AN INVESTIGATION OF INVERTED YIELD CURVES

AND ECONOMIC DOWNTURNS

Except where reference is made to the work of others, the work described in this dissertation is my own or was done in collaboration with my advisory committee. This dissertation does not include proprietary or classified information.

_____

Paul Francis Cwik

Certificate of Approval:

_____	_____
Leland B. Yeager Professor Emeritus Economics	Roger W. Garrison, Chair Professor Economics
_____	_____
Daniel M. Gropper Associate Professor Economics	Stephen L. McFarland, Dean Graduate School

AN INVESTIGATION OF INVERTED YIELD CURVES AND ECONOMIC DOWNTURNS

Paul Francis Cwik

A Dissertation

Submitted to

the Graduate Faculty of

Auburn University

in Partial Fulfillment of the

Requirements for the

Degree of

Doctor of Philosophy

Auburn, Alabama

May 14, 2004

VITA

Paul Francis Cwik, son of Ralph Francis and Paula Ann Cwik, was born on October 8, 1970, in Royal Oak, Michigan. He graduated from Henry Ford II High School as *Magna Cum Laude* in 1988. He attended Hillsdale College in Hillsdale Michigan and graduated *Magna Cum Laude* with a Bachelor of Arts degree in Economics in May 1992. He then entered Tulane University in August 1992 and received a Masters of Arts in Economics in December 1993. He entered Graduate School, Auburn University, in September 1994. He was an Assistant Professor of Economics at Campbell University from 1998 until 2003. He married Heidi Dianne Teichman, daughter of Dr. Siegmund and Jutta Maria Teichman, on November 8, 2003.

DISSERTATION ABSTRACT

AN INVESTIGATION OF INVERTED YIELD CURVES

AND ECONOMIC DOWNTURNS

Paul Francis Cwik

Doctor of Philosophy, May 14, 2004
(M.A., Tulane University, 1993)
(B.A., Hillsdale College, 1992)

222 Typed Pages

Directed by Roger W. Garrison

This dissertation presents an answer to why the yield curve tends to invert one year before a recession. The capital-based macroeconomic model used in this dissertation makes a distinction between individual production plans and the social structure of production. The analysis traces out the effects of an injection of short-term working capital into the model. There are two consequences of this injection: the Wicksell effect and the Fisher effect. The Wicksell effect entails the downward pressure on interest rates, while the Fisher effect entails the upward pressure on interest rates.

The analysis then compares the effects of monetary injections with the effects of monetary intermediation. The conclusion reached is that although there are some

positive aspects of monetary intermediation, malinvestments still accumulate in the economy.

The analysis then shows that short-term credit can create both short- and long-term malinvestments in the social structure of production. The restricted model demonstrates that, during the malinvestment boom phase, both short- and long-term malinvestments emerge in the early stages of production. These malinvestments are unsustainable and must be liquidated.

The crunch phase of the business cycle begins this process of liquidation. This phase may take the form of a credit crunch, a real resource crunch, or a combination of the two. Each scenario culminates in an inverted yield curve approximately one year before the upper-turning point of a recession. Each recession since the mid-1950s is categorized and is placed into either the credit crunch or the real resource crunch scenarios.

This dissertation also provides a detailed survey of the literature on the appearance of inverted yield curves before economic downturns.

Additionally, this dissertation builds a modified Preferred-Habitat Theory of the yield curve on a time-preference based theory of interest. The purpose of this modification is to base the theory on a microeconomic foundation and to demonstrate that a monetary authority can create a relatively stable term structure of interest in disequilibrium.

ACKNOWLEDGMENTS

I would like to thank Llewellyn H. Rockwell, Jr. and the Ludwig von Mises Institute. Without their support, this dissertation would never have been finished. Additional thanks are due to my committee: Roger W. Garrison, for his assistance and advice; Leland B. Yeager, for setting high standards which pushed me beyond what I thought I was capable of; and Daniel M. Gropper, for his constant encouragement. My parents, Ralph and Paula, have given me their unconditional love and support. Without them, I would have quit long ago. Richard M. Ebeling has been my mentor and good friend since my undergraduate days. I appreciate all that he has done. Finally, I cannot express the level of gratitude and love that I have for my wife, Heidi. She has truly earned a PHT (Put Him Through). Her encouragement, support and editing skills are so appreciated that if I hadn't already pledged my life to her, I would do it again.

Style manual used was the *MLA Handbook for Writers of Research Papers*, 3rd Edition.

Computer software used was Microsoft® Word 2002 and Microsoft® Excel 2000.

TABLE OF CONTENTS

LIST OF TABLES, FIGURES AND EQUATIONS

CHAPTER ONE: INTRODUCTION

Section 1.1 Overview

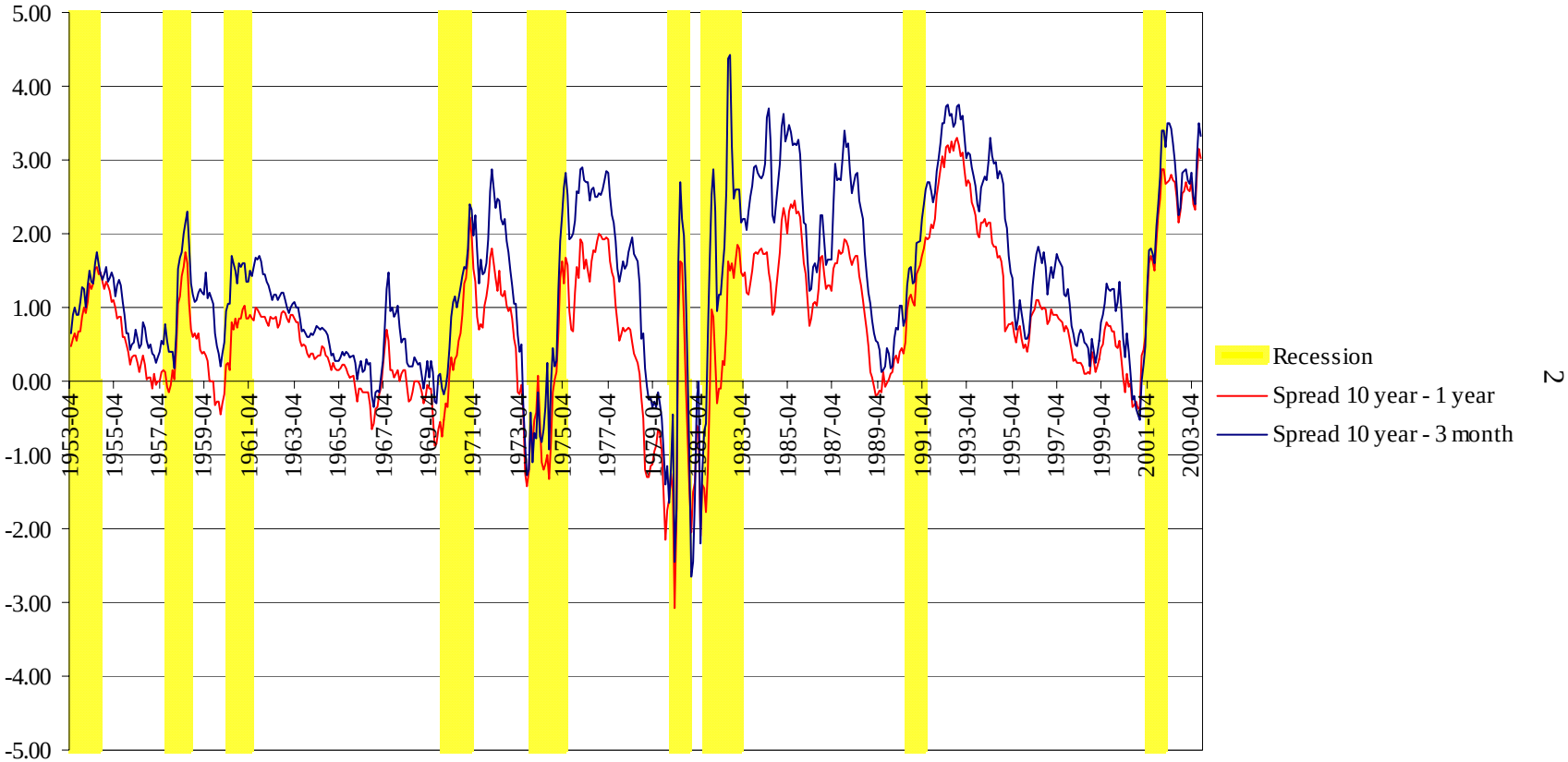
This dissertation addresses the question of why the yield curve tends to invert before a recession. It does not create a model to demonstrate that such a phenomenon exists, as this relationship has already been well established. This dissertation uses the capital-based macroeconomic approach set forth by Garrison (2001) to explain that a correlation exists between the yield curve's spread and real output. Accordingly, the topic is examined by disaggregating investment and capital-formation decisions. This approach allows one to analyze and draw conclusions about the problem in a manner that is superior to more aggregated methods.

Section 1.2 Presentation of the Relationship

Economists, government officials, and businessmen have long searched for accurate business cycle indicators. One strong predictor of the upper-turning point of a business cycle is the inverted yield curve. Chart 1-1 illustrates the 10-year Treasury Bond and the 1-year T-Bill spread and the 10-year T-Bond and the 3-month T-Bill spread between April 1953 and October 2003.[1]

[1] The NBER dating of the recessions is used. All data for this dissertation were obtained from the Federal Reserve Bank of St. Louis' FRED II.

Chart 1-1: Yield Curve Spreads between 1953 and 2002



Recessions are dated according to the NBER.

The data for interest rates were obtained from Federal Reserve Bank of St. Louis' FRED II.

An inverted or humped yield curve has occurred no more than 5 quarters before every recession since the mid-1950s. Except for the Q3:1990-Q1:1991 recession, the yield curve has inverted in every recession since the mid-1960s. Prior to the Q3:1957-Q2:1958, Q2:1960-Q1:1961 and Q3:1990-Q1:1991 recessions, the 10-year/3-month spread did not become negative. The lowest points for this spread were 0.24% in February 1957, 0.20% in December 1959 and 0.13% in August 1989. Preceding these recessions, the yield curve was technically humped and not inverted. The 10-year/1-year spread was negative in December 1956 and from February through April 1957; and according to McCulloch (1990), the 15-year/6-month spread (not shown in the chart) was negative from November 1956 through March 1957. The 10-year/1-year spread was also negative in the period of September 1959 through February 1960 and February through September 1989.

There is one instance where an inverted yield curve was not followed by a recession. From September 1966 through January 1967 the yield curve inverted, but no recession took place. Some refer to this occurrence as a false positive, but the second quarter of 1967 did experience a negative growth rate of -0.06% (real GDP). While this decline in real output did not constitute an official recession, it does confirm the relationship under study.[2]

The historical record does not show this connection to be only a post-WWII phenomenon. The yield curve inverted between June 1920 and March 1921 and again

[2] The true exception to this relationship is the Q2:1953-Q2:1954 recession, where the yield curve flattened but did not invert.

between January 1928 and November 1929.[3] Data from the 19th century are incomplete and do not easily lend themselves to analysis.[4] Nevertheless, support for the thesis of the yield curve as a predictor of business cycles can be traced as far back as the mid-1800s.[5]

Section 1.3 Organization of the Dissertation

The remainder of this dissertation is divided into four chapters. Chapter 2 presents a comprehensive review of the literature. The current research can be separated into two basic models: the consumption-based capital asset pricing model (CCAPM) and the Estrella models. The essential idea of the CCAPM is that investors smooth income across business cycles. Criticism of the CCAPM has led to the development of an alternative theoretical model.

The second group of papers examined present models that build on variations of the following economic tools: the Expectations Hypothesis, the Phillips curve, the IS curve, a monetary reaction function, and the Fisher Equation. The initial exogenous change for these models is a monetary shock. The origin of these models is Estrella (1998).

This dissertation will argue that the Estrella model is also inadequate for understanding *why* the yield curve tends to invert before a recession. The Estrella models derive the relation between interest rates and real output from the Phillips curve and the IS curve. Both of these tools are criticized. The Phillips curve (an empirical and not a

[3] Cecchetti (1987) demonstrates that the observed bond market data from the 1930s and 1940s are distorted due to heavy government intervention. As an illustration of the degree of distortion, on December 31, 1932, institutional forces caused the 3½% US Liberty Bond's yield to fall to a nominal rate of –1.74%.
[4] Davis (1971) examined U.S. capital markets from 1820 through 1930. He shows these markets were not integrated until after World War I.
[5] See Keen (1989).

theoretical relationship) fails to explain the microeconomic relation between inflation rates and real output. While it shows that a connection exists, the theoretical foundation needed to understand the relationship is not explained. To complete the argument, this dissertation briefly argues against the use of the Keynesian IS curve.

Several recent papers focus on regime-switching models to enhance prediction results. This method is important since each article that includes regime-switching finds a significant relationship between the spread and real output, while those which deny the relationship do not use break points to identify the different regimes.

Chapter 2 also examines the existence of an empirical relationship but demonstrates that the debate on theory remains unresolved. None of the reviewed articles examines the effects of non-neutral monetary injections through a heterogeneous capital structure. This dissertation contends that the addition of Austrian insights can provide an alternate (and fruitful) perspective to this debate.

Chapter 3 surveys the theories of interest, the yield curve, and their literature. This dissertation separates the necessary and sufficient conditions for the formation of interest rates from factors that merely influence the height of the market rate. It argues that essentially Böhm-Bawerk was correct, even if his exposition was unclear.

After addressing the issue of the originary factors, an extension of the theory to the yield curve is made. The main question that surrounds the yield curve is, "In a world with well functioning arbitrage markets, why does the yield curve tend to have a positive slope?" The four theories that attempt to answer this question are the following: the Expectations Hypothesis, the Liquidity Preference Hypothesis, the Segmented Markets Theory, and the Preferred-Habitat Theory. In addition to reviewing each theory, the

Stochastic-Process No-Arbitrage Approach and the analysis offered by Rothbard (1993) are critically examined.

Several recent contributions to yield curve theory are briefly reviewed. Most of the recent articles on the yield curve attempt to determine the yield curve's informational content on future inflation. While this is an interesting topic, it is not within the scope of this dissertation's examination. The conclusion reached through this review is that there is a gap, which the Austrian perspective can fill.

Chapter 3 concludes with the development of a modified Preferred-Habitat Theory. The difference between the standard Preferred-Habitat Theory and the modification is that the modified theory uses as the root of real interest rates Böhm-Bawerk's analysis (instead of Fisher's analysis). In other words, the modified Preferred-Habitat Theory contains the following: expectations, a term premium, the imperfect substitutability of assets and Böhm-Bawerk's reasoning for time preference. This modified theory then serves as the foundation for the capital-based approach.

Chapter 4 explains why the capital-based approach is reasonable and demonstrates that an inverted yield curve is the result of malinvestments created during the boom phase of the business cycle. Macroeconomic theories attribute economic downturns to monetary or real factors. The capital-based approach allows for both. The flexibility of the capital-based approach is that it is able to account for expectations, monetary and real factors in the analysis. Furthermore, this disaggregated approach can capture the non-neutral monetary effects on the capital structure, while other theories aggregate away these microeconomic dynamics. This dissertation does not argue that a

particular theory of the business cycle is better than others are. However, a disaggregated approach allows for analysis and insights other theories cannot provide.

Unique to this dissertation is the inclusion of a yield curve (specifically the modified Preferred-Habitat Theory) within the general outline of the Austrian Business Cycle Theory (ABCT). The capital-based approach posits that initial disequilibrium (malinvestment) begins with monetary injections. Monetary injections, by sending opposite signals to entrepreneurs and consumers, set off a malinvestment "boom." The beneficial effects of monetary intermediation are examined and contrasted with the negative effects of the monetary injections.

The phases of the business cycle leading to the upper-turning point are analyzed with the inclusion of the yield curve. As money is injected into the economy, the yield curve steepens. The steepening yield curve creates incentives for entrepreneurs to create short-term malinvestments throughout the structure of production, and it misleads entrepreneurs so that they do not terminate long-term malinvestments. These long- and short-term malinvestments accumulate in every part of the economy.

When the level of disequilibrium becomes so great, the economy reaches the upper-turning point and heads toward a recession. In the standard literature, either monetary or real factors are often selected as the immediate "cause" of the downturn. However, the capital-based approach, by not over-aggregating the effects of monetary injections, show that each of these "causes" have the same root—malinvestments.

The consequence of the malinvestment boom is an inverted yield curve. The analysis explains why the yield curve inverts (instead of simply shifting) before a recession. During the crunch phase of the business cycle, either the monetary authority

reduces the rate of monetary expansion or real resource prices are bid up faster than output prices. Each of these scenarios leads to the conclusion of an inverted yield curve.

The inverted yield curve precedes the upper-turning point of the business cycle, because it is the manifestation of the entrepreneurs' attempt to avoid the consequences of the malinvestment boom. The recession is the inevitable result of the market's liquidation of the malinvestments, which is a necessary step for recovery and long-term growth. A possible outcome of the initial liquidation of the malinvestments is Hayek's "secondary depression." While the examination of the recession and recovery phases are important for a complete theory of the business cycle, these aspects of the cycle are beyond the scope of the problem under consideration.

Chapter 5 provides a summary and conclusion to the question of why the yield curve tends to invert before a recession. Finally, several questions are raised for future research when further integrating the yield curve into the Austrian macroeconomic model.

Concluding the dissertation is an appendix that summarizes the 95 items reviewed in Chapter 2. It identifies the article as primarily theoretical, empirical or a combination of the two. The table summarizes the data set and model used in each. Additionally, there is a column that illustrates if the article supports the relationship between the yield curve and real output. Finally, a brief overview of each article is supplied.

CHAPTER TWO: LITERATURE REVIEW

Section 2.1 Overview

Economists, businessmen and government officials have long been searching for a way to forecast accurately the turning points of recessions. Since the 1990s, many leading indicators have been created.

Although Kessel (1965) examines the predictive ability of the yield curve, nearly all study of the yield curve as a predictor of changes in real output has occurred over the past 17 years. In an extensive survey of leading indicators, Stock and Watson, in their 1989 article, include the yield spread as a component of their leading indicators index. After 14 years of study, Stock and Watson (2003) continue to keep the yield spread as a part of their index.

In four early essays, Evans (1987), Laurent (1988, 1989) and Keen (1989) offer the yield curve's movements as a simple method for predicting real output. At first Bernanke (1990) disagreed that the yield spread, the difference between long and short rates, was the best predictor of real output. He shows the difference between commercial paper and public securities (the paper spread) outperforms the yield spread. However, his model assumes a constant monetary policy across the various monetary regimes. Revisiting the topic, Bernanke and Blinder (1992) employ a non-linear model that demonstrates the yield spread better predicts real output than other monetary aggregates.

However, Bernanke and Blinder (1992) indicate predictive ability has emerged only since the mid-1980s. Over the past 17 years, the research demonstrates that the inclusion of policy regime shifts significantly affects the ability of the models to predict real output.[1]

Haubrich and Dombrosky (1996), Ahrens (1999) and Phillips (1998/1999) compare the yield curve with other leading indicators and find the yield curve to be better. Haubrich and Dombrosky (1996), by using a linear model, find the yield spread to be a good predictor, but its predictive ability has diminished since 1985. Ahrens (1999) and Phillips (1998/1999) use regime-switching models and find the yield spread to be the most reliable and with the longest lead. In addition, Ahrens (1999) finds the predictive ability of the yield spread has remained strong across the entire period of M1:1959-M5:1995, in contrast to Bernanke and Blinder (1992) and Haubrich and Dombrosky (1996).

The above articles all caution that, while the yield spread has been a helpful guide for monetary policy, it should not be used in isolation.

Berk (1998) presents the most recent survey of papers examining the relationship between the yield curve and real output. He concludes the following: 1) the theory is still in dispute; 2) the empirical results vary with the country and segment of yield curve examined; 3) the results are sensitive to type of model used; 4) there is a consensus that the slope contains considerable information; and 5) the various models do not have stability or controllability, so the relationship is not a useful tool for monetary authorities.

[1] The inclusion of break points in the models will be addressed in more detail in Section 2.6.

Hamilton and Kim (2002) state that few articles examine the underlying reasons why a relationship exists between the yield curve and real output. This dissertation focuses on the two leading models: the consumption-based capital asset pricing model (CCAPM) and the Estrella model.

The remainder of this chapter is divided into six sections. Section 2.2 evaluates the CCAPM: the theory, the international aspects, its linkage with the Real Business Cycle (RBC) model, empirical evidence and criticism of the model. Section 2.3 examines the Estrella model: the theory, its international aspects, its linkage with the IS-LM model, empirical evidence and criticism of the model. Section 2.4 reviews articles that do not support the relation between the yield spread and real output. Section 2.5 summarizes articles that address theory but do not fit under Sections 2.2 or 2.3. Section 2.6 discusses empirical articles that do not explore theory. Section 2.7 summarizes and concludes this chapter. A table containing a short summary of the 95 items is presented as Appendix I.

Section 2.2 The Consumption-based Capital Asset Pricing Model

The first set of papers derives its theoretical foundation from a consumption-based capital asset pricing model (CCAPM). Although the CCAPM approach is not specific to any particular macroeconomic theory, it is most commonly associated with the Real Business Cycle model.

The first application of the CCAPM to the yield spread and real output is found in Harvey (1986). The basic assumption of the CCAPM is that investors smooth income

across business cycles. A representative agent's expected returns on his assets are linked to his expected consumption choices. The time horizon is initially broken into two periods. At time t_0, the investor will smooth his income (and consequently his consumption) across a recession by buying bonds for a future time t_1. In other words, if the investor suspects the economy will be in a recession next period,[2] he trades current income for a bond, which will yield a return during the recession. The model is generalized to encompass assets with up to k maturities and a time horizon of N periods.

The early articles compare the yield curve with consumption growth. In particular, Harvey (1986) shows the predictive power of spread was weaker in the 1960s, and was strongest in the 1970s – 1980s. He shows the spread to outperform lagged consumption and real stock returns. Consumption growth is used as a proxy for real-output growth, Harvey (1986, 1988), since consumption spending is the largest factor in GDP. The connection between the yield curve and real output is established through consumption. Later CCAPM articles drop this proxy and directly examine the relation between the yield spread and real output.

Stojanovic and Vaughan (1997) and Harvey (1989) confirm the relation between the yield spread and real output. The yield spread compares favorably to Leading Indicators and the S&P 500. However by using the CCAPM, Harvey (1989) overestimates a growth rate of 1.7% for Q3:1989 – Q3:1990 and fails to predict the Q3:1990 recession.

[2] The actors of this model are assumed to have rational expectations.

The relation between the yield spread and real output has been tested in other nations. The results of the out-of-sample tests show the yield spread outperforms alternative indicators in the G-7 countries. Harvey (1991a) shows the yield spread predicts real output for Germany and outperforms standard German indicators. Specifically, the yield spread has lower forecast errors than the DIW and the indicators of five other (unnamed) research institutions. He states the reason that a recession did not immediately follow the inverted yield curve in Q4:1989 was because of the reunification of Germany. Harvey (1997) attempts to separate the influence of the US on Canada's economy. He shows the component of the Canadian yield curve that is uncorrelated with the US yield curve is able to predict Canadian economic growth. In addition, the Canadian yield spread can predict the portion of the Canadian growth that is uncorrelated with US growth. Harvey (1991b) shows that the yield spread/real output relation holds across the G-7 countries.[3] In this application of the CCAPM, a "World Spread" is constructed and found to be a good indicator of real global output. He further predicts (from the perspective of 1989) that the US will have slow economic growth in 1990. Hu (1993), applying the CCAPM to the G-7 countries, confirms the yield spread has more predictive ability with in-sample forecasts than stock prices, and the yield spread's out-of-sample forecasts are better than alternative indicators.

Unlike the previous papers in this section, Chapman (1997), Roma and Torous (1997) and Campbell and Cochrane (1999) use the real yield curve. Chapman (1997) extends the CCAPM to reduce the signal-to-noise ratio by using expected consumption

[3] Harvey (1991b) finds that yield spread/real output relation is weak for Japan. However, the relation improves after 1978. Japan will be discussed in more detail in Section 2.6.

growth, not *ex post* consumption growth. He finds the following: 1) the yield spread is weakly correlated with expected consumption growth over the full sample; 2) the yield spread is strongly correlated between 1979 – 1985; 3) pre-1979 cyclical properties are qualitatively similar and consistent with a simple RBC model; and 4) the real yield curve at NBER peaks appears to lie everywhere above the real yield curve at NBER troughs. Roma and Torous (1997) estimate the real yield curve by using a time-separable consumption function. Thus, a flat yield curve (not an inverted yield curve) appears at the business cycle peak and the yield curve appears steep at the trough. They find the yield spread provides more information about future changes in stochastic detrended real GDP than about future growth rates in real GDP. Campbell and Cochrane (1999) use the CCAPM to look at stock price movements over the period of 1871-1993. They argue a CCAPM with habit formation provides an equilibrium framework where large, negative yield spreads (inverted yield curves) precede reduced economic activity.

Several papers use the CCAPM in conjunction with the RBC theory to explain the connection between the yield spread and real output. Chen (1991) confirms that the default spread, the yield spread, the 1-month short rate, lagged industrial production and the dividend-price ratio are all determinants of future stock returns, recent growth in GNP, future growth in GNP and consumption. Harvey (1993) uses the RBC theory and assumes the term structure of expected inflation is flat. He states that the magnitude of the inversion predicts the severity of the recession. Labadie (1991), in a non-empirical article, examines whether real GNP should be modeled as trend stationary (having temporary effects) or as difference stationary (having permanent effects). According to

her model, if real GNP is difference stationary, then the average nominal yield curve has a negative slope and negative term risk premium.

Clinton (1994), Fuhrer and Moore (1995) and Evans and Marshall (1998) test the CCAPM and the RBC theory. Clinton (1994) suggests the traditional AS/AD view is not empirically supported. He finds that the yield spreads of Canada and US tend to move together, but Canada's yield spread is a better indicator for Canada's real output. While the yield spread is an accurate indicator of real GDP, it is a less accurate indicator of any particular component of GDP. Of the components, the yield spread is the most accurate with durable consumption. This result is surprising because the yield curve is typically associated with investment decisions. While Clinton (1994), observes some information is found in investment in capital equipment and housing, he finds no information in non-residential construction.

Fuhrer and Moore (1995) examine the interest rate transmission mechanism along the yield curve. They contend the 10-year rate explains real output. Their VAR suggests the 10-year rate and the 3-month rate move together. Thus, short-term rates should be the focus of monetary authorities.

Evans and Marshall (1998) find evidence that contractionary monetary policy increases term premia for shorter maturities, raising real interest rates. A money supply shock raises the level of the yield curve but reduces its slope and curvature. The effects of the monetary shock on the slope and curvature dissipate in 4-6 months and the yield curve returns to its original level within 6 months. The authors' results for long-term rates fit the Expectations Hypothesis.

Peel and Taylor (1998) and Cecchetti and Ehrmann (1999) use the CCAPM/RBC model to make policy recommendations to monetary authorities. Peel and Taylor (1998) separate permanent shocks to real output from temporary shocks. Permanent shocks are associated with the supply side, while temporary shocks are associated with the demand side. The authors first purge GDP of supply innovations. They then test the yield spread's predictive ability on this modified GDP data set. Then they repeat the process with the purging of demand innovations. They find that without supply innovations, the yield spread predicts real-output growth, but without demand innovations, the yield spread fails to predict real-output growth. They conclude that the yield curve's power is based on the temporary shocks of demand-side activity (Aggregate Demand).

Cecchetti and Ehrmann (1999) use a Quadratic Loss Function to model monetary policy makers' decisions. They model the decision as a minimization of the discounted sum of squared deviations of output and prices from predetermined targets. They then used a VAR to identify monetary shocks. The results show that in the 1990s, central banks shifted monetary policy to target inflation directly. The countries that significantly targeted inflation decreased inflation variability and slightly increased output variability. The authors find that an aversion to inflation increased in all 23 countries examined. Furthermore, the authors recommend an improvement in forecast models by allowing for structural breaks in policy regimes.

Criticisms of the CCAPM and RBC Model

Although the CCAPM is based on the real yield curve, most articles use the nominal yield curve. The CCAPM does not explain movements of the nominal yield curve.[4] Additionally, when attempts are made to use the real yield curve empirically, the data are deflated by an index. This adjustment strips the yield curve's information content on inflation and biases the results on real output.

The CCAPM and RBC model hold that only "real" shocks to the economy produce business cycles. Smets and Tsatsaronis (1997) take an opposing position and reject the view that "real" underlying shocks are the only source of the yield spread's link to real output. They show a positive yield spread is associated with expanding real economic activity and argue the credibility of the monetary regime is critical to this relationship. Their results illustrate that the predictive content of the yield spread is *not* policy independent. Monetary policy affects the link through direct intervention (e.g., a policy of "leaning against the wind") and by modifying expectations. For example, having a credible, strong anti-inflation policy diminishes uncertainty, reducing the impact of nominal shocks to long rates.

Estrella and Hardouvelis (1991) criticized the CCAPM for its neglect of consumer durables and investment. Clinton (1994), however, suitably addresses this criticism.

Ragnitz (1994) provides additional criticism of the CCAPM.[5] He argues that monetary policy determines short rates. Thus deliberate monetary policy, not just

[4] See Smets and Tsatsaronis (1997).

[5] The writer of this dissertation would like to thank Jörg Guido Hülsmann for translating the article from German.

random exogenous shocks, affects the yield spread. He further argues that stable long rates weigh against a simple Expectations Theory of the yield curve.

Although Salyer (1994) supports the CCAPM and RBC view of the economy, in his RBC model, he characterizes growth as random technological shocks. He concludes that the yield curve inverts at the bottom of the business cycle, a conclusion that is not empirically true. The yield curve tends to invert before a recession, which is precisely the reason the yield spread is used as a *predictor* of real output.

While the arguments presented above are reasons to call into question the use of the CCAPM, they miss a significant problem inherent to the model—the reasoning of the CCAPM is circular. Harvey (1991b) states the advantage of this model is that it can reduce the uncertainty of business forecasting.[6] The CCAPM is not a model that *forecasts* real activity; it is a model that *reflects* entrepreneurial expectations. The model assumes that investors believe there will be a recession in the next period. Fearing a recession in the next period, investors will buy bonds, which drive down long rates and invert the yield curve.[7] The argument is circular in that the inverted yield curve is both the cause and the effect of entrepreneurial action. The investors' expectations are the cause of the inverted yield curve, and at the same time, the inverted yield curve is the basis of their expectations, signaling an upcoming recession. Since the yield curve is

[6] Specifically Harvey (1991b) states, "Uncertainty about future economic growth has many negative consequences. Perhaps the most serious consequence concerns the business investment process. Uncertainty about economic growth may cause firms to defer capital investment projects, which could exacerbate a slow growth environment. An accurate forecasting model such as the one described here [the CCAPM] may help reduce uncertainty." p. 19.

[7] Long rates do not empirically fall relative to short rates; short rates rise relative to long rates. See Bernanke and Blinder (1992), Ragnitz (1994), Campbell (1995), Gamber (1996) and Ang, Piazzesi and Wei (2003).

such a good forecasting tool, an inverted yield curve is the effect and not the cause. Thus the CCAPM cannot be true.

The entire model is predicated on some entrepreneurs correctly forecasting a recession in time period t_1, yet the source of their initial fear of recession is never adequately explained. Either the recession is caused by some "super knowledgeable" entrepreneurs (who do not need the CCAPM) or the recession is caused by some unknown psychological factors.

Finally, Harvey (1991b) states that the CCAPM outperforms other models (like the stock market models) because the CCAPM did not produce a false positive in 1988. The stock market models predicted a recession in 1988, but the yield curve did not invert. However, according to the CCAPM, the *fear* of a recession inverts the yield curve. Harvey (1991b) fails to address this inconsistency by explaining why the investors' actions did not cause the yield curve to invert.

In summary, the CCAPM has the following problems: 1) it fails to explain the movements of the nominal yield curve; 2) it holds that only real shocks produce business cycles; and 3) its reasoning is circular. Thus, the CCAPM is insufficient to explain *why* the yield curve tends to invert before a recession.

Section 2.3 Estrella Models

The second set of papers presents theories about the statistical relationship between the yield curve and the upper turning point by building models on variations of the following economic components: the Expectations Hypothesis, a short-run Phillips

curve, the IS curve, a monetary authority reaction function, and the Fisher Equation.[8] The initial exogenous change in this model is a monetary shock. While there is no particular name to this model, for brevity and clarity it will henceforth be referred to as the Estrella model.

Estrella (1998) creates a two-period, rational expectations model based on the economic components presented above. The model suggests that the empirical regularities are not structural but are significantly affected by national monetary policy. When the monetary authority reacts to levels of national income below full employment, the yield curve is an optimal predictor. The more adverse a regime is to inflation, however, the less significant is the link between the yield spread and real output. An inflation-wary regime also reduces the link between the yield spread and inflation. The monetary reaction function is the key equation linking the yield curve to real output. Estrella (1998) endorses the use of break points for empirical analysis of the yield spread and real output. In an application of the Estrella model, Venetis, Paya and Peel (2003) find break points in Canada, the UK and the US.

Hamilton and Kim (2002) and Kotlán (2002) build upon the Estrella model. Hamilton and Kim (2002) measure the extent to which short-term rates move relative to long-term rates and confirm the predictive power of the yield spread. According to the authors, both the signal of expected future short rates (the expectations effect) and the signal of a change in the term premium (the term-premium effect) test significant, although the expectations effect is slightly stronger. Kotlán (2002) confirms that the

[8] Estrella (1998) originates and typifies this approach.

predictive ability of the yield spread is dependent on monetary policy. However, his results oppose Estrella (1998). Kotlán (2002) concludes that, when the monetary authority pays more attention to inflation, the predictive ability of the yield spread increases (through the monetary authority's reaction function).

Technically, while Lowe (1992) does not use the Estrella Model, he applies the Estrella and Hardouvelis (1991) methodology (a precursor to the Estrella model) to an Australian data set. Specifically, he uses the IS curve as the basis for his analysis. By breaking the data set in two (to account for a regime change in July 1982), Lowe (1992) confirms the yield spread's predictive ability for Australian nominal output growth and inflation.

Berk and Van Berggeijk (2000) argue that the yield spread/real output relation is based on a Risk-adjusted Fisher Equation, the IS curve and the Expectations Hypothesis. They conclude that, while there is a significant relationship between the yield spread and real output, the effect is weak in the Eurosystem.[9] The authors are not looking for the "best model," instead they are concerned if the spread provides information "over-and-above" past patterns of inflation and output. They theorize that a steepening of the yield curve may indicate: 1) an upward revision of expected inflation; 2) an expectation of increased productivity in capital; and 3) an expectation of future monetary tightening by a credible policy maker.

[9] The Eurosystem is comprised of the European Central Bank and the national banks that have adopted the Euro.

Estrella (2003) criticizes earlier works that examine the yield spread/real output relation, stating that most of these works are not based on theory.[10] He simplifies his earlier model to include only rational expectations, the IS curve and the Phillips curve. The modified Estrella model supports his previous conclusion that the yield spread is connected to real output through the monetary policy regime function, not through structural relationships. The main contribution of the Estrella (2003) paper is that it presents "both an explicit term structure of interest rates and a closed-form solution."[11] This paper attempts to combine the earlier IS based models with the CCAPMs into a single framework. The backward-looking version of the model corresponds to an IS-LM model, and the forward-looking version is consistent with the CCAPM and RBC model. Unfortunately, only the backward-looking version consistently produces a positively sloped yield curve. When the forward-looking version is used, a positively sloped yield curve emerges only when inflation is expected in the next period. Furthermore, when the model is in equilibrium, the implied real rate of interest is zero. Estrella (1998) argues that deviations from an interest rate of zero can be expressed as deviations from a non-zero equilibrium rate. Estrella (2003) does not include this argument.

The Estrella models address the question of why the yield curve inverts before a recession, but fail explain the underlying relationship. Estrella (1998, 2003) acknowledges several shortcomings in the Estrella models. However, the broader issue is that the models never explain *why* the economic phenomena move together. This

[10] Several articles reference the Estrella model as the reason for the yield spread/real output relation and then embark upon a purely empirical analysis. These papers are presented in Section 2.6.
[11] See Estrella (2003) p. 1.

explanation cannot be found by mere empirical tests as to whether or not such a relationship exists. The yield spread/real output relation has already been firmly established. The fundamental question that ought to be addressed is why it occurs. To find an answer to this question, the macroeconomic model used must have a microeconomic foundation. Only a macroeconomic model based in microeconomic theory can effectively explain the underlying relations. If one is looking for merely a forecasting tool, then the microeconomic foundations are less relevant. However, this dissertation expressly searches for an explanation of the tendency of the yield curve to invert prior to a recession. Thus any model not rooted in microeconomic theory, such as the Estrella models, cannot provide an explanation.

The Estrella models develop the relation between interest rates and real output from a short-run Phillips curve and the IS curve. The Phillips curve is merely an empirical relationship and is not based on a microeconomic foundation.[12] The underlying economic relationships are fundamental to finding the overarching yield spread/real output relationship. However, the theoretical underpinnings needed to understand the relationship are not explained and are hidden beneath this aggregated curve. Thus when the Phillips curve is used as a structural component of an economic model, the yield spread/real output relationship cannot be explained.

Models based on the IS curve, such as the Estrella models, should not be used to analyze the upper turning point of a business cycle. The use of the IS curve in a dynamic context violates its own theoretical assumptions. Hicks, in his 1982 and 1988 articles,

[12] For a critical review of the Phillips curve, see Herbener (1992).

has virtually recanted his position on the IS-LM model. He states that the IS curve can be used properly if one assumes a perpetual state of equilibrium.[13] When investigating the upper turning point of a business cycle, a state of perpetual equilibrium is an invalid assumption.

Additionally, Berk (1998) argues that in order for the IS curve to produce real effects in the Estrella models, the IS curve must be based on the assumption of fixed prices. While it is true that movements along the IS curve entail a changing interest rate and hence changing asset prices, the curve is based on a fixed investment demand. In the Keynesian framework, investment is a function of income and psychological factors, not of interest rates.[14] According to Keynes (1936), the main cause of a recession is a drop in the level of investment. The IS curve's assumptions of fixed prices and constant investment demand are violated when analyzing a business cycle.[15] Furthermore, Estrella and Hardouvelis (1991) admit that the IS-LM model is insufficient to explain a business cycle because the model needs exogenous shocks to the IS curve to produce changes in real output. The authors find the greatest exogenous shock comes from the least predictive component of GDP—government spending.

---

[13] See Hicks (1982) pp. 327-8.

[14] Leijonhufvud (1981) p. 135 states, "Keynes' obfuscation of interest theory inheres in his LP [liquidity preference] hypothesis but stems from his insistence on the savings-investment equality as an identity. If saving and investment are always equal, they cannot govern the rate of interest, nor can the interest rate possibly serve to coordinate saving and investment decisions."

[15] Horwitz (2000) p. 8 states, "The fundamental problem with the IS curve is that the equilibrium condition that defines the curve ignores the crucial difference between *ex ante* and *ex post* savings and investment. *Ex post* investment always equals savings, i.e., if investment is taking place, the savings must have come from somewhere. However, investment and savings need not be equal *ex ante*, and this is the point that the IS-LM analysis is unable to handle." Prior to and at the upper turning point of a business cycle, savings and investment are not equal. Chapter 4 discusses how the inequality between savings and investment can be created from an expansion of credit.

In summary, the Estrella model has the following problems: 1) it lacks microeconomic foundations; 2) the Phillips curve lacks theoretical underpinnings; and 3) the IS curve cannot be used to examine a dynamic relationship.

Section 2.4 Articles Disputing the Yield Spread/Real Output Relationship

Not all articles agree that the yield spread has predictive power over real output. These articles argue one of the following: that the link is not universal—Sauer and Scheide (1995), and Bange (1996) or that it has diminished over time—Erenburg and Goebel (2001), Gamber (1996), and Dotsey (1998) or that the yield spread does not have superior predictive ability to forecast real output—Davis and Fagan (1997) and Kozicki (1998).

Sauer and Scheide (1995) use a Granger Causality test and find that the yield spread is not a good predictor for France or Italy. However, the yield spread is a good predictor for Germany. They recommend a policy of money-supply targeting in lieu of interest rate targeting, as the money stock provides an anchor for the price level and inflation, while the yield curve does not.

Bange (1996) confirms that the yield spread is a good predictor for Germany, Japan and the US, but not the *best* predictor for Japan and the US. She bases her results on goodness-of-fit tests. The best predictor for Japan is past stock returns, while for the US, the best predictors are stock returns and expected changes in inflation. Furthermore, she cautions that stock returns lose their power with floating exchange rates.

Erenburg and Goebel (2001) agree that a correlation between the yield spread and real output exists, but that the yield spread is not the best predictor. They examine the predictive ability of the international/domestic interest rate spread and the yield spread in a model with flexible exchange rates and open capital markets. The results from the VAR show that both spreads correspond significantly to real output. While the results are positive for the yield spread, they argue that the international/domestic interest rate spread's influence has grown since 1986 and dominates the yield spread.

Some papers find a relationship between the yield spread and real output but argue that the yield spread's informative content has diminished over time. Gamber (1996) argues that the yield spread was a good predictor prior to October 1979 but has since lost much of its predictive power. He finds that the yield spread contains information only when the Federal Reserve does not react to changes in that variable. The yield spread's ability to predict output growth has declined since October 1979. Since September 1979, however, the yield spread has gained independent information on inflation. His Granger tests say that the federal funds rate is a robust predictor of inflation over the 1955 – 1992 period. Furthermore, Gamber (1996) notes that the yield curve appears to get its predictive power from the federal funds rate, an observation that is in agreement with Bernanke and Blinder (1992) and Ang, Piazzesi and Wei (2003). Like Gamber (1996), Dotsey (1998) also argues the predictive content of the spread has diminished. In his analysis, the predictive power of the yield spread weakens after 1985. Neither Gamber (1996) nor Dotsey (1998) incorporate regime-switching techniques. Articles that use regime-switching models find break points in 1979 and 1985. The

articles that do find break points also find that the yield spread is a strong predictor of recessions.

Davis and Fagan (1997) and Kozicki (1998) deny the predictive ability of the yield spread. Davis and Fagan (1997) test the yield spread, a reverse yield gap/stock price variable, the paper spread,[16] and the foreign bond yield differentials. They find that the yield spread has poor out-of-sample performance. Although they do not perform stability tests, they report that the estimated equations appear to be unstable. They conclude that financial spreads should not be used "comprehensively and indiscriminately" as indicators of output and inflation in EU countries.

Kozicki (1998) argues that earlier papers suffer from specification error. Due to the specification error of the dependent variable, the coefficients and their R^2s are flawed. She argues a positive yield spread is associated with increasing inflation. The dependent variable's coefficient likely reflects correlations between the yield spread and current inflation. Furthermore, the coefficient should not be interpreted as evidence of future inflation. She concludes that the yield spread is a reflection of current monetary policy.

Section 2.5 Alternate Models

While the following articles support the yield spread's relation to real output, they present alternative theories to explain the yield curve's behavior.

Turnovsky (1989) uses the New Classical model to examine the effects of monetary policies on the term structure. In his model, monetary policy is conducted

[16] Davis and Fagan (1997) use the term "quality" spread for the paper spread, which is the difference of returns between commercial paper and public instruments with the same maturity.

through the use of short-term assets, which affect long-term assets. The long-term assets, in turn, affect growth rates. He concludes that the response of the yield curve is highly sensitive to the nature of the underlying shocks.

Mishkin (1990c), McCallum (1994) and Kim (2000) base their approach on the Expectations Hypothesis. Mishkin (1990c) concludes that the yield spread is positively correlated with changes in short rates. However, the yield spread is negatively correlated with long rates.[17] McCallum (1994) addresses the failure of the Expectations Hypothesis under the assumption of rational expectations. The conclusion is that one would have to estimate accurately the policy reaction function of the monetary authority in order to test the Expectations Hypothesis. Kim (2000) decomposes the yield curve into an expectations effect and a term premium effect. While both variables are significant, Kim (2000) performs a Wald test to determine that the expectations effect is slightly stronger.

Fama (1990) argues that long rates contain information on real rates, expected inflation, and the term premia, but he is unable to separate the information that is contained in each. The yield spread has power to predict one and 2-year changes in the real rate of return for 1-year bonds. The lagged 1-year spot rate has forecasting power for real output in 1-3 years. The yield spread has forecasting power beyond 3 years.

Plosser and Rouwenhorst (1994) demonstrate that information found in long rates does not stem from short rates. Furthermore, the information that the long rates contain on real growth rates is not related to monetary policy. They find that the yield spread is a better predictor at horizons of two quarters or more. In the US and Germany, the yield

[17] This result is the opposite of the Expectations Hypothesis.

spread is a better predictor for real growth than for nominal growth or for consumption growth. Additionally, the inclusion of the world interest spread improves the R^2s in US, UK and Germany (but not for Canada or France).

Within the context of the New Keynesian and the New Classical models, Berk (1998) examines the yield spread/real output relation. The New Keynesian approach uses sluggish price movements and rational behavior to arrive at the conclusion that the yield spread will have information. Berk states that the behavior of the yield curve "might be consistent with New Keynesian principles" but cautions monetary authorities from using it as a policy tool because this behavior is not a structural relationship. Finally, Berk reports that the New Classical model denies that the yield spread can have any predictive content.[18]

Section 2.6 Summary of Empirical Articles

The purpose of this section is to survey empirical papers that have the objective to find the best predictor of the turning points of a business cycle. Reliable data sets are not available for the period before the mid-1950s. Cecchetti (1987) explores the abnormal data for the Great Depression and demonstrates why data from the 1930s and 1940s should not be used. Institutional factors, taxes and other types of governmental intervention caused government securities to have negative nominal returns. Cecchetti (1987) attempts to recalculate the yield curve for the period of 1933 to 1941, but no paper has used this modified data.

[18] The conclusions of the New Classical model are contrary to the empirical data, which show the tendency of the yield curve to invert prior to a recession.

A popular approach to modeling the yield spread's relation to real output was first presented by Estrella and Mishkin (1996).[19] The authors use a Probit model based on the yield spread to determine the likelihood of a recession. Although the Stock-Watson Index is a better predictor for one quarter ahead, the yield spread outperforms the Stock-Watson Index for periods beyond one quarter. After six quarters, the performance of the yield spread diminishes. Estrella and Mishkin (1998) expand their data set to include data earlier than 1960. They again find that the yield spread is the best predictor for periods beyond one quarter.[20] The use of data earlier than 1959 does not have an appreciable effect on results.

Dueker (1997) adds a Markov-switching component to the Mishkin Probit model. He concludes that the yield spread is superior at predicting real output than the Commerce Department's index of leading indicators, real M2 growth, the paper spread, or the percentage change in the S&P 500. Even with a lagged dependent variable, the yield spread still outperforms the other indicators. Despite the robustness of the results, the Estrella-Mishkin Probit model with Markov-switching has trouble predicting mild recessions. Del Negro (2001) compares the Estrella-Mishkin Probit model with Federal Reserve Bank of Atlanta's Bayesian vector autoregression (BVAR) model and the Commerce Department's leading indicators. Del Negro's focus is to provide evidence for the econometric models' ability to forecast turning points. The Atlanta Federal Reserve BVAR model outperforms the Commerce Department's leading indicators

[19] Popularity is based on the number of times this model has been cited in subsequent literature.
[20] Estrella and Mishkin (1998) compare the yield spread with the paper spread, finding that the paper spread has good in-sample results for one and two-quarter horizons. The paper spread, however, does not have out-of-sample predictive power at any horizon.

model, while the Estrella-Mishkin Probit model outperforms the Atlanta Federal Reserve BVAR model. While Lahiri and Wang (1996) also use a two-regime Markov-switching model, they do not compare the yield spread with real output. Instead, they posit that the economy can be in a state of either expansion or recession. The 10-year/1-year spread, when evaluated with the NBER dating of recessions, predicted all 15 peaks and troughs and created no false alarms. Lahiri and Wang conclude that the 10-year/1-year spread outperforms the 10-year/federal funds spread, the 6-month paper spread, and the Leading Economic Indicators.

Estrella and Mishkin (1997) broaden their analysis of the yield spread/real output relationship to include France, Germany, Italy, the UK and the US. Their findings support the existence of a relation between the yield spread and real output in each country except Italy. The authors find that the credibility of the monetary regime is critical to the strength of the relation. In general, the yield spread is a good indicator for Europe, but Estrella and Mishkin do not recommend it as a policy tool. Funke (1997) supports Estrella and Mishkin (1997) by applying the Estrella-Mishkin Probit model to an expanded German data set. The author finds that the yield spread outperforms nine other leading indicators and performs best when the lead is four quarters.

Resnick and Shoesmith (2002) extend the Estrella-Mishkin Probit model to predict movements in the stock market. They report the *ex ante* probabilities of being in a bear market. The out-of-sample model is reliable for forecasting a stock market turning point one month in advance.

While commonly referenced throughout the literature, the Estrella-Mishkin Probit model is not always used. Using their own modeling techniques, Brown and Goodman (1991), Hejazi (2000), and Ang, Piazzesi and Wei (2003) find the yield spread to be the best predictor of real output in the US. Brown and Goodman (1991) set up 3-, 4-, 6-, 9-, and 12-month models yet fail to predict the 1990-1 recession. While Friedman and Kuttner (1993) focus on the paper spread, they include the spread between the 10-year Treasury Bond and the federal funds rate in their analysis. While the results for the yield spread test significantly at the 1% level, Friedman and Kuttner (1993) also fail to predict the 1990-1 recession. Friedman and Kuttner (1998) speculate that the reason that the paper spread did not predict 1990-1 recession might be because the recession was not caused by monetary tightening. The lack of monetary tightening may be the reason that the Brown and Goodman model also failed to predict the recession.[21] Hejazi (2000) separates the yield curve into a term premium component and an expectations component. Using a GARCH-M model of the term structure, he shows increases in term premia result in reductions in industrial production. Ang, Piazzesi and Wei (2003) compare multiple yield spreads. They confirm that the slope of the yield curve indicates future growth rates. Their analysis reveals that the magnitude of the slope is positively correlated with growth rates. Additionally, Ang, Piazzesi and Wei (2003) show that a maximal yield spread is best for forecasting. They affirm the position of Bernanke and Blinder (1992) and Gamber (1996) that nominal short-term rates dominate the yield spread.

[21] This dissertation will argue an upper turning point may be caused by a real resource crunch, which will also cause the yield curve to invert before a recession.

The correlation between the yield spread and real output extends to other industrialized countries. Reinhart and Reinhart (1996) find that both the Canadian yield spread and US yield spread outperform 14 other indicators for forecasting Canadian turning points. Multinational comparisons are made by Stokman (1991), Davis and Henry (1994), Cozier and Tkacz (1994), Canova and De Nicoló (2000), and Atta-Mensah and Tkacz (2001). Although the strongest correlations are found in the US, Germany and Canada, each industrialized country confirms the predictive power of the yield spread. Stokman (1991)[22] examines Canada, France, Germany, Italy, the Netherlands, the UK, and the US. He finds that the yield spread is the best predictor in each country. Davis and Henry (1994) look at Germany and the US. Their model successfully predicted that the German Q1-2:1991 growth rate would be sluggish and would then turn negative. Cozier and Tkacz (1994) show that the Canadian yield spread is endogenous with the business cycle but that the relationship is not stable. In particular, the simple model's results are not stable for the 1970s, but the model can be corrected by setting detrended output growth as the dependent variable. The yield spread's correlation with real output is strongest for time horizons greater than one year, while its correlation is weakest for time horizons less than one year. Interestingly, the yield spread is strongly correlated with consumer durables at the 1-year horizon and with investment expenditures at a 4-year horizon and beyond. Furthermore, the yield spread helps to predict inflation beyond 2 years. Canova and De Nicoló (2000) use a linear model but limit the sample to post–1973 data due to regime changes, which cause structural breaks in the data. They find

[22] The writer of this dissertation would like to thank Marcus Verhaegh for helping me translate the article from Dutch.

that the spread is a good predictor for only Japan and the US. The authors state that their results may differ with the results of others because Canova and De Nicoló are using Industrial Production measures, not GDP. Atta-Mensah and Tkacz (2001) confirm that the yield spread is the best predictor 5 quarters ahead in Canada and the US. Beyond 5 quarters, the Oil and Gas sub-index (deflated by CPI) is the best predictor. They argue that long rates may act as a proxy for an equilibrium interest rate or for a policy-neutral short-term rate.

A curious anomaly had emerged in the international studies; the yield spread was consistently the best predictor of real output in every industrialized country except Japan. The papers documenting this irregularity are Barran, Coudert, and Mojon (1995), Bange (1996), Moersch (1996), Bonser-Neal and Morley (1997), Kozicki (1997), Bernard and Gerlach (1998), and Galbraith and Tkacz (2000). The econometric methods they use include OLS regressions, time-series regressions, Granger Causality models, Probit models and Maximum Likelihood Estimation models. The data used in these articles span from the first quarter 1964 through the last quarter 1998.

The fact that yield spread/real output relationship was not evident in Japan has caused some concern. Kim and Limpaphayom (1997) resolve the apparent inconsistency with other industrialized countries by demonstrating that a break point occurs for Japan in 1983/4.[23] During these years, Japan deregulated its capital markets. The Bank of Japan had tightly controlled both the long and short rates. In April 1983, over-the-counter sales of government bonds were legalized. By June of 1984, many firms acquired licenses to

[23] Galbraith and Tkacz (2000) use a maximum likelihood test to search for the Japanese break point but are unsuccessful in finding a date for the break point.

trade bonds in secondary markets. In 1986, Japan first began issuing their equivalent to US Treasury Bills. Following the deregulation of Japan's capital markets, the same correlation between the yield curve and real output emerges in Japan. Using a Bivariate model, Kim and Limpaphayom (1997) are able to predict GDP growth between 1984 and 1991 but are unable to predict growth before 1983.

As illustrated by this example, incorporating regime-switching into a model is an important innovation. Kotlán (2002) argues that linear models produce biased predictions. Several recent papers focus on regime-switching models to enhance prediction results: Harvey (1988), Hardouvelis (1988), Bernanke and Blinder (1992), Dueker (1997), Estrella (1998), Phillips (1998/1999), Cecchetti and Ehrmann (1999), Ahrens (1999), Andreou, Osborn and Sensier (2000), Ivanova, Lahiri and Seitz (2000), Chauvet and Potter (2002), Peel and Ioannidis (2003), Shaaf (2000), Tkacz (2001), Ahrens (2002), Kotlán (2002), Estrella, Rodrigues and Schich (2002), and Venetis, Paya and Peel (2003).

Incorporating regime-switching techniques into models is important because none of the articles that deny the relationship includes break points. Each article that includes a regime-switching component finds a significant relation between the yield spread and real output.

Harvey (1988) is the first to use the idea of regime changes in his CCAPM model. His article does not actually use a regime-switching model but instead compares a sub-sample of the data with the overall results. He finds that the predictive power is stronger for the 1972-1987 data set than for the 1959-1987 full data set.

Cecchetti and Ehrmann (1999) also do not specifically use break points. They model the monetary decision makers' aversion to inflation. At the end of their analysis they recommend that break points be used in future research. Chauvet and Potter (2002) also look for break points. Their model confirms that break points exist but that the Probit model has trouble finding them. Phillips (1998/1999) uses a Bayesian Regime-switching model and finds the yield spread to be a good predictor of real GDP in comparison to the Commerce Department's leading indicators and Stock and Watson's indicators. However, the conclusion drawn is that there are not enough observations to make a definitive choice between the indicators.

Hardouvelis (1988) finds reliable evidence that forward rates have the power to predict future spot rates. He confirms a break point in Oct. 1979. Until 1979, the Federal Reserve's policy was to target interest rates. During this period, forward rates had significant prediction results only one week in advance. Between October 1979 and October 1982, the Federal Reserve changed to a policy of not targeting interest rates. The predictive power increased for the time horizon of 6 weeks ahead and the time horizons for 14-21 weeks ahead. After October 1982, the Federal Reserve again changed its policy to that of partial interest rate targeting. The predictive power for this period was strong through the time horizon of 9 weeks ahead.

Dueker (1997), Ahrens (1999) and Andreou, Osborn and Sensier (2000) each use a non-linear model and conclude that the yield spread is the best predictor of output. Ahrens (2002), confirming the relation of the yield spread with real output, states that the

addition of Markov-switching to a Probit model does not improve out-of-sample forecasting.

Ivanova, Lahiri and Seitz (2000) focus on making a better model for prediction. Their results support Estrella and Hardouvelis (1991) and Plosser and Rouwenhorst (1994). They further find that the yield spread outperforms the spread between bank bonds and public bonds. Additionally, the yield spread forecasts inflation turning points at the 3-5 year horizon. The authors' model accounts for a lag in the monetary transmission mechanism.

Peel and Ioannidis (2003) break their data set into subsets to examine expected regime changes. An anti-inflation policy regime reduces the coefficient of the yield spread/real output link. The authors conclude that structural breaks are needed to increase the predictive powers of their model.

Kotlán (2002) is more forceful in his opposition to linear models than are the authors of the previous papers. He argues that such models generate biased predictions. Using simulated data, he finds that the predictive ability of the yield spread is dependent upon monetary policy. The more attention authorities place on inflation, the greater predictive power the yield spread has on output. Kotlán models the predictive ability of the yield spread through the central bank's reaction function. Estrella (1998) also builds a structural model and calls for the use of break points. However, his conclusion is that the more adverse a regime is to inflation, the *smaller* the linkage is between the yield spread with real output and inflation. Estrella (1998) does not use data to support his conclusions, but Venetis, Paya and Peel (2003) apply the Estrella model to Canada, the

UK and the US. Their findings support Estrella (1998) and find break points in each country. They conclude linear models may signal "false alarms."

Two papers, Shaaf (2000) and Tkacz (2001), use a neural-network or artificial intelligence model. Their models assume that a hidden parameter is driving the results. Neural-network models are data-driven and can learn from (and adapt to) underlying relationships. Such models are useful where one does not have any *a priori* beliefs about functional forms. While the results confirm that a downward sloping yield curve forecasts a recession, the results are better for time horizons greater than 4 quarters. Shaaf (2000) calculates that a 5% increase in the yield spread corresponds to a 9.33% increase in real GDP growth. Overall, his model has less error and lower variation in out-of-sample data than traditional models do.

Estrella, Rodrigues and Schich (2002) present an extensive survey of theoretical and empirical works. They conclude that all models must be used with caution. While they estimate break point dates for monetary policy regimes and find positive results, they state that the stability of the relationship and the stability of any forecasting model must be thoroughly tested. As they cannot rule out instability by theoretical arguments, which model is most accurate becomes an empirical issue.

Finally, Watkins (1997) states that the empirical papers have not followed econometric procedures correctly and should therefore be discounted. He argues that the information content of the yield curve is derived from the short rate, the long rate or the variability of the interest rate. None of the models that he examines includes the third factor, skewing the results. Furthermore, he criticizes the models that use proxy variables

(such as the CCAPM and RBC models), because proxies add measurement errors, making OLS techniques insufficient.

Section 2.7 Conclusion

This examination of the existing literature on the relation between the yield spread and real output confirms that an empirical relationship exists yet also illustrates that the debate on theory remains unresolved. None of the articles reviewed examines the effects of non-neutral monetary injections through a heterogeneous capital structure. The two major models, the CCAPM and the Estrella models, first demonstrate that the yield spread is a good predictor of real output and then attempt to explain *why* it is such a good predictor. When regime-switching techniques are applied to these models, the empirical relationship becomes evident. However, the articles fail to explain adequately why this phenomenon occurs. It is the contention of this dissertation that a gap exists where the addition of Austrian insights can make a significant contribution to the theory and understanding of the relationship between the yield spread and real output.

CHAPTER THREE: INTEREST RATE AND YIELD CURVE THEORIES

Section 3.1 Overview

In the literature that examines the relationship between the yield curve and real output, only the CCAPM articles attempt to connect the inversion of the yield curve to a microeconomic foundation. This dissertation is in search of the reason why the yield curve tends to invert before a recession. It is necessary to ground the model in a microeconomic foundation in order to find the reason for the inversion. The analysis of a yield curve should separate the examination of the positive theory of interest into two parts. Specifically, it should be divided into a question of the origin of interest, an essentialist question, and a question of the formation of interest rates in the real world, a functionalist question.[1] After the essentialist question has been answered, the functionalist question can be addressed.

The objectives of this chapter are twofold: to answer the essentialist question and then to build that foundation into a theory of the term structure of interest. In order to do so, this chapter reviews the origin and function of interest, examines the existing theories of the yield curve and proposes an alternative theory for the term structure of interest.

[1] Although the terms "Essentialist" and "Functionalist" are not unique to interest rate theory, they will be used in manner of Pellengahr (1986b and 1996).

The remainder of this chapter is divided into twelve sections. The analysis begins in Section 3.2 with an analysis of the Böhm-Bawerkian framework. The concept of time-preference is then used in Section 3.3 to establish an initial interest rate. Section 3.4 integrates capital's productivity with Austrian interest theory. Section 3.5 introduces the yield curve. The Expectations Theory, the Liquidity-Preference Hypothesis, the Segmented Markets Theory, the Preferred-Habitat Theory, the Stochastic-Process No-Arbitrage Approach and the Rothbardian Theory are critically examined in Sections 3.6-3.11. Section 3.12 looks at recent contributions to yield curve theories. In Section 3.13, a modified Preferred-Habitat Theory of the yield curve is created and contrasted with the other theories.

Section 3.2 Böhm-Bawerk's Analysis of Interest

Time-preference forms the core of Böhm-Bawerk's theory. Simply put, time-preference is the preference of having a good sooner rather than later.[2] Mises adds that time-preference is an essential requisite of action.[3] To illustrate the idea of time-preference, suppose two people (A and B) are considering a trade. Let person A have good X. Further, assume that both people desire good X. Since a precondition for trade is that the exchange must be mutually beneficial, B must make an offer that is acceptable

[2] Böhm-Bawerk (1959) states, "Present goods are as a general rule worth more than future goods of equal quality and quantity. That sentence is the nub and kernel of the theory of interest...." vol. II, p. 259. (italics removed)

[3] See Mises (1966) pp. 483-490 ff. Pellengahr (1996), Lewin (1997b, 1999), Murphy (2003) and other Austrians object to classifying time-preference as a praxeological law. The issue of whether time-preference is a praxeological law or empirical observation is not relevant to the argument of this dissertation.

to A. B may offer either present goods or future goods to A. If B offers future goods (in terms of X), he must offer a sufficient quantity of these future goods to induce A to part with good X now. The ratio of exchange becomes the intertemporal price of future goods relative to present goods.[4] Thus, an interest rate can be established by using the standard formula:

$$\text{Interest} = \frac{\text{Value of Future Goods - Value of Present Goods}}{\text{Value of Present Goods}}. \qquad \text{Equation 3 - 1}$$

With the exchange, an interest rate emerges, becoming the intertemporal price of goods across time. Therefore, time-preference alone is a necessary and sufficient condition for the formation of an interest rate. Each person acts at his respective margins in his choices. These economic agents make their decisions according to the first two of Böhm-Bawerk's three reasons for the formation of interest rates. Yeager summarizes these reasons as follows:

1. Present wants are more intense than future wants in relation to the means for satisfying them, chiefly for the following reasons:
   a. Earning capacity may be greater in the future than at present.

[4] Although this example uses a good, the essential question is centered on utility. The question may be rephrased as, "Why are 100 present utility units (utils) valued more than 100 future utils?" The difference in value between present and future utils is interest. While Murphy (2003) demonstrates that using cardinal utility is inconsistent with the Austrian position on cardinal versus ordinal utility, this inconsistency is not a refutation of the time-preference argument. To avoid resorting to cardinal utility, time-preference can be defined of as the opportunity cost of waiting.

b. Some people are in more urgent need now because of illness, loss, and so forth.

c. The holder of a durable asset is at liberty to use it either now or in the future. Money in particular is durable and cheap to store; hence a person intending to spend it only in the future nevertheless values present money more highly because holding it is a way of keeping his options open. (This point obviously abstracts from inflation.)

2. Many people underestimate future wants relative to present wants because they lack imagination or will power or are uncertain about their life spans.

3. Present goods have a technical superiority over future goods; roundaboutness is productive.[5]

The marginal productivity of capital is the basis of Böhm-Bawerk's third reason for the formation of interest. Fetter and Rothbard reject this third reason. Knight, however, views the marginal productivity of capital as the sole reason for the formation of interest rates.[6, 7]

Rothbard and Fetter criticize Böhm-Bawerk's inclusion of his third reason, stating that Böhm-Bawerk has created an incongruity in his theory.[8] It is unclear in Böhm-Bawerk's own writings whether he maintained the third reason as an independent

---

[5] Yeager (1993) pp. 118-119. The three causes are found in Böhm-Bawerk (1959) vol. II, pp. 265-289. See also Conard (1959) pp. 36-38.

[6] See Fetter (1977), Rothbard (1977) and Knight (1964).

[7] Section 3.4 explores the integration of the productivity of capital with interest theory.

[8] See Rothbard's introduction in Fetter (1977) where he states: "...Fetter quite properly pointed to the major textual contradiction in Böhm-Bawerk's theory of interest: Böhm-Bawerk's initial finding that interest stems from time preference for present goods over future goods is contradicted by his later claim that the greater productivity of roundabout production processes is what accounts for interest." p. 7. Fetter's analysis takes place on pages 185-187.

condition for the formation of interest or he believed that it was the prime influence on the height of interest rates as they emerge in the market.[9] While there remains controversy on this point, this dissertation adopts Böhm-Bawerk's later position; although the third factor, the marginal productivity of capital, has a significant influence on the market rate of interest, it is not a necessary and sufficient condition for the formation of interest rates.

Section 3.3 A Time-Preference Based Theory of Interest

The pursuit of the answer to the essentialist question is the search for the necessary and sufficient conditions for the formation of interest rates. This dissertation takes the position that time-preference, as defined and presented by Böhm-Bawerk, Mises

---

[9] Böhm-Bawerk's theory of interest centers on the difference in value between present goods and "future goods of equal quality and quantity." vol. II, p. 259. In responding to the criticism of Bortkiewicz and Fisher, Böhm-Bawerk states, "I do not believe that any reader or opponent of mine doubts in the least that the phenomenon of interest would vanish, or at least be seriously affected in scope and extent, if the fact of higher productivity of capitalist production methods would cease to exist." vol. III, p. 151. This sentence is representative of Böhm-Bawerk's style. Unfortunately, the construction of this sentence does not make his position clear and leaves it open to interpretation. It is plain that Böhm-Bawerk argues that his third reason is an explanation for the difference in the valuation between present and future goods. However, by including the phrase "or at least..." it seems that he is admitting that his third reason is not an "essentialist" reason for the formation of interest rates. Thus, Böhm-Bawerk is unmistakably arguing that his third reason has a significant influence on the market rate of interest, but at the same time, it seems that he agrees that it is not an originary (ursprünglicher) factor of interest. Wicksell (1958) upholds this interpretation by stating that it was not until "*subsequent* parts of [Böhm-Bawerk's] work" that he explores this topic. Wicksell further argues in the later works, "[Böhm-Bawerk] was only concerned to explain the existence of interest, its *quale*, [and] he evidently considered that details about its *quantum* could be disregarded, thinking to reach his immediate goal by a short-cut." p. 183. (italics in the original) Wicksell suggests that even Böhm-Bawerk did not use his third reason when examining the essentialist question, by writing, "In order to avoid the absurdity that … all production ought really to be extended indefinitely, Böhm-Bawerk here falls back upon the 'first and second main grounds,' to ensure that the 'economic centre of gravity' will be brought closer in time." p. 182. See also Wicksell (1961) pp. 167-171. Additionally, Lutz presents Böhm-Bawerk's model to differentiate between the market rate of interest and the internal rate of return (ursprünglicher Zins). See Lutz (1968) p. 12. See also Hennings (1997) pp. 116-129.

and the Austrian school, answers the essentialist question. It is not relevant for this discussion to determine whether time-preference is a praxeological law or it is an empirical fact that is so plainly obvious that it is accepted. Nevertheless, time-preference is based upon the internal and subjective valuations of each actor. Wieser states:

> The future want, wherever it comes into the domain of the present, is preceded by a physical reflection, and this reflection is a totally different nature from the want itself. It is far finer, more *innerlich*, and, even in the case of purely bodily wants, is always mental. The hunger of a future day, e.g., does not act as hunger, but as anxiety for sustenance; the object of desire is the same, but the desiring is different. Instead of a *want* of we have an *interest* in.[10] (italics in the original)

A modern interpretation of Wieser is that each individual subjectively determines his own time-preference and that the intensity of wants is different between present and future goods.

The formation of market interest rates is the result of a combination of the following: time-preference, the productivity of capital, changes in wealth, changes in expectations, the length of time needed to complete an investment project, the risk of default, liquidity assessments, inflation, information costs, and institutional factors. Time-preference is endogenous to the action of individuals, while the other factors are exogenous and simply modify the market rate of interest.

---

[10] Wieser (1989) pp. 16-17. While Wieser favors a productivity theory of interest, he correctly identifies the problem as subjective valuations.

In the model of the investable[11] funds market (i.e., financial capital), the subjective and objective factors are present in both the demand *and* supply sides. Through their interplay, a market rate emerges and aligns the quantity of investable funds supplied with the quantity of investable funds demanded.

In a single interest rate market, all the exogenous factors are initially held constant. The demand for investable funds can be shown as a typical downward sloping demand curve, which is due to the application of the law of diminishing marginal returns on projects for which the funds are borrowed. The supply of investable funds is shown as an upward sloping supply curve. Again, the law of diminishing marginal returns is applied to the alternatives for holding money (the reservation demand for holding money). The interest rate and quantity of investable funds tend to move toward the intersection of the curves (the point of equilibrium). Within demand and supply functions, time-preference, as well as objective factors, influences the formation of the interest rate.

Section 3.4 Integrating Capital's Productivity with Austrian Interest Theory

Austrians and fellow travelers have been debating the issue of including Böhm-Bawerk's third reason, capital's productivity, into their models. As established above, Rothbard and Fetter state that interest is explained by time-preference alone. Rothbard states:

---

[11] Garrison (2001) uses the phrase "investable funds" instead of "loanable funds" to draw attention to the link between savings and investment.

> We have seen that in order for more capital to be invested [in a stationary economy], there must be a fall in the pure rate of interest, reflecting general declines in time preferences. ... It should be noticed what we are *not* saying. We are *not* asserting that the pure rate of interest is determined by the quantity or value of capital goods available. We are not concluding, therefore, that an increase in the quantity or value of capital goods lowers the pure rate of interest because interest is the "price of capital" (or for any other reason). On the contrary, we are asserting *precisely the reverse:* namely, *that a lower pure rate of interest increases the quantity and value of capital goods available.*[12] (italics in the original)

One must note two points regarding Rothbard. First, Rothbard is referring only to the "pure" rate of interest. Although the pure rate of interest is not necessarily the rate seen in the real world, he makes no distinction later. Second, the relationship is unidirectional—from the rate of interest to the capital structure.[13] In a functionalist model, the marginal productivity of capital does influence the market rate of interest, whereas in an essentialist model the marginal productivity of capital does not influence the rate of interest. In his criticism of Böhm-Bawerk, Rothbard, following Fetter, fails to separate the essentialist question from the functionalist question. Similarly, Fisher (1930) mistakenly characterizes Böhm-Bawerk as using only the productivity of capital to

---

[12] Rothbard (1993) pp. 495-496. See Rothbard (1993) pp. 313-350 and Mises (1966) pp. 527-528. For a summary of the Subjectivist Austrian position, see Pellengahr (1986a) p. 65.

[13] Rothbard (1977) p. 7, reaffirms his position, "[W]hile this [increased] productivity may increase the rents to be derived from capital goods, it cannot account for an increase in the rate of interest return, that is, the ratio between the annual rents derived from these capital goods and their present price. That ratio is strictly determined by time preference."

explain interest rates. By focusing on Böhm-Bawerk's lengthy discussion of the influence of capital productivity on interest, Rothbard, Fetter and Fisher misinterpret Böhm-Bawerk's separation of the essentialist and functionalist questions.[14] Fisher, responding to Böhm-Bawerk, states:

> The causal solution cannot be so simply conceived as to make one factor solely cause and another solely effect. The advance of all science has required the abandonment of such simplified conceptions of causal relationship for the more realistic conception of equilibrium. Here, all factors, are considered as variables. Any disturbance in one factor reacts on all the others, and the variations in these other factors react upon the factor of the original disturbance.[15]

Böhm-Bawerk, however, is not using changes in the productivity of capital as the *sole* cause of changes in nominal interest rates. Although he admits that it is the dominant factor in his functionalist model.

Böhm-Bawerk argues that in the short run, the marginal productivity of capital dominates all other factors in the formation of market interest rates.[16] While the issue of which element holds the most influence may be disputed, the current debate between Austrians is if the productivity of capital has any influence at all on the formation on interest rates. The resolution of the Austrian debate between Böhm-Bawerk and Fetter

---

[14] Admittedly, Böhm-Bawerk's exposition can at times be unclear, inconsistent, and contradictory. See Wicksell (1961) p. 147 and pp. 167-171. See also fn. 9.
[15] Fisher (1930) fn. 39, p. 484.
[16] See Böhm-Bawerk (1959) vol. II.

(with Rothbard) is this: Time-preference is the core of interest theory, i.e., time-preference is a necessary and sufficient condition to the formation of interest rates. However, in the real world, it is not the sole determinant. Böhm-Bawerk makes the distinction between "the *origin* of interest from that of its *rate*," in stating, "All interest-originating causes undoubtedly are also determining factors for the actual rate. But not all rate-determining factors are also interest-creating causes; they may also be *obstacles* that we have to overcome."[17]

Over the course of this debate, the essentialist and functionalist questions have become muddled. Recent debates, such as the Reswitching debate,[18] have not helped make the separation of these questions clear.[19] Yeager is correct when he states:

> The physical productivity of waiting or roundaboutness is an objective element in interest-rate determination. Objective and subjective factors interact. The rate of time preference, or the subjectively appraised agio of present over future goods, is a marginal concept; and where the margin occurs depends largely on how extensively people have made provision for present and future consumption. This in turn depends partly on the transformability through investment of present goods into future goods.[20]

---

[17] Böhm-Bawerk (1959) vol. III, pp. 191, 192. (italics in the original)
[18] While the Reswitching debate centers on the use of capital equipment in relation to changing interest rates, this dissertation focuses only on its impact on interest rate theory.
[19] See, for example, Yeager (1979) and Garrison (1979).
[20] Yeager (1979) p. 206.

In order to convey this idea more forcefully, he uses an example of a machine that instantly becomes more productive. Unfortunately, this example obscures his own position; an increase in productivity depends upon investment, which is based on the entrepreneur's time horizon—his time preference. Yeager's example is misleading (but not necessarily incorrect) because one needs to remember that growth is not magical or exogenous. In the course of the debate, Yeager's rivals focus on the example's lack of realism and the core of the argument is lost in the confusion.

To clarify the argument, consider the example recast in this way. When an entrepreneur develops a new idea of how to operate more efficiently, he generates economic growth. As this cost cutting idea is implemented, it has unintended effects on the rest of the economic actors. In other words, there is a wealth effect. Each person, at the margin, decides how to apportion this wealth and determines if relatively more funds will flow into consumption or savings. Unlike the Keynesian models, Austrians do not subscribe to an iron rule of the marginal propensity to consume. Individuals make this consumption/saving decision at the margin of their own time preferences.[21] There is no way to make an *a priori* prediction as to whether supply or demand will be more strongly affected. In other words, the wealth effect will shift both the supply and demand for

[21] Individuals are not programmed with a specific rate of time-preference that controls how they decide between future and present goods. Instead, this decision is made at the margin of the individual's supply of and demand for investable funds and can vary across maturities. However, even if each person is programmed with a specific rate of discount, this case does not mean that everyone has the *same* rate of discount. As long as individuals are different, the impact on interest rates depends on *who* gets the new money first.

investable funds. There is no way to tell whether or not these shifts will create a state of equilibrium at the same rate (price).

To use a more familiar analogy, one can examine the effects of inflation in a model where money is non-neutral.[22] When there is an increase in the money supply, it is injected into the economy at specific points. Different people receive the new money at different times. A person receiving this new money experiences a wealth effect. In his view, he has become richer. This perception changes the individual's demand for the various present goods and services, as well as for the various future goods and services. The people who experience the wealth effect first have the initial impact on interest rates. If the less anxious people receive the new money first, one would see a relative increase in savings over consumption. *Ceteris paribus*, the effect would be a relative expansion of investable funds, and would exert downward pressure on interest rates.

However, instead of monetary expansion causing the wealth effect, the wealth effect stems from increased productivity. The same process would occur. If the less anxious people experience the wealth effect first, one would again see downward pressure on interest rates. Regardless of the final equilibrium position, the change in productivity affects the equilibrium rate of interest.

The Reswitching debate has stifled the development and application of interest rate theory. A false dichotomy has been created. Garrison poses it in this way:

---

[22] See Mises (1990).

> Are time preferences of market participants and capital productivity independent co-determinants of the rate of interest, as Irving Fisher would have it? Or does time preference alone—the systematic discounting of the future—account of the payment that we call interest? [23]

It is not a choice between these two alternatives. Like all economic modeling, the nature of the problem that the economist is studying should determine the relevant variables. However, in general, when applying the Austrian theory of interest rates to real world problems, one should first establish the rate formed by time preferences (through examining the essentialist question) and then allow these other factors to modify it (through examining the functionalist question). As Pellengahr points out, Austrian theorists have failed to offer a "satisfactory explanation of the determination of the size of the rate of interest."[24]

Recently, Böhm-Bawerk's original separation of the questions has been reestablished.[25] As a result, most modern Austrian models have not developed beyond the use of one interest rate. An Austrian theory explaining the yield curve has not been developed due to the focus of scholars on the issues of time-preference and capital productivity's impact on interest rates. As a result, Austrian theories on the business

---

[23] Garrison (1988) p. 45.

[24] Pellengahr (1996) p. 59. Pellengahr further concludes that Austrian Subjectivists are also unable to prove why the signs of interest rates are positive due to an incomplete definition of "time-preference." Characterizing time-preference as the opportunity cost of waiting addresses Pellengahr's objection.

[25] See Pellengahr (1986a and 1986b) and Kirzner (1996) especially pp. 146-148.

cycle and financial markets are not yet fully developed. The construction of a yield curve theory is a step to correct this deficiency.

Section 3.5 Introduction to Yield Curve Theories

The world does not have a single rate of interest; rather, there are different structures of interest rates. By including the risk structure of interest rates, the effects of differing default risks, liquidity assessments, and tax considerations upon the yields of financial instruments with the same maturity, heterogeneous interest rates can be studied. When each of these assumptions (like equal default risks) is relaxed, the conclusions are relatively non-controversial. For example, if there are two financial instruments, which are identical except for different default risks, the riskier instrument will have a risk premium attached to its return to attract investors. The same analysis can be performed for a liquidity premium or for a tax premium.

When considering two instruments, which differ only in their maturities, different yields are observed. Many theories purport to explain the differences in the yields. Typically, the instrument with a longer maturity has a larger nominal yield. The yield curve (also called the term structure of interest rates) is a graphical representation of instruments with various maturities. As illustrated in Figure 3-1, the yield curve can have several shapes. The yield curve represents the returns for instruments with differing maturities but having the same risk structure.

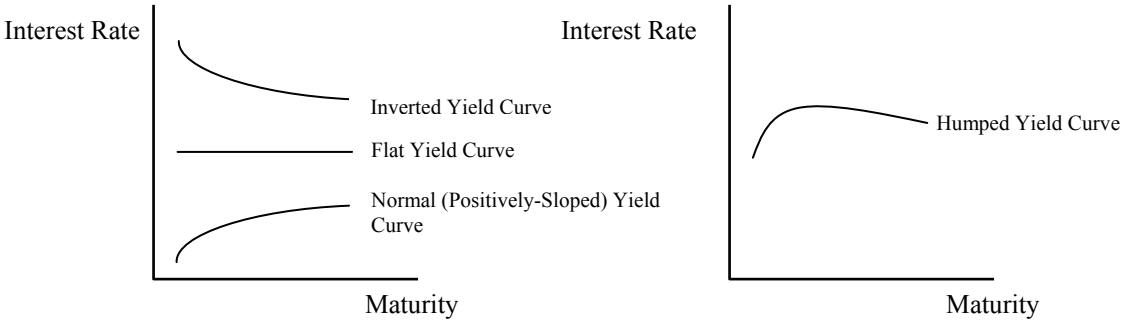


Figure 3-1: Common Yield Curves

A complete theory of the yield curve must account for three empirical observations. First, the yield curve is typically positively sloped. Secondly, long and short rates tend to move together.[26] Finally, "when short-term rates are low, yield curves are more likely to have an upward slope; when short-term rates are high, yield curves are more likely to slope downward and be inverted."[27] The third factor restated is that long rates tend to remain stable relative to short rates. Bernanke and Blinder (1992), Ragnitz (1994), Campbell (1995), Gamber (1996), Ireland (1996) and Ang, Piazzesi and Wei (2003) show that long rates tend to remain stable, while short rates fluctuate over time.[28]

The major theories that will be reviewed are the Expectations Theory, the Liquidity Preference Hypothesis, the Segmented Markets Theory, the Preferred-Habitat Theory, a Stochastic-Process No-Arbitrage Approach, and a theory unique to Rothbard.[29]

---

[26] See Miller and VanHoose (2001) and Hubbard (1997).
[27] Mishkin (2001) p. 137.
[28] However, King and Kurmann (2002) report that changes in a stochastic trend affect long rates more than the short rates.
[29] See Shiller (1990) for a detailed summary of the Expectations Theory, the Liquidity Preference Hypothesis, and the Preferred-Habitat Theory.

Section 3.6 The Expectations Theory

Using expectations in the analysis of the yield curve can be traced at least as far back as the work of Irving Fisher (1896).[30] The Expectations Theory assumes that all financial instruments along the yield curve are perfectly substitutable. The shape of the yield curve is dependent upon two factors: present short interest rates and expected future short rates. As described by Fisher's model, short rates are determined by both time-preference and the marginal productivity of capital. The *n*-period model is demonstrated by equation 3-2:

$$i_{n,t} = i\frac{i_{1,t} + i^{e}_{1,t+1} + \ldots + i^{e}_{1,t+n-1}}{\text{n}}, \quad \text{Equation 3 - 2}$$

where $i_{n,t}$ is the yield for an *n*-year bond for time period t, and $i^{e}_{1,t+1}$ is the expected interest rate for a one-year bond at time period t+1. The long rates are based on the expected movements of future short rates. The theory assumes that investors are endowed with rational expectations, face low information costs and operate in a market

[30] See Fisher (1896), specifically Ch. 5, pp. 23-29 and Ch. 12, pp. 88-92. Malkiel (1966) states, "One can find anticipations of the expectations theory in Henry Sidgwick … and even in J. B. Say…." fn. 1, p. 17. Upon closer inspection, it seems that Say's theory more closely fits the liquidity-preference theory. (See fn. 48 below.) For early overviews of the Expectations Theory, see Lutz (1940) and Meiselman (1962). See Shiller (1990) and McEnally and Jordan (1995) for summaries of the Expectations Theory.

where all assets' prices are reflected in their fundamental value.[31] In equilibrium, the price of a bond equals its discounted present value.

A positively sloped yield curve will emerge only if economic actors believe that future interest rates will rise. With the expectation of higher future rates, the future returns are discounted by a larger interest rate. As a result, the present value of bonds falls. Investors enter into forward contracts to hedge against interest rate risk. The forward rates act as an unbiased estimate of future spot rates, causing the yield curve to have a positive slope. A limitation of this theory is that it can explain only rotations of the yield curve but cannot explain shifts.

The empirical data are not congruent with the Expectations Theory in three respects: it cannot account for the general tendency of the yield curve to be positively sloped, it cannot explain why the long and short rates tend to move together, and it cannot demonstrate why the long rate is relatively more stable than the short rate.[32]

The Expectations Theory generates a positively sloped yield curve *only* when investors believe that interest rates will rise in the future.[33] If this theory were true, the tendency of the yield curve to remain generally positive would imply that investors were

---

[31] These assumptions lead to the complication of logical circularity between the actions of investors and their expectations. For example, market participants may change their expectations due to the results of the actions they undertake in their part of the economy. However, these prior actions are based on their earlier expectations. Thus the theory does not separate exogenous from endogenous factors. In other words, this theory does not deal with the root causes for changes in the yield curve, i.e., it is silent on why there are changes in expectations.

[32] For an extensive survey of the results, see Campbell and Shiller (1991) and Rudebusch (1995).

[33] Lutz (1940) states, "The risk and cost factors make … for rates which ascend slightly with the increasing length of the maturity. However, the difference due to these factors are probably so slight in practice that they will always be overshadowed by the expectations factor." fn. 4, p. 56.

almost always expecting the future inflation rate to accelerate. Since the US has not had hyperinflation in the 20th or 21st century, the acceptance of this theory would mean that these entrepreneurs have been perpetually wrong. If entrepreneurs had been perpetually wrong, then profit opportunities would have arisen to arbitrage the markets back to realistic levels of inflation expectations. Either the markets are not efficient or the theory is not adequate in explaining the movements of the yield curve. Lutz (1940) argues, "…the impression gained from studying the material [the empirical evidence] is that 'arbitrage' in the bond market does not work as perfectly as is does, for instance, in the foreign exchange market, so that a yield may be out of line for this reason alone."[34] To give Lutz the benefit of the doubt, it may be true that capital markets prior to 1940 were not very efficient. However, capital markets today are efficient and yet the same pattern persists. Therefore, one must conclude that the Expectations Theory is insufficient to explain the movement of yield curves.

Peterson (2001) attempts to explain why the Expectations Theory is inaccurate. He states that there is a rational bias for investors to go "with the crowd." Specifically, he shows that an institutional investor going against the crowd has a high degree of visibility to one's superiors. The risk / reward calculation is biased toward not "sticking one's neck out." If he goes against the crowd and rightly predicts the market, he gains some positive recognition. However, if he goes against the crowd and wrongly predicts the market's movements, then it could be the end of his career. Thus, the forecasts are

---

[34] Ibid. p. 57.

rationally biased to go along with the crowd. These actions skew the yield curve and produce results that contradict the Expectations Theory.

As noted earlier, the Expectations Theory also fails to explain why the long and short rates tend to move together. The theory derives the long rates from the expected rates of future inflation, but it does not explain why the short rates originate. If the reasons for the formation of the short rates differ from that of expectations (which of course it must), then there is no reason why the short and long rates should move together. Miller and VanHoose (2001) and Mishkin (2001) report that a common feature of the yield curve is that long-term instruments and short instruments tend to move together.[35]

Finally, the theory is unable to demonstrate the third empirical observation on the yield curve. As entrepreneurs believe that future inflation will accelerate, the theory posits that short rates should remain stable and long rates should vary with changes in expectations. The evidence shows that the Expectations Theory alone cannot be the sole explanatory factor for the shape of the yield curve.[36]

---

[35] Rudebusch (1995) finds that contrary to the expectations hypothesis, the spreads between certain long and short rates appear unrelated to future changes in the short rate. McDermott (1998) tests the Expectations Theory within the context 18th century England (Q4:1719 – Q3:1797) and is unable to demonstrate that the theory holds. However, Drakos (2002) tests the Expectations Theory in the Eurocurrency market. His results for Germany and the UK are consistent with the hypothesis. Furthermore, he cannot reject the hypothesis that the Expectations Theory is an adequate description of the US yield curve. While Drakos is unable to show the validity of the Expectations Theory, his work demonstrates that debate remains active in this area.

[36] Dotsey and Otrok (1995) argue that investor's adjustments to Federal Reserve behavior causes the tests of the Expectations Theory to fail.

Cox, Ingersoll & Ross (1981) reexamine the Expectations Theory and demonstrate that the theory has five versions: the globally equal expected holding-period return variant, the local expectations version, the unbiased expectations hypothesis, the return-to-maturity expectations hypothesis, and the yield-to-maturity version.[37]

"The *globally equal expected holding-period return* variant states that expected total returns from securities of all maturities for holding periods of all lengths are equal."[38] If an investor holds a 5-year, a 12-year and a 30-year bond for 5 years, at the end of 5 years they should each have yielded the same amount.

"The *local expectations* version says that the expected total returns from long-term bonds over a short-term horizon equal's today's interest rate over this horizon. Thus, the local expectations form is less comprehensive than the global version; it refers only to total returns over a horizon beginning at *present*."[39] For example, the investor who has the same set of bonds will see each bond produce the same 6-month return.

"The *unbiased expectations* hypothesis states that forward rates are equal to the corresponding spot rates the market expects in the future. This is another way of saying that long-term interest rates are an average of expected future short-term rates."[40] This scenario corresponds to Equation 3-2.

"The *return-to-maturity* expectations hypothesis says that the certain total return from holding a bond to maturity (a zero-coupon bond with no reinvestment risk) is equal

---

[37] These variants follow the divisions set forth by McEnally and Jordan (1995).
[38] Ibid. p. 791. (italics in the original)
[39] Ibid. (italics in the original)
[40] Ibid. (italics in the original)

to the expected total return from rolling over a series of short-term bonds over the same horizon."[41] In other words, the investor could either hold a 3-year bond or roll over three successive 1-year bonds and obtain the same return.

"The *yield-to-maturity* version states that the periodic rate of return, or holding-period yield, from holding a zero-coupon bond with no reinvestment risk to maturity is equal to the expected holding-period yield from rolling over a series of short-term bonds over the same horizon. Thus, this version deals with periodic returns, such as annualized returns, whereas the return-to-maturity version is concerned with total or cumulative returns over the investment horizon."[42]

The conclusion of Cox, Ingersoll & Ross (1981) is that with uncertain interest rates, these versions are not equivalent. Only the local expectations version is consistent with equilibrium. Campbell (1986), Livingston (1990) and McEnally and Jordan (1995) have since argued that these differences are of second-order importance.

To find the role of expectations as a determining factor of the yield curve, Cox, Ingersoll & Ross (1981, 1985) reexamine the Expectations Theory and the Preferred-Habitat Theory[43] and present a modified version of these theories. They develop a dynamic model (the CIR model) where an individual maximizes utility by choosing his optimal level of consumption in a single factor market. When this choice is made, "the interest rate and the expected rates of return on the contingent claims [bonds] must adjust

---

[41] Ibid. p. 791-792. (italics in the original)
[42] Ibid. p. 792. (italics in the original)
[43] Section 3.9 details the Preferred-Habitat Theory. The Preferred-Habitat Theory is the composite of the Expectations Theory, the Liquidity Preference Hypothesis, and the Segmented Markets Theory. Thus, any modification of the Expectations Theory has implications for the Preferred-Habitat Theory.

until all wealth is invested in the physical production processes."[44] The CIR model bases its analysis on a mean-reversion parameter called the adjustment coefficient. Constantinides (1992) bases his model on the CIR model and calls this parameter the yield of the long-maturity discount bond.[45] The CIR and Constantinides models use this arbitrary constant as an anchor to base their mapping of the stochastic process. In other words, they assume the long rate and generate a path that will revolve around and eventually return to this constant. This procedure will be the focus of Section 3.10. Lamoureux and Witte (2002) follow this procedure to test the CIR model. Their results are mixed, but they determine that a model with at least three orthogonal factors has the highest goodness-of-fit test results.

There are several flaws in this method. While this approach seems mathematically elegant, it assumes a predetermined answer.[46] It provides an equation that mimics a yield curve but does not add insight into *why* the yield curve takes the shape that it does. The approach fails to explain *why* the yield curve performs in the manner in which it does. Finally, the model excludes money (particularly financial capital). After the equilibrium positions for the real variables have been determined, the CIR and Constantinides models use a price-level parameter to account for inflation.[47] Additionally, the CIR and Constantinides models are subject to the same criticisms of the

---

[44] Cox, Ingersoll & Ross, (1985) p. 387.

[45] Brigo and Mercurio (2001) also expand upon the CIR model and create a time-homogeneous short-rate model to reproduce any observed yield curve. Ahn, Dittmar, and Gallant (2002) and Ahn, Dittmar, Gallant, and Gao (2003) build affine term structure models based on Constantinides' model. These models are subject to the same criticism as the CIR and Constantinides models.

[46] See Mises (1985) for a critique of using this method.

[47] Austrian theory makes a very strong case against using neutral money in this manner. See Mises (1990).

Expectations Theory for not accounting for the three empirical regularities stated above. Therefore, these models are unsuitable for explaining the relationship between the yield curve and real output.

Section 3.7 The Liquidity Preference Hypothesis

The Liquidity Preference Hypothesis (LPH) stems from Keynes's line of reasoning on the demand for money.[48] According to this model, money, the most liquid asset, has no interest rate. Less liquid instruments yield interest rates that are higher the longer the maturity. The analysis is based on interest rate risk, the risk that investors face with the movement of the interest rate. When interest rates rise, investors face capital losses, and as interest rates fall, investors are subject to lower reinvestment rates. Due to interest rate risk, it is less of a risk to hold cash than to hold a bond. Therefore, investors are discouraged from holding long-term investment instruments. In order to assuage the investors' relative risk adversity, a liquidity premium is attached to the financial instrument.[49] The rate of the premium's growth diminishes as the maturities increase,

---

[48] While Keynes (1936) is cited as the inspiration of this model, the Liquidity Preference Hypothesis is usually attributed to Hicks (1965 [1939]). However, an early formulation of the theory can be traced at least back to Jean-Baptiste Say (1971 [1803]) where he states, "Among the circumstances incident to the nature of the employment, which influence the rate of interest, the duration of the loan must not be forgotten; *ceteris paribus*, interest is lower when the lender can withdraw his funds at pleasure, or at least in a very short period; and that both on account of the positive advantage of having capital readily at command, and because there is less dread of a risk, which may probably be avoided by timely retreat." pp. 346-347.

[49] Matthews (1963) states, "If asset-owners dislike risk, the possibility of a capital loss will discourage them from holding bonds, even though they consider a capital gain no less likely than a capital loss. The demand for money arising from this source will be interest elastic, because asset-owners have to weigh the riskiness of bonds against their yield." p. 201. Hicks (1965) presents an early version of the Liquidity Preference Hypothesis. He observes that when economists discuss the interest rate, they have the long rate

i.e., its first derivative is positive, while its second is negative.[50] The implication of this theory is that the yield curve will always be sloping positively, even when future rates are expected to fall.

The proponents of the LPH argue against the Expectations Theory. In 1939, Hicks touched off a controversy by rejecting the Expectations Theory. Hicks (1965) states, "…to say that the rate of interest on perfectly safe securities is determined by nothing else but uncertainty of future interest rates seems to leave interest hanging by its own boot-straps."[51] Hicks' position is that liquidity preference alone accounts for the term structure of interest rates.

Several arguments have challenged the position that liquidity-preference is the only relevant factor in the formation of the yield curve.[52] Robinson (1951) states, "The most important influences upon interest rates … are social, legal, and institutional."[53] The responses to Hicks can be categorized into two general arguments. The first argument centers on the social factors, while the second focuses on legal and institutional factors. The first argument states that some people may prefer bonds to cash because bonds represent a secure income stream. Robinson (1951) and Kahn (1954) state that there may exist a class of asset-owners, like "widows and orphans," who view bonds as less risky than cash. Their primary aim is to ensure a steady stream of income and they

---

in mind. He further argues that "when the long rate is expected to remain steady, the short rate will lie below it to the extent of the normal risk-premium…." p. 151. While each approach the analysis from a different starting point, they have the same result.

[50] See Smith and Spudeck (1993) p. 117 and McEnally and Jordan (1995) p. 795.

[51] Hicks (1965) p. 164.

[52] See Harrod (1948), Robertson (1951), Robinson (1951), and Kahn (1954).

[53] Robinson (1951) p. 92.

are not worried about capital loss since they are unwilling to sell these assets before their maturities. This predisposition can be categorized as a "solidity preference." Matthews (1963), working in the Keynesian framework, concludes that there is no *a priori* means of determining which group will be "outweighed by the others unless some more specific assumption is made about how assets are divided among interest-gainers [those with a liquidity preference] and interest-losers [those with a solidity preference]."[54]

The second argument states that legal and institutional factors also play a significant role in the shape of the yield curve. Kahn (1954) provides an example of the effect of these factors by arguing that changes in banking policy influence interest rates. Banks may change their portfolio mix by adding and subtracting bills and bonds. When the banking system changes the relative balance of bills and bonds, the relative prices between bonds and bills change. Thus, the yield curve's shape changes to reflect the new pattern. After presenting several different scenarios, Kahn states:

> [The Hicks school's] logical position is … that neither the bond rate nor the bill rate is altered. The fact that in the real world the two rates will be moved in opposite directions testifies that we live in a world of doubt and of disagreement and one in which different persons not only take different views and are influenced by different degrees of conviction, but are sensitive to risk in different ways. There is no factual basis for assuming that the relevant elasticity of substitution is infinite. Both blades of Marshall's pair of scissors must be allowed freedom of movement, —a change in the position of the

[54] Matthews (1963) p. 218.

> margin, and of the identity of the person situated on it, carries with it a significant change in all the relevant expectations and dispositions. [55]

In other words, the LPH holds the premium as a fixed function across maturities. If the premium is fixed, it can explain the first two stylized facts of the yield curve. The hypothesis can account for the general tendency of the yield curve to be positively sloped, and can also explain why the long and short rates tend to move together. However, it cannot demonstrate why the long rate is relatively more stable than the short rate. Additionally, the empirical observation of inverted yield curve shows how the LPH alone cannot explain the term structure of interest rates. Lutz (1940) argues:

> We know, however, that the short-term rate can be *above* the long-term rate, a fact which does not seem to fit in very well with the liquidity theory of interest. It is not possible to get out of this difficulty by calling a situation in which the short rate is above the long an exception, and ascribing it to the "technical conditions of the market" in times of financial crisis. The short rate is too frequently above the long, and often stays above it for too long a time, to warrant such a statement. In London, for instance, the short rate was above the long rate for nineteen months from the end of 1919 to the middle of 1921, and for eleven months in 1929.[56]

---

[55] Kahn (1954) p. 235-236.
[56] Lutz (1940) p. 62.

Lutz's criticisms of the LPH also bolster the argument of this dissertation. It is interesting to note that the dates Lutz references are prior to economic recessions. In summary, a strong case is made of the inclusion of liquidity-preference as an influential factor for the shape of the yield curve; however, liquidity-preference is not sufficient to explain the movements of the yield curve.

Section 3.8 The Segmented Markets Theory[57]

The Segmented Markets Theory is the least often used by economists, but seems to be popular with investment specialists.[58] The theory is most frequently attributed to Culbertson (1957) and is usually looked upon as a special case of the Preferred-Habitat Theory. Unlike the previous theories of the yield curve, this theory assumes that financial instruments are not substitutable. It begins with the assumption that investors are risk adverse. By trading in specific segments of the yield curve, investors (particularly long-term investors) are able to minimize their personal risk. Thus, the investment instruments are not substitutable across the term structure. For example, life insurance companies have relatively long outlooks on the financial market. Therefore, they will prefer to buy and sell financial instruments at the long-term end of the yield curve. Their desire to hedge risk outweighs their liquidity-preference.[59] If a life insurance company writes an annuity contract that is expected to last thirty years, then to

[57] It is also known as the Hedging-Pressure (or Institutional) Hypothesis. See Malkiel (1966).
[58] See Hakim and Rashidian (2000) and McEnally and Jordan (1995).
[59] This desire has also been called a "solidity-preference." See Bailey (1964).

minimize risk, the company buys a thirty-year asset. This process is called "matching maturities." In this case, the company is looking for a specific asset; there are no substitutes. One-year instruments rolled over for thirty years would expose the investor to a reinvestment risk each year. Other institutions, such as commercial banks, are faced with legal requirements that necessitate producing liquidity on short notice. Thus, the yield curve is comprised of many segments of noncompeting groups.

Additionally, according to the Segmented Markets Theory, forward rates have no relationship with expected future interest rates, since investors are interested in minimizing risk and not maximizing profits. In effect, separate markets determine long-term and short-term instruments. While most economists argue that arbitrage should link the various markets together even with the presence of these "segmented" investors, yet some empirical evidence of market segmentation exists. Hakim and Rashidian (2000) argue that when there is a relative change in the supply of one security, it can have the effect of "twisting the yield curve."[60] They show that the monetary authority can have an effect on the yield curve beyond expectation and liquidity effects. However, the effect of the monetary authority diminishes across the term structure, i.e., the effect is strongest for short- and medium-term securities.

---

[60] In 1961, the Kennedy Administration engaged in a project called "Operation Twist." The goal was to flatten the yield curve by raising short-term rates while maintaining long-term rates. The higher short-term rates would reduce the flow of capital from the US, while the lower long-term rates would encourage domestic investment. The Federal Reserve's open market operations and Treasury debt management operations increased the issuance of short-term securities while decreased the availability of long-term securities. The result was that the policy had the opposite effect. See Modigliani and Sutch (1966) and Hakim and Rashidian (2000). However, Smith and Spudeck (1993) argue that the policy failed because it was not carried out "aggressively" enough.

Seo (2003) presents a new direction for the Segmented Markets Theory.[61] The author argues that the markets may be segmented due to transaction costs. Arbitrage will not occur if the transaction costs are above the profit to be gained through the arbitrage process. The author finds that there are significant transaction costs that reduce the effectiveness of the arbitrage process and thus the market segments. Seo (2003) admits that "many authors" have rejected the segmented markets approach, yet he maintains that this factor should be included in the prediction of future movements of the yield curve.

The shortcoming of the Segmented Markets Theory is that it cannot explain the three empirical facts of the yield curve: a persistent positive slope, the tendency for long-term and short-term rates to move together, and the reason that long rates tend to remain stable relative to short rates.[62] If markets across the yield curve are completely separate, as the theory claims, then the long- and short-term instruments should move independently. Culbertson (1957) attempts to explain the three empirical facts first by arguing that the persistently upward slope of the yield curve stems from liquidity-preference. While Culbertson does not completely separate the Segmented Markets Theory from the Liquidity-Preference Theory, modern textbooks do.[63] Culbertson then argues that the demand for short-term securities is more variable than the demand for

---

[61] This analysis is also congruent with the Preferred-Habitat Theory.

[62] See Miller and VanHoose (2001) p. 113 for criticisms of the Segmented Markets Theory's inability to address the first two empirical facts. See also Mishkin (2001) pp. 142-143 for criticisms of the theory's failure to address the second two empirical facts.

[63] In fact, some textbooks go so far as to present the theory as a refutation of the existence of the term structure. Gardener and Mills (1994) state, "Relying heavily on the existence of market imperfections, the segmented markets theory argues that there really is no term structure." pp. 200-201. See Miller and VanHoose (2001), Hubbard (1997) and Mishkin (2001) for standard presentations of the Segmented Markets Theory.

long-term securities. Although he claims that the theory accounts for the third empirical fact, the theory itself provides no such rationale.

While the Segmented Markets Theory cannot, on its own, be a complete theory of the yield curve, it does draw attention to important rigidities in the arbitrage process and the effect of specific government actions to specific segments. These aspects are combined with expectations and liquidity-preference to form a distinct theory, the Preferred-Habitat Theory.

Section 3.9 The Preferred-Habitat Theory

Culbertson (1957) combines the Liquidity-Preference Theory with the idea of segmented markets to present an alternative to the Expectations Theory. Modigliani and Sutch (1966) are the first to combine the three different theories and create what has become known as the Preferred-Habitat Theory. Although it is able to answer the three empirical facts of the yield curve, the Preferred-Habitat Theory, like the Expectations Theory, has serious shortcomings. It assumes an underlying interest rate and fails to explain the origin of this initial rate.

The Preferred-Habitat Theory (also called the institutional demand theory) is similar to the Liquidity Preference Hypothesis in that it also focuses upon investors' planning horizons. Financial instruments in this theory are assumed partially substitutable. Investors care about maturities and expected returns. The Preferred-Habitat Theory assumes that there are different market participants that have different planning horizons. Several markets form across maturities due to the investors

participating in preferred areas. In accordance with the Liquidity Preference Theory, many investors are assumed to prefer short-term securities relative to long-term securities. However, the investors do not view the financial instruments as perfect substitutes and will not buy instruments outside of their preferred habitat without an inducement. In addition, the arbitrage process is also hampered by transaction costs. Therefore, a term premium is added to compensate investors for having to invest in a less preferred maturity. As a result, equation 3-3 can be constructed:

$$i_{n,t} = \frac{i_{1,t} + i^{e}_{1,t+1} + \ldots + i^{e}_{1,t+n-1}}{n} + h_{n,t}, \quad \text{Equation 3 - 3}$$

where $h_{n,t}$ is the term (habitat) premium for the particular maturity.[64] However, the term premium is not a constant and is estimated *a posteriori*. The result is a "rigging" of the equation to match the data. The underlying theory has explanatory power for the formation of the yield curve. It is able to demonstrate a traditionally positive sloped yield curve, explain why short- and long-term rates move together, and take into account the relatively greater fluctuations of the short rates.[65]

The Preferred-Habitat Theory is primarily used to model and forecast the existing term structure. It does not independently explain the origin of interest rates. To answer the essentialist question, the theory relies on Fisher's groundwork. While it is true that

[64] See Miller and VanHoose (2001) pp. 164-166, Mishkin (1995a) p. 164, and Smith and Spudeck (1993) p. 118.
[65] See Miller and VanHoose (2001) pp. 167 and Mishkin (1995a) p. 165.

Fisher and Böhm-Bawerk reach the same functionalist answers, they differ on the essentialist question. Since this dissertation focuses on the why the yield curve tends to invert before a recession, there is a need to answer the essentialist question. As described in Section 3.2, Böhm-Bawerk's construction of interest uses time preference as the core and, as a result, answers the essentialist question. Therefore, this dissertation will modify the Preferred-Habitat Theory by grounding it in the Böhm-Bawerkian theory. Thus, a modified Preferred-Habitat Theory contains time-preference, expectations, liquidity-preference, and a degree of market segmentation due to risk aversion.

Section 3.10 The Stochastic-Process No-Arbitrage Approach

The Stochastic-Process No-Arbitrage Approach (SPNAA) is a method and a model, not a theory or hypothesis.[66] McEnally and Jordan (1995) view it "as an alternative way of examining the term structure rather than as a competitor to traditional theories."[67] Paralleling the Black-Scholes model of asset pricing, the SPNAA attempts to model uncertainty. It begins with the premise that bond prices are predictable only up to a point, after which uncertainty takes effect. The term structure and bond prices are related to certain stochastic factors. These factors evolve over time, according to a particular stochastic process. The No-Arbitrage condition applies to a state of equilibrium where no investment strategy can produce a rate greater than the risk-free return of a riskless investment.

---

[66] See McEnally and Jordan (1995).
[67] Ibid. p. 799.

The most popular presentation[68] to represent the evolution of this rate is:

$$dr = \beta(\mu - r)dt + \sigma r dz, \quad \text{Equation 3 - 4}$$

where *dr* is the instantaneous change in this rate; β is a speed-of adjustment component, and β is also greater than zero; (μ - r) is the extent by which the current interest rate exceeds (r > μ) or falls short (r < μ) of some steady-state mean level μ; *dt* is the passage of time; *dz is* a stochastic process; and σ is the standard deviation of the process.

The equation has a predictable and an unpredictable component. "The predictable component is equal to the extent to which the current rate differs from its long-term value, multiplied by a coefficient that measures its rate of adjustment back toward its long-term value. The unpredictable component is equal to the product of the standard deviation of the rate, the initial level of the rate, and some stochastic process."[69]

The most common models are Ogden's single factor model and the Brennan-Schwartz two-factor model.[70] They are consistent with the unbiased expectations hypothesis and address the three empirical facts of the yield curve.[71]

The SPNAA has many applications. For example, it is useful in fixed income contingent claim valuation, because it places a probability on the range over which the yield curve will fluctuate. The Stochastic-Process No-Arbitrage Approach has recently

---

[68] See Ogden (1987).
[69] McEnally and Jordan (1995) pp. 799-800.
[70] See Brennan and Schwartz (1982).
[71] See McEnally and Jordan (1995) p. 800.

become a popular method of forecasting the future movements of the yield curve. Brody and Hughston (2001), Fisher (2001), Ho, Cadle, and Theobald (2001), Jeffrey, Linton and Nguyen (2001), and Mansi and Phillips (2001) all use a Stochastic-Process to generate a model of the yield curve. All of them attempt to find the best predictive model to forecast movements of the yield curve. Deaves and Parlar (2000) and Linton, Mammen, Nielsen, and Tanggaard (2001) use a cubic spline to interpolate and calculate a zero-coupon bond yield curve. Furthermore, Ioannides (2003) argues that parsimonious representations of the term structure perform better than the linear spline counterparts do, because the linear splines, which overfit the data, generate misleading results. The cubic spline method overcomes this defect and is important for future empirical research of the yield curve. Recent trends in the development of the Stochastic-Process No-Arbitrage Approach use a class of affine models, namely a Gaussian model, to account for multivariate diffusion with affine drift and constant variance.[72]

While the SPNAA is a useful model for businessmen, it does not explain *why* the yield curve is positively sloped, or *why* it moves in the manner in which it does. It is designed to model future movements of the yield curve, i.e., it is used to forecast. It is not a *theory* of the yield curve. However, the creators of this model state upfront that it does not attempt to explain the origin of interest, the essentialist question. It is simply looking for patterns and trends. In essence, it is a sophisticated version of the chartist method of picking stocks. Therefore, although the SPNAA is a useful tool for predicting

[72] See Bams and Schotman (2003), Babbs (2002) and Dai and Singleton (2002) for recent examples of such techniques.

yield curve movements, it is not a useful model for this dissertation, which seeks to explain why the yield curve tends to invert before a recession.

Section 3.11 The Rothbardian Theory

The Rothbardian Theory[73] begins with a steady state, or Evenly Rotating Economy (ERE).[74] Rothbard then assumes that the financial instruments along the yield curve are perfectly substitutable. Through the process of arbitration, the yields of the various instruments will move "until the rate of interest is uniform throughout the time structure."[75] This rate is based upon people's time-preference, i.e., the rate at which they prefer sooner to later. Thus, the yield curve is flat in the ERE and will only shift up or down as time preferences change. Only during the arbitrage process will the yield curve have a slope.

This theory makes a hidden assumption that the time preferences of the economic actors remain constant through all maturities. In other words, Rothbard assumes that if a person's personal time-preference is a rate of 8%, then that same discount rate applies for both tomorrow and 50 years from now. However, there is no praxeological reason for this. It is conceivable that a person's time-preference could change over different lengths of maturities, in the form of liquidity-preference. For example, one could assume that as an individual grows older his rate of discount may change. Accordingly, this person may

---

[73] See Rothbard (1993) pp. 381-385.
[74] See Mises (1966) pp. 244-250, and Rothbard (1993) pp. 297-312.
[75] Rothbard (1993) p. 384.

discount tomorrow at a rate of 8% and 50 years from now at 12%. He could discount the future at an increasing rate. Since it is impossible to rule out everybody having a constant rate of discount over various maturities, it seems probable that at least one person will have an increasing rate of discount. With at least one person discounting at an increasing rate, the yield curve will be (if just ever so slightly) positively sloped.

Of the three empirical facts of the yield curve, Rothbard's Theory is able to explain only the tendency for long-term and short-term rates to move together. With the addition of an increasing rate of time-preference, it could be argued that Rothbard's theory may account for the yield curve's persistent positive slope. However, it is unable to explain how long rates tend to remain more stable relative to short rates. In fact, the theory shows that the long and short rates must move in lock step. Since this dissertation attempts to demonstrate why the yield curve tends to invert before a recession, the Rothbard Theory cannot be used.

Section 3.12 Recent Contributions to Yield Curve Theory

Recent advances in yield curve theory focus on the relationship between the yield and macroeconomic variables such as growth, inflation, and future interest rates. The yield curve is often used as an indicator of the type of monetary policy being pursued.[76] While this dissertation examines the relationship between the yield spread and real

[76] See the IMF Staff Paper (1994) for a short review of the uses of the yield curve.

output, there is a large body of literature that examines how much information the yield curve contains on inflation and future interest rates.

The Expectations Theory leads to the idea of the yield curve as a predictor of future inflation, positing that long-term rates are based upon the investors' expectations of future interest rates (and therefore inflation). An increase in current long rates indicates that investors expect future short rates to increase. Several authors have found considerable evidence of a relationship between the yield curve and inflation, namely Browne and Manasse (1989), Mishkin (1990a and 1990b), Jorion and Mishkin (1991), Mishkin (1991), Frankel and Lown (1994), Gerlach (1997), Schich (1999), and Schich (2002), among others. Mishkin (1990a and 1990b) tests the period between 1953 and 1987 and show that the yield curve does not have any predictive power at the 0 – 6 month range. However, for the 9 – 12 month range, he shows significant results. Frankel and Lown (1994) extend Mishkin's analysis and use the whole yield curve for the 1960 – 1991 period. Gerlach (1997) demonstrates that the 5-year/2-year spread is the best predictor, while Schich (1999) argues that the 3 – 8 year segment provides the most information on inflation.

The analysis is broadened to examine if the relation holds across international lines. Browne and Manasse (1989) find that the relation holds for six OCED countries but not at longer horizons. While Jorion and Mishkin (1991) confirm the relation for the UK, West Germany, and Switzerland, they find the best predictor to be at the 5-year rates. Mishkin (1991) also finds positive results for France, Germany and the UK.

Finally, in a recent paper, Schich (2002) strengthens the findings for Canada, Germany, the UK and the US.

Despite these positive results in this literature, there are those who have found the relationship does not hold. Blough (1994) states that the 1-year/2-year spread fails for the full 1923-90 sample and for the 1950-90 and 1971-90 subsamples. Hardouvelis (1994) shows an increase in the yield curve's spread should predict an increase in long rates, but the opposite happens in the US. The author states that white noise or risk premium explanations do not account for this discrepancy. Hardouvelis is at a loss for an explanation of this phenomenon. Koedbk and Kool (1995) examine seven countries[77] and use monthly data to test the period between M1:1981 - M9:1991. They conclude that the 1-year/5-year spread's ability to predict future inflation depends on the time period and the country. The authors claim that their results differ from other papers because the real term structure may not be a constant, as assumed by Jorion and Mishkin (1991). Tzavalis and Wickens (1996) use cointegration analysis to find that the real interest rate contains more information about future inflation than the term spread.

In addition to those who have found results that support and deny the relationship between the yield curve and inflation, there are those who find mixed results. Most notably they are Campbell and Shiller (1991), Abken (1993), Hardouvelis (1994), Frankel (1995), Crockett (1998), and Blake, Henry and Robertson (2002). They all find some predictive power of the yield curve to forecast inflation, but the results are

[77] These countries are Belgium, France, Germany, Japan, the Netherlands, Switzerland and the US.

relatively weak. A recent study, Blake, Henry and Robertson (2002), finds some informational content at the longer rate segments, but it admits that these results are not robust. Instead of using the Expectations Theory, Ferderer and Shadbegian (1993) add a term premium to the theory. They find that market participants gradually learned about changes in monetary policies. In other words, the authors claim that market forecasts will accurately reflect market beliefs, but only after a period of time where investors "figure out" the latest Federal Reserve policy. Finally, Ederington and Goh (1997) argue that the problem may stem from the data used in the analyses. They show that the yield curve is able to predict future rates if they use monthly data but not with quarterly data.

While the inflation rate is an important macroeconomic variable, it is not of relevance to this dissertation. The approach taken in this analysis is based on an application of a capital-based macroeconomic model. The focus of the analysis is on the relative price changes that result from fiscal and monetary policies. Caporale and Williams (2001) argue that long rates in the G-7 countries (except Japan in the 1980s) are affected by the size of public debt. They conclude that fiscal policy affects the shape of the yield curve. However, Evans and Marshall (2001) and Ang and Piazzesi (2003) argue that real world shocks affect the yield curve, not the other way around. The yield curve is just a reactive element in the economy and does not influence real macroeconomic variables. Ang and Piazzesi (2003) state that observable factors affect short and middle rates, but unobservable factors affect long rates. Evans and Marshall (2001) and Ang and Piazzesi (2003) use variants of the Real Business Cycle (RBC) model to generate their results. Since the RBC model excludes the possibility of monetary factors influencing

the economy, these results are hardly surprising.[78] While the capital-based macroeconomic approach does not rule out nonmonetary influences on the economy, it focuses on the monetary aspects.

Section 3.13 A Positive Theory of the Yield Curve

The purpose of this chapter is to find a robust theory of the yield curve so that, when combined with a macroeconomic model based on a heterogeneous capital structure, the analysis can answer the question of why the yield curve tends to invert before a recession. Therefore, it is necessary to construct a theory that contains the strengths of the reviewed theories yet leaves aside those elements that detract from a clear analysis.

In the reviewed yield curve theories, only the Preferred-Habitat Theory accounts for the three empirical facts of the yield curve and is grounded in microeconomic foundations. Unfortunately, it is grounded in Fisher's theory of interest rates. As demonstrated above, Böhm-Bawerk's theory of the interest rate is able to answer both the essentialist and the functionalist questions, because of its use of time preference as the core. Thus, this dissertation constructs a theory of the yield curve using a combination of time-preference (as presented by Böhm-Bawerk), expectations, liquidity-preference, and risk aversion (the preference for matching debt and equity).[79]

---

[78] See Section 2.2 for criticisms on the use of the CCAPM and RBC models.

[79] Through the employment of the *ceteris paribus* assumption, international factors and transaction costs will be held constant. The verification of these assumptions may be conducted at a later date through empirical testing, but this analysis is outside of the scope of this dissertation.

Each of the reviewed yield curve theories, on its own, either cannot meet the three empirical facts of the yield curve (the Expectations Theory, the Liquidity Preference Hypothesis, the Segmented Markets Theory and the Rothbardian Theory) or fails to answer the essentialist question (Preferred-Habitat Theory and the Stochastic-Process No-Arbitrage Approach). The Expectations Theory explains why long and short rates tend to move together, but fails to account for a persistently positive slope and cannot explain why long rates tend to remain stable relative to short rates. The Liquidity Preference Hypothesis explains the positive slope (assuming the liquidity-preference outweighs the solidity-preference) and explains why long and short rates tend to move together, but the hypothesis fails to account for the reason why long rates tend to remain more stable than short rates do. The Segmented Markets Theory and the Rothbardian Theory fail to meet any of the three empirical facts. Despite these shortcomings, however, each of these theories raises issues that must be addressed in a complete theory of the yield curve.

The Preferred-Habitat Theory and the Stochastic-Process No-Arbitrage Approach fail to answer the essentialist question. The Preferred-Habitat Theory is a composite of the theories presented above, and both the Preferred-Habitat Theory and the SPNAA are able to account for the three empirical facts. Dolan (1999) compares these two theories in a global context and argues that the Preferred-Habitat Theory is superior to the Stochastic-Process model. Additionally, the proponents of the SPNAA readily admit that it is merely a tool for forecasting and not a theory. Thus on functionalist grounds, the Preferred-Habitat Theory outperforms the others. However, the problem with using the

Preferred-Habitat Theory is that it does not pass the essentialist test. It cannot explain the origin of interest rates, it can only account for the relationships between the various rates along the term structure. In other words, once a single interest rate is established, the other rates can be derived. To establish the initial interest rate, a yield curve theory must answer the essentialist question. Thus, a yield curve theory based on Böhm-Bawerk's theory of interest is used to create the modified Preferred-Habitat Theory.

With regard to the use of time-preference, Böhm-Bawerk's theory differs from the standard Austrian theory of interest.[80] Fetter and Rothbard set a social rate of time-preference as a parameter to which everything must adjust.[81] While they agree that the *market* rate of interest can be influenced by exogenous factors, e.g., the inflationary effects of monetary expansion, they deny that other factors, such as productivity, can influence the social rate of time-preference and thus the *natural* rate of interest. The danger with this approach is that it can easily lead to establishment of an economic constant. It is akin to saying that there is constant price for gasoline.[82] As outlined in Section 3.3, each entrepreneur has his own internal rate of time-preference. As each invests in projects with higher productivity, a wealth effect is created. This wealth effect changes who the marginal borrower is and who the marginal lender is. It is in this manner that the productivity of capital is able to affect the underlying social rate of time-preference, from which both the natural and market rates are derived. Thus, the yield

---

[80] The standard Austrian theory, the pure time-preference theory (PTPT), is best represented in the writings of Fetter (1977), Rothbard (1977, 1993) and Kirzner (1996).

[81] See Section 3.4, especially fn. 13.

[82] As Yeager (1991) points out, there are "no numerical constants" in economics. See also Mises (1966) pp. 55-56, 118, and 351-352.

curve theory adopted by this dissertation is a modified Preferred-Habitat Theory grounded not in the standard Austrian Theory, but in Böhm-Bawerk's theory.[83]

The modified Preferred-Habitat Theory contains time-preference (in the Böhm-Bawerkian sense), expectations, liquidity-preference, and risk aversion. The last factor, risk aversion, posits that securities are not perfectly substitutable, however, unlike in the Market Segmentation Theory, the process of arbitrage links the long and short rates together.[84] The true test of this theory depends on if it can answer the essentialist and functionalist questions as well as meet the three empirical facts of the yield curve.

The modified Preferred-Habitat Theory satisfies the essentialist question. It provides the rationale that time-preference is the necessary and sufficient condition to the formation of an interest rate. Once this interest rate is established, expectations, liquidity-preference and risk aversion explain the formation of the term structure of interest rates. These rates reflect the underlying social rate of time preference across the various maturities of the yield curve.

Additionally, the modified Preferred-Habitat Theory answers the functionalist question. In this theory, the yield curve is influenced by the four endogenous factors as well as exogenous factors. Changes in both endogenous and exogenous factors are presented to illustrate how the modified Preferred-Habitat Theory reacts to alterations in market activities.

---

[83] This author has not found any reference to a "modified Preferred-Habitat Theory" in the literature. This name was chosen because it is the most descriptive.

[84] It may be noted that the arbitrage process will be hindered if transaction costs are significant.

When a change in any one of the endogenous factors occurs, the implications must be carefully examined. The reason behind an endogenous factor's change will direct the reasoning to the conclusion. Suppose that, for cultural reasons, individuals change the social rate of time-preference by becoming less patient. In the age of "instant gratification," they save less and consume more. Holding all other factors constant, this change results in the yield curve shifting upward. However, this assumes that the change in time-preference is distributed evenly across the entire term structure. It is reasonable to posit that only a segment of the population has changed its time-preference. To follow the reasoning in the modified Preferred-Habitat model, the term premium cannot be held constant during the equilibration process and the yield curve would not only shift, but would rotate as well.

The same chain of reasoning can be employed for changes in expectations, liquidity-preference, or the desire to avoid risk by matching maturities. Ireland (1996) argues the risk premium (the liquidity-preference) is relatively small when compared to the expectations effect. Thus the expectations effect can occasionally dominate the liquidity-preference, and it is possible to witness inverted yield curves in the real world.

While exogenous factors influence the expectations of entrepreneurs, expectations are fundamentally an internal component of the entrepreneur. Entrepreneurs' decisions are made at their own, individual margins. Thus, expectations need to be considered as an endogenous component. Although expectations have a close relationship to exogenous influences, because new information affects expectations, the new information is treated as an exogenous factor. Often an entrepreneur's expectations are changed due to outside

forces. In an investigation of this relationship, Fleming and Remolona (1999) examine the effects of surprise announcements made by the Federal Reserve and the US Treasury. Their conclusion is that "[t]he announcement effects are relatively weak for the short maturities and strong for the intermediate maturities of one to five years. When plotted by maturity, these effects form hump-shaped curves."[85]

The modified Preferred-Habitat Theory can also account for changes in technology. With a change in technology, one usually assumes that the initial factor is an increase in the productivity of capital. When capital becomes more productive, the entrepreneur needs to make two decisions. First, he must determine the length of time the project requires before it starts generating revenue. Secondly, he must decide on a method of financing. The entrepreneur can finance this project either internally or externally. If he uses internal financing, he withholds funds from the market and incurs the opportunity cost of not receiving interest for these funds. Interest rates are not lowered due to the withholding of his financial capital, and thus, the yield curve is higher than it would have been if the entrepreneur had invested the money into the market.

If the entrepreneur uses external financing, he must choose whether to match funds based on the duration of his project or to incur interest rate risk. If an entrepreneur chooses to externally finance a project that will take five years before it begins to yield a return, he can choose to finance his project through issuing bonds.[86] The entrepreneur's

---

[85] Fleming and Remolona (1999) p. 28.

[86] The entrepreneur may choose between a five-year bond, one-year bonds for five years, or a two-year bond and three one-year bonds, etc.

decision on the type of financing is based upon his own preferences and cannot be determined *a priori*. Regardless of his decision, arbitrage forces act to "smooth out" the yield curve. When he enters into the market, he will lower the price of similar debt instruments. No matter in which segment of the yield curve the entrepreneur operates, the market process will equilibrate the yields of shorter maturity bonds and of longer maturity bonds until arbitrage returns no longer exist. With the assumption of imperfectly substitutable securities, the results may generate humped or inverted yield curves, but only when the risk aversion effect dominates both the expectations effect and the liquidity-preference effect. Thus, the net effect will be an upward movement of the yield curve.

Therefore, the modified Preferred-Habitat Theory clearly answers the functionalist question. Additionally, it is also consistent with the three empirical facts of the yield curve: the likelihood of the yield curve to have a positive slope, the observation that long and short rates tend to move together, and the tendency of long rates to be more stable than short rates. The modified Preferred-Habitat Theory is consistent with the first two empirical facts due to the incorporation of liquidity-preference. The second empirical observation is also bolstered by the inclusion of expectations. The third empirical observation is addressed by combining expectations with liquidity-preference and risk aversion. Long-term investors are not concerned with the day-to-day fluctuations of the market. Their expectations of long rates tend to be more stable. Thus, the movements of the term structure are based upon the short investors' expectations—the marginal investors. If these investors believe that the short rates are currently low and

will rise to some normal level in the future, the average of the expected short rates (the long rates) will get a boost from a positive term premium. The result is a steep yield curve. As the short rates rise, the expectations of future increases in short rates fall. Thus, the short rates will equilibrate to long rates. If investors believe that short rates are high and will fall in the future, the long rates would be lower than the short rates, but the existence of a positive term premium dampens the drop in the long rates. Again, as the short rates drop, the expected future movement of the short rates diminishes and the long rates tend to remain stable.[87]

The modified Preferred-Habitat Theory passes all the tests: the essentialist question, the functionalist question and the three empirical facts of the yield curve. This theory can easily be combined with a macroeconomic model based on a heterogeneous capital structure. It retains the strengths of the theories outlined in this chapter and jettisons the deficiencies. For these reasons, this dissertation will employ the modified Preferred-Habitat Theory to examine why the yield curve tends to invert before a recession.

[87] See Mishkin (1995a) p. 165, for further analysis.

CHAPTER FOUR: A CAPITAL-BASED EXPLANATION OF AN INVERTED YIELD CURVE

Section 4.1 Overview

This chapter applies the capital-based macroeconomic approach to find an explanation for the tendency of the yield curve to invert prior to a recession. As shown in Chapter 2, the CCAPM and the Estrella models were unable to demonstrate why this relationship occurs. The capital-based approach of macroeconomic theory is well suited for the examination of this question, since it is a theory of the upper-turning point of a business cycle.[1]

Macroeconomic theories attribute economic downturns to either monetary or real factors. The capital-based approach allows for both. A disaggregated analysis allows for insights that other theories cannot provide. Unlike the capital-based approach, most macroeconomic theories that examine the upper-turning point focus on the immediate causes of the downturn. They do not include the underlying capital structure as a part of the theory, because this structure is viewed as an unnecessary complication to the theory. By ruling out capital (and the malinvestments that could be built up during the expansionary phase), the leading macroeconomic theories focus on more aggregated causes—such as monetary or real shocks to the economy.

[1] See Hayek (1969) where he states, "This theory [the Austrian Business Cycle Theory or ABCT] never claimed to do more than account for the upper turning point of the typical nineteenth-century business cycle." p. 282.

It is the contention of this dissertation that the current models are too aggregated to properly answer the question of why the yield curve tends to invert before a recession. Prior to the 1990-91 recession, several economists called attention to the past performance of the yield spread as a predictor of a business cycle's upper-turning point. However many dismissed the signal, declaring it may be a false positive.[2] Another had argued that there would not be a recession in 1989 or 1990 because there was "an absence of the kind of gross imbalances in the economy that have typically preceded past recessions."[3] It is possible in retrospect to see that the imbalances were in the economy and were liquidated in the 1990-91 recession.[4] The current approach, however, lacks the ability to uncover the imbalances (malinvestments) created during the "boom" phase. It is here that Austrian theory can provide insight.

To clarify terminology, a distinction is made between an individual project's period of production and the social period of production.[5] The individual period of production corresponds to the length of time that an entrepreneur's project will take until it yields output for the next stage of production. Individual projects are divided into long and short terms, and they correspond to the long and short rates of the yield curve.[6]

The social period of production is comprised of these various individual projects. In Hayek's various formulations, the distinction between an individual and social period

---

[2] See Brown and Goodman (1991) and Estrella and Mishkin (1998).
[3] See Keen (1989) p. 40.
[4] See, for example, Hughes (1997) for an empirical analysis supporting this claim.
[5] See Schmitz (2004).
[6] A long-term project may be financed through a series of short-term loans. A simplifying assumption of a hard link between the length of the project and the duration of the loan will not change the analysis.

of production is not examined.[7] The social period of production corresponds to Hayek's vision of the overall degree of economy-wide roundaboutness. In other words, the degree of complexity of an economy is the social period of production.

While short-term projects are found at every stage in the structure of production, long-term projects tend to be associated with the earlier stages of production. Firms tend to match the borrowing of short-term funds with short-term individual projects. Even firms that are characteristically labeled as early-stage firms, such as a coal mining operation, may borrow short-term funds for short-term projects. However when firms engage in long-term projects, they tend to employ more roundabout means of production and lengthen the capital structure. The effect is that they extend their position through the social structure of production. For example, if a restaurant owner decides to build another store, his actions result in more than capital widening. It is true that, when finished, the completed restaurant would be located in the late-stages of the social structure of production. However, the tasks in the construction of the building, namely the clearing of the land, the pouring of concrete, etc. are operations further removed from consumers and lengthen the social capital structure. As the new building is being constructed, the entrepreneur effectively extends his operation through the social structure of production. The implication is that long-term projects are often identified with the earlier stages of the production process.

A contrived example of a long-term investment at a late production stage (and one that does not lengthen the social structure of production) may be the training of consumer

[7] See Hayek (1967 and 1941). Hayek's models use only working capital and do not have long- or short-term projects in particular stages.

relation employees in a foreign language. A firm may plan to expand its operations overseas and instead of hiring new employees, the firm decides to train its existing staff. It is assumed that these employees engage directly with final consumers. While the project may take quite some time for the employee to complete, such a project does not necessarily lengthen the social capital structure of the economy. This example, although unrealistic, shows how a long-term investment may take place at a late-stage of production without resulting in capital deepening. The extent of unrealism such an example must take actually reveals the weakness of the link between long-term investments and late-production stages. Nevertheless, this example demonstrates that a hard link between long-term investment and early-production stages cannot be proven. The results of this dissertation do not rest on this point, because it assumes that only short-term working capital is injected into the economy. However, as shown in Section 4.2, several Austrians ignore this point in their analysis.

Furthermore, capital is divided into two forms—working capital and fixed capital. Working capital, also known as circulating capital, refers to the funds that flow through the structure of production. Fixed capital is the capital equipment, buildings, machines, etc. that do not flow through the structure of production. Instead, fixed capital is embedded at the different stages within the structure of production. Through the investment process, working capital is used to purchase inputs such as labor and goods-in-process; additionally, working capital is also transformed into fixed capital.

The remainder of this chapter is divided into five sections. Section 4.2 critically examines the most recent Austrian contributions to integrating the yield curve with a

capital-based macroeconomic system. Section 4.3 analyzes how expectations are affected by the information contained in the yield curve within the context of the Austrian Business Cycle Theory (ABCT). Section 4.4 examines how monetary injections affect the yield curve and distort price signals to entrepreneurs. Section 4.5 continues the analysis by showing that monetary injections lead to a malinvestment boom. Section 4.6 establishes how such malinvestments are not sustainable and inevitably lead to the "Crunch phase" of the business cycle and then demonstrates why the yield curve inverts (prior to the upper-turning point) during the crunch phase. Section 4.7 summarizes this chapter.

Section 4.2 Recent Integration of the Yield Curve into Austrian Analysis

Austrian theorists have not often used the yield curve in their models.[8] A group of Austrians, Skousen (1990), Hughes (1997), and Mulligan (2002), associate specific segments of the yield curve with specific segments of the structure of production. They create a hard link between the late-stages of production and the short rates of the yield curve and another hard link between the early-stages of production and the long rates. In his empirical analysis, Keeler (2001 and 2002) does not explicitly make this same association, but he fails to present a theory explaining the underlying relationship between the yield curve and real output.

The social structure of production is a concept that emphasizes that there is a process to production. Böhm-Bawerk first formulated a structure of production as

[8] Since 1990, there have been three published articles, a conference paper, and subsections in two books that include the yield curve in Austrian macroeconomic models.

concentric circles radiating from an initial, central point.[9] In 1931, Hayek reconstructs the idea into a continuous-input/point-output model.[10] The Hayekian structure of production is an abstract concept that illustrates the flow of goods-in-process through the various stages of production until they become consumer goods. During the production process, the value of each unfinished good can be measured at each stage. Figure 4-1 illustrates the social structure of production.

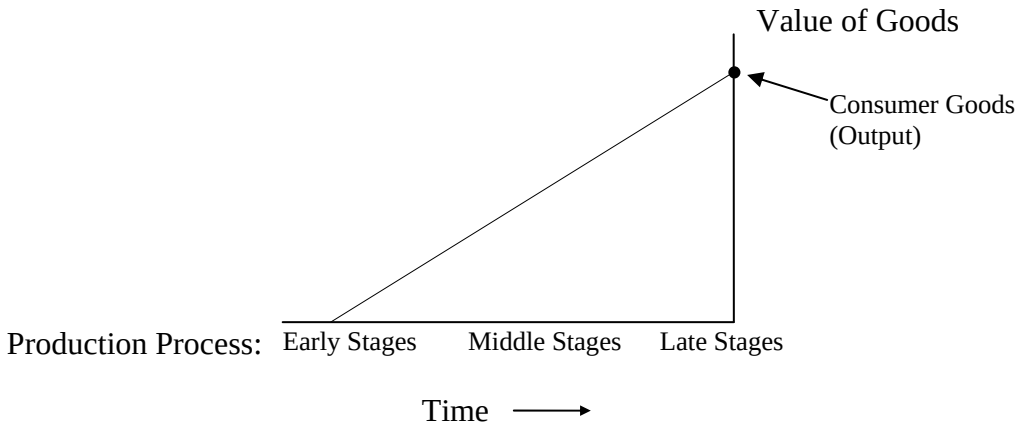


Figure 4-1: The Social Structure of Production

In Figure 4-1, there are two axes. The horizontal axis is labeled "Time" and the vertical axis is labeled "Value of Goods." A line that connects both axes illustrates the structure of production.[11] The horizontal axis, while illustrating that time must elapse in the production process, is not measuring a specific amount of time; rather it is depicting the *ordering* of the different stages of production. A stage of production is where labor, capital equipment, and natural resources are combined with goods-in-process

[9] See Böhm-Bawerk (1959) vol. II, pp. 106-108.
[10] See Hayek (1967). See also Garrison (2001) (especially pp. 45-53) for an integration of this model in a macroeconomic framework.
[11] This relation has led to its label, "the Hayekian Triangle." See Hayek (1967).

(intermediate capital). The process continues until a consumption good is created. The stage furthest to the right represents final (consumption) goods. As more stages are added to the production process, the social structure of production lengthens along the horizontal axis; the economy becomes more roundabout. The length of the structure of production is not an indication of how quickly a product can be made. Instead, the model portrays the stages that a product must pass through.[12] For example, today's assembly lines can produce more than one car per minute, much faster than 50 years ago. However, the degree of roundaboutness to construct a car has increased over the same 50 years. To design a modern car, engineers use highly sophisticated computers. The research and development of these machines are added to the car's production process, lengthening the structure of production.[13]

Skousen (1990), Hughes (1997), and Mulligan (2002) open themselves to criticism when they create a hard link between the short rates of the yield curve with late-stages of production, and albeit to a lesser degree, when they also link the long rates with the early-stages of production. Such an association implies that early-stage firms are unable to adopt short-term individual projects.

After presenting the tendency of the yield curve to have a historically positive slope, Skousen asks and then answers the following questions,

---

[12] The triangle does not attempt to measure the quantity of stages in the production process. It is an attempt to simplify the concept of an order of production into a graphical representation. Austrian theorists are not unified in the applicability of the structure of production. While disagreeing with the use of a *triangular* representation of the structure of production, Lewin (1997a) agrees with the framework of a structure of production with individual stages. He states, "...[W]e must give up hope of measuring production processes in terms of time. The increased number of stages is indicative of increased complexity, which, in turn, is indicative of increased productivity." p. 544.

[13] Böhm-Bawerk (1959) vol. II, p. 83, uses a similar example of a sewing machine producing coats. He specifically points out that the construction of the sewing machine must be taken account of when examining the length of the structure of production.

> What about the alleged higher risk involved in the "higher order" industries involved in the transformation of raw commodities and natural resources? Don't they take greater chances because they are so far removed from final consumption? Wouldn't investors in such "higher order" projects need to be compensated more? Undoubtedly there would be a marked risk premium on such long-term debt if there were no secondary market for such securities.[14]

While Skousen argues that arbitrage will flatten the yield curve, he is associating the long rates of the yield curve with the early stages of production. Mulligan (2002) associates the 3- and 6-month rates with the late-stages of production and the 3- and 5-year rates with the early stages.[15] Although Hughes (1997) does not specifically use the yield curve, he makes the same association. He links the length of an individual investment project with a specific position on the structure of production.[16] One can infer that the next logical step in Hughes' analysis would be to match the maturity of the debt instrument with the length of the project in question.

These authors confuse the time-span of an individual project with its location in the structure of production. Each firm in the structure of production may adopt projects of varying length. While it may be reasonable to associate long-term projects with the early-stages of the social capital structure, the adoption of a hard link between short-term

---

[14] Skousen (1990) p. 194.
[15] See Mulligan (2002) pp. 19 and 28-32.
[16] Hughes (1997) states, "Most higher-stage investments take longer than four-and-a-half years before they begin to pay dividends. Most lower-stage investments take much less time than that." p. 111.

rates with the late-stages of production creates holes in their analysis. As noted above, early-stage firms may undertake short-term projects.

Keeler (2001 and 2002) presents two empirical papers that incorporate the yield curve into the ABCT. In these papers, Keeler bases the yield curve on the Expectations Theory and combines it with the Liquidity Preference Hypothesis. His approach models the empirical relationship of the yield curve with real output, but does not explain the underlying causes of this relationship.

Keeler (2001) tracks the movement of the yield curve over the course of the business cycle.[17] He shows that during a period of credit expansion, the yield curve would shift down and become steeper. For the eight business cycles between 1950 and 1991, Keeler notes that, "Despite the variations across cycles, a pattern emerges that in the expansion phase, the short-term rate is low relative to the long-term rate, and late in the expansion and in the recession, the short-term rate rises relative to the long-term rate."[18] These results correspond to the third empirical observation of the yield curve presented in Chapter 3, Section 3.5.

In the two papers, Keeler traces the relation of the yield curve and real output over the course of the business cycle. Keeler (2002) argues that early-stage firms are more sensitive to interest rate fluctuations than late-stage firms are. Thus an expansionary

[17] Additionally, Keeler (2002) states, "A liquidity effect is evident at the beginning of the cycle as the yield curve becomes steeper, and increases the SLOPE [his empirical variable measuring the difference between 3-month and 10-year government securities], over two quarters. Through the rest of the cycle, during the expansion phase of income increase, the yield curve flattens, as expected, and returns toward its initial value." p. 19.

[18] Keeler (2001) p. 338. He further notes, "[m]ost of the cycles … display steep, positively sloped yield curves initially, which flatten or invert over the course of the cycle." p. 338.

monetary shock, which diminishes short-term rates (and steepens the yield curve),[19] affects the early-stage firms more than late-stage firms.

> … [F]irms respond differently to the changes in interest rates, according to their stage of production, and the allocation of investment flows is altered from that during general equilibrium. Early stage production processes that are more distant in time from the consumer good experience a larger effect on the demand for capital than later stage processes. Capital asset prices rise more, and both investment and output increase relatively more for capital intensive industries that are further removed in time from the final product. As investment responds to the change in asset prices, the composition of the capital stock is changed. Given the long life of capital goods, the specific design that limits substitutability among capital types, and the irreversibility of investment decisions, the expansion has long lasting effects on the economy, and consequently money is not considered neutral in the long run.[20]

The problem with this analysis is that it confuses the length of time of converting an intermediate capital good into a consumer good with the length of time of a particular investment project. The entrepreneur does not concern himself with his relative position in the structure of production. In fact, there is no method to determine the location of any particular firm within the structure of production. The entrepreneur focuses on the length of time that his financial capital would be tied up in a project before it starts to generate a revenue stream. An early-stage firm may engage in a short-term project of less than a

[19] See Keeler (2002) p. 5. Additionally, Keeler's argument is similar to the argument found in Hughes (1997).
[20] Keeler (2002) p. 4.

year. The short-term interest rate (within the yield curve) which matches the length of the project is what the entrepreneur bases his cost/benefit analysis upon, not on how long it will take the item to ultimately become a consumer good.

Keeler correctly notes that capital goods are not perfectly substitutable. In other words, capital equipment cannot always be easily transferred between stages of production. This reason may help explain the depth and duration of the recession, but as Mises explains, the downturn is not created by the specificity of the capital goods.[21] Thus, the specificity of capital cannot be considered a causal factor in the upper-turning point in the business cycle.

In outlining the movement of the yield curve during the upper-turning point of the business cycle, Keeler attributes the recession to a real resource crunch, but fails to account for a credit crunch.[22] Keeler (2002) summarizes that "[i]n the recession phase, the investment incentives are reversed and unsustainable investment will be liquidated or converted to alternative uses."[23] While this statement is consistent with the findings of this dissertation, Keeler provides no further analysis on why this outcome should occur.

---

[21] Mises (1966) states it is erroneous to blame the cycle on the rigidities of malinvestment. It clearly has an influence, but "[t]he crisis is precisely characterized by the fact that these [intermediate capital] goods are offered in such quantities as to make their prices drop sharply." p. 560. Additionally, an increase in inventories prior to a downturn can be traced as far back to the writings of Jean-Baptiste Say. Say (1971) states, "Thus, to say that sales are dull [meaning high inventories], owning to the scarcity of money, is to mistake the means for the cause…." p. 133. Say's Law is a response to the argument that the downturn is caused by a lack of money, or otherwise stated, a surplus of goods as illustrated by increasing inventory stocks.

[22] Specifically, Keeler (2002) states, "The recession phase begins as resource prices and short-term interest rates rise, reducing demands of consumption and investment goods." p. 5. He continues by stating that "no further monetary shock, specifically a change in monetary policy, is specified by the [Austrian Business Cycle] theory to induce recession." Ibid.

[23] Ibid. p. 6.

Keeler (2001) provides another reason explaining the movement of the yield curve during the downturn. He states, "Another distinctly Austrian concept is the endogenous reversal of the expansion leading to a recession, through the Ricardo effect. Specifically, levels of interest rates should fall and the slope of the yield curve will increase during expansion, and these patterns are reversed during contraction."[24] Apart from these sentences, Keeler provides no further analysis on the underlying relationship explaining why the yield curve tends to invert prior to a recession.

In summary, Keeler, from an Austrian perspective, models a known statistical relationship, namely that the yield curve tends to invert before a recession, but fails to explain *why* this relationship holds. In other words, his analysis is general and does not explain why the yield curve would invert before a downturn. He neither explains why the Austrian theory presents this relationship better than any other macroeconomic theory nor examines the use of the CCAPM or the Estrella models. Although Keeler shows that the Austrian model is consistent with empirical evidence, he fails to establish a theoretical explanation for why the yield curve tends to invert before a recession.

Section 4.3 Refuting the Austrian Business Cycle Theory with the Yield Curve

Cowen (1997) argues that the existence of the yield curve completely negates the Austrian Business Cycle Theory (ABCT).[25] While this dissertation does not intend to justify the ABCT, Cowen's objection to the creation of malinvestments needs to be examined.

[24] Keeler (2001) p. 334.
[25] See Cowen (1997) pp. 92-94.

The argument presented by Cowen centers on the ability of the entrepreneur to distinguish between a permanent change in savings preferences and a temporary (or unsustainable) change. Cowen argues that the key to distinguishing between these changes can be found in the movement of the long-term interest rates. If the long-term interest rates decrease, then there has been a permanent change in the amount and duration of savings.[26] However, if the yield curve steepens, where the short rates decrease but the long rates remain relatively stable, then there has not been a permanent change in savings.[27] A change in slope of the yield curve, posits Cowen, is a result of monetary expansion engineered by the central bank. According to Cowen, entrepreneurs correctly recognize this action as inflationary and do not engage in long-term malinvestments. The result is that the yield curve rotates and does not shift.[28] It is well documented that short rates decrease more than long rates during the boom phase of the business cycle.[29] Thus when the monetary authority expands the money supply, entrepreneurs do not engage in long-term malinvestments. Without the creation of malinvestments, the ABCT is refuted.

---

[26] It seems that Keeler (2002) agrees with this position when he assumes the long-term rate (the 10-year rates) is the natural rate. Specifically, he states, "The long-term interest rate is assumed here to represent the exogenously determined natural rate, or the rate of marginal productivity of capital." p. 14.

[27] Cowen (1997) states, "The term structure of interest rates may communicate information which limits the ability of monetary inflation to induce excessive investment term-length. Monetary inflation tends to lower short-term real rates more than it lowers long-term real rates; the resulting signals limit entrepreneurial tendencies to malinvest." p. 92.

[28] Cowen states, "Declines in the short rate, unaccompanied by comparable declines in the long rate, signal relatively impermanent or temporary increases in the supply of loanable funds. Entrepreneurs will not respond to these signals by undertaking excessive long-term investment. The long-term interest rate, which serves as a direct indication of savings permanence, correctly signals entrepreneurs not to mistakenly assume the time duration of savings has risen." p. 93.

[29] See ibid. p. 93. See also the third empirical observation of the yield curve presented in Chapter 3, Section 3.5, which presents Bernanke and Blinder (1992), Ragnitz (1994), Campbell (1995), Mishkin (2001), Gamber (1996), Ireland (1996), and Ang, Piazzesi and Wei (2003).

Cowen's criticism must be addressed in to order to uphold the contention that, in a model with a yield curve, malinvestments can result from credit expansion. Cowen's analysis is in error in three respects. First, Cowen assumes that the long rates are an accurate reflection of savings preferences. Secondly, even if long rates were actually to contain such information, the incentives would be such that entrepreneurs could not avoid malinvesting. In other words, even if entrepreneurs knew the ABCT, they would still produce malinvestments. Thirdly, Cowen's criticism is not internally consistent.

In the model presented by Cowen, he assumes that each actor has rational expectations. Thus, the long interest rates perfectly forecast future short rates. However, Cowen's argument raises the question of who knows what.[30] If long rates actually contain the correct information is this regard, it must be because "the market," i.e., buyers and sellers of long-term securities know—or behave as if they know—what long rates should be independent of any policy effects on those rates. Nevertheless, how do they know? Entrepreneurs have only market signals to guide them. There is no other mechanism to convey information on the future short rates.[31] With the steepening of the yield curve, an entrepreneur cannot tell if the change is due to monetary expansion, a change in expectations, or new institutional conditions, etc. Entrepreneurs are able to

[30] Cowen (1997) states, "Under the Austrian claim, *someone*—at the very least the new money recipients—must know inflation has taken place rather than an increase in private savings." p. 93. (italics in the original) Actually, the reverse is true. It is precisely because entrepreneurs cannot tell the difference between the new credit and the old that they embark on the new projects.

[31] Garrison (2001) points out, "it is not logically consistent to claim (1) that there is a representative agent who already has (or behaves as if he or she already has) the information about the underlying economic realities independent of current prices, wages rates and interest rates *and* (2) that it is prices, wage rates and interest rates that convey this information." p. 27. (italics in the original)

look at only the changes in relative yields, not the underlying factors. A signal extraction problem exists.

Additionally, the entrepreneurs cannot be sure to what extent the additional money affects the long rates. With an expansion of the money supply, the expectation of future inflation increases the long rates. However, as noted before, when the slope of the yield curve steepens during monetary expansions, the long rates remain relatively stable, while the short rates decrease. The influx of new money is preventing the long rates from rising.[32] Thus, the entrepreneur cannot simply read the long rates and determine the actual saving preferences in the economy.

Furthermore, if market participants cannot be sure about the nature of the rate cut, entrepreneurs will behave as if the shock is at least partially a real one. Mainstream macroeconomic models that use rational expectations, such as models that contain the Lucas Supply Curve, hold that if suppliers (of labor in this model) cannot immediately distinguish between a real shock and a purely nominal shock, then the suppliers will initially behave as though the shock were based on real factors.

Cowen argues that entrepreneurs will not engage in malinvestments because they recognize that the changes in interest rates are temporary. Even if entrepreneurs were fully aware that the changes in interest rates were temporary, entrepreneurs would still engage in actions that generate malinvestments. Accepting the empirical observation that

[32] See Section 4.4 below on the discussion of the Wicksell effect.

short rates decrease more than long rates during monetary expansion, a greater relative increase in short-term projects ensues.[33]

Supposing that an entrepreneur could distinguish between a temporary and a permanent change in the time-preferences of savers, he would still have an incentive to borrow funds at the artificially low rate.[34] Entrepreneurs must react to the changes in the rates. Knowing that their competitors would take advantage of the cheap credit during the boom, entrepreneurs would have to act to remain competitive. The duration of the artificially low interest rates would not be known. For the period of time where the interest rates were low, the entrepreneurs who borrowed would have lower costs than their rivals would. These lower costs increase the profit margins of these borrowers. Thus, they would be in a position to attract resources and would get an edge on those who got the new money later. Thus during a credit expansion, those who are able to get the new money would experience a wealth effect first.[35] As long the market yield curve differs from the equivalent of a "natural yield curve," entrepreneurs will change their production practices and create malinvestments.

While such new projects are called malinvestments, they compete for the same resources used by normal investments. When it is discovered that the preferences underlying the yield curve have not really changed (by an increase in interest rates from inflationary pressures or by a shortage of real factors), some projects will need to be

---

[33] The issue of how these short-term projects are malinvestments will be presented in Section 4.5.

[34] Carilli and Dempster (2001) apply the Prisoner's Dilemma to the situation faced by the entrepreneur. They conclude that the equilibrium state is for the entrepreneurs always to engage in the investment project. See also Mises (1943).

[35] See Mises (1990).

liquidated. Therefore, the mere existence of the yield curve does not refute the creation of malinvestments.

Finally, Cowen is not consistent in his criticism. Cowen's objection centers on the point that the long-term rate acts as a signal independent of the short-term rate. The independent signal of the long rate provides enough information so that few malinvestments are made and the artificial boom is too small for a major economic contraction.

However, in his argument against the ABCT, Cowen uses only the Expectations Theory of the yield curve, and ignores the other factors that contribute to its shape, i.e., liquidity preferences, imperfect substitutability among instruments, etc. While the term structure of interest provides signals to entrepreneurs, Cowen forces the short and long rates to move in lock step by his use of the Expectations Theory of the yield curve. In such a model, the relative difference between short- and long-term rates remains constant.

Cowen then strays from this implication by referring to empirical evidence that illustrates the short rates move more than the long rates whenever the monetary authority expands the money supply.[36] The long rate either sends an independent signal apart from the short rate or moves in conjunction with the short rate. Thus, Cowen's criticism is contradicted by his own empirical observations. Since he exclusively uses the Expectations Theory of the yield curve, the long-term rates will also be affected by a change in the money supply. Such a change in long-term rates will also contain the misleading information and therefore not prevent malinvestments from occurring.

[36] See Cowen (1997) p. 93.

Section 4.4 Monetary Expansion

This section examines the effects of monetary expansion. Presented first is an examination of an increase in the money supply traced through the term structure of interest rates. Next, a general overview of the effects of inflation is introduced. Finally, the banking sector is included in the examination and the effects of monetary intermediation are explored.

Monetary Injections

The capital-based approach posits that the initial disequilibrium of the business cycle is caused by monetary injections.[37] Credit is injected at the short end of the yield curve and spreads through the economy causing non-neutral effects. The effect of the new credit is separated into the Wicksell effect and Fisher effect. These opposing effects distort price signals and hamper their ability to transmit relative scarcities to entrepreneurs. As a result, monetary expansion lowers and alters interest rates that falsely signal entrepreneurs to embark upon malinvestments.

The effects of monetary expansion are traced through the yield curve, which was developed in Chapter 3. The modified Preferred-Habitat Theory of the yield curve is a combination of time-preference (in the Böhm-Bawerkian sense), expectations, liquidity-preference, and risk aversion (the preference for matching debt and equity).

[37] Many factors can cause an economic downturn—war, sweeping changes in institutions, radical changes in monetary policy, etc., but these are outside of the scope of this topic. This dissertation specifically focuses on downturns caused by monetary injections.

Böhm-Bawerk's analysis is the basis for the formation of interest rates, since it satisfies both the essentialist and functionalist questions regarding interest. After an initial interest rate is established, a yield curve can be derived by adding expectations, liquidity-preference, and risk aversion to the analysis. As shown in Chapter 3, the modified Preferred-Habitat Theory is consistent with the three empirical observations of the yield curve, which were presented in Section 3.5.

When the monetary authority engages in a policy of monetary expansion, the new money is injected into the monetary system at specific points.[38] The effect of additional liquidity is sometimes called the Wicksell effect.[39] The Fisher effect is the change in interest rates caused by changes in the expectations of future inflation.[40] The Wicksell effect and the Fisher effect are opposing forces. The Wicksell effect tends to lower interest rates while the Fisher effect tends to raise them. Figures 4-2 and 4-3 illustrate the Wicksell and Fisher effects.

[38] The Federal Open Market Committee typically adjusts monetary policy using of open market operations and the discount rate, changing the aggregate level of depository institutions' reserves. Changes in these reserves induce changes to the federal funds rate. The federal funds rate is the interbank interest rate for short-term loans, usually overnight. See Miller and VanHoose (2001).

[39] The phrase "Wicksell Effect" was first used in the Cambridge Capital Controversy of the 1960s. The phrase was divided into a "Real Wicksell Effect" and a "Price Wicksell Effect," describing the change in the relationship between the rate of profit and capital intensity in real or value terms. The phrase "Wicksell Effect" used in this dissertation refers to an "Interest Wicksell Effect" (or a liquidity effect) where money added to an economic system, by expanding the supply of investable funds, initially reduces the market rate of interest.

[40] See Mishkin (2001) pp. 107-108.

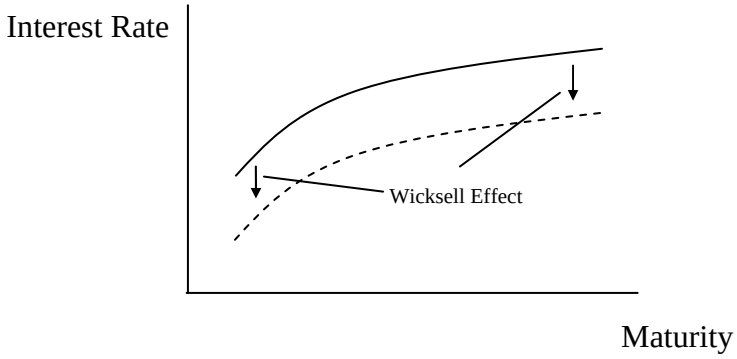


Figure 4-2: The Wicksell Effect

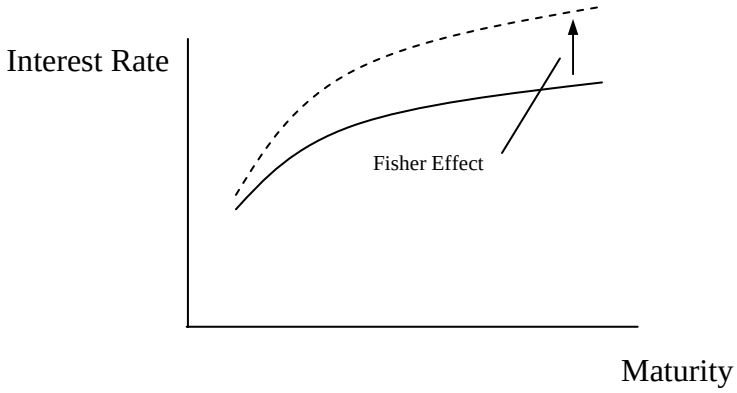


Figure 4-3: The Fisher Effect

With a policy of monetary expansion, the Wicksell effect first dominates interest rate movements. As money is injected into the short end of the yield curve (through the monetary base and thus the federal funds rate) an initial lowering of short rates and a steepening of the slope of the yield curve results. Keeler (2002) states,

> The liquidity effect of a monetary shock will lower interest rates in general and lower short-term rates relative to long-term rates. The yield curve will shift down and become steeper in slope…. [41]

Although Keeler is correct about the steepening of the yield curve, empirical observation does not support the tendency of the yield curve to shift, as long rates tend to remain stable relative to short rates. Bernanke and Blinder (1992) argue that the short rates move while the long rates remain stable. In other words, the federal funds rate drives the yield spread.[42] The Fisher effect increases the forward short rates, thus applying upward pressure to long rates. However, the new money is arbitraged across the term structure. The Wicksell effect prevents the long rates from rising. Thus the yield curve rotates instead of shifting, as shown in Figure 4-4. The new yield curve is presented as the dashed curve.

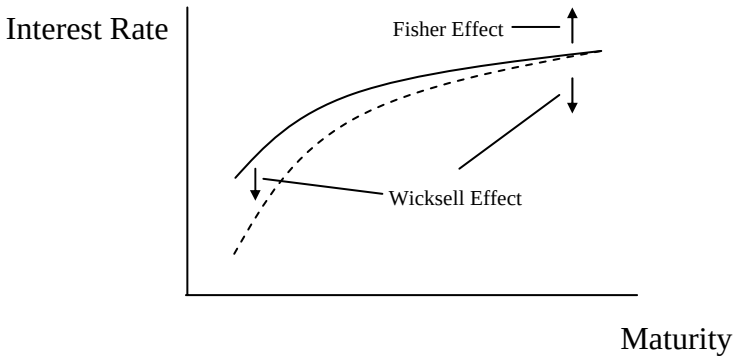


Figure 4-4: The Wicksell and Fisher Effects Combined

[41] Keeler (2002) p. 5. See also Keeler (2001) pp. 333 and 335.
[42] See the third empirical observation in Chapter 3, Section 3.5.

According to Keeler (2002), the steepening of the yield curve begins during the expansion phase of the business cycle.[43] However, the yield curve is steepest at the lower-turning point of the business cycle.[44] These observations are not inconsistent with Keeler's observations if the recovery phase of the business cycle is also included as part of the expansionary phase of the next cycle.

In sum, the analysis begins with the Böhm-Bawerkian framework to establish an initial interest rate. Expectations, liquidity-preference and risk aversion are added to create a modified Preferred-Habitat Theory of the yield curve. With monetary expansion, the Wicksell effect shows the lowering of short rates due to an increase in the supply of investable funds. The long rates tend to remain stable relative to the short rates due to the interaction of the Wicksell and Fisher effects.

Effects of Inflation[45]

The standard consequences of monetary expansion are the following: a change in the relationship between debtors and creditors, a transfer of real wealth, and multiple distortions of price signals. The first general effect of monetary expansion is that debtors gain at the expense of creditors, because the purchasing power of each monetary unit

[43] See fn. 17 above.

[44] This empirical observation was made as early as Kessel (1965) and has since been seen as a consistent pattern of the yield curve.

[45] The definition of the term "inflation" has changed over time. The original usage meant an increase in the money supply (the cause), whereas its current usage denotes the increase in the general price level (the effect). In a static economy, the two are the same; an increase in the money supply leads to an increase in the general price level. In a dynamic economy with high levels of growth, however, both an increase in the money supply and a deflation in prices can occur simultaneously. Thus, the use of the term "inflation" must be used with care. For the purpose of this analysis, inflation is used in the current meaning, a general increase in the price level.

diminishes as the general price level increases. Thus, the real wealth that is paid back to the creditors is less than the amount derived under conditions of price level stability.

The second general effect of monetary expansion is a real wealth transfer from those who receive the new money last to those who receive the new money first. This transfer is called a "Cantillon effect," for Richard Cantillon is credited as the first to describe this process.[46] Money is injected into the economy at specific points into the economy. Those who receive the new money first are able to purchase real goods and services at preexisting prices. As these recipients spend the new money, they attract resources to themselves by bidding up prices. The second round recipients of the new money then spend the new money according to their own preferences. The new money works its way through the economic system with each transaction, increasing prices in an inconsistent manner. The people who have not yet received the new money face higher prices and are unable to purchase as much. Their real wealth diminishes. Thus, the last recipients lose real wealth to those who gained the new money first.

The third general effect of monetary expansion is that increases in the money supply add "static" to the market signals, reducing the entrepreneurs' ability to coordinate their actions with the rest of the economy. Since new money does not enter an economic system uniformly or at a steady rate, the already difficult job of entrepreneurs, to read market signals correctly, becomes even more difficult.[47] Entrepreneurs need to read correctly these market signals to make profits, and consequently, coordinate the

[46] See Cantillon (1964 [1755]). The Cantillon effect is also referred to as an injection effect, since money is injected into the economy at particular points.

[47] Prices are packets of information that signal to entrepreneurs the relative scarcities of the various goods and services throughout the economy. See Hayek (1945).

economy.[48] Since the price changes resulting from an increase in the money supply are not uniform, entrepreneurs have difficulty determining the source of the change. The price changes either stem from a change in relative scarcities or are the result of inflationary pressures. In other words, they are not able to distinguish between relative price changes and inflationary price changes. As a result, the economy becomes more wasteful and less efficient.

Monetary Intermediation

As an economy grows, resources are transferred from the relatively unsuccessful sectors to the growth industries. The banking sector connects ultimate borrowers with ultimate savers; it serves as an intermediary. Yeager (1997) argues that in a period of growth, the consequences of the transfer of control of resources to the growth industries through price deflation are more significant than the distortions caused by injection effects. As described in Section 3.4, growth is not magical or exogenous. Specific individuals develop new ideas about reducing costs, increasing efficiency or creating entirely new products. Assuming that the new ideas are successful, these entrepreneurs generate a wealth effect for themselves. In other words, they have more wealth to spend in the form of consumer goods, to invest in terms of savings, or to have on hand as cash balances. When the additional wealth is held as additional cash balances, the general price level decreases. When the additional wealth is channeled instead back into

[48] See Mises (1980).

spending streams, demand for various consumer and investment goods increases.[49] Thus for price deflation to occur, the Cambridge k must either be held constant or decrease at a rate lower than the increase in the rate of real growth. There is a strong reason to conclude, therefore, that under the assumption of growth the demand for real money holdings increases.

With an increase in the demand for real money holdings, Yeager argues, "…nothing so sinister follows from merely satisfying, and at the existing price level, what would otherwise have been an excess demand for money."[50] In fact, Yeager makes the point that by not expanding the money supply the consequences might be worse than the consequences of the injection effects. As individuals increase their holdings of cash balances, they are relinquishing their power over consumer goods and real factors of production. Without an expansion of the money supply, the withholding of spending[51] by these individuals will be registered by relative decreases in the demands for various consumer and investment goods. These reductions cause the prices of these goods to fall, diminishing the revenue of several firms and perhaps driving many of them out of business. The effect seen in the labor market is structural unemployment. The positive effect of this process is that with the fall in prices, control of the resources is relinquished by those who decide to hold higher cash balances and is instead transferred to the growth industries. This transfer is a necessary step to recoordinate the economy toward a new state of equilibrium.

---

[49] It should be further noted that even if all of the additional profits were spent, there is still the same amount of dollars "chasing" more goods and some price deflation would occur.

[50] Yeager (1997) p. 258.

[51] Spending, in this sense, means spending either on consumer goods or on investment goods. Saving money in a financial institution also constitutes a form of investment spending.

Price deflation generates pain through a liquidation process where the control of resources is transferred from the cash holders to investors. Yeager argues that increasing the money supply would avoid the pain of liquidation that would otherwise result from price deflation.[52] The injection effect transfers real wealth to the investors. The loans, generated from the increase in the money supply, provide the investors with the wherewithal to bid resources away from those businesses where demand has been falling.[53] Instead of these businesses facing liquidation, they are "bought out" by the investors with the new money. Investors bidding for labor and other resources can mitigate high levels of structural unemployment. Thus through the injection of new money in the economy, the transfer of command over resources can avoid the painful process of liquidation which would occur in the price deflation scenario.

There are several problems with the analysis of the benefits of intermediation. Yeager's analysis is based on the stability of the Cambridge k. As Yeager (1991) argues, there are no economic constants and the stability of the Cambridge k is therefore an empirical issue. The stability of this variable is under dispute as standard money and banking textbooks show.[54] The decision to consume, to save, or to hold a cash balance is made at the margin by each individual. Increasing the money supply transfers resources to investors, thereby distorting these consumption/investment decisions and,

[52] Implicit in Yeager's argument is the assumption that capital is sold-off during the liquidation process in whole units. Such an assumption is untenable since capital is heterogeneous. The liquidation process is the breaking up of failed capital structures into smaller units where some capital may end up in new combinations while other capital units are scrapped.

[53] As Yeager (1997) states, "The public, in acquiring the new money, is relinquishing command over resources; and the money and banking system, in expanding its loans, is transferring command over these relinquished resources to the borrowers. Money itself is an 'indirect security' in the process of financial intermediation." p. 258.

[54] For example, see Mishkin (2001) pp. 541-543 and Miller and VanHoose (2001) pp. 674-676, where they argue that the Cambridge k (and velocity) is not stable.

consequently, price signals. The falsified price signals lead to malinvestments. Yeager downplays these distortion effects and takes the position that the liquidation process is more harmful.

In addition to the distortions of price signals and wealth transfer effects caused by expansionary monetary policy, the pain of liquidation is only temporarily avoided, because increases in the money supply cause not only malinvestments (due to distorted price signals), but may also cause misintermediation.[55]

Misintermediation is the consequence of the market not aligning the time horizons of producers with the time horizons of consumers. The traditional perception of thrift institutions is that they "transform maturities," by borrowing short and lending long.[56] These institutions are the nexus between ultimate savers and ultimate borrowers, and the importance of this function cannot be ignored. Nevertheless, since the creation of new money is exogenous to the market, the intermediation process can be at odds with the preferences indicated by the actors of the market. The newly injected money may go to borrowers whose time horizon is different from that of the consumers. If they engage in projects that ripen before the public is willing to buy these goods and services, then many resources are wasted. Not only would the liquidation process that Yeager fears return, but additional resources would also have been wasted.

To illustrate the process of misintermediation, one must return to Yeager's starting point where growth in an economy leads to an increase in the demand for real

[55] McCulloch (1981) argues that misintermediation is a cause of the business cycle. While his argument is consistent with the ABCT, he claims that credit expansion is not necessary for macroeconomic fluctuations.
[56] McCulloch (1981) argues, "most economists take it for granted that this [transformation of maturities] is an essential function of financial intermediation, if not *the* essential function." p. 103. (italics in the original)

cash balances. Supposing that cash holders wish to hold the higher levels of cash balances until time period t_2, their consumption and savings levels would decrease at t_0. Yeager argues that an increase in the money supply (through loans) would transfer resources to investors and that they would buy out the relatively unprofitable entrepreneurs. As the money supply increases, the initial effects are seen in the short rates of the yield curve. The yield curve steepens.[57] With the decrease in short rates, investors engage in projects of short duration that will produce goods and services at t_1. Consumers, however, are not willing to part with their cash holdings until t_2. As a result, the investors have created malinvestments, which will have to be liquidated. Not only will the resources that were transferred to the investors again need to be liquidated, but all of the new capital that was put in place during this period will also need to be liquidated. The extent of this additional liquidation depends on the substitutability of the capital employed by these investors. Furthermore, time, an original factor of production, has also been wasted.

This example is unrealistic, because it rigidly assumes that demand for the higher levels of cash balances exists only until t_2 and further assumes more short-term projects will ripen in t_1. Nevertheless, this example illustrates the problem stemming from misintermediation, which occurs whenever the alignment of time horizons between

[57] For this example, the assumption used is that the expectations for future rates of inflation (the Fisher effect) balances with the liquidity effect (the Wicksell effect). The result is that long rates remain stable, which is consistent with the third empirical observation of the yield curve presented in Chapter 3, Section 3.5.

producers and consumers does not coincide.[58] Except for the signals sent through the price system, the time horizons of consumers are unknown. As a result, monetary authorities and recipients of the new money cannot act rationally, i.e., solve the problem of economic calculation, to coordinate production and consumption plans. The action of injecting new money into the system distorts the very price signals that the monetary authorities and investors need to read. However, changes in the expectations of monetary expansion yield similar results. Furthermore, the extent to which the money supply should be increased cannot be known until after economic growth has occurred. Thus, the monetary authority must solve the knowledge problem not only with respect to the time-horizon of consumers,[59] but also with respect to the expansion of the money supply. While McCulloch concludes that a system which allows misintermediation is better than a system without any intermediation at all, the positive benefits from intermediation through monetary expansion are at best temporary and do not avoid the other problems it generates, i.e., real wealth transfers, price signal distortions, and the creation of malinvestments. Nevertheless, monetary authorities in each country manipulate monetary policy in the hopes of generating a stable economic growth rate.

As the monetary authority expands the money supply, two further considerations on intermediation need to be taken into account. First, there is an inconsistency in the analysis. The analysis assumes that the owners of the growth industries are holding

---

[58] McCulloch (1981) states, "If all planned future borrowing and lending, whether by ultimate borrowers, by ultimate savers, or by financial intermediaries, were precontracted during t_0, this kind of inconsistency could not arise." p. 111.

[59] Instead of changing the discount rate, the Federal Reserve may engage in Open Market Operations, where it can buy and sell Bills, Notes and Bonds. The problem for the monetary authority is which to buy and sell and in what quantities.

higher cash balances. They are the very people to whom the resources should be transferred to in a growing economy. If they are increasing their cash balances, then why is it assumed that they would be borrowing and attracting resources? More realistically, the relatively less profitable firms would be borrowing at the lower interest rates in order to prevent liquidation. Thus, the transfer of resources to the growth industries may be hampered by an expansion of the money supply.

Secondly, as the money supply lowers interest rates, the entrepreneurs and consumers do not change their time preferences. Instead of shifting the supply and demand curves, there is a downward movement along the investable funds curves. As the interest rates decrease, suppliers of investable funds will cut back on the amount of real savings and actually increase their demand for consumer goods and services. Furthermore, the entrepreneurs receive a falsified signal (of lowered interest rates) indicating that consumers are more patient and do not want consumer goods in the near future. In accordance with the example provided above, the consumers will increase their spending on consumer goods and services in t_1, while entrepreneurs engage in projects that will not produce goods until t_3. With the falsified signals, there is no method to determine exactly when the consumers are willing to expand their purchases. Thus, these falsified signals may hinder or defeat the intermediation process.

There is no *a priori* method of determining if the benefits of the intermediation effect outweigh the harms of the injection effect. Although there may be an avoidance of structural unemployment in the short run, it is only temporary. The injection effect causes the following: it changes the relationship between debtors and creditors; it distorts

price signals, making the coordination of the economy more difficult; it creates malinvestments, which will have to be liquidated at a later date; and it may lead to misintermediation, which will require even greater amounts of liquidation.

Current Research on Monetary Transmission Mechanisms

The effects of various monetary policies have substantial consequences on the real economy. In the current research on monetary policy, the examination of the monetary transmission mechanism has been separated into four channels: the interest rate channel, the exchange rate channel, other asset price effects, and the credit channel.[60] There has been much debate as to which of these mechanisms are important and which are not.[61]

Within this debate, it is interesting to note that each model begins with the assumption of monetary contraction and the consequences of monetary expansion are downplayed, if not entirely ignored.[62] An assumption of monetary contraction allows the macroeconomist to examine monetary policy with real output, because contractionary monetary policies tend to have immediate consequences on real output. The links between contractionary monetary policy and the real sector are readily apparent, whereas, the effects from expansionary monetary policy may not become apparent until 6-18 months after the policy is implemented. This approach of focusing on monetary

[60] See Mishkin (1995b) for a summary of each of these channels.
[61] See Romer and Romer (1990), Bernanke and Blinder (1992), Kashyap, Stein and Wilcox (1993), Romer and Romer (1993), Ramey (1993), Bernanke (1993), Taylor (1995), Bernanke and Gertler (1995), Mishkin (1995b), and Christiano, Eichenbaum and Evans (1996).
[62] Taylor (1995) is the exception to the cited articles in fn. 61. Instead of focusing on monetary expansion or contraction, he examines the effects of exchange rate movements.

contractions implicitly assumes that the results and conclusions are symmetrical to the effects of monetary expansion through the same channels. The capital-based macroeconomic approach demonstrates that this relationship is not symmetrical.[63]

Monetary theorists who do not include a heterogeneous capital structure in their analysis limit their scope by examining monetary contractions. In highly aggregated models, the causes of inflation are either an expansion of the money supply (at a rate greater than real output or velocity can adjust) or a shock to Aggregate Supply.[64] As a result, these highly aggregated models are unable to incorporate the disruptions created by the injection of money into the system, i.e., the injection effects.

As noted above, the effects of monetary expansion are ignored in the recent literature of the transmission policy.[65] Textbook monetary theory provides three avenues for the Federal Reserve to expand the money supply: the purchase of securities through open market operations, the lowering of the discount rate, and the lowering of the reserve requirements. From the lack of criticism for these various channels, it can be inferred that the standard textbook treatment of monetary expansion is correct. The effects of monetary expansion are the same regardless of which channel is most significant during a

---

[63] For a view of the expansionary effects, see Garrison (2001) Chapter 4.

[64] The attribution of an Aggregate Supply shock as a cause of inflation is not logically consistent because such reasoning violates the fallacy of composition. The standard reference to such a shock is the oil crisis of the 1970s. The cost of oil increases and raises the cost of energy and the costs of production. Consequently, the general price level rises. However, this line of reasoning confuses a relative price change of a specific good with the general price level. As the price of oil (or energy) increases, it is only a relative price change. A single good cannot increase the price of all goods and services unless it connects all transactions. There is only one good that connects all transactions—money. Therefore, only an increase in the money supply can be the cause of inflation. (Such reasoning is in line with Friedman's famous statement "Inflation is everywhere and always a monetary phenomenon." See Friedman (1968) p. 39.) The highly aggregated models of the AS/AD framework are unable to accommodate relative price changes due to the level aggregation and are susceptible to the fallacy of composition.

[65] See fn. 61 and 62 above.

monetary contraction. In his analysis comparing the monetary transmission mechanism under both a Keynesian and Monetarist framework, Pippenger (1982) examines the effects of monetary expansion through the open-market operations mechanism. He concludes that,

> Even though the monetary authorities cannot influence interest rates in the long run, open-market operations drive a wedge between private saving and investment which generates fluctuations in the capital stock and output. In other words, reducing short-run movements in interest rates creates something similar to an Austrian School business cycle.[66]

The wedge that Pippenger refers to is the result of the falsified price signals caused by a policy of monetary expansion. With the injection of new money, consumers become less patient for consumer goods, while entrepreneurs embark upon more roundabout production processes.

To summarize, this dissertation posits that the monetary authority injects money into the economy through short-term credit markets. The addition of credit lowers short rates, while the Fisher effect (from the expectation of higher future rates) should increase long rates. However, the yield curve steepens and does not shift. The Wicksell effect (the reduction of interest rates from the expansion of the supply of investable funds) is transmitted across the term structure of interest through the process of arbitrage and the Fisher effect on long rates is reduced. Thus, monetary injections artificially lower

[66] Pippenger (1982) p. 550.

interest rates across the entire yield curve. These false rates signal to entrepreneurs that consumers have shortened their time-preferences, leading to a malinvestment boom.

Section 4.5 The Malinvestment "Boom"

In the previous section, the idea of malinvestments was introduced. This section examines the nature of these malinvestments in the context of a capital-based macroeconomic approach. The crisis stems from the need to liquidate the malinvestments that are built during the boom. During this crisis, which is the upper-turning point of a business cycle, the yield curve inverts because of the liquidation process.

Expansion of Short-Term Working Capital

This dissertation seeks to demonstrate that monetary injections (in the form of working capital) into an economic system necessarily lead to an inverted yield curve prior to an economic downturn. As a result, this dissertation assumes the extreme case where monetary expansion initially takes the form of working capital in the short-term credit markets.[67] As this assumption is relaxed, the argument is strengthened.

As previously demonstrated, the monetary injections during an economic boom (and also during a recovery) cause the yield curve to steepen.[68] Short rates fall, while long rates tend to remain relatively stable. With a monetary injection at the short end of

[67] This dissertation is additionally assuming that the traditional role of thrift institutions of "transforming maturities," by borrowing short and lending long, does not take place.
[68] See Keeler (2002) p. 19 and Keeler (2001) p. 338.

the yield curve, the modified Preferred-Habitat Theory suggests that the yield curve should shift down instead of rotate. However, the empirical evidence shows that yield curve rotates and steepens, but shifts very little. This seeming inconsistency with the theory is due to the Wicksell effect explored in the previous section. The impact of the Wicksell effect on long-term and early stage malinvestments is discussed below.

The monetary injections, which rotate the yield curve, send opposite signals to entrepreneurs and consumers. As new short-term working capital is injected into the economy, the economy embarks upon a malinvestment "boom." As the cost of borrowing decreases, the marginal borrowers (those previously excluded from the market) will now be able to obtain the wherewithal to fund their individual projects. Real resources are transferred to these borrowers and the working capital is converted into fixed capital as distinct production processes are added to the economy. Machlup (1932) illustrates this process,

> The fresh borrowers employ the fresh capital—either for a new enterprise or for the expansion of an already existing one—by demanding means of production, partly original factors of production, partly intermediate goods. This increased demand will raise the price of production goods. Therefore the borrowers who are in the best position to compete are those who are less affected by the increased cost of intermediate goods than by the lowering of the rate of interest. This is *not* the case with investment in raw materials and goods in process, but it *is* the case with investments in *fixed* capital since in

> calculating the prospects of such investments the interest rate is of much greater importance than the price of the goods used.[69] (italics in the original)

After debating with Haberler, Machlup demonstrates "that the investment of fresh capital for an increase of production and output which might be technically possible without expanding fixed capital, is economically impossible."[70] Machlup's point is that in order to achieve an expansion of output, working capital must be transformed into fixed capital. In a later work, Machlup (1935) reinforces his conclusion that a decrease in interest rates leads to the formation of new investment in fixed capital.[71] While Machlup argues that the short-term funds will eventually be transformed into longer-term fixed capital, at this part of the analysis, the point to be emphasized is that working capital is transformed into fixed capital. These short-term projects are malinvestments and must be liquidated at a future date unless additional real savings are supplied.

In the meantime, the short-term projects in the late-stages of production (those stages closest to the consumers) are justified through increased profitability due to the increase in the demand for consumer goods. With a decline in short rates, the cost of financing short-term consumer purchases (with credit instruments such as credit cards) falls. Thus, an immediate result of the monetary injection is an increase in the demand for consumer goods. The effect is seen in Figure 4-5.

---

[69] Machlup (1932) pp. 276-277. With expansionary monetary policy and an increase in output, Machlup concludes that, even with additional short-term funds, "the short-term use of capital is theoretically impossible." p. 277.

[70] Machlup (1932) pp. 277.

[71] Machlup (1935) states, "As a cost factor, the interest rate has real significance only as it applies to *new investment in fixed equipment*." p. 462. (italics in the original) "A decrease in the interest rate changes the comparative cost-calculation in favor of those methods of production which make the heavier demands on capital." p. 462.

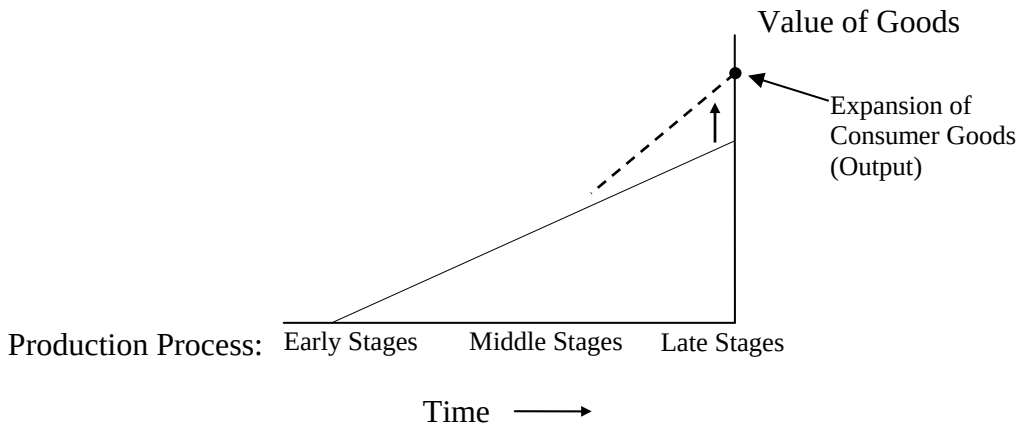


Figure 4-5: The First Effect from Additional Working Capital

The dashed line in Figure 4-5 represents the additional projects accumulating toward the late-stages of production.

By restricting monetary injections to the addition of working capital in the short-term credit markets, the analysis leads to the conclusion that short-term projects at the late-stages of production are built up. Machlup demonstrates that, over time, the working capital will be transformed into fixed capital. The fixed capital is combined with additional inputs to create consumer goods. These consumer goods are purchased with the new credit extended to consumers.

Long-Term Malinvestment

In this analysis, monetary injections have been restricted to the form of additions of working capital to the short end of the yield curve. As this working capital is transformed into distinct production processes to supply consumer goods, a portion of the working capital is applied to the purchase of inputs while the remainder is transformed

into fixed capital. While the analysis has focused on an expansion of the late-stages of production, empirical observation of a boom is that early-stage markets experience larger swings relative to intermediate and consumer goods markets.[72] Such empirical evidence raises two particular questions: "If short-term rates fall relative to long rates thus increasing the amount of short-term projects, where is the long-term malinvestment?" and "Where is the early-stage malinvestment?"[73] To find answers the analysis will use Bastiat's "unseen."

When the monetary authority engages in monetary expansion, entrepreneurs increase their expectation of future inflation. Within the model of the modified Preferred-Habitat Theory, the middle and long rates should rise in accordance with the Fisher effect, but empirically they do not. As previously observed, short rates fall relative to the long rates and the long rates tend to remain stable.

Nevertheless, long-term malinvestments emerge from the injection of short-term working capital. The arbitrage process from the shorter rates prevents the long rates from rising. In other words, credit is flooding into the long bond markets, keeping their yield from rising. The Wicksell effect counters the Fisher effect. (See Figure 4-4 above.) The "unseen fact" is that many long-term projects would have been curtailed with an increase in long-term rates, but the Wicksell effect discourages their liquidation. These non-liquidated projects are now in a state of disequilibrium. They, too, are malinvestments.

---

[72] See Skousen (1990) pp. 303-305.

[73] Long-term malinvestment and early-stage malinvestment are not the same. Long-term malinvestment refers to individual projects with a long-term planning horizon. Such projects may be found at any stage in the structure of production, but tend to lengthen the social structure of production. Early-stage malinvestment refers to the projects at the higher-order stages of production. They may employ both long- and short-term individual projects.

The degree to which the Wicksell effect inhibits long-term rates from rising corresponds to the extent of long-term malinvestment.

Machlup (1935) presents the rate of interest as a cost and capitalization factor in the production process. As interest rates (the short-term rates in particular) decline, the capital values of all fixed capital increases. The capitalization effect yields a greater return for the longer-lived capital equipment.[74] Such a change in the relative value of long-lived fixed capital encourages the expansion of long-term investments despite the increase in only short-term working capital. Thus, not only are some projects that should be liquidated not discontinued, but also new long-term projects are started. As the newly expanded short-term malinvestments are added to the long-term malinvestments, the economy moves beyond the production possibility frontier curve—it has an unsustainable capital structure.

The argument so far is that the monetary authority has injected working capital into short-term credit markets. The addition of credit lowers the short rates, the yield curve steepens, and the arbitrage process prevents increases in the long-term rates, i.e., the Wicksell effect counters the Fisher effect. In the circled area of Figure 4-6, the Wicksell and Fisher effects offset each other, while the Wicksell effect dominates the short-term segments of the yield curve.

[74] See Machlup (1935) p. 465.

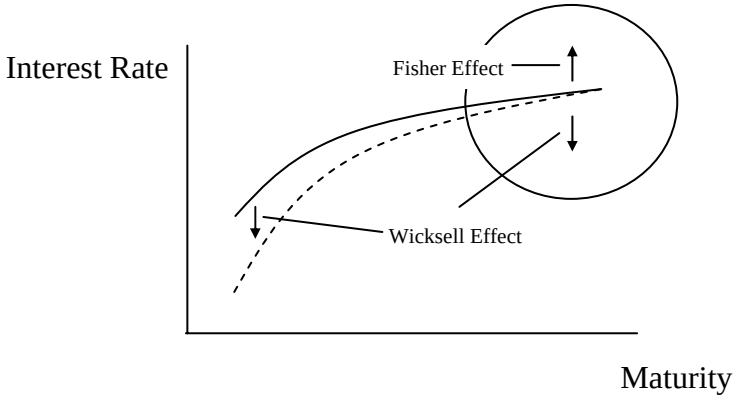


Figure 4-6: The Wicksell Effect Offsets the Fisher Effect

Short-term projects (malinvestments) are commenced due to the lowering of the short rates. These short-term projects embed various degrees of fixed capital into the social structure of production. Up to this point of the analysis, the short-term projects have been located toward the late-stages of production, but the addition of short-term projects is not necessarily an addition of projects to a particular stage. Short-term projects may be added throughout the social structure of production.

Simultaneously, the rotation and steepening of the yield curve is evidence that long rates are artificially held down. The prevention of increasing long rates delays the liquidation of some long-term projects. Additionally, new long-term projects are started because of the relative change in the return of long-lived fixed capital. These long-term projects are not supported by a foundation of real savings and will need to be liquidated at some future date. These long-term projects are malinvestments. Thus malinvestments (in both long and short terms) emerge throughout the structure of production.

Despite demonstrating that long- and short-term malinvestments arise from monetary injections, one may be led to ask the second question posed above, "Where is the early-stage malinvestment?" While a hard link between long-term investments and the early-stages in the social structure of production cannot be technically proven, it is reasonable to assume that such an association exists. The case can be argued that individual long-term investment projects necessarily affect the social period of production to the extent these long-term projects prompt capital lengthening. Nevertheless, to avoid using a conjecture that cannot be proven, this dissertation adopts the extreme case that long- and short-term projects may occur at any stage in the production process. To the extent that long-term investments lengthen the social period of production, the overall argument of this dissertation is bolstered.

Early-Stage Malinvestment

Despite all of the stringent assumptions about the monetary authority injecting working capital into the short end of the yield curve and that long- and short-term projects may occur at any stage in the structure of production, a malinvestment boom in the early stages can be demonstrated.

In his seminal paper, Hayek (1945) demonstrates that entrepreneurs have only price signals to guide them to meet consumers' demands and make profits. Prices are information packets that not only signal to entrepreneurs the quantity and quality of the goods they are to produce, but also allow entrepreneurs to calculate which types of inputs and production processes are the most efficient. It is in this manner that the economy is

coordinated. A network of prices ties the structure of production together. For a single interest rate model in equilibrium, the rate of interest equals the rate of profit. When the model is expanded to include a term structure of interest rates, the same principle applies, but the rate of profit for each individual project corresponds to the matching instrument in the yield curve. For example, a two-year project's rate of return should correspond to the yield of a two-year bond.[75,76] Thus when the rates across the yield curve fall (or are held down by the Wicksell effect), the cumulative effect is a change in the social period of production. The decrease in the short-term interest rates and the artificially low long rates signal to the entrepreneurs that the normal rate of economic profit has been lowered.

To illustrate this process, the analysis begins with a single interest rate model. Suppose that all individual projects have a length of 3 months and there is a corresponding single interest rate for 3-month instruments. The monetary injections falsify the price signals to the entrepreneurs.[77] The effect of the additional credit lowers the interest rate and lowers the normal rate of return for these projects. In other words, the opportunity cost of each project is lowered.

---

[75] The modified Preferred-Habitat Theory is able to accommodate the segmentation of the yield curve.

[76] While long-term projects may be financed through a series of short-term loans, the entrepreneur will use the maturity that matches the individual project as the relevant yield. With a positively sloped yield curve, the yield of rolling over short-term instruments is below that of the longer maturity instrument. However, the entrepreneur will not view the short-term instruments as a relevant substitute for the project. Instead, if he is looking to engage in a long-term project, he will look to the yield of the longer-term instrument as the opportunity cost of such an investment. For example, if the yield of a one-year bond is 4% and the yield of a two-year bond is 5%, the entrepreneur will regard the 5% as the opportunity cost of embarking upon a two-year project.

[77] The importance of Hayek's observation is that entrepreneurs have *only* price signals to guide them in their conduct. Evans (1987) argues that a "mis-assessment of risk" by investors can occur when the "true" risk structure of the economy is uncertain. Since the true risk structure is never precisely known, entrepreneurial error can occur even under the best conditions. When the monetary authorities manipulate price and interest rate signals, these errors are intensified.

As the rate of interest changes, so to does the rate of return necessary to obtain normal economic profits.[78] As the monetary injections lower the interest rate, two effects emerge. The first effect is that consumers, experiencing a decrease in their return on their savings, shift their wealth into consumer goods. Garrison (2001) refers to this situation as over-consumption.[79] As consumers dedicate fewer resources to their savings, retailers face an increase in the consumers' demand curves in their markets. As a result, retailers increase their demand of wholesaler goods in order to take advantage of the profit opportunities. The cumulative effect of the entrepreneurs' actions at the late-stages of production is to reduce the degree of roundaboutness in the economy. The effect is illustrated in Figure 4-5 above.

The second effect is that the injected money is lent simultaneously to entrepreneurs, thereby increasing the amount of investment throughout the structure of production. In this phase, the amount of investment is no longer equal to the amount of savings. A "tug-of-war," to use Garrison's phrase, arises between saving and investment. Garrison argues, "…the conflict is resolved initially in favor of investment spending—because the investment community has more to pull with, namely, the new money that was lent into existence at an attractive rate of interest."[80] As a result of this conflict, the economy is pulled in the direction of more roundabout production processes by the investors and consumers pull the economy in the direction of less roundabout production processes. A "dueling production structure"[81] emerges. Figure 4-7 illustrates this result.

---

[78] The following analysis follows the analysis of Cwik (1998).
[79] See Garrison (2001) pp. 69-70.
[80] Ibid. p. 71.
[81] This phrase was coined by Cochran (2001) p. 19.

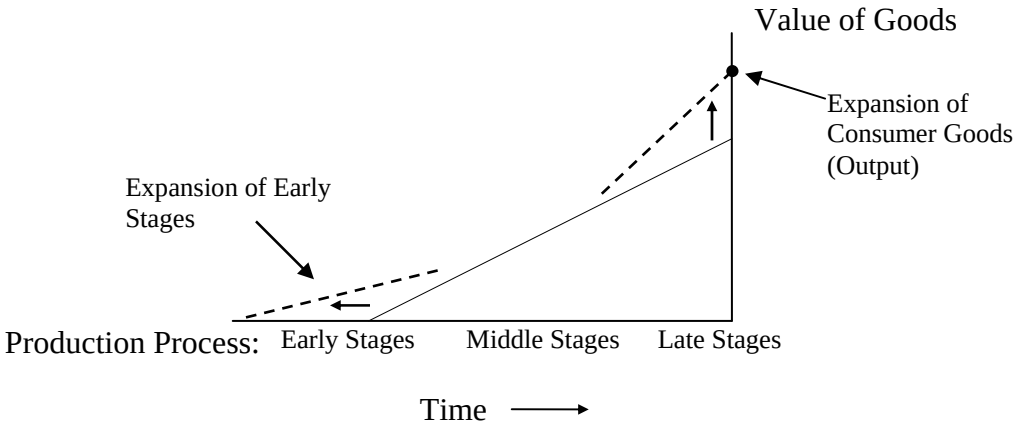


Figure 4-7: The Dueling Production Structure

Garrison is able to achieve this result by arguing that lower interest rates make longer-term investments more profitable. To the extent that longer-term investments lengthen the social period of production, this result is correct. However, there is a more fundamental reason why the economy becomes more roundabout. As the normal rate of profit falls, the effect of the decrease in the interest rate is compounded through the social structure of production (via relative price changes), and it yields the largest impact at the earliest stages of production.

With an increase in investable funds, the normal rate of profit for all businesses decreases. As firms react to compete for the new profits in the late-stages of production, they bid up input prices until they establish this new rate of profit. The cumulative effect of bidding up input prices creates windfall returns for the firms in the early stages. These economic profits attract new investment into the early stages creating the dueling production structure.

To illustrate this idea, suppose that there is a simple, four-stage, production process. Each stage is 3-months long and the initial rate of interest is 10%. As a starting point, assume that the initial price of inputs is $100. Under equilibrium, each stage meets the normal rate of profit of 10%. Using the discounted present value formula, the price of the final output (one year later) is $146.41. Figure 4-8 demonstrates this relationship.

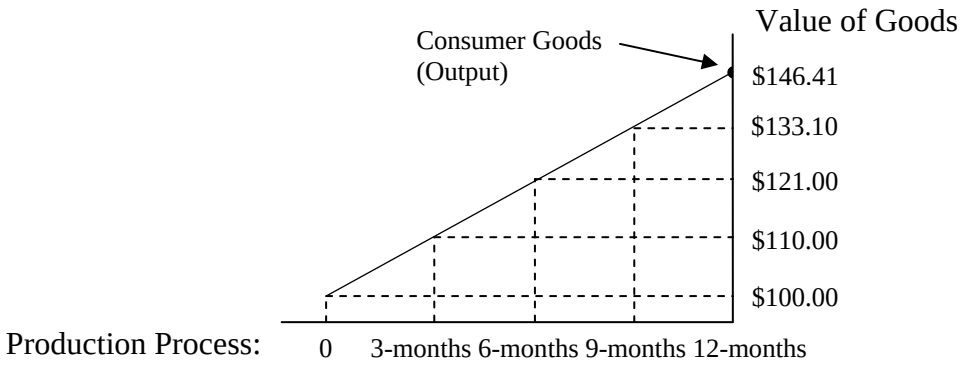


Figure 4-8: Prices for Each Stage Production

Holding, for the moment, the price of the final output constant, when the rate of interest falls to 8%, the price of 9-month goods will be bid up to $135.56, thus yielding an economic profit of 1.85% to those firms operating at the wholesale stage of the production process. Table 4-1 shows the economic profit is highest for the owners of natural resources.

Table 4-1: The Effects of Relative Price Changes on Economic Profit

Stage:	0-months (Natural Resource Owner)	3-months	6-months	9-months	12-months (Final Output)
Prices with 10% interest rate.	$100	$110	$121	$133.10	$146.41
Prices with 8% interest rate.	$107.61	$116.22	$125.52	$135.56	$146.41
Rate of Economic Profit	7.61%	5.66%	3.74%	1.85%	0%

The rate of economic profit is expressed in Equation 4-1.

$$\text{Rate of Economic Profit} = \left(\frac{(1+r_1)^{t_n - t_x}}{(1+r_2)^{t_n - t_x}} - 1 \right) * 100. \qquad \text{Equation 4-1}$$

where r_1 is the initial interest rate,
r_2 is the interest rate after the monetary injection,
t_n is the maximum number of stages in the production process, and
t_x is the stage under examination.

Equation 4-1 shows that rate of economic profit is larger for the earlier-stages of production. This process demonstrates how the early-stage markets are able to expand while consumer market's demand curves are rising. While it may look as though the expansion of the early-stages depends upon longer-term investment (using the discounted present value formula), the assumption of early-stages having long-term investments is not necessary. The large swings in early-stage production processes result from changes in relative input/output prices.

The example provided above makes the unrealistic assumption of a specific number of stages that follow a precise order. In the real world, there is no method by which to determine where a firm is located in the structure of production.[82] Additionally, there are many recursive loops in the structure of production, where a portion of a firm's output may be sold in both the consumer and early-stage markets. An example of such a product is the desktop computer. Computers are sold to research and development institutions and to consumers. Nevertheless, the principle illustrated above holds true when the economy is examined from the perspective of the social period of production.

When the assumption of holding the output price constant is relaxed and the output price is allowed to rise in accordance with the increased demand for consumer goods, the effect upon the level of economic profit is magnified. Furthermore, when the assumption of a single rate of interest is relaxed, the same formula and analysis can be applied and extended across the entire term structure of interest rates. The early-stage firms are able to derive economic profits from engaging in both long- and short-term projects. The major difference for the long-term interest rates is that r_1 becomes the rate of interest that would have materialized on the market if the Wicksell effect did not affect it.[83]

Responding to the compounding effects of relative price and interest rates changes, entrepreneurs act as if the social period of production has changed and build processes that are more roundabout. Keeler (2002) empirically demonstrates that relative prices are the key component of the propagation mechanism during the malinvestment

[82] See also fn. 12 above.
[83] The rate, r_2, is still the observed rate of interest after the monetary injection has had its effect.

boom phase of the business cycle. Furthermore, he establishes that investment reallocation and capacity utilization are expanded toward the early stages of production.[84]

Additionally, Machlup (1932) points out that even short-term investments in working capital require an array of higher-order capital (a superstructure) to support its production. Thus even if a short-term project is transformed into fully integrated fixed capital, it requires an additional array of higher-order capital to maintain its output. Machlup further argues that the effect on capital is compounded the "more distant" an individual production project is from consumers. Thus, a malinvestment boom in the early production stages occurs even when only short-term working capital is expanded.

A conclusion from this analysis is that the extent of the Wicksell effect (the reduction of interest rates from the expansion of the supply of investable funds) corresponds to the degree of malinvestments. In other words, to the degree that the new credit is able to prevent an upward shift (or even cause a downward shift) in yields across maturities, one will see maintenance (and expansion) of disequilibrated capital projects. It is important to note that only a disaggregated approach can examine the capital structure in this manner. The more aggregated theories are unable to draw these conclusions. Thus the disaggregated, capital-based approach explains the malinvestment boom that Keen (1989), Brown and Goodman (1991) and Estrella and Mishkin (1998) missed prior to the 1990-1 recession.

A key aspect of the malinvestment boom is not the boom, but the malinvestment. The malinvestments maintained and created during the boom phase are *mal*investments

[84] See Keeler (2002) p. 15.

because they are not supported by real savings.[85] As a result, they must be liquidated at a future date. These malinvestments are revealed during the crunch phase of the business cycle.

Section 4.6 The Crunch Phase and an Inverted Yield Curve

As noted above, the theories of the upper-turning point of the business cycle center on either monetary or real factors as the primary cause of the downturn.[86] While the capital-based macroeconomic theory of the upper-turning point is not unique in describing the upper-turning point, the significance of this approach is that it is able to account for both monetary and real factors. Robertson (1959) presents a classic observation on the phenomenon:

> How is this cumulative upward process [of the economy] stopped and reversed? It seems to me unlikely that there is a single answer applicable to all occasions; there is a great variety of reasons why, in Haberler's language, the system may become more and more sensitive to "deflationary shocks" as expansion proceeds. Some interpreters have laid stress on purely monetary factors—the fact that the banks, finding their reserves slipping away through withdrawals of legal tender money to pay the enhanced wage-bills, etc., ultimately draw in their horns with a jerk. Others lay stress on the emergence of what they call a "shortage of saving," which no liberality on the part of the banks could remedy. According to this picture, windfall profits are eaten into by rising wages and

[85] Additional savings (entering the economy from abroad or through a tax cut on savings) will transform some (or maybe even all) malinvestments back into stable investments. However, additions to the money supply change the international price of the currency and reduce the incentive of foreigners to invest in economy under examination.
[86] See fn. 37 above.

> interest rates, which at this stage no longer lag appreciably behind the rise in prices, and with the disappearance of windfall profits the main source of demand for instrumental goods is dried up. There turns out to be an overproduction of such goods in the sense, as Cassel puts it, of "an overestimate of the…amount of savings available for taking over the real capital produced."[87]

Within the above passage, Robertson identifies two causes of the onset of a recession as either a "deflationary shock" or a shortage of savings. The capital-based approach identifies each of these factors as a potential and immediate cause of a recession, but the underlying factor in each case is the malinvestment built up during the boom phase. Monetary injections create disequilibria that cannot be maintained forever. The crunch phase of the business cycle, where the scramble to prevent the liquidation of malinvestments takes place, can come about in two ways—the credit crunch or the real resource crunch. While each scenario may cause the economy to turn from boom to bust, they often occur together. However, the capital-based approach, by not over-aggregating the effects of monetary injections, shows that each of these "causes" have the same root—malinvestments.

Since the mid-1960s, there have been six official recessions.[88] Except for the 1990-1 recession, monetary policy was tightened in each instance. However, when tightening occurred after the recession started, it cannot be concluded that the recession

[87] Robertson (1959) pp. 96-97. Robertson does not provide the specific cite for the Cassel quotation.
[88] In addition to the six recessions, the second quarter of 1967 experienced a negative growth rate. It was preceded by an inverted yield curve and a credit crunch in 1966.

was caused by a credit crunch.[89] In five instances, 1966, 1969-70, 1973-5, 1981-2, and 2001, a credit crunch preceded an economic downturn. The recessions that are not preceded by a policy of credit tightening are 1980 and 1990-1. These recessions were caused by a real resource crunch where economic pressure increased input prices, which led to an economic downturn.

Credit Crunch

The credit crunch occurs when the monetary authority determines inflation (or expected inflation) is too high and "slams on the monetary brake." The monetary authority's actions force short-term rates to rise. The yield curve rotates instead of shifts because the rate of future inflation is expected to fall. The Wicksell effect dominates the Fisher effect at the short end of the yield curve and they negate each other at the long-end. Thus the yield curve tends to invert prior to a recession, as seen in Figure 4-9.

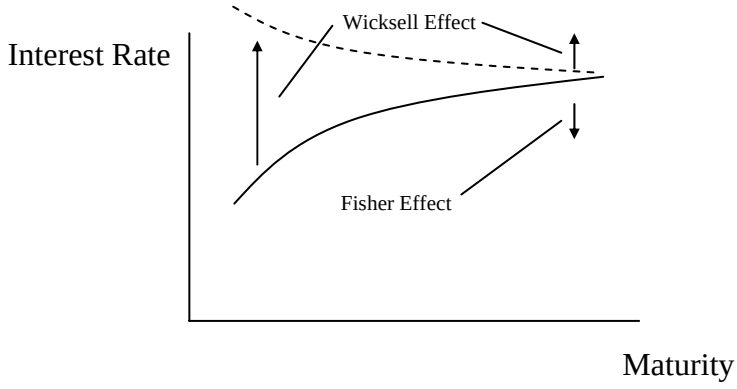


Figure 4-9: Inverting the Yield Curve with the Wicksell Effect and the Fisher Effect

[89] Owens and Schreft (1995) argue that there was tight credit in 1966, 1969-70, 1973-4, first half of 1980, 1981-2, and early 1990-2. However, they state that the 1990 crunch was market induced, while the others stem from actual policies of monetary tightening or threats of increased regulatory oversight.

Hayek (1969) states that in order to maintain the level of malinvestment, the rate of money supply increases must be accelerated even when expectations of future prices remain constant. If there is an expectation of future inflation, the rate of monetary expansion must also outpace expectations of inflation. During periods of increasing price levels, expectations of future inflation are not constant. In the neo-classical model of the Long-Run/Short-Run Phillips curves, the economy is on a point to the left of the Long-Run curve. Such a point is inherently unstable and the only manner in which the economy can maintain its level of output is through accelerating rates of inflation.

With monetary expansion, price levels increase for two reasons: the previous expansions of the money supply drive prices higher in an uneven manner and the instability of the malinvestments induces entrepreneurs to bid up input prices. Malinvestments are projects for which there is not enough savings to support them. During the monetary expansion phase of the boom, new investments are encouraged and consumers increase their levels of consumption and decrease their level of savings.[90] As a result, there is a shortage of real resources at existing prices. Assuming that prices are not sticky upwards, the consequence is an increasing input-price level at an accelerating rate. The inflationary effects of the earlier monetary expansion are compounded due to the need of entrepreneurs to finance their malinvestments. A disaggregated approach, such as the capital-based approach, shows that the money supply must not only expand to

[90] Again, the significance of using the modified Preferred-Habitat Theory becomes important. The fact that there is a divergence between entrepreneur's plans and that of consumers is based upon the inclusion of Böhm-Bawerk's formulation of time-preference. Since consumers have not changed their time-preferences, when new money is injected into the economy, they decrease their rate of savings. A Preferred-Habitat Theory using Fisher's theory as its foundation could not support such a claim.

account for expectations, but that it must expand at an accelerating rate to accommodate increasing input prices and maintain output levels.[91]

Kashyap, Stein and Wilcox (1993) demonstrate that when the monetary authorities engage in a policy of monetary contraction, there is an immediate effect on the money stock. The first consequence is a reduction of new loans made to entrepreneurs. As input prices increase, there is a need for new financial capital to complete or maintain the malinvestments. The firms with investment-grade bonds have access to credit markets, but firms without this rating scramble for financial capital. They drive up short-term rates in order to finance their projects. Cantor and Wenninger (1993) illustrate how, in a time of credit tightness, funds flow away from low-grade investment instruments (in their analysis, away from the junk bond market) and into bonds with at least a grade of Baa. Long-term rates do not change due to two factors: expectations for future inflation have not changed and firms with investment-grade bonds are able to borrow long-term by tapping the funds flowing out of the low-grade investment instruments. Romer and Romer (1993) show that "[S]mall firms are particularly dependent on banks for finance…."[92] They also conclude that during the periods of monetary contraction where the Federal Reserve is able to increase short-term interest rates, banks are able to maintain the levels of loans. However, banks do not increase their loan levels that would be required to maintain the malinvestments.

---

[91] If the monetary authorities adopt a policy of accelerating inflation, the consequence is hyperinflation. However, a real resource crunch will usually come about before that point is reached, e.g., the 1980 recession.

[92] See Romer and Romer (1993) p. 39.

When the monetary authorities believe that the current rate or future rate of inflation is too high, they engage in a policy of monetary tightening. Christiano, Eichenbaum and Evans (1996) show that a contractionary monetary policy increases the federal funds rate. The short-term rates increase relative to the long-term rates. Kashyap, Stein and Wilcox (1993) show that after monetary tightening, the issuance of commercial paper and bonds jumps relative to bank loans. Bernanke and Blinder (1992) argue that a tight monetary policy leads to a short-run sell-off of the banks' security holdings (with little effect on loans), therefore reducing the capital value of these assets and making it more difficult for firms to borrow against their assets. They demonstrate that, over time, banks terminate old loans and refuse to make new ones. In other words, the monetary shock hits securities first. After the securities are sold off, banks rebuild their portfolios and loans start to fall off. After an average period of 2 years, securities return to their previous levels and loans reflect the entire decline. When there is a monetary contraction, according to the results of Kashyap, Stein and Wilcox (1993), a reduction of the supply of loans and the effects on production will not begin to materialize until 6-9 months later. Furthermore, they find evidence that output corresponds with loans. Christiano, Eichenbaum and Evans (1996) argue that households do not adjust their financial assets and liabilities for several quarters after a contractionary monetary shock. The authors also support the findings that the net funds raised by businesses are able to increase for up to one year after the policy shock, after that period, these funds decline. This delay explains the timing issue—the fact that the yield curve tends to invert approximately one year before a recession.

Bernanke and Gertler (1995) argue that interest rates initially spike after monetary contraction and return to their trends after 9 months. This evidence corresponds to the data that show that the yield curve tends to return to its normally positive slope just prior to a recession. This phenomenon was observed in 1957, 1960, 1967, 1989-90 and 2001. Furthermore, Bernanke and Gertler (1995) argue that with a monetary contraction, final demand falls off before production does, implying that inventories rise in the short-run.[93] According to their results, durable spending displays the largest response to monetary policy shocks, which corresponds to the arguments presented in Section 4.5.

Owens and Schreft (1995) argue that the recessions of 1953-4, 1957-8 and 1960-1 were caused by credit crunches. They report that a credit crunch occurred in the spring of 1953 and the recession began in Q2:1953. While the yield curve did not become invert or humped, it flattened throughout the preceding period.

The next US recession began in Q3:1957. Based on the Minutes of the FOMC Meetings, Romer and Romer (1993) identify a contractionary monetary shock in September 1955. The yield curve displayed the effects of a credit crunch when it became humped in December 1956, but it did not invert over the course of the recession.[94, 95]

Owens and Schreft (1995) find evidence of a credit crunch in last third of 1959. The recession began in Q2:1960, and while the yield curve became humped in September 1959, it did not invert.

---

[93] Dimelis (2001) demonstrates that business inventories are procyclical and are more volatile than sales. She also points out that EU swings are larger than US swings. She attributes this characteristic to better inventory practices in the US.

[94] However, Owens and Schreft (1995) do not find evidence of a credit crunch until the fall of 1957.

[95] A humped yield curve is one where the middle rates exceed both the long and the short rates. See Figure 3-1.

As noted above, the economic downturns of 1966, 1969-70, 1973-5, 1981-2 and 2001 were also caused by a credit crunch. In February 1966, President Johnson publicly stated that he feared an approaching inflation and said that he was counting on the Federal Reserve to prevent it. Owens and Schreft (1995) report that the Federal Reserve met with bankers and imposed quantitative limits on certain types of lending. The yield curve inverted in September 1966 and the economy experienced negative growth for Q2:1967.

In late 1968, the fear of inflation arose again. Romer and Romer (1993), using the Minutes of the FOMC Meetings, identify the contractionary monetary shock in December 1968. Owens and Schreft (1995) identify the January 14, 1969 meeting of the FOMC where a shift toward tighter monetary policy took place. The recession began in Q4:1969 and lasted through Q4:1970. In any case, the yield curve became humped in November 1968, inverted briefly in January 1969, and then again inverted between July 1969 and August 1969. It inverted once more between November 1969 and January 1970.[96]

For the 1973-5 recession (which began in Q4:1973), the fear of inflation led the Federal Reserve to raise discount rate from 4.5% to 5% on January 15, 1973. The yield curve became humped in February 1973, inverted in June of the same year, and remained inverted until September 1974. However Romer and Romer (1993), again using the Minutes of the FOMC Meetings, identify the contractionary monetary shock in April 1974.

[96] It is interesting to note that the yield curve became humped before the contractionary monetary policy was put into place. A possible reason for this is that there was a real resource crunch just staring to take effect at this time as well. The real resource crunch is explained below.

Preceding the recession of 1981-2, which began in Q3:1981, Owens and Schreft (1995) argue that the Federal Reserve maintained tight credit policy throughout 1981. The yield curve became humped in September 1980 and inverted in November1980.

On December 5, 1996, Chairman Greenspan used the phrase “irrational exuberance,” sending the first warning that inflationary pressures were on the horizon. However, after a series of rate cuts (cutting the discount rate by 50 basis points to 4.50% by December 1998) the Federal Reserve did not increase the discount rate until August 1999. Beginning in that month, the Federal Reserve began a series of discount rate increases, which culminated in a discount rate of 6.00% in June 2000. The stated reason for the change in policy is found in the FOMC Press Release August 24, 1999, “Today's increase in the federal funds rate, together with the policy action in June and the firming of conditions more generally in U.S. financial markets over recent months, should markedly diminish the risk of rising inflation going forward.” The November 16, 1999 FOMC Press Release stated that the Federal Reserve was increasing the federal funds rate and the discount rate to check “inflationary imbalances.” However the annualized rate of inflation, according to the Consumer Price Index (CPI), for August and November 1999 were merely 1.48% and 1.47% respectively.

As a consequence of the policy of monetary tightening, the yield curve became humped in April 2000 and inverted in August 2000. It and remained inverted through December 2000. The NBER dates the beginning of the recession in March 2001.

While the cause of the 2001 recession may be claimed to be the monetary policy, the Federal Reserve was actually reacting to significant inflationary pressures in the

producers markets.[97] Between April 2000 and January 2001, the Producer Price Index (PPI) for industrial commodities increased over 8.09% and the PPI for all commodities increased over 7.11%. Also during this period, the CPI increased at an approximate rate of only 2.21%. These inflationary pressures are accounted for by a real resource crunch where malinvestments that have built up in the economy can no longer be supported without an accelerating rate of inflation. In other words, if the Federal Reserve had not intervened with a contractionary monetary policy, the economy would have experienced an inverted yield curve and recession because of the impending real resource crunch. The action of the Federal Reserve only hastened the outcome, but did not substantively change the result.

In the surveyed downturns, the monetary authority actively followed a policy of monetary contraction. However, not all recessions are caused by such policies. The recessions of 1980 and 1990-1 were caused by a real resource crunch. The existence of malinvestments can be analytically identified only with a capital-based approach. The subsequent need to liquidate these malinvestments is significant because this need causes the yield curve to invert and sets the economy down a path toward recession even without a policy of monetary contraction.

Real Resource Crunch

Unlike more aggregated models, the capital-based approach can also account for the upper-turning point of a business cycle even when the monetary authorities do not

[97] This case is the opposite scenario of the 1980 recession, which was a recession caused by a real resource crunch and enhanced by a credit crunch.

engage in monetary tightening. During the malinvestment boom, entrepreneurs are given false signals to undertake malinvestments. Also during the boom phase, consumers rebalance their portfolios so that they increase their spending on consumer goods and reduce their level of savings. These malinvestments are unstable because there are not enough resources to complete and maintain each of these projects. As Robertson described above, windfall profits disappear, wages and input prices rise and "no longer lag appreciably behind the rise in prices…."[98] Consequently, there is a scramble for financial capital by entrepreneurs to prevent the liquidation of their projects. They bid up short-term rates and the yield curve inverts due to a real resource crunch.

As described above, the price level is driven upward during the malinvestment boom because of two factors: the expectation of future inflation and the bidding up of input prices by entrepreneurs to prevent the liquidation of their projects. Even when the monetary authorities engage in a policy of monetary expansion to meet the increasing expectations of inflation, the total amount of stable investments is limited at any one point in time by the level of savings in the economy. Savings provide the wherewithal for entrepreneurs to build, complete and maintain their projects.

Monetary injections falsify the price signals to the entrepreneurs, causing them to begin more projects than are actually tenable at that point in time. Additionally, the steepening of the yield curve signals to consumers that short-term credit for consumer purchases are less expensive. As described in Section 4.5, a decrease in short-term rates indicates that the cost of financing short-term purchases falls. Furthermore, with ever

[98] See Robertson (1959) pp. 97 and fn. 87 above.

increasing rates of inflation, consumers will rebalance their portfolios away from savings and checking accounts (and cash holdings) and into tangible assets. In the aggregate, the demand for consumer goods increases and consumers save less. With fewer savings in the economy, the total amount of possible stable investment projects diminishes.

The initial effect of the monetary expansion is that entrepreneurs are able to bid resources to their projects because they are able to cheaply borrow and use the new credit. However, the act of embarking on these investment projects bids up these resource prices. At first the effects of the misalignment of the social structure of production is not apparent and the dueling structure of production emerges (as seen in Figure 4-7 above).

To better illustrate this process, the following example is provided.[99] Suppose that a builder exists who has enough bricks to finish four houses, yet he starts to build five. With a decrease in the normal rate of profit, he sees the additional house as a potential windfall (economic) profit. He figures that he will be able to purchase the bricks necessary for the completion of the project in the future when he needs them. Suppose further that he borrows $100,000 to finance the project. Competing entrepreneurs also follow this pattern due to the false market signals. As the entrepreneur runs out of bricks, he starts to purchase more to complete the project. However, other entrepreneurs are also bidding for more bricks. The price of the bricks increases with the increasing demand. The $100,000 initially borrowed to complete the project is no longer

[99] This example is similar to one presented in Mises (1966) pp. 559-560.

enough. The entrepreneur must find additional financial capital to complete all five houses.

To state the situation more generally, the amount of funds previously borrowed to complete projects (across all lengths) is now insufficient. There is an immediate need for funds to complete and maintain the malinvestments. The scramble for additional funds may be more intense with short-term projects. All entrepreneurs are faced with the alternative of liquidation or of finding supplementary funds to complete their project, but the intensity in demand for funds may be much higher for projects that are almost complete. In other words, an entrepreneur may be more highly motivated to secure funds to finish a project that will produce output next month than he would be to secure funds for a project that will not yield a return until next year.

As a result of these actions, short-term rates are bid up quickly, inverting the yield curve.[100] Tribó (2001) argues that smaller firms must look for short-term credit when faced with output problems.[101] He further finds that larger firms are able to tap into the long-term credit markets. However, as noted above, those firms without investment-grade ratings scramble for financial capital.

Over the course of a business cycle, long rates tend to remain relatively stable. The larger firms with investment-grade ratings are able to attract funds for long-term

[100] Summarizing his empirical findings, Keeler (2002) states, "As the aggregate economy expands and firms progress in building capital and expanding output, shortages of resources occur which raise resource prices. Short term interest rates are increased toward long term rates and the yield curve flattens or may invert. The primary mechanism in this endogenous market process is the intertemporal disequilibrium between sources and uses of income; at low interest rates, consumers and investors increase spending, and need to finance an increase in both consumption and investment, but savers decrease the quantity supplied of funds." p. 5.

[101] See also Romer and Romer (1993).

investments from the low-grade investment sectors. The effect from the increases in the short rates is diminished across the yield curve, because long-term lenders take on less risk since they tend to be the mortgage holders, etc. They are the first to collect if the firm enters bankruptcy. There is a liquidity premium to lending long, yet long-term instruments have an inherent hedge against business cycle risk. Thus, the yield curve inverts instead of shifting.

Three of the recessions since the mid-1950s were not caused by a credit crunch. While there is evidence that there was monetary tightening in every recession except for the 1990-1 recession, the tightening for the 1980 downturn did not take place until after the recession was under way.

As shown above, the 1969-70 recession has elements of both a credit crunch and a real resource crunch. The yield curve became humped in November 1968, a month or two before the policy of monetary contraction was agreed upon by the Federal Reserve. These two causes are not mutually exclusive and may work simultaneously, thus this evidence is not surprising.

The recession of 1980 is an example of a recession caused by a real resource crunch and enhanced by a credit crunch.[102] The recession began in Q1:1980. The yield curve became humped in September 1978, inverted in December 1978, and remained so until April 1980. While Romer and Romer (1993) identify contractionary monetary shocks in August 1978 and October 1979, Owens and Schreft (1995) argue that the credit crunch did not occur until the first half of 1980. Their position is that in order to regain

[102] As noted above, the 1980 and 2001 recessions are opposite scenarios but both recessions contain the same components—a policy of monetary contraction and a real resource crunch.

control over inflation and the expectation of high rates of future inflation, the Carter Administration imposed credit controls on March 14, 1980. Furthermore, the Federal Reserve did not fully enforce these regulations until the Federal Reserve officials met on May 17, where Chairman Volcker warned the banks that the Federal Reserve would enforce the program.

Producer prices grew at an accelerating rate between September 1978 and January 1980 (the dates where the yield curve became humped and the beginning of the recession). Over this period, the PPI for industrial commodities grew at a rate over 22.64% and the PPI for all commodities at a rate over 17.19%. The CPI, over the same period, grew at a rate of 16.99%. This evidence corresponds with the scramble by entrepreneurs to find funding to complete their projects.

The first post-war recession that did not experience a contractionary monetary policy was the 1990-1 recession, which began in Q3:1990. Although the yield curve never inverted, it became humped in February 1989 and lasted in this state through September 1989. While Romer and Romer (1993) identify a contractionary monetary shock in December 1988, most analysts doubt that such a shock occurred. Cantor and Wenninger (1993) state that, “One of the most striking features of the recent credit cycle [of the 1990-1 recession] has been the [credit] crisis that never happened.” They argue that there was a boom in the credit markets between 1986 and 1991. Bernanke (1993) interprets the 1990-1 recession as the result of a credit crunch without a contractionary monetary policy.

A real resource crunch is evidenced by increasing rates of input prices while output prices fail to keep pace. Unfortunately, the aggregated data from the Federal Reserve Bank of St. Louis is not specific enough to capture this relationship.[103] Hughes (1997) provides some evidence that corresponds to the real resource crunch scenario. He shows that a malinvestment boom took place, with long-term bank borrowing by manufacturing industries increasing from $60.5 billion in 1981 to $197.2 billion in 1991 (in unadjusted dollars). He also demonstrates that early-stage firms (such as primary metals and Iron and Steel industries) greatly expanded their capacity from 1981 to 1985, but their output prices collapsed in 1986. While his arguments tend to support the ABCT, he seems to argue that, at least for the early-stage industries, the 1990-1 recession really began in 1986. Thus to find evidence of a real resource crunch for the 1990-1 recession, one must look at the market which most analysts identify as the one which set off the recession—the commercial real estate market.

When viewed from the perspective of the commercial real estate market, one sees that the 1990-1 recession was caused by a real resource crunch. Cantor and Wenninger (1993) demonstrate that there was a large increase in the value of real estate prices prior to the late 1980s. Additionally, the authors argue that deregulation forced non-bank thrift institutions (like insurance companies) to look for ways to increase their rates of return. Thus these institutions extended credit to more risky ventures (like those in the real estate

[103] Nevertheless, the data from FRED II is as follows: from the date when the yield curve began to change, January 1989, through the beginning of the recession, June 1990, the PPI for industrial commodities increased at a rate greater than 3.28%, and the PPI for all commodities increased faster than 3.43%.

market), but the capital requirements for these thrift institutions remained low and many weak firms were exempted from tough regulatory scrutiny.

Cantor and Wenninger (1993) point out that the real estate market collapsed in the late 1980s, after which regulators increased scrutiny of these types of loans, making it very difficult to obtain funding for real estate ventures. Owens and Schreft (1995), in their paper that also observed decreasing real estate values in the late 1980s, state that there were complaints that regulators were too closely scrutinizing real estate portfolios, making real estate lending extremely difficult. Many new buildings came on the market at the same time, depressing rental and sales prices. Additionally in many cases, the tax breaks that made commercial building profitable were removed. Bernanke (1993) observes that large losses in the real estate market reduced the amount of bank capital, which he labeled a "capital crunch." However, Bernanke downplays the supply of funds as a major cause of the recession, because as bank loans fell in 1989, commercial paper increased. Cantor and Wenninger (1993) state that during the period between 1986 and 1991, "nondepository credit growth continued to exceed GDP growth by a wide margin (4.5 to 5.5 percentage points). Depository credit, on the other hand, decelerated sharply as thrift credit went into an outright decline in the 1989-1991 period."[104] There was a shift from financing through banks, etc. to self-financing in the commercial paper and commercial bond markets. Those firms with investment-grade securities were able to obtain financing, while those without such a rating were not. Cantor and Wenninger (1993) further argue that just prior to the recession (1989-90), money stopped flowing

[104] See Cantor and Wenninger (1993) p. 5.

into “junk” bonds and instead went into investment-grade corporate bonds. Despite an easy monetary policy,[105] those borrowers without direct access to the financial markets (i.e., those without investment-grade ratings) did not benefit from this policy. Their scramble for financial capital caused the yield curve to become humped. Below investment-grade borrowers were shut out of the long- and short-term money markets and eventually were forced to liquidate their projects, while those with investment-grade ratings benefited from the easy credit policy.

Bernanke and Lown (1991) support the conclusion that the decrease in bank loans was not supply-side related. Thus, they are skeptical that a credit crunch caused the recession. The lack of contractionary monetary policy explains the appearance of a humped yield curve instead of an inverted yield curve. While Bernanke and Lown argue that the demand for loans was a more important cause of the 1990-1 slowdown, the evidence they provide is that all forms of credit (including commercial paper) decreased *during* the 1990-1 recession—indicating a decrease in demand for credit. There seems to be a timing discrepancy in their analysis. In 1989 commercial paper increased and then, when the recession began, all forms of credit decreased. Their evidence supports the real resource crunch scenario, instead of the scenario where a fall in the demand for credit caused the recession. There was a scramble for credit in the late 1980s, which is seen in the increase in commercial paper issuances and the change in the shape of the yield curve. When businesses started to fail in 1990, the demand for all credit fell and the recession was underway.

[105] Owens and Schreft (1995) report that the Federal Reserve eased monetary policy in the spring of 1990.

Section 4.7 Summary

The capital-based approach compares favorably with CCAPM and Estrella models because it is able to explain why the yield curve tends to invert before a recession. Unlike these other models, this approach centers its focus on the malinvestments built up during the malinvestment boom. These other models, by over aggregating, are unable recognize that the root cause of the inversion of the yield curve is the malinvestments.

In this Chapter, the assumption was made that the initial monetary injection was short-term working capital. It has been shown that this capital is transformed into fixed capital, long-term projects and early-stage malinvestments. To the extent that these projects are inconvertible, the liquidation process becomes more severe.

The modified Preferred-Habitat Theory is an essential component to the model used, because it is able to illustrate how monetary injections lead to a state of disequilibrium between consumption/savings horizons of households and the investment projects of entrepreneurs. Monetary injections cause the yield curve to steepen, which falsely signals entrepreneurs to begin new investments and encourages households to increase their demand for final goods and services.

The unstable malinvestments force input prices to rise and lead to a credit crunch, a real resource crunch, or a combination of both. In their attempts to prevent their individual projects from being liquidated, entrepreneurs will cause the yield curve to flatten, become humped or even invert as they scramble for financial capital (even when

the monetary authority adopts a policy of easy credit). Thus in every recession since the mid-1950s, an inverted or humped yield curve occurred no more than 5 quarters prior to the upper-turning point of the business cycle.

CHAPTER FIVE: CONCLUSION AND SUGGESTED FUTURE RESEARCH

Section 5.1 Summary

This dissertation addresses the question of why the yield curve tends to invert one year before a recession. The first chapter presents the historical evidence, showing a relationship between the yield curve and real output.

Chapter 2 conducts a literature review and demonstrates that there are two major types of models (the CCAPM and Estrella models) that are commonly used to explain this relationship. However, both of these approaches fail to adequately answer the causal connection. Either, as in the case of the CCAPM, the microeconomic reasoning is flawed or, as in the case of the Estrella models, the models are based on statistical aggregates and fail to connect it with microeconomic theory.

The third chapter begins the task of creating a model with a microeconomic foundation by looking at interest rate and yield curve theories. First, the parameters of the analysis are defined. To establish a proper microeconomic foundation, an acceptable theory of interest rates must be able to answer the question of the origin of interest. That is, it must answer the essentialist question. It is necessary to answer the essentialist question in order to create a model of a single interest rate from which one can build a term structure. If this essentialist question were not satisfactorily answered, then any subsequent yield curve theory would be built on a shaky foundation.

This dissertation answers the essentialist question by using a time-preference based theory of the interest rate. Once the fundamental theory is in place, then a market rate of interest (a functionalist model) can be constructed by adding such factors as capital productivity, changes in wealth, changes in expectations, the length of time needed to complete an investment project, the risk of default, liquidity assessments, inflation, information costs, and institutional factors.

Once the construction of a functionalist model of a single interest rate is established, a theory of the term structure of interest can be derived. After reviewing the various theories of the yield curve, this dissertation creates a modified Preferred-Habitat Theory of the yield curve. Unlike the standard Preferred-Habitat Theory of the yield curve, the modified version uses as its core a time-preference based interest rate theory. The importance of this substitution is twofold: first, it grounds the yield curve theory in an essentialist foundation, and secondly, it allows the macroeconomic model (presented in Chapter 4) to separate the market rate of interest from a natural rate. This separation allows a discrepancy to arise between the individual planning horizons of entrepreneurs and that of consumers.

The fourth chapter uses a capital-based model of the macroeconomy to answer why there is a tendency for the yield curve to invert before a recession. Previous contributions that integrate a yield curve with a capital-based macroeconomic model are reviewed. Several counterarguments are made regarding if the existence of the yield curve prevents malinvestments from developing. Subsequently, the formal model used in this dissertation is developed. The analysis begins by separating the individual plan of

production from a social period of production. The model then is restricted to an extreme case where only short-term working capital is injected into the credit market. The credit injection has two consequences: the Wicksell effect and the Fisher effect. As the new money enters the system, the yield curve steepens—short rates fall while long rates remain stable. A comparison is made between the effects of the monetary injection and the process of monetary intermediation.

The result of the injection of short-term working capital into the economy is a malinvestment boom. The analysis demonstrates that both short-term and long-term malinvestments emerge. The short-term malinvestments emerge with the artificial lowering of the short rates. Many long-term individual projects become malinvestments as the Wicksell effect prevents long rates from rising.

Furthermore, the model adopts the highly restrictive assumption that these short- and long-term projects may develop across the entire social structure of production. This dissertation shows that a malinvestment boom occurs in the early stages of production even when the restrictive assumption is used.

The malinvestment boom is an unsustainable state. There is an insufficient supply of savings to support the malinvestments built up during the boom. The resulting crunch comes about as a credit crunch, a real resource crunch, or a combination of the two. Each of these scenarios leads to an inverted yield curve approximately one year before the economic downturn. The credit crunch occurs when the monetary authority's fear of inflation leads it to cut back on the rate of monetary growth. The real resource crunch may occur in conjunction with a credit crunch or it may be an independent reason

for the downturn. A real resource crunch develops because the amounts of resources are insufficient to complete and maintain the malinvestment projects.

During the boom phase, the monetary injections drive all prices higher. However, toward the end of the boom, input prices rise faster than output prices. When the monetary authority tightens monetary policy, a credit crunch develops. Firms without investment-grade bonds scramble for financial capital to complete their projects. As a consequence, short-term rates are driven up. The yield curve inverts with short rates rising and long rates remaining stable. At the short-end of the yield curve, the Wicksell effect dominates the Fisher effect; while at the long-end, the two effects negate each other. Those firms who are unable to obtain the funds at these higher rates are forced to liquidate. Thus, the yield curve tends to invert before the upper-turning point of an economic downturn. Empirical evidence of the recessions caused by the credit crunch (1953-4, 1957-8, 1960-1, 1969-70, 1973-5, 1981-2, and 2001) is presented and explained.

While the credit crunch scenario is the most common course of a business cycle, the downturns of 1969-70, 1980 and 1990-1 are the result of real resource crunches. Even when the monetary authorities engage in policies of monetary expansion, the total amount of stable investment is limited at any one point in time by the level of savings in the economy. Thus as input prices rise, even with a lax monetary policy, entrepreneurs (particularly smaller firms) must scramble for resources to complete and maintain their projects. As a result, there is an upward pressure on the price of short-term credit and the yield curve inverts.

As firms fail and liquidate, the yield curve's shape returns to normal. However, this liquidation process brings real losses to both the financial sector and the productive sector. The losses in the financial sector reduce the amount of loans made and the effects on production materialize six to nine months later. Thus, this model accounts for the timing issue of why the yield curve tends to invert one year before a recession.

Section 5.2 Problems for the Austrian Business Cycle Theory

The inclusion of a yield curve in the ABCT complicates the analysis after the upper-turning point. In particular, can a capital-based macroeconomic model with the yield curve account for the large negative swing in the early-stage industries? The argument presented above is that during the crunch phase the smaller firms, without access to the investment-grade bond market, drive up the short rates. Further investigation will have to examine if there are enough failing small firms (operating in the early stages) to cause the wide swing. Additionally, since the long rates tend to remain stable over the course of the boom and crunch phases, future research should investigate the degree to which long-term projects in the early stages are affected by an inverted yield curve.

Ultimately, there is a need to fully integrate the term structure of interest with the structure of production. Lionel Robbins once stated,

> The notion of a single rate of interest, either natural or monetary, needs to be replaced by the idea of the structure of interest rates…. Monetary theory and capital theory alike are at an *impasse* when the theory of money is limited to the simple quantity theory and the

> theory of capital is divorced from the theory of the money market. … The relations between the supply of capital and the supply of money, between the money rate of interest and the rates of real accumulation and investment, not to mention the relations between relative prices at various stages of production and the rate of borrowing of the entrepreneurs—all these problems, whose solution is essential to any comprehensive theory of economic change, remain unexplained until this fundamental conjunction has been effected.[1]

The resolution of Robbins' challenge is the work of a lifetime and, hopefully, this dissertation is a step toward meeting it.

[1] See Robbins' introduction to Knut Wicksell (1961 [1934]) pp. xvii-xviii.

BIBLIOGRAPHY

Abken, Peter, 1993. "Inflation and the Yield Curve," Federal Reserve Bank of Atlanta, *Economic Review*, 78(3), 13-31.

Ahn, Dong-Hyun, Robert Dittmar, A. Ronald Gallant, and Bin Gao, 2003. "Purebred or Hybrid?: Reproducing the Volatility in Term Structure Dynamics," *Journal of Econometrics*, March (forthcoming), 1-34.

Ahn, Dong-Hyun, Robert Dittmar, and A. Ronald Gallant, 2002. "Quadratic Term Structure Models: Theory and Evidence," *The Review of Financial Studies*, 15(1), 243-288.

Ahrens, Ralf, 2002. "Predicting Recessions with Interest Rate Spreads: a Multicountry Regime-Switching Analysis," *Journal of International Money and Finance*, 21(4), 519-537.

_____, 1999. "Examining Predictors of U.S. Recessions: A Regime-Switching Approach," *Schweizerische Zeitschrift fur Volkswirtschaft und Statistik*,135(1), 97-124.

Andreou, Elena, Denise Osborn, and Marianne Sensier, 2000. "A Comparison of the Statistical Properties of Financial Variables in the USA, UK and Germany Over the Business Cycle," *The Manchester School*, Special Issue, 68(4), 396-418.

Ang, Andrew, and Monika Piazzesi, 2003. "A No-Arbitrage Vector Autoregression of Term Structure Dynamics with Macroeconomic and Latent Variables," *Journal of Monetary Economics*, 50(4), 745-787.

_____, Monika Piazzesi, and Min Wei, 2003. "What Does the Yield Curve Tell Us About GDP Growth?," Seminar Paper at Federal Reserve Bank of New York, February 11.

Atta-Mensah, Joseph, and Greg Tkacz, 2001. "Predicting Recessions and Booms Using Financial Variables," *Canadian Business Economics*, 8(3), 30-36.

Babbs, Simon, 2002. "Conditional Gaussian Models of the Term Structure of Interest Rates," *Finance & Stochastics*, 6(3), 333-353.

Bailey, Martin, 1964. "Discussion," *American Economic Review, Papers and Proceedings*, 54(3), 554.

Bams, Dennis, and Peter Schotman, 2003. "Direct Estimation of the Risk Neutral Factor Dynamics of Gaussian Term Structure Models," *Journal of Econometrics*, April (forthcoming), 1-28.

Bange, Mary, 1996. "Capital Market Forecasts of Economic Growth: New Tests for Germany, Japan, and the United States," *Quarterly Journal of Business Economics*, 35(4), 3-17.

Barran, Fernando, Virginie Coudert, and Benoit Mojon, 1995. "Interest Rates, Banking Spreads and Credit Supply: The Real Effects," Centre d'Etudes Prospectives et d'Informations Intemationales, Paris, Working Paper no. 95-01, March.

Berk, Jan Marc, 1998. "The Information Content of the Yield Curve for Monetary Policy: a Survey," *De Economist*, 146(2), 303-320.

_____, and Peter Van Berggeijk, 2000. "Is the Yield Curve a Useful Information Variable for the Eurosystem?," ECB, Working Paper no. 11.

Bernanke, Ben, 1993. "How Important is the Credit Channel in the Transmission of Monetary Policy?: A Comment," *Carnegie-Rochester Conference Series on Public Policy*, 39, 47-52.

_____, 1990. "On the Predictive Power of Interest Rates and Interest Rate Spreads," Federal Reserve Bank of Boston, *New England Economic Review*, November/ December, 51-68.

_____, and Alan Blinder, 1992. "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review*, 82(4), 901-921.

_____, and Mark Gertler, 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *The Journal of Economic Perspectives*, 9(4), 27-48.

_____, and Cara Lown, 1991. "The Credit Crunch," *Brookings Papers on Economic Activity*, 2, 205-247.

Bernard, Henri, and Stefan Gerlach, 1998. "Does the Term Structure Predict Recessions? An International Evidence," *International Journal of Finance and Economics*, 3(3), 195-215.

Blake, N., S.G.B. Henry, and D. Robertson, 2002. "Term Structure Forecasts of Inflation: Some Further Results," *The Manchester School*, 70(6), 822-832.

Blough, Stephen, 1994. “Yield Curve Forecasts of Inflation: A Cautionary Tale,” *New England Economic Review*, May/June, 3-15.

Böhm-Bawerk, Eugen von 1959. *Capital and Interest*, 3 vols., South Holland, IL: Libertarian Press.

Bonser-Neal, Catherine, and Timothy Morley, 1997. “Does the Yield Spread Predict Real Economic Activity? A Multicountry Analysis,” Federal Reserve Bank of Kansas City, *Economic Review*, Third Quarter, 37-53.

Brennan, Michael, and Eduardo Schwartz, 1982. “An Equilibrium Model of Bond Pricing and a Test of Market Efficiency,” *Journal of Financial and Quantitative Analysis*, 17(3), pp. 301-329.

Brigo, Damiano, and Fabio Mercurio, 2001. “A Deterministic-Shift Extension of Analytically-Tractable and Time-Homogeneous Short-Rate Models,” *Finance and Stochastics*, 5(3), 369-387.

Brody, Dorje, and Lane Hughston, 2001. “Interest Rates and Information Geometry,” *Proceedings Royal Society London: Mathematical, Physical & Engineering Sciences*, 457(2010), 1343-1363.

Brown, William, and Douglas Goodman, 1991. “A Yield Curve Model for Predicting Turning Points in Industrial Production,” *Business Economics*, July, 55-58.

Browne, Frank, and Paolo Manasse, 1989. “The Information of the Term Structure of Interest Rates: Theory and Practice,” OECD, Working Papers no. 69.

Campbell, John, 1995. “Some Lessons from the Yield Curve,” *The Journal of Economic Perspectives*, 9(3), 129-152.

_____, 1986. “A Defense of Traditional Hypotheses about the Term Structure of Interest Rates,” *Journal of Finance*, 41(1), pp. 183-193.

_____, and John Cochrane, 1999. “By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior,” *The Journal of Political Economy*, 107(2), 205-251.

_____, and R.J. Shiller, 1991. “Yield Spreads and Interest Rate Movements: A Bird’s Eye View,” *Review of Economic Studies*, 58(3), 495–514.

Canova, Fabio and Gianni De Nicolo, 2000. "Stock Return, Term Structure, Real Activity, and Inflation: An International Perspective," *Macroeconomic Dynamic*, 4(3), pp. 343 – 372.

Cantillon, Richard, 1964 [1755]. *Essai Sur La Nature Du Commerce En General*, Higgs, Henry (Tr.), New York, NY: Augustus M. Kelley.

Cantor, Richard, and John Wenninger, 1993. "Perspective on the Credit Slowdown," Federal Reserve Bank of New York, *Quarterly Review*, 18(1), 3-36.

Caporale, Guglielmo Maria, and Nikitas Pittis, 1998. "Term Structure and Interest Differentials as Predictors of Future Inflation Changes and Inflation Differentials," *Applied Financial Economics*, 8(6), 615-625.

_____, and Geoffrey Williams, 2001. "Bond Markets and Macroeconomic Performance," *Zagreb International Review of Economics & Business*, 4(1), 27-44.

Carilli, Anthony and Gregory Dempster, 2001. "Expectations in Austrian Business Cycle Theory: An Application of the Prisoner's Dilemma," *The Review of Austrian Economics*, 14(4), 319-330.

Cecchetti, Stephan, 1987. "The Case of the Negative Nominal Interest Rates: New Estimates of the Term Structure of Interest Rates During the Great Depression," NBER, Working Paper no. 2472.

_____, and M. Ehrmann, 1999. "Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers' Preference and Outcomes," NBER, Working Paper no. 7426.

Chapman, David, 1997. "The Cyclical Properties of Consumption Growth and the Real Term Structure," *Journal of Monetary Economics*, 39(2), 145-172.

Chauvet, Marcelle, and Simon Potter, 2003. "Predicting a Recession: Evidence from the Yield Curve in the Presence of Structural Breaks," *Economics Letters*, 77(2), 245-253.

Chen, Nai-Fu, 1991. "Financial Investment Opportunities and the Macroeconomy," *Journal of Finance*, 46(2), 529-54.

Christiano, Lawrence, Martin Eichenbaum, and Charles Evans 1996. "The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds," *The Review of Economics and Statistics*, 78(1), 16-34.

Clinton, Kevin, 1994. "The Term Structure of Interest Rates as a Leading Indicator of Economic Activity: A Technical Note," *Bank of Canada Review*, 1994/1995, 21–40.

Cochran, John, 2001. "Capital-Based Macroeconomics," *Quarterly Journal of Austrian Economics*, 4(3), 17-25.

Crockett, Jean, 1998. "Rational Expectations, Inflation and the Nominal Interest Rate," *Journal of Econometrics*, 83(1/2), 349-363.

Conard, Joseph, 1966. *The Behavior of Interest Rates: A Progress Report*, New York, N.Y.: NBER and Columbia University Press.

_____, 1959. *Introduction to the Theory of Interest*, Berkeley and Los Angeles, CA: University of California Press.

Constantinides, George, 1992. "A Theory of the Nominal Term Structure of Interest Rates," *The Review of Financial Studies*, 5(4), 531-552.

Cox, John, Jonathan Ingersoll, Jr. and Stephen Ross, 1985. "A Theory of the Term Structure of Interest Rates," *Econometrica*, 53(2), 385-407.

_____, 1981. "A Re-examination of Traditional Hypotheses about the Term Structure of Interest Rates," *The Journal of Finance*, 36(4), 769-799.

Cowen, Tyler, 1997. *Risk and Business Cycles: New and Old Austrian Perspectives*, New York, NY: Routledge.

Cozier, Barry, and Greg Tkacz, 1994. "The Term Structure and Real Activity in Canada," Bank of Canada, Working Paper, no. 94-93.

Culbertson, John, 1957. "The Term Structure of Interest Rates," *Quarterly Journal of Economics*, 71(4), 485-517.

Cwik, Paul, 1998. "The Recession of 1990: A Comment," *Quarterly Journal of Austrian Economics*, 1(2), 85-88.

Dai, Qiang, and Kenneth Singleton, 2002. "Expectation Puzzles, Time-Varying Risk Premia, and Affine Models of the Term Structure," *Journal of Financial Economics*, 63(3), 415-41.

Davis, Lance, 1971. "Capital Mobility and American Growth," in: Fogel, Robert, and Stanley Engerman (Eds.), *The Reinterpretation of American Economic History*, New York, NY: Harper & Row, pp. 285-300.

Davis, E. Philip, and Gabriel Fagan, 1997. "Are Financial Spreads Useful Indicators of Future Inflation and Output Growth in EU Countries?," *Journal of Applied Econometrics*, 12(6), 701-714.

_____, and S.G.B. Henry, 1994. "The Use of Financial Spreads as Indicator Variables: Evidence for the United Kingdom and Germany," IMF Staff Papers, no. 41, 517-525.

Deaves, Richard, and Mahmut Parlar, 2000. "A Generalized Bootstrap Method to Determine the Yield Curve," *Applied Mathematical Finance*, 7(4), 257-270.

Del Negro, Marco, 2001. "Turn, Turn, Turn: Predicting Turning Points in Economic Activity," Federal Reserve Bank of Atlanta, *Economic Review*, Second Quarter, 1-12.

Dimelis, Sophia, 2001. "Inventory Investment over the Business Cycle in the EU and the US," *International Journal of Production Economics*, 71(1-3), 1-8.

Dolan, Charles, 1999. "Forecasting the Yield Curve Shape: Evidence in Global Markets," *The Journal of Fixed Income*, 9(1), 92-99.

Dotsey, Michael, 1998. "The Predictive Content of the Interest Rate Term Spread for Future Economic Growth," Federal Reserve Bank of Richmond, *Economic Quarterly*, 84(3), 31–51.

Drakos, Konstantinos, 2002. "A Daily View of the Term Structure Dynamics: Some International Evidence," *De Economist*, 150(1), 41-52.

Dueker, Michael, 1997. "Strengthening the Case for the Yield Curve as a Predictor of U.S. Recessions," Federal Reserve Bank of St. Louis, *Review*, 79(2), 41-51.

Ederington, Louis, and Jeremy Goh, 1997. "A Variance Decomposition Analysis of the Information in the Term Structure," *Journal of Financial Research*, 20(1), 71-91.

Erenburg, S.J., and David Goebel, 2001. "The Effects of the International-Domestic Interest Rate Gap on US Output," *Applied Economics*, 33(4), 515-521.

Estrella, Arturo, 2003. "Why Does the Yield Curve Predict Output and Inflation?," Federal Reserve Bank of New York, Working Paper, January.

_____, 1998. "Monetary Policy and the Predictive Power of the Term Structure of Interest Rates," Federal Reserve Bank of New York, Working Paper, November.

_____, and Gikas Hardouvelis, 1991. "The Term Structure as a Predictor of Real Economic Activity," *Journal of Finance,* 46(2), 555-576.

_____, and Frederic Mishkin, 1998. "Predicting U.S. Recessions: Financial Variables as Leading Indicators," *The Review of Economics and Statistics*, 80(1), 45-61.

_____, and Frederic Mishkin, 1997. "The Term Structure of Interest Rates and its Role in Monetary Policy for the European Central Bank," *European Economic Review*, 41(7), 1375-1401.

_____, and Frederic Mishkin, 1996. "The Yield Curve as a Predictor of U.S. Recessions," Federal Reserve Bank of New York, *Current Issues in Economics and Finance*, 2(7), 1-6.

_____, and Anthony Rodrigues, and Sebastian Schich, 2002. "How Stable is the Predictive Power of the Yield Curve? Evidence from Germany and the United States," *The Review of Economics and Statistics*, 85(3), 629-644.

Evans, Charles, and David Marshall, 2001. "Economic Determinants of the Nominal Treasury Yield Curve," Federal Reserve Bank of Chicago, Working Paper no. WP-2001-16.

_____, 1998. "Monetary Policy and the Term Structure of Nominal Interest Rates: Evidence and Theory," *Carnegie-Rochester Conference Series on Public Policy*, 49(1), 53-111.

Evans, Martin, 1987. "A Macroeconomic Model of the Term Structure of Interest Rates," New York University Salomon Brothers Center, Working Paper no. 445, 29.

Fama, Eugene, 1990. "Term-Structure Forecasts of Interest Rates, Inflation, and Real Returns," *Journal of Monetary Economics*, 25(1), 59-76.

Ferderer, J. Peter, and Ronald Shadbegian, 1993. "A Comparison of Alternative Term Premium Estimates," *Quarterly Review of Economics and Finance*, 33(2), 179-195.

Fetter, Frank 1977. *Capital, Interest and Rent: Essays in the Theory of Distribution*, Rothbard, Murray (Ed.), Kansas City, KS: Sheed, Andrews and McMeel, Inc.

Fisher, Irving, 1930. *The Theory of Interest: As Determined by Impatience to Spend Income and Opportunity to Invest It*, New York, NY: The Macmillian Company.

_____, 1896. "Appreciation and Interest," *Publications of the American Economic Association*, 11(4), 1-98.

Fisher, Mark, 2001. “Forces That Shape the Yield Curve,” Federal Reserve Bank of Atlanta, *Economic Review*, 86(1), 1-15.

Fleming, Michael and Eli Remolona, 1999. “The Term-Structure of Announcement Effects,” Federal Reserve Bank of New York, *Staff Report*, 76, 1-50.

Frankel, Jeffrey, 1995 [1994]. “The Power of the Yield Curve to Predict Interest Rates (or Lack Thereof),” *Financial Markets and Monetary Policy*, Frankel, Jeffrey A. (Ed.), Cambridge and London: MIT Press, 131-143.

_____, and Cara Lown, 1994. “An Indicator of Future Inflation Extracted From the Steepness of the Interest Rate Yield Curve Along Its Entire Length,” *Quarterly Journal of Economics*, 109(2), 517-530.

Friedman, Benjamin, and Kenneth Kuttner, 1998. “Indicator Properties of the Paper-Bill Spread: Lessons From Recent Experience,” *Review of Economics and Statistics* 80(1), 34–44.

_____, 1993. “Why Does the Paper-Bill Spread Predict Real Economic Activity?” in: Stock, James H., and Mark W. Watson (Eds.), *Business Cycles, Indicators, and Forecasting*, University of Chicago Press, NBER, Chicago, 213–249.

Friedman, Milton, 1968. *Dollars and Deficits*, Englewood Cliffs, NJ: Prentice Hall.

Fuhrer, Jeffrey, and George Moore, 1995. “Monetary Policy Trade-Offs and the Correlation Between Nominal Interest Rates and Real Output,” *American Economic Review*, 85(1), 219-239.

Funke, N., 1997. “Predicting Recessions: Some Evidence for Germany,” *Weltwirtschaftliches Archiv* 133(1), 90–102.

Galbraith, John, and Greg Tkacz, 2000. “Testing for Asymmetry in the Link Between the Yield Spread and Output in the G-7 Countries,” *Journal of International Money and Finance*, 19(5), 657–672.

Gamber, Edward, 1996. “The Policy Content of the Yield Curve Slope,” *Review of Financial Economics*, 5(2), 163-179.

Gardener, Mona and Dixie Mills, 1994. *Managing Financial Institutions: An Asset/Liability Approach*, Third edition, New York, NY: The Dryden Press.

Garrison, Roger, 2001. *Time and Money: The Macroeconomics of Capital Structure*, New York, NY: Routledge.

_____, 1988. “Professor Rothbard and the Theory of Interest,” in Block, Walter, and Llewellyn Rockwell, Jr. (Eds.), *Man, Economy, and Liberty: Essays in Honor of Murray N. Rothbard*, Auburn, AL: Ludwig von Mises Institute, 44-55.

_____, 1979. “Waiting in Vienna,” in *Time, Uncertainty, and Disequilibrium: Exploration of Austrian Themes*, Rizzo, Mario (Ed.), Lexington, MA: Lexington Books, 215-226.

Gerlach, Stefan, 1997. “The Information Content of the Term Structure: Evidence for Germany,” *Empirical Economics*, 22, 161–79.

Hakim, Sam, and Manochehr Rashidian, 2000. “Testing for Segmentation in the Term Structure: Operation Twist Revisited,” *Quarterly Journal of Business Economics*, 39(1), 3-21.

Hamilton, James, and Dong Heon Kim, 2002. “A Reexamination of the Predictability of Economic Activity Using the Yield Spread,” *Journal of Money, Credit, and Banking*, 34(2), 340-360.

Hardouvelis, Gikas, 1988. “The Predictive Power of the Term Structure During Recent Monetary Regimes,” *Journal of Finance*, 43(2), 339–356.

_____, 1994. “The Term Structure Spread and Future Changes in Long and Short Rates in the G-7 Countries: Is there a puzzle?,” *Journal of Monetary Economics*, 33(2), 255–283.

Harrod, R. F., 1948. *Towards a Dynamic Economics*, London: Macmillian & Company.

Harvey, Campbell, 1997. “The Relation Between the Term Structure of Interest Rates and Canadian Economic Growth,” *Canadian Journal of Economics*, 30(1), 169-93.

_____, 1993. “The Term Structure Forecasts Economic Growth,” *Financial Analysts Journal*, 49(3), 6-8.

_____, 1991a. “Interest Rate Based Forecasts of German Economic Growth,” *Weltwirtschaftliches Archiv*, 127(4), 701–718.

_____, 1991b. “The Term Structure and World Economic Growth,” *Journal of Fixed Income*, 1(June), 7-19.

_____, 1989. “Forecasts of Economic Growth from the Bond and Stock Markets,” *Financial Analysts Journal*, 45(5), 38-45.

_____, 1988. “The Real Term Structure and Consumption Growth,” *Journal of Financial Economics*, 22(2), 305-333.

_____, 1986. “Recovering Expectations of Consumption Growth from an Equilibrium Model of the Term Structure of Interest Rates,” Ph.D. Dissertation, University of Chicago.

Haubrich, Joesph, and Ann Dombrosky, 1996. “Predicting Real Growth Using the Yield Curve,” Federal Reserve Bank of Cleveland, *Economic Review*, 32(1), 26–34.

Hayek, Friedrich von, 1969. “Three Elucidations of the Ricardo Effect,” *Journal of Political Economy*, 77(2), 274-285.

_____, 1967 [1935]. *Prices and Production*, New York, NY: Augustus M. Kelley.

_____, 1945. “The Use of Knowledge in Society,” *American Economic Review*, 35(4), 519-530.

_____, 1941. *The Pure Theory of Capital*, London: Routledge & Kegan Paul Ltd.

Hejazi, Walid, 2000. “Yield Spreads as Predictors of Industrial Production: Expectations on Short Rates or Term Premia?,” *Applied Economics*, 32(8), 945-955.

Hennings, Klaus, 1997. *The Austrian Theory of Value and Capital: Studies in the Life and Work of Eugen von Böhm-Bawerk*, Brookfield, VT: Edward Elgar Publishing Company.

Herbener, Jeffrey, 1992. “The Fallacy of the Phillips Curve,” in: Skousen, Mark (Ed.), *Dissent on Keynes: A Critical Appraisal of Keynesian Economics*, New York, NY: Prager, pp. 51-71.

Hicks, John, 1988. “Toward a More General Theory,” in: Kohn, Meir, and Sho-Chieh Tsiang, (Eds.), *Finance Constraints, Expectations, and Macroeconomics*, New York, NY: Clarendon Press – Oxford, pp. 6-14.

_____, 1982 [1980]. “IS-LM – an Explanation,” in *Money, Interest and Wages: Collected Essays on Economic Theory*, vol. II, Cambridge, MA: Harvard University Press, pp. 318-331.

_____, 1965 [1946]. *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*, Second edition, Oxford: The Clarendon Press.

Ho, Lan-Chih, John Cadle, and Michael Theobald, 2001. "Estimation and Hedging with a One-Factor Heath-Jarrow-Morton Model," *Journal of Derivatives*, 8(4), 49-61.

Horwitz, Steven, 2000. *Microfoundations and Macroeconomics: An Austrian Perspective*, New York, NY: Routledge.

Hu, Zuliu, 1993. "The Yield Curve and Real Activity," IMF Staff Papers, 40(4), 781-806.

Hubbard, R. Glenn, 1997. *Money, The Financial System, and The Economy*, Reading, Mass. : Addison-Wesley Pub. Co.

Hughes, Arthur, 1997. The Recession of 1990: An Austrian Explanation, *Review of Austrian Economics*, 10(1), 107-123.

IMF Staff, 1994. "Information Content of the Yield Curve," *World Economic Outlook*, May, 89-92.

Ioannides, Michalis, 2003. "A Comparison of Yield Curve Estimation Techniques Using UK Data," *Journal of Banking & Finance*, 27(1), 1-26.

Ireland, Peter, 1996. "Long-Term Interest Rates and Inflation: A Fisherian Approach," Federal Reserve Bank of Richmond, *Economic Quarterly*, 82(1), 21-35.

Ivanova, Detelina, Kajal Lahiri, and Franz Seitz, 2000. "Interest Rate Spreads as Predictors of German Inflation and Business Cycles," *International Journal of Forecasting*, 16(1), 39-58.

Jeffery, Andrew, Oliver Linton, Thong Nguyen, and Peter Phillips, 2001. "Nonparametric Estimation of a Multifactor Heath-Jarrow-Morton Model: An Integrated Approach," Yale Cowles Foundation Discussion Paper no. 1311, July, 1-47.

Jorion, Philippe, and Frederic Mishkin, 1991. "A Multicountry Comparison of Term-Structure Forecasts at Long Horizons," *Journal of Financial Economics*, 29(1), 59–80.

Kahn, R. F., 1954. "Some Notes on Liquidity Preference," *The Manchester School of Economic and Social Studies*, 22(3), 229-257.

Kashyap, Anil, Jeremy Stein and David Wilcox, 1993. "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance," *American Economic Review*, 83(1), 79-98.

Keen, Howard, 1989. "The Yield Curve as a Predictor of Business Cycle Turning Points," *Business Economics*, 24(4), 37-43.

Keeler, James, 2002. “Relative Prices and the Business Cycle,” paper presented at the Southern Economic Association Annual Meetings in Tampa, the Society for the Development of Austrian Economics, Session 42C: Research in Empirical Austrian Economics.

_____, 2001. “Empirical Evidence on the Austrian Business Cycle Theory,” *Review of Austrian Economics*, 14(4), 331-351.

Kessel, Reuben A, 1965. “The Cyclical Behavior of the Term Structure of Interest Rates,” NBER, Occasional Paper no. 91.

Keynes, John M., 1936. *The General Theory of Employment, Interest and Money*, New York, NY: Harcourt, Brace & World, Inc.

Kim, Dong Heon, 2000. “Essays on the Term Structure of Interest Rates, Monetary Policy and Business Cycle,” Ph.D. Dissertation, University of California San Diego.

Kim, Kenneth, and Piman Limpaphayom, 1997. “The Effect of Economic Regimes on the Relation between Term Structure and Real Activity in Japan,” *Journal of Economics and Business*, 49(4), 379-392.

King, Robert, and André Kurmann, 2002. “Expectations and the Term Structure of Interest rates: Evidence and Implications,” Federal Reserve Bank of Richmond, *Economic Quarterly*, 88(4), 49-95.

Kirzner, Israel, 1996. *Essays on Capital and Interest: An Austrian Perspective*, Brookfield, VT: Edward Elgar.

Knight, Frank, 1964. *Risk, Uncertainty and Profit*, New York, NY: Augustus M. Kelley, Bookseller.

Koedbk, Kees, and Clemens Kool, 1995. “Future Inflation and the Information in International Term Structures,” *Empirical Economics*, 20, 217–242.

Kotlán, Viktor, 2002. “Monetary Policy and the Term Spread in a Macro Model of a Small Open Economy,” Czech National Bank, Working Paper Series 1, October.

Kozicki, Sharon, 1997. “Predicting Real Growth and Inflation with the Yield Spread,” Federal Reserve Bank of Kansas City, *Economic Review*, Fourth Quarter.

_____, 1998. “Predicting Inflation With the Term Structure Spread,” Federal Reserve Bank of Kansas City, Working Paper no. 98-02.

Labadie, Pamela, 1994. “The Term Structure of Interest Rates over the Business Cycle,” *Journal of Economic Dynamics & Control*, 18(3-4), 671-697.

Lahiri, K., and J.G. Wang, 1996. “Interest Rate Spreads as Predictors of Business Cycles,” in: Maddala, G.S., and C.R. Rao (Eds.), *Handbook of Statistics: Statistical Methods in Finance*, 14, 297–315.

Lamoureux, Christopher, and Douglas Witte, 2002. “Empirical Analysis of the Yield Curve: The Information in the Data Viewed through the Window of Cox, Ingersoll, and Ross,” *The Journal of Finance*, 57(3), 1479-1520.

Laurent, Robert, 1989. “Testing the Spread,” Federal Reserve Bank of Chicago, *Economic Perspectives*, 13(4), 22-34.

_____, 1988. “An Interest-based Indicator of Monetary Policy,” Federal Reserve Bank of Chicago, *Economic Perspectives*, 12(1), 3-14.

Leijonhufvud, Axel, 1981. “The Wicksell Connection: Variations on a Theme,” in *Information and Coordination*, Oxford: Oxford University Press.

Lewin, Peter, 1999. *Capital in Disequilibrium: The Role of Capital in a Changing World*, New York, NY: Routledge.

_____, 1997a. “Capital in Disequilibrium: A Reexamination of the Capital Theory of Ludwig M. Lachmann,” *History of Political Economy*, 29(3):1-19.

_____, 1997b. “Rothbard and Mises on Interest: An Exercise in Theoretical Purity,” *Journal of the History of Economic Thought*, 19(1), 141-159.

Linton, Oliver, Enno Mammen, Jans Perch Nielsen, and Tanggaard, Carsten, 2001. “Yield Curve Estimation by Kernal Smoothing Methods,” *Journal of Econometrics*, 105(1), 185-223.

Livingston, Miles, 1990. “Appendix: Local versus Unbiased Expectations Hypothesis,” in *Money and Capital Markets*, Englewood Cliffs, NJ: Prentice-Hall, 254-256.

Lowe, Philip. 1992. “The Term Structure of Interest Rates, Real Activity and Inflation.” Research Discussion Paper no. 9204, Reserve Bank of Australia, Sydney.

Lutz, Friedrich, 1968. *The Theory of Interest*, Chicago, Ill.: Aldine Publishing Company.

_____, 1940. “The Structure of Interest Rates,” *Quarterly Journal of Economics*, 55(1), pp. 36-63.

Machlup, Fritz, 1935. “The Rate of Interest as Cost Factor and Capitalization Factor,” *American Economic Review*, 25(3), 459-465.

_____, 1932. “The Liquidity of Short-Term Capital,” *Economica*, 12(35-38), 271-284.

Malkiel, Burton, 1966. *The Term Structure of Interest Rates: Expectations and Behavior Patterns*, Princeton, N.J.: Princeton University Press.

Mansi, Sattar, and Jeffrey Phillips, 2001. “Modeling the Term Structure from the On-the-Run Treasury Yield Curve,” *The Journal of Financial Research*, 24(4), 545-564.

Matthews, R.C.O., 1963. “Expenditure Plans and the Uncertainty Motive for Holding Money, The Journal of Political Economy, 71(3), 201-218.

McDermott, C. John, 1998. “Testing the Expectations Model of the Term Structure in Times of Financial Transition,” *Applied Financial Economics*, 8(6), 663-669.

McCallum, B. T., 1994. “Monetary Policy and the Term Structure of Interest Rates,” NBER, Working Paper no. 4938, Cambridge, MA.

McCulloch, J. Huston, 1990. “Appendix B: U.S. Term Structure Data, 1946-87,” in: Friedman, B.M., and F.H. Hahn (Eds.), *Handbook of Monetary Economics*, North-Holland, Amsterdam, pp. 672–687.

_____, 1981. “Misintermediation and Macroeconomic Fluctuations,” *Journal of Monetary Economics*, 8(1), 103-115.

McEnally, Richard, and James Jordan, 1995. “The Term Structure of Interest Rates,” in: Fabozzi, Frank, and Dessa Fabozzi (Eds.), *Handbook of Fixed Income Securities*, Burr Ridge, Ill.: Irwin Professional Publishing, 779-829.

Meiselman, David, 1962. *The Term Structure of Interest Rates*, Englewood Cliffs, N.J.: Prentice-Hall.

Miller, Roger LeRoy and David VanHoose, 2001. *Money, Banking, & Financial Markets*, 2001 edition, Australia: South-Western / Thomson Learning.

Mises, Ludwig von, 1990. “The Non-Neutrality of Money,” in Ebeling, Richard (Ed.), *Money, Method, and the Market Process*, Norwell, MA: Kluwer Academic Publishers, 69-77.

_____, 1985 [1957]. *Theory and History: An Interpretation of Social and Economic Evolution*, Auburn, AL: Ludwig von Mises Institute.

_____, 1980. “Profit and Loss,” in *Planning for Freedom*, Fourth Edition, South Holland, IL: Libertarian Press, 108-150.

_____, 1966. *Human Action: A Treatise on Economics*, Third Revised Edition, Chicago, IL: Contemporary Books, Inc.

_____, 1943. “Elastic Expectations’ and the Austrian Theory of the Trade Cycle,” *Economica*, 10(39), 251-252.

Mishkin, Frederic, 2001. *The Economics of Money, Banking, and Financial Markets*, Sixth edition, New York, NY: Addison Wesley Longman.

_____, 1995a. *The Economics of Money, Banking, and Financial Markets*, Fourth edition, New York, NY: HarperCollins College Publishers.

_____, 1995b. “Symposium on the Monetary Transimission Mechanism,” *Journal of Economic Perspectives*, 9(4), 3-10.

_____, 1991. “A Multi-country Study of the Information in the Shorter Maturity Term Structure About Future Inflation,” *Journal of International Money and Finance*, 10(1), 2-22.

_____, 1990a. “The Information in the Longer-Maturity Term Structure About Future Inflation.” *Quarterly Journal of Economics*, 105(3), 815-828.

_____, 1990b. “What Does the Term Structure Tell Us About Future Inflation?,” *Journal of Monetary Economics*, 25(1), 77-95.

_____, 1990c. “Yield Curve,” NBER, Working Paper no. 3550, 9.

Moersch, Mathis, 1996. “Interest Rates or Spreads as Predictors of Real Economic Activity?,” *Konjunkturpolitik*, 42, 40–52.

Modigliani, Franco, and R. Sutch, 1966. “Innovations in Interest Rate Policy,” *American Economic Review*, 56(1/2), 178–197.

Mulligan, Robert, 2002. A Hayekian Analysis of the Term Structure of Production, *Quarterly Journal of Austrian Economics*, 5(2), 17-33.

Murphy, Robert, 2003. “Unanticipated Intertemporal Change in Theories of Interest,” Ph.D. Dissertation, New York University.

Ogden, Joseph, 1987. "An Analysis of Yield Curve Notes," *Journal of Finance*, 42(1), 99-110.

Ohlin, Bertil, D. H. Robertson and R. G. Hawtrey, 1937. "Alternative Theories of the Rate of Interest: Three Rejoinders," *The Economic Journal*, 47(187), 423-443.

Owens, Raymond, and Stacey Schreft, 1995. "Indentifying Credit Crunches," *Contemporary Economic Policy*, 13(2), 63-76.

Peel, David, and Christos Ioannidis, 2003. "Empirical Evidence on the Relationship Between the Term Structure of Interest Rates and Future Real Output Changes When There Are Changes in Policy Regimes," *Economic Letters*, 78(2), 147-152.

_____, and Mark Taylor, 1998. "The Slope of the Yield Curve and Real Economic Activity: Tracing the Transmission Mechanism," *Economics Letters*, 59(3), 353-360.

Pellengahr, Ingo, 1996. *The Austrian Subjectivist Theory of Interest: An Investigation into the History of Thought*, New York, N.Y.: Peter Lang.

_____, 1986a. "Austrians Versus Austrians I: A Subjectivist View of Interest," in *Studies in Austrian Capital Theory, Investment and Time*, Faber, Malte, (Ed.), series - Lecture Notes in Economics and Mathematical Systems, #277, 60-77.

_____, 1986b. "Austrians Versus Austrians II: Functionalist Versus Essentialist Theories of Interest," in *Studies in Austrian Capital Theory, Investment and Time*, Faber, Malte, (Ed.), series – Lecture Notes in Economics and Mathematical Systems, #277, 78-95.

Peterson, Steven, 2001. "Rational Bias in Yield Curve Forecasts," *The Review of Economics and Statistics*, 83(3), 457-464.

Phillips, Keith, 1998-1999. "The Composite Index of Leading Economic Indicators: A Comparison of Approaches," *Journal of Economic and Social Measurement*, 25(3-4), 141-162.

Pippenger, John, 1982. "Monetary Policy, Homeostasis, and the Transmission Mechanism," *American Economic Review*, 72(3), 545-554.

Plosser, Charles, and K. Geert Rouwenhorst, 1994. "International Term Structures and Real Economic Growth," *Journal of Monetary Economics*, 33(1), 133-155.

Ragnitz, Von Joachim, 1994. "Zinsstruktur und Wirtschaftswachstum," *Kredit und Kapital*, 27, 11–29.

Ramey, Valerie, 1993. "How Important is the Credit Channel in the Transmission of Monetary Policy?" *Carnegie-Rochester Conference Series on Public Policy*, 39, 1-45.

Reinhart, Carmen, and Vincent Reinhart, 1996. "Forecasting Turning Points in Canada," mimeo, International Monetary Fund (March).

Resnick, Bruce, and Gary Shoesmith, 2002. "Using the Yield Curve to Time the Stock Market," *Financial Analysis Journal*, 58(3), 82-90.

Robertson, Dennis, 1959. *Lectures On Economic Principles*, Volume 3, London: Staples Press.

Robertson, Dennis, 1951. "Some Notes on the Theory of Interest," in *Money, Trade, and Economic Growth: In Honor of John Henry Williams*, New York, NY: The Macmillan Company, 193-209.

Robinson, Joan, 1951. "The Rate of Interest," *Econometrica*, 19(2), 92-111.

Roma, Antonio, and Walter Torous, 1997. "The Cyclical Behavior of Interest Rates," *Journal of Finance*, 52(4), 1519–1542.

Romer, Christina and David Romer, 1993. "Credit Channels or Credit Actions?" NBER, Working Paper no. 4485.

_____, 1990. "New Evidence on the Monetary Transmission Mechanism," *Brookings Papers on Economic Activity*, 1, 149-213.

Rosa, Robert, 1951. "Interest Rates and the Central Bank," in *Money, Trade, and Economic Growth: In Honor of John Henry Williams*, New York, NY: The Macmillan Company, 270-295.

Rothbard, Murray, 1993. *Man, Economy, and State: A Treatise on Economic Principles*, Revised Edition, Auburn, AL: Ludwig von Mises Institute.

_____, 1977. "Introduction," in *Capital, Interest and Rent: Essays in the Theory of Distribution* by Frank A. Fetter, Rothbard, Murray (Ed.), Kansas City, KS: Sheed, Andrews and McMeel, Inc, 1-23.

Rudebusch, Glenn, 1995. "Federal Reserve Interest Targeting, Rational Expectations, and the Term Structure," *Journal of Monetary Economics*, 35(2), 245-274.

Salyer, Kevin, 1994. "The Term Structure of Interest Rates within a Production Economy: A Parametric Example," *Journal of Macroeconomics*, 16(4), 729-734.

Sauer, Christine, and Joachim Scheide, 1995, "Money, Interest Rate Spreads, and Economic Activity," *Weltwirtschaftliches Archiv* 131(4), 708–722.

Say, Jean-Baptiste, 1971 [1803/1821]. *A Treatise on Political Economy or the Production, Distribution and Consumption of Wealth*, C. R. Prinsep (Tr.), reprint of the New American Edition [6th edition], New York, NY: Augustus M. Kelley Publishers.

Schich, Sebastian, 2002. "Assessing the Stability of the Relationship Between Yield Curves and Inflation," *Applied Economics Letters*, 9(8), 485-491.

_____, 1999. "The Information Content of the German Term Structure Regarding Inflation," *Applied Financial Economics*, 9(4), 385-395.

Schmitz, Stefan, 2004. "Uncertainty in the Austrian Theory of Capital," *Review of Austrian Economics*, 17(1), 67-85.

Seo, Byeongseon, 2003. "Nonlinear Mean Reversion in the Term Structure of Interest Rates," *Journal of Economic Dynamics and Control*, 27(11-12), 2243-2265.

Shaaf, Mohamad, 2000. "Predicting Recession Using the Yield Curve: An Artificial Intelligence and Econometric Comparison," *Eastern Economic Journal*, 26(2), 171-190.

Shiller, Robert, 1990. "The Term Structure of Interest Rates," in: Friedman, B.M., and F.H. Hahn (Eds.), *Handbook of Monetary Economics*, North-Holland, Amsterdam, pp. 627–715.

Skousen, Mark, 1990. *The Structure of Production*, New York, NY: New York University Press.

Smets, Frank, and Kostas Tsatsaronis, 1997. "Why Does the Yield Curve Predict Economic Activity? Dissecting the Evidence for Germany and the United States," Bank for International Settlements, Basle, Working Paper no. 49.

Smith, Stephen, and Raymond Spudeck, 1993. *Interest Rates: Principles and Applications*, New York, NY: The Dryden Press.

Stock, James, and Mark Watson, 2000 (revised 2003). "Forecasting Output and Inflation: The Role of Asset Prices," Mimeo, Kennedy School of Government, Harvard University.

_____, 1996. "Evidence of Structural Instability in Macroeconomic Time Series Relations," *Journal of Business and Economic Statistics*, 14(1), 11–30.

_____, 1989. "New Indexes of Coincident and Leading Indicators," in: Blanchard, Olivier, and Stanley Fischer (Eds.), *NBER Macroeconomic Annual*, 4, Cambridge, Mass.: MIT Press, 351-394.

Stokman, A.C.J., 1991. "Rentestructuur in Theorie en Empirie," *Maandschrift Economie*, 55, pp. 114–129.

Stojanovic, Dusan, and Mark Vaughan, 1997. "Yielding Clues About Recessions: The Yield Curve as a Forecasting Tool," Federal Reserve Bank of St. Louis, *The Regional Economist*, October, 10-11.

Taylor, John, 1995. "The Monetary Transmission Mechanism: An Empirical Framework," *The Journal of Economic Perspectives*, 9(4), 11-26.

Tkacz, Greg, 2001. "Neural Network Forecasting of Canadian GDP Growth," *International Journal of Forecasting*, 17(1), 57–69.

Tribó, Josep, 2001. "Inventories, Financial Structure and Market Structure," *International Journal of Production Economics*, 71(1-3), 79-89.

Turnovsky, Stephen, 1989. "The Term Structure of Interest Raters and the Effects of Macroeconomic Policy," *Journal of Money, Credit, and Banking*, 21(3), 321–347.

Tzavalis, Elias, and M.R. Wickens, 1996. "Forecasting Inflation from the Term Structure," *Journal of Empirical Finance*, 3(1), 103–122.

Venetis, Ioannis, Ivan Paya, and David Peel, 2003. "Re-examination of the Predictability of Economic Activity Using the Yield Spread: A Nonlinear Approach," *International Review of Economics and Finance*, 12(Annual Issue), 187-206.

Watkins, Clinton, 1997. "The Term Structure of Interest Rates and Economic Activity: An Empirical Critique," *Mathematics and Computers in Simulation*, 43(3-6), 487-493.

Wicksell, Knut, 1961 [1934 English / 1901]. *Lectures on Political Economy, Volume I: General Theory*, 2nd edition, E. Classen (Tr.), London: Routledge & Kegan Paul Ltd.

_____, 1958 [1911]. "Böhm-Bawerk's Theory of Capital," in Lindahl, Erik (Ed.), *Selected Papers on Economic Theory*, Cambridge, Mass.: Harvard University Press, 176-185.

Wieser, Friedrich von, 1989 [1893]. *Natural Value*, William Smart (Tr.), Fairfield, N.J.: Augustus M. Kelley, Publishers.

Yeager, Leland, 1997. "Injection Effects and Monetary Intermediation," in *The Fluttering Veil: Essays on Monetary Disequilibrium*, Selgin, George (Ed.), Indianapolis, IN: Liberty Fund, 253-279.

_____, 1993. "Capital and Interest," unpublished manuscript.

_____, 1991 [1957]. "Measurement as Scientific Method in Economics," reprinted in *Champions of Freedom: Austrian Economics: A Reader*, Ebeling, Richard (Ed.), Volume 18, Hillsdale, MI: Hillsdale College Press, 150-163.

_____, 1979. "Capital Paradoxes and the Concept of Waiting," in *Time, Uncertainty, and Disequilibrium: Exploration of Austrian Themes*, Rizzo, Mario (Ed.), Lexington, MA: Lexington Books, 187-214.

APPENDIX I: TABLE OF LITERATURE REVIEW

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
Ahrens 2002	E	Canada France Germany Italy Japan Nether-lands UK US	M1:1970 – M12:1996 10 year – 3 month	Probit With Markov-switching	N	Y	A Probit model with Markov-switching does not improve forecasting ability. Overview of connection through the use of the expectations hypothesis.
Ahrens 1999	E	US	M1:1959 – M5:1995 30 year – 3 month	Time Series With Markov-switching	N	Y	Uses Total Index of Industrial Production. Spread is confirmed as better predictor (most reliable & longest lead). Compared with Commerce Dept. Leading Indicators, real M2 growth, paper-bill spread & percentage change in S&P 500.
Andreou, Osborn, Sensier 2000	E	Germany UK US	M1:1955 – M12:1998 US & UK: used 10yr Germany: 7-15 year All: 3-mo.	Time series with Structural Breaks	N	Y	Overall, yield curve's spread outperformed interest rates, stock market indices, dividend yields, and monetary aggregates. Dividend yields were best in UK. Non-linearities were detected in all countries.
Ang, Piazzesi, Wei 2003	E	US	Q2:1952 – Q4:2001 1yr, 2yr, 3yr, 4yr,	Gaussian VAR with 1 lag	Y	Y	Compared multiple spreads. Slope of the yield curve indicates future growth rate. The larger the slope, the greater the growth. Maximal spread is best for

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			& 5yr zero-coupon bonds				forecasting. Nominal short-term rates dominate the spread. Lagged GDP is important for short forecasting. With no-arbitrage assumption, they predict better than OLS.
Atta-Mensah, Tkacz 2001	E	Canada US	Q1:1957 – Q4:1966 Canada: 10year – 90 day US:10yr – Fed Funds	Probit	Y	Y	Spread is best predictor 5Q ahead. Beyond 5Q, Oil & Gas Sub-index (deflated by CPI) is best predictor. Long rates may act as a proxy for equilibrium or policy-neutral short-term rate.
Bange 1996	B	Germany Japan US	Q1:1964 – Q4:1988 US:10yr – 3 month Germany: 4 year – 3 month Japan: long-term & 3 month	Time Series	Y	N	Based on Goodness of fit tests, best predictors are: nominal slope of yield curve (Germany), past stock returns (Japan), and stock returns and expected change in inflation (US). With floating exchange rates, stock returns lose their power. US & Japan's nominal spread and change in expected inflation contain information about future economic growth.
Barran, Coudert, Mojon 1995	B	France Germany Japan UK US	Q1:1975 – Q4:1993 (France starts in 1979) day-to-day	Granger Causality	Y	Y See Comment	Spread is a good predictor, except in Japan. Monetary aggregates perform poorly, except in France & Japan. Interest rates are not significant. Intermediation margin spreads show future employment, private consumption and consumer

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			6 month & 10 year				durables, but NOT GNP or investment. Quality banking spread is negative in US & UK on real output, suggesting this spread is the risk premium on the borrower's default rate.
Berk 1998	T	N/A	N/A	N/A	N/A	Y	Literature survey paper. Expectations Hypothesis assumes term premium is constant. IS curve is based on the assumption of fixed prices, so any shock will have real effects. New Keynesian approach uses sluggish price movements and rational behavior, so spread will have information. New Classical model denies spread can have any predictive content. Simple New Classical view is empirically refuted. Theory is still in dispute. Empirical results vary with country and segment of yield curve. Results are sensitive to type of model used. The consensus is the slope contains considerable information. However, the model does not have stability or controllability, so it is not a useful tool for monetary authorities.
Berk, Van Berggeijk 2000	B	Austria Belgium Denmark France	Q1:1970 – Q4:1998	Time Series	Y	Y	Reports positive relationship between yield curve & output. However, the effect is weak in the Eurosystem (Eurosystem = ECB and national banks that adopted the

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
		Germany Ireland Italy Japan Nether-lands Switzer-land UK US					euro.) Argues the relationship is based on the Risk-adjusted Fisher Equation, IS Curve and the Expectations hypothesis. They are not looking for the "best model," only if it provides information "over-and-above" past patterns of inflation and output. Underlying causes for steepening may reflect: 1) an upward revision of expected inflation; 2) an expectation of increased productivity in capital; and 3) expectations of future monetary tightening by a credible policy maker.
Bernanke 1990	E	US	M1:1961 – M12:1989 10 year – 1 year & Fed Funds	Time Series	Y	Y	Compares paper spread (long and short) with term spread (10y-1y & 10y -FF) for prediction of real output. The short paper spread has the best predictive power.
Bernanke Blinder 1992	B	US	M7:1959 – M12:1989 10 year – 3 month – Fed Funds	Granger & VAR	N	Y	Reports spread is a better forecaster than monetary aggregates since the mid-1980s. Fed Funds (FF) is better predictor than M1, 3-month T-Bills, 10-year Bonds, and quality spread. They argue FF drives the spread. Tight monetary policy has little effect on loans. Over time banks terminate old loans and refuse new loans. A shock causes banks to sell of securities first. As banks rebuild securities, loans will start to fall off. After 2 years, securities will be

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
							back and loans reflect entire decline.
Bernard, Gerlach 1998	E	Belgium Canada France Germany Japan Nether-lands UK US	Q1:1972 – Q4:1993 10 year – except: Bel. 6 yr. Net. 5-8 yr. & 3 month	Probit	Y	Y See Comment	Spread predicts recessions in all countries, as much as 2 years ahead. Definition of recession needs to be consistent. Algorithm had trouble dating recessions in France, Belgium, and the Netherlands. Strongest results were in US, Germany, and Canada. They attribute differences to financial market regulations. Adding leading indicators increased results for 1-3Q out, but not longer than that. Added US and German spread to other countries' recessions. Pseudo R^2 suggests added information is limited, except when Germany's spread has added to Japan. They determined that Japanese and German recessions tend to coincide.
Bonser-Neal, Morley 1997	E	Australia Canada France Germany Italy Japan Nether-lands Sweden Switzer-land	Q1:1971 – Q4:1996 Neth. starts Q1:1977 Swe. set: Q1:1972 – Q3:1995 10 year – 3 month	OLS	Y	Y See Comment	Used Index of Industrial Production. In sample results show: 1) the spread is a significant predictor in every country except Jap.; 2) 2 year horizon is a significant in Canada, France, Germany, Netherlands, Switzerland, UK and US; 3) 3 year horizon is a significant in Canada, France, Germany, Netherlands, and US. OLS shows a larger spread is correlated with larger growth. Therefore, leading indicators should include the spread.

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
		UK US					
Brown, Goodman 1991	E	US	M1:1968 – M2:1991 1 year – 3 month	Logit	Y	Y	Sets up 3-, 4-, 6-, 9-, and 12-month model and estimates coefficients so that one could plug in spread and get a percent likelihood for a recession. (They assume the coefficients are stable.) Model does not predict 1991 recession.
Campbell, Cochrane 1999	T	N/A	NYSE Index 1947 – 1995 S&P 500 Returns 1871 – 1993 Per capita consumption 1889 – 1992 Simulated data: 1890s – early 1990s	N/A	N/A	Y	Uses CCAPM model to look at stock price movements. CCAPM model with habit formation provides equilibrium framework where large (negative) spreads precede (negative) economic growth. Utility is based on level of consumption relative to habit index. Habit index moves slowly to constant steady state. Model uses real yield curve. "Individuals fear stocks primarily because they do badly in recessions, not because stock returns are correlated with declines in wealth or consumption."
Canova, De Nicoló 2000	E	Germany Japan UK US	M1:1973 – M12: 1995 5+ year – 3 month for all except US: 10 year – 3 month	VAR	Y & N See Comment	Y	They used a linear model, but limited the sample to post –1973 data due to structural breaks. Spread is only good for Japan & US. It may be because they are using Industrial Production measures, not GDP. They are only looking for effects of innovations not static correlations on the

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
							level of variables. They provide evidence contrary to the simple Expectations Hypothesis.
Caporale, Pittis 1998	E	Canada France Germany Italy Japan UK US	Q4:1966 – Q1:1996 Q1:1973 – Q4:1997 Q1:1977 – Q3:1997 Q3:1974 – Q4:1997 Q1:1981 – Q4:1997 Q1:1982 – Q4:1996 Q2:1976 – Q4:1997 10 year – 3 month	System and single-equation time series analysis	Y	Y	Asks: What affects the yield curve? Is it government debt or does Ricardian Equivalence hold? Fisher effect does not seem to hold, but results are consistent with IS-LM and Ricardian Equivalence. Long rates are affected by public debt in each country, except Japan. All of the following affect long rates: short rates, growth of GDP, Government debt ratio, expected inflation and Debt-to-GDP ratio. They conclude fiscal policy impacts the slope of the yield curve.
Cecchetti Ehrmann 1999	E	23 Industrial Countries	All vary, but roughly 1980 – 1997	Quadratic Loss Function & Structural VAR	Y	Y	Used QLF modeling policy makers' decision to minimize discounted sum of squared deviations of output and prices from targets. Then used VAR to identify monetary shocks. In 1990s, central banks shifted to direct targeting of inflation. Targeting countries significantly decreased inflation variability and slightly increased output variability. All countries

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
							increased their aversion to inflation. Recommends an improvement in forecast models by allowing for structural breaks in policy regimes.
Cecchetti 1987	E	US	Great Depression	N/A	N/A	N/A	Empirical research of the Great Depression. Institutional factors (taxes, etc.) caused negative nominal returns on government securities. He demonstrates why 1940s data should not be used. Attempts to recalculate yield curve from 1933 to 1941.
Chapman 1997	E	US	Q1:1953 – Q1:1991 2 year – 3 month	Time Series	Y	Y	Uses real yield curve. Extends CCAPM model by decreasing noise—uses expected consumption growth not ex post consumption growth. Spread is: 1) weakly correlated over full sample; 2) strongly correlated between 1979 – 1985; 3) pre-1979 cyclical properties are qualitatively similar and consistent with simple RBC model; 4) real yield curve at NBER peaks appear to lie everywhere above the real yield curve at NBER troughs.
Chauvet, Potter 2002	E	US	M1:1967 – M12:2000 10 year – 3 month	Probit	N	Y	Uses probit model to examine the stability of recession forecasts. Structural break greatly affects results. Predictive power is not stable over long periods of time. They argue that break points are necessary. They cannot find the break points and

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
							argue that each "business cycle is different." They believe break points exist in: 1) early 1970s, 2) mid-1980s, and 3) early 1990s.
Chen 1991	E	US	Q1:1954 – Q4:1986 10 year – 1 month	Time Series	Y	Y	Confirmed default spread, term spread, 1-month short rate, lagged industrial production and dividend-price ratio are determinants of future stock returns, because they show recent and future growth in GNP and consumption. Alludes to RBC (& CCAPM) to explain connection between spread and real output.
Clinton 1994	E	Canada	Q1:1961 – Q1:1994 10 year – 3 month	OLS	Y	Y	Suggests traditional view (AS/AD) is not empirically supported. Uses RBC model to support relationship. Canada's and US's spread tend to move together, but Canada's is better predictor for Canada's real output. Spread is less accurate with any particular component of GDP (vs. all GDP). Spread is most accurate with consumption (in particular durables). Some information is found in investment in capital equipment and housing. No information is found in non-residential construction.
Cozier, Tkacz	E	Canada	Q1:1961 – Q4:1991	Time Series	Y	Y	Spread appears endogenous with business cycle. Spread has strong positive relation

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
1994			10 year – 3 month – 30 day				with changes in future real income. (Strongest at 1+ years and weakest < 1 year.) Most strongly correlated to consumer durables at 1-year horizon and investment expenditure at 4+ year horizon. Spread helps predict inflation beyond 2 years. Simple model is NOT stable during 1970s, but can be corrected with detrended output growth as the dependent variable.
Davis, Fagan 1997	E	Belgium Denmark France Germany Ireland Italy Nether-lands Spain UK	1970s – Q4:1992 OECD typical "long-term interest rates" and typical "short-term interest rates"	Granger and Bivariate VAR	Y	N	Tested yield curve spread, reverse yield gap/stock prices, credit quality spread and foreign bond yield differential. Financial spreads should not be used comprehensively and indiscriminately as indicators of output and inflation in EU countries. They found poor out-of-sample performance. Estimated equations appear unstable.
Davis, Henry 1994	E	Germany UK	Q2:1974 – Q2:1992 Q1:1968 – Q1:1991 20 year – 3 month	VAR	Y	Y	Model Successfully predicts Q1-2:1991 growth would be sluggish and then negative. German model outperforms restricted models for 1992 recession. Spread has information on real output, consumption and inflation.
Del Negro	E	US	M1:1970 – M12:1998	BVAR & Probit	Y	Y	Focuses on providing evidence on econometric models' ability to forecast

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
2001			N/A				changes turning points. Atlanta's BVAR model outperforms the Leading Indicators model. The Estrella/Mishkin (1998) Probit model outperforms the Atlanta Fed's BVAR model.
Dotsey 1998	E	US	Q1:1955 – Q4:1997 10 year – 3 month	Time Series	Y	Y See Comment	Shows predictive content of the spread (US) has diminished since 1985. Used linear model, but included a variable to represent recessions. The same regime was assumed. Results from 5 year – 3 month and 2 year – 3 month spreads are similar.
Dueker 1997	E	US	M1:1959 – M5:1995 30 year – 3 month	Probit	N	Y	Confirms Estrella and Mishkin (1998). Examines 1) change in leading indicators; 2) real M2 growth; 3) quality spread; 4) Percent change in S&P 500; and 5) yield curve spread. They add a lagged dependent variable and still the spread outperforms. The Markov-switching model had trouble predicting mild recessions. Conclusion: Yield curve spread is the single best predictor.
Erenburg Goebel 2001	E	US	Q1:1970 – Q4:1996 10 year – 1 year	VAR	Y	Y	Find both the international/domestic gap and the term structure have significant effects on real output. Assumes flexible exchange rate and open capital markets. International gap's influence has grown over the past 10 years and dominates the

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
							yield curve.
Estrella 2003	B	US	Annual 1962-2000 2 year – 1 year	VAR	Y	Y	Criticizes earlier works by saying they are not based in theory. Model includes rational expectations, IS-LM and the Phillips Curve. The spread is connected to real output through the monetary policy regime, not through structural relationships.
Estrella 1998	T	N/A	N/A	Model: 1) Phillips Curve 2) IS Curve 3) Monetary Reaction Function 4) Monetary Shock 5) Fisher Equation 6) Expectations Hypothesis	N/A	Y	Addresses the theoretical question of why of the yield spread should forecast real activity. The yield curve is NOT solely determined by monetary factors. The key coefficient that links yield curve with output is in the monetary reaction function. Therefore, the more adverse a regime is to inflation, the smaller the linkage between the spread with real output and inflation.
Estrella, Hardou-velis 1991	E	US	Q2:1955 – Q4:1988 10 year – 3 month	OLS & Probit	Y	Y	Criticizes the CCAPM model—it misses consumer durables and investment. Spread has useful information by predicting real output up to 4 years in the future. Spread is more than just a reflection of monetary policy.
Estrella, Mishkin 1998	E	US	Q1:1959 – Q1:1995 10 year –	Probit	Y	Y	Beyond 1Q, the spread is the best predictor. Quality spread has good in-sample results for 1Q & 2Q, but does not

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			3 month				have any out-sample predictive power at any horizon. Use of earlier data does not have appreciable effect on results.
Estrella, Mishkin 1997	E	France Germany Italy UK US	M6:1978 – M7:1973 – M10:198 – M4:1978 – M7:1973 – All end at M2:1995 10 year – 3 month	VAR	Y	Y	Argues credibility of monetary regime is critical to results. Inflation is the strongest with Germany and US, because they have independent monetary policy. Upholds relation between the spread and real output in each country except Italy. For Europe, the spread is a good indicator, but not a policy tool.
Estrella, Mishkin 1996	E	US	Q1:1960 – Q1:1995 10 year – 3 month	Probit	Y	Y	Establishes probit model to predict if an economy will go into a recession. Stock-Watson Index is better 1Q ahead. Spread outperforms Stock-Watson at 2Q+. At 6Q the spread's performance diminishes.
Estrella, Rodrigues Schich 2002	B	US Germany	M1:1955 – M12:1998 M1:1967 – M12:1998 A total 22 pairings of 1-8 year maturities were used.	GMM	N	Y	Conclusion: all models must be used with caution. It estimates break point dates for monetary policy regimes. Stability must be tested. They cannot rule out instability of Neo-classical theories and thus must default to empirics. The best predictor is 8 year with 1 year. It contains an extensive survey of theoretical and empirical works.
Evans, Marshall	B	US	M1:1959 – M12:1995	Shock and	Y	Y	They find some evidence that contractionary monetary policy increases

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
1998			10 year – 3 year – 1 year – 6 month – 1 month	response function are modeled.			term premia for shorter maturities, raising real interest rates. A monetary shock raises the level of the yield curve but reduces the slope and curvature. The effects on the slope and curvature dissipates in 4-6 months and the level returns within 6 months. Long-term rates fit the expectations hypothesis. Results are broadly consistent with empirical patterns.
Evans 1987	T	N/A	N/A	Overlapping Generations Model	Y	Y	Evans develops a simple equilibrium model that examines the effects of stabilization by monetary authorities when faced with monetary shocks. The risk premium is the nexus through which Evans connects the individual investor with the macroeconomy.
Fama 1990	B	US	M6:1953 – M12:1988 5 year – 4 year – 3 year – 2 year – vs. 1 year	Lagged Time Series	Y	Y	Long rates contain information on real rates, expected inflation and term premia, but there are problems isolating them. Predictive power diminishes with changing term premia. Spread has more predictive power on 1 year inflation than spot rates. Spread has power to predict 1 & 2 year changes in real returns on 1 year bonds. Lagged spot has forecast power at 1-3 years, then spread takes over at 3+ years.
Friedman	E	US	M1:1975 –	VAR	Y	N/A	Examines why the quality spread (also

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
Kuttner 1998			M9:1996 3 month paper and bills				called paper-bill spread) did not forecast the 1990-1 recession. Reasons the gap failed to widen: 1) 1990-1 recession wasn't caused by monetary tightening; and 2) changes in commercial paper was driven for non-business cycle reasons.
Friedman Kuttner 1993	B	US	M2:1960 – M12:1990 10 year – Fed Funds	Time Series	Y	Y	The focus of the authors is the paper-bill spread for prediction. They include the yield spread as a variable and it is also significant at the 1% level.
Fuhrer, Moore 1995	B	US	Q1:1965 – Q4:1992 3 month & Fed funds	VAR & Full-information Maximum likelihood estimation	Y	Y	They observe Fed Funds rate and real economic activity by looking at interest rate transmission along the yield curve. The 10 year rate explains real output. Their VAR suggests the 10 year rate looks like the 3 month rate. Thus short-term rates should have our focus.
Funke 1997	E	Germany	Q3:1971 – Q4:1995 8-15 year – 3 month	Probit	Y	Y	Applies Estrella/Mishkin model to Germany and confirms results. Compares 9 indicators. The spread is the best with a lead of 4Q. If international factors influence the spread, then its predictive power falls.
Galbraith Tkacz 2000	E	Canada France Germany	Q1:1956 – Q2:1997 Q1:1965 – Q4:1997 Q1:1960 –	OLS & Maximum likelihood for thresholds	N	Y See Comment	They report that the spread's relation to output may be nonlinear. The spread is a successful predictor in each country except Japan. They detect threshold effects between spreads and real output

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
		Italy Japan UK US	Q4:1994 Q1:1971 – Q4:1997 Q3:1966 – Q4:1997 Q1:1961 – Q4:1997 Q3:1954 – Q4:1997 S-T varies between day-to-day & 3 month L-T varies between 3 year & 10 year				growth in US and Canada. Do not find nonlinear relation in other G-7 countries. An explanation may be the dollar's role as the world currency coupled with the US's low dependency on international trade. The spread has less impact on growth with a steep yield curve, because the marginal impact is smaller.
Gamber 1996	E	US	M1:1955 – M7:1992 10 year – 3 month	Granger & VAR	Y	Y See Comment	The spread contains information only when the Fed does not react to changes in that variable. The spread's ability to predict output growth declines after October 1979. The spread contains independent information on inflation after September 1979, but not before. Granger tests say the Fed Funds rate is a robust predictor of inflation over 1955 – 1992. Yield curve appears to get its predictive power from Fed Funds rate.

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
Hamilton Kim 2002	T	US	Q2:1953 – Q2:1998 10 year – 3 month	Time Series on Decom-position & GARCH on Variance of Short Rates	Y	Y	Addresses the theoretical question of why the yield spread should forecast real activity. States few other articles ask "why?" It measures the extent to which short-term rates move relative to long rates. It confirms the predictive power of the spread. Both the signal of expected future short rates (expectations effect) and signal change in term premium (term premium effect) test significant, although the expectations effect is slightly more important. They assume contractionary policy will decrease growth in interest sensitive sectors.
Hardou-velis 1988	E	US	M1:1972 – M11:1985 6 months – 2 weeks	VAR	Y	N/A	He found reliable evidence that forward rates have predictive power of future spot rates. Until 1979 (with Fed targeting rates), forward rates could only predict one week later. Between Oct. '79-Oct. '82 (no Fed targeting), predictive power increased to 6 weeks and 14-21 weeks. After Oct. '82 (with partial targeting), predictive power was strong through 9 weeks. Confirms break in Oct. 1979.
Harvey 1997	B	Canada US	Q1:1958 – Q2:1995 10 year – 3 month –	Time Series	Y	Y	The part of the Canadian yield curve that is uncorrelated with the US yield curve is able to predict Canadian economic growth. The part of the Canadian growth

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			& 1-3 year (Canada) & 3 year (US)				that is uncorrelated with the US can be predicted with the Canadian yield curve. He uses the CCAPM & RBC models.
Harvey 1993	E	US	Q4:1969 – Q4: 1992 5 year – 3 month	Time Series	Y	Y	States the magnitude of the inversion predicts the severity of the recession. Uses the RBC model. Assumes the term structure of expected inflation is flat.
Harvey 1991a	E	Germany	Q1:1971 – Q4:1989 Averaged 3+ years – money-market rate	Time Series	Y	Y	Spread has lower forecast errors than DIW and 5 other (unnamed) Research institution's predictors. US and German spreads are correlated. The reason the spread was negative in Q4:1989, but no recession occurred, was due to reunification.
Harvey 1991b	E	Canada France Germany Italy Japan UK US	Q1: 1970-Q4:1989 w/ a sub-sample of Q1:1976 – Q4:1989 S-T varies between money call rate & 3 month L-T was at least 5 yrs	Time Series	Y	Y	Using the CCAPM, he shows information is contained in the yield curve on real output and consumption in each country. Japan's numbers improve after 1978. He creates a "World Spread" and finds this is a good predictor. He predicts (from the perspective of 1989) that the US will have slow economic growth in 1990.

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
Harvey 1989	B	US	Q2:1953 – Q2: 1989 10 year – 3 month	Time Series	Y	Y	Uses CCAPM model. Spread compares favorably to Leading Indicators and S&P 500. Predicts growth rate of 1.7% for Q3:1989 – Q3:1990.
Harvey 1988	B	US	Q1:1953 – Q1:1987 1 year – 9 month – 6 month – 3 month	Time Series & GMM	Y	Y	Uses CCAPM model. Looks at consumption growth, not output. Results from sub-period Q1:1972 – Q1:1987 are stronger than Q1:1959 – Q1:1987. Spread outperforms 7 "for fee" econometric models at 2Q & 3Q. It comes in 5th for 1Q forecasts. Conclusion: it may not be statistically better, but it's "free."
Harvey 1986	B	US	Q2:1953 – Q3:1985 1 year – 9-12 month 3 month & A:1900 – A:1984 1 yr. Corp. – 3 month	Time Series & GMM	Y	Y	Develops CCAPM model. Predictive power of spread is weaker in 1960s, and is strongest in '70s –'80s. Spread outperforms lagged consumption and real stock returns.
Haubrich, Dombrosky 1996	E	US	Q1:1961 – Q3:1995 10 year – 3 month	Time Series	Y	Y See Comment	The spread is a good predictor over a 4Q model. Predictive content of the spread (US) has diminished since 1985. Compared the spread with leading indicators, lagged GDP, Lagged GDP+spread, DRI/McGraw-Hill and Blue

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
							Chip Economic Indicators. Over the 30 year sample, the spread was the best predictor, but over 1985 – 1995 it was the worst.
Hejazi 2000	E	US	M6:1964 – M12:1995 10 year – 1 month	GARCH-M	Y	Y	Separates yield curve into term premium and expectations components. GARCH-M model of the term structure shows increases in term premia results in reductions in industrial production. Results are consistent with literature. Increased interest rate volatility corresponds to future reductions in industrial output.
Hu 1993	B	Canada France Germany Italy Japan UK US	Q1:1957 – Q1:1971 – Q1:1961 – Q1:1972 – Q1:1967 – Q1:1959 – Q1:1958 – All end at Q4:1991 5+ year – 3 month	Time Series	Y	Y	Uses CCAPM model. Slope is positively related to expected growth rates of G-7. Spread has more power with in-sample forecasts than stock prices. Out-of-sample forecasts are better than alternative models.
Ivanova, Lahiri, Seitz 2000	E	Germany	Q4:1973 – Q2:1998 9-10 year – 1-2 year	Two-Regime Markov-switching	N	Y	Results confirm Estrella & Hardouvelis (1991) and Plosser & Rouwenhorst (1994). Focus of paper is on making a better prediction model. Spread forecasts

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			(3 month was tested but not reported)				inflation turning points at 3-5 year horizon. Model accounts for a lag for monetary transmission mechanism. Yield curve spread outperformed the quality spread.
Keen 1989	B	US	Q1:1955 – Q2:1989 10 year – 3 month	Presented summary of raw data	N/A	Y	While has been a good predictor in the past, it should not be used in isolation. Argues there may not be a recession in 1989 or 1990 because there is an absence of gross economic imbalances.
Kessel 1965	B	US	20th century	N/A	N/A	Y	One of the first papers to recognize the connection between yield curve spread and real output. Explains the yield curve in terms of the expectations hypothesis and liquidity preference.
Kim, 2000	B	US	Q2:1953 – Q2:1998 10 year – 3 month	Time Series	Y	Y	Decomposes the yield spread into an expectations effect and a term premium effect. Both are significant. Shows the yield spread has predictive power for up to 12 quarters ahead. Outperforms lagged GDP & oil price indices.
Kim, Limpa-phayom 1997	E	Japan	Unspecified Monthly 1975-1991 10 year – 3 month	GMM	N	Y	Demonstrates a break in 1983/4. Japanese government deregulated their bond market during this period. Prior to deregulation, no relation between the spread and real output emerged. After deregulation, the relation is clear.
Kotlán	T	Simulation	Calibrated	OLS for	N	N/A	Argues that linear models are biased in

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
2002		of Czech Republic	coefficients with Q3:1994 – Q1:2001	calibration Model: 1) Phillips Curve 2) AD 3) C/Bank Reaction Function 4) Uncovered Interest Rate Parity & 5) Rational Expectations Hypothesis			predictions. Uses small, open economy—Czech economy. Predictive ability of the term spread is monetary policy dependent. More attention of authorities to inflation increases the predictive power of the spread (through the central bank's reaction function). The way which expectations are formed is necessary to understand the spread as an indicator. Predicts inflation 6Q out and real output 3Q ahead. Divides agents into two groups. One has rational expectations and the other group is unsure, so they set long-term rates. Runs simulations to conclude spread has information on expected inflation.
Kozicki 1998	B	Australia Canada France Germany Italy	Q2:1969 – 10 year – 13 week M1:1958 – 10+ year – 3 month M1:1970 – Long-term & 3 month M1:1961 – 7-15 year-3 month M3:1976 –	Time Series	Y	N	Shows positive spread is associated with expanding inflation. Criticizes earlier papers saying they suffer from specification error. Due to the specification error of the dependent variable, R^2s and βs are flawed. They likely reflect correlations between spread and current inflation, and should not be interpreted as evidence of future inflation. Conclusion: the current spread reflects the stance of current monetary policy.

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
		Japan Nether-lands Sweden Switzer-land UK US	Prior to 1991: 15-20 year After 1991: 9-10 year – 3 month M1:1969 10 year – 3 month M10:1972- 10 year – 3 month M12:1962- 9-10 year – 3 month M1:1958 – 5-12 year – 3 month M1:1962 – 20 year – 3 month M1:1958 – 10 year – 3 month All ended at M12:1997				
Kozicki 1997	E	Australia Canada France Germany	Q1:1970 – Q1:1996 except Germany	Time Series	Y	Y See Comment	Each country, except Japan, yields significant results. In the US, a decrease in the spread by 100 basis points = a decrease in real GDP by 0.99%. Spread

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
		Italy Japan Sweden Switzer-land UK US	– Q4:1994 Sweden – Q3:1995 Swtizer-Land – Q4:1995 10 year – 3 month				has maximum predictive power at 4Q. Spread helps predict inflation 2-4 years in the future. A 100 basis point decrease in UK spread = 1.26% expected inflation over 4 years. However, it is the short rate that predicts inflation, not the spread.
Labadie 1991	T	N/A	Assumes indexed bonds vs. nominal bonds	Discount Bond Pricing Model & Asset Pricing Model	N/A	N/A	Examines the economy from the RBC perspective. Asks whether real GNP should be modeled as trend-stationary (temporary effects) or as difference-stationary (permanent effects). If it is difference stationary, the average nominal yield curve has a negative slope and negative term risk premium.
Lahiri, Wang 1996	E	US	M1:1953 – M3:1993 10 year – 1 year M1:1955 – M3:1993 10 year – Fed Funds	Maximum Likelihood Estimation	N	Y	Compared the 10 year – 1year spread with NBER recessions, not with Real Output. The model predicted all 15 peaks and troughs and created no false alarms. 10 year – 1 year spread outperforms the 10 year – Fed Fund spread, the 6 month paper spread, and the Leading Economic Indicators.
Laurent 1989	B	US	Q2:1961 – Q1:1989 Prior to 1986: 20 year	Presented summary of raw data &	Y	Y	Presents Fed's setting of monetary policy to stabilize economy. Fed implements actions through overnight Fed Funds. Long Rates appear insulated from

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			After 1986: 30 year – Fed Funds	OLS			monetary policy. Sees little difference between 10, 20, & 30 year bonds rates. Concludes the spread is a helpful guide for monetary policy.
Laurent 1988	E	US	Q1:1961 – Q4:1986 20 year – Fed Funds	Time Series	Y	Y	Early paper exploring the spread as a superior predictor to the Fed Funds rate, the real Fed Funds rate and M2.
Lowe 1992	B	Australia	M9:1972 – M6:1991 10 year – 6 month	OLS	N	Y	Uses the Estrella and Hardouvelis (1991) methodology to confirm the spread's significance for Australian output growth and inflation. Breaks data set at July 1982 for a regime change. The author finds that for every 1% point increase in the spread, the rate of output growth over the next 12 months increases by 0.5%.
McCallum 1994	T	N/A	N/A	N/A	N/A	N/A	Addresses the failure of the Expectations Hypothesis under rational expectations. In order to really test the Expectations Hypothesis, one would have to accurately estimate the policy reaction function of the Fed.
Mishkin 1990	T	N/A	N/A	N/A	N/A	N/A	Models yield curve as the weighted average of future changes in short rates. Concludes the spread is positively correlated with changes in short rates. However, the spread is negatively correlated with long rates (opposite of

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
							Expectations Hypothesis). An increasing spread is a predictor of future inflation. Summarizes results of earlier papers.
Moersch 1996	E	Canada Germany Japan UK US	Q2:1958 – Q4:1993 Q3:1976 – Q4:1994 Q4:1979 – Q4:1993 Q3:1970 – Q1:1994 Q2:1960 – Q1:1994 Long rate is line 61 in IFS data set 3 month	Time Series	Y	Y See Comment	Spread is a significant predictor in each country except Japan. When both the spread and the short rate is included in the regression, the spread is still significant for Canada, Germany and the US, but it fails in Japan and the UK.
Peel, Ioannidis 2003	E	Canada US	Q2:1972 – Q1:1991 Q3:1959 – Q1:1999 10 year – 3 month	Model: 1) Phillips Curve 2) IS Curve 3) Monetary Reaction Function 4) Fisher Equation 5) Expectations Hypothesis	Y	Y	A policy regime that is anti-inflation reduces the link's coefficient. Breaks data set into subsets to examine supposed regime changes. Concludes structural breaks are needed to increase predictive powers of the model.
Peel, Taylor	E	UK US	Q1:1957 – Q4:1994	VAR	Y	Y	Separates permanent shocks to output from temporary shocks. Temporary

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
1998			10 year – 3 month				shocks are associated with the demand side. They purge GDP of supply innovations and run tests. Then do the same with demand innovations. Results: without supply innovations, the spread predicts real output, but without demand innovations, the spread does not predict. They conclude the yield curve's power is based on demand side activity (Aggregate Demand).
Phillips 1998 / 1999	E	US	M1:1989 – M6:1999 10 year – 1 year – 3 month	Bayesian Regime-switching	N	Y	A lag of 12-18 months was best result for the spread. Then compares Leading Indicators, Stock/Watson Indicators, with spread. Using data from 1988, the Stock-Watson indicator performed best. However, there were not enough observations to make a good comparison.
Plosser, Rouwen-horst 1994	E	Canada France Germany UK US	Q1:1957 – Q1:1991 Q1:1970 – Q1:1991 Q1:1960 – Q3:1991 Q1:1975 – Q4:1990 Q1:1957 – Q1:1991 10+ year –	Time Series	Y	Y	They demonstrate information in the long-end of the term structure does not stem from movements in the short-end of the term structure. Long rates contain information on real growth rates that is unrelated to monetary policy. Spread is a better predictor at 2Q+'s out. In the US and Germany, the spread is a better predictor of real growth than nominal growth or consumption growth. World interest spread improves R^2 on US, UK

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			3 month				and Germany. US's spread helps predict growth in UK and Germany, and vice versa.
Ragnitz 1994	B	Germany	Q1:1972 – Q3: 1992 10 year – Day-to-Day	OLS	Y	Y	Presents evidence that the slope of the yield curve has a significant ability to predict future GNP growth in Germany. Argues short rates are determined by monetary policy. Stable long rates weigh against a simple Expectations theory of the yield curve.
Reinhart & Reinhart 1996	E	Canada	M2:1958 – M7:1995 10 year – 3 month	Conditional Probability Models	Y	Y	Compares 16 leading indicators and finds that the best predictors of recession in Canada are both the US and Canadian term structure spreads.
Resnick, Shoesmith 2002	E	US	M1:1960 – M12:1999 10 year – 3 month	Probit	Y	N/A	Extends Estrella & Mishkin (1996, 1998) probit model to predict movements in stock market. Finds *ex ante* probabilities of being in a Bear Market. Out-of-sample model is reliable to forecasting a stock market turning point 1 month in advance.
Roma, Torous 1997	B	US	Q3:1960 – Q3:1992 5 year – 3 year – 1 year – 6 month – 3 month	Maximum likelihood	Y	Y See Comment	Uses CCAPM model. Estimated real yield curve by using a time separable consumption function. Thus, a flat yield curve appears at the business cycle peak and it is steep at the trough. Term spread is more informative of future changes in stochastic detrended real GDP than future growth rates in real GDP.

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
Salyer 1994	T	N/A	N/A	Stochastic Growth Model	N/A	N/A	Analyzes the yield curve within a RBC model, where growth is characterized as random technological shocks. Concludes the yield curve will invert at the bottom of the cycle.
Sauer, Scheide 1995	E	France Germany Italy	Q1:1978 – Q2:1969 – Q2:1975 – All end on Q2:1994 Long rate is defined as gov't or semi-public bonds & 3 month	Granger	Y	Y&N See Comment	Spread does not improve results for France and Italy (in contrast to bivariate studies). However, the results were significant for Germany. They do not recommend termination of monetary targeting in favor of interest rate targeting, because the money stock provides an anchor for the price level (inflation), while the yield curve does not possess this property.
Shaaf 2000	E	US	Q1:1959 – Q1:1997 1 year – 3 month	Neural Network	N	Y	Uses a neural-network or artificial intelligence model. The model assumes that a hidden parameter is driving the results. Results confirm a downward sloping yield curve forecasts a recession. It calculates a 5% increase in the spread corresponds to a 9.33% change in growth of real GDP. This model has less error and lower variation in out-of-sample data than traditional models.
Smets, Tsatsar-onis	E	Germany US	Q1:1960 – Q4:1995 10 year –	Structural VAR	N	Y	Shows positive spread is associated with expanding real economic activity. Argues credibility of monetary regime is critical.

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
1997			3 month				The predictive content of the spread is NOT policy independent. They reject the view that "real" underlying shocks are the only source of the spread's link. Thus criticizing RBC and CCAPM approaches. Monetary policy affects the link by: 1) leaning against the wind and 2) credibility of a strong anti-inflation policy leads to diminishing uncertainty, thereby reducing the importance of nominal shocks to long rates.
Stock, Watson 2003	E	Canada France Germany Italy Japan UK US	M1:1959 – M12:1999 M1:1964 – M3:1999 M1:1960 – M12:1999 M1:1974 – M12:1999 M10:1966-M12:1999 M1:1964 – M12:1999 M1:1959 – M12:1999 43 variables were used Simply states Long medium and	Time Series & Granger	Y	Y	Business cycle predictors literature review covers 93 articles and working papers, emphasizing the past 15 years work. They conclude "some asset prices predict inflation or output growth in some countries in some periods." Asset prices are more useful for predicting real output than inflation. Forecasts based on individual indicators are unstable. Granger tests do not provide assurance of stability. Combining information from various predictors reduce instability problems. They find evidence the yield curve is a serious candidate for predicting recessions at the 1% level for Canada, France, Germany, and the US.

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			short rates.				
Stock, Watson 1996	E	US	M1:1959 – M12:1993 76 series in 8 categories	8 univariate and 8 bivariate models are compared	Y	Y	Looks for best predictor of business cycles. Stability is rejected in over 55% of the 5,700 bivariate relations tested. Adaptive models only slightly outperformed non-adaptive models. If the parameters of a higher-dimensional VAR are constant, then the parameters of all possible bivariate VARs (with those variables) will be stable. They include the spread as a component of their model.
Stock, Watson 1989	E	US	M1:1959 – M12:1987 10 year – 1 year	Time Series	Y	Y	Paper reports the results of a project to find a new leading indicators index. The quality spread (6-month commercial paper rate and 6-month T-Bill rate) and the yield spread are included in their index. M1, M2 and inventories are left out of the index. Multiple sources of recession calls for many variables.
Stojanovic Vaughan 1997	E	US	N/A Simply reports Estrella & Mishkin (1996).	Reports Probit results	Y	Y	Short review paper of connection for popular understanding. Reviews Expectations Hypothesis and Preferred Habitat Theory. They allude to the CCAPM model or psychological causes to a business cycle.
Stokman 1991	E	Canada France Germany	1979 – 1986 Monthly Unspecified	Time Series, Compares	Y	Y	The nominal yield curve has predictive power at 4 quarters. Rational expectations theory is the basis for the analysis. Paper

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
		Italy Nether – lands UK US	Long & Short Rates	OLS with SUR			concludes the yield curve is not a good monetary policy tool for stabilizing inflation.
Tkacz 2001	E	Canada	Q1:1968 – Q2:1999 10 year – 3 month	Neural Network	N	Y	Objective is to improve the accuracy of forecasts of Canadian output growth by using leading indicator neural network models. Neural networks are data-driven and can learn from, and adapt to, underlying relationships. This is useful where one does not have any *a priori* beliefs about functional forms. Results are better for 4Q+ horizons.
Turnov-sky 1989	T	N/A	N/A	Stochastic New Classical Model	N/A	N/A	Uses simple macro model to examine policies and the term structure. Monetary policy is conducted through short assets which affects long assets which affects growth rates. Examines effects: 1) of temporary vs. permanent changes; 2) of anticipated vs. unanticipated changes; 3) on long vs. short rates; and 4) real vs. nominal rates.
Venetis, Paya, Peel 2003	B	Canada UK US	Q1:1961 – Q3:2000 Q1:1964 – Q3:2000 Q1:1950 –	Transition nonlinear model with Regime-switching and time-	N	Y	Model includes "accelerationist" Phillips Curve, IS Curve, Monetary Policy Reaction Function, Fisher Equation, Expectations Hypothesis. Supports Estrella (1998) break points. Found break

Author:	Theory, Empirical, or Both	Countries:	Data Set: Dates & Spread	Model Type:	Linear? Y/N	Supports Relation? Y/N	Comments:
			Q4:2000 10 year – 3month	varying parameters			points in each country. Linear models may signal "false alarms."
Watkins 1997	T	N/A	N/A	N/A	N/A	N/A	His purpose is to evaluate others' empirical models. Every model that he examined was done incorrectly. Theory suggests information content of the yield curve is derived from: 1) the short rate, 2) the long rate or 3) interest rate variability. No model includes #3. Proxy variables add measurement error, which makes OLS insufficient.