	2.88e+08*	25.15344*	25.46012	25.27600
3	-943.4020	4.409983	3.00e+08	25.19479	25.62414	25.36638
4	-942.1485	2.210214	3.23e+08	25.26707	25.81908	25.48768
5	-941.1982	1.625420	3.51e+08	25.34732	26.02201	25.61696
6	-938.9884	3.663682	3.69e+08	25.39443	26.19179	25.71309
7	-937.5929	2.240142	3.96e+08	25.46297	26.38300	25.83066
8	-935.5098	3.234276	4.19e+08	25.51342	26.55611	25.93013

France

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1215.048	NA	1.32e+10	28.97734	29.03521	29.00060
1	-995.8343	422.7695	78413390	23.85320	24.02683	23.92300
2	-989.0038	12.84787	73319202	23.78581	24.07519	23.90213
3	-972.9980	29.34401	55117246	23.49995	23.90509	23.66281
4	-956.4244	29.59572	40893356	23.20058	23.72147	23.40997
5	-947.6564	15.23967	36554970	23.08706	23.72370	23.34298
6	-922.0755	43.24392*	21910700*	22.57323*	23.32562*	22.87568*
7	-918.1892	6.384493	22030123	22.57593	23.44408	22.92492
8	-914.5527	5.801085	22301556	22.58459	23.56849	22.98011

Germany

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-737.5509	NA	152147.2	17.60836	17.66623	17.63162
1	-539.7569	381.4600	1507.967	12.99421	13.16784*	13.06401*
2	-535.5851	7.846927	1502.144	12.99012	13.27950	13.10645
3	-529.7039	10.78222*	1437.054*	12.94533*	13.35047	13.10819
4	-527.9608	3.112576	1517.720	12.99907	13.51996	13.20846
5	-524.6404	5.771265	1544.596	13.01525	13.65189	13.27117
6	-522.2556	4.031363	1608.352	13.05371	13.80610	13.35616
7	-518.0971	6.831820	1606.669	13.04993	13.91808	13.39892
8	-515.6925	3.835970	1674.875	13.08792	14.07182	13.48344

Italy

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1097.139	NA	2.94e+09	27.47849	27.53804	27.50236
1	-894.6150	389.8596	20577133	22.51537	22.69403*	22.58700*
2	-890.6237	7.483655	20586886	22.51559	22.81335	22.63497
3	-886.2921	7.905268	20428562	22.50730	22.92416	22.67443
4	-880.6180	10.07144	19611151	22.46545	23.00141	22.68033
5	-876.2024	7.616931	19439383*	22.45506*	23.11012	22.71769
6	-874.6963	2.522680	20737773	22.51741	23.29157	22.82779
7	-868.4965	10.07463*	19690338	22.46241	23.35567	22.82055
8	-867.2219	2.007558	21166829	22.53055	23.54291	22.93643

Japan

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-427.0078	NA	50239.44	16.50030	16.57535	16.52907
1	-298.6802	241.8482	421.1421	11.71847	11.94361	11.80478
2	-286.2305	22.50511	304.5757*	11.39348*	11.76872*	11.53734*
3	-284.2314	3.460046	329.6305	11.47044	11.99577	11.67184
4	-283.3454	1.465284	372.9684	11.59021	12.26564	11.84915
5	-275.5309	12.32286*	323.9904	11.44350	12.26902	11.75998
6	-273.4420	3.133345	351.7419	11.51700	12.49262	11.89103
7	-270.3774	4.361205	369.0475	11.55298	12.67869	11.98455
8	-269.1133	1.701626	416.6618	11.65820	12.93402	12.14732

United Kingdom

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-756.3694	NA	238151.2	18.05641	18.11429	18.07968
1	-489.7070	514.2773	457.9935*	11.80255*	11.97618*	11.87235*
2	-486.9172	5.247516	471.4862	11.83136	12.12075	11.94769
3	-486.6972	0.403393	516.1421	11.92136	12.32650	12.08422
4	-478.9474	13.83892*	472.4717	11.83208	12.35297	12.04147
5	-477.0303	3.332026	497.1768	11.88167	12.51832	12.13760
6	-475.6411	2.348515	530.1157	11.94383	12.69623	12.24629
7	-472.5127	5.139402	542.7103	11.96459	12.83274	12.31358
8	-467.4880	8.015581	531.5351	11.94019	12.92409	12.33571

United States

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-360.7009	NA	49546.53	16.48641	16.56751	16.51648
1	-273.1425	163.1770*	1110.946*	12.68830*	12.93160*	12.77852*
2	-271.9180	2.170788	1262.276	12.81445	13.21995	12.96483
3	-268.5388	5.683120	1302.932	12.84267	13.41037	13.05320
4	-262.7212	9.255406	1207.134	12.76005	13.48995	13.03073
5	-261.3717	2.024160	1375.303	12.88053	13.77263	13.21136
6	-258.8896	3.497574	1495.299	12.94953	14.00382	13.34051
7	-255.6578	4.260050	1580.566	12.98445	14.20094	13.43558
8	-252.8375	3.461292	1714.596	13.03807	14.41676	13.54935

Notes:

* Indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion