Do Domestic Yield Curves in Emerging Market Economies Prove to be Useful in Forecasting Future Economic Growth?

by

Rushai Gosai
0510713v.

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Supervisor: Mr James Britten

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Abstract

Much has been said and researched about the term spreads ability to forecast the path of Gross Domestic Product (GDP) in developed economies. The relationship holds that should the yield spread turn negative that this indicates that future GDP will retract and that a recession is eminent. At the back end of 2019, the subject found prominence again as the yield spread measured by the ten year government bond and the three month Treasury Bill (Tbill) turned negative. The Federal Reserve Bank of America (The Fed) lowered interest rates in the hope that lower borrowing costs would stimulate the economy and lead to an increase in aggregate demand. It then follows, could the domestic yield curve spread perhaps be suitable in forecasting domestic Emerging Market (EM) GDP growth? This research highlights the EM experience whilst still testing the ability of the yield curve in the US to predict future economic growth. The framework based on the work of Bosner-Neal and Morley (1997), found over the horizon of 1980 to 2020, for the EM countries of Brazil, Russia, India, China and South Africa (BRICS) unsupportive evidence that the domestic yield curve spread is a suitable indicator to forecast future GDP growth.

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Abbreviations

Gross Domestic Product – GDP

South African Reserve Bank – SARB

Gross National Product - GNP

Emerging Market - EM

Brazil, Russia, India, China, South Africa - BRICS

The United States of America – The US

Treasury Bill - Tbill

The United Kingdom – The UK

1. Introduction

1.1. Background and overview

Investigating the yield curve term structure between the three month T bill and the ten year government bond has at times shown to be inverted. Inverted yield curves arrive when short term debt is deemed riskier than long term debt. Though many investors may try to time the market, the consensus represented by an inversion is historically correct and foreshadows economic woes to come. Harvey (1988) found that the yield spreads between US treasuries forecasted real Gross National Product (GNP) activity at least five quarters in advance. Estrella and Hardouvelis (1991), one of the seminal references in this topic, show that when yield spreads turn negative, this precedes a decline in economic activity. Whilst the three-month, ten-year spread may prove to be negative at times in the United States. This research investigates whether using the same term points to calculate a term point differential provides insight into future economic activity for developing economies.

Figure 1 below shows the illustrative history over a twenty-year period of the spread between The United States (The US) ten year government bond yield less The US three month Tbill rate. The shaded areas show The United States recessions and it can be seen that when the term spread turns negative, it precedes a recession both in 2001 and 2008. Figure 1 is similar to Figure 2 from Estrella and Hardouvelis (1991) which shows the same relationship over a different time period.

Central banks around the industrialised world have historically used the term spread as a precursor for a declining economic environment. While forecasting time periods vary, models used by the St Louis Federal Reserve forecast economic conditions from two to six quarters ahead. This is graphically shown below in figure 1.

Figure 1 - Term Spread 10 year bond less 3 month Tbill (USA)
Source: Adopted from "South Africa's Taylor's Rule calculated by, "https://fred.stlouisfed.org/series/T10Y3M, January 28, 2021

Recent economic events, such as the Federal Reserve's emergency cut in interest rates and enormous intervention in the markets which was followed by a total of 300 basis points cut by the South African Reserve Bank (The SARB), has raised the argument again whether inverted yield curves signal a fore coming economic recession. With all the monetary policy intervention, it is the aim of this research to determine whether the yield curve spread provides valuable and accurate forecasting information related to economic growth in EM. Rate cuts lowered short term rates as a monetary response to create aggregate demand. This intervention in the US did not permeate through the longer tenors of the yield curve as investors are of the belief that longer term yields and expectations of the future are more grounded in reality than those of the current. Given that we have seen yield curve inversion in 2020, which preceded a recession, the argument is whether the SARB and other developing economies, who similarly cuts rates as well, show a similar relationship when comparing the short term rates to long term rates and whether this will hold informational content about the economic prospects.

Research from Fama (1984), Harvey (1988) and Estrella and Hardouvelis (1991) to name a few have suggested that inverted yield curves have been shown to forecast economic downturns and subsequently economic growth. The key element missing, and one that this research addresses, is to study whether the term spread of emerging economies has informational content that can be used to forecast the path of future economic growth.

The ten year US bond yield (10 Year Treasury Rate, n.d), which is taken as the risk free rate for financial transactions across the globe, has dropped below one percent since late March 2020.

The yield spread, which is predominantly taken as the difference between the ten year government bond yield and the three month Tbill rate, as highlighted in figure 1, turned negative in February 2020 and stayed negative into early March 2020. Typically, bonds with longer maturities pay more in periodic coupons -this is common sense. However, this is also based on the expectation that that the economy will grow in the future.

To illustrate why the yield curve inverts before recession, let's consider the example of the yield curve representing monetary policy expectations. If market participants expect growth to slow down in the near future, they start pricing in higher probabilities of future rate cuts to support economic growth. This has resulted in long dated bond yields decreasing by a higher margin than short dated bonds and hence, the yield curve flattens.

Historically, an inverted yield curve has successfully signaled a recession six to eighteen months before it happened (Lewis, 2019), thus justifying recent debate on whether a US recession is incoming. Market participants keep a close eye on the ten year bond, three month Tbill spread. It is this spread and the relation to economic growth which literature shows has a forecasting relationship that key market participants have picked up on.

1.2. Motivation of the study

The study is motivated by the review of the literature which shows that the bulk of the studies in the field of yield curve analysis for forecasting output or inflation is primarily centred on The US and other industrialised or first world countries. There have been very few studies, when compared to the vast literature on the topic in developed economies, that have considered whether the yield curve can forecast the path of future output growth in emerging market economies.

The aim of this research is to determine if the informational properties highlighted in previous research related to output and inflation drawn from the yield curve holds for emerging market economies. It is the primary outcome of this research to replicate the studies based predominantly on first world economies that have gone before to determine if the relationship, as seen in the review of the literature, which implies that the yield curve does hold forecasting properties related to the path of future output and inflation.

1.3. Research objective

Bernard and Gerlach (1998) build on the work by Estrella and Hardouvelis (1991) who showed that the yield curve forecasts recessions from using the term spread by as much as two years in advance. The general market accepted methodology is that yield curve inversion predicts a future recession four quarters ahead.

There are research studies which show that forecasting real economic activity forms the basis of many decisions. This can take the form of businesses relying on such forecasts in order to plan their production process. Central bankers consume such statistical outputs and reports when making decisions that relates to the trajectory of monetary policy going forward into the future or when planning for future budgetary processes. Therein lies the true question of the research, the value of the choices mentioned above depends on the quality of the forecast.

The objective of this paper is to determine whether the domestic yield curves in emerging market economies also hold the same informational content which forecast economic output. The objective of this research is to make use of the paper by Bosner-Neal and Morley (1997) and replicate the methodology presented in the paper with the change of using emerging market economy data to determine whether the term spread in emerging economies has the forecasting ability as mentioned by Estrella and Hardouvelis (1991) and Bosner-Neal and Morley (1997).

1.4. Problem statement

Bosner-Neal and Morley (1997) illustrate that the application of the yield curve spread as a variable to forecast real economic activity is well established for data based on The US. The authors ask the question whether this is the case in other countries. There are studies which ask the question outside of The US such as Mehl (2009) as well as Plosser and Rouwenhorst (1994), initially these studies were limited but have grown in significance and importance, and those that have asked the question have limited their studies to other industrialised economies as well as the length of the forecast horizon.

It must be noted that the studies mentioned in the research by Evgenidis, Papadamou and Siriupoulos (2018) are all based on information that is specific to the US. Subsequently there have been a number of studies that have investigated whether the yield curves forecasting ability is applicable in other countries. The diffusion of the study moved from the US and across to Euopean nations to determine if the yield curve relationship to GDP held. Whilst this was a natural evolution, the bulk of the European nations studied are all developed economies. Plosser and Rouwenhosrt (1994) were among the first to study the yield curves forecasting ability outside the US. The results showed that the yield curve spread proved a suitable forecasting tool for information from Canada and Germany however the same cannot be said for the UK and France.

In summary, the problem statement is centered around the investigation on emerging market economies. The research that has been reviewed is clear in that the research has not really been done on emerging market economies. This is the aim of this research.

1.5. Hypothesis

Estrella and Mishkin (1991), Bernard and Gerlach (1998), Bosner-Neal and Morley (1997), Hamilton and Kin (2000) and Evgenidis and Siriopolous (2016), to name a few of the studies reviewed for this research, have shown that the yield curve spread holds informational content related to the future path of economic output. It has been documented that this relationship holds for the US and many other industrialised countries. It is the aim of this research to determine if the relationship that the yield curve spread holds information content for economic output growth. If so, how far into the future does the yield curve spread forecast the future path for economic output and whether this forecast will have a statistically and economic significant impact for the EM countries that have been selected.

1.6. Contribution to the study

The yield curve spread as an economic indicator for future economic growth has become somewhat of a stylized fact over the last few decades. This relationship that the spread can forecast economic growth and, in particular, forecast future downturns has been shown to be prevalent in developed economies. This research aims to determine if the relationship holds for emerging market economies and to what extent.

It is well known that the US and other developed economies are the major trading partners of the emerging economies studied in this research and as such it would be a safe approximation that the domestic yield curves of the developed economies will impact that of the developing economies. In this research we ignore the impact of developed economies' interrelatedness and focus primarily on the domestic yield curve informational content. This research will aim to understand to what extent the domestic yield curve has informational content about domestic economic growth.

Core findings show that in the US, the term point differential between the 3 month Tbill and 10 year does have explanatory power for future economic growth one, two and three years into the future. The results are mixed at best for the BRICS countries with the results leading to less than satisfactory. Only South Africa shows some evidence that the yield curve has explanatory power for future economic growth but only at the one year ahead horizon.

The remainder of the research proceeds as follows: Section two will introduce a literature review on the topic of yield spread and the relationship with forecasting economic growth. Section three introduces the methodology that the research employed and the variables used in the regression model. Section four highlights the results of EM countries and The US. Section five provides a conclusion of the research. Section six provides future research with section seven highlighting the references used for this research.

2. Literature review

2.1. The yield curve as a variable to forecast economic growth

Yield inversion is the term used when long term rates are lower than short term rates. This happens when investors are nervous about the future and expect short term rates to fall. When so many investors think rates are going to fall, they will crowd into the longer-dated bonds to try to lock in the 'high' rate for as long as possible. The traditional measure of whether or not the yield curve is said to be normal, flat, or inverted is by examining the relationship between the 3-month and 10-year rates. The below chart shows the value of the 10-year bond (normally high) minus the value of the 3-month bond (normally low). We should expect the result to be a positive number, given a normally sloped yield curve. This is observed in the chart below. The majority of the data points are above 0%, shaded blue. The few periods where the yield curve was inverted are shaded red. The grey vertical lines indicate recessions, and occur after each inversion.

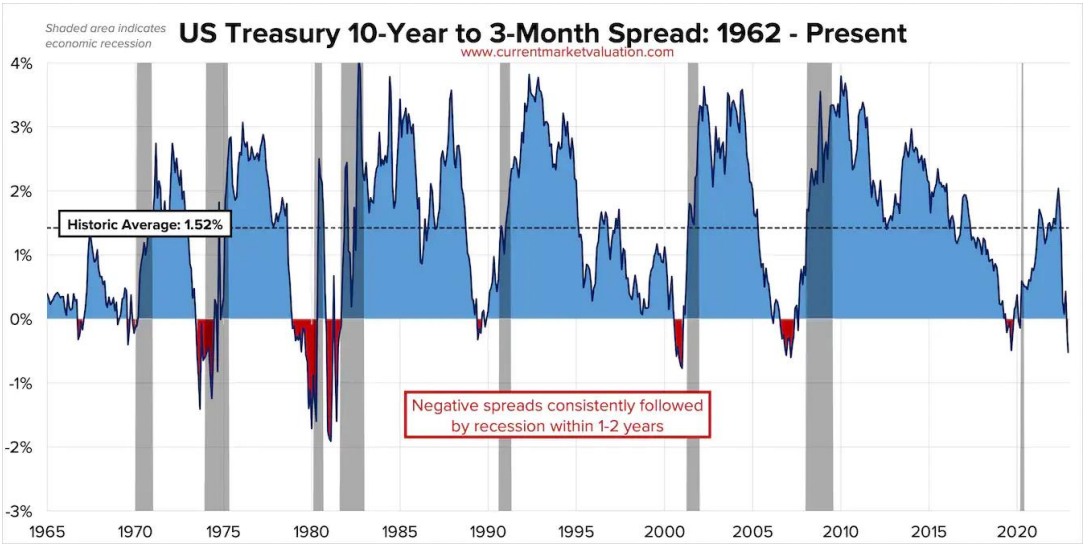

Figure 1 – Term spread 10 year bond less 3 month Tbill (Present USA)
Source: Yield curve indicates stock market is fairly valued by, “https:// https://www.currentmarketvaluation.com/models/yield-curve.php

The implication of the forecasting ability of the term spread in forecasting economic activity has been accepted for The US in papers by Fama (1984), Harvey (1988), Estrella and Hardouvelis (1991), Davis and Henry (1994), Bosner-Neal and Morley (1997), Davis and Fagan (1997) and Stock and Watson (2003).

The maxim that when the yield curve inverts, it signals a recession has been formalized by a number of studies namely Laurent (1988, 1989), Harvey (1988), Stock and Watson (1989) as well as Estrella and Hardouvelis (1991). The studies mentioned here focused primarily on using the term spread to forecast future output growth based on data from the US.

Fama (1984) examined the one to six month Tbill rates from 1959 through to 1982. Fama (1984) found that forward rates forecasted the correct direction of the changes in short term rates. Mankiw and Miron, (1986) in their research evidence showing the forecasting ability of short term rates on real economic activity, using the three and six month Federal Reserve rates. Mankiw and Miron (1986) looked at data during periods monetary regimes.

While this is not the purpose of this research, the study is suitable as it does pertain to the forecasting power of the term spread. The results interestingly show that the forecast ability of short term rates on real economic activity varies through monetary regimes. Over the periods studied 1890-1914, 1915-1933, 1934-1951, 1951-1958 the results show that there is zero to little evidence of the short term rates having some sort of forecast ability on real economic activity. The relationship then changes completely from 1959 to 1979. Whether this is due to changes in macroeconomic policy or policy regime or integrated financial markets is unclear.

Harvey (1988) found that the yield spreads between the US treasuries forecasted real GNP activity at least five quarters in advance. In the same breath, Estrella and Hardouvelis (1991) found that the term spread differential between the ten year government bond and the three month US Tbill proved suitable in forecasting output growth and recessions in the US. Fama and Bliss (1987) found that longer term forward rates have forecast ability power for a horizon at least two to four years ahead.

Hardouvelis (1988) examined the forecasting ability of forward rates spanning through multiple monetary policy system changes. The research used the three month Tbill rates with maturities from one to twenty six weeks. The research found that there was no connection between the ability of the Fed to stick to rate targeting and the forecast

ability of interest rates. That said, Hardouvelis (1988) reported that the forecasting ability of term spread did increase from 1979.

Harvey (1988) examined the term structure of real interest rates as a variable to forecast future consumption - the evidence supported that the slope of the yield curve is a better forecasting variable of real economic growth. Harvey (1988) outlined that a common approach for research within the financial field is to use or find variables that explain movements of prices. Harvey (1988) differed in that expected returns were first estimated and subsequently information about future consumption growth was extracted.

Harvey (1988) employed the use of quarterly data using a regression model which tests for real consumption growth on the expected real yield spread over the period 1953 to 1987. Yield spread data is used for three, six and nine month Tbills and one year Treasury bonds. Harvey (1988) showed that there is informational content about future consumption growth in the real term structure. Harvey (1988) went further and showed that for the data set and period used, real interest rate variables proved to be better in forecasting consumption growth than lagged variables. This was shown in both in sample and out of sample testing.

Mishkin (1988) corroborated the evidence found by Fama (1984) who used multiple time series regressions with the purpose of determining the informational content in forward interest rates. Fama (1984) found evidence that one month forward rates has power to forecast the spot rate one month ahead. Hardouvelis (1988) used weekly Tbill data with maturities ranging from one to twenty six weeks in a regression model in which Hardouvelis (1988) finds that r-squared values indicated little forecast ability. This is also similar to the regression results of Estrella and Hardouvelis (1991) as well as Bosner-Neal and Morley (1997).

Hardouvelis (1988) found that when The Fed let interest rates fluctuate between the period of 1979 and 1982, forecasting power increased substantially from a one week ahead to twenty one weeks ahead. Mishkin (1990) examined yields with maturities stretching from one to twelve months and found that most of the data inherent in forward rates is about the expectation of future real rates.

Mishkin (1990) found in the research that the term spread provided in sample forecasting content for real interest rates, particularly at shorter horizons. Interestingly, Fama (1990) found that an increased spread differential between the five year bond and the one year bond forecasted an uptick in the rate of economic growth rate for the prevailing five years and a subsequent decrease in the real interest rate between two to three years into the future. Fama (1990) employed the use of a regression model using spot rate, inflation rate and real return on the five year yield spread to forecast the one year spot rate one year ahead into the future. The results show that the yield spread shows no forecasting power over the one year ahead spot rate. The yield spread evidence however did show strong evidence in forecasting inflation. Studies specific to inflation, make the distinction where the importance lies, “inferring where the economy is”

There are studies that investigated the forecasting qualities of the yield curve and inflation. The Fisher equation illustrates that nominal rates reflect expectations of both future inflation as well as the real rates. Mishkin (1990) finds forecasting information of the US yield curve and inflation. Further Mishkin and Jorian (1991) get to a similar conclusion over ten developed economies.

Estrella and Hardouvelis (1991) showed in the review of the literature that the data is comparable with the idea that the gradient of the yield curve has forecasting ability about interest rates in the short and long term. Estrella and Hardouvelis (1991) provided the strong evidence using their probit regressions.

Estrella and Hardouvelis (1991) observed quarterly real GNP from the 1955 through to 1988. In their simple regression model the dependent variable is the annualised cumulative percentage change in the seasonal adjusted real GNP numbers. The interest rate set of data used for the study is the ten year government bond and the three month Tbill rate, where the ten year rate government bond represents the long term rate and the Tbill rate represents the short term rate.

It is the aim of this research to follow a similar approach to Estrella and Hardouvelis (1991), Bosner-Neal and Morley (1997) provided a refreshed view of the methodology employed by Estrella and Hardouvelis (1991). The results of both support the notion that the yield holds forecasting ability as it relates to future GDP growth.

The regression model from Estrella and Hardouvelis (1991) present their regression results which illustrates that the findings are consistent with previous theory and research in that a steeper or flatter yield curve slope implies that there will be a faster or reduced expectation of future economic growth in real output. The data shows that for a one hundred basis point spread between the ten year bond and the three month Tbill shows that the cumulative change over the course of a year the real GNP is forecasted to grow by three percent. This illustrates that there is a relationship between the term spread of short term and long term rates and the impact they have on future economic productivity.

Estrella and Hardouvelis (1991) show that for a forecast of negative real rates to occur from a current quarter to a future quarter, the slope of the yield curve would need to be less than -1.31%. More importantly, the results how that the marginal forecasting power for market participants will occur six to seven quarters in advance. Estrella and Hardouvelis (1991) showed that the term spread explained close to one third of the variation in the future real output.

As a visual representation of the result from the study by Estrella and Hardouvelis (1991), Figure 2 highlights that the shaded areas are defined by the National Bureau of Economic Research as recessions. The illustration shows that when the slope of the yield curve spread tracks the future realization of output quite effectively, this coincides with the decline in economic activity.

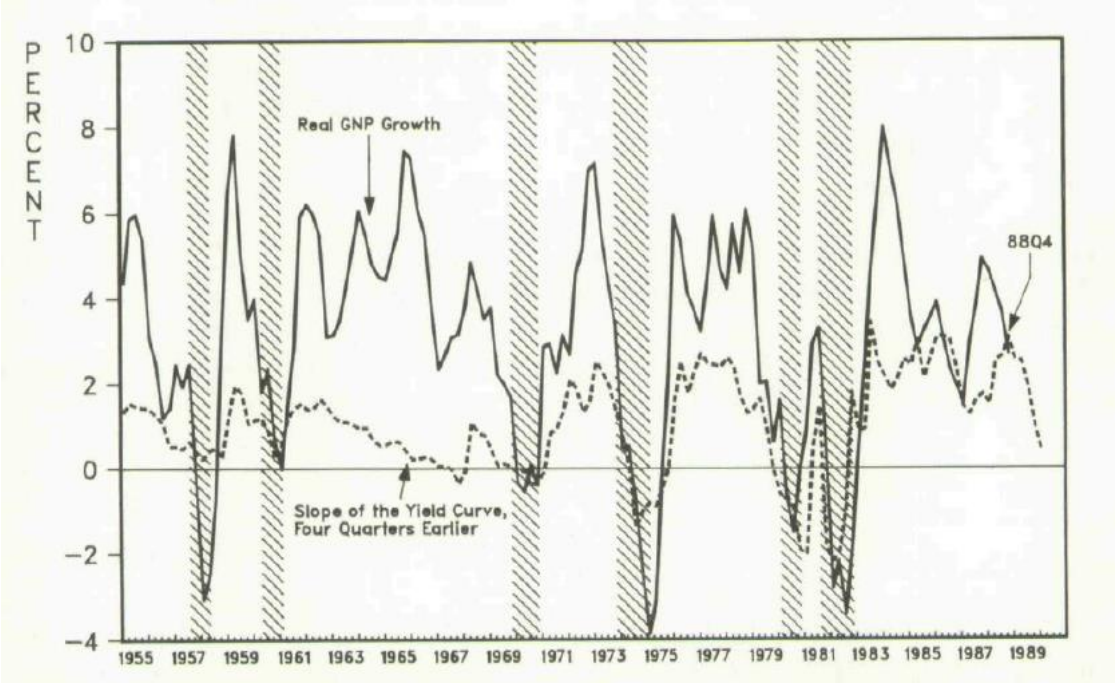

Figure 3 - Yield curve spread tracks future output
Source: Adapted from “The term structure as a forecaster of real economic activity” by Estrella and Hardouvelis (1991)

The current growth in real GNP and the slope of the yield curve four quarters earlier.

To summarize, Estrella and Hardouvelis (1991) presented evidence to support the notion that the slope of the yield curve can be used to forecast changes in the real economic output at least four years into the future.

Mishkin (1991) linked the information of the term structure to the focus at the time of central banks on price stability. In order for the central banks to pursue price stability, one of the major markers a central bank would need information on is inflation and one of the best sources of explanatory information is to analyse the term structure. One of the primary reasons why the information carried in the term structure relating to inflation requires careful analysis is due to the central bank using the term structure as a guide for monetary policy.

Of further importance is the evidence shown by Mishkin (1991) which highlights that the term structure of real interest rates has an important role in understanding of asset pricing as well as the business cycle. Mishkin (1991) examined the term structure and the relation to inflation in The US and nine other industrialised countries.

This research notes that it is noteworthy that the term structure informs about future inflation in other countries. This is critical to this research as the investigation attempts to determine if the term structure hold future forecasting analysis about economic growth within the domestic country.

Mishkin (1991) examined the explanatory power of the term structure on inflation using short term maturities of twelve months or less. It is important to note that Mishkin (1991) illustrated that forecast surveys do better using longer term maturities. Mishkin (1990) found that for maturities that are over a year, the differential in the term structure for The US appeared to be significantly smaller.

This methodological change shows that using the same methodology, the coefficients using the longer maturities are above zero and are statistically significant. Mishkin (1991) empirical evidence revealed that every country which includes The US, Canada, Belgium, France, West Germany, Italy, Netherlands, Switzerland, Japan bar the United Kingdom (UK), showed that there is a great deal of valuable information in the term structure of nominal rates at the short end of the curve. The finding has had a profound impact in that it suggested that most countries can observe data on a nominal scale which provides information about the behaviour of the real term structure.

Estrella and Hardouvelis, (1991) showed that historically the information reflected in the slope of the yield curve are independent of monetary policy and therefore the slope provides suitable information to market participants as well as central bankers and policy makers.

The flattening of the yield curve in 1988 and subsequent inversion in 1989 according to Estrella and Hardouvelis, (1991) has been interpreted by both market participants and financial commentators as data that a downturn in economic conditions recession is forthcoming. The implication herein is that when the yield curve flattens and forecasts a future drop in interest rates, this inevitably forecasts a lower level of GNP.

Estrella and Hardouvelis (1991) reviewed the research at the time (Harvey (1988), Hardouvelis (1988) and Mishkin (1991) and showed that the recent work of the time confirmed that fluctuations in the term spread do forecast the correct course of future expected spot rates, however, the authors do show that at the time there was sparse practical work of the forecasting of the changes in economic activity.

Through the review of the literature, a number of investigations provided information that showed that the term spread has forecasting ability of the path of future economic growth. Plosser and Rouwenhorst (1994) were among the first to study the yield curves forecasting ability outside the US. The results showed that the yield curve spread proved a suitable forecasting tool for information from Canada and Germany however the same cannot be said for the UK and France.

Plosser and Rouwenhorst (1994) used monthly data for The US, The UK and Germany over the period 1973 to 1988 where the yield spread was calculated between the one year term point and the three and five year term point. This approach is similar to the approach taken by Jorion and Mishkin (1991) in terms of the term points referenced.

Plosser and Rouwenhorst (1994) make use of a regression model with the aim of determining if the yield spread forecasts real economic growth, the results in the paper are consistent with that of Estrella and Hardouvelis (1991) in that the slope of the yield curve forecasts real output growth in The US. The results are similar for the German set of data, but for the UK, the results are weaker due to the finding, as cited by Plosser and Rouwenhorst (1994), that inflation was higher and more variable in the UK sample which obscures informational content of the yield curve.

Estrella and Mishkin (1995) showed that in many countries the yield curve differential are suitable for forecasting recession at least six to eight quarters in advance. Estrella and Mishkin (1995) examine the relationship between the term spread, future inflation, the central bank rate and future real activity for France, Germany, the UK, Italy and The US. Estrella and Mishkin (1995) employ, much like the authors above, a regression model. The results are positive and significant for France, Germany, the UK and The US with forecast for real GDP being significant from four to eight quarters ahead.

Italy is shown to be the only country where the results from a statistical point of view are significantly lower. Estrella and Mishkin (1995) reason that the term spread is suitable for forecasting future economic growth in developed in economies as the evidence suggests, especially is the US, it provides ample warning of a coming recession as the yield curve inverts. The evidence holds true for the UK, Germany, Italy but the results are statistically weak for the France dataset.

Tzavalis and Wickens (1996) agree with the general finding from previous research studies using The US as a baseline that the greater the time horizon used the more information that term structure possess regarding future inflation. In summation, Tzavalis and Wickens (1996) agreed with the general findings of the body of literature in that the greater the time horizon, the more information the term structure would be able to provide related to future inflation and growth. Tzavalis and Wickens (1996) go further by showing that the forecasting of abilities of the term spread is poor but that the real interest rate contains far more suitable and forecasting information about future inflation and growth than the term spread.

In light of the practicality of the term spread as a forecasts for real economic growth, Bosner-Neal and Morley (1997) show that forecasts of economic activity can be unreliable. The authors illustrate that forecasts based on macroeconomic models are often let down by the lack of accurate and timeous data Added to this is the unnecessary over complication of models used to create forecasts. Bosner-Neal and Morley (1997) postulate that there has been a steady growth in interest of using financial variables in order to create forecasts. The pros of using financial variables are that they are readily available and easy to implement in models but probably more important is that they are less prone to error in measurement. This finding is brought to light in other studies surveyed in this literature review.

A financial variable that been particularly successful in forecasting real economic activity is the yield spread or the difference between the long term and short term interest rates. In simple and general terms a positive spread, is one in which the long term interest rates are higher than the short term rates, and is usually associated with economic expansion.

The reverse of this situation in which shorter term rates are higher than long term rates usually implies that there is a chance of economic contraction. Important to note is that the nature and size of the change of the term spread indicates the scale at which economic growth expands or contracts, the relationship indicates that greater the deviation of the larger the spread the greater the consequent impact on the real economy.

Bosner-Neal and Morley (1997) illustrated that the application of the yield curve spread as a variable to forecast real economic activity is well established for data based on The US. The authors asked the question whether this is the case in other industrialised countries.

Bosner-Neal and Morley (1997) examined the link between yield spread and forecasting real economic activity over eleven industrialised countries. The authors found empirical evidence that specifies that the yield spread is a statistically and economically important forecasting variable of economic activity in several countries. Further, Bosner-Neal and Morley (1997) find that the yield curve spread forecasting model generally outperforms other economic variable forecasting models used to forecast future real economic activity.

In order to understand the relationship between the yield curve spread and real economic growth, an understanding of the yield curve and the movements in the yield curve is important. This paragraphs below discuss the relevance of the yield curve spread and the yield curve as well as discusses the argument behind why the yield curve could be reliably used as an economic variable to forecast economic activity.

There are two possible reasons for this empirical relationship between the yield spread and economic activity. The first being that yield spread may reflect the position of central bankers with respect to the stance of monetary policy. When the monetary policy stance is tightened then short term interest rates increase. What follows is that long term rate increase but not by the same degree, the result of which is that the yield curve spread narrows or could perhaps turn negative.

The result of this tightening is to impart a tightening of economic activity by making the cost of borrowing more expensive and thus is the monetary policy stance to cooling the economy down. The consequence of this is that a yield spread that happens to be negative is generally a precondition to mean a slowdown of future projected economic growth.

The alternate approach is that the yield curve reflects the market expectation of future economic growth. If the expectation that real income is set to rise in the future, the expectation is that there will be an increase in profitable investment opportunities. For market participants armed with this knowledge to take advantage of this movement, the investment houses increase their borrowing and issue more bonds. The bonds issued will tend to be longer term to lock in investors as well as secure long term financing. The knock on impact would be an uptick in the supply of longer dated debt securities which has the impact of reducing the price of the bonds but subsequently increasing the yield.

Rates on longer term debt instruments will therefore increase when compared to short term debt instruments rates and the yield curve will steepen but positively so. Should the expectation that real income realise to even a slight increase in real economic growth, then the positive steepening of the yield curve will be associated with the increase of real economic activity into the future, this according to the research of Harvey (1988). This point is further elaborated on in other research that was surveyed in the literature review.

Research suggests that both theories presented in their own right above have value. Estrella and Hardouvelis (1991) as well as Estrella and Mishkin (1995) show that the inclusion of other variables to forecast real economic activity is suitable but not as suitable and significant as the yield curve.

Thus the result suggest that the yield curve spread reflects more than just the current monetary policy stance of central bankers. The higher short term rates contracts lending activity which then has the desired impact of contributing to slowing the economy down as cited by Bernanke and Blinder (1992).

The results of the research by Bosner-Neal and Morley (1997) show that the yield curve spread is suitable in forecasting economic activity based on the regression of the term spread calculated by using the ten year government bond and three month Tbill and real GDP. Bosner-Neal and Morley (1997) go on to show the same conclusion for in and out of sample results as well, the former showing the more promising results.

The results of Bosner-Neal and Morley (1997) are presented here and contrasted in the results section of this research as this research employs the regression methodology as used by Bosner-Neal and Morley (1997). The results of Bosner-Neal and Morley (1997) can be seen by the bar charts shown below in Figure 3 which highlights the GDP response to a one percent change in the yield spread. The bar chart visually illustrates the beta coefficients for each country over the respective forecast horizons calculated by Bosner-Neal and Morley (1997) based on their regression equation where future real GDP is the dependent variable and the term spread is the independent variable. The bars highlighted in blue are statistically significant.

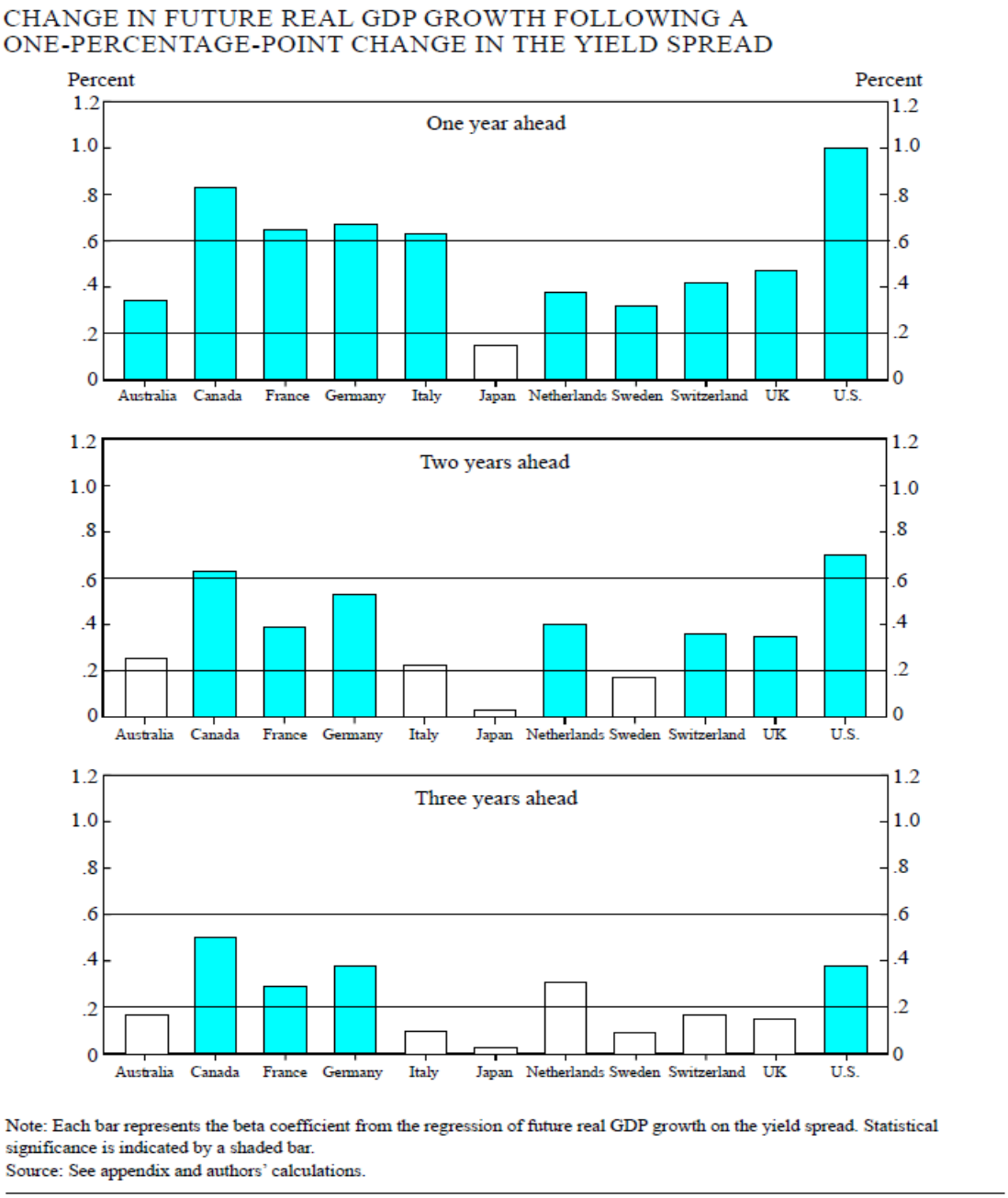

Figure 4 - Beta coefficients for each country for real GDP using the term spread
Source: Adapted from Source: Adapted from "Does the yield spread forecast real economic activity" by Bosner-Neal and Morley (1997)

The results also show another important relationship, the forecasting ability and statistical significance reduces as the forecast horizon is expanded. A more up to date investigation by Kim and Limpaphaymon (1997) and Davis and Fagan (1997) found in their research that the term spread is a suitable forecaster of output growth in six out of the nine European countries that were studied.

Davis and Fagan (1997), Smets and Tsatsaronis (1997) and Canova and De Nicolo (2000) provided evidence against the plethora in support of the yield curve forecasting ability. Davis and Fagan (1997) find subpar and erratic evidence for forecasting performance in the nine euro countries covered in their research. Smets and Tsatsaronis (1997) investigated the slope of the yield curve in The US and Germany as leading indicators of future output growth.

Smets and Tsatsaronis (1997) found that monetary policy stance is at the centre of attraction in determining the intensity of the relationship between the term structure and output growth. Smets and Tsatsaronis (1997) make an interesting point indicating that the forecasting content of the yield curve is not policy independent. This gives rise to the problem of endogeneity in that monetary authorities do attempt to respond to market events as they have impacts on assets prices which are themselves based on the anticipation of the central banks current and future policy actions. Smets and Tsatsaronis (1997) note that the endogeneity does not reduce or invalidate the information inherent in asset prices but imply that a central bank would need to use this information in a complementary fashion to make its own independent valuation. Canova and De Nicolo (2000) found only limited evidence for forecasting using the term premium in Germany, Japan and the UK.

2.2. Forecasting inflation from the term structure

Inflation has been seen as a suitable tool used to forecast economic activity. The general premise is as aggregate demand increases and borrowing increases to support growth, inflation rises. The research reviewed below illustrates the distinction between inflation and forecasting growth. The research presented above showed the use of the yield curve as a variable to forecast economic growth. Given the relationship between interest rates and inflation and subsequently inflation and GDP, the research presented below illustrates the literature of inflation used as a variable to forecast GDP.

Estrella and Mishkin (1997) make the case that since the forward looking debt instruments are intently intertwined to the core debt securities then the term structure of interest rate can be shown to contain valuable information about the future expectations of the term structure in relation to real economic activity and inflation.

Davis and Fagan (1997) use quarterly data over the period of 1986 to 1992 employing a univariate auto regression model for Belgium, Denmark, Germany, Spain, France, Ireland, Italy, Netherlands and the UK. At a ten percent significance level the results for Germany, Italy, Belgium and Denmark shows that out of sample forecasting shows very little to no forecasting ability for future inflation and economic growth.

For output growth, the performance of the model is somewhat better with the yield curve being found to be suitable in forecasting for Germany, France, Belgium, Denmark, Netherlands and the UK. That said however, the forecasting ability is not found to be suitable when trying to satisfy the condition of stability using out of sample data.

Overall the study by Davis and Fagan (1997) tested whether a handful of leading indicators have forecasting ability over future inflation and output growth. The leading indicators that the authors looked at are the yield curve spread, which is relevant to his study in particular, stock prices, credit spreads and foreign bond yields.

Overall, the authors find that there are instances where the yield curve does provide forecasting ability of future inflation and output growth, however overall the authors find no significant evidence that yield spreads in particular are suitable leading indicators for future inflation and output growth.

Bernard and Gerlach (1998) build on the work by Fama (1984), Mankiw and Miron (1986) and Estrella and Hardouvelis (1991) who showed that the yield curve forecasts recessions from using the term spread by as much as two years in advance. Bernard and Gerlach (1998) show that while the slope of the yield curve slope is suitable in forecasting macroeconomic growth there are in fact three considerations that make this especially striking for the purpose for forecasting real economic activity.

The first is that data of the term spreads are instantaneously available. The second is that yield curve data is not revised which is a problem that GDP data suffers from. The third and probably most insightful is that interest rate data is available for long maturities which allows forecasts to be computed for much longer time horizons.

Bernard and Gerlach (1998) provided a cross country approach to evidence the practicality of the term spread and hence the probability of recession within the following eight countries, Canada, France, Belgium, Germany, Netherlands, Japan, the UK and The US over the period 1972 to 1993. Bernard and Gerlach (1998) noted the evidence from Estrella and Mishkin (1995) who showed that the forecasting ability of the term spread is found to be the highest in Germany followed by the US and Canada and the lowest in Japan.

Bernard and Gerlach (1998) show that there are no definitive findings that which evidence that economic leading indicators contain information for extended forecast horizons of economic activity into the future. Whilst Bernard and Gerlach (1998) do not go into why there is a relationship the slope of the yield curve and real economic activity, they do offer two leading hypotheses. The first holds that the relationship arises from the relationship between term structure and the effect from monetary policy.

To illustrate this relationship Bernard and Gerlach (1998) assume that the central bank increases rates on short term debt securities and since the action by the central bank is temporary, market participants will revise their expectations upward to reflect changes in future short term rate by less than the change in real short term rates.

The knock on impact of this is that long term interest rates also raise by less than the current real short term interest rate. The impact of this is that the yield curve evolves into a downward slopping curve. Given all of this, and the fact that the transmission mechanism takes between twelve to eighteen months to show the impact in the real economy, the argument that tightening of interest rate policy is then linked with a contraction in future growth and hence an escalation in the chance of economic downturn, Bernard and Gerlach (1998).

The second hypothesis put forward in the research by Bernard and Gerlach (1998) relied on the expectation of market participants and the view of future economic growth. Bernard and Gerlach (1998) illustrated that if market expectations of a recession start to materialize, inflation will reduce as a result of a lower growth environment, and as such the outlook is expectations are predictably likely to lead to a decrease in longer term yields and an increase in shorter term yields. Bernard and Gerlach (1998) go on to note that it is somewhat of an exercise to meaningfully by way of econometric analysis differentiate between the two hypotheses. That said, the research by Bernard and Gerlach (1998) focus to add to the current evidence of the ability of the term structure to forecast real economic growth.

Bernard and Gerlach (1998) make mention of a point that is stressed by Estrella and Mishkin (1995) in that one reason that the term spread is as suitable as the evidence suggests in developed in economies, especially is the US, is because it provides ample warning of a coming recession as the yield curve inverts. Bernard and Gerlach (1998) ask the question, does the same relationship hold in other developing countries. Table 1 below shows the empirical results from Bernard and Gerlach (1998) when the authors tested for estimated probabilities across other countries by using the term spread in each of the countries mentioned earlier.

Table 1 - Probability of recession four quarters ahead

Probability of a recession four quarters ahead as a function of the current spread

Spread (%)	Belgium	Canada	France	Germany	Japan	Netherlands	UK	US
4.00	0.10	0.02	0.06	0.00	0.19	0.21	0.05	0.00
3.00	0.18	0.04	0.11	0.02	0.20	0.28	0.09	0.02
2.00	0.29	0.09	0.17	0.07	0.22	0.36	0.14	0.08
1.00	0.43	0.16	0.25	0.20	0.24	0.44	0.21	0.21
0.00	0.57	0.25	0.34	0.41	0.25	0.53	0.30	0.41
-1.00	0.71	0.37	0.45	0.66	0.27	0.62	0.40	0.64
-2.00	0.82	0.51	0.56	0.85	0.29	0.70	0.51	0.83
-3.00	0.90	0.64	0.66	0.95	0.31	0.77	0.62	0.94
-4.00	0.95	0.76	0.76	0.99	0.33	0.83	0.72	0.98

Source: Adapted from “Does the term structure forecast recessions? The international evidence” by Bernard and Gerlach (1998)

An interpretation of the results shows that for a period of four quarters into the future, if the term spread differential for Germany for instance, is 4%, the probability of recession is 0.00%. However, more importantly, the results do show that as the rates go negative the probability of recession starts to increase.

Table 1 from Bernard and Gerlach (1998) show that data for Germany seems to show the most forecasting power of the term spread for real economic activity in to the future.

Research studies show that forecasting real economic activity forms the basis of many decisions. This can take the form of businesses relying on such forecasts in order to plan their production process. Policymakers make use of such research reports when deciding on a path of monetary policy going forward or when planning the national budgeting process. Therein lies the true question of the research, the value of the choices mentioned above depends on the quality of the forecast.

Over the past couple decades, financial markets have seen integration that has been unprecedented over the past fifty years. This is particularly important for yield curve analysis as this process of integration has a profound impact for transmission shocks across financial assets and the real economy.

Neumeyer and Perri (2001) research was motivated by examining real interest rates and business cycles in emerging markets. The emerging market economies looked at are Argentina, Brazil, Mexico, Korea and the Philippines. The evidence presented shows that in emerging economies that interest rates act counter cyclically in that they lead business cycles, the opposite was found of developed economies. The important relationship is that the yield curve has forecasting ability for economic growth. Neumeyer and Perri (2001) find that interest rate shocks are an especially important factor in explaining business cycles in emerging economies.

Stock and Watson (2003) introduce the principle that yields on debt securities as well as tradeable assets contain valuable information related to future economic prospects is embodied in the fundamental foundation concepts of macroeconomics. This relation was postulated by Irving Fisher in that the nominal interest rate is calculated by taking the real interest rate plus the expected inflation value. If a central bank tightens monetary policy by increasing short term interest rates, an inverted yield curve generally leads to future economic slowdown.

Stock and Watson (2003) reviewed fifteen years' worth of research studies that have considered forecasting economic activity using asset prices. The important consideration is that Stock and Watson (2003) define asset prices as including interest rates or more specifically the differential between the short term and long term interest rates. During the 1970s and 1980s there were many studies that employed monetary aggregates to forecast inflation and output growth.

Stock and Watson (2003) on close examination show that the GDP data for the USA successfully forecasted by the short term rates rather than the term spread itself. Stock and Watson (2003) examined various leading indicators and examined the data leading up to the US 2001 recession, Stock and Watson (2003) showed that the term spread did turn negative in advance of the recession.

The fundamental issue, as highlighted by Stock and Watson (2003), with using monetary aggregates is that there are constant revisions to the aggregates. In stark contrast, tradeable assets and tradeable debt securities are observed in real time and there is hardly a revision of these results which proves exceptionally beneficial to econometric studies in that the measurement error is reduced greatly.

The analysis by Stock and Watson (2003) employed quarterly data for forty three variables from France, the UK, Japan, Italy, the US, Canada and Germany for the period 1959 to 1999. The evidence suggests that asset prices prove to be more suitable in forecasting future output growth than for inflation. The basis of the review of the research by Stock and Watson (2003) is centred on the evidence provided on using the term spread and the relationship to output growth. Arnwine (2004) adds to this by showing that lower long term rates may reflect lower real yields due the expectations of the slower output growth. This then leads to an inversion of the yield curve.

With the body of evidence presented above, the bulk of which is on developed economies, the evidence shows that interest rate shocks can explain economic business cycles in developed economies. The evidence summarized the performance of real GDP growth and the four quarter horizon. The results as given evidence before, are consistent with previous studies. The forecast based on the term spread are of particular importance. The results show that, consistent with the literature, the term spread is suitable in its forecasting in the first period for the US and Germany, however the forecast improved in the second period in Canada and Japan but not for France, Italy the UK and the US.

Stock and Watson (2003) show that there are additional studies which provide a more holistic view of whether the yield curve as a forecaster of economic activity holds in other countries. Harvey (1990), Hu (1993), Bosner-Neal and Morley (1997) and others generally all conclude that the yield curve spread has forecasting content for real economic activity in countries other than the US.

Uribe and Yue (2005) show through their research that country spreads and business cycles are interrelated in emerging economies. Uribe and Yue (2005) found that country spreads do drive business cycles in emerging economies, however the evidence of the effects are fairly muted over the period of consideration. Specifically, Uribe and Yue (2005) find that if country spreads in emerging market economies were independent of The US interest rate then variance of the economic activity explained by the domestic yield curve drops by sixty six percent.

This finding is related to the interconnectedness of global economies but more so to the fact that developing nations respond more to state of developed nations as a result of the balance of the power over global trade that developed economies have due to globalization.

The paper examines the term structure of interest rates, monetary policy and the consequent impact on real activity in Europe and The US. The yield curve is thus a reliable measure that can be used as one piece of suitable information which, along with other leading indicators, can be used to assist in directing the course of central banks decision making.

Uribe and Yue (2005) show that the business cycle in emerging market economies are correlated with the cost of financing that those countries face in the financial markets. This is typically shown through a combination of interest rates and economic production. The results showed that over the period of 1994 to 2001 periods of low interest are associated with economic growth and period of high interest show economic decline. This finding is intuitive as lower cost of borrowing makes it cheaper for business to expand or pay down outstanding debt.

It is generally conceded to contain some information that may be of use to both market participants and to the monetary authority. This paper builds on the research by Uribe and Yue (2005) by examining those associations in a multi-country methodology.

Does a Central Bank wield enough influence to directly impact the yield curve and thereby influence the yield curve term spread through intervention via the short term instrument? The answer, more often than not for credible and independent Central banks is that they can directly impact the short end of the yield curve and that to a large and impactful manor. The long end, however, will be determined by many other considerations, including long term expectations of inflation and real economic activity.

The term structure contains valuable information which relates to the markets expectations of where future economic growth will go as well as the projection of inflation. There are other building blocks that make up a yield, such as credit risk premium and liquidity premiums, however these inputs create more noise and make the isolation of the future economic expectations and inflation difficult to zero in on.

The out of sample results of using the term spread to forecast economic growth has shown more promising results than the results from research using a host of other economic indicators to forecast economic growth.

A worthwhile contraction of monetary policy should have varying impacts on both the short end debt securities as well as the longer term debt instruments. The major impact of a contractionary monetary policy stance is a reduction in the need for borrowing by consumers at the short end of the curve. The long end of the curve is determined more by expectations of what future inflation and economic growth will look like. If the monetary policy intervention is deemed to be worthy this will have an impact of a lowering the expectation of long term inflation.

The combined result is that the change in long term rates tends to change by less than the change in the short term rates and subsequent the term spread declines. The case study suggests that an increase in the monetary authority base rate is probably going to have an impact on the yield curve spread if the intervention by the central bank is credible and does not lead to the perceived expectation by market participants and consumers of further intervention in the near term.

Furthermore, they show that central bank credibility may be an important factor in determining the estimated responses of the spread to a change in the central bank rate. More important is that Estrella (2005) showed that the yield curve has forecasted almost every post war recession in the US.

Interestingly, Estrella (2005) showed that the extent to which the yield curve is a good forecaster of future GDP is dependent on the form of monetary policy that is adopted by the in country central bank.

While this is not within the scope of this research, the form of monetary regime and the impact that has on the yield curve and subsequently GDP growth could be followed up for future research in emerging economies.

Literature shows that asset prices, interest rates, dividend yield and exchange rate as forecasters of growth and inflation, Burn and Mitchell (1935), Stock and Watson (2003) have provided the most suitable for forecasting the slope of the yield curve according to Mehl (2006). The forecasting of the yield curve has come into much focus due to the inversion of The US yield curve. The important consideration is that there is evidence to suggest that the inverted yield curve is a signal of a recession Mishkin (1991)

The paper by Mehl (2006) investigates the degree to which the slope of the yield forecasts domestic inflation and growth, the distinguishing point of research with this paper is that it referred to emerging market economies.

The bulk of the evidence and research in the field of yield curve slope has been done primarily on developed economies.

Mehl (2006) noted at the time of publication, international evidence has remained scarce to a limited number of industrialised countries. The evidence for emerging economies at the time was nil. This was primarily due to domestic bond markets in emerging economies only starting to deepen since the turn of the millennium, Mehl and Reynaud (2005). On a high level, the research found evidence to support the finding that that domestic yield curves within EM economies has forecasting content that can be reliably used in some geographies to forecasting economic growth and resultant inflation.

Mehl (2006) sampled fourteen emerging market economies with the purpose of investigating the appropriateness of the domestic yield curves in each country to forecast growth and inflation over the past ten years. The paper by Mehl (2006) contributed to existing literature by investigating the practicality of the slope of the yield curve as a forecaster of growth and inflation across fourteen emerging economies - this is the main interest of this paper.

The other areas contributed by the author related to whether the yield curve spread in the US or the European Union contribute in some way to forecast growth and inflation in the fourteen emerging market economies. Mehl (2006) also tested whether there is any information contained in the domestic yield curves that can be explained by The US and or Euro area. Lastly, Mehl (2006) investigated whether the movements in the domestic yield curves are country specific or whether there are other variables that can impact the domestic yield curve movements.

There is research which showed empirical evidence that the inversion of the slope of the yield curve signals a coming recession This dates back to research by Mishkin (1990) as well as Hardouvelis (1991). Mehl (2006) outlined the economic rationale behind this - the standard economics understanding is that the slope of the yield curve is directly related to monetary policy. As the central bank tightens interest rates, the short term interest rates are high relative to the longer term rates.

Mehl's (2006) evidence found across the fourteen emerging market economies, and using the methodology prescribed by Stock and Watson (2003), that on average a one hundred basis point steepening created the grounds whereby, inflation and lagged growth are expected to accelerate by thirty basis points a year ahead. It is important to present this evidence here as this is includes results for developing economies, some of which are examined in this research.

The results of Mehl (2006) show that the slope of the yield curve in emerging economies is found to have information content for future inflation and output growth. The results of the slope of the yield curve, which is used as a forecaster of domestic inflation and production growth, are summarized below.

The results in Mehl (2006) are reported for all of the thirteen countries from a six month forecast horizon to a two year forecast horizon with the interval between horizons being six months. The corresponding betas area also shown for lagged inflation as well as production growth for a one hundred basis point steepening of the domestic yield curve.

A one hundred basis points steepening of the US yield curve observed over the two year forecast horizon is linked with a projected acceleration in inflation by around forty basis points over the next six months for The US. The growth response is fairly robust in The US with two hundred and seventeen basis point response in relation to a steepening of the yield curve by one hundred basis points.

The results for the countries that are examined for this research show that for a one hundred basis points steepening would result in an eighty eight and eighty five basis points increase in inflation and production growth respectively. India shows a converse result with a one hundred and seventy basis points increase in inflation but a ninety seven basis points reduction in production growth. The result set for South Africa shows that the inflation response is sixty six basis points increase and a one hundred and thirty seven basis points increase in production growth.

Similarly, the study by Evgenidis and Siriopolous (2016) added additional evidence supporting the finding by Harvey (1988) and Estrella and Hardouvelis (1991) in that the yield curve provided suitable forecasting of output growth and inflation from one quarter to up to two years in advance. It must be noted that the studies mentioned above are all based on information that is specific to The US. Subsequently, there have been a number of studies that has investigated whether the yield curves forecasting ability is applicable in other countries.

Evgenidis, Papadamou and Siriupoulos (2018) showed what many other research papers before them have shown in that policy makers need to have the ability to influence the expectation over short and medium term expectations. However, in order to execute on this ability, central bankers require a solid foundation and knowledge of where the economic trajectory is actually headed. In layman's terms, central bankers need the ability to use reliable forecasts and one of those reliable forecasting tools that is most widely used in gaining a feel for the trajectory of the economy is the implementation and subsequent analysis of the difference between the difference on long and short term treasury securities.

Evgenidis, Papadamou and Siriupoulos (2018) surmise the essence of using the yield spread to forecast the trajectory of the economy to be particularly successful in forecasting the course of the economy particularly inflation and output growth. Evgenidis, Papadamou and Siriupoulos (2018) note that the ability of the yield curve to forecast inflation and output growth using the term spread has become a stylized fact and remains today as a powerful tool used by central bankers to forecast the course of the economy.

That said, it must be noted that there is literature where Evgenidis, Papadamou and Siriupoulos (2018) cite Dotsey (1998), Venetis and Paya (2005) and Hamilton and Kim (2002) whose research attempted to determine the effectiveness of forecasting inflation and output growth using the yield curve but whose results range from statistically positively significant to negative consequences.

The authors show that in some countries the ability of the yield curve to forecast output growth is strong whereas is other countries the evidence is muted at best. The work of Evgenidis, Papadamou and Siriupoulos (2018) provided a view of the preeminent research in this field in order to gain a complete view of the literature available on the yield curves ability to forecast economic output and inflation. The sample periods cover a long period which includes multiple economic shocks such as the Asian Crisis, the introduction of the Euro, the Dot Com bubble and the Global Financial Crisis.

Harvey (1988) and Estrella and Hardouvelis (1991) were amongst the first to study the impact of the forecasting ability of the yield spread on forecasting economic output and inflation.

Evgenidis, Papadamou and Siriupoulos (2018) go further by reviewing studies within the previous ten years which studies the forecasting ability of the yield spread and whether it has increased or decreased over time. Dotsey (1998), for example, found that the yield spreads forecasting power has reduced since the mid 1980's. Stock and Watson find similar evidence in the US from 1985 onwards. To expand on this article, Benati and Goodhart (2008) examined data for the US, UK, Euro area, Australia and Canada and find that the yield spreads forecasting power has considerably reduced after the 1908's and up until 2005.

Evgenidis, Papadamou and Siriupoulos (2018) focused their analysis on the country coefficients to paint a clearer picture of where the yield spread is suitable as an economic variable for future output growth. The results are depicted in the table below which highlights by the sign and the significance of the coefficients that the ability of the yield spread to forecast future economic output is valid in the US, Canada and Europe. Japan's coefficient estimates are insignificant and the coefficient estimates for Australia are negative. This indicates that the yield spread is not as suitable as an economic variable to be used as a forecaster of future economic growth.

Furthermore, the results in the table below notes the differences in magnitude and the significance of the coefficients through the decades. The results suggest that from the early 2000s to the 2007 Global Financial Crisis, the coefficients have been significantly positive. Going back further, the results show that through the 1970s, 1980s and the 1990s the coefficients were insignificant. This lead the authors to postulate that the yield curves ability to forecast future output growth is time varying in nature.

The paper finds that there are five main points that evolve from the investigation. The first being that US interest rate shocks explain about twenty percent of the average economic activity in emerging economies, second that in-country spread shocks explain about twelve percent of the impact on the business cycle in emerging economies, third that once the US raises rates the emerging market economies rates first fall followed by a delayed overreaction. Fourth that US interest rate shocks impact domestic economic variables mostly through the yield spread and finally, that the emerging market feedback on term spreads significant exaggerate business cycle fluctuations.

The question can be posed as to why a relationship between the yield curve spread and GDP should exist. The first plausible reason is that monetary policy is a key determinant that goes into the construction of the term structure, especially the short end of the curve, as well as an indicator for future real activity. Contractionary monetary policy has the impact of flattening the curve which would then lead to a slowdown of borrowing which then has the impact of leading to a slowdown of economic activity.

In several research studies, the yield curve has been shown to be a suitable and accurate economic variable to for forecast economic activity and subsequently inflation, with forecasting periods ranging from one to two years for economic activity and extended forecast horizons for inflation. This supports the evidence found by Smets and Tsatsaronis (1997) as their research found that the forecasting content of the yield curve is not policy independent.

Although the resulting statistical significance tend to be somewhat consistent across the countries, the important consideration is that the economic significance is shown to vary considerably across the different nations. This relationship is brought to light in that the six quarters ahead results the coefficient varies between 0.35 and 0.62. Thus if the yield curve spread experiences a change of one percentage point increase this will mean that this is linked to an average annualized six quarter real GDP growth between thirty five and sixty two basis points higher.

Overall, through the analysis of the research reviewed for this study, it is clear that the yield curve is a suitable leading indicator for output growth, especially in The US as early research was focused. The research then opened to other developed countries which the research reviewed for this study showed that the yield curve in general is a suitable indicator for forecasting future economic growth.

The question then follows, does the same relationship between the yield curve spread and economic activity hold for developing economies? Mehl (2006) provides detailed information of the yield curve as indicators for lagged inflation and industrial output for emerging economies. Bosner-Neal and Morley (1997) provide a suitable, simple and effective regression model which is used in this research with the change of using emerging market economy data for Brazil, Russia, India, China and South Africa. The US is examined as well as a base case for the relationship as shown by Bosner-Neal and Morley.

3. Description of data and research methodology

The research will be conducted by making use of secondary, longitudinal GDP, three month Tbill and ten year government bond data for the period 1980 quarter two to 2020 quarter two. The preeminent studies and previous research on the forecasting strength of the yield spread in The US as well as developed economies has focused on the spread between the three month Tbill and the ten year government bond.

This study will replicate the methodology of Bosner-Neal and Morley (1997) and employ a regression model which is detailed in section 3.1. The regression will focus on the beta coefficient as this will show the nature and the rate of change which illustrates to what degree GDP growth changes for a one percentage point change in yield spread. As such, the purpose of this analysis is to determine if the forecasting power of the yield curve in emerging economies holds using the same term points to calculate a spread. A further reason for this is that the three month Tbill represents the borrowing costs in the near team and the ten year in the long term.

Research data will be sourced from online repository data in which the researcher makes use of secondary data. Secondary data, which is described by Saunders and Lewis (2012), is data that has already been collected from other sources and is readily available. Quarterly data sampling is consistent with the approach taken by Bosner-Neal and Morley (1997) as well as Mehrotra and Sanchez-Fung, (2011).

3.1. Theoretical framework

Estrella and Hardouvelis (1991) showed through their research which employed the use of the three month Tbill rate and the ten year government bond rate was used to calculate the term spread by subtracting the long term rate from the short term rate. This research will follow the same approach in calculating the term spreads for the following countries, the US, South Africa, Brazil, Russia, China and India.

Mehl (2006) does show that due to globalisation, financial markets have become more interconnected but more importantly, that financial markets, and specifically bond markets in emerging market economies, have also developed at an astonishing pace. It is the aim of this study to employ the methodology developed by Bosner-Neal and Morley (1997) and to use the term points of the three month Tbill and ten year government bond as described in the seminal work by Estrella and Hardouvelis (1991).

The framework employed in this research will adopt the methodology applied by Bosner-Neal and Morley (1997) and is shown below as equation 1 in section 4. where the dependent variable is the percentage change in real GDP:

$$(Y)_i = \beta_0 + \beta_1 X_1 + error$$

Where:

- Y_i is the dependent variable
- β_0 is the sample intercept
- $\beta_1$is the slope coefficient and X_1 is the independent variable
- *error* is the random error term

The hypothesis is centred on the assumption that the yield spread between the three month Tbill and the ten year government bond has been shown to have forecasting power for future economic growth in developed economies. Therefore this research's aim is to determine whether the same informational content holds for emerging market economies.

3.2. Data

The basis of this investigation makes use of the following data: The three month Tbill rate which represents the short term rate and the ten year government bond rate which represents the long term rate. As defined by many of the research studies that were reviewed earlier in the literature review, the term spread is calculated by subtracting the long term government bond yield from the three month Tbill rate. The last economic indicator that will be consumed in this research study is the real GDP numbers for the countries in question.

3.3. Variables

The variables listed below are the key inputs into the regression model from equation 1 mentioned above. The topic of which points on the yield curve to use varies. Examples such as the research by Fama (1984) and Harvey (1988), used different points in the yield curve, predominantly shorter term maturities. As the research in the field developed, the focal point became the spread differential between the ten year government bond and the three month Tbill.

Estrella and Hardouvelis (1991) were amongst the first to employ the ten year government bond, three month Tbill spread. The same term point were also referenced in Bosner-Neal and Morley and it remains to this day an integral term spread indicator that market participants frequently reference. When choosing the yields of debt securities, the critical factor comes down to choosing securities which are actively traded. This research followed suit of Estrella and Hardouvelis (1991) and Bosner-Neal and Morley (1997) in an attempt to balance both comparability across the countries as well as the availability of the data.

As mentioned above in the literature review, yield curve data proves to be a much more reliable and better economic data point since the yield curve data is instantaneously available and the data is not revised. That said, this is based on the fact that the bulk of the studies that have been done in the field have been on the US and first world countries, all of whom have deep and liquid financial markets which

provided previous authors with an accurate and large data set that goes back several decades.

As for the measure of economic activity to use, this research used real GDP since this is the primary measure by which economic activity is measured and for the countries studied, this is the measure that was readily available.

Three month Tbill rate, ten year government bond rate

Real GDP growth measured as quarter on quarter growth, yearly numbers

Term spread (calculated by the difference between the ten year government bond yield and the three month Tbill).

3.4. Limitations

Early research into the forecasting ability of the term spread employed the use of short term maturities such as used in the work of Fama (1984) and Harvey (1988). As the research into the field evolved, other term points on the yield curve were used. The basis of using the three month Tbill and ten year government bond rate was primarily based on the availability of the data as well as the fact that the term points reflect debt instruments that are actively and frequently traded. In countries where debt securities are not actively traded in a deep liquid market, a substitute should be found. Similarly, in countries where the three month short term debt security bill rate is not available, a substitute for the three month rate needs to be found - one such rate could be three month forward rate notes or negotiable certificates of deposit with the same maturity.

Furthermore, it must be noted that due to the impact of globalization and the impacts developed economies have on developing economies through interconnectedness of financial markets, the impact that developed economies yield curve may have on the developing markets is ignored entirely. This effect has been studied by Mehl (2006).

The specific limitations related to this research arise due to countries not having deep, liquid and longstanding bond markets for history to develop for the ten year government bond and three month Tbill. India, China, Brazil and Russia are the countries impacted. In light of this limitation, the research used data as far back as

possible so as not to use other proxies to keep to the methodology of Bosner-Neal and Morley (1997).

3.5. Hypotheses

3.5.1 H0 – The term spread has not been optimal in forecasting future real economic growth one year ahead

3.5.2 H1 – The terms spread has been optimal in forecasting future real economic growth one year ahead

3.5.3 H0 – The term spread has not been optimal in forecasting future real economic growth two years ahead

3.5.4 H1 – The terms spread has been optimal in forecasting future real economic growth two years ahead

3.5.5 H0 – The term spread has not been optimal in forecasting future real economic growth three years ahead

3.5.6 H1 – The terms spread has been optimal in forecasting future real economic growth three years ahead

4. Results

The section below will outline the regression statistics that were produced using the regression model outlined by equation 1. The regression was run on all five BRICS countries as well as The US. Following on from the regression statistics, the analysis will then turn to a results section.

To recap, the literature surveyed has predominantly examined The US and the impact of the forecasting ability of the yield curve on future GDP as well as inflation. Harvey (1988), Hardouvelis (1988), Estrella and Hardouvelis (1991), Bosner-Neal and Morley (1997) and Mehl (2006), to name a few, found evidence that the yield curve is a valuable variable for forecasting future GDP. As the maxim that the yield curve provided forecasting information about GDP gained momentum, studies were then expanded to other developed economies such as the UK, Germany, France, Italy and the Netherlands. The results of the expanded research also confirmed that the yield curve proves to be a suitable variable in forecasting the path of GDP and inflation.

The purpose of this research is simply to determine whether the yield curve holds informational content which can be used to forecast the path of real GDP. Mehl (2006) provided a more up to date and econometrically complex methodology, the research focused on the lagged response of inflation and production output. On review of the methodology used by Bosner-Neal and Morley (1997), the appeal delivered by the simplicity, efficiency and replicability of the regression model was what ultimately made the decision to use the model. Moreover, the results presented by Bosner-Neal and Morley (1997) show impacts on real GDP, which is another reason for employing the regression model. Mishkin (1991) indicates that there is more informational content in longer term maturities which further supports the use of the ten year government bond.

At this point it is important to stress that the purpose of this research is to determine whether the domestic yield curve in the EM countries chosen holds informational content related to forecasting the path of real GDP. That said, the research does include the results for The US as a baseline.

The framework employed in this research will adopt the methodology applied by Bosner-Neal and Morley (1997) and is shown below as equation 1 where the dependent variable is the percentage change in real GDP:

$$(\%\ change\ in\ real\ GDP)_{t,\ t+k} = \alpha + \beta * (spread)t + error$$

Where:

- Percentage change is real GDP is defined as the year on year change from the quarterly real GDP number in the previous year to the current year
- Spread is the difference between the ten year government bond and the three month Tbill
- α designated Alpha is the intercept value
- β designated Beta measures the change in real GDP for a given change in the yield spread

4.1 Regression Results

This section outlines the statistical results of the regression model outlined in section 3.1. The results show quite a bit of information returned by the excel regression function. The key numbers to pay attention to are the R-square, Beta coefficients and p-values of the beta coefficients for the five BRICS countries and The US.

Regression results for The Unites States of America are outlined below.

Table 2 - Regressionstatistics for The United States of America

SUMMARY OUTPUT

Regression Statistics	*One year ahead*	Two years ahead	Three years ahead
Multiple R	0.167730404	0.154401273	0.160177699
R Square	0.028133488	0.023839753	0.025656895
Adjusted R Square	0.024084045	0.019755401	0.021563017
Standard Error	4.410424485	4.417286905	4.421940624
Observations	242	241	240

ANOVA One year ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	135.1415796	135.1415796	6.947494472	0.008940788
Residual	240	4668.442594	19.45184414		
Total	241	4803.584174			

ANOVA Two years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	113.8910906	113.8910906	5.836850046	0.01644471
Residual	239	4663.469241	19.5124236		
Total	240	4777.360332			

ANOVA Three years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	122.5448192	122.5448192	6.267136325	0.0129708
Residual	238	4653.747014	19.55355888		
Total	239	4776.291833			

One year ahead

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.070949958	0.455405877	4.547481849	8.61742E-06	1.173846999	2.968052918	1.173846999	2.968052918
X Variable 1	0.621494095	0.235788653	2.635810022	0.008940788	0.157014585	1.085973605	0.157014585	1.085973605

Two years ahead

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.165598911	0.457637362	4.732128737	3.80465E-06	1.264081039	3.067116784	1.264081039	3.067116784
X Variable 1	0.571348252	0.236489376	2.415957377	0.01644471	0.105478511	1.037217992	0.105478511	1.037217992

Three years ahead

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.132333101	0.460137002	4.63412656	5.90724E-06	1.225871706	3.038794495	1.225871706	3.038794495
X Variable 1	0.594049794	0.237294831	2.503424919	0.0129708	0.126583359	1.061516229	0.126583359	1.061516229

The regression statistics above illustrates the results for The US. For the purpose of this research the focus is on the R-square, Beta coefficients and p-values of the beta coefficients. The R-square numbers produced by the regression model using regression equation 1 consumes the real GDP quarter on quarter annualised growth number as well as the yield spread which is the differential between the ten year government bond rate and the three month Tbill rate. The GDP variable in this analysis is the dependent variable and the term spread is the independent variable.

The R-squared result provides a signal of the informational content of the term spread for real GDP growth. The Beta coefficient from equation 1 estimates the rate at which real GDP growth changes following this particular research, a one percentage-point change in the yield spread. To interpret the results of the model it is important to reflect that a positive value of the Beta coefficient from a statistical perspective would infer a positive linear relationship between the term spread and future economic growth.

In essence, this can be distilled into the following relationship, the bigger and more positive the spread between the ten year government bond spread and the three month Tbill, the stronger the real GDP growth will be into the future.

Estimates of the Beta coefficients from equation 1 provide insight into economic significance of the yield curve as being a reliable economic variable to forecast future real economic growth. Specifically, what is meant is that the Beta coefficient measures the change in real GDP growth for a given, in this case a, one-percentage-point, change in the yield spread. The beta coefficients produced for The US for the one, two and three year ahead forecasts compare favourably with the results shown by Bosner-Neal and Morley (1997) in that they are significant and show a steady decline in the Beta values as the forecast goes further out into the future.

The next section delves in to the result set of South Africa's regressiojn statistics from the regression model outlined in equation 1. Following this, the rest of the countries results are summarized accordingly.

Table 3 - Regression statistics for South Africa

SUMMARY OUTPUT

Regression Statistics	*One year ahead*	Two years ahead	Three years ahead
Multiple R	0.19210196	0.108032182	0.085895935
R Square	0.036903163	0.011670952	0.007378112
Adjusted R Square	0.030729465	0.005294636	0.000932515
Standard Error	1.846159265	1.871216441	1.879663831
Observations	158	157	156

ANOVA One year ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	20.37307397	20.37307397	5.977481407	0.0156028
Residual	156	531.6954287	3.40830403		
Total	157	552.0685027			

ANOVA Two years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.408914633	6.408914633	1.830359668	0.178055173
Residual	155	542.7249001	3.501450969		
Total	156	549.1338148			

ANOVA Three years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.044291608	4.044291608	1.144674724	0.286340729
Residual	154	544.1029619	3.533136116		
Total	155	548.1472535			

One year ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.282475313	0.166881513	1.692669894	0.092514502	-0.047163655	0.612114281	-0.047163655	0.612114281
X Variable 1	0.146045278	0.059734936	2.444888833	0.0156028	0.028051605	0.264038951	0.028051605	0.264038951

Two years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.357856624	0.169147773	2.115644902	0.035973348	0.02372429	0.691988959	0.02372429	0.691988959
X Variable 1	0.082926977	0.061295362	1.352907856	0.178055173	-0.038155093	0.204009047	-0.038155093	0.204009047

Three years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.373935936	0.170190815	2.197156976	0.029503166	0.037726014	0.710145858	0.037726014	0.710145858
X Variable 1	0.065902216	0.061596916	1.069894726	0.286340729	-0.055781757	0.187586189	-0.055781757	0.187586189

The Regression results of South Africa are presented above. The R-squared coefficients are poor and do not necessarily provide the best reading in terms of the forecasting power of the model over the forecasting horizon of the one, two and three year ahead values being 3.6%, 1.1% and 0.01% respectively.

The Beta coefficient estimates for South Africa, however, reveal results that are inconsistent with that of the literature surveyed as well as that of Bosner-Neal and Morley (1997). The Beta coefficient in the one year ahead regression is statistically significant with a p-value that is les that 0.05. The p-values for the two and three year ahead regressions are both above 0.05.

A one-percentage-point change in the yield spread today is associated with a 0.14 percentage-point change in real GDP growth one year ahead, an annualized 0.082 percentage-point change in growth two years ahead, and an annualized 0.065 percentage-point change in real GDP growth three years ahead.

South Africa's dataset is the only emerging economy country that has history equal to the full range of the analysis and the results produced are not conclusive to determine that the yield curve is a suitable variable to forecast future economic growth. The South Africa results is in contradiction with Tzavalis and Wickens (1996). Tzavalis and Wickens (1996) show a general finding from a number of research studies using the Unites States as a baseline that the greater the time horizon used the more information that term structure possess regarding future GDP and inflation.

Table 4 - Regression statistics for India

SUMMARY OUTPUT

Regression Statistics	*One year ahead*	Two years ahead	Three years ahead
Multiple R	0.062230712	0.110887141	0.019473566
R Square	0.003872661	0.012295958	0.00037922
Adjusted R Square	-0.00857893	-0.000366914	-0.012436431
Standard Error	3.890742389	3.175887347	3.940996074
Observations	82	81	80

ANOVA One year ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.708142686	4.708142686	0.311017383	0.578613798
Residual	80	1211.030107	15.13787634		
Total	81	1215.73825			

ANOVA Two years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	9.79400509	9.79400509	0.971024409	0.327471696
Residual	78	786.7283146	10.08626044		
Total	79	796.5223197			

ANOVA Three years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.459581271	0.459581271	0.029590365	0.863868515
Residual	78	1211.453105	15.53145006		
Total	79	1211.912686			

One year ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.396454983	0.606206151	2.303597518	0.023841312	0.190066298	2.602843669	0.190066298	2.602843669
X Variable 1	0.253772814	0.455043342	0.557689325	0.578613798	-0.651792295	1.159337924	-0.651792295	1.159337924

Two years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.042029982	0.508739451	2.04825865	0.043899341	0.029207536	2.054852427	0.029207536	2.054852427
X Variable 1	0.371755509	0.377261371	0.985405708	0.327471696	-0.379314187	1.122825205	-0.379314187	1.122825205

Three years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.590767962	0.631300787	2.519825724	0.013784339	0.333944641	2.847591283	0.333944641	2.847591283
X Variable 1	0.080530132	0.468148086	0.172018501	0.863868515	-0.851481113	1.012541377	-0.851481113	1.012541377

When comparing the result of India, the R-squared coefficients again do not necessarily provide the best reading in terms of the forecasting power of the model with the one year, two year and three year ahead values being 0.03%, 0.012% and 0.03% respectively.

The Beta coefficient estimates for India however reveal results that are inconsistent with that of the literature as well as that of Bosner-Neal and Morley (1997). The results are peculiar in that the research tends to show that the term spreads power of forecasting real GDP growth tends to diminish as the regression is pulled further out in to the future. India's results shows that the Beta value actually increases in the second year and then decreases in the third year. While the behaviour is peculiar, it is important to note that the beta values are still statistically insignificant.

The regression results pertaining to India are presented below. As can be seen the Beta coefficient estimates for India reveal results that are inconsistent with that of the literature surveyed including that of Bosner-Neal and Morley (1997).

The Beta coefficient in the one, two and three year ahead regression is statistically insignificant with a p-value that is greater than 0.05. A one-percentage-point change in the yield spread is calculated to have a 0.25 percentage-point change in real GDP growth one year ahead, an annualized 0.37 percentage-point change in growth two years ahead, and an annualized 0.08 percentage-point change in real GDP growth three years ahead. The results are peculiar, however, in that the research tends to show that the term spread efficacy of forecasting real GDP growth tends to diminish, such as seen in Estrella and Mishkin (1997) and Mehl (2006), as the regression is pulled further out in to the future. India's results shows that the Beta value actually increases in the second year and then decreases in the third year.

Table 5 - Regression statistics for Russia

SUMMARY OUTPUT

Regression Statistics	*One year ahead*	Two years ahead	Three years ahead
Multiple R	0.618971446	0.496139214	0.330344374
R Square	0.383125651	0.24615412	0.109127406
Adjusted R Square	0.37405397	0.234902689	0.095629336
Standard Error	1.047684468	1.1657328	1.270976396
Observations	70	69	68

ANOVA One year ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	46.35690602	46.35690602	42.23314576	1.12104E-08
Residual	68	74.63970661	1.097642744		
Total	69	120.9966126			

ANOVA Two years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	29.73016899	29.73016899	21.87758327	1.4558E-05
Residual	67	91.04850832	1.35893296		
Total	68	120.7786773			

ANOVA Three years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	13.05981839	13.05981839	8.084667573	0.005936247
Residual	66	106.615146	1.615381		
Total	67	119.6749644			

One year ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.676661814	0.125279978	5.401196768	0.00000091	0.42666951	0.926654118	0.42666951	0.926654118
X Variable 1	0.269050001	0.041400566	6.498703391	0.00000001	0.186436457	0.351663545	0.186436457	0.351663545

Two years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.668011	0.140422226	4.757160042	0.00001085	0.387727065	0.948294936	0.387727065	0.948294936
X Variable 1	0.21561867	0.046098489	4.677347889	0.00001456	0.123605701	0.307631639	0.123605701	0.307631639

Three years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.644615105	0.154215471	4.179963936	0.00008764	0.336713984	0.952516226	0.336713984	0.952516226
X Variable 1	0.142911549	0.050261592	2.843354985	0.00593625	0.042561042	0.243262055	0.042561042	0.243262055

When comparing the result of Russia, the R-squared coefficients provide a much better linear relationship, albeit not great. Again, the forecasting power represented by the R-square results are not strong and do not necessarily provide the best reading in terms of the forecasting power of the model within the one, two and three year forecast horizon periods ahead with values being 38.3%, 24.6% and 10.9% respectively. The result is similar to the results seen in Hardouvelis (1991), Estrella and Mishkin (1997), Bosner-Neal and Morley (1997).

The Beta coefficient estimates for Russia however reveal results that are consistent with that of the literature surveyed. The Beta coefficient within the forecasting periods are statistically significant with p-values that are less than 0.05.

A one-percentage-point change in the yield spread is calculated to have a 0.26 percentage-point change in real GDP growth one year ahead, an annualized 0.21 percentage-point change in growth two years ahead, and an annualized 0.14 percentage-point change in real GDP growth three years ahead. Interestingly, the Russia results set do align with the research that has been presented for developed economies.

China's results, depicted below, are non-compliant in every sense with the yield curve used as an indicator to forecast the path of future economic growth.

Table 6 - Regression statistics for China

SUMMARY OUTPUT

Regression Statistics	*One year ahead*	Two years ahead	Three years ahead
Multiple R	0.024662283	0.054587095	0.054719642
R Square	0.000608228	0.002979751	0.002994239
Adjusted R Square	-0.017238053	-0.01514789	-0.01546883
Standard Error	0.114252041	0.114610858	0.115598605
Observations	58	57	56

ANOVA One year ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.000444884	0.000444884	0.034081509	0.854200492
Residual	56	0.730997612	0.013053529		
Total	57	0.731442496			

ANOVA Two years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.002159187	0.002159187	0.164376102	0.686731935
Residual	55	0.722460688	0.013135649		
Total	56	0.724619875			

ANOVA Three years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.002167144	0.002167144	0.16217451	0.688752214
Residual	54	0.721604029	0.013363038		
Total	55	0.723771173			

One year ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.037243227	0.015087998	2.468400756	0.016650856	0.007018334	0.067468119	0.007018334	0.067468119
X Variable 1	-0.00257212	0.01393259	-0.184611778	0.854200492	-0.030482452	0.025338212	-0.030482452	0.025338212

Two years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.034916034	0.015251045	2.289419113	0.02591709	0.004352257	0.065479812	0.004352257	0.065479812
X Variable 1	0.005683327	0.014017911	0.405433227	0.686731935	-0.022409195	0.033775849	-0.022409195	0.033775849

Three years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.035539343	0.015506734	2.29186509	0.025838599	0.004450213	0.066628474	0.004450213	0.066628474
X Variable 1	-0.005704551	0.014165443	-0.402708964	0.688752214	-0.034104554	0.022695452	-0.034104554	0.022695452

When comparing the results of China, the R-squared coefficients are dismal in providing an indication of the linear relationship between real GDP and the term spread. Again, the forecasting power represented by the R-square results are not strong and do not necessarily provide the best reading in terms of the forecasting power of the model within the forecasting horizon of the one, two and three year forward values being 0.06%, 0.2% and 0.2% respectively.

The Beta coefficient estimates for China however reveal results that are completely inconsistent with that of the bulk of the literature as well as that of Bosner-Neal and Morley (1997). The Beta coefficient in the one, two and three year ahead regression are statistically insignificant with p-values that are greater than 0.05. A one-percentage-point change in the yield spread is calculated to have a -0.02 percentage-point change in real GDP growth one year ahead, an annualized 0.05 percentage-point change in growth two years ahead, and an annualized -0.05 percentage-point change in real GDP growth three years ahead. Interestingly, the China results set do

not comply at all, not even in the first year regression, with the bulk of the evidence that has been presented for developed economies.

Lastly, the Regression statistics are presented below for Brazil.

Table 7 - Regressionstatistics for Brazil

SUMMARY OUTPUT

Regression Statistics	*One year ahead*	Two years ahead	Three years ahead
Multiple R	0.024662283	0.054587095	0.054719642
R Square	0.000608228	0.002979751	0.002994239
Adjusted R Square	-0.017238053	-0.01514789	-0.01546883
Standard Error	0.114252041	0.114610858	0.115598605
Observations	58	57	56

ANOVA One year ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.000444884	0.000444884	0.034081509	0.854200492
Residual	56	0.730997612	0.013053529		
Total	57	0.731442496			

ANOVA Two years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.002159187	0.002159187	0.164376102	0.686731935
Residual	55	0.722460688	0.013135649		
Total	56	0.724619875			

ANOVA Three years ahead

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.002167144	0.002167144	0.16217451	0.688752214
Residual	54	0.721604029	0.013363038		
Total	55	0.723771173			

One year ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.037243227	0.015087998	2.468400756	0.016650856	0.007018334	0.067468119	0.007018334	0.067468119
X Variable 1	-0.00257212	0.01393259	-0.184611778	0.854200492	-0.030482452	0.025338212	-0.030482452	0.025338212

Two years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.034916034	0.015251045	2.289419113	0.02591709	0.004352257	0.065479812	0.004352257	0.065479812
X Variable 1	0.005683327	0.014017911	0.405433227	0.686731935	-0.022409195	0.033775849	-0.022409195	0.033775849

Three years ahead	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.035539343	0.015506734	2.29186509	0.025838599	0.004450213	0.066628474	0.004450213	0.066628474
X Variable 1	-0.005704551	0.014165443	-0.402708964	0.688752214	-0.034104554	0.022695452	-0.034104554	0.022695452

Looking at the results set of Brazil, the R-squared coefficients again do not necessarily provide the best reading in terms of the forecasting power of the model over the forecasting horizon of the one, two and three year period values being 9.1%, 3.3% and 1.3% respectively.

The Beta coefficient estimates for Brazil however reveal results that are inconsistent with that of the literature as well as that of Bosner-Neal and Morley (1997). The Beta coefficient in the one year ahead regression is statistically significant with a p-value that is less than 0.05. The p-values for the two and three year ahead regression are both above 0.05 that a one-percentage-point change in the yield spread is calculated to have a 0.40 percentage-point change in real GDP growth one year ahead, an annualized 0.25 percentage-point change in growth two years ahead, and an annualized 0.16 percentage-point change in real GDP growth three years ahead.

The results show the R-squared and alpha coefficients values for France, Germany, Italy, the UK and the USA. The R-squared results of Estrella and Mishkin (1997) are similar in comparison to this research in that they show very little by way of a linear relationship between the yield curve and real GDP growth.

However, the alpha values do show valuable informational content provided by the yield curve in forecasting real GDP. The results show alpha values decreasing as the forecast period goes further out which is consistent with the results set of The US and Russia. The alpha values can be compared to the beta values in this research and Bosner-Neal and Morley (1997). The results from Estrella and Mishkin (1997) are presented in Table 8 in Appendix 1.

4.2 Results

4.2.1 Results for the USA

When comparing the result of The US, as an example, R-squared coefficients do not necessarily provide the best reading in terms of the forecasting power of the model given the forecasting horizon over the one, two and three year periods ahead values being 2.8%, 2.3% and 2.5% respectively.

The Beta coefficient estimates, however, reveal results that are consistent with that of the literature surveyed namely, Stock and Watson (2003) and Bosner-Neal and Morley (1997). The Beta coefficients illustrate that for a given one-percentage-point change in the yield spread today, this is associated with a 0.62 percentage-point change in real GDP growth in the one year ahead forecast horizon, a 0.57 percentage-point change in growth in the two years ahead horizon and a 0.59 percentage-point change in real GDP growth three years ahead horizon.

Hence, all else constant, if real GDP growth in The US was 1 percent, a widening of the yield spread by one percentage point would imply an increase in real GDP growth to 1.62 percent (1 + 0.62 x 1) over the next one year forecast horizon, to 1.57 percent (1 + 0.57 x 1) on average over the two year forecast horizon and to 1.59 percent (1 + 0.59 x 1) on average over the three year forecast horizon. The graph below illustrates the beta comparisons over the three year forecasting period. While the results are economically and statistically significant, the results show that the two year ahead forecasting ability reduces when compared to the one year forecast and the third forecast increases which is contrary to the literature presented by Estrella and Mishkin (1997), Bosner-Neal and Morley (1997) and Mehl (2006).

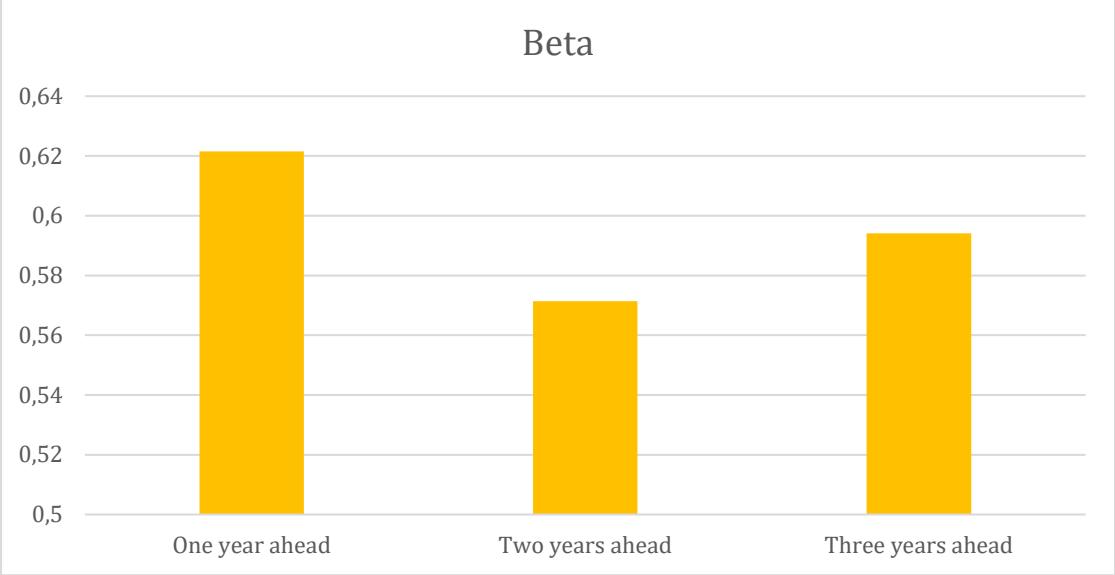

Figure 5 - Beta results for the USA

The outcome of the results when measured against the hypotheses reveals the following:

The research results present the p-values for the beta estimates for one, two and three years ahead. The results illustrate that the p-values in all the forecast periods are less than 0.05 and hence are statistically significant. This leads to the rejection of the null hypothesis in favour of the alternate hypothesis and can therefore determine that the term spread has been suitable in forecasting future real economic growth for the USA in all three forecast periods of the one, two and three years ahead testing.

4.2.2 Results for SA

From a South African perspective, if real GDP growth in South Africa was one percent, a widening of the yield spread by one percentage point would imply an increase in real GDP growth to 1.14 percent (1 + 0.14 x 1) over the next one year forecast horizon, to 1.08 percent (1 + 0.08 x 1) on average over the two year forecast horizon and to 1.065 percent (1 + 0.065 x 1) on average over the three year forecast horizon. That said, the beta values was only statistically significant at the one year forecast time period.

When measured against the hypotheses, the outcome of the results reveals the following:

The research results present the p-values for the beta estimates one, two and three year ahead. The results illustrate that the p-value in the one year ahead forecast is significant as the p-value is less than 0.05 and hence we reject the null hypothesis in favour of the alternate. However, for the beta estimates in the two and three year ahead regression, the p-values are greater than 0.05 and are therefore statistically insignificant. This leads to accepting the null hypothesis the regression results two and years ahead. The results indicate that the relationship of the term spread being a reliable indicator in forecasting future economic growth is not entirely dependable.

Below is a visual representation of the beta coefficients for South Africa over the one to three year forecast horizon.

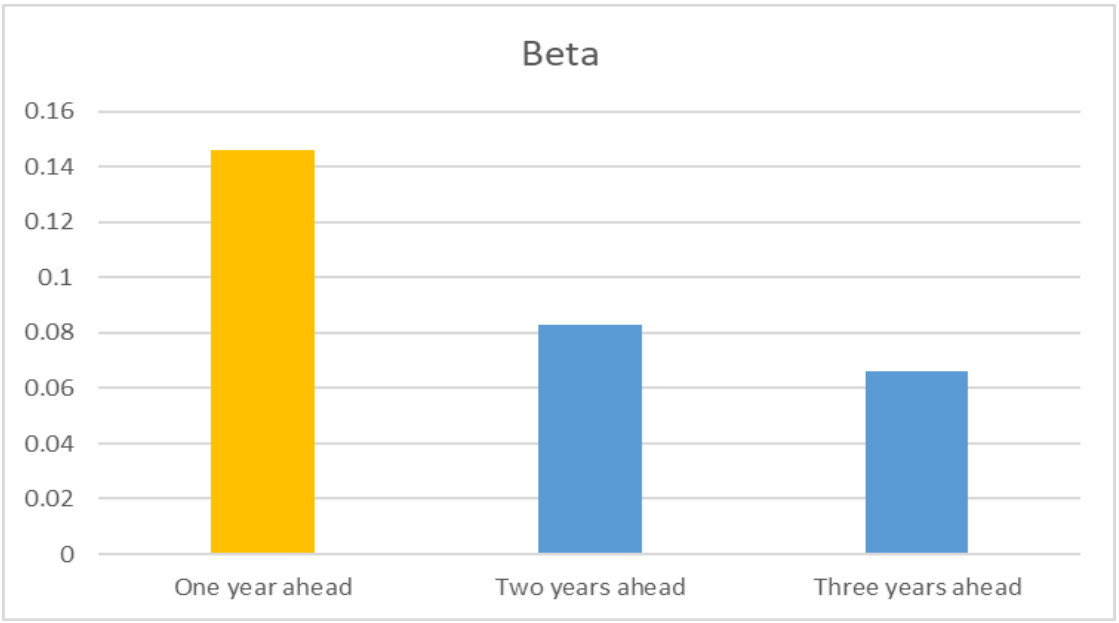

Figure 6 - Beta results for South Africa

4.2.3 Results for India

If real GDP growth in India was one percent, a widening of the yield spread by one percentage point would imply an increase in real GDP growth to 1.24 percent (1 + 0.25 x 1) over the one year forecast horizon, to 1.37 percent (1 + 0.37 x 1) on average over the two year forecast horizon and to 1.08 percent (1 + 0.08 x 1) on average over the three year forecast horizon.

When measured against the hypotheses, the outcome of the results reveals the following:

The research results present the p-values for the beta estimates for one, two and three years ahead. The results illustrate that the p-values in all the forecast periods are greater than 0.05. As a result of the p-values being greater than 0.05, we accept the null hypothesis which leads us to show that the term spread in India does not provide the necessary statistical and economic significance in order to be a reliable indicator of future real economic growth.

4.2.4 Results for Russia

If we assume real GDP growth in Russia was one percent, a widening of the yield spread by one percentage point would imply an increase in real GDP growth to 1.26 percent (1 + 0.26 x 1) over the one year forecast horizon, to 1.21 percent (1 + 0.21 x 1) on average over the two year forecast horizon and to 1.14 percent (1 + 0.14 x 1) on average over the three forecast horizon.

The outcome of the results when measured against the hypotheses reveals the following:

The research results present the p-values for the beta estimates for one, two and three years ahead. The results illustrate that the p-values in all the forecast periods are less than 0.05. As a result of the p-values being less than 0.05, which tells us that the Beta values are statistically significant, we reject the null hypothesis which leads us to show that the term spread in Russia does provide the necessary statistical and economic significance in order to be a reliable indicator of future real economic growth.

4.2.5 Results for China

The China dataset, as illustrated in the regression statistics section, is completely non-compliant with the literature that has been surveyed in this research. From a real GDP point of view, if growth in China was one percent, a widening of the yield spread by one percentage point would imply a change in real GDP to 0.98 percent (1 + -0.02 x 1) over the one year forecast horizon, to 1.05 percent (1 + 0.05 x 1) on average over the two year forecast horizon and to 0.95 percent (1 + -0.05 x 1) on average over the three year forecast horizon. The results showed that the yield curve for China has no empirical forecasting ability on real GDP. This in itself could be a research topic and could very well be due the constraints held on the economy and its connectedness in the global economy through its yield curve dynamics.

The outcome of the results when measured against the hypotheses reveals the following:

The research results present the p-values for the beta estimates for one, two and three years ahead. The results illustrate that the p-values in all the forecast periods are greater than 0.05. As a result of the p-values being greater than 0.05, which tells us that the Beta values are statistically insignificant, we accept the null hypothesis which leads us to show that the term spread in China does not provide the necessary statistical and economic significance in order to be a reliable indicator of future real economic growth.

4.2.6 Results for Brazil

Hence, all else constant, if real GDP growth in Brazil was one percent, a widening of the yield spread by one percentage point would imply an increase in real GDP growth to 1.4 percent (1 + 0.4 x 1) over the one year forecast horizon, to 1.25 percent (1 + 0.25 x 1) on average over the two year forecast horizon and to 1.16 percent (1 + 0.16 x 1) on average over the three year forecast horizon.

The outcome of the results when measured against the hypotheses reveals the following:

The research results present the p-values for the beta estimates for one, two and three years ahead. The results illustrate that the p-value in the one year ahead forecast period is significant as the p-value is less than 0.05 and hence we reject the null hypothesis in favour of the alternate. However, for the beta estimates in the two and three year ahead regression, the p-values are greater than 0.05 and are therefore statistically insignificant. This leads to accepting the null hypothesis for the regression results two and three years ahead. The results indicate that the relationship that the term spread is a reliable indicator in forecasting future economic growth is not entirely dependable.

Below is a summary of the beta coefficients for each country surveyed in this research over the one, two and three year ahead forecast periods. Figure 7 brings together a summary of the beta coefficients calculated using Equation 1. Together, the results indicate that the yield spread provides suitable information which helps forecast future real GDP growth in the USA and Russia for which the literature provides support for the same conclusion in other developed countries, the same cannot be said of the developing nations selected based on the evidence presented in this research. The explanatory power of the yield spread is highest in The US, and lowest in China. For the purpose of this research, we are primarily concerned with real GDP.

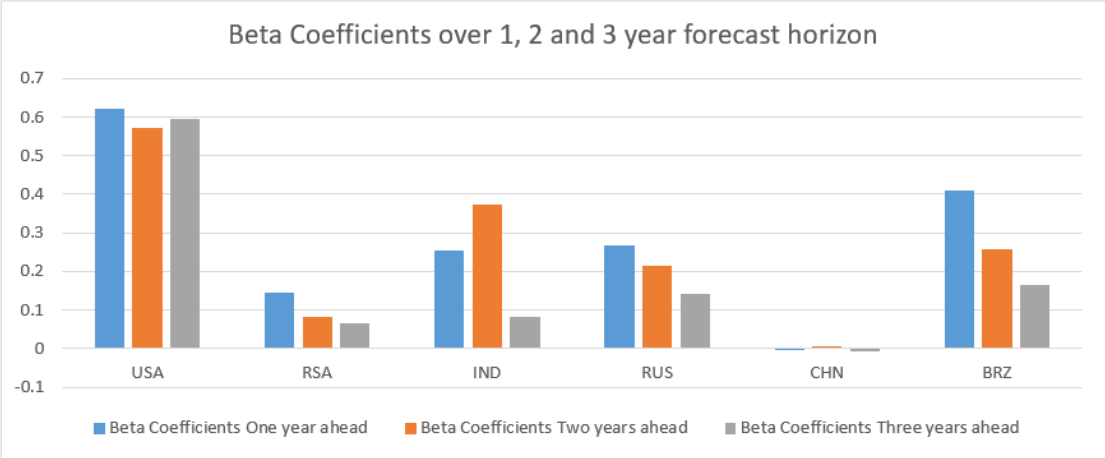

Figure 7 - Summary of Beta results for countries examined

Appendix 1 includes an excerpt from the research of Bosner-Neal and Morley (1997), table 9, in which the authors present the beta coefficients and r-squared statistics for the developed countries reviewed. The results from Bosner-Neal and Morley (1997) show that the beta coefficients are most suitable in their forecasting ability in the earlier forecasting period and wither away as the foresting period is extended.

The results of this research show similarity for The US and Russia in terms of those beta values that are economically and statistically significant. South Africa and Brazil, while not showing great results as the forecasting period goes further out in to the two and three year range, the beta values do diminish as the research surveyed and Bosner-Neal and Morley (1997) show.

The outliers in this research are India and China. India's results, while not statistically significant, show and improvement in beta values in the second year and then drop off in the third year. China is a complete outlier showing no comparison at all between the yield curve and real GDP.

In essence, we can conclude from the results that monetary policy intervention, especially in the short end of the curve, has an impact on the future expectations of the borrowing costs for longer dated debt. This in turn has an impact on the forecasting ability of the future path of GDP. This is the case in The US and Russia. That said, the yield curves of the rest of the EM countries do not show complimentary supportive results in favour of the yield spread reliably forecasting GDP growth.

The results produced in this research follows suit of the results from Estrella and Hardouvelis (1991), Bosner-Neal and Morley, (1997) and Estrella and Mishkin (1997) as they relate to the R-squared values. The results show that R-squared values are particularly low for the regression model.

Statistics tells us that this indicates that the independent value is not explaining much in terms of providing an explanation of the dependent variable. In summation, the research that has looked at the forecasting ability of the yield curve over the future path of GDP and inflation, be it real or lagged, has been around for some time. Initial studies by Fama (1984), Harvey (1988), Estrella and Hardouvelis (1991) all showed that for The US data and time periods of study, the yield curve showed forecasting ability for GDP.

As time elapsed further, authors looked into the maxim that the yield curve offers forecasting ability of future GDP and added to the research by changing methodologies to more complex econometric models as well as increasing the time period and the courtiers within the spectrum of study. Generally, the research still tends to find positive results for the USA and other developed economies.

Plosser and Rouwenhorst (1994) were amongst the first to study the effect the yield curve has on forecasting GDP outside of The US. The results showing that the relationship of forecasting the path of GDP using the domestic yield curve holds for Germany but the results are mixed for the UK. Bosner-Neal and Morley (1997) picked up on the research before and tried to determine whether in sample or out of sample data provided better results for the countries chosen in their research.

For the eleven countries studied by Plosser and Rouwenhorst (1994), the results showed that for out of sample data, the yield curve does hold forecasting ability particularly within the one year ahead forecast. However, this was not the case for Japan. As the forecast tenure was extended into the two and three year ahead vectors, the results show that the forecasting ability reduces in its economic and statistical significance.

Mehl (2006) was one of the first to develop and test an economic model for emerging market economies to determine if, based on the research that preceded, whether the domestic yield curves have forecasting ability over the lagged GDP and inflation. The results, which were screened for a comparison of similar choice of countries between this research and Mehl (2006), showed favourable results for South Africa and India on a lagged basis.

As a result of the literature reviewed and the direct involvement of central banks around the world to lower the rates and the front end of the curve in an effort to boost current economic demand due to depressed economic growth and subsequently, the impact of COVID, the question of inverted yield curves and the message that it carries of forecasting an economic downturn has become topical. Based on this, the purpose of this research was to determine whether domestic yield curve of the BRICS economies would show similar behaviour to what has been seen in The US and other developed countries where the yield curve has forecasting ability over the future path of GDP.

Based on the data collected and the subsequent results of the regression model, the yield curve shows that it has forecasting ability for South Africa in the one year ahead forecast, Russia in all the forecasting periods and Brazil in the one year ahead forecast. It must be mentioned however, that only South Africa has data for the full time period of this research from the BRICS countries. Brazil, Russia, India and China all have limited data availability.

5. Conclusion

The purpose of this research was to assess whether the term spread of emerging market economies has any forecasting content which would assist in trying to gauge the path of future GDP growth. As mentioned earlier in the paper, at the back end of 2019 term spreads as a subject found prominence again as The US yield spread measured by the ten year government bond and the three month Tbill turned negative as a result of the Federal Reserve Bank of America (The Fed) lowering interest rates in the hope that lowering borrowing costs stimulates the economy and lead to an increase in aggregate demand.

Overall, the results of the research, particularly that of The US, is supportive with the research of Bosner-Neal and Morley, (1997), Estrella and Hardouvelis (1991), and Estrella and Mishkin (1997). Surprisingly, the data reveals that Russia falls into line with the bulk of evidence in support of term spreads as forecasters of future economic growth. The evidence finds that the beta estimates of the regression model are statistically significant for the one, two and three year ahead result set.

The evidence for Brazil and South Africa is not fully supportive of the bulk of research showing that term spreads are suitable forecasters of future GDP growth. India and China are complete outliers, based on the results, in that none of the beta coefficients are statistically significant.

South Africa and Brazil do show some evidence, particularly in the one year ahead time frame, which is supportive of the findings from Bosner-Neal and Morley (1997). The two to three year ahead evidence does support Bosner-Neal and Morley (1997) results in that the beta coefficients reduce in explanatory power as the regression goes further into the future. That said, the beta estimates for Brazil, India, China and South Africa show subpar evidence in favour of term spreads as a suitable forecaster of GDP for all three forecasts.

This favours the results as shown by Davis and Fagan (1997), Smets and Tsatsaronis (1997) and Canova and De Nicolo (2000). Davis and Fagan (1997), Smets and Tsatsaronis (1997) and Canova and De Nicolo (2000) who provide evidence against the research in support of the yield curve forecasting ability. Davis and Fagan (1997) found subpar and erratic evidence for forecasting performance in the nine euro countries covered in their research.

Based on the research results in this paper, the conclusion can be reached that the term spread in emerging market economies is not as suitable as a variable to forecast future GDP as it is in the developed nations as the research reviewed tends to show.

6. Future research

Given that this study has investigated the fundamental relationship between yield curve spreads and real GDP in domestic EM. Given that most developing nations are dependent on trade with developed countries, in particular the USA and the Euro Zone, it is very plausible to find evidence that yield curve decisions and the shape of the yield curves in those developed countries are mirrored in part to the experience of the emerging market economies as most of those countries will have offshore borrowings and major trade deals with developed countries.

Future research could look at the interconnectedness of markets. In early 2020 the US yield curve did invert. However as can be seen from the research presented none of the EM domestic yield curves inverted as a result of the US yield curve inversion. Given that the EM countries studied in this research have the US as a major trading partner it could be fruitful to investigate the interconnectedness between the US and yield curve and the EM domestic yield curves.

Mehl (2006) does investigate the impact of yield spread as well as the connectedness of financial markets and the level of forecasting power these have over lagged GDP and inflation. In light of the fact that the paper was published in 2006, it seems plausible that a refresh of the study could be done to determine which is a more accurate forecaster of GDP growth between term spread or connectedness of financial markets, with the additional change of using real GDP instead of lagged GDP.

Whilst South Africa is the only EM country with data going as far as 1980, it would be suitable to collect more data for the other EM countries that have been reviewed over time to determine whether additional data points will lead to results in favour of the bulk of the research or whether this will still show that the term spread is not a suitable forecaster of future GDP growth.

Stock and Watson (1989) provide numerous forward and backward looking variables that are used to try and forecast the future growth path of GDP. Further research could be done in this regard for emerging economies to determine which of the forward looking variables in particular are suitable in forecasting the future growth path of GDP.

The variables would need to be used in conjunction with the term spread to keep the consistency of applying the yield spread to forecast the path of GDP. This would be akin to adding variables with the purpose of producing a more accurate forecast such as that done to the Arbitrage Pricing Theory model first described by Stephen Ross in the 1970s.

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Appendix 1

Table 8 - Yield curve spreads and the forecasted GDP reaction

Predicting future change in real GDP using yield curve spread (Sample: Quarterly, 1973 to 1994)

k (quarters ahead)	France		Germany		Italy		UK		USA	
	α	R^2	α	R^2	α	R^2	α	R^2	α	R^2
1	0.38	0.04	0.61	0.06	0.05	(0.01)	0.32	0.01	1.13	0.21
	(0.21)		(0.81)		(0.50)		(0.20)		(0.25)	
2	0.43	0.11	0.63	0.15	0.20	-	0.34	0.04	1.24	0.38
	(0.20)		(0.14)		(0.46)		(0.19)		(0.19)	
3	0.49	0.22	0.66	0.32	0.48	0.12	0.35	0.08	1.16	0.53
	(0.18)	(0.13)	(0.39)	(0.18)	(0.16)					
4	0.49	0.22	0.66	0.32	0.48	0.12	0.35	0.08	1.16	0.53
	(0.16)	(0.11)	(0.33)	(0.17)	(0.15)					
5	0.51	0.27	0.65	0.34	0.48	0.13	0.38	0.12	1.10	0.57
	(0.15)	(0.10)	(0.31)	(0.16)	(0.14)					
6	0.45	0.23	0.62	0.38	0.41	0.10	0.35	0.12	1.02	0.58
	(0.15)	(0.09)	(0.29)	(0.16)	(0.13)					
7	0.48	0.26	0.60	0.40	0.30	0.05	0.33	0.11	0.95	0.56
	(0.15)	(0.08)	(0.29)	(0.16)	(0.10)					
8	0.47	0.24	0.39	0.31	(0.06)	(0.01)	0.16	0.03	0.56	0.35
	(0.15)	(0.07)	(0.27)	(0.17)	(0.01)					
12	0.46	0.24	0.39	0.31	(0.06)	(0.01)	0.16	0.03	0.56	0.35
	(0.17)	(0.08)	(0.19)	(0.18)	(0.10)					
16	0.44	0.29	0.28	0.23	(0.13)	0.01	0.10	0.01	0.26	0.11
	(0.18)	(0.07)	(0.14)	(0.15)	(0.09)					
20	0.30	0.15	0.16	0.11	(0.10)	0.01	0.01	(0.01)	0.07	-
	(0.13)	(0.07)	(0.12)	(0.13)	(0.08)					

Source: Adapted from “The forecasting power of the term structure of interest rates in Europe and the United States: Implications for the European Central Bank” by Estrella and Mishkin (1997)

Table 9 - Beta Coefficients and forecasted real GDP reaction

Coefficient estimates for a regression of real GDP growth on the yield spread

	Forecast horizon								
	1 year			2 years			3 years		
	Constant	Slope		Constant	Slope		Constant	Slope	
Country	α	β	R^2	α	β	R^2	α	β	R^2
Australia	3.08	0.34	0.12	3.08	0.25	0.15	3.02	0.17	0.11
	(9.22)	(2.62)		(10.56)	(1.69)		(12.43)	(1.37)	
Canada	2.82	0.83	0.50	2.88	0.63	0.46	2.88	0.50	0.42
	(9.31)	(6.55)		(8.65)	(4.95)		(8.04)	(4.35)	
France	1.64	0.65	0.30	1.89	0.39	0.20	1.94	0.29	0.17
	(5.82)	(4.52)		(7.35)	(2.87)		(7.17)	(2.80)	
Germany	1.61	0.67	0.29	1.71	0.53	0.33	1.81	0.38	0.28
	(4.21)	(5.48)		(5.13)	(6.42)		(6.98)	(4.24)	
Italy	3.53	0.63	0.27	2.89	0.22	0.07	2.60	0.10	0.02
	(8.13)	(4.39)		(6.59)	(1.49)		(7.24)	(1.24)	
Japan	3.54	0.15	0.10	3.46	0.03	-	3.37	0.03	-
	(9.14)	(1.26)		(8.64)	(0.44)		(8.84)	(0.47)	
Netherlands	2.02	0.38	0.09	2.04	0.40	0.20	2.06	0.31	0.18
	(5.89)	(2.35)		(6.04)	(2.56)		(5.78)	(1.95)	
Sweden	1.59	0.32	0.11	1.55	0.17	0.05	1.48	0.09	0.01
	(4.60)	(2.34)		(3.93)	(1.28)		(3.64)	(0.71)	
Switzerland	0.97	0.42	0.07	1.00	0.36	0.09	1.07	0.17	0.03
	(2.33)	(3.16)		(2.25)	(3.48)		(2.49)	(1.30)	
UK	1.82	0.47	0.19	1.86	0.35	0.18	1.86	0.15	0.05
	(4.40)	(3.33)		(3.96)	(2.73)		(4.07)	(1.09)	
US	1.46	1.00	0.40	1.78	0.70	0.36	2.21	0.38	0.20
	(4.36)	(6.14)		(6.00)	(6.21)		(6.00)	(3.47)	

Source: Adapted from “Does the yield spread forecast real economic activity” by Bosner-Neal and Morley (1997)