THE YIELD CURVE AS A FORECASTING TOOL: DOES THE YIELD SPREAD PREDICT RECESSIONS IN SOUTH AFRICA?

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Abstract

This paper examines the ability of the yield curve to predict recessions in South Africa, and compares its predictive power with other commonly used variables that include the growth rate in real money supply, changes in stock prices and the index of leading economic indicators. The study also makes an attempt to find out if monetary policy explains the yield spread's predictive power with regards to future economic activity. Regarding methodology, the standard probit model proposed by Estrella and Mishkin (1996) that directly estimates the probability of the economy going into recession is used. Results from this model are compared with a modified probit model suggested by Dueker (1997) that includes a lagged dependent variable.

Results presented in the paper provide further evidence that the yield curve, as represented by the yield spread between 3-month and 10-year government paper, can be used to estimate the likelihood of recessions in South Africa. The yield spread can produce recession forecasts up to 18 months, although it's best predictive power is seen at two quarters. Results from the standard probit model and the modified probit model with a lagged dependent variable are somewhat similar, although the latter model improves forecasts at shorter horizons up to 3 months.

Compared with other indicators, real M3 growth is a noisy indicator and does not provide much information about future recessions, whilst movements in the All-Share index can provide information for up to 12 months but does not do better than the yield curve. The index of leading economic indicators outperforms the yield spread in the short run up to 4 months but the spread performs better at longer horizons. Based on the results from the study, it appears that changes in monetary policy explain the yield spread's predictive power. This is because the yield spread loses its explanatory power when combined with a variable representing the monetary policy stance of the central bank.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Economies have been historically observed to experience cycles in economic activity. Rather than grow steadily year after year, economies go through recurring intervals of economic expansion followed by times of contraction. These intervals are termed business or trade cycles and are characterised by recurrent but non-periodic fluctuations in the general business activity of the economy. Each cycle consists of four phases: a lower turning point (trough), an expansion, an upper turning point (peak) and a contraction. South Africa (RSA) has been no exception to this.

South Africa's economy continues to power ahead and data for the second quarter (2004) shows that real gross domestic product (GDP) grew by 4% from 3½ % in the previous quarter. The present economic upswing, which commenced during the third quarter of 1999, represents the longest period of uninterrupted quarter-on-quarter growth since 1960 (SARB, 2004:3). Since economies are observed to move in cycles, the question is how long this expansion will last before we see the next recession. Policymakers always seek to avoid recessions and steer the economy on a steady non-inflationary growth path and are always on the lookout for information that provides the likelihood of recessions.

Business cycle theory identifies two sets of factors that drive the cyclical movements of the economy: exogenous disturbances and the endogenous components of the economic system (Zarnowitz, 1972:17). Attributing business cycles to exogenous disturbances means that cumulative effects of external shocks or unexpected events cause economic fluctuations and these may include wars, inventions, oil price shocks, variations in weather or political and economic policy changes (Zarnowitz, 1972:17).

Endogenous[1] causes of instability in the economic system may be attributed to the decisions of governments, financial market participants or businesses. If business cycles are caused by exogenous factors (external shocks to the economic system), it means we can never predict recessions, whilst on the other hand, if they are caused by observable decisions of economic agents, policymakers have a better chance of understanding, predicting and avoiding recessions.

Central bankers, investors and financial market participants normally use complex macroeconomic models and composite indexes of leading business cycle indicators to forecast the path of the economy and the likelihood of recessions. Financial variables such as interest rates, stock prices and monetary aggregates also provide useful information about future economic activity (Estrella and Mishkin, 1996:1). Such financial indicators may be used to double-check both econometric and judgmental predictions as they are fairly quick and simple to use (Estrella and Mishkin, 1998:46). Proponents of financial indicators as forecasting tools maintain that financial markets are good aggregators of information because of broad participation in the markets and suggest that market participants have strong incentives to price securities as closely as possible to their fundamental values (Dueker, 1997:41).

The yield curve (the spread between the yields on long and short term government bonds) has been observed by researchers to be a useful forecasting tool. The yield curve[2] can be seen as a crystal ball that incorporates a wide range of information regarding the future development of inflation, the level of economic activity and interest rates. There is a significant body of empirical evidence to suggest that the yield spread is a useful tool for forecasting inflation, recessions, interest rates and possibly even the growth rate of real output (see Stojanovic and Vaughan, 1997:10, Nel, 1996:161 and Estrella and Mishkin, 1996:1).

[1] Endogenous in the sense that the business cycle is determined by factors within the economic system.
[2] The yield spread is assumed to mean the yield curve in this paper.

According to Dueker (1997:42), historical evidence shows that in the United States, at least on several occasions prior to recessions, long-term interest rates fell below short-term rates (yield curve inverts). In fact, Dueker shows that by 1997 the yield curve had become inverted prior to all five recessions that had occurred in the country since 1960. Several studies provide the same observation in other countries.[3] Estrella and Mishkin (1996:23) observe that the yield curve as a recession predictor outperforms many highly regarded forecasting measures including the Commerce Department's index of leading indicators and the movement in stock prices. Bernard and Gerlach (1996:4) also highlight a major attraction of the yield curve as a forecasting tool. They note that interest rate data is instantaneously available, it is never revised and the availability of data at both short and long term maturities makes it possible to forecast for long horizons.

Since 1980, periods identified by the South African Reserve Bank (SARB) as official recessions have been preceded by an inverted yield curve. Due to the fact that the country possesses highly developed financial markets, financial indicators such as bond yields should provide valuable information about the state of the economy. The theoretical justification for the use of the slope of the yield curve to predict economic activity can be found in the expectations theory of the term structure of interest rates. This theory assumes that long-term interest rates represent weighted averages of expected future short-term interest rates and, as such, spreads between rates of different maturities are interpreted as expectations of future rates corresponding to the period between the two maturities (Estrella and Mishkin, 1998:45).

Given the forward looking nature of financial markets, expectations about future interest rates should, in turn, reflect expectations about future real economic activity. Since several empirical studies have shown the usefulness of the yield curve in predicting future macroeconomic conditions in various countries, one might also want to model the business cycle in South Africa using the slope of the yield curve.

[3] Amongst the studies are Ivanova *et al* (2000) for Germany, Moneta (2003) for Euroland, Atta-Mensah and Tkacz (1998) for Canada.

1.2 PROBLEM STATEMENT

Government policy aims to deliver long-term sustainable and non-inflationary growth and, as such, endeavours to avoid periods of recession. It is for this reason that policymakers are always looking for information that will make them predict future economic conditions. Turning points in the business cycle (peaks and troughs) are hard to forecast and economists have a bad record with regard to predicting recessions. Since business cycle peaks are seldom predicted in advance, this normally leads to misguided policies.

A central bank that has missed the business cycle peak may continue tightening monetary policy in its fight against inflation and this could weaken economic growth further. The central bank's credibility will be compromised, as it will be seen as 'behind the curve'. Investors who have missed the turning point in the business cycle will invest in the wrong asset classes and thus sustain losses. Businesses will continue investing to increase capacity if they do not anticipate a recession and only realise late that demand for their goods has actually slowed down.

An accurate prediction of the business cycle turning points can be useful. Economic conditions sometimes change fast and unpredictably. Investment decisions are made with reference to future economic conditions and the clearer the crystal ball, the wiser the decision (Del Negro, 2001:1). From a policy perspective, if recessions can be successfully predicted a number of quarters in advance, this would represent a signal for a future rise in the output gap and a possible fall in inflation and monetary policy could then respond accordingly (Atta-Mensah and Tkacz, 1998:3).

Since changes in monetary policy affect real activity by a lag of 18 to 24 months, it is necessary for the South African Reserve Bank to accurately predict turning points in economic activity. This is of major importance to the central bank since it emphasises pre-emptive monetary policy. Based on the relationship between asset prices and the

business cycle, investors and portfolio managers can improve their asset allocation decisions by knowing when prices will reach their maximum and minimum levels (Moolman, 2002:44). A better understanding of the relationship between the term structure of interest rates and economic activity might also provide us with an insight into the way securities are priced in financial markets.[4] This is important for fixed income portfolio managers and bond traders.

Since several studies have shown that the slope of the yield curve provides a significant amount of information about future economic activity, and the yield slope outperforms other indicators in predicting recessions, the question is to what extent does the yield curve predict economic activity in South Africa? If the yield spread contains information about future economic conditions, does it do better than other financial variables in predicting recessions? Lastly, since the slope of the yield curve is indirectly influenced by the central bank, does monetary policy have an effect on the business cycle?

1.3 GOALS OF THE RESEARCH

The major objective of this dissertation is to study the ability of the yield curve to predict business cycle turning points in South Africa and to compare its predictive power with that of other economic indicators. To achieve this main objective, the following specific objectives will be pursued;

(a) To provide an overview of the relationship between the slope of the yield curve and the business cycle to assess if the yield spread provides any information about the business cycle;

[4] The yield curve can also be seen as representing the term structure of interest rates, which can be defined as the relationship between interest rates on financial instruments, and the maturities of those instruments (Mishkin 2004:127).

(b) To use movements in stock prices, growth in money supply and the index of leading economic indicators to estimate the probability of the economy going into recession and to assess if any of these indicators perform better than the yield curve;

(c) To assess if monetary policy is responsible for the yield curve's predictive power with regard to future economic activity;

(d) Based on the analysis, to draw conclusions on the information provided by the yield curve for monetary policy, investment decision-making and fixed income portfolio management.

1.4 JUSTIFICATION FOR THE STUDY

Although evidence on the predictive power of the yield curve is abundant, studies on the relationship between the slope of the yield curve and economic activity in South Africa are limited. Nel (1996) uses cointegration techniques to study the relationship between the term structure of interest rates and economic activity in South Africa and finds that the slope of the yield curve is positively related to the growth in real economic activity. Nel only studies the relationship between the yield curve and economic activity and does not use the yield spread to predict the business cycle. Also, his study only covers the period between 1974 and 1993 and as such, seems outdated since major structural changes took place in South Africa's economy since 1994.

Moolman (2002) uses data from 1979 to 2001 and a probit model to show that the term structure of interest rates can be used to predict turning points of the South African business cycle and specifically models the likelihood of the economy going into recession given the slope of the yield curve[5]. Moolman only uses the slope of the yield curve to

[5] Several authors, including Moolman (2002:44), do not differentiate between the term structure of interest rates and the yield spread.

predict recessions and does not compare its performance with other financial indicators to see if the yield spread does better. Several studies in other countries show that economic indicators like stock prices, money supply growth, leading economic indicator indices, spreads between government and commercial paper and foreign term spreads also possess useful information for predicting the business cycle (see Dueker, 1997; Estrella and Mishkin, 1998; Atta-Mensah and Tkacz, 1998; Moneta, 2003). It would be interesting to find out if such variables perform better than the yield spread in predicting recessions in South Africa. One other limitation of Moolman's study is that it does not cover one crucial period (2003) when the yield curve inverts but the economy does not go into recession.

Both Nel and Moolman's studies provide evidence that the yield curve possesses information in South Africa about economic activity and can therefore be used by both policymakers and the private sector in decision making. This study aims to fill the gap in the literature by comparing the predictive power of the yield curve with that of other variables that include changes in stock prices, money supply growth and the index of leading economic indicators. In addition, a modified probit model that includes a lagged-dependent variable is employed to find out if the results obtained from the simple model improve. Lastly, an analysis is made to ascertain if the yield spread's predictive power represents only the effect of monetary policy. The results of the study should also be of interest to countries closely linked to South Africa, especially countries in the Common Monetary Area (CMA).

The existence of large-scale macro econometric models and experienced professional forecasters may render the use of observing a single financial variable like the yield spread too simplistic. Besides gaining knowledge about the yield curve itself, policymakers and market participants can benefit in several ways from this approach (Haubrich and Dombrosky, 1996:27). Predictions made using the yield spread may be used as a check on the complex models and judgemental forecasts and perhaps highlight where causal relationships or assumptions need rethinking. On the one hand, if predictions from the model are in agreement with the financial indicator, confidence in

the model is enhanced. On the other hand, getting different results from the two methods may signal a need to review the assumptions that led to the prediction.

1.5 METHODOLOGY

1.5.1 Data Types and Sources

Data on the yield curve is the monthly average of the yield spread between the 10-year RSA government bond and the 91 days RSA government Treasury Bill. Data on share prices represents yearly percentage changes in the JSE All-share index and figures on money supply are year-on-year growth rate in real M3. The series on the repo rate represents the SARB's repurchase rate (formerly bank rate). All the above series were obtained from the Quoin Institute, RSA. Data on the business cycle represents periods identified by the SARB as official upswings and downswings. Data on the index of leading economic indicators is the percentage change in the index over 12 months. The series on the business cycle and the index of leading indicators were obtained from the SARB.

1.5.2 Method of Analysis

Descriptive statistics (graphs) will be used to explore the relationship between the business cycle and each of the variables. The aim is to assess if there is any observable trend of each variable along the business cycle phases. An econometric model (probit model) is used to estimate the probability of recessions given each of the variables. The study presents in-sample forecasts for each of the variables used.

1.6 SCOPE OF THE STUDY

Several variables can be used to model the business cycle. The study concentrates on the predictive power of the yield curve. The yield slope is represented by the nominal yield

spread between the 10-year government bond and the 3-month Treasury Bill. The study aims to directly estimate the likelihood of the economy going into recession given the yield spread. The performance of the yield curve is compared with that of the three variables mentioned above (stock prices, real M3 and the index of leading economic indicators). Monthly data covering the period January 1980 to June 2004 is used.

1.7 OUTLINE OF THE STUDY

Following this introductory chapter that lays the foundation and major objectives of the research, the rest of the study is organised as follows:

Chapter 2 sets out the theoretical foundation of the study. The theories of the business cycle and the term structure of interest rates are explained, followed by an analysis of the theoretical relationship between the business cycle and the yield curve. The chapter also reviews previous studies on the use of the yield curve to predict economic activity.

Chapter 3 provides an overview of South Africa's economy over the period studied with an emphasis on the business cycle. An analysis of the relationship between the variables studied and the business cycle is presented.

Chapter 4 presents the methodology of the study. The individual variables and the data used in the study are explained. The probit model and its specification are presented. The method used is reviewed, evaluated and justified.

Chapter 5 gives the empirical evidence and the results from the estimated probit model are explained. The chapter assesses whether the variables studied predict the business cycle, and a comparison of their predictive power is presented.

Chapter 6 concludes the study. Recommendations are presented on the usefulness of financial variables in predicting the business cycle and its role in monetary policy formulation and investment decision-making.

CHAPTER 2

LITERATURE REVIEW

2.1 THEORETICAL ISSUES

2.1.1 Introduction

The first objective of this study is to provide an overview of the relationship between the business cycle and the yield curve in South Africa. Understanding such a relationship requires knowledge of the theories behind both the business cycle and the yield curve. This chapter therefore sets out the theoretical foundation of the study and explains the economic theories behind the yield curve and the business cycle. The theoretical relationship between the two variables covered in this chapter should enable us to understand why the slope of the yield curve can be used to predict economic activity. This chapter also explores the empirical literature on the ability of the yield curve to predict economic activity; the theoretical relationship between the two variables and the methods used to predict the business cycle given the yield spread. Business cycle theory is considered first.

2.1.2 Business cycle theory

The observation that the aggregate economy does not climb on a steady trend but experiences occasional booms of activity and recessions is as old as the economics profession itself (Laubscher, 2004:22). Generally, the business cycle can be defined as the sequence of economic activity typically characterised by recession, fiscal recovery, growth and fiscal decline. Burns and Mitchell (1946, in Del Negro, 2002:3), some of the pioneers of studies on cyclical fluctuations in economies, say the business cycle consists of expansions occurring at about the same time in many economic activities, followed by similar general contractions. Each cycle consists of four phases: a lower turning point

(trough), an expansion, an upper turning point (peak) and a contraction. Business cycle literature distinguishes between classical business cycles and growth cycles (Laubscher, 2004:22).

The classical business cycle is a type of fluctuation in aggregate economic activity consisting of expansions occurring at about the same time in many economic activities, followed by similar general recessions and revivals which merge into the expansion phase of the next cycle. Such changes in economic activity are recurrent but non-periodic and vary from one to twelve years in duration (Smit and Van der Walt, 1982:49). A growth cycle can be defined as the fluctuation of the general economic growth rate around the long-term potential rate of growth, with such fluctuations being recurrent but not periodic (Laubscher, 2004:22).

For the purposes of this study, cyclical movements in economic activity in South Africa will refer to the business cycle in both classical and growth cycle terms. There are several competing theories of the business cycle, and despite the age of the debate, there is little consensus on the causes of cyclical fluctuations in the economy. Business cycle theory has evolved from the belief that cyclical fluctuations in the economy are caused by factors inherent in the economic system and as such, the economy will forever move in a cycle, to theories that attribute the business cycle to random shocks that move the economy away from its full employment level. Since such a debate is intense and beyond the scope of this paper, the main theories of the business cycle will be mentioned.

According to Chatterjee (2000:1), "early analysts of the business cycle believed that each cyclical phase of the economy carries with it the seed that generates the next cyclical phase. A boom generates the next recession; that recession generates the next boom; and the economy is forever caught in a self-sustaining cycle." This view of the business cycle was too broad and simplified and emphasised only self-sustaining behaviour. Chatterjee argues that a major implication of this view is that the economy cannot deliver stable and sustainable economic performance and therefore calls for aggressive countercyclical policies that are aimed at smoothening out the cycle.

The shock-based theory of the business cycle is based on the premise that there always exists a full employment level of economic activity, which the economy could theoretically always achieve (Romer, 1993:3). The full employment level of output tends to grow as the population rises and new technologies are discovered, and if nothing disturbs the economy, this level can be maintained forever. Business cycles therefore occur because the economy is occasionally disrupted by large shocks that force it to move temporarily away from the full employment level (Fuhrer, 1998:10). This view of the causes of the business cycle emphasises the effect of exogenous influences on the economic system that drive it away from its optimal potential and implies that without shocks there are no business cycles. Examples of such shocks can include terrorist attacks, drastic changes in weather, oil price shocks, balance of payments crises, rapid inflation, changes in money supply *etc*. Recent examples of exogenous shocks that have impacted heavily on economic activity have been the speculative capital flows to emerging markets that triggered severe recessions in a number of Asian economies in the late 1990s and the September 11 terrorist attacks in the United States in 2001. Attributing economic fluctuations to shocks implies that we cannot predict the business cycle and thus counter-cyclical policies can never work.

Monetary theorists put a great emphasis on the observed relationship between changes in money supply and changes in national income, and given this, they believe that monetary policy is at the heart of the business cycle (Hardwick *et al.*, 1990:404). Monetary policy can be defined as the government's attempts to influence aggregate demand in the economy by regulating the cost and availability of credit. Former SARB Governor Dr Chris Stals noted "there is a definite relationship between developments in real economic activity (the business cycle) and in the financial aggregates relevant for monetary policy" (Stals, 1997:1).

Central banks, in their pursuit of long-run price stability, have played a significant role in causing many recessions (Fuhrer 1998:2). Since an ultra-loose monetary policy is normally associated with upswings in economic activity and tight monetary policy with

contractions in GDP growth, we may infer that erratic monetary policy could cause fluctuations in economic activity (Macfarlane, 1993:4). Romer (1993:4) observes that monetary policy appears to have played a crucial role in causing business cycles in the United States since World War II. This theory of the business cycle also has its shortcomings.

Macfarlane (1993:9) points out that since cycles occur in all countries and business cycles across countries tend to be highly correlated, does it mean that all countries go through a series of policy errors? Fuhrer (1998:2) notes that it is important to distinguish the systematic response of monetary policy to existing conditions from the policy regime shifts and exogenous shocks. During the emerging market crisis of 1996/1997, the SARB hiked interest rates aggressively in an effort to defend the rand from speculative attacks and the economy slipped into a recession later on. Can we therefore safely assume that it was monetary policy or the speculative attacks (external shock) that caused the recession? These are some of the conflicting issues with regard to the causes of the business cycle.

Real business cycle theory is the latest attempt by economists at explaining cyclical fluctuations in the economy. Real business cycle theorists believe the business cycle would occur even if there were no monetary and financial disturbances such that countercyclical policies play no role at all (Chatterjee, 1999:2). This theory suggests that changes in productivity explain the cyclical movements in economic activity. Such productivity changes arise because of improvements in technology and workers' skills. Real business cycle theory assumes the important driver of the business cycle is the rate of change in technology that affects the supply side of the economy (Fuhrer, 1998:2). Fuhrer notes that technological changes are highly and positively correlated to output and business cycles and as such cause fluctuations in economic activity. The most controversial aspect of real business cycle theory is that it ascribes no importance to countercyclical policies and assumes that some policies aimed at reducing the severity of business cycles may worsen the situation (Chatterjee, 1999:2).

On the whole, a number of factors lie behind the business cycle and such factors are equally important. Laubscher (2004:23) concludes that business cycles are shaped by both external and internal developments and propagated by some endogenous law of regularity. Although business cycle theories differ on the causes of the cyclical fluctuations, what is noteworthy from the debate is that several consistent observations have been made by the various studies. Pradhan (2001:23) summarises the 'stylized facts' (observations made consistently over a long period of time) of business cycles and some of them are listed below:

- Upswings and downswings caused by the business cycle affect the entire economy and not only a few industries.
- Business cycles follow a similar pattern (boom, slowdown, recession, recovery) but the length of each cycle is unknown and cannot be predicted with certainty.
- Production data provides a good idea of the part of the business cycle the economy is in. For example, if production is rising, it can be inferred that GDP will rise.
- A slowdown in GDP is normally preceded by a decline in the growth rate of money supply. (Causation is not implied here since this presents part of the debate on the causes of the business cycle).
- Inflation responds to changes in the growth rate of money supply after a lag such that a reduction in money supply growth is followed by a decline in inflation after a period of time.
- A consistent rise in the stock market usually indicates the economy will perform better in the near future. Causation is also not implied in this case since stock prices also react to the current performance of the economy.
- Nominal interest rates increase after the economy begins a boom and start falling once the economy experiences a slowdown. Such a relationship also has implications about expected inflation. When the economy enters a boom period, people expect prices and inflation to start increasing and as such nominal interest rates will rise.

- A large fluctuation in the GDP of large countries affects the GDP of their trading partners.

If all the theories that explain the business cycle agree on the various and consistent observations stated above, rather than join the debate on the causes of the business cycle, it makes sense to use the 'stylized facts' to try and predict the business cycle. This paper therefore uses the observed relationship between the business cycle and nominal interest rates to predict future economic activity. The shape of the yield curve represents the movement of nominal interest rates in the study. Since monetary policy influences the level of interest rates, it is not implied at this stage that monetary policy causes the business cycle. This issue will be tackled at a later stage.

The next section reviews yield curve theory.

2.1.3 Yield curve theory

2.1.3.1 Introduction

It is generally accepted that the yield curve, which is representative of the term structure of interest rates, possesses valuable information about the course of the business cycle (Nel, 1996:162). Mishkin defines the yield curve as the plot of yields on bonds with different terms to maturity but the same risk, liquidity and tax considerations and it describes the term structure of interest rates for particular types of bonds, such as government bonds[6] (2004:127). Since the yield curve shows the relationship between yields and the term to maturity, the spread between short-term and long-term interest rates can also be seen as representative of the term structure of interest rates. The important issue on term structure discussions is the effect that term to maturity has on

[6] Mishkin (2004:120) also defines the term structure of interest rates as the relationship among interest rates on bonds with different terms to maturity.

yields when all other possible explanations for yield variations have been removed (Howells and Bain, 1998:183).

Nel (1996:163) summarizes the relationship between the business cycle and the yield curve and concludes that the term structure of interest rates embodies market expectations about future economic activity. In an economic upswing, long-term interest rates normally exceed short-term rates and the yield curve is upward sloping and positively shaped. As the economy approaches its peak and during the initial stages of the slowdown, the yield curve inverts (yield curve assumes negative slope) such that short-term rates exceed long-term interest rates. This would imply that by studying the changes in the shape or slope of the yield curve, it should be possible to predict future economic conditions. Theoretically, why should this happen? This question is tackled next.

Firstly, the main theories that explain why yields should vary with the term to maturity are covered.

2.1.3.2 Term Structure Theories

A review of interest rate fundamentals is necessary for one to understand why the yield curve can be used to forecast the business cycle. Theories of the term structure of interest rates explain the shape of the yield curve. More often than not, the yield curve slopes upward, indicating that long-term securities offer higher yields than short-term securities, although the curve can be downward-sloping (inverse), virtually flat across all maturities or display a hump in a certain maturity range (Santomero and Babbel, 2001:78).

Mishkin and Eakins (1998:147) point out that a good theory of the term structure of interest rates must explain the following three important empirical observations about yield curves: interest rates on bonds of different maturities tend to move together over time; yield curves usually slope upward; and when short-term interest rates are low, yield curves are more likely to have a steep upward slope, whereas when short-term rates are high, yield curves are more likely to be inverted. Three main theories explain the term

structure of interest rates, i.e. the relationship between interest rates on bonds of different maturities reflected in yield curve patterns. These are the *expectations theory,* the *segmented markets theory* and the *liquidity premium theory* (Mishkin, 2004:128). The *preferred habitat hypothesis* is closely linked to the liquidity premium theory.

2.1.3.2.1 The expectations hypothesis

The expectations hypothesis can be regarded as the classical theory of the term structure and it holds the view that the slope of the yield curve depends exclusively upon the expectations of the capital market about future interest rates (Dodds and Ford, 1974:18). This theory assumes that the yield on a long-term bond equals the average of the expected interest rates on short-term bonds. The central hypothesis of the expectations theory is that long-term interest rates are an average of current and expected future one-year interest rates (Van Zyl *et al.*, 2003:41). The key assumption behind this theory is that all securities in a given risk class, regardless of their maturity, are perfect substitutes and thus the expected return on these bonds is equal. Bond investors therefore do not prefer securities of one maturity over another and thus they will not hold any bond if its expected return is less than that of another bond with a different maturity (Mishkin and Eakins, 1998:149).

If the expectations hypothesis is correct, the slope of the yield curve can be used to forecast the future path of interest rates. The theory provides an explanation of why the term structure of interest rates changes at different times. Since the yield curve is derived directly from the market's estimates of future short-term interest rates, daily movements in the yield curve reflect changes in the market's expectations about future short-term interest rates. An upward sloping yield curve, as per the expectations theory, suggests that short-term interest rates are expected to rise in the future. A flat yield curve suggests short-term interest rates are expected to remain constant whilst a downward sloping or inverted yield curve implies that, on average, the market expects short-term interest rates to decline in the future. A humped yield curve would mean that short-term interest rates are expected to increase first and then fall.

The expectations hypothesis explains the fact that interest rates on bonds with different maturities move together over time (Mishkin, 2004:132). Historically, an increase in short-term interest rates has led to higher interest rates in the future, and since long-term rates are the average of expected future short-term rates, short and long-term interest rates tend to move together. The expectations theory also explains the tendency of the yield curve to slope downwards when interest rates are at historical highs and to slope upwards when rates are at the bottom of their range (Howells and Bain, 1998:187).

The above fact can be explained with the concept that investors perceive a range of 'normal' interest rates to which they expect future rates to return whenever current rates are at or outside the limits of this range. Therefore, when short-term rates are low, investors expect them to rise to some normal level in the future, and thus the average of future expected short-term rates is high relative to the current short-term rate. The yield curve will therefore slope upwards as long-term interest rates will be above current short-term rates. When short-term rates are high, there will be a general expectation for them to come back down to their normal level and long-term rates will then drop below the current short-term rate and the yield curve will become inverted.

The expectations theory also explains another important fact about the term structure of interest rates. If interest rates are mean reverting, (i.e. they tend to return to their normal levels if they are either unusually high or low), it implies that long-term rates will have a lower volatility than short-term rates since they represent an average of the future short-term rates (Mishkin, 2004:132). The major shortcoming of the expectations theory is that it does not explain the classical shape of the term structure, that is, the typical yield curve tends to be upward sloping. Does this mean there are in-built biases towards a positively shaped yield curve due to other factors not related to interest rate expectations, or are investors simply wrong on the average? According to the expectations hypothesis, short-term rates are just as likely to rise, as they are to fall.

2.1.3.2.2 The liquidity premium theory

The term (liquidity) premium theory of the term structure explains the yield curve's historical tendency to slope upwards (positive slope) except when interest rates are at very high levels, indicating that, as a general rule, bonds with longer maturities offer higher yields (Howells and Bain, 1998:188). This theory states that the interest rate on a long-term bond equals an average of short-term rates expected to occur over the life of the bond plus a liquidity premium (also called a term premium) that responds to supply and demand conditions of that bond (Mishkin, 2004:133).

The liquidity premium theory's key assumption is that, although bonds of different maturities are substitutes, they are not perfect substitutes. Since bond prices fluctuate with interest rates and the interest elasticity increases with a bond's duration, longer-term debt securities tend to have more volatile prices than short-term securities. Investors therefore tend to prefer short-term bonds since they bear less interest rate risk. The term premium theory therefore argues that investors must be paid an extra return in the form of an interest rate premium to encourage them to buy long-term bonds and compensate them for the increased risk (Van Zyl *et al.*, 2003:43).

Closely associated with this theory is the preferred habitat hypothesis, which assumes that investors have a preference for bonds of one maturity over another, i.e. a particular maturity segment (preferred habitat) in which they prefer to invest (Mishkin, 2004:134). Such investors will be tempted to move away from their preferred maturity sector only if they will earn a higher return. Since investors are more likely to prefer the habitat of short-term bonds (due to interest rate risk), they will be willing to hold long-term bonds if they offer higher expected returns. This fact explains the tendency of the yield curve to slope upwards. The term premium increases with term to maturity as investors demand extra compensation for having to invest in their less preferred maturities.

The term premium and preferred habitat theories recognise the important role played by expectations in influencing the shape of the yield curve. The shape of the yield curve is

therefore determined by expectations about future short-term interest rates plus a liquidity or term premium that compensates investors to invest in long-term bonds or to move away from their preferred habitat. These theories explain the facts that interest rates on different maturity bonds move together over time, yield curves tend to have an upward slope when short-term interest rates are low and to be inverted when short-term rates are high.

The tendency of the yield curve to typically slope upward is explained by investors' preferences for short-term bonds and the fact that the liquidity premium is always positive and increases with term to maturity (Mishkin, 2004:134). A downward sloping yield curve would arise in instances when market expectations of lower short-term rates in the future are so high that they far outweigh the term premium.

2.1.3.2.3 The segmented markets theory

The market segmentation theory of the term structure assumes that markets for different maturity bonds are completely separate and segmented (Mishkin and Eakins, 1998:151). The segmentation occurs because investors are interested in different aspects of securities rather than yields alone. The main assumption of this theory is that bonds of different maturities are not substitutes at all and the expected return from holding a bond of one maturity has no effect on the demand for a bond of another maturity.

The segmentation theory holds that investors have specific investment preferences that are ultimately dictated by the nature of their liabilities (Howells and Bain, 1998:190). Investors will therefore concentrate in a particular segment of the yield curve mainly to hedge their liabilities and to take advantage of arbitrage opportunities. A common example involves pension funds and insurance companies who have long-term liabilities and mainly invest at the longer end of the yield curve to try and match the duration of their liabilities.

According to the market segmentation theory, the slope of the yield curve is influenced by the demand for and supply of bonds within each maturity segment. This theory can explain why the yield curve will normally slope upwards since investors generally prefer securities with shorter maturities because of their lower interest rate risk. Long-term bonds will have higher yields due to their lower demand since investors prefer short-term bonds. This theory, however, does not explain why bonds of different maturities move together since it assumes the yield curve in each submarket is set in isolation from the yields in all other markets. The theory can also not explain why yield curves tend to slope upwards when short-term interest rates are low and to be inverted when short-term interest rates are high.

A combination of all the assumptions underlying the theories of the term structure gives us a more complete understanding of the factors that shape the yield curve. The liquidity premium and preferred habitat theories explain all the three empirical facts about the term structure and are thus widely accepted (Mishkin, 2004:137). These theories maintain that the interest rate on a long-term bond equals the average of the short-term interest rates expected to prevail over the life of the bond plus a liquidity or term premium, and thus these theories contain features of both the expectations and segmented market theories. All these theories, however, cannot explain the origin of interest rates and only account for the relationship between the various rates along the term structure.

It is widely accepted in economics that monetary authorities directly control the short end of the yield curve. Central banks, in pursuit of their monetary policy objectives, set the interest rate for overnight funds and are therefore responsible for explaining the movements in the short end of the yield curve. In South Africa, the SARB sets the repo rate for accommodation to the banking system and this influences overnight call rates (the lowest point on the yield curve). In the United States (US), the Federal Reserve sets the federal funds rate for overnight loans of reserves between banks. Financial market expectations about future economic activity, future levels of inflation, demand and supply concerns and the expected future path of short-term interest rates contribute to the determination of long-term interest rates. The central banks therefore influence the long

end of the yield curve indirectly through the effects of monetary policy on the expected rate of inflation and economic activity. Since interest rates are the key monetary policy tool for fighting inflation and can also be used to stabilise output and employment, changes in short-term interest rates change expectations about the future levels of inflation, output and employment and hence the future level of short-term interest rates.

2.1.4 Explaining the shape of the yield curve and economic activity

The theories of the yield curve can help one make predictions about the movement of short-term interest rates in the future. An upward sloping yield curve would suggest short-term interest rates are expected to rise, an inverted yield curve would imply short-term rates are expected to fall and a flat one would mean that rates are not expected to change in the future. According to Stojanovic and Vaughan (1997:11), market expectations about future interest rates also reflect expectations about future real economic activity and monetary policy. This gives rise to the relationship between the slope of the yield curve and the business cycle as determined by the expectations of future short-term interest rates.

If the term structure of interest rates reflects in part the collective forecast of expected inflation, it must also reflect investors' assessments of future real economic growth and interest rates. Interest rates fluctuate over the business cycle. Normally, interest rates are high at the peak of an expansion, they fall as the economy contracts, are at their lowest levels as the economy reaches a recession and rise again as the economy expands (Estrella and Hardouvelis, 1991:566).

Several studies (especially in the US) have shown that the yield curve inverts prior to recessions (see Stojanovic and Vaughan, 1997:10 and Dueker, 1997:42). This typically occurs several months or quarters before the onset of the recession. Since interest rate cycles normally lead the business cycle, can we safely assume that an inverted yield curve signals a recession? This question will be answered towards the end of the dissertation. Since the main objective of this study is to assess the ability of the yield

curve to forecast recessions, it is necessary to explain theoretically why the yield curve would invert before a recession. Moneta (2003:10) argues that there are three main reasons that explain the relationship between the term structure of interest rates and economic growth that make the yield curve contain information about future recessions. These are *market expectations about future interest rates, monetary policy effects* and *investor hedging.*

Moneta suggests that a positive relationship exists between the yield curve and economic growth. This relationship is mainly reflected in the expectations of financial market participants about future economic growth. An upward or 'normal' yield curve is associated with an increase in real economic activity whilst a negative yield curve is associated with a decline in real economic activity (Moneta, 2003:10).

The causes of the theoretical relationship between the yield curve and economic activity are discussed next.

2.1.4.1 Market expectations about future interest rates

The expectations hypothesis gives one explanation for the relationship between the yield curve and the business cycle (Karunaratne, 1999:2, Moolman, 2002:44). Since the expectations hypothesis assumes long-term interest rates represent the average of future expected short-term rates, long-term interest rates have embedded expectations about future economic activity. As investors anticipate that a recession is close, the response of the yield curve will depend on their assessment of the magnitude and duration of the recession's effect on short-term interest rates (Dueker, 1997:42). Generally, investors would expect short-term interest rates to fall during a recession. The expectation of lower interest rates may be due to an expectation of a counter-cyclical monetary policy designed to stimulate the economy, lower real rates of return, low inflation or a combination of these factors (Moneta, 2003:10).

In any of the cases mentioned above, if the expectations hypothesis holds, long-term interest rates should fall to take into account the lower short-term rates that are expected to prevail during the recession, thus causing the yield curve to flatten and then finally become inverted prior to the recession. On the other hand, market expectations of an economic recovery would cause the yield curve to exhibit a positive slope that steepens further as the economy powers ahead due to expectations of higher inflation and a tight monetary policy.

2.1.4.2 Monetary policy effects

The effect of monetary policy is clearly evident in the term structure of interest rates. One major importance of the yield curve is that it is an important mechanism for the transmission of monetary policy (Gowland, 1991:207). Central banks normally operate on the short end of the yield curve and therefore are only able to directly influence short-term interest rates. A combination of factors determines long-term interest rates. Since most forms of economic activity are influenced by long-term interest rates, the effect of monetary policy on aggregate demand will depend on how changes in short-term interest rates affects the longer end of the yield curve (Gowland, 1991:208). The impact of monetary policy therefore depends upon the nature of the term structure relationship, or specifically the slope of the yield curve.

The effects of monetary policy on the yield curve can also explain the relationship between the term structure of interest rates and the business cycle. Most central banks presently use interest rates as their key monetary policy tool with the ultimate objective of fighting inflation. When monetary policy is tightened through a hike in short-term interest rates, long-term interest rates will typically rise but usually by less than the change in the current short-term rate and thus lead to a flattening of the yield curve (Bernard and Gerlach, 1998:5). This could be due, in one instance, to an acknowledgement of the central bank's credibility in fighting inflation by the financial markets. The credibility of a central bank's monetary policy affects the way in which the

yield curve changes shape in response to a change in short-term interest rates (Wesso, 2000:76).

If the SARB hikes short-term interest rates and the yield curve flattens (i.e. the spread between short-term and long-term interest rates declines), this would imply that markets expect inflation to decline in the future and short-term interest rates to come down again. Since a monetary policy contraction can reduce spending in some parts of the economy and cause economic growth to slow down, if investors believe the SARB's actions could trigger a recession in the months ahead, the yield curve could flatten and eventually become inverted due to the increased probability of a recession (Moolman, 2002:45). An ultra loose monetary policy on the other hand could trigger an economic expansion and ignite fears of inflation in the months ahead thus causing the yield curve to steepen and show a positive slope.

2.1.4.3 Investor hedging

The maximisation of consumer choices can be seen as the third reason for the relationship between the yield curve and economic activity (Moneta, 2003:11). The preference for a stable level of income rather than a very high income during an expansion and a very low income during slowdowns will cause consumers to hedge against recessions (Moolman, 2002:44). If there is a general agreement in the financial markets that the economy is heading for a slowdown, investors may shift their funds into financial instruments such as long-term bonds that will deliver payoffs during the recession. The rush for long-term bonds will cause their prices to rise (and their yields to decline). Further, to finance their purchases of long-term bonds, investors will liquidate their holdings of short-term instruments and their yields will rise. The shifting of funds from short-term to long-term securities in anticipation of a recession will cause the yield curve to invert. This intuition is sometimes referred to as the Consumption Capital Asset Pricing Model and assumes movements in asset prices are associated with developments in economic activity (Alessandrini, 2003:3).

Expectations of an economic expansion will, on the other hand, cause investors to shift funds to short-term securities thus causing the yield curve to steepen and show a positive slope. The increased demand for long-term securities when a recession is anticipated can also be explained by the duration effect on fixed income instruments. Since long-term bonds have a higher duration, when the central bank loosens monetary policy during the slowdown, the prices of long-term securities will rise by a higher margin than short-term bonds and thus deliver a higher payoff.

Although several studies have shown that slope of the term structure contains information about future economic activity, no formal economic theory or model provides a reason for this (Dotsey, 1998:31, Plosser and Rouwenhorst, 1994: 138). The slope of the yield curve contains information on a number of economic variables and is presumably influenced by the path of expected inflation, expected real interest rates and risk premiums (Plosser and Rouwenhorst, 1994: 138). Changes in any of these variables will therefore cause the slope of the yield curve to change. Deliberate actions of central banks directly affect short-term interest rates. It is market expectations about the future levels of inflation, interest rates and economic activity that cause changes in long-term interest rates and hence the slope of the yield curve.

Expectations of higher inflation may cause the yield curve to steepen and this may prompt the SARB to hike short-term interest rates. In most cases, long-term rates will rise by a lesser margin than short-term interest rates and the yield curve would flatten. As inflationary expectations subside, the yield curve will invert thus prompting the tight monetary policy to cause a recession (Dotsey, 1998:37). Weak economic growth and low inflation expectations on the other hand may cause the central bank to cut short-term interest rates and this can cause the yield curve to steepen. High economic growth can lead to higher expected inflation and the yield curve may steepen further.

The next section reviews the literature on previous studies that tested the ability of the yield curve to predict economic growth and the likelihood of recessions.

2.2 EMPIRICAL LITERATURE

2.2.1 Introduction

Several studies have documented the strong predictive power of the slope of the term structure or the yield spread for future inflation, interest rates, the growth rate of real output and the timing of recessions. Since the major objective of this paper is to study the ability of the yield curve to predict recessions, this literature review focuses on studies that provide evidence on the information content of the yield spread with regard to economic activity. Studies on the use of econometric models to predict future economic activity have focused on two approaches.

The first one is predicting the future values of economic variables, one of which could be real GDP growth (see Plosser and Rouwenhorst, 1994; Haubrich and Dombrosky, 1996; Bonser-Neal and Morley, 1997) and the other method is to build a model that focuses on directly predicting the event of interest. The event of interest in this case would be the turning point in economic activity (see Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1998; Bernard and Gerlach, 1996). Predicting turning points is a by-product of the first type of models, whilst for the second category it is the ultimate goal of the model. Particular attention is paid to studies that determine whether the yield curve can predict the timing of recessions, since this is the main objective of the dissertation. For the yield spread to be able to predict recessions, it should also be in a position to forecast real GDP growth rates. Before reviewing evidence on the yield curve's ability to forecast recessions, its ability to predict real GDP growth is considered.

2.2.2 Forecasting real economic growth

There is a significant amount of empirical evidence (especially in the US) suggesting that a relationship exists between the future rate of growth in real GDP and the current slope of the yield curve. Estrella and Hardouvelis (1991), using US figures from 1955 to 1988, present evidence that the slope of the term structure can predict cumulative changes in

output for up to four years in the future and successive marginal changes in real output up to a year-and-a-half into the future. They use a simple econometric model to regress real GDP data on a yield curve represented by the yield difference between the 10-year government bond rate and the 3-months Treasury bill. They run in-sample forecasts using quarterly data for periods up to 20 quarters ahead. Estrella and Hardouvelis find that a steeper yield curve implies faster economic growth in the future whilst a flatter curve is associated with a slower growth in real output. They also observe that the slope of the yield curve outperforms variables such as lagged output growth, lagged inflation, the index of leading indicators and the level of real short-term interest rates in predicting real output growth.

Estrella and Hardouvelis (1991:566) also seek to find out if the slope of the yield curve reflects the effects of monetary policy only or if it reflects the influence of other factors besides monetary policy. They address this issue by adding the current level of the short-term rate to their simple regression and check to see if the yield spread continues to have statistically significant coefficients at the various forecasting horizons. Their study indicates that the information on the slope of the yield curve is mostly about variables other than current or expected monetary policy, as the predictive power of the slope remains almost intact. They argue that this feature of the term structure makes it provide useful information for central banks in their efforts to stabilize output and employment. Theoretically, they acknowledge the responsibility of current and expected future monetary policy on the predictive power of the yield curve but they fail to state the other variables that they cite as more important.

Plosser and Rouwenhorst (1994) study the information contained in the term structure about future real economic growth in the US, UK and Germany and seek to find whether movements of short term interest rates, current and expected monetary policy explain the predictive content of the yield curve. They find evidence that the yield curve has predictive power for real economic growth as measured by the growth rate of industrial production in the US and Germany and to a lesser extent the UK. The weaker predictive power for the UK was explained by the fact that inflation was both higher and more

variable in the sample period, thus obscuring the information in the term structure about real activity. They offer support to Estrella and Hardouvelis' (1991) findings that the slope of the yield curve contains information about future real activity that is independent of current or future monetary policy. They state that the yield curve does contain information about the future path of monetary policy but there is also a component of the spread that is useful for predicting real economic activity. Plosser and Rouwenhorst (1994:138) argue that the nominal term structure predicts future economic activity presumably because the path of expected inflation, expected real interest rates and risk premiums influences it.

Haubrich and Dombrosky (1996) follow on the work of Estrella and Hardouvelis and use a basic model designed to predict GDP growth in the US four quarters into the future based on the current yield spread. Their sample runs from 1961:1 to 1995:3 and a qualitative analysis of their data revealed a positive relationship between real GDP growth and the lagged yield spread. They observe that a decline in real GDP growth is usually preceded by a decrease in the yield spread and a narrowing yield spread often signals a decrease in real GDP growth. An increase in the yield spread, on the other hand, is associated with higher real GDP growth.

Their study also shows that an inverted yield curve usually (but not always) precedes a recession[7]. Their econometric model confirms the observation that the 10-year-3-month yield spread has significant predictive power for real GDP growth. However, Haubrich and Dombrosky also observe that the performance of the yield curve in the last decade had deteriorated, maybe due to a change in the relationship between the yield spread and economic activity (Haubrich and Dombrosky 1996: 34).

Bonser-Neal and Morley (1997) search for evidence on the usefulness of the yield curve as a predictor of real economic activity outside the United States. They evaluate the ability of the yield curve to forecast real economic growth in Austria, Canada, France,

[7] Although the 1990-91 recession was preceded by a flat yield curve, this was viewed as a dramatic change in its shape and hence quite informative in its own right.

Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the UK and the US. Using data from 1971 to 1996, they model changes in real GDP growth or Industrial Production on the yield spread and generate in-sample and out-of-sample forecasts. Their results also indicated that the yield spread is a significant predictor of economic activity across the countries concerned over the next 1, 2 and 3 years and provide evidence of the term structure's predictive power outside the US (Bonser-Neal and Morley 1997:48).

Bonser-Neal and Morley (1997:38) came up with the following observations: increases in the yield spread are followed by increases in real economic growth whilst decreases in the spread are followed by decreases in economic growth; the size of the spread is related to the level of economic growth, *i.e.* the larger the spread, the higher is the future level of real economic growth; and lastly, the strength of the relationship between the slope of the yield curve and future real economic growth varies across the eleven countries studied. They therefore conclude that the evidence on the predictive power of the yield curve for future economic activity seems almost well established.

According to Bonser-Neal and Morley (1997:39) two main explanations exist for the empirical relationship between the yield slope and economic activity. Firstly, the yield curve reflects the central bank's monetary policy stance. When short-term interest rates are hiked, long-term interest rates typically rise usually by a lesser amount and as a result the yield spread narrows and even becomes negative. Higher interest rates may reduce spending in some sectors of the economy and cause real economic growth to decline. As a result, a negative yield spread will normally be associated with slower real economic growth in the future.

The second explanation for the link between the slope of the yield curve and future economic growth stems from the hypothesis that the yield spread reflects market expectations about future economic growth. An expectation of higher economic growth in the future may lead to an increase in demand for credit from both the business and consumer sectors. Since borrowing will normally be long-term, there will be an increase in the supply of long-term bonds and this will cause their prices to fall. Long-term

interest rates will rise relative to short-term rates and the yield curve will steepen. Expectations of higher inflation due to increasing demand pressures will cause the yield curve to steepen further.

Several other papers investigate the yield curve's predictive power and find that the spread is a useful indicator of future real economic activity. Such papers, include among others, Hu (1993), Cozier and Tkacz (1994), Kozicki (1997), Smets and Tsatsaronis (1997) and Dotsey (1998). Although such evidence is abundant, it is unfortunate that it comes mainly from the United States and other highly developed countries. One interesting feature of the study on the relationship between the yield curve and economic activity has been the yield spread's ability to forecast the timing or likelihood of recessions.

Evidence on the ability of the yield curve to predict recessions is presented next.

2.2.3 Forecasting recessions

Estrella and Hardouvelis (1991) were the frontrunners in the study of the yield curve as a forecasting tool for predicting recessions. Using US data for the period 1955 to 1988, they first show that the yield spread between the 10-year Treasury bond and the 3-months Treasury bill is a useful indicator for future economic growth rates. Further, they propose that the yield curve may indicate more accurately when drastic changes in output occur. They argue that the yield curve may be a predictor of a binary variable (X_t) that indicates the presence or absence of a recession. Estrella and Hardouvelis estimate a nonlinear econometric model (probit model) that relates the indicator (X_t) to the slope of the yield curve lagged four quarters. Their model estimates the probability of a recession as dated by the National Bureau of Economic research (NBER) during the present quarter to the slope of the yield curve four quarters earlier.

Estrella and Hardouvelis find that the yield spread forecasts recessions in the US up to four quarters ahead. Their study shows that a negative relationship exists between the

slope of the yield curve lagged four quarters and the probability of a recession in the present quarter. This means that an increase in the spread between long-term and short-term interest rates would lead to a decrease in the probability of a recession four quarters later. Generally, this would mean that a steepening of the yield curve implies increasing chances of higher economic growth four quarters later and a downward sloping yield curve means a higher probability of a recession[8]. This lends support to the observation that the yield curve normally inverts prior to recessions.

Estrella and Mishkin (1996) also use a probit model to examine the usefulness of the US yield curve in predicting recessions and compare its predictive power with other financial and macroeconomic variables used to predict economic events. They follow Estrella and Hardouvelis (1991) and use a probit model to estimate the probability of the economy going into recession given the various indicators. Using data from Q1: 1960 to Q1: 1995, they find that the yield spread between the 10-year government bond and 3-month Treasury bill has a useful role in macroeconomic prediction and that it outperforms other highly regarded forecasting measures including the New York Stock Exchange (NYSE) stock price index, the Commerce Department's index of leading indicators and the Stock-Watson index of economic indicators.

Estrella and Mishkin (1996:4) observe two important facts about the performance of the four variables studied: all the variables have a forecasting ability one quarter ahead but the leading economic indicator indices produce the best forecasts over this horizon, and the performance of the yield curve dominates the other variables as the forecast horizon is increased to two and four quarters. They conclude that the yield spread can have a useful role in macroeconomic forecasting, especially with longer lead times. Since the yield curve is relatively quick and simple to use, they also argue that it can be used to supplement econometric and judgmental predictions. Getting similar results from the macroeconomic forecasting model and the yield curve can enhance confidence in the model whilst if the yield curve indicator gives a different signal, a review of the

[8] When the yield curve steepens, the spread between short-term and long-term bonds widens and when the yield curve flattens, the spread declines.

assumptions behind the model may be necessary (Estrella and Mishkin, 1996:5). According to Estrella and Mishkin (1996:2), current monetary policy, expectations of future inflation and real interest rates contained in the yield spread seem to play an important role in the prediction of economic activity.

Bernard and Gerlach (1996:22) investigate the ability of the term structure to predict the probability of a recession within the following eight quarters in several countries. The countries studied include Belgium, Canada, France, Germany, Japan, the Netherlands, the UK and the US. They also seek to find whether foreign spreads are useful in predicting domestic recessions since the movement in term spreads and economic activity tends to be correlated across countries. Using data covering the period 1972 to 1993, they apply the standard probit model to determine the probability of a recession given the spread of the yield curve. Their findings provide further evidence of the yield curve's predictive power even outside the United States.

Bernard and Gerlach (1996:22) come up with four major findings from their study: the slope of the domestic yield curve provides information about the likelihood of recessions in all eight countries; term spreads in some countries contain information for predicting recessions as much as six to eight quarters ahead; while German and US spreads were frequently significant in the regressions of other countries, the added information was limited except in the UK and Japan; and lastly, while leading indicators contain information not included in the term spread, this information is only useful for forecasting recessions in the immediate future.

Dueker (1997) provides further evidence of the ability of the yield curve to forecast recessions in the US. Using data from 1959 to 1995, he also applies a probit model to determine the timing of recessions and compares the forecasting performance of the Commerce Department's index of leading indicators, real M2 growth, the spread between 6-months Commercial Paper and 6-months TB rates, the percentage change in the S&P 500 stock index and the spread between 30-year Treasury bonds and 3-month Treasury Bills. Dueker also introduces a modified probit model that includes a lagged dependent

variable and introduces a Markov-switching coefficient variable in the model to confirm the results of the standard probit model (Dueker, 1997:45).

Dueker's results also indicate that the yield spread remains the best recession predictor amongst the examined set of indicators even under the extension of the basic probit model. He finds that the term spread performs better than the autoregressive series of the state of the economy, and the forecast accuracy, only at one quarter forecast horizon, was improved with the addition of the last variable. Dueker's findings strengthen the claim that the yield curve is a useful indicator and he concludes that the term structure has two properties that make it a favorable recession predictor. Firstly, the yield curve is readily available and gives a signal that is easy to interpret, and secondly, the expectations hypothesis of the term structure provides a theoretical foundation for the predictive power of the yield curve.

Estrella and Mishkin (1998) extend their 1996 study and examine the performance of various macroeconomic and financial variables in predicting future US recessions. The variables studied include the stock price indices (Dow Jones Industrial Average, NYSE Composite and S&P 500), 10year-3months yield spread, 6-months Commercial Paper and TB spread, monetary aggregates (M0, M1, M2, M3), macroeconomic indicators (growth in real GDP, CPI, Purchasing Manager's survey) and indices of leading economic indicators (Commerce Department's index of leading indicators, Stock and Watson's 1989 index and Stock and Watson's 1993 index). Standard probit models were used in the study using data from 1959 to 1995.

Their results show that the indices of leading indicators have a strong predictive power for short horizons, especially one quarter ahead. The spread of the yield curve possesses the best performance across all other horizons, followed by the stock price indices. Estrella and Mishkin conclude that the two variables (yield spread and stock prices) may be observed individually over their respective primary horizons or they may be combined to produce a more reliable simple model. They find that such indicators can supplement macroeconomic models and judgmental forecasts and can serve as "quick and reliable

checks of more elaborate predictions" (Estrella and Mishkin, 1998:55). Estrella and Mishkin also perform out-of-sample forecasts of the various variables studied in an effort to confirm their in-sample forecasts. They discover that the in-sample forecasts are confirmed by out-of-sample predictions but the performance of the variables showed some deterioration in terms of both accuracy and length of predictive horizon.

Atta-Mensah and Tkacz (1998) follow closely the technique employed by Estrella and Mishkin (1996) and use a probit model to examine the performance of selected financial variables in predicting recessions in Canada. Their results are similar to findings made in the US (Estrella and Mishkin, 1996; Dueker, 1997) and in Europe (Bernard and Gerlach, 1996) that the spread between Canadian long bonds and the 90-day Commercial Paper rate is best at predicting recessions in Canada when compared to other financial variables like stock indexes and money supply. In-sample forecasts of the yield curve's predictive power are also confirmed by out-of-sample forecasts. However, they observe that one drawback to their model was the lack of a dynamic structure and suggested that one might include a lagged dependent variable in the model as suggested by Dueker to address this shortcoming.

Karunaratne (1999) demonstrates that the yield curve, represented by the difference in yields between the 10-year bond rate and the 90-day bank bill rate, correctly predicts economic activity in Australia and a probit modelling of recessions reveals that the inverted slope of the yield curve provides reliable forecasts of recessions four quarters ahead. Karunaratne further finds that the forecasting power of the yield spread improves dramatically when the probit model is enhanced by a dynamic lag structure as per Dueker's (1999:12) recommendation. The stylized relationship between the yield spread and economic activity is explained by the expectations, liquidity preference, preferred habitat, monetary policy stance and consumption-smoothing hypotheses (Karunaratne, 1999:2).

Ivanova *et al.* (2000:) study the comparative performance of a number of interest rate spreads as predictors of German inflation and the business cycle. They study yield

spreads between 1-2 years and 9-10 years government bonds (public term structure spread), 1-2 years and 9-10 years bank bonds (bank term structure spread), 1-2 year bank bonds and 1-2 years government bonds (bank-public spread), the spread between the Lombard rate[9] and 9-10 years government bonds and the spread between the call rate and 9-10 years government bonds (both called term structure series). They use quarterly data over the period 1973:4 to 1998:2 and applied a two-regime Markov-switch model that allows the dynamic behaviour of the economy to vary between expansions and recessions.

The findings of Ivanova *et al.* (2000:54) confirm the usefulness of yield spreads for forecasting inflation cycles and economic downturns in Germany. Ivanova *et al.* (2000:55) observe that the bank term structure, public term structure and the spread based on the call rate predicted all recessions with a comfortable lead, although they lagged some of the recoveries by a few months. The spread between 1-2 year bank bonds and 1-2 year government bonds generated a series of false signals and the spread series based on the Lombard rate performed notably worse than the three market based series, implying that "the source of predictive power of market rate spreads is the information they contain about factors independent of monetary policy.

Moneta (2003) studies the informational content of the slope of the yield curve as a predictor of recessions in the euro area. The historical predictive powers of ten yield spreads for different segments of the yield curve are tested using two forms of the probit model. Using quarterly data over the period 1970:1 to 2002:2, Moneta estimates the standard probit model proposed by Estrella and Hardouvelis (1996) and the modified probit model with a lagged dependent variable suggested by Dueker (1997). He finds that the yield spread can be used to forecast recessions in the euro area and the best predictor is the spread between the 10-year and 3-month yields. According to Moneta (2003:43) the use of a lagged dependent variable only helps to forecast recessions in the immediate term.

[9] This is the rate at which the Bundesbank (German central bank) provides loans to banks secured against high quality paper (Bloomberg definition).

Moneta also compares the predictive power of the yield spread with other variables including the OECD composite leading indicator for the euro area, the quarterly growth rate of the stock index and the GDP growth rate. He finds the yield curve to be the most powerful predictor of recessions in the euro area for horizons beyond one quarter, and most importantly for up to four quarters, which is the most important forecast horizon for monetary policy. Moneta's conclusion is that the simple probit model with only the 10-year minus 3-months spread as an explanatory variable appears to be fairly reliable in predicting recessions in the euro area and its short-run forecasting ability is improved by adding the autoregressive series of the state of the economy. Moneta (2003:24) also finds that out-of-sample forecasts confirm the in-sample predictions but the best forecasting lag declines from four to two quarters.

Empirical work in South Africa on the relationship between the term structure of interest rates and economic activity is quite limited. Nel (1996) specifies and tests the relationship between the term structure of interest rates and growth in real economic activity. Employing data covering the period 1974 to 1993, Nel uses cointegration techniques to model the course of the business cycle with respect to the spread between the long-term government bond and the 3-months TB rate. Nel (1996:168) discovers that the slope is positively related to growth in real economic activity and concludes that the yield curve contains information about the real sector of the economy and may be used to forecast future economic activity.

Moolman (2002) uses a probit model to predict turning points of the South African business cycle based on its relationship with the term structure of interest rates. Quarterly data for the period 1979:1 to 2001:3 is used in the analysis and Moolman estimates the probability of the economy going into recession given the slope of the yield curve. The results from the study show that the probability of a recession in a specific quarter is a negative function of the yield spread lagged two quarters. The results indicate that the yield curve successfully predicts turning points of the business cycle two quarters ahead. The forecasting horizon of the yield curve (according to Moolman's study) seems to be

shorter in South Africa as most studies (especially in the US and Europe) point out that the yield curve gives its best results in a forecasting horizon of four to eight quarters.

Several other studies (see Stojanovic and Vaughan, 1997; Dotsey, 1998; Alessandrini, 2003) provide empirical evidence that the term structure of interest rates, as represented by the spread between short-term and long-term bond yields, correctly predicts the likelihood of recessions. The simple probit model, with only the term spread as an explanatory variable, appears to be fairly reliable in terms of forecasting recessions. Adding a dynamic lag structure to the simple probit model only improves the forecasting power of the spread over the short term (Dueker, 1997; Moneta, 2003). Most studies (especially in the US and Europe) show that the slope of the yield curve outperforms other financial variables and economic indicators in predicting recessions, especially for horizons beyond one quarter. Other financial indicators that feature prominently in the studies are changes in stock prices, the index of leading economic indicators, changes in real money supply growth, and the credit spread between government paper and commercial paper.

Although the observation that the yield spread provides useful information for predicting economic activity and the likelihood of recessions is almost well established, the theory that explains such a relationship remains somewhat rudimentary (Alessandrini, 2003:3). Since monetary policy has an influence on the slope of the yield curve, it is not surprising that several authors acknowledge the effects of current and expected monetary policy in explaining why the yield spread should forecast recessions (see Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1996; Moneta, 2003). It is also generally accepted in the literature that monetary policy effects do not fully account for the yield curve's predictive power.

Closely associated with monetary policy is the role played by the expectations hypothesis in explaining the forecasting ability of the yield curve. A change in monetary policy can alter the expectations of individuals about the future level of interest rates, inflation and in turn real economic activity. The Consumption Capital Asset Pricing Model provides

another theoretical explanation and assumes that households seek to maximize their utility by smoothening out their consumption path over time. When investors purchase financial assets like bonds, they substitute current for future consumption, and as such they form expectations about the future state of the economy (Alessandrini, 2003:3). Such expectations are reflected in the prices of the financial assets and this in turn leads to the forecasts for future economic conditions.

2.3 SUMMARY

Several important conclusions can be drawn from the literature. First and most importantly, the slope of the yield curve, as represented by the yield spread between short-term and long-term interest rates provides valuable information about future rates of real GDP growth and the likelihood of recessions. The theoretical justification for the spread's predictive power comes from the expectations hypothesis of the term structure, monetary policy and the Consumption Capital Asset Pricing Model (Stojanovic and Vaughan, 1997; Bernard and Gerlach, 1998; Moneta, 2003).

Secondly, although empirical evidence on the yield curve's predictive power is clearly abundant, most studies were done in the United States (for example Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1996; Haubrich and Dombrosky, 1996) and Europe (see Plosser and Rouwenhorst, 1994; Bernard and Gerlach, 1996; Bonser-Neal and Morley, 1997; Moneta, 2003) with limited evidence from emerging markets. With regard to forecasting real GDP growth, simple regressions of GDP on the yield spread consistently provide sufficient results.

The standard probit model dominates and provides consistent results for studies that forecast the likelihood of recessions. Other variables that feature in the literature as useful indicators for future economic activity are the movements in stock prices, changes in money supply, the index of leading economic indicators and the credit spread between commercial and government paper. The yield spread between 10-year bonds and 3-month treasury bills outperforms all other yield curve segments and economic indicators in

predicting the likelihood of recessions, especially at longer forecasting horizons (see Dueker, 1997; Estrella and Mishkin, 1998; Atta-Mensah and Tkacz, 1998; Moneta, 2003). Lastly, only a limited number of the studies confirm their in-sample forecasts with out-of-sample predictions.

The major aim of this study is to examine the ability of the yield curve to predict business cycle turning points in South Africa with an emphasis on the likelihood of recessions. From the literature review, it is clear that the yield curve is widely accepted as a forecasting tool and can also be used in South Africa. Evidence on the yield curve's predictive power is limited in South Africa and a comparison of the performance of the yield spread to other variables has not been documented.

CHAPTER 3

SOUTH AFRICA'S BUSINESS CYCLE SINCE THE EARLY 1980s

3.1 INTRODUCTION

In order to achieve the objective of this study as stated earlier, it is necessary to provide an overview of the country's business cycle and its relationship with the yield curve. This chapter analyses South Africa's business cycle since the early 1980s, focusing on prominent features of the business cycle and the relationship between the yield spread and the business cycle. Since the forecasting power of the yield curve is compared with that of changes in stock prices, money supply and the index of leading economic indicators, the relationship between the business cycle and each of the variables is also presented in the chapter.

3.2 BUSINESS CYCLE PHASES

The South African Reserve Bank has used various methods to determine the upper and lower turning points of South Africa's business cycle since 1946 (Venter and Pretorius, 2001:63). Measuring the business cycle from peak to peak, South Africa is currently in the upward phase of the fourth business cycle since the early 1980s (see Table 1).

Table 1 **Business Cycle Phases of South Africa since 1981**

Business Cycle	*Downward Phase*	*Length (Months)*	*Upward Phase*	*Length (Months)*
1	Sept 81 – Mar 83	19	Apr 83 – Jun 84	15
2	Jul 84 – Mar 86	21	Apr 86 – Feb 89	35
3	Mar 89 – May 93	51	Jun 93 – Nov 96	42
4	Dec 96 – Aug 99	33	Sept 99 – now	60-plus

Source: SARB Quarterly Bulletin, March 2003

The SARB uses the growth cycle for analyzing cyclical fluctuations in economic activity and for determining the reference turning points in the business cycle[10] (Smit and Van der Walt, 1982:50). The downward phase of the business cycle would be associated with declining growth rates that are below the long-term growth potential. Such growth rates will decline until they become negative and the economy will be in a recession when two consecutive quarters of a decline in real GDP are experienced. When the economy enters its downward phase, the possibility of a recession therefore increases. Once in a recession, the turning point in the business cycle will be marked by the first of two consecutive quarters of real GDP growth. The business cycle will assume its upward phase where growth rates will exceed the long-term growth potential (see Van der Walt, 1982:50 and Laubscher, 2004:22).

Laubscher (2004:25) notes that the first most important fact about South Africa's business cycle (especially in the 1980s) is its close correlation with the global business cycle; *i.e.* the domestic cycle is largely influenced by developments abroad. Laubscher uses the relationship between G7 countries' Industrial Production and South Africa's domestic coincident business cycles indicator to demonstrate that the country's business is influenced by fluctuating economic conditions in industrial countries. He argues, "as a supplier of commodity inputs to the major industrial country production processes, business cycle developments in these countries were rapidly transmitted to South Africa" (2004:26).

3.2.1 The Business Cycle in the 1980s

The September 1981 to March 1983 downswing phase of South Africa's business cycle was mainly attributed to the slowdown experienced by the United States and other industrial countries as a result of the first oil shock (SARB, 1982:1). The global slowdown was reflected in declining exports from RSA. The huge decline in the gold

[10] A growth cycle refers to the fluctuation of economic activity around a long-term growth trend (Laubscher, 2004:22).

price in the early 80s also contributed to a great extent to the slowdown in South Africa since the economy was largely dependent on gold exports. According to the IMF (2002:125), emerging market economies like South Africa are highly vulnerable to commodity price shocks because they specialize in commodity exports and are also dependent on commodity inputs, especially oil. The drought experienced in the early 1980s also had an adverse effect on agricultural output and the domestic economy (SARB, 1983:1). The SARB noted that a recovery in the gold price and global demand was necessary for the economy to recover from its slump. The downswing lasted for 19 months and the trough was reached in March 1983.

The business cycle changed in the second quarter of 1983 with an increase in domestic demand rather than a recovery in exports driving the recovery and transferring the economy into the upswing phase of the business cycle. Real private and government consumption expenditure were the main forces behind the upswing phase of the business cycle (SARB, 1984:1). Excessive money creation brought about by a decline in interest rates since 1983 supported the upswing (SARB, 1984:20). Export growth also started responding to the recovery in the industrial nations and this lent further support to the recovery in South Africa.

The high level of domestic expenditure, however, led to increases in inflation, a weakness in the balance of payments and a sharp depreciation of the rand. The above factors, which started appearing in the fourth quarter of 1983, coupled with a further decline in the dollar price of gold and a persistent drought, presented problems for the economy and required countercyclical policies (SARB, 1984:20). The SARB started tightening monetary policy from 1983 and this led to a decline in money supply and in turn, private consumption expenditure. Government consumption expenditure moderated in the period also reflecting the restrictive policy measures.

The gradual tightening of monetary policy and further restrictive fiscal policy measures caused the business cycle to change and the upswing, which had been in progress from the second quarter of 1983, gave way to a downswing in the third quarter of 1984.

According to the SARB (1984:1), the corrective policy measures were a result of the "unsustainability of the economic upswing which had largely been based on an increase in government and private consumption expenditure". The countercyclical policies that include tighter monetary policy and fiscal restraint were therefore behind the downswing observed from July 1984. Stals (1995:3) notes that the 1980s economic recovery was not sustainable because of the following major constraints: *balance of payments problems due to the country's inability to attract capital inflows; excessive reliance on bank credit to finance an expansion due to a low savings rate;* and lastly, *the lack of stability in financial markets due to an ultra loose monetary policy.* He concluded that a correction of the above deficiencies was necessary for the economy to maintain a long-term positive growth path.

The cyclical downturn observed since mid 1984 began to level out in the third quarter of 1985 and the economy improved in several aspects. Money supply was brought under control, domestic savings increased, the current account in the balance of payments started showing surpluses and credit demand started weakening (SARB, 1985:6). The SARB started to lower interest rates gradually in 1985 and the Ministry of Finance embarked on various fiscal measures aimed at promoting an economic recovery. The business cycle eventually changed and assumed an upward phase in April 1986.

Other features of the upswing phase in 1987 were an expansion in real private consumption expenditure, an increase in real fixed capital formation and an improvement in the exchange rate that was largely helped by an increase in the gold price (SARB, 1987:3). The country was however not spared from the stock market crash of 1987 that led to the re-rating of equity values worldwide and a slowdown in the global economy. The economy reached a peak in February 1989 and according to the SARB (1989:3), the fading of growth momentum in the South African economy from the fourth quarter of 1988 presented the outcome of self-generating business cycle forces and was further manifested by more stringent monetary and fiscal policies from the end of 1987 and early 1988.

3.2.2 The Business Cycle in the 1990s

The March 1989 to November 1996 (peak to peak) business cycle covers the important period of political change in South Africa and presents an interesting case of whether endogenous cyclical forces or exogenous factors drive the business cycle (Laubscher, 2004:27). Another interesting question would be whether a structural change in South Africa's economy is observable in this period. The downward phase observed from 1989 to 1993 was the longest since the 1980s and had both exogenous and endogenous components. Both phases of the cycle (upswing and downswing) had characteristics similar to the business cycle observed in the 1980s. The slowdown was driven by a protracted world economic recession, a persistent drought in the region (including South Africa) and a restrictive monetary policy in response to inflationary pressures and balance of payments concerns. A recovery in the world economy, an end to the drought and an increase in commodities prices (including gold) helped the economy to recover and assume an upward phase in the second quarter of 1993. This upturn was briefly interrupted in early 1994 during the political transition due mainly to labour-market turmoil but the economy regained its momentum in the second half of the year.

According to Pretorius *et al.* (1999:40), the upswing that started in 1993 was accompanied by key structural changes in the economy that were supportive for growth in the long term. These included the end of economic sanctions after the first democratic election in 1994, the gradual liberalization of exchange controls and improved financial stability as reflected by a slowdown in inflation. Other key drivers of the upswing were domestic fixed investment and private consumption expenditure, all of which resulted from increasing business and consumer confidence. Government consumption expenditure was also a feature of the upswing but to a lesser extent as the government changed its priorities to focus on fiscal discipline and reducing the budget deficit. The upswing led to a strong growth in credit extension and money supply and this prompted the SARB to start hiking interest rates in an effort to counter inflationary effects of the upswing.

A key structural change observed in the country in the second half of 1994 was that the current account of the balance of payments was allowed to go into deficit without restricting economic growth (Pretorius *et al.*, 1999:41). This was due to the fact that South Africa started attracting net capital inflows that were used to offset the deficit on the current account. The key problem with the inflows was that the country mainly attracted portfolio capital flows that had high volatility characteristics. This became evident in 1996 when the inflows were interrupted following speculative attacks on the currency. The rand depreciated heavily following the reversal of the portfolio inflows and the SARB hiked interest rates in an effort to bring stability in the markets. The above developments signalled an end to the upswing phase and by 1997 the cooling down of the economy was evident in low levels of output growth, weaker growth in real domestic expenditure and falling inventory levels (Pretorius *et al.*, 1999:42).

The reprieve in the balance of payments seen in 1994 was short lived and signalled that integration with the world economy meant the country was now more vulnerable to international shocks. According to the SARB, the business cycle turned in December 1996 and assumed a new downward phase. The slowdown in economic activity that began in December 1996 was characterized by a decline in domestic demand that was attributed mainly to a fall in both household and government consumption expenditure. The decline in government expenditure was a reflection of the government's commitment to reducing the budget deficit and redressing macroeconomic imbalances in the economy.

In 1998, several emerging market economies in Asia came under severe financial pressure that spilled over to South Africa. The country's financial markets were adversely affected as capital flew out of the country, the rand depreciated heavily and liquidity conditions tightened. The SARB responded to the crisis by hiking interest rates in an effort to stabilize the markets and prevent capital outflows. These events, coupled with a steep decline in commodity prices and demand from Asia, prolonged the downward phase and delayed the recovery in economic activity (Venter and Pretorius, 2001:68).

The emerging market crisis ended towards late 1998. Monetary conditions eased from October, capital inflows were observed in early 1999, commodity prices improved, business confidence rose and the volume of exports started to increase in 1999. The SARB lowered interest rates and by July 1999, the level of interest rates was below levels seen before the financial market turmoil of 1998 (Venter and Pretorius, 2001:68). A recovery in commodity prices and fast expansion in world economic activity following the Asian crisis led to an improvement in the South African economy. The weaker rand also benefited the country's export sector. According to the SARB, the economy reached a lower turning point of its business cycle in August 1999 and went into a new upward phase.

The present economic upswing (as of 2005), which commenced during the third quarter of 1999, represents the longest period of uninterrupted quarter-on-quarter growth since 1960 (SARB, 2004:3). From 1999, the upswing was led by a decline in interest rates and a big improvement in world economic activity in the aftermath of the Asian crisis. A sudden downward change in the outlook for the world economy towards the end of 2000, declining business and consumer confidence in RSA and a sharp depreciation of the rand to record lows in 2001 all did not bode well for the RSA economy but South Africa was able to cushion itself from all the negative factors.

Although the world economy experienced a major slowdown in 2001 with several industrial countries going into recession, the domestic economy was able to weather the storm. Laubscher (2004:32) notes that the resilience in South Africa's economic growth in the face of a global recession in 2001 was in sharp contrast to earlier periods of equally weak economic growth. He argues that the resilience reflects "a stronger endogenous growth momentum in the economy that is less dependent on the global economic cycle" and attributes this to improved productivity and profitability levels in the corporate sector, steady cumulative growth in after tax real incomes, moderately stimulatory fiscal and monetary policies and more competitive exports.

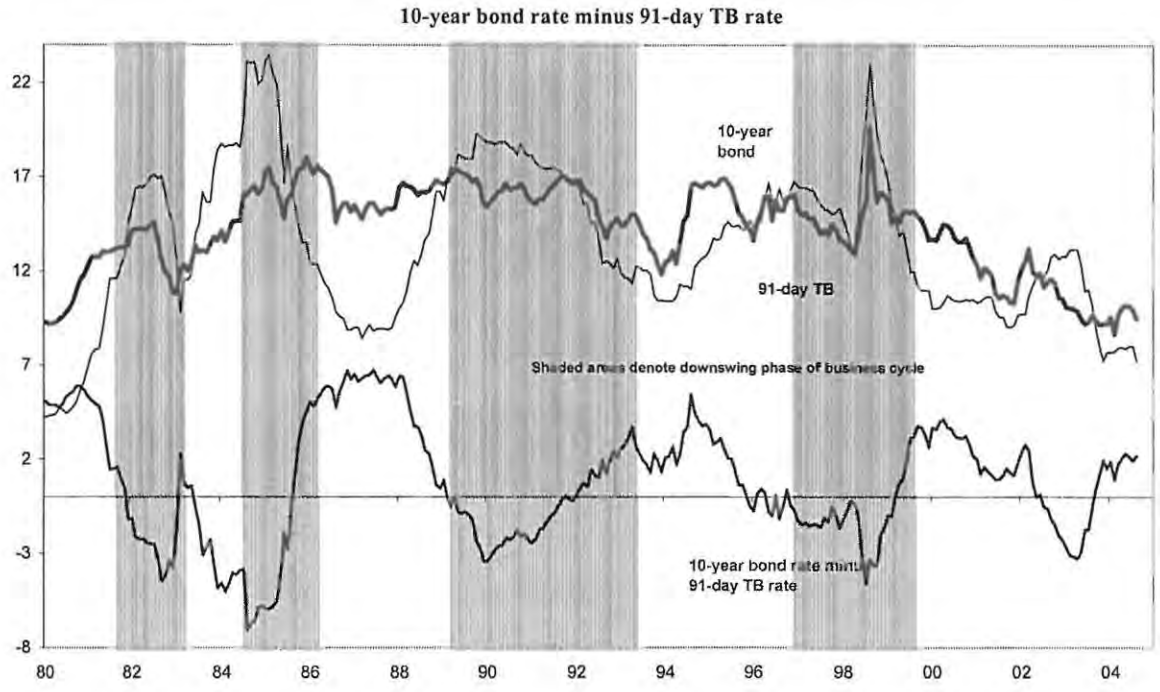
It is quite evident from the above discussion that South Africa's business cycle is driven by both exogenous and endogenous factors. In the early 1980s, the South African economy was mainly export oriented with the domestic business cycle closely linked with that of the major industrial nations. The international commodity prices cycle also exerted a strong influence on the domestic business cycle, mainly because of the country's reliance on gold exports. It is also worth noting that an economic expansion was not sustainable in this period since it led to inflationary pressures and balance of payments concerns. This always made it necessary for policymakers to introduce counter-cyclical policies aimed at addressing these problems. An export-led expansion therefore had to be stopped at some point using anti-expansionary monetary and fiscal policies.

Although the business cycle is still influenced to some extent by global economic conditions, the domestic economy has recently shown a strong endogenous component that makes it resilient to adverse global cyclical fluctuations. Laubscher (2004:33) argues that such resilience provides evidence of a structural change in the economy due to corrective macroeconomic policies implemented after 1994. Evidence of such resilience is provided by the fact that the economy survived the global recession of 2001. The emerging market crisis of 1998 should, however, remind us that a greater integration with the world economy makes the country more vulnerable to international shocks. Since the country still attracts huge capital inflows in the form of portfolio capital that is highly reversible on changes in investor sentiment, a reversal of these flows would have far reaching consequences. The country is however in a better position now to deal with situations similar to the Asian crisis of 1998 due to several factors that work in its favour. Such factors, which also support the endogenous component of the economy, include prudent macroeconomic policies, fiscal discipline, a clear and austere monetary policy framework, a high level of foreign exchange reserves and high business and consumer confidence levels.

The next section reviews the relationship between the yield curve and the business cycle in South Africa.

3.3 THE YIELD SPREAD AND THE BUSINESS CYCLE IN RSA

Figure 1



SOURCE: QUOIN INSTITUTE

Historical experience (especially in the US and Europe) provides evidence that on several occasions prior to recessions, long-term interest rates have fallen below short-term interest rates such that the yield curve became inverted (an inverted yield curve is represented by a negative spread between long-term and short-term interest rates). Figure 1 shows the movement of the yield curve represented by the spread between yields on the 10-year government bond and the 91-day Treasury bill rate over the various phases of the business cycle in South Africa since 1980. The shaded areas denote the periods identified by the South African Reserve Bank as official downswing phases of the business cycle.

Figure 1 illustrates that since 1980 the yield curve had become inverted prior to all four downswings. This is the key feature of the yield curve identified in several studies that makes the yield spread a valuable indicator for the likelihood of recessions. Before the first downswing phase of the business cycle (September 81 – March 83), the spread

between long-term and short-term interest rates declined steeply, and the yield curve finally became inverted in December 1981. The economy went into recession in the second quarter of 1982, *i.e.* two quarters after the yield curve inverted[11]. The upswing phase observed from April 1983 to June 1984 was quite short (only 15 months) and the yield spread remained negative almost throughout this period indicating that the upswing was not sustainable. The yield spread became negative in June 1983 whilst the economy officially went into recession in the second quarter of 1985 *i.e.* three quarters later[12].

The upswing observed from April 1986 to February 1989 was associated with a positively sloped yield curve with the spread between the 10-year government bond and the 3-months Treasury bill rising to reach a peak in February 1988. The yield spread started declining in March 1988 with the yield curve finally inverting in February 1989 to coincide with the start of the downswing phase of the business cycle as identified by the SARB. The economy went into recession in the second quarter of 1990 (*i.e.* four quarters after the yield curve inverted). The downswing from March 1989 to May 1993 was the longest (it lasted 51 months) in the period studied. The spread remained negative until December 1992 where the yield curve changed and assumed a positive shape. This signalled an end to the downswing phase and that an upturn was imminent. According to the SARB, the economy reached a trough in April 1993 with the business cycle changing to the next upswing phase. This further confirmed that the change in the shape of the yield curve correctly predicted the change in the course of the business cycle.

In the upward phase of the business cycle observed from June 1993 to November 1996, the yield spread gradually increased and reached a peak in August 1994, where it started falling. The yield curve briefly inverted in December 1995 but remained almost flat until November 1996 when long-term interest rates went below short-term rates to coincide with the start of the downswing phase in December 1996. The yield spread remained negative until February 1999 to signal the downswing phase was nearing its end.

[11] The conventional definition of two consecutive quarters of negative growth in real GDP is used to describe a recession in this case.
[12] Although the economy officially went into recession in Q2 1985, the downswing phase commenced in July 1984.

Although the economy never reached an official recession in this period, real GDP growth declined substantially and was below the average growth rates of around 3.5% observed earlier in the period. The inversion of the yield curve did indicate the outlook for a below par performance of the economy.

The yield curve changed to exhibit a normal positive shape in March 1999 and the economy entered the upswing phase of the business cycle in September 1999. In this upswing phase of the business cycle, the yield spread peaked in April 2000 and started narrowing from May onwards. The decline in the spread between 2000 and 2001 reflected the negative outlook for both the world and South African economies. Although the world economy went into recession in 2001, South Africa was able to achieve positive real GDP growth in its economy (real GDP growth however declined between Q3 and Q4 2001).

The above analysis provides evidence that a relationship indeed exists in South Africa between the yield spread (representing the yield difference between short-term and long-term interest rates) and the various phases of the business cycle. An observation of the changes in the shape of the yield curve can provide an insight into the outlook for the economy. An increase in the spread normally indicates an increase in the likelihood of the economy changing into an upswing whilst a decline in the spread increases the likelihood of a downswing. Figure 1 also shows that the yield curve has become inverted prior to all downswing phases of the business cycle and recessions observed in South Africa, although the timing between the inversion of the curve and the recession dates has varied from two to four quarters. This confirms the argument that the slope of the yield curve is a valuable leading economic indicator and as such correctly predicts future economic conditions.

Figure 1 points to an interesting observation in the period between February 2002 and December 2003. Although the economy was still in the upswing phase of the business cycle, the yield spread started narrowing in February 2002 with the yield curve finally inverting in July 2002. This is in sharp contrast to previous observations when a decline

in the yield spread and an inverted yield curve was consequently followed by a downswing and finally a recession. The spread remained negative until September 2003 when the yield curve changed to assume a normal shape. A question that one might ask is whether the shape of the yield curve gave a false signal in this period. This observation will be discussed later on. It is interesting to note that in this period, the yield on the long-term bond rate was declining whilst the yield on the 91-day Treasury bill was rising. A closer inspection of developments in the bond and money markets during this period can provide an insight into this.

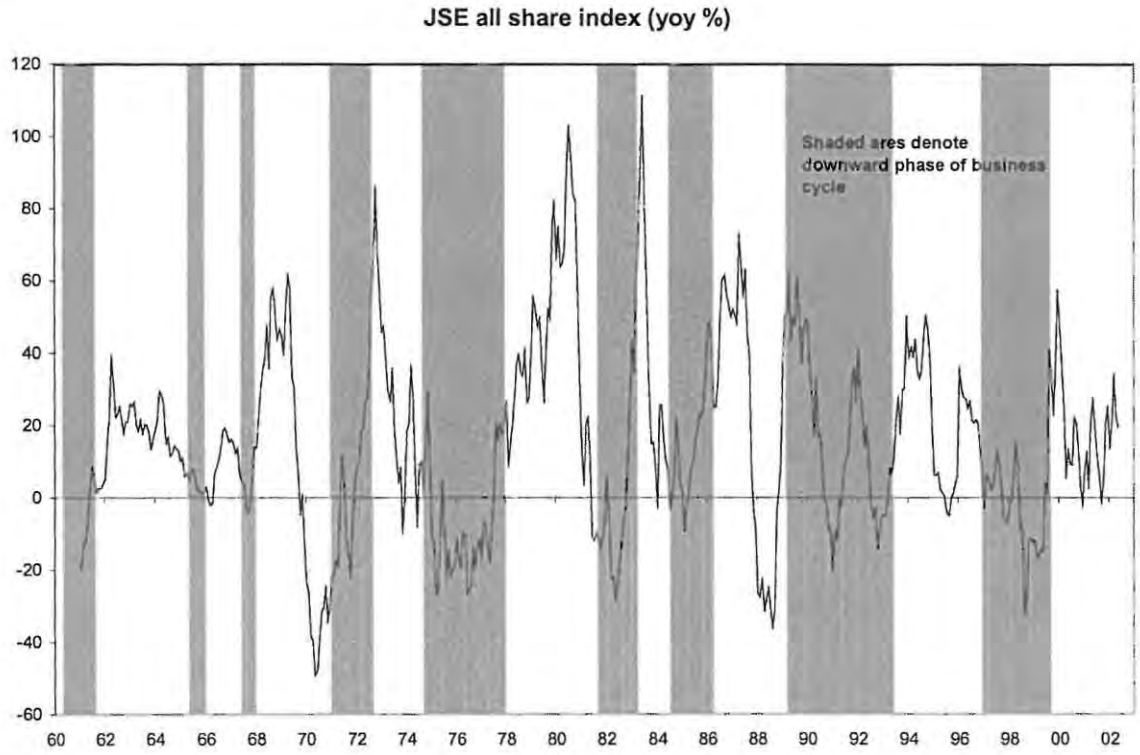
Since the predictive power of the yield curve is compared to that of other variables seen as good leading indicators, the relationship between the business cycle and each of the variables is presented next.

3.4 BUSINESS CYCLE AND OTHER ECONOMIC INDICATORS

3.4.1 The Business Cycle and Stock prices

According to the International Monetary Fund (2000:94), "there is extensive evidence that asset price changes tend to lead output growth in industrial countries". Such asset price fluctuations (including fluctuations in share prices) are highly correlated with business cycles and as such have a significant predictive power for output growth in many countries. Two major reasons have been put forward as to why share prices are a close indicator of business cycle conditions. First, stock prices incorporate information about future growth since they represent discounted values of future dividend cash flows, which in turn are determined by future economic conditions (Mishkin, 2004:164). The other explanation comes from the wealth effects of increases in share prices (IMF, 2000:96). From this point of view, an increase in share prices raises the wealth of economic agents and this enhances business and consumer confidence, which in turn leads to higher consumption. Figure 2 below shows changes in the JSE All Share Index during the various phases of the business cycle in South Africa.

Figure 2



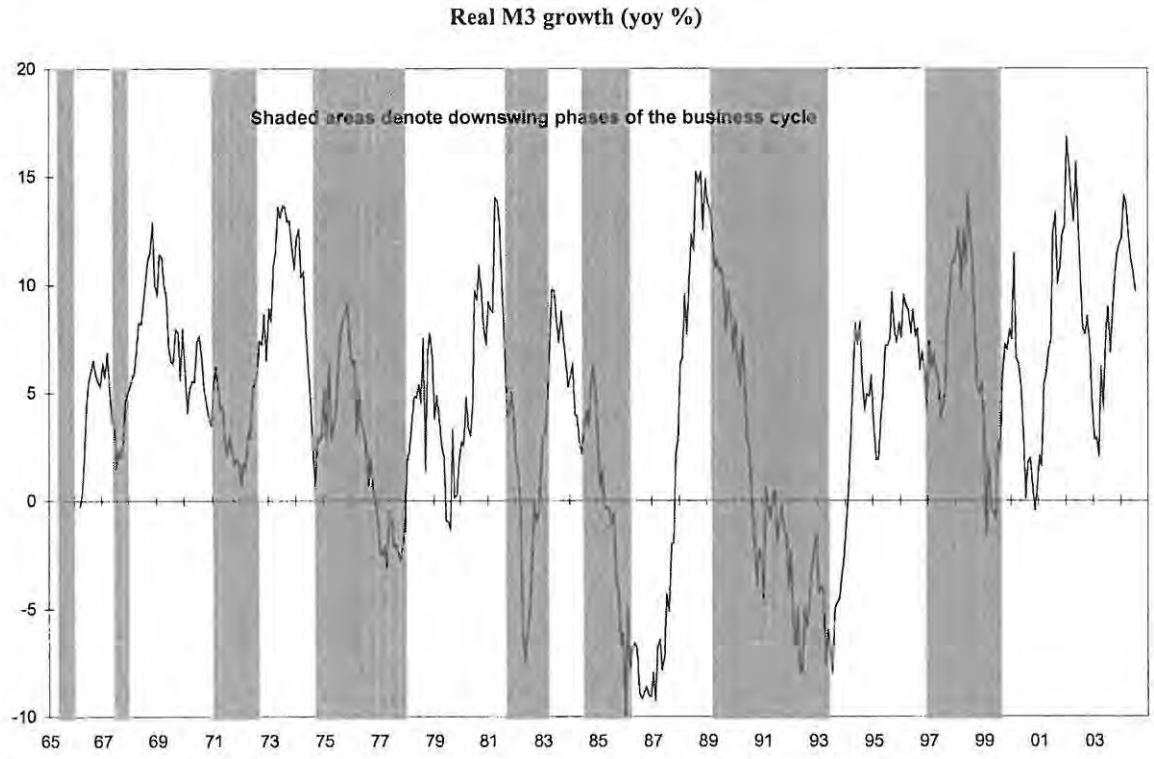
SOURCE: QUOIN INSTITUTE

The above chart clearly shows that changes in share prices generally move in a regular trend along the various phases of the business cycle in South Africa. Increases in share prices as represented by changes in the JSE All Share Index, normally peak during the upswing, and more often in the early phase of the upswing. After the middle phase of the upswing, share price increases decline but remain positive. Share prices begin to fall in the late stages of the upswing or early phases of the downswing. Figure 1 also shows that the decline in share prices tends to be lower in duration than increases during upswings. Share prices start to increase in the later stages of the downswing phase to complete their cycle. One notable feature of Figure 2 is that changes in share prices look more volatile when compared to movements in the yield spread as shown in Figure 1.

3.4.2 The Business Cycle and changes in Money Supply

Monetarists believe a definite relationship exists between fluctuations in real economic activity, as depicted by the business cycle, and financial aggregates relevant for monetary policy (Stals, 1997:1). Monetary policy is therefore seen as the heart of the business cycle. Monetary authorities endeavour to influence economic conditions through influencing credit extension and money supply. An increase in money supply normally stimulates economic growth and is associated with the upswing phase of the business cycle, whilst a decline in money supply suppresses growth and leads to downswing phases of the cycle. Since increases in money supply may be due to expectations about both economic activity and inflation, changes in real money supply (which eliminates the inflation effect) provide a truer reflection of economic conditions. Figure 3 below shows the observed relationship between real money supply growth and the business cycle in South Africa.

Figure 3



SOURCE: QUOIN INSTITUTE

Figure 3 conforms to theoretical expectations since business cycle phases in South Africa are correlated to changes in real money supply growth. According to the above chart, real M3 growth increases and normally peaks near the end of the upswing phase to nearly coincide with the start of the downswing. In the early stages of the downswing, real M3 growth declines and remains positive until the middle phase of the downward phase. Real money supply declines in the middle to late stages of the downswing and starts increasing near the beginning of the upswing phase. A key observation from Figure 3 above is that changes in real money supply growth have a shorter leading period to business cycle changes. This might show that changes in money supply have a shorter forecasting period for business cycle changes[13].

3.4.3 The Business Cycle and the Index of Leading Economic Indicators

The index of leading economic indicators is a widely used measure of the future state of the economy. The index is a compilation of economic and financial variables such as unemployment, new business formation, factory orders and interest rates that tend to move ahead of and in the same direction as general economic activity (Bloomberg Definition). Leading business cycle indicators are constructed from variables that have historically been correlated with future activity and a change in the direction of the indicator usually provides an indication that a turning point in the business cycle is imminent (Venter and Pretorius, 2001:63).

Leading business cycle indicators are seen as strong predictors of economic activity in the short run and have been used in other studies to predict economic activity (Bernard and Gerlach, 1996:15). This index, together with coincident and lagging business cycle indices, is one of the main measures used by the SARB to determine turning points in the business cycle. According to the SARB, changes in the direction of the composite leading business cycle indicator have led to changes in the course of the business cycle. Although the central bank does not use the leading business cycle indicator on its own, it does play an important role in the determination of business cycle turning points in South Africa. It

[13] The optimal forecasting horizon for each of the indicators will be assessed later using the probit model.

is therefore interesting to find out if such an indicator can do better than other variables like the yield spread if considered on its own.

CHAPTER 4

METHODOLODY

4.1 INTRODUCTION

It will be recalled that the main objective of the study is to assess the ability of the yield curve to predict turning points of the business cycle in South Africa. If changes in the shape of the yield curve correctly predict changes in economic activity, such information can be used to determine the likelihood of recessions. Why should recessions be of major interest? Government policy always aims to deliver long-term sustainable economic growth and will always endeavor to prevent periods of recession. From a monetary policy perspective, an advance warning about an imminent recession allows policy makers to ease monetary conditions to mitigate the severity and duration of the recession. According to Filardo (1999:41) "an advance warning is particularly important because monetary policy affects the economy with long and variable lags". This chapter therefore presents the methods used in the study to assess the predictive power of the yield spread and the other variables with regard to business cycle turning points. The probit model is presented, reviewed and its use in the study justified. Before considering the popular methods used to determine business cycle turning points and the likelihood of recessions, it is necessary to define what a business cycle turning point is.

4.2 BUSINESS CYCLE AND FORECASTING METHODS

Over the past decade, several economists have devoted some effort into modelling the features of the expansion and recession phases of the business cycle. Such studies have shown that financial market indicators like interest rates and stock prices can be reliable recession predictors. Using the conventional definition of a recession, *i.e.* two consecutive quarters of a decline in GDP, the first of the two quarters represents a turning point in the business cycle and the beginning of a recession (Del Negro, 2001:2). The end

of a recession is thus represented by the first of two consecutive quarters of positive GDP growth.

For the purposes of this study, it is also necessary to draw an analogy between downswing phases of the business cycle and recessions. The National Bureau of Economic Research (NBER) in the United States, the organization responsible for officially dating the beginnings and ends of US recessions, defines a recession as "a broad decline in aggregate economic activity (which is measured as a common movement in output, income, employment and trade), usually lasting from six months to a year, and marked by widespread contractions in many sectors of the economy" (Filardo, 1999:36). This definition of recessions is consistent with the observed downswing phases of the business cycle in South Africa as identified by the SARB (see Figure 1). The NBER therefore considers the two-quarter definition of a recession too narrow, but for practical purposes, turning points of the business cycle defined using the NBER definition and the two-quarter rule are not very different[14].

On a broader sense, popular approaches to predicting business cycle turning points and the likelihood of recessions include using simple rules of thumb involving leading economic indicators or the use of econometric methods. Leading economic indicators (which are normally represented by an index) are commonly used and constitute variables that have historically tended to lead the business cycle, with changes in the direction of the indicators signalling a change in the business cycle (Pretorius *et al.*, 1999:38). Leading indicators are quite popular because they can be easily understood and interpreted. Forecasters also tend to rely on such indicators because of their in-sample forecasting power, *i.e.* they have been able to predict past recessions (Del Negro, 2001:4). Leading economic indicator indices have been found to be fairly accurate in predicting recessions but they generally have short lead times (Estrella and Mishkin, 1998:55).

[14] In any case, once the economy enters into a downswing phase, chances of negative real GDP growth increase. In the period studied, out of the four downswings observed, using the two-quarter rule, the economy went into recession 3 times (in South Africa).

Regarding the use of econometric methods, two direct approaches to predicting turning points of the business cycle can be identified. The first and commonly used approach is to build a model that forecasts future values of GDP. According to Filardo (1999:39) "the GDP forecasting model is a simple multi-equation regression model, whereby real GDP depends on variables like past growth rates of real GDP, past growth rates of the index of leading economic indicators, past changes in the yield spread between 10-year yields and 3-month treasury bill yields and past changes in the 3-month treasury bill yield". The explanatory variables may be lagged, relative to the dependent variable, by an amount of time equivalent to the forecasting horizon (Chin *et al.*, 2000:3). Such a model would therefore produce GDP forecasts and a signal of a forthcoming recession would be represented by a forecast of two consecutive quarterly declines in GDP.

Various GDP forecasting models exist and they differ substantially from one another with regards to econometric methodology, variables used and the importance of judgmental factors. One key feature of such models is that they embody a so-called "extrinsic view" of the business cycle such that the underlying structure of the economy is stable and can be described and approximated by a linear probability model[15] (Del Negro, 1999:6). Business cycle theory shows that downswings and upswings in economic activity are not simply the result of huge external shocks but are also highly influenced by factors intrinsic to the economic system. GDP forecasting models are known to have a bad record when it comes to predicting recessions (see Filardo, 1999; Del Negro, 2001; Estrella and Mishkin, 1998). Such econometric models also suffer from the problem of overfitting[16] (Estrella and Mishkin, 1998:46) and their reliance on two consecutive quarters of negative GDP growth as a measure of recessions does not conform to NBER defined recessions.

Given the large forecasting errors of large-scale GDP forecasting models around the turning points of the business cycle, Estrella and Hardouvelis (1991) came up with a

[15] Extrinsic in the sense that the business cycle is only caused by external shocks to the system and not factors originating from within the system.
[16] Adding variables or another lag of a variable to a model can improve the in-sample results but undermine the predictive power of the model beyond the sample.

different approach to forecasting turning points in the business cycle. They estimate a non-linear probit model that directly estimates the probability of a recession at a given time horizon. Bernard and Gerlach (1996), Dueker (1997), Estrella and Mishkin (1998), Atta-Mensah and Tkacz (1998), Karunaratne (1999), Moneta (2003) and Moolman (2004) are amongst others who use the probit model in subsequent studies to model the likelihood of recessions. The major objective of this model is to forecast turning points in the business cycle and not future values of GDP growth. The model employs leading economic indicators to produce probabilistic statements about the prospects of future recessions or expansions for the economy at a specific time horizon. The probit model therefore uses a regression-based framework to generate a probability of future recessions given a set of leading indicators. A probability closer to zero implies lower chances of a recession, whilst the closer it is to unity the more likely it is that a recession will be experienced. In other words, the threshold criterion for the model is 0.50. If the probability obtained is less than 50%, the model signals an expansion since that is more likely than a recession. A probability above 50% implies a recession is more likely (Filardo, 1999:4).

The major strength of the probit model is that it is geared specifically towards predicting turning points in the business cycle. This feature still points to a need for a large macroeconomic or GDP forecasting model that will be supplemented by the smaller probit model around turning points of the business cycle. Obtaining similar results from the two modelling approaches, together with judgmental forecasts, can enhance confidence on the forecasts obtained. Other advantages of the probit model are that it can be used to evaluate the forecasting power of any group of indicators one at a time or jointly; and the model allows the forecaster to identify the outperforming set of indicators at a given forecasting horizon (Filardo, 1999:38).

Since this study specifically aims to predict turning points in the business cycle, and for a comparison to be made with previous studies, a probit model is used. The approach of Bernard and Gerlach (1997), Estrella and Mishkin (1998), Atta-Mensah and Tkacz (1998) and Moneta (2003) is followed. In the following section, the basic model used to

perform the predictive tests is described, together with the criteria used to evaluate the results.

4.3 MODEL AND ESTIMATION METHODS

4.3.1 The Probit Model

Estrella and Hardouvelis (1991:562) suggest that the yield curve may be a predictor of a binary variable R_t that indicates the presence ($R_t = 1$) or absence ($R_t = 0$) of a recession. A model that relates the indicator variable R_t to the slope of the yield curve k quarters earlier can help study the ability of the term structure to predict the business cycle turning points. A standard linear regression model would be stated as follows;

$$R_t = \alpha + \beta X_{t-k} + \varepsilon_t \qquad (1)$$

where R_t is an unobservable variable that determines the occurrence of a recession at time t and X_{t-k} is the explanatory variable(s) - (lagged) - at time t-k. The integer k measures the time lag and this is necessary if the yield spread is to become a predictor of recessions that will occur several quarters ahead. Since the dependent variable (R_t) can take on two possible values, i.e. whether the economy is in or is not in a recession, a binary dependent variable model is necessary. The major objective of such a model is to find the probability of an event occurring (in this case we are interested in the probability of the economy going into recession). There are three approaches to developing a model for a dichotomous response variable; *the linear probability model (LPM), the logit model* and *the probit model* (Gujarati, 2003:582).

The LPM is the simplest of the three models as it can be estimated by Ordinary Least Squares (OLS) but it suffers from various shortcomings. The most important problems with the LPM are that it assumes the probability of an event occurring increases linearly with the regressor, and the model also does not guarantee that the conditional probability of an event occurring will lie between zero and one (Gujarati, 2004:586). This is a major

violation of probability theory. The logit and probit models guarantee that the probability will lie between zero and one. According to Gujarati (p. 614), both models give qualitatively similar results, with the main difference being that the logistic distribution has slightly flatter tails such that the probability approaches zero or one at a slower rate in logit than probit models. Moneta (2003) estimates a logit model and his results confirm those obtained from running a probit model. The probit model is chosen in this study for easy comparison of the results with previous studies as most use the probit model.

The model is therefore used in the study to relate the probability of a recession in South Africa as dated by the SARB during the current period to the slope of the yield curve observed several months earlier. The predicted values of the regression thus need to be constrained and to fall within the 0-1 interval. Choosing a non-linear functional relationship between the dependent and explanatory variables does this. The probability of a recession at time t, with a forecast horizon of k periods is given by the following probit model that is estimated:

$$Pr(R_t = 1) = F(\alpha + \beta X_{t-k}), \qquad (2)$$

where Pr denotes the probability that a recession will occur, conditional upon the observed value of the explanatory variable X lagged k quarters. F is the cumulative normal distribution. The parameters α and β are estimated by maximizing the log-likelihood function (Atta-Mensah and Tkacz, 1998:5,).

Several issues arise with regard to estimating the model (2) stated above. Firstly, the definition of a recession is fundamental for constructing the binary time series R_t (Moneta, 2003:47). The recession indicator in the study is obtained from the SARB's official recession dates. The central bank applies the NBER methodology in dating official downswings of the business cycle and this method goes beyond the general two consecutive quarters of declining GDP. Applying this convention, the SARB identified four recessions since 1980 in the following periods; September 1981 to March 1983, July 1984 to March 1986, March 1989 to May 1993 and December 1996 to August 1999.

A second potential problem arises from the nature of time series data. Dueker (1997:45) notes that the general probit model assumes the random shocks in the model are independent and identically distributed with a mean of zero, whilst for many time series applications this is not a plausible assumption. According to Estrella and Mishkin (1998:47), the probit model has an overlapping data problem such that the forecast errors are likely to be serially correlated. This raises the possibility that tests of significance of the variables using conventional test statistics may provide meaningless results. This problem is corrected by applying the Newey-West (1997) technique such that the test statistics are calculated using standard errors adjusted for the autocorrelation problem (see Estrella and Mishkin, 1998; Moneta, 2003).

Dueker proposes another method to remove the serial correlation in the error term by adding a lag of R_t (the indicator variable of the state of the economy) to the probit model (1) stated above[17]. Dueker observes that adding a lag of the dependent variable increases the validity of the assumption that the error term has a mean of zero, conditional on availability of information over time $t+k$. The new model proposed by Dueker is stated below. The model (3) is the probit analogue of adding a lagged dependent variable to a linear regression model.

$$Pr(R_t = 1) = F(\alpha + \beta_1 X_{t-k} + \beta_2 R_{t-k}) \qquad (3)$$

A third key issue in the estimation of the probit model is a measure of the goodness of fit. The principal measure of the predictive power of a given variable at a given horizon for probit estimation was developed by Estrella (1995) and is subsequently used in several studies that include Dueker (1997), Bernard and Gerlach (1997), Estrella and Mishkin (1998) and Moneta (2003). The measure is a *pseudo* R^2, a measure of the goodness of fit of the estimated equation that corresponds intuitively to the coefficient of determination in a standard linear regression (Estrella and Mishkin, 1998:47). The *pseudo* R^2 statistic is defined as

[17] Karunaratne (1998), Atta-Mensha and Tkacz (1998), and Moneta (2003) also recommend this approach.

$$Pseudo\ R^2 = 1 - (L_u/L_c)^{-(2/N)\,Lc} \qquad (4)$$

Where L_u is the value of the log-likelihood of the estimated model (unrestricted) and L_c is the value of a constrained model containing only the constant term (all coefficients are zero except constant). N is the number of observations. According to Estrella and Mishkin (p.47), "the form of the above function ensures that the values 0 and 1 correspond to no fit and perfect fit respectively, and their intermediate values have roughly the same interpretations as their analogues in the linear case". The *pseudo* R^2 is used together with t statistics from the estimated regressions to find the lags that give the best fit for all the variables studied.

Lastly, it is necessary to measure the predictive accuracy of the models estimated. Moneta (2003:26) calculates the forecast error of the probit model as the difference between the estimated probability and the indicator of recession and uses the absolute value as a function of loss. Since in an ideal situation, the model should give 1 in a recession period and zero otherwise, a lower forecast error could be associated with a better accuracy of the forecast. Other studies (see Dotsey, 1998; Alessandro, 2000) use the root mean square error (RMSE) to compute the accuracy of out-of-sample forecasts. The RMSE determines how the forecasting power of a model evolves through different time horizons. This error statistic (according to Eviews User Guide) is a relative measure of forecasting performance and the smaller the error, the better the forecasting ability of the model. The RMSE is employed in the study, together with the variance proportion (VP), to evaluate the forecasting accuracy of the model. The variance proportion should tell us how far the variation of the forecast is from the variation of the actual series.

4.3.2 Indicators Examined and Data Used

a) The Yield Spread: Since the yield curve normally inverts prior to recessions, an inverse relationship should be observable between the yield spread and the probability of a recession. A narrowing of the yield spread increases the probability of a recession whilst

an increase in the spread reduces the likelihood of a recession. Data on the yield spread used in the study is the difference in yields between the 10-year RSA government bond and the 91-day Treasury bill. Several studies (including Nel, 1996; Estrella and Mishkin, 1998; Moneta, 2004 and Moolman, 2004) show that the difference between the two yields possesses useful information that can be used for predicting recessions. Another reason for choosing these segments of the yield curve are that they represent benchmarks for the money and bond markets respectively. This makes securities in these segments to be highly traded and thus represent a true reflection of financial market conditions.

b) Other Indicators Used: Data on leading indicators is the percentage change in the *composite index of leading economic indicators* over twelve months. *A priori*, a negative relationship is expected between the change in the index and the probability of a recession. An increase in the index would mean higher expected economic activity ahead and thus a reduction in the likelihood of a recession (Venter and Pretorius, 2001:63). A decline in the index would signal slower activity ahead and an increase in the probability of the economy going into recession. Data on *share prices* used in the study represents year-on-year percentage changes in the JSE All-share index. *A priori*, an inverse relationship is expected between changes in the All-share index and the likelihood of a recession. Data on *monetary aggregates* represents year on year growth rates in real M3. The relationship between changes in real money supply and the probability of a recession is expected to be negative.

The series on the yield spread, money supply and the All-share index were obtained from the Quoin Institute, RSA. Data on the business cycle represents periods identified by the SARB as official upswings and downswings of the business cycle. These figures, together with data on the index of leading economic indicators, were obtained from the SARB. The period covered in the study is January 1980 to June 2004.

4.4 SUMMARY

Since the nature of the problem to be solved in the study is qualitative and the event of interest can take only two possible variables (economy is in a recession or not), a probability model is necessary. The probability model should give us the likelihood (probability) of the economy going into recession conditional upon the explanatory variable(s) chosen. As stated earlier on, the probit model is chosen, mainly because it features prominently in previous studies and gives consistent results. The general strategy of analysis is stated below.

Firstly, the simple probit model (1) is estimated. The probit equation is estimated using each variable to assess if it has any predictive power. The objective is to evaluate the forecasting power of each variable individually, and to identify the optimal forecasting horizon for each variable. The simple probit model is also estimated including the yield spread in conjunction with the other variables to see if the variables used jointly perform better. The same analysis is repeated for the modified probit model (2) that has been corrected for serial correlation to see if the results improve. The *pseudo* R^2 is the principal measure of the goodness of fit. To give a quantitative measure of the forecasts, the root mean square error and the variance proportion were used.

CHAPTER 5

EMPIRICAL RESULTS

5.1 INTRODUCTION

This section presents the results of the study based on the probit equations estimated. First, the simple probit model is estimated to examine the explanatory power of the yield spread with predictive horizons ranging from 1 to 24 months ahead. The optimal forecast horizon is determined by the highest *pseudo* R^2 and statistically significant coefficients. The predicted or fitted values of the variables will be compared with the actual recession dates to assess if they have any prediction power. The results presented include a *pseudo* R^2, the slope coefficient, the z-statistic and the *p*-value of the variable being tested. With regards to forecast evaluation, the root mean squared error (RMSE) and the variance proportion (VP) are presented. The comparative performance of each variable is assessed by the magnitude of the *pseudo* R^2, the RMSE and the VP. The ability of the yield curve to predict recessions in South Africa is presented next.

5.2 YIELD SPREAD: IN-SAMPLE RESULTS

Table 2: Results from simple probit Model

$Pr(R_t = 1) = F(\alpha + \beta X_{t-k})$ based on yield spread only

Months Ahead	k=1	k=3	k=5	k=6	k=9	k=12	k=15	k=18	k=21	k=24
Beta	-0.2595	-0.3066	**-0.3241**	-0.3201	-0.2659	-0.1958	-0.1247	-0.0736	-0.0372	-0.0148
Z-statistic	-8.5454	-9.1237	**-9.2642**	-9.2598	-8.6444	-7.2694	-5.0755	-3.0935	-1.5787	-0.6265
Prob	0.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000	0.0000	0.0002	0.1144	0.5310
Pseudo R^2	0.2980	0.3708	**0.3979**	0.3944	0.3162	0.2048	0.0947	0.0348	0.0091	0.0015
RMSE	0.4188	0.40076	**0.3939**	0.3939	0.4145	0.4432	0.4723	0.4884	0.4952	0.4965
VP	0.3130	0.2657	**0.2496**	0.2536	0.3017	0.3948	0.5400	0.6900	0.8272	0.9269

The results presented in Table 2 show that the slope coefficients from the estimated probit model conform to the theoretical expectations as they exhibit an inverse relationship between the slope of the yield curve and the probability of a recession. An increase in the spread (steepening of the yield curve) leads to a reduction in the likelihood of a recession in the period ahead whilst an inversion of the yield curve increases the probability of a recession several months later. The results show that the term structure, as judged by the significance of the slope parameter, is useful for predicting recessions in RSA up to 18 months[18].

The explanatory power, as measured by the *pseudo* R^2 varies with the forecast horizon. It increases from a forecast horizon of one month, peaks at 6 months and then falls gradually as the number of lags is increased (Table 2). The results show that the yield spread performs best at a forecasting period of around 6 months. The lag that represents the best fit is 5 months with the highest *pseudo* R^2 of 0.3979 and a *z*-statistic of -9.2642. This result is significant at 1% and if compared with the *pseudo* R^2 of the other spreads, a conclusion can be drawn that the best recession predictor is the spread lagged 5 months[19]. The root mean square error and the variance proportion are also at their lowest levels at five months. This confirms the findings of Moolman (2002) who observed that the yield spread successfully predicts business cycle turning points two quarters ahead. The probit results obtained from a forecasting period of two quarters can therefore be used to make estimates of the probability of a recession given the yield spread.

Based on the statistical criteria of the highest *pseudo* R^2 and statistically significant spread term, the best fitting probit equation for predicting a recession is the one for the 5-months forecast horizon as given by the following probit equation:

$$Pr(R_{t+5} = 1) = F(-0.042243 - 0.3242X_t) \qquad (5)$$

[18] Slope coefficients are statistically significant at 1% for forecast horizons of up to 18 months.
[19] The difference is very small between *Pseudo* R^2 and z-statistics of 5 and 6 months.

The best fitting probit function (5) quantifies in percentage terms the probability of the occurrence of a recession for different levels of the yield spread. Based on data from January 1980 to June 2004, and applying the best-fit probit function (5), Table 3 below shows the probability of a recession 5 months ahead based on the yield spread between 3-month and 10-year government paper.

Table 3: Probability of a recession as predicted by the best probit model

$Pr(_{t+5})\%$	*5*	*10*	*15*	*20*	*25*	*30*	*40*	*50*	*60*	*70*	*80*	*90*
Spread	5.22	4.14	3.34	2.62	2.23	1.64	0.93	0.13	-0.64	-1.50	-2.46	-3.82

As the table indicates, the estimated probability of a recession five months ahead estimated from this model is 10% when the spread averages 4.14 percentage points over the month, 50% when the spread averages 0.13 percentage points and 90% when the spread averages -3.82 percentage points. The next question one would ask is: how well did this model predict past recessions or downswing phases of the business cycle in South Africa? Consider Figure 4 below.

Figure 4

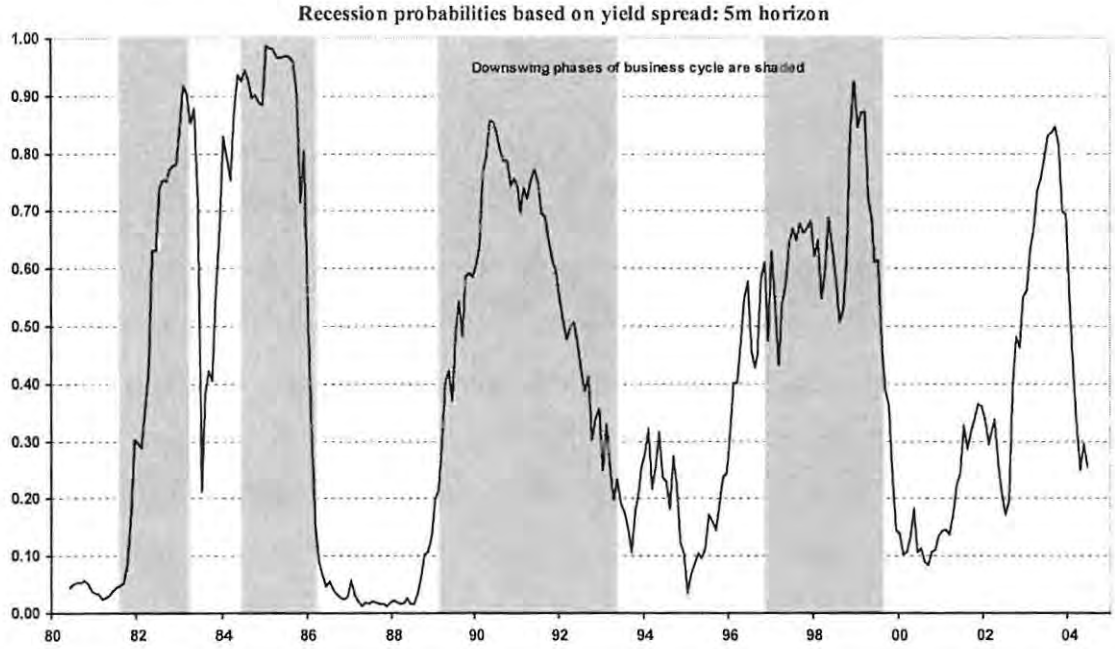


Figure 4 shows the recession probabilities estimated from the historical data based on the best fitting simple probit model with a forecast horizon of 5 months. The chart shows the predictions of the state of the economy for a particular date, based on information on the yield spread that was available five months earlier. It is clearly evident that changes in the yield spread correctly predict changes in the business cycle phases in South Africa. A general observation is that the simple probit model correctly predicted all past recessions. Figure 4 shows that at the start of all downswing phases of the business cycle (except for the 1981-1983 slowdown), the forecast probability of a recession clearly exceeded 50%, thus confirming the reliability of the model. The probabilities decline during the downswing phases to signal an imminent change in the state of the economy as an upswing is reached.

Although the predicted probability of a recession was around 30% at the onset of the 1981 – 1983 recession, Figure 4 shows that the probability increased from less than 10% in 1980 to correctly signal an increase in the likelihood of a recession. The model, however, gives a false signal in 2003 as the probability of a recession increases to reach 84% in April and May although the economy never goes into recession. Does this mean the yield spread is losing its explanatory power? We might have to wait until the next recession to get a precise answer.

Next we examine the in-sample forecasting power of the other indicators to assess if they correctly signal business cycle turning points. The probit model is estimated for each variable individually and the results are compared with those obtained from the yield spread. A combination of all the variables with the yield spread is also explored.

5.3 COMPARISON WITH OTHER VARIABLES

5.3.1 Real money supply (M3) growth

Table 4: Results from simple probit model based on real M3 growth

Months Ahead	k=1	k=2	k=3	k=4	k=5	k=6	k=18	k=21	k=24
Beta	-0.0495	-0.0397	-0.0279	-0.0166	-0.0033	0.0071	0.0936	0.0756	0.0546
Z-statistic	-4.1499	-3.3606	-2.3732	-1.4094	-0.2811	0.5961	6.7101	5.6991	4.3114
Prob	0.0000	0.0008	0.0176	0.1587	0.7786	—	—	—	—
Pseudo R^2	0.0594	0.0389	0.0193	0.0068	0.0012	—	—	—	—
RMSE	0.4794	0.4847	0.4898	0.4931	0.4949	—	—	—	—
VP	0.6105	0.6715	0.7558	0.8469	0.9674	—	—	—	—

___ *Pseudo* R^2, Prob, RMSE and VP are not reported for highly insignificant results

The results from the study indicate that the growth rate in real money supply does provide some information that can be used for predicting recessions in the very short run (1 to 3 months). This variable however loses its explanatory power after 3 months as the results become statistically insignificant and the estimated coefficients change their signs and become positive at a 6 months horizon. This result supports the view that real money supply growth in the short term does predict economic activity but this variable is much more a coincident than a leading business cycle indicator[20]. Since forecasters are normally interested in longer horizons, changes in real M3 do not provide us with much information about future economic conditions and the likelihood of recessions.

5.3.2 Changes in the JSE All-Share Index (ALSI)

The results support the view that the movement in stock prices is a good predictor of the business cycle and can be used to estimate the likelihood of recessions in South Africa (see Figure 5 below). The movement in the All-share index loses its explanatory power after 12 months as the estimated coefficients lose their statistical significance. Based on

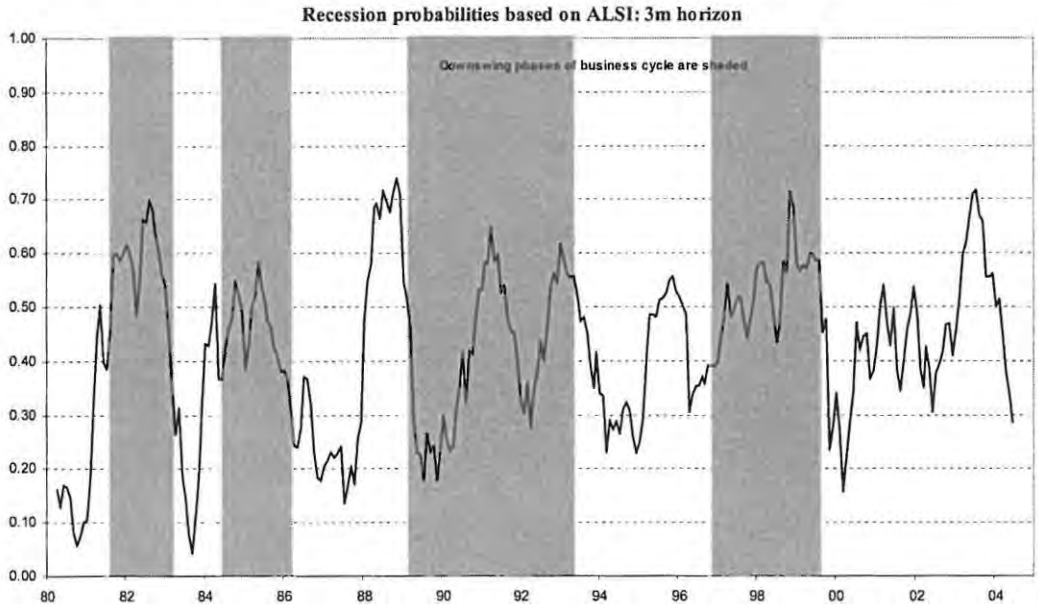
[20] The best forecasting horizon for real M3 growth is 1 month as indicated by the highest *pseudo* R^2 and lowest RMSE and VP.

the highest *pseudo* R^2, low RMSE and VP criterion, the best forecasting horizon for the stock index is one quarter (see Table 5).

Table 5: Results from simple probit model based on the All-share index

Months Ahead	k=1	k=2	k=3	k=4	k=5	k=6	k=9	k=12	k=15	k=18
Beta	-0.0144	-0.0150	**-0.0160**	-0.0157	-0.0149	-0.0147	-0.0134	-0.0069	-0.0010	.0012
Z-statistic	-4.7371	-4.9062	**-5.1546**	-5.0653	-4.8585	-4.7990	-4.3997	-2.4332	-0.3777	0.4354
Prob	0.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000	0.0000	0.0150	0.7056	0.3002
Pseudo R^2	0.0818	0.0884	**0.0988**	0.0955	0.0878	0.0860	0.0725	0.0214	0.0000	0.0000
RMSE	0.4749	0.4735	**0.4712**	0.4723	0.4746	0.4753	0.4793	0.4912	—	—
VP	0.5602	0.5472	**0.5286**	0.5338	0.5472	0.5498	0.5749	0.7451	—	—

Figure 5



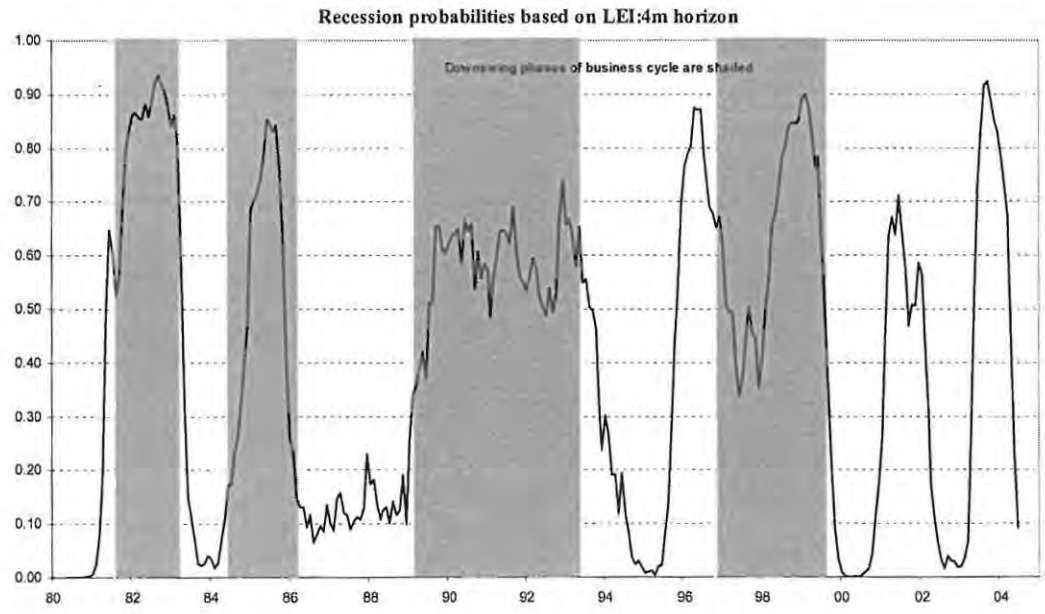
5.3.3 Index of leading economic indicators (LEI)

Table 6: Results from simple probit model based on the LEI

Months Ahead	k=1	k=2	k=3	k=4	k=6	k=9	k=12	k=15	k=18
Beta	-0.1227	-0.1331	-0.1391	**-0.1402**	-0.1292	-0.0964	-0.0620	-0.0353	-0.0130
Z-statistic	-8.6051	-8.7767	-8.8613	**-8.8452**	-8.6057	-7.7547	-5.8800	-3.6529	-1.4045
Prob	0.0000	0.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000	0.0492	0.1602
Pseudo R^2	0.3524	0.3848	0.4027	**0.4051**	0.3715	0.2635	0.1350	0.0492	0.0072
RMSE	0.4096	0.4017	0.3966	**0.3961**	0.4059	0.4324	0.4643	0.4850	0.4957
VP	0.2724	0.2530	0.2445	**0.2432**	0.2614	0.3386	0.4710	0.6401	0.8439

According to the study, the index of leading economic indicators helps predict economic activity and business cycle turning points in South Africa at a forecast horizon of up to 17 months. The estimated coefficients conform to *a priori* expectations, as an inverse relationship exists between changes in the index and the probability of a recession. Its best predictive power is observable at four months (highest *pseudo* R^2 than all other periods).

Figure 6



The two charts above clearly show that the two variables (stock prices and index of leading economic indicators) correctly predict the business cycle in South Africa. Figure 5 shows that changes in stock prices exhibit some form of volatility when compared to both the yield spread and the index of leading economic indicators. This could mean that changes in share prices perform better at a shorter forecasting horizon. Since all the variables studied above exhibit some forecasting power with regards to turning points of the business cycle when considered individually, it is necessary to compare their forecasting power at different time horizons. Consider the table below.

Table 7: Measures of fit for probit model variables by themselves in-sample

$$Pr(R_t = 1) = F(\alpha + \beta X_{t-k})$$

$$k = \underline{quarters}\ ahead$$

Variables	k=1	k=2	k=3	k=4	k=5	k=6	k=9	k=12	k=15	k=18
Spread	0.2890	0.3143	0.3708	0.3886	**0.3979**	**0.3944**	**0.3162**	**0.2048**	**0.0947**	**0.0348**
ALSI	0.0818	0.0884	0.0988	0.0955	0.0878	0.0860	0.0725	0.0214	__	__
LEI	**0.3524**	**0.3848**	**0.4027**	**0.4051**	0.3923	0.3715	0.2635	0.1350	0.0492	__
M3	0.0594	0.0389	0.0193	__	__	__	__	__	__	__

Note: *pseudo* R^2 is reported for each model;

__ indicates model is not statistically significant even at 10%

Table 7 shows that the yield spread is the only variable that provides information about the likelihood of recessions on forecasting horizons of up to 18 months. At a shorter horizon of up to 4 months, the index of leading economic indicators outperforms all other indicators including the spread, as it produces better forecasts[21]. At the longer horizon (above 4 months), the yield spread provides better information on the likelihood of recessions than all the other variables, with the index of leading economic indicators being the second best.

Although the All-Share Index does provide explanatory power up to 12 months, the index does not do better than both the yield spread and the index of leading indicators. Changes in real money supply do not do better than all the indicators at all horizons and thus

[21] Magnitude of *pseudo* R^2 and statistically significant coefficients are used to compare goodness of fit for the variables at each horizon (see Estrella & Mishkin, 1998: Kurunaratne, 1999 and Moneta, 2003).

provide very little information on the likelihood of recessions. Based on the in-sample results, it can be argued that the slope of the yield curve dominates the other variables since the results are consistent and the spread only loses its significance after 18 months. The results are consistent with the findings of Estrella and Mishkin (1998) in the US who state that the yield curve outperforms other variables, especially at longer forecasting horizons.

A combination of the yield spread with the other indicators is considered next to assess if the results improve.

5.3.4 Variables Combined

Table 8: Measures of fit for Multi-variate probit models in-sample (pseudo R^2)

K = months	*2*	*3*	*6*	*9*	*12*	*15*	*18*
SP	0.3413	0.3708	0.3944	0.3162	0.2048	0.0947	0.0348
SP+M3	0.4506	0.4499	0.3967	0.3345	0.3044	0.2624	0.1982
SP+ALSI	0.3574	0.3879	0.4045	0.3245	0.2050	0.1024	0.0434
SP+LEI	0.4734	0.5060	0.5018	0.3771	0.2229	0.0981	0.0353
SP+ALSI+LEI	0.4782	0.5087	0.5055	0.3778	0.2307	0.1155	0.0440
SP+ALSI+LEI+M3	0.5714	0.5650	0.5057	0.4096	0.3556	0.3086	0.2171

Note: SP: yield spread, ALSI: All-share Index, M3: real M3, LEI: Index of leading economic indicators

A combination of the yield spread with the other variables in a single model confirms the results of the single variable analysis, although some interesting observations can be made. First, the yield spread remains significant in all combinations at least up to 15 months. The *pseudo* R^2 increases as more variables are added but some of the indicators lose their explanatory power. Real M3 growth is statistically significant at most up to 3 months. The All-Share Index, when combined with the yield spread loses its power at 6 months but is insignificant in all other combinations.

The results of the model that combines the yield spread with the index of leading economic indicators suggests these variables form a strong combination across all

horizons up to 12 months[22]. Combining all variables in one model gives the best fit (highest *pseudo* R^2) but changes in real M3 and stock prices do not have any explanatory power after 3 months. (See Appendix 1 for a summary of the results obtained from estimating the multi-variate models in Table 8).

The next section considers results from the modified probit model.

5.4 MODIFIED PROBIT MODEL

As pointed out by Dueker (1997:45), one deficiency of the simple probit model is the assumption that the error terms are independent and identically distributed with a mean of zero. This assumption is not plausible for time-series applications since the error terms may be highly correlated. Following Dueker, a modified probit model is estimated to remove the serial correlation in u by adding a lag of R_t to the simple model. The model is therefore allowed to use the information contained in the auto correlative structure of the dependent variable to form predictions[23]. The resultant probit model is stated as follows:

$$Pr(R_t = 1) = F(\alpha + \beta_1 X_{t-k} + \beta_2 R_{t-k})$$

The *pseudo* R^2 is calculated in the same manner as the simple probit model, although the restricted model L_c comes from a model where only β_2 is equal to zero. This allows us to test for the information that goes beyond that already contained in the autoregressive structure of the binary time series (Moneta, 2003:21). Table 9 below presents results obtained from estimating the modified probit model using the yield spread and a lagged dependent variable.

[22] The yield spread between 3-month and 10-year government paper forms part of the index of leading economic indicators.
[23] See also Karunaratne (1999) and Moneta (2003).

Table 9: Results from Modified Probit Model

$$Pr(R_t = 1) = F(\alpha + \beta_1 X_{t-k} + \beta_2 R_{t-k})$$

Variables	k=1	k=3	k=5	k=6	k=9	k=12	k=15	k=18	k=21	k=24
SPREAD										
Z-stat	-3.1706	-5.3071	-6.1698	-6.3971	-6.2970	-5.6715	-4.6140	-3.7398	-3.1670	-2.4602
Prob	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0015	0.0139
R_{t-k}										
Z-stat	10.2938	10.4805	8.8617	7.7542	4.5262	1.7090	-0.6239	-2.2046	-3.3343	-3.3968
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0874	0.0000	0.0275	0.0009	0.0007
Pseudo										
R^2	0.0475	0.1333	0.1664	**0.1783**	0.1575	0.1229	0.0785	0.0347	—	—
RMSE	0.4710	0.4006	0.3969	**0.4000**	0.4248	0.4474	—	—	—	—
VP	**0.0154**	0.0587	0.1503	0.1992	0.3238	0.4275	—	—	—	—

__ in pseudo R^2 indicates negative values

Several observations can be made from the results of the modified probit model presented in Table 9 above. Most importantly, the yield spread does not lose its statistical significance and its forecasting power increases to 24 months[24]. Coefficients of the lagged dependent variable are statistically significant up to 12 months. The lag that presents the best fit is 6 months (it was 5 months in the standard model) and the value of the *pseudo* R^2 is 0.1783. The RMSE is also at its lowest at this horizon. This confirms that the yield spread provides its best forecast at a horizon of 2 quarters. The estimated probabilities of recession obtained from running this model are plotted together with the recession periods in Figure 7 and they are compared with the estimated probabilities obtained previously running the standard probit model.

[24] Results from simple probit model with yield spread only showed coefficients were statistically significant in periods up to 18 months.

Figure 7

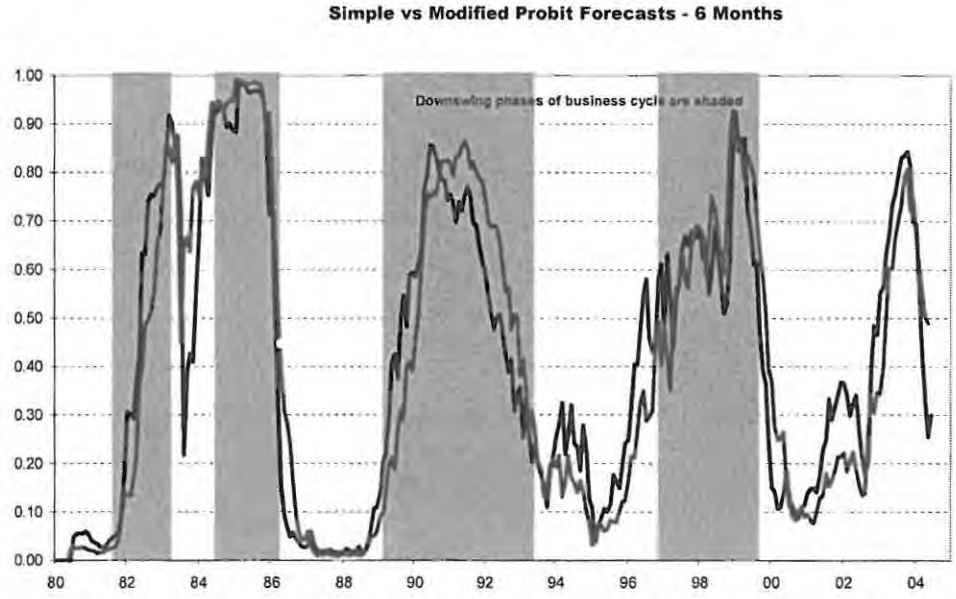
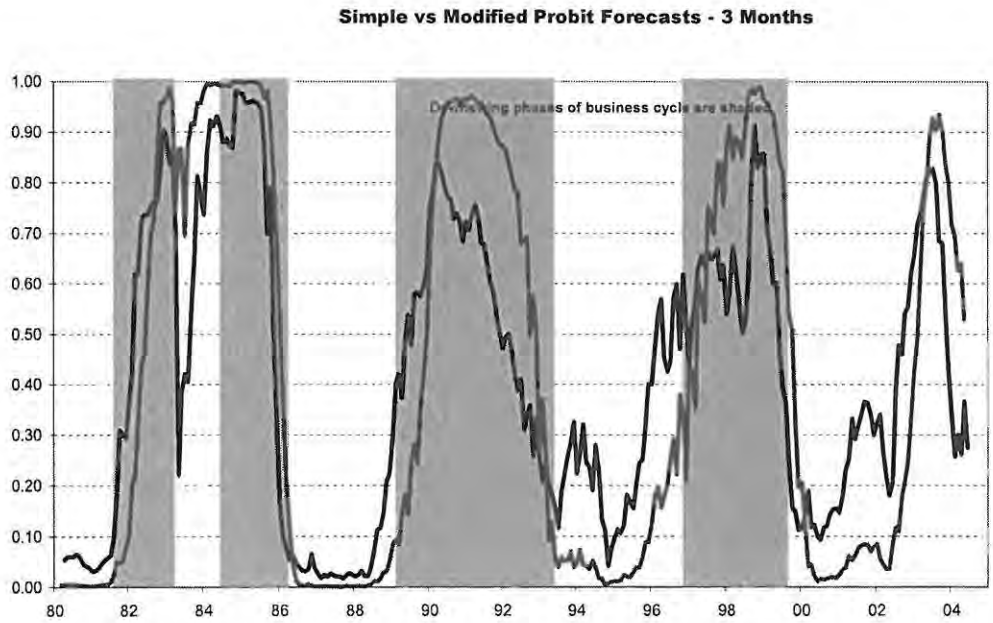


Figure 7 above shows the estimated probabilities of a recession using both the simple (dark line) and modified (light line) probit models at a 6 months forecasting horizon. Ideally, when using any model, the probability should be one in a recession period (shaded area) and zero otherwise. Figure 7 shows that the estimated probability increases in recession periods and remains low in upswing phases. Both models correctly predict peaks and troughs of the business cycle. The results from both models look highly similar and it can be concluded that the simple probit specification provides good forecasts, and the modified probit model that has been corrected for auto correlation confirms the results.

Dueker (1997) and Moneta (2003) observe that the modified probit model improves the recession forecasts at shorter horizons. A different specification of the *pseudo* R^2 is calculated whereby the restricted model L_c gives the value of a constrained model containing only the constant term (all coefficients are zero except constant). This gives the joint explanatory power of the lagged dependent variable and the yield spread. Figure 8 below compares the estimated probabilities at a 3 months horizon and confirms that the estimated probabilities improve when the modified profit model (light line) is used.

Figure 8



5.5 IS MONETARY POLICY RESPONSIBLE FOR THE PREDICTIVE POWER OF THE YIELD SPREAD?

The study has demonstrated thus far that the spread between short-term and long-term interest rates can be a useful indicator for predicting the business cycle and the probability of recessions in South Africa. Various factors are said to account for this empirical relationship, one of them being the monetary policy stance of the central bank (Estrella and Mishkin, 1998:50). The transmission mechanism of monetary policy suggests that a hike in short-term interest rates by the central bank directly affects the availability of funds to commercial banks, and hence their ability to expand the monetary base by giving out loans. This should be associated with lower future economic growth and a higher probability of a recession. A decline in official interest rates would have the opposite effect. A question one would ask therefore would be to what extent is monetary policy responsible for the yield spread's predictive power? The empirical analysis is concluded with an attempt to provide an insight into this question.

It is without doubt that monetary policy influences the shape of the yield curve. Estrella and Hardouvelis (1991:566) argue that it is not monetary policy alone that explains the predictive power of the yield. They suggest that this argument can be simply addressed by adding a variable that represents the current stance of monetary policy to the probit model. The objective is to see if the yield spread continues to have statistically significant coefficients at the various forecasting horizons; *i.e.*, does the yield curve lose its significance once a variable representing the stance of monetary policy is included. The SARB's repo rate (formerly bank rate) is used as a proxy for monetary policy in the study. *A priori*, a positive relationship is expected between the repo rate and the probability of a recession. An increase in interest rates should lower future economic growth and increase the probability of a recession whilst a reduction in the repo rate should lower the likelihood of a recession. The results are presented below.

Table 10: Results from Combination of Repo Rate and Yield Spread

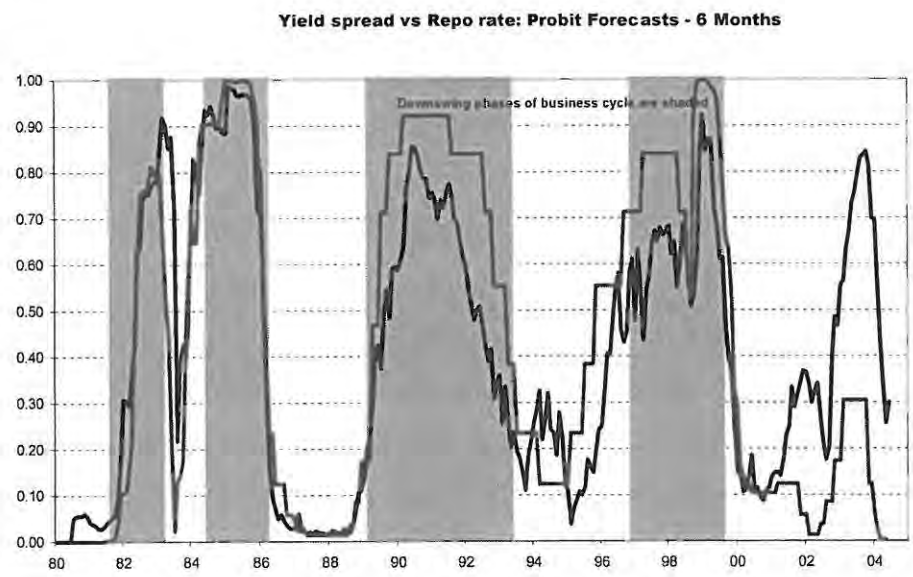
Variables	k=1	k=3	k=6	k=9	k=12	k=15	k=18	k=21	K=24
SPREAD									
Z-stat	2.8478	1.9494	0.3170	-0.6406	-1.9507	-2.7919	-3.2298	-3.5403	-3.0934
Prob	0.0044	0.0513	0.7513	0.5218	0.0511	0.0052	0.0012	0.0004	0.0020
Repo Rate									
Z-stat	8.1228	7.9730	7.1723	5.4163	2.4904	-0.1772	-1.9602	-3.1812	-3.1752
Prob	0.0000	0.0000	0.0000	0.0000	0.0128	0.8593	0.0500	0.0015	0.0015
RMSE	0.3331	0.3104	0.3149	0.3690	0.4314	0.4725	0.4857	0.4863	0.4873
VP	0.1499	0.1303	0.1911	0.2841	0.4006	0.5386	0.6391	0.6404	0.6627

The results from the probit model with the two variables (repo rate and yield spread) are quite revealing. Firstly, the repo rate is statistically significant (mostly at 1%) for periods up to 12 months and the estimated coefficients have the correct signs. Secondly, the yield spread totally loses its explanatory power in the short run between 1 and 9 months, as the parameters are highly insignificant. The yield curve however regains its predictive power at longer horizons as the repo rate loses its statistical significance. It can be concluded

that monetary policy dominates the yield spread and provides the most explanation for business cycle phases in South Africa.

Probit equations were also estimated to calculate the probability of a recession in South Africa using the repo rate alone and the results were quite striking. Based on this study, it can be concluded that changes in monetary policy have a major influence on the business cycle in South Africa[25]. Although the yield spread correctly predicts business cycle phases, most of its predictive power comes from monetary policy. Figure 10 below compares the estimated recession probabilities based on a model containing the spread alone (dark line) and the repo rate only (light line). What is noteworthy is the observation that a model containing the repo rate only does not give a false signal in 2003 as compared to the other variables, with the yield spread included.

Figure 9



[25] It is not implied here that monetary policy is solely responsible for the business cycle. The results here are somewhat rudimentary and the effect of monetary policy on the business cycle could fill several dissertations! What is suggested here is that monetary policy appears to explain the yield curve's predictive power.

5.6 SUMMARY

Empirical results presented in this chapter provide further evidence that the yield curve, as represented by the yield spread between 3-month and 10-year government paper can be used to estimate the likelihood of recessions in South Africa. The yield spread can produce recession forecasts up to 18 months, although it's best predictive power is seen at two quarters. Results from the standard probit model proposed by Estrella and Hardouvelis (1991) and the modified probit model with a lagged dependent variable are somewhat similar, although the latter model improves forecasts at a shorter horizon up to 3 months.

Compared with other indicators, real M3 growth is a noisy indicator and does not provide much information about the probability of future recessions. Movements in share prices can be used to predict economic activity up to 12 months but this indicator does not do better than the yield curve. The index of leading economic indicators outperforms the yield spread in the short run up to 4 months but the spread does better at longer horizons. The results, however, show that all the variables give a false signal in 2003 as they indicate a high probability of a recession that never takes place. A combination of the yield spread with the index of leading economic indicators produces strong forecasts. Based on the results from the study, it appears that changes in monetary policy explain the yield spread's predictive power. This is due to the fact that the yield spread loses its explanatory power when combined with a variable representing the monetary policy stance of the central bank.

CHAPTER 6

SUMMARY OF FINDINGS AND RECOMMENDATIONS

6.1 SUMMARY OF FINDINGS

The study set out to evaluate the ability of the yield curve to predict recessions in South Africa and to compare its predictive power with other commonly used variables that include the growth rate in money supply, changes in stock prices and the index of leading economic indicators. The study also made an attempt at explaining if monetary policy is responsible for explaining the yield spread's predictive power. Regarding methodology, the standard probit model proposed by Estrella and Mishkin (1996) that directly estimates the probability of a recession was used. Results from this model are compared with a modified probit model suggested by Dueker (1997) that includes a lagged dependent variable.

The study confirms the usefulness of the yield curve as a predictor of the business cycle and the timing of recessions in South Africa. Results from the study support the findings of Moolman (2002), who concludes that the yield spread produces the best recession forecasts at a horizon of two quarters. In comparison to the other variables, the results show that the yield spread is the most powerful business cycle indicator at horizons beyond one quarter but it does not do better than the index of leading economic indicators in shorter periods.

The yield curve correctly predicts all past recessions since 1980 but gives a false signal in 2003, where it inverts but the economy never goes into recession. Results also indicate that the yield curve's predictive power seems to reflect the monetary policy stance of the South African Reserve Bank. This is because the yield spread loses its explanatory power when combined with a variable that serves as a proxy for monetary policy. Before concluding with policy recommendations and possibilities for further research, an

explanation for the yields curve's false signal in 2003 is necessary. This is briefly discussed next.

6.2 WHY DID THE YIELD CURVE GIVE A FALSE SIGNAL IN 2003?

From theory, we know that the shape of the yield curve (and hence the spread between short-term and long-term bond yields) is influenced by various factors including the monetary policy stance of the central bank, inflation expectations, growth expectations and the demand and supply for loanable funds. The central bank, through its monetary policy actions, only has a direct influence on short-term interest rates such that market forces largely determine the movement in the longer end of the yield curve. In an inflation-targeting monetary policy regime (like in RSA), a hike in short-term interest rates should tighten monetary conditions and lead to a decline in inflation expectations going ahead. Such an increase in short-term rates does not primarily lead to a parallel upward shift in the yield curve. Financial market participants (largely investors and bond traders) determine the response of the longer end of the yield curve to changes in short-term rates as influenced by the central bank.

A hike in short-term interest rates that is perceived as anti-inflationary by the markets will reduce inflation expectations in the period ahead and cause long-term interest rates to decline. Why should long-term interest rates decline if there are low inflation expectations? The answer to this question can be obtained from the Fisher equation (nominal interest rate = real interest rate + expected inflation). In such an environment, the spread between short-term and long-term interest rates will decline and the yield curve will flatten, with a high possibility of the curve inverting. The upward pressure on the shorter end of the curve will be exerted by the restrictive monetary policy, whilst declining future inflation expectations will cause long-term bond yields to decline[26].

[26] Declining inflation expectations are also associated with a credible monetary policy action of the central bank, especially in an inflation-targeting framework.

One important thing to note, however, is that inflation expectations are not the only factor determining long-term bond yields. If the central bank raises short-term interest rates aggressively to fight inflation, this may sometimes be viewed as negative for growth such that the markets lower their forecasts for economic growth. This will be reflected in lower long-term interest rates, as the central bank will be expected to cut short-term interest rates in the future. A combination of low inflation and growth expectations will definitely cause the yield curve to invert.

According to the SARB (2003:59), the yield curve inverted in 2003 because of an improved inflation outlook brought about by an appreciation in the value of the rand and a reduction in the supply of long-term fixed-interest securities by the government. Such inflation expectations led to speculation the SARB would start lowering interest rates, after hiking them by a total 400 basis points (4%) between January 2002 and June 2003. In a nutshell, it means that in 2003, the low long-term bond yields reflected low inflation expectations, an anticipated decline in short-term interest rates and a limited supply of long-term paper. Tight monetary conditions due to the hikes in interest rates by the SARB ensured that short-term interest rates were higher than long-term rates.

Since the inversion of the yield curve in 2003 was a reflection of the above factors, with a limited possibility of an economic slowdown or probability of a recession, the yield curve gave a false signal and one would argue that its predictive power for economic activity is diminishing. This might be true but one episode of a false signal cannot provide conclusive evidence. The problem with studying or trying to predict recessions is that they are rare events and we might have to wait several years before we experience another one. It is therefore necessary to compare the predictive power of various indicators when generating forecasts in order to get more reliable results. One observable fact is that the yield curve is indeed a powerful tool as it reflects the rational expectations of investors. It is important to note that the yield curve possesses vital information not only about future economic growth but also for inflation and demand and supply for fixed income instruments. Changes in the shape of the yield curve will reflect a combination of

the above forces, with the most important one at any particular period largely responsible for the shape.

6.3 POLICY IMPLICATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

It is shown in the study that the yield curve (together with stock prices and the index of leading economic indicators) can play a useful role in macroeconomic prediction. The shape of the yield curve possesses vital information on future real activity, inflation expectations and the demand and supply of funds in the bond market. The interaction between the above factors determines changes in the shape of the yield curve from time to time. Although an inverted yield curve has preceded all recessions in the past, an inverted yield curve does not summarily imply a recession. A closer look at the other key economic indicators and the underlying conditions in the bond market is necessary. This, however, does not detract from the yield curve's usefulness as a forecasting tool. The South African Reserve Bank can read out future growth and inflation expectations from the shape of the yield curve. A flattening yield curve can signal the effectiveness of monetary policy in bringing down inflation expectations, as this was the case in 2003. Low long-term interest rates can also signal a great demand for long-term bonds that is not met by an adequate supply of paper[27]. Institutions like the government or corporates might find it cheaper at that particular time to raise long-term funds.

The simplicity of the yield curve makes it a handy tool for supplementing forecasts obtained from more formal macroeconomic models and for crosschecking judgmental predictions. The probit approach used in the study provides a different dimension into forecasting economic activity. The probability of the economy going into recession is quite interesting on its own and can be used to compare with GDP growth forecasts

[27] Such demand can come from insurance companies and pension funds that seek to match their long-term liabilities. An inadequate supply may mean the government is unwilling to issue debt due to a healthy fiscal position that is reflected by low budget deficits.

obtained from a large forecasting model. Obtaining similar results, together with judgmental forecasts, increases the plausibility of the forecasts obtained.

Since the study shows that monetary policy might be responsible for the yield spread's predictive power, a further investigation into this observation provides an interesting topic for further research. If monetary policy can indeed explain the business cycle in South Africa, can it be used more aggressively (although not at the expense of price stability) to boost economic growth and fight unemployment? Regarding methodology, other approaches at predicting business cycle turning points (such as logit and regime-switching models) may be worth investigating.

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APPENDIX 1

A) BUSINESS CYCLE PHASES

Upswing Phase	Downswing Phase
January 1978 – August 1981	September 1981 – March 1983
April 1983 – June 1984	July 1984 – March 1986
April 1986 – February 1989	March 1989 – May 1993
June 1993 – November 1996	December 1996 – August 1999
September 1999 -	

Source: SARB Quarterly Bulletin, December 2004

B) PROBIT MODEL RESULTS FOR COMBINED VARIABLES

i) Spread + M3

Variables	*K=1*	*K=2*	*K=3*	*K=6*	*K=9*	*K=12*	*K=15*	*K=18*	*K=21*	*K=24*
SPREAD										
Z-stat	-9.2274	-9.4483	-9.5368	-9.3528	-8.4012	-6.8873	-4.5696	-2.3122	-0.7316	0.0637
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0208	0.4644	0.9492
M3										
Z-stat	-6.3357	-5.6985	-4.6840	-0.8720	2.3773	5.2317	6.5319	6.4339	5.5593	4.2780
Prob	0.0000	0.0000	0.0000	0.3832	0.0174	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo										
R^2	0.4378	0.4506	0.4409	0.3967	0.3345	0.3044	0.2624	0.1982	0.1283	0.0708
RMSE	0.3836	0.3793	0.3805	0.3916	0.4141	0.4248	0.4339	0.4502	0.4669	0.4799
VP	0.2220	0.2185	0.2265	0.2557	0.2798	0.2952	0.3376	0.3941	0.4772	0.5814

ii) Spread + All-Share Index (ALSI)

Variables	*K=1*	*K=2*	*K=3*	*K=6*	*K=9*	*K=12*	*K=15*	*K=18*	*K=21*	*K=24*
SPREAD										
Z-stat	-7.7201	-8.1607	-8.3644	-8.6247	-7.9496	-6.9453	-5.2689	-3.4327	-2.3050	-1.5448
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0212	0.1224
ALSI										
Z-stat	-2.0123	-2.0696	-2.3428	-1.8068	-1.6040	0.2358	1.4735	1.5455	2.4384	2.8441
Prob	0.0442	0.0385	0.0191	0.0708	0.1087	0.8136	0.0000	0.1222	0.0148	0.0045
Pseudo R^2	0.3108	0.3547	0.3879	0.4045	0.3245	0.2050	0.1024	0.0434	0.0312	0.032
RMSE	0.4153	0.4040	0.3960	0.3913	0.4133	0.4430	0.4689	0.4852	0.4885	0.4878
VP	0.3076	0.2802	0.2599	0.2509	0.2967	0.3948	0.5336	0.6681	0.7126	0.7066

iii) Spread + Index of leading economic indicators (LEI)

Variables	*K=1*	*K=2*	*K=3*	*K=6*	*K=9*	*K=12*	*K=15*	*K=18*	*K=21*	*K=24*
SPREAD										
Z-stat	-4.7107	-5.2406	-5.5860	-6.1046	-5.6861	-4.9386	-3.6679	-2.7739	-2.2599	-1.8824
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0055	0.0238	0.0598
LEI										
Z-stat	-5.8185	-5.9725	-6.0389	-5.4475	-4.2044	-2.3025	-0.9780	0.3912	1.7024	2.3439
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0213	0.3281	0.6957	0.0887	0.0191
Pseudo R^2	0.4228	0.4734	0.5060	0.5018	0.3771	0.2229	0.0981	0.0353	0.0197	0.0220
RMSE	0.3857	0.3711	0.3615	0.3635	0.3997	0.4386	0.4714	0.4882	0.4924	0.4914
VP	0.2391	0.2170	0.2038	0.2075	0.2658	0.3802	0.5351	0.6879	0.7556	0.7411

iv) Spread + All-share Index (ALSI) + Index of Leading Indicators (LEI)

Variables	*K=1*	*K=2*	*K=3*	*K=6*	*K=9*	*K=12*	*K=15*	*K=18*	*K=21*	*K=24*
SPREAD										
Z-stat	-4.7662	-5.2958	-5.6198	-6.1482	-5.7076	-5.0039	-3.7340	-2.8124	-2.2935	-1.8859
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0049	0.0218	0.0593
ALSI										
Z-stat	1.1957	1.2700	0.9549	1.1354	0.4741	1.5388	2.2243	1.5538	1.8643	1.9768
Prob	0.2318	0.2041	0.3396	0.2562	0.6354	0.1238	0.0261	0.1202	0.0623	0.0481
LEI										
Z-stat	-5.6530	-5.8041	-5.7645	-5.3361	-3.9963	-2.7442	-1.9271	-0.4109	0.5960	1.1012
Prob	0.0000	0.0000	0.0000	0.0000	0.0001	0.0061	0.0540	0.6812	0.5512	0.2708
Pseudo R^2	0.4720	0.4782	0.5087	0.5055	0.3778	0.2307	0.1155	0.0440	.0325	.0365
RMSE	0.3854	0.3709	0.3617	0.3626	0.3992	0.4353	0.4644	0.4850	0.4884	0.4874
VP	0.2332	0.2104	0.1991	0.2035	0.2653	0.3750	0.5190	0.6674	0.7044	0.6826

v) ALL VARIABLES

Variables	*K=1*	*K=2*	*K=3*	*K=6*	*K=9*	*K=12*	*K=15*	*K=18*	*K=21*	*K=24*
SPREAD										
Z-stat	-5.9435	-6.1895	-6.2360	-6.1558	-5.3107	-4.1599	-2.4198	-1.3194	-0.9264	-0.8634
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0155	0.1870	0.3542	0.3879
ALSI										
Z-stat	1.5171	1.7595	1.3286	1.1415	0.5693	1.8830	2.7749	2.1214	2.4412	2.4006
Prob	0.1292	0.0785	0.1840	0.2537	0.5691	0.0597	0.0055	0.0339	0.0146	0.0164
LEI										
Z-stat	-5.2286	-5.4728	-5.4920	-5.3147	-4.4308	-3.8948	-3.4856	-1.9163	-0.7109	0.1560
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0005	0.0553	0.4772	0.8760
M3										
Z-stat	-5.7888	-5.2422	-4.2625	-0.2179	3.1471	5.8293	7.0289	6.6598	5.5713	4.1500
Prob	0.0000	0.0000	0.0000	0.8275	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.5457	0.5714	0.5650	0.5057	0.4096	0.3556	0.3086	0.2171	0.1509	0.1009
RMSE	0.3554	0.3486	0.3472	0.3622	0.3952	0.4130	0.4215	0.4448	0.4616	0.4727
VP	0.1735	0.1610	0.1692	0.2040	0.2382	0.2560	0.2951	0.3704	0.4395	0.5160