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Causes of the curve: Assessing risk in public and private financial economics

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Abstract. *Can bond yield curves, the Anxious Index, and/or institutional factors indicate if investors expect too much risk in the short-term, and therefore recessions? While hypothesizing that they can, yield curves may also be affected by shocks, inflation, debt, and maturity preferences, controlled for using both short-term, and wide-spanning, post-World War II regressions, in various countries. While these theories are found valid, the three main hypotheses are most presaging, and the effect of debt stands out, though dependent on savings. Finally, the article analyzes risk in financial institutions, finding that diversification of society can buffer risky, volatile finance institutions, and vice-versa.*

Keywords: bonds, yield curve, Anxious Index, interest rate, debt, monetary policy.

JEL Classification: G12, G21, G28.

I. Introduction

The topics of "finance and government" nourish both consumption and trade with the money necessary to operate. As they do so, bond yield curves are constantly changing. Can bonds, and other factors, indicate if too much or little risk is expected in the short or long-term? One of the central hypothesis considered here is that indicators like government bonds, one type of investment, can to an extent indicate coming periods of growth or recession. Bond yield curves, showing interest rates for short- versus longer turn bonds, turn inverted before recessions hypothetically because investors have more worried risk expectations about the present, than the future, and are willing to pay greater risk premiums, while in the future they cannot bear more risk. Little has been researched on these issues in countries other than the United States.

The primary growth of society is through financial risk, which is the cardiac aspect of the system, supplying each part with blood. Too much risk can spell disaster, whether through crisis, recession, or volatility. British economist John Maynard Keynes was the first to write about the qualities of money, which affected investment, and, in turn, affected the labor market, all in the short-run, in *The General Theory* (1936). The Investment: Saving-Liquidity: Money (IS-LM) Model, developed slightly later by J.R. Hicks and Franco Modigliani, links the goods market to the financial market through interest rates. Due to riskiness, the return on a project or investment may differ from the original interest-rate-level source of funding, which require use of macro models. As interest rates rise, there is more risk for demand, and less for supply. Firms take out loans at specific interest rates, to fund projects they believe will have higher returns, what Keynes called the "marginal efficiency of capital" (Keynes, 1936, p. 135), now called the "internal rate of return". Nearly every recession in the United States in the 20th and 21st Century, except for 1991, was predated by an inversion of the bond yield curve.

Investors may also move back and forth between stocks and bonds over riskiness, or between different lengths of bonds due to tastes and preferences, as suggested by "market segment theory", or "the preferred habitat hypothesis". Fiscal or monetary policy, inflation from oil, shocks, or micro issues collectively called the "financial accelerator", also raise bond yields, called "premiums". Others point to policy decisions by central banks in raising interest rates, while government debt raises interest rates, through supply and demand, and thus risk, as well. The central idea is that the yield spread between short-term bonds and long-term bonds indicates the risk expectations of investors of the near future compared with the distant future. This idea of "expectations" dates back to works by Lucas and Romer from the 1970s, and is now called New Classical Economics (Klamer, 1984, p. 1). New Keynesians have diffidently accepted expectations. If bond yields turn inverted, it not only signals expectations of upcoming recessions, but also that the country has absorbed as much financial risk possible. The hypotheses are that the expectation effects of the yield curve are real, that premium theories are more significant than the market segmentation theory or the preferred habitat hypothesis, that government monetary and fiscal policy (debt) also raise or lower yield curves via risk (Arnold, 1998, p. 319), and that the Anxious Index and institutions, mainly more long-term, also matter in divining volatility. The author will attempt to unearth which of all of these theories are veritable.

II. Literature review and theories of interest rates

Empirical evidence in recent years substantiates that the market segmentation hypothesis holds for the short term, in the contexts of studies by Mustafa and Rahman (1995), Park and Switzer (1997) Simon (1991), and Taylor (1992). Research for longer periods is weak. One examination of the theory was a paper by Phillips (2003), which looked specifically at the United States (U.S.) government in 1999 (Phillips, 2003, p. 1). The "market segmentation" theory contends that bond investors have a market segment in which they like to invest, for business reasons. A similar theory, the "preferred habitat hypothesis", argues that bond holders will only move out of their habitat for a premium (Kidwell et al., 2000). Phillips (2003) examined this "preferred habitat hypothesis", using the Constant Maturity Treasury (CMT) yields, a weekly yield curve estimate by the Treasury Department. Using OLS regression analysis**,** he subtracted forecasted yields from the CMT expectation and found only a slight, insignificant difference, but significant at the time in November, 1999 when the Federal Reserve announced its buyback program. He finds this as verification of his initial hypothesis, but also notes that bond yields may have reacted to Federal Reserve interest rate policies. However, short-term yields did not cause investors to move from longer term markets to shorter ones (Phillips, 2003, pp. 1-5).

Turning to another theory, Thomas and Wu (2006) considered interest rate moves *following* announced changes in future deficits. These two authors cite several studies which find that following decrees proposing laws reducing deficits, such as in 1985 and 1990, interest yields fell (Thomas and Wu, 2006, pp. 1-2). Relatedly, Thomas and Wu find that each one percent increase in the expected two-year-ahead deficit/GDP ratio likely increases the yield spread by 20-50 basis points (Thomas and Wu, 2006, p. 5). According to Fisher (2001), such expectations can remove arbitrage (Fisher, 2001, p. 1), the ability to shift money for slight gains in yield variations.

Another possible causal path of why yield curves are related to recessions is microeconomic- yield curves worry bank managers by putting pressure on the margin between interest earnings and funding costs. Low margins can lead bank managers to take more *risks* in hopes of earning more. During the 2001 recession, the charge-off rate for U.S. banks, which are losses divided by total loans, increased by 50% until it reached a height of 0.16% in December of 2002. Loans usually have longer time-spans than shorter term deposits. When the yield curve inverts, and long-term rates fall, margins on loans oftentimes shrink, as do profits, which encourages greater bank risk taking, called "chasing yield" (Balla et al., 2007, pp. 37-38).

Banks can also pursue a leverage-growth strategy, of expanding assets owned in an effort to broaden out risk. Surprisingly, banks usually try to take on more *risk*, by lowering standards and lending in areas they would typically avoid, or providing new instruments (Balla et al., 2007, p. 38). This risk taking actions by banks is another causal factor of why flattened curves may actually "cause" recessions, but usually there is a lag before recessions, which gives more weight to expectations theory, and banks as of 2019 are more cautiously managing assets and using fixed rates and fees, which over three decades was a great basis of revenue (Balla et al., 2007, p. 2).

Still, Wang and Yang (2012) disagree, claiming both recessions and inversions may be caused together by some event, such as a financial crisis or tight monetary policy, which first affects the yield curve, and then output, but not *causing* the decline in GDP. This explanation differs from theories that higher short-term rates drive out investment and *cause* recessions. The yield curve inversion is merely a "by-product" (Wang and Yang, 2012, p. 6). The LM, or money market curve, shifts left, and Y (GDP) decreases. Regrettably, they offer no real world examples of the "shocks" that they say affect these changes (Wang and Yang, 2012, pp. 5-6). Using another example, Hamilton and Kim (2002) theorize what occurs when central banks use tight monetary policy. Investors expect there will be a temporary rise in the short-term rate, then long-term rates will rise less, the curve will flatten, and there will be less short-term spending, hurting growth. A policy of expansion would have the reverse effect (Hamilton and Kim, 2002, p. 4).

The issue of whether yield curves predict recessions involves two types of literature; first, trying to predict the actual future growth rate, and second, trying to predict the probability of recessions; here, the latter theory is of concern. Though most research is post-World War II (WWII), some economists find predictions of output dating to the 1870's in the United States and Germany (Haubrich, 2006, pp. 2-3). Balla et al. (2007) report that "a recession has not followed every inversion" (Balla et al., 2007, p. 39). The largest discrepancy was 1966-1967 when the curve flipped but there was no *official* recession (Balla et al., 2007, p. 39). Still, today, other economists claim the yield curve "might not be as reliable a predictor … as it used to be" (Haubrich, 2006, p. 1). In the 1992-1994 period, Federal Reserve Chairman Allan Greenspan commented on the flat yield curve, arguing that the traditional yield curve is less important than the gap between "the current and long-run levels of the real *federal funds rate*" (Haubrich, 2006, pp. 2-3).

This gap theory leads into an analysis by Wright (2006-07), who believes that the probability of a recession can actually be predicted by the *degree* of inversion (Wright, 2006-07, p. 7). Such evidence seems to verify Chairman Greenspan's comments. Wright, in 2006-2007, predicted a 50% chance of recession in the next four quarters using the model with the federal funds rate, but only 20% when not including it – his results were prophetic (Wright, 2006-07, p. 60).

In addition, attempts to predict growth may fail due to the powerful lack of inflation in the 21st Century, which in the past has made future yields look less steep, an area that Haubrich has examined (Haubrich, 2006, p. 4). Phillips (2003), mentioned earlier, also questions orthodoxy by rejecting that the central bank's monetary policy affects the yield curve. He notes that the federal funds rates rose in 2000, yet the yield curve declined in this period. Phillips then tested the expectation hypothesis with a statistical regression in which the yield on the U.S. 30-year bond was a function of a constant and on a premium from all of the shorter term bonds, with a high explanatory R2 of 0.98 (Phillips, 2003, p. 5).

Stock and Watson (1989) reinitiated the discussion of *why* yield curves might affect economies, using the premium difference between the six-month commercial paper (private bonds) and the six-month Treasury bill, as well as the difference between the ten-year and one-year Treasury bond rates (Hamilton and Kim, 2002, p. 1). Zamsky provided several reasons why the T-bill is the best metric. They are the "benchmark rate for …

decisions", and the "pricing of new bond issues", they are used to "hedge interest rate risk", they are used for international "value comparison", and they are very liquid (Zamsky, 2000, p. 2). Estrella and Trubin (2006) added United States data since World War II. Another round of papers followed, including Harvey (1988, 1989), who linked term structures to output growth, and Estrella and Hardouvelis (1991), who used the difference between the ten-year Treasury bond and the three month T-bill and several European states beyond the United States. Plosser and Rouwenhorst (1994) examined three industrialized countries, and found the curve is a better predictor than monetary policy. Estrella and Mishkin (1998), the most famous study, found term structures to be the best predictors of a recession in the next four quarters. Haubrich and Dombroski (1996) and Dotsey (1998) found that the yield curve's utility is diminishing over time (Hamilton and Kim, 2002, p. 1).

According to Hamilton and Kim (2002), the causation of the yield curve is unclear, because "no one has yet proposed a way of separately measuring the role of the term premium itself in accounting for the spreads' usefulness in forecasting" (Hamilton and Kim, 2002, p. 1). This would involve very timely surveying of premiums investors would pay based on risk. Using the spread of the 10-year Treasury bond and the three month T-bill, and independent variables for the Federal Funds' rate, estimates for M1 and M2 money supply, and an index for oil prices, the coefficient for recessions linked with GDP remained significant two years ahead (Hamilton and Kim, 2002, pp. 2-4). Therefore, methodology is the key to how one views the subject.

Still, market expectations of future *macroeconomic* growth may play a role, because if one expects high growth, the yield on long-term bonds should rise, based on "expectations". But *risk* plays a role as well. If interest rates become very volatile toward the end of an expansion, expectations do not change, but the risk premium does, which could lead to a flattening of the curve (Hamilton and Kim, 2002, p. 4). According to Estrella and Trubin (2006), most research has been empirical, developing correlations rather than building theories. They furthermore state that short-term rates are more predictive, because prior to four United States' recessions, the long term rates rose instead of falling. They also find that the more pronounced inversions, especially the two in the 1980s, are "associated" with deeper recessions (Estrella and Trubin, 2006, p. 3).

Mody and Taylor (2003), in light of the yield curve's lack of inversion before the 1990-91 U.S. recession, offer an alternative hypothesis discussed in the literature, that of the "financial accelerator" (Mody and Taylor, 2003, p. 1). This is calculated as the premium on "high yield" or "junk bonds" on top of government debt or high-rated, AAA corporate bonds. They found the accelerator theory particularly useful for predicting in the 1970s and 1980, yet since then they do have "a high predictive content" (Mody and Taylor, 2003, p. 1). Tight U.S. monetary policy, through short-term interest rates, increase capital outflows to developing countries. The reduced U.S. supply steepens yield curves. Higher yield spreads predict higher default rates, less access to credit, and slower economic activity (Mody and Taylor, 2003, pp. 1-3).

The financial accelerator begins when, and only when, there is friction in the financial market, as in the case of asymmetric information or contract enforcement costs, or more *risk*. High yield bonds are at times more available in the developing world, creating a

"premium" for external funds from the more prestigious United States (Mody and Taylor, 2003, p. 4). Until recently, theorists struggled to explain this premium, but it is related to the concept of "chasing yield", which the accelerator theory portrays (Mody and Taylor, 2003, p. 4).

Write Mody and Taylor (2003), a high yield spread in particular tends to predict an economic slowdown, but yield curves lost their predictive power in the mid-late 1980s, already discussed, due to more aggressive policies targeting inflation. Conversely, the 1970s had high inflation, and oil shocks, which resulted in flatter yields and less economic activity. One should note, this is contrary to other findings that oil prices play only a small part in yield curves. Mody and Taylor predicted, in 2003, that the accelerator's friction would decline over time (Mody and Taylor, 2003, p. 11), which was apparently wrong, as rates are low today, driving savings oversees.

Writing in 2006, directly before onset of the 2008 U.S. financial crisis, Thomas and Wu (2006) asked why the yield curve was flat, in spite of large deficits, numerous rate hikes by the Fed, a "major" upsurge of energy prices, and higher US inflation, leading Greenspan to call it a "conundrum" (Thomas and Wu, 2006, p. 5). Asian countries were investing heavily in U.S. long-term bonds, but one would think this demand would cause the curve to increase. Thomas and Wu had foreseen that Social Security and Medicare could put strains on the system and cause longer-term rates to rise. The crises that followed was self-obvious (Thomas and Wu, 2006, pp. 5-6).

Of importance is distinguishing between the shape of the yield curve and the height, or level, of the curve, the former which is more useful here. Europe is a good place to analyze debt theories, as, by 2007, countries were highly integrated. Integration convinced some borrowers there was little difference between nations, when there *was* a difference, in terms of risk. Greece had a margin over European Monetary Union bond yields until 2001, but it disappeared once it joined the Euro after that year. The Treaty of Maastricht made clear that each country maintained full responsibility for its own debts, with no "bail-out" (Holland et al., 2011, p. 1). In 2010, the markets started to diverge, revealing European debt was not risk-free. Credit agencies downgraded Greek and Irish debt, in 2009, then Portugal in 2010. From November 2009 to May 2011, these three countries saw 32 agency downgrades (Holland et al., 2011, pp. 1-6).

In mid-July 2011, Greek bonds were 15 points higher than in Germany (a stable country), Ireland's bonds were 11.2 points higher, and Portugal's bonds were 10.3 points higher. The EU and IMF agreed to reduce rates of interest in order to make borrowing more profitable. In other countries, Spain had a spread over Germany of 3.1 points, Belgium was at 1.5 points higher, and Italy was at 2.7. These borrowing spreads not only mean, as already stated, the loss of wealth to citizens, but losses to firms and banks, reducing consumer spending, weakening balance sheets, crunching credit for banks, and increased bank lending margins. The European rescue plans, given its debt crisis, involve restructuring and swapping existing bonds for new, altered bonds with less principal or interest, and more length, so-called refinancing (Holland et al., 2011, pp. 1-6).

Europe gives further evidence to the theory that fiscal discipline lowers interest rates. In addition, a country's credit risk ratings, forecasts of its fiscal debt, and the liquidity of its markets, which is related to market size, also affect yields levels. Additionally, Bayoumi, Goldstein, and Woglom (1995) found that bond yields of U.S. states are determined by level of state debt, while national debt may also affect spreads between public and corporate bonds, according to Alesina et al. (1992). Another statistic used for risk prediction is known as the "Anxious Index" (Trader's "Reassessing", 2010, pp. 1-3).

With the Anxious Index, also called the Survey of Profession Forecasters (SPF), and with the Livingston Survey and the University of Michigan prediction of inflation, the SPF relies on human intuition rather than direct data alone. While, in the course of this analysis, the "yield curve" and the "Anxious Index" are neither themselves "rules" which affect policy, the Anxious Index does indeed rely more upon human "gut" feelings, best made by a holistic examination of the market, whereas the "yield curve" simply follows data (Keane and Runkle, 1989, p. 24).

In 1968, the SPF forecasts were used on 10 macroeconomic variables; four were eliminated and 11 were added in 1981 (Baghestani and Nelson, 2011, p. 1). The SPF was created in-part by Victor Zornowitz, and since then number of respondents have varied between fifteen and sixty "experts" (Kean and Runkle, 1989, p. 27). There has been some discrepancy over what exactly constitutes a recession for all such studies. A study by Lahiri and Wang (2006) concluded that "external shocks cannot, by definition, be predicted". However, shocks can time "to generate", during the early stages of which they can be better predicted. Their study shows experts as having under-confidence, since the average forecast of a recession was 7.2%, whereas in other sciences weather or earthquakes are over-predicted (Lahiri and Wang, 2006, pp. 26-28).

A study by Keane and Runkle (1989) tested whether or not people are "rational", in the context of "rational expectations", or the "efficient market hypothesis", in which case prices are in essence "built into the system" by everyone beforehand, all having similar information. They theorized, though, that professional forecasters have an incentive to be more accurate since their reputation is on the line, as is their business. Further, they contend their study uses different and more accurate data, and assume that forecasters' errors may be correlated (Keane and Runkle, 1989, p. 29). The moment "*when* forecasters have current [information] is crucial" (Keane and Runkle, 1989, p. 32). In this study, forecast errors were low and were themselves unpredictable, indicating rationality. Forecast errors were duly low for inflation (Keane and Runkle, 1989, p. 33)

According to Lahiri and Wang (2006), "Psychologists have shown that individuals (tend to) bias their estimated probabilities towards an anchor, the base rate in this case (30%), particularly when they face difficult forecast situations" (Lahiri and Wang, 2006, p. 32). The SPF did not forecast the 2001 recession, and had true false signals in 1975 and 1980, probably because, for the last, the National Bureau of Economic Research (NBER) denied the economy was in recession definition-wise when it most likely was (Lahiri and Wang, 2006, p. 33). Stock and Watson (2003), proponents of the yield curve, noted the 2001 miss (Lahiri and Wang, 2006, p. 35). Still, "the variance (error)… was found to be three times

more than necessary", due to "cues or predicators that are not related to … negative GDP growth" (Lahiri and Wang, 2006, p. 35).

Baghestani and Nelson (2011) cite Bernstein and Silbert (1984) as finding that professional forecasters are "better than naïve predictions" (Baghestani and Nelson, 2011, p. 1). They find that some variables are easier to predict than others, and that forecasts made at later times are more accurate than early forecasts. For instance, the unemployment rate is easier to forecast than the 3-month T-bill rate. Inflation was found to be the most difficult, even using a Phillips Curve model. Nevertheless, while no single forecaster was "constantly accurate", "average forecast error" was considerably low, and professional forecasters were evaluated to be more accurate than "naïve" ones (Baghestani and Nelson, 2011, pp. 1-2).

A Su and Su (1975) study suggests professional forecasters are more accurate than econometric time-series models and also better at predicting changes in data rather than the resultant data itself, such as changes in Gross Domestic Product (GDP) versus exact future GDP. A Hafer and Hein (1985) research paper found forecasters to be more accurate about inflation than models based on interest rates, which usually foresee higher inflation. A Lahiri and Teigland (1987) study concluded that that forecasts are not usually normally distributed. Consequently, there is a greater tendency for experts to skew their predictions either right or left of the mean. Lahiri, Teigland, and Zaporowski (1988) interestingly found that real (not nominal) interest rates actually decline upon heightened uncertainty over inflation (Croushore, 1993, p. 13).

A 1990 Keane and Runkle paper implies that forecasters are rational, meaning they do not "leave useful information unexploited" (Croushore, 1993, p. 13). Changes are anticipated and built into the market ahead of time so that individual profit-making is more difficult. A paper by McNees (1992) discovered that forecasting mistakes are greater when recessions or expansions begin than at other times, and a Rudin (1992) study recognized that forecasters all have very different beliefs, which are not always consistent with time series models (Croushore, 1993, p. 13).

Regarding the ability to predict *inflation*, the author compares two articles, one by Levy (1982), the other by Estrella (2005). Levy took the yield curve in times of low inflation and "compare[d] it with the yield curves observed during periods of high inflation in order to obtain an estimate of future inflation rates as predicted by the market" (Levy, 1982, p. 37). He agreed that short term rates indicate "liquidity preferences and [risks]" (Levy, 1982, p. 37). When compared with the benchmark, low inflation years of 1961-1964, "estimates were [close to] actual inflation… " (Levy, 1982, p. 37). The only era when estimates missed was 1972-1981. In the late 1970s investors could not foresee policies during very high inflation (Levy, 1982, pp. 37-42).

The second article, Estrella (2005), summarizes itself: "The slope of the yield curve has been shown empirically to be a significant predictor of inflation and real economic activity…," but adds that it does so not *because* of anticipations of changes in monetary policy (Estrella, 2005, 722). Estrella cites a paper by Mishkin in which inflation was predicted better in a shorter time horizon (Estrella, 2005, p. 723), especially if it "is optimally supplemented with other information" (Estrella, 2005, p. 734). The relationship

between the "term spread" and inflation is stronger from 1963-1987, than it is after 1987, when Alan Greenspan was appointed Federal Reserve Chairman, after which inflation targeting was used more (Estrella, 2005, pp. 738-743). These findings, though, are only true if monetary policy is active, not passive (Estrella, 2005, p. 724), and if monetary policies is not based on different goals (Estrella, 2005, p. 727). The curves predictive power declines long-term as bond rates approach infinity (Estrella, 2005, p. 742).

III. Methodology

This article contributes by containing more countries over a longer time period than most others, and by testing sundry different theories. Methodologically, the analysis contains several regressions for each. Statistically, the Ordinary Least Square method can be used to link independent variables with dependent variables based on the "line of best fit" that minimizes the collective difference from such line. Beta tests are used to measure the standard deviation of variables to compare them, since they are inevitably in different units, to see which theories are more plausible. Dummy variables are binary variables that indicate the presence or absence of some phenomenon, in this case, a recession or financial crisis, which will be used as the x variable, so as to include other explanatory variables (Wooldridge, 2009, pp. 68, 187-188, 225). Investment institutions may try to restrict long-term lending if they believe the curve will flatten, trying to solidify expensive rates, which may be another cause, not only a harbinger, of the recessions, along with a lack of demand in taking out short-term, risky loans.

The United States' Operation Twist at the end of Chairman Ben Bernanke's term flattened out the current shape of the US curve, raising it at the beginning, and lessening it at the end, with little effect in the middle, a deliberate move. This action gives some support for the preferred habitat hypothesis, since bond buyers remained in their same "habitat". As a result**,** the author will regress the 30-year minus 20-year premium on the Twenty year bond minus ten year premium and also the volume change between the two, and look at the beta, to see if theories related to premium are stronger, that is, if one premium affects the other across time periods, or if market segmentation theories (which would increase demand and premiums), hold in this period. One caveat of the regressions is that of multi-collinearity, because the 20-year and 30-year bonds were also affected by the change in volume. Premiums indicate that longer term bonds have more risk, which they should, because of increased chance of default.

In an analysis of European countries, the author will test an additional, age-old question of whether debt-GDP ratios increase interest rate levels. A regression is run using the debt-GDP ratios for randomly chosen 2nd quarter, which is in the middle of the year, from 2012-2015, with the average 10-month European country bond. The European data is excellent to use, since many countries have such high levels in the 2000s, and data is easily obtainable. Using the European countries: Portugal, Italy, Ireland, Greece, and Spain, and a number of other random European countries, the author tests the hypothesis that larger deficits create higher interest rate levels. This researcher also runs a regression for non-Euro-zone, European states, after noticing that these countries had much lower debt levels.

Finally, and most importantly, this article creates an historical model, to prove the "expectations" hypothesis, by regressing long-minus-short-term yield spreads by a dummy variable for recessions that followed shortly afterwards, the money supply, and a deficit/debt statistic, again, with a beta. This article will aim to include diverse global countries. Homer and Sylla's (2005) *A History of Interest Rates* includes data on short- and long-term rates, namely Japan, India, South Africa, Sweden, Denmark, Norway, and New Zealand, Australia, the United Kingdom, and the United States from the 1940s to the present. As bond denominations differ across countries, just a long- and short-term rate is used. Brian Mitchell's *International Historical Statistics*, was used, from the Yale and Southern Connecticut State University libraries. Some of the bond data came from the Quandl Investing Database, and from the OECD for Australia, the United States, and New Zealand after 1990. Data missing needed counter-factuals, such as with the United Kingdom where M2 was used, and India, where rates were deduced from a graph for 1998-2006, and 2010. Investment taxes were not used. Breusch Pagan tests measure heteroscedasticity, data divergence: all tests pass but one, which will be indicated.

IV. Results

I. Preliminary Findings

Below, data from Fall 2011, the start of "Operation Twist", gives credibility to the market segmentation hypothesis since a change in volume affected supply and therefore the value of the three month T-bills, short-term.

Table 1. *Market Segmentation Test. A change in volume affects interest rates.*
Dependent Variable: Three_month_T_bill P > F = 0.0077* R2 = 0.6098 Obs: 10

Variable	Coefficient	t	p
Average_Volume	0.0732064	3.54	0.008*
constant	-0.0035081	-0.72	-0.0147582*

* significant at 95% or greater.

Next, Operation Twist, the Fall 2011 policy of the United States' Federal Reserve's to lower long-term rates, was tested by regressing the change in 30-year rates via changes in volume initiated by the Federal Reserve. It also had an effect upon the shape of the yield curve between 30-year bonds and 20-year bonds, but not upon the difference between 20-year bonds and ten year bonds, which are shown below. Overall, then, its effect was to flatten out the current shape of our curve, raising it at the beginning, and lessening it at the end, with little effect in the middle, a deliberate move by the U.S. Federal Reserve. This gives some support for the preferred habitat hypothesis.

More volume means greater supply, so Ho: B = 0, Ha = B < 0

Table 2. *Monetary Policy and Rates. Operation Twist lowered long-term rates*
Dependent Variable: Thirty_over_Twenty P > F = 0.0146* R2 = 0.5458 Ob:10

Variables:	Coefficient	t	p
Average_Volume_rise	-0.4685	-3.10	0.015*
Constant	0.4136515	11.62	0.000*

* Significant at 95% or greater.

The negative sign indicates that the average volume rise reduced the 30-year over 20-year premium. Consequently, the United States' Federal Reserve's Operation Twist was effective at reducing long-term bond rates.

To compare the two, the statistical work below represents running a regression of the 30-year minus 20-year premium on the 20-year bond minus 10-year premium and also the volume change, and the model with just these two variables was highly significant. Both variables were significant, but the beta of the premium was almost twice as strong at predicting the change as volume change, which leads one to presume that theories related to premium are stronger. One premium for one period affects the next. A caveat of the regressions is that of multi-collinearity, because the 20-year and 30-year bonds were also affected by the change in volume brought about by the Federal Reserve. The 30-year bond, meanwhile, varies day to day based on unintelligible factors. The 20-over-10 is less than the 30-over-20, so the coefficient should be positive. Ho: B1 = 0, Ha: B1 < 0, while volume increases supply, so: Ho: B2= 0, B2 < 0.

Table 3. *Premium Theory and Rates. One bond rate affects the rest*
Dep. Variable: 30-over-20 F > p = 0.000* R2 = 0.9665 Obs: 10

Variables	Coefficient	t	p	beta
Twenty-over-ten	0.7253331	9.38	0.000*	0.7224276
Average_Vol.	-0.2667448	-5.46	0.001*	-0.4206301
constant	-0.2070382	-3.46	0.018*	No beta

* Significant at 95% or greater.

These sample sizes are small, but the R2, and adjusted R2, are still high.

In an analysis of European countries, to test an additional, age-old question of whether debt-GDP ratios increase interest rate levels, the author ran a regression using the debt-GDP ratios for the 2nd quarter, randomly chosen, from 2012-2015, a "strong case" since Europe has such high levels but was *recovering* from its debt crisis, with the average 10-month European country bond during this period. As one can see below, the results were highly significant, strongly indicating that debt levels result in higher interest rates. Based on the data, a one percentage point increase in the debt-GDP ratio, which is significant at the 1% level, increases 10-year bonds by 0.12 percent. The author also ran a regression for non-Euro zone, European countries, after noticing that these countries had much lower debt levels. The results shown were insignificant, meaning that belonging to the Euro zone may have some intrinsic quality that links debt to interest rates, which demands further research. Perhaps investors see putting forth money for so many countries, not diversified, is more risky: perhaps the euro is a more risky currency since it is linked to the European Central Bank's monetary policies, or perhaps because Europe only has debt limit "suggestions", which, when not met, may raise rates.

Fiscal Policy and Debt/Deficits:

Euro countries: Ho: B1 = 0, Ha: B1 > 0

Table 4. *European Zone Debt and Rates. Debt raises interest rates, short-term.*
Dependent Variable: Average 10 yr. bond yield P > F = 0.000* R2= 0.2590 Obs: 64

Variable	Coefficient	t	p
Debt_GDP	0.0547321	4.66	0.000*
constant	-1.238575	-1.11	0.272

* Significant at 99%.

Table 5. *Non-Euro Zone Countries and Rate. Debt is not significant*
European, Non-euro Countries:
Dependent Variable: 10 yr. non-euro bond yield P > F = 0.6058 R2 = 0.0071 Obs: 40

Variable	Coefficient	t	p
Debt_GDP	0.0078588	0.52	0.606
Constant	2.788855	3.53	0.001*

The constant is significant at 99%, but, more importantly, the model as a whole is not, after witnessing that P > F is 0.6058, which is extremely high.

It is meaningful to note that Croatia was explicitly excluded from the regressions because it changed its European Union status in the midst of the time frame, 2012-2015. In the non-Euro area above, the relationship is less strong, and even non-existent, perhaps, also, because non-Euro states have more control over their interest rates, or there is greater incentive, given the increased responsibility, to manage their own fiscal policy.

These findings confirm the seminal papers by Reinhart and Rogoff (2010, 2012), whose data were found non-duplicable by a professor-led group undergraduate students at the University of Massachusetts. Still, the works suggest that economies collapse when they approach 90% debt to GDP ratio, yet there is no theory for the reason why. The elasticities of debt and interest payment, which depend on risk, make a difference as to the effect if a country exceeds a 100% debt to GDP ratio, based on the institutional strength of a countries central bank, and its willingness to allow for inflation. These factors will both allow for greater GDP, but would reduce investment, depending on the elasticity of investment with regards to the interest rates, compared to a debt unchecked by monetary policy, that would increase rates in this model.

Growth of state spending is equal to total spending itself, aside from inflation, so this elasticity is 1, meaning that the loss of investment must not be caused by elasticity than a loss of 1, but anything less than 1 will still generate growth, except for the inflation; once investment reaches 0, no more growth would plausibly be possible, but people may rely on previous savings for consumption, or else personal debt. The higher the interest rate, the more investment should taper off with additional interest increases, assuming that the risk of investment does not change, which can cause liquidity traps. The elasticity of investment can vary, ranging from high numbers during liquidity traps to possible low numbers closer to 1 when investments are less risky and more fruitful. The greater the investment elasticity, the harder it is for states, while already at high levels of debt, to stimulate the economy, because increases in deficits will raise rates and lessen investment. Government spending from debt depends largely on entitlements. Some studies, from White (1956) to Guiso and Parigi (1999), find inelasticity of investment to interest rates, but elasticity should taper as it rises, except during liquidity traps (see Figure 1, in the Appendix).

2. Recession Theory and All Variables Together:

Ten countries, chosen semi-randomly based on the availability of data (Japan, India, Denmark, Norway, the United Kingdom, the United States, Sweden, Australia, New Zealand, and South Africa), offer the most information on historical interest rates and recessions of this dissertation. Incidentally, none of the European countries utilize the euro, making the interest rate data consistent across the time scope from World War II, 1945, thereby including European integration. Of the 10 countries, four are significant as to yield curve inversions predicting recessions, the United States and the United Kingdom, with a one year lag, and South Africa, and Australia. Australia is significant only including the 1974 oil crisis as a recession, indicated by Hancock (2017), but not in the statistical yearbooks.

With the United States, the significance was at least 98.5%: for the United Kingdom, it was 99.8%: for South Africa, it was with at least 99.9% significance, and for Australia, it was with 99.6% significance. The magnitude of the effect of the inversion, that is, the coefficient of the recession, was greatest for South Africa, and least for the United States; in other words, the more developed the financial markets, the less the inversion. As financial systems have become more complex, the time between yield curve inversions and recessions appeared increased. Likely, developed markets, especially the United States as an example, can see risk further out.

However, for the other countries under consideration, Denmark, Sweden, and Norway did not have enough recessions over this period, to indicate a significant relationship, while for India and Japan, GDP was too volatile over this period to connect to inversions. Though the United Kingdom was significant, the Quandl data set was used from 1961-2010, since interest rates varied among different sources, most likely due to the strict austerity of its Exchequer from conservative governments in the 1970s forward. This type of banking likely influenced its colonies, such as India, which also had very high interest rates during this time. As for New Zealand, its yield curves were inverted almost constantly during this time, indicating a lack of stable financing, which one could call “development”. Denmark, Sweden, and Norway also have weak economic institutions. Their central banks may not be able to keep rates low enough that would lead to inversion. The institutions of banking systems is discussed later in this article.

The most interesting finding is perhaps the difference between the significant and insignificant countries. There have been dramatic changes in savings since World War II, with some rates falling from 20% and 30% down to 0%, but countries averaging over 7% saving over the last 25 years (1985-2010) were not significant for the yield curve inverting before recessions, and those for those under 7% the yield curve held (OECD.org 2017l “Saving”, 1). New Zealand was the exception, because it did not save 7% and yet was not significant with the yield curve. This suggests that higher savings may allow investors in countries to react to higher interest rates in the short-term with plentiful funds able to bring down short-term rates before recession.

A *penultimate* regressions was run amongst both groups, those where there was a yield curve-recession linkage, and those in which there was not. This regression, for both groups,

added variables for money supply, as measured by change in M1, cash and short-term notes, the most liquid form of money making it a strong case, and change in national debt, which is represented by a proxy variable of trade account deficit since data on government debt is not available since 1945, and the two figures are similar conceptually, as government debt goes to finance a trade deficit, known as the "twin deficit" problem. The equation and results are below:

Ho: B1 = 0, Ha: B1 < 0, Ho: B2 = 0, Ha: B2 > 0, Ho: B3 = 0, Ha: B3 >0

Yield Curve Inversion= B1 recession (dummy variable) + B2 debt + B3 monetary policy

Table 6. *Interest Rate Variables Combined. Recessions and inversions are linked*
Significant states Prob > F 0.0000* R2: 0.1461 Obs: 244
Dependent Variable= yield curve spread

	Coefficient	t value	p value	beta
Recession	-1.9181	-5.55	0.000*	-0.3316
% Δ Debt	0.0046	1.50	0.136	0.0897
% Δ in Money	2.9883	2.91	0.004*	0.1741
Constant	1.4108	0.00	0.000*	N/A

* Significant to at least 95%.

In this analysis of the four significant countries, the variable for a recession occurring sometime within one year, and the variable for monetary policy, had the largest effects on interest rates over the 1945-2010 year period, with recession having a slightly greater influence of the two, at a 0.1575 higher beta. Changes in debt fell just short of significance. Growing the money supply typically brings down short-term rates, thereby increasing the yield spread. Despite this, the R2 explanatory power is very low at 0.1461, meaning that many other economic factors contribute to interest rates. For the six countries in which the yield curve was not linked with recessions, first, the model is not significant, and additionally, none of the variables are. Premium theory could not be included in these models because it is designed to study the effects of one bonds relationship to another, and in these regressions, the dependent variable includes all of the possible yield curve spread, volumes of bond trades over this length are lacking.

3. The Yield Curve vs. The Anxious Index

The yield curve and "Anxious Index" were compared as to their predictive power, with data only going back to 1969 because that was the inception of the "Anxious Index". When using a lag for the bond yield curve, the yield curve for the United States was a better predictor of yield curve inversions, at 98% significance, than the Anxious Index, since over 30% of "experts" predicted recession. But, when the Anxious Index was changed to having a lag, then it turned out to be a better predictor, at 99% significance, an unexpected finding. When recession was the dependent variable, and the "Anxious Index" is lagged, the "Anxious Index" is a better predictor, with 89.6% significance, which would be higher if economic quarters were used, not years. Still, the yield curve is much more significant at 99% without a lag. These results, though, had high heteroscedasticity. The Anxious Index can also predict more variables, like inflation, which the yield curve cannot since inflation is already built into long-term premiums.

V. Institutions

This part looks longer-term, at institutional concentration in society and finance.

Interest rates also depend on governments, culture, structures, policies towards regulations, and the concentrations of firms and society themselves, which are combined in a scatter plot to evaluate growth and interest rates later on. Now, combining society and finance, while a society may be diversified, and financial/ economic institutions also may be, the relationship between the two is important. A strong, diversified society should be able to buffer centralized economic organizations, and vice-versa. In the Appendix, Figure 2, descriptive scatter plots are used to juxtapose concentrations of finance, with the concentration of society. The matrix itself is a Boston Consulting Group model originally developed to pinpoint segments in a firm. One can place economies in the matrix, as long as one realizes that there are just two variables. The Herfindahl-Hirschman (HHI) Index is used to measure financial diversification, and the data comes from an average calculated by a paper by Liu and Mirzaei (2013) over a ten year period of 2001-2010. The GINI coefficient is a measure of societal income inequality, used from the United Nations, which is rough since it is not calculated every single year, but has been averaged. Volatility is: [(abs. growth-ave)/ave.]. The nations were chosen semi-randomly so that some states Migdal (1988) cites were used, plus the United States: the rest are fully random.

One would expect countries in the matrix to look like what the BCG (Boston Consulting Group) calls a "cash cow" (Berkowitz et al., 1997, p. 38), with fast, developing states in the first and third quadrants, where most of the countries should fall, and the smallest growing, developed states in the 4th, the conclusion of the pathway. In the model (Figure 2, again, in the Appendix), the clear circles indicate countries' average growth over this time frame, from the World Bank. The time spans includes the 2008 stock crash. The blue circles indicate volatility, sometimes greater than the country's average growth itself; volatility was calculated as the average of the absolute value deviations over yearly growth average. Interest rates varied, typically lowest in IV, with highs in II (CEIC 2019). The results are as expected, showing that a strong society can buffer dense businesses, and vice-versa, in a Migdal sense, reducing risk, in two of the four quadrants, with the developing countries in Quadrants I and II, the emerging countries in Quadrant III, and the sluggish developed countries in Quadrant IV, which need to rejuvenate their economies. The United States seems to be repeating the model, which would expressly turn true once the baby-boom generation passes, and will reformat the world economy. The suggestions for the example countries based on this policy area, at this time frame, would be for Argentina: continue along the same path, for Egypt to take more risky policies because it can increase volatility, for Slovakia to continue as it is, but be weary of immobility, for Portugal to diversify firms, for Israel to take less risk, by diversifying its tech businesses, for Austria to take more risk to jump-start its economy, for Germany, which was hit hard by the 2008 global financial crisis, but soon recovered, to focus less on income equality. The United States will likely merge and consolidate firms, which it has been, and hopefully deal with inequality to diversify its society. Japan should free up business concentration even more; Mexico should diversify its industry for less volatility.

VI. Conclusion

The central issues of this article, again, were how risk and its associated policies and behaviors affect interest rates, mainly bond yield curves, contrasted with other theories (Charles, 2008, p. 128). The control theories under consideration, (premium, market segmentation/ preferred habitat hypothesis, debt financing, recessions, and monetary policy) all were significant in terms of effects on interest rates. However, the penultimate regression showed that recessions and money supply have the strongest long-term effects on interest rates. Strikingly, a 7% of GDP national savings rate can explain the differences between states. These findings counter "modern monetary theory", that states can simply issue money without consequences.

The "Anxious Index" is a better predictor of the yield curve inverting than the recession measure does, but yield curve inversions have higher significance and is a thereby a better indicator of recessions than the "Anxious Index". In short, the comparisons depend entirely on methodology and how one defines a recession, but both measures have value. In terms of government institutional concentration, there may not be one best model, but some today question the extreme tradition of concentration of economists in so few agencies, which is a British model and used by the countries they colonized, including the United States. The use of more diverse and diversified, inter-department task forces, or subgroups might be advisable.

Some other interesting findings of this research are: the one-year U.S. yield curve lag was found linked with recessions, corroborating Trobias, Estrella, and Shin (2010). They write there is a significant relationship between the maximum spread before the recession and the length *until* the U.S. recession. These three find it to be almost constant at 12.6 months, or 4 quarters, after the inversion. Their study corroborates the 12 month lag used in this article's regressions. The length of the recession in the 2010 study was not affected by the spread, but, all of the U.S. recessions since 1968 average 11.6 months. In their work, the recession length was not linked with how long the yield curve stays inverted, and the spread size did not affect the duration.

In summation, while some believe that watching for yield curve inversions, as well as levels, is like reading tea leaves, others fervently hold that it is a predictor of doom to come (Estrella and Trubin, 2006, p. 3). In 2008, before the "Great Recession", after the yield curve inverted, Estrella's models forecasted the United States as having a 40% chance of going into recession in the next month. But, even a month before "the Crash", New York Fed officials were saying there was no possibility (Hahn 2008, 1). One strategist at RBC Capital Markets in London, asserted, "I don't think it's a recessionary signal, it's (sic) a bit simplistic to look at yield curves as a sign of recessions" (Chibber, 2006, p. 9), completely ignoring the signals in 2006. Two other businessmen said, "Some people talk about recessions, but I don't see it as a sign of one" (Chibber, 2006, p. 9). They, and many others, were probably shocked by the 2008 global crisis. Even former Fed chairman Greenspan, as noted, told Congress in July 2005, prior to inversion, that "there is 'a misconception' of the yield curve importance. The curve's efficacy as a forecasting tool has diminished very dramatically" (Chibber, 2006, p. 10).

To the contrary, say the results from this article; the yield curve is a strong predictor, with more theories, countries, variables, and time horizon than in previous studies. This article addressed each of the interest rate theories involved both distinctly and all together. Investors prefer to purchase bonds, to finance investments, within certain markets, they pay premiums in interest for expected risk, which are also affected by monetary and fiscal policy, and these risks in premiums spike before recessions, the penultimate result of 10 countries from 1945-2010. If the findings are correct, as more developing economies save less than the key 7% of GDP discovered, predicting recessions should become even more accurate. In Spring 2019, the U.S. bond yield curve turned partly inverted, an ominous sign, and did so again in early 2020. Future research could contribute with a governmental institutional concentration index based on the theories used here, and using quarterly statistics, rather than yearly data.

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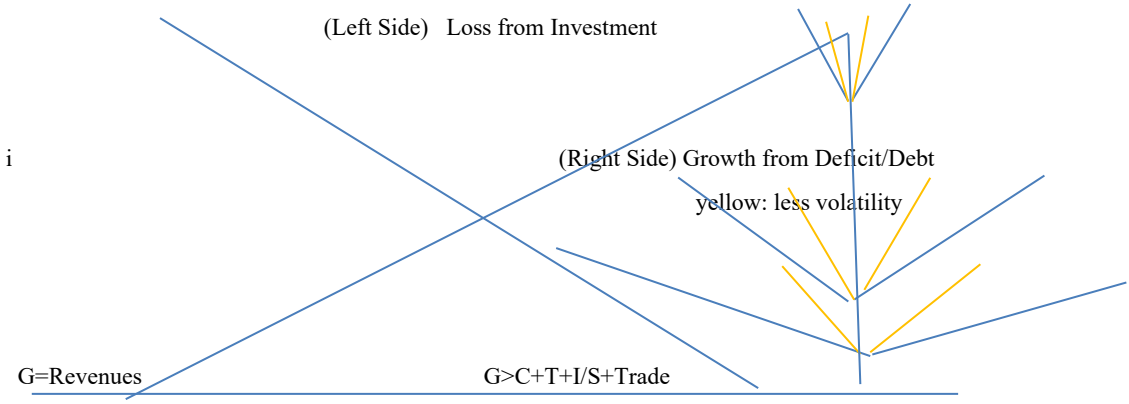
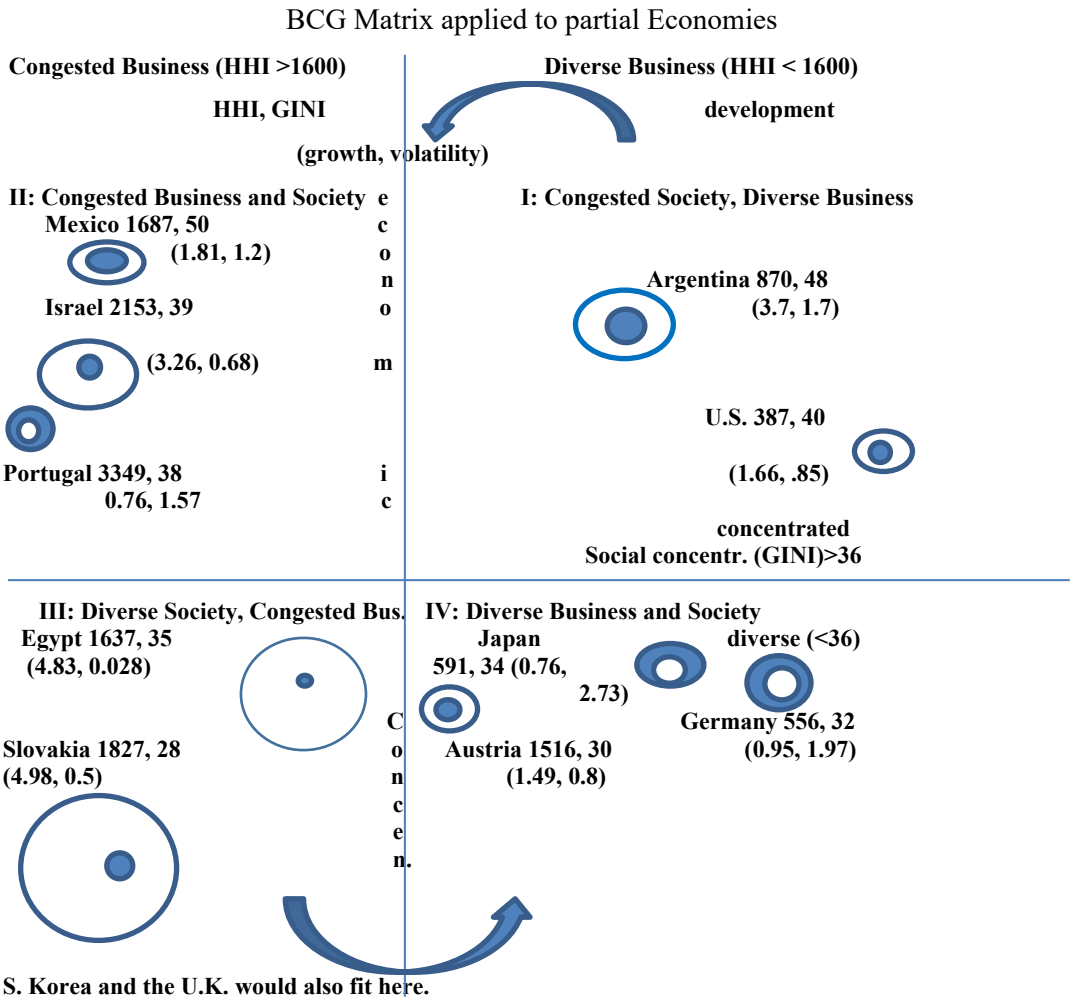
Figure 1. *Risk of government debt*

Growth = elasticity of G gained compared to I lost at the Federal Reserve-able interest rate.



Once a nation's resources have been close to fully used, public (government) debt can increase GDP, rightward, but can crowd out investment, leftward, dependent upon the elasticity of liquidity and the country's central bank ability to control interest rates while debt is rising (Barry, 2018).

Figure 2. *The BCG matrix for a nation*



Above, from 2001-2010, one expects the graph to look like a cash cow in the first and third quadrants, and smallest in the 4th, since a strong society can buffer a strong state, which it does. The HHI is a diversification Index, and growth (clear circle) and volatility (blue circle), are also indicated in the parenthesis (,) (Barry, 2018).