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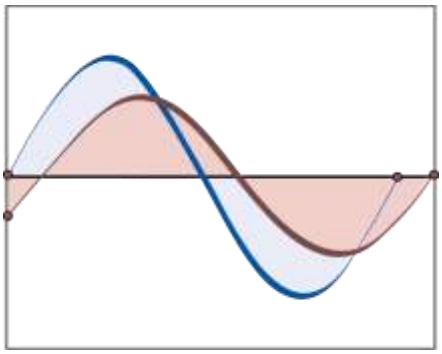

WP 01/2017 June 2017

An Examination of the Predictive Power of Financial Market Indicators in Trinidad and Tobago

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Abstract

In small, open economies such as Trinidad and Tobago, economic challenges pose significant risks to the development of the nation. As such, there is growing demand for economic forecasting tools which can assist in the goal of maintaining economic stability. This paper investigates the performance of major financial market indicators as predictors of recessions and inflation in the local economy. Specifically, the paper utilizes a Probit model, complemented with Receiver Operating Characteristic (ROC) analysis and sensitivity and specificity classification, to examine the predictive abilities of the sovereign yield curve spread between the 3-month and 10-year Treasury rates and the domestic stock market All T&T Index (ATI). The results indicate that the yield curve spread is a strong predictor of recessions and is moderate in forecasting inflation while the stock market index is reasonable in anticipating recessions but weak in its inflation foretelling abilities.

JEL Classification Numbers: C25, E43, E44, and E47.

Keywords: Probabilities, Interest Rates / Term Structure, Financial Markets and the Macroeconomy, and Forecasting Models.

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Contents

An Examination of the Predictive Power of Financial Market Indicators in Trinidad and Tobago

Alon Dhanessar[1]

1. Introduction

Over the past decade, Trinidad and Tobago has experienced many economic challenges; the most recent has been the significant terms of trade shock experienced in 2015 and 2016 due to low energy prices. To deal with an ever changing economic climate, forecasting is becoming increasingly important.

Although a variety of complex economic and financial models are often used to forecast macroeconomic conditions such as business cycles[2] and price levels, simpler financial market indicators are becoming increasingly popular in the arsenal of economists and analysts. Evidence from advanced economies show that the yield curve and stock market indices contains predictive information on economic activity. For example, Estrella and Hardouveils (1991) found that the slope of the yield curve can successfully predict looming recessions, while Estrella and Mishkin (1995) found that the steepness of the yield curve can also provide insight into expectations of future inflation. Additionally, Mehl (2006) sampled a group of emerging economies and found that the developments in their bond markets over the past two decades have afforded their yield curves information content to forecast macroeconomic conditions. Another financial market gauge, stock market indices, is also thought to contain pertinent information about the state of the economy. Considering that stock prices reflect firms' expected future earnings, a change in expectations and hence share prices can occur as a result of the anticipation that the economy will be slowing in the future.

Domestic financial markets have deepened significantly since the 1980's. The Treasury and Central Government bond markets have expanded, while trading has increased through the development of the secondary Central Government Bond Market within the Trinidad and Tobago Stock Exchange (TTSE). Additionally, the TTSE equities market which formally opened in 1981 has grown to a substantial size, around 80 per cent of current GDP in 2016. The establishment of these financial markets in the domestic economy provides reason to assume that they may contain information on macroeconomic conditions. Given the success of financial market indicators in advanced and emerging economies, this paper seeks to determine if domestic financial indicators, yield curve and stock market indices, can predict future macroeconomic events such as a recession or inflation. Specifically, the paper examines the usefulness of the spread[3] between the 3-month Treasury bill (short-term) and the 10-year Central Government bond rate (long-term), in addition to the TTSE All T&T Index (ATI)[4] in predicting a recession and swings in inflation.

The paper proceeds as follows: Section 2 entails a review of the relevant theoretical and empirical literature on the predictive abilities of yield curves and stock prices. Section 3 provides an overview of macroeconomic and financial indicators in Trinidad and Tobago, including movements in economic output as represented by annual GDP at constant prices and the Central Bank of Trinidad and Tobago Quarterly GDP (QGDP) index, core and headline inflation, yield curve interest rates and spreads, and lastly the trends in the stock market index. This is followed by Section 4 which describes the empirical approach and the variables employed; while Section 5 discusses the results. Section 6 outlines the limitations encountered and lastly Section 7 concludes with a discussion on the usefulness of financial market indicators as predictors of macroeconomic conditions in Trinidad and Tobago.

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[2] "Business cycles refer to the irregular pattern of expansions and contractions that characterize the time path of aggregate economic activity. The end of an expansion and start of a contraction is the cycle peak, while the end of a contraction and start of an expansion is the cycle trough" (Pearce, 1983).

[3] In this case, the spread is defined as the difference in yield between two fixed income securities, specifically, a short-term and long-term treasury security.

[4] The All T&T Index (ATI), according to the Trinidad and Tobago Stock Exchange is a "market-value weighted index (which) collectively measures the price movements of the ordinary shares for Trinidadian companies listed on the First Tier Market of the Exchange" (Annual Report 2015).

2. Literature Review

2.1 Yield Curve Spread

Interest rate spreads and the slope of the treasury yield curve[5] are generally believed to forecast future macroeconomic conditions. According to Stock and Watson (1989),"it is generally recognized that an inverted yield curve[6] signals a future slowdown in economic activity". The authors also propose an alternative interpretation where "an increase in the spread, all else equal, might induce some firms to postpone investment, resulting in a decline in aggregate demand" (Stock and Watson, 1989). On examining the usefulness of the spread between the 3-month and 10-year forward interest rates in predicting future recessions, Estrella and Mishkin (1995) determine that "the significance and fit of the yield curve spread increase up to the fourth quarter, in which they peak", furthermore, "between quarters 2 and 6, the Treasury spread is more significant than other variables". Based on the encouraging results of their comparative analysis, they conclude that the yield curve spread can be useful in macroeconomic forecasting. In another study, Estrella (2005) suggests that under most conditions, the yield curve is a good predictor of output and inflation; however, the efficiency and accuracy of a yield curve as a predictor can be affected by monetary policy strategies[7]. For example, using a probit model to examine the predictive abilities of the yield curve in Japan, Hasegawa and Fukuta (2011) determined that the spread contains information on future recessions prior to a structural break in 1996 which was related to Japanese monetary policy and affected the efficiency of the yield curve as a predictor of recessions. Furthermore, in comparing consumer and business sentiment variables against the term spread as predictors for US recessions Christiansen et al (2016) conclude that "sentiment variables provide the bulk of the predictive content at the shorter horizons, whereas the classical variables, and especially the term spread, provides most of the predictive content at longer horizons".

Most studies on the predictive abilities of yield curves focus on advanced economies, while investigations for emerging economies are comparatively non-existent. This is likely due to the previously limited development of bond markets and inefficient bond pricing mechanisms, which, according to Mehl (2006), "have started to deepen significantly only since the turn of the millennium". However, using panel data, Ozturk and Pereira (2013) reveal that the yield curve "has robust predictive power not only for the countries that have long time series but also for the countries that have shorter time series". In light of the limited studies focusing on emerging economy, Mehl (2006) employed a regression technique to investigate the usefulness of the yield curve in forecasting inflation and growth in 14 emerging economies and found that "the yield curve has information content in almost all countries".

In supporting the yield curve as an operational indicator, Estrella and Trubin (2006) propose two explanations. The first considers that "monetary policy can influence the slope of the yield curve" (Estrella and Trubin, 2006). Aguiar-Conraria et al (2011) confirm that "tighter monetary policies have been associated with flatter yield curves, meaning that monetary policy has impacted differently on the short-end and on the long-end of the yield curve". This suggests that monetary policy tightening[8] increases short-term rates which can result in an economic slowdown, while relaxing of monetary policy decreases short-term rates which can spur inflation. The second explanation by Estrella and Trubin suggests that the slope of the yield curve is influenced by changes in investor expectations where the future real demand for credit and future inflation are related to future short-term interest rates. Furthermore, Coroneo et al (2016) explain that "the short end of the yield curve moves closely with the policy instrument under the direct control of the central bank, which responds to changes

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5 Berge (2015) mentions that "the power of the yield curve as a predictor of future economic activity largely endures, in the sense that models selected to forecast recession 1 year ahead rely heavily on this indicator".

6 Demonstrated by the 1-year and 10-year Treasury bond spread inverting in most cases roughly twelve months prior to a cyclical peak and six to twelve months prior to a cyclical trough as dated by the National Bureau of Economic Research (NBER) (Stock and Watson, 1989).

7 Estrella mentions that "the extent to which the yield curve is a good predictor depends on the form of monetary policy reaction function, which in turn may depend on explicit policy objectives" (2005).

8 While monetary policy tightening increases short-term rates, "long-term rates tend to reflect longer term expectations and rise by less than short-term rates" and therefore "monetary tightening both slows down the economy and flattens (or even inverts) the yield curve" (Estrella and Trubin, 2006).

in inflation, economic activity, or other economic conditions". Monetary policy tightening can therefore result in a "slowdown in real economic activity and credit demand, putting downward pressure on future real interest rates" (Estrella and Trubin, 2006)[9]. Furthermore, slower economic activity is expected to reduce inflationary pressures and increase the prospect of an impending ease in monetary policy. "The expected declines in short-term rates would tend to reduce current long-term rates and flatten the yield curve (and) this scenario is consistent with the observed correlation between the yield curve and recessions" (Estrella and Trubin, 2006).

Considering these explanations on the predictive power of yield curves, Estrella and Trubin (2006) employ a probability model in which the steepness of the yield curve is used to predict subsequent recessions. They use the short-term 3-month Treasury rate as the monetary policy influencer, and the long-term 10-year Treasury rate as the effect of investor expectations. They establish that "tracking the level of the ten-year to three-month Treasury spread is useful in predicting recessions" and that "the consistency with which these explanations relate a yield curve flattening to slower real activity provides some assurance that the indicator is valid"[10]. Furthermore, "earlier research suggests that the 3-month Treasury rate, when used in conjunction with the 10-year Treasury rate, provides a reasonable combination of accuracy and robustness in predicting US recessions over long periods" (Estrella and Trubin, 2006).

In another study, Wright (2006) discusses that "growth, recessions, and interest rates are all endogenous and any association among them is purely a reduced form correlation. However, historically, the three-month less ten-year term spread has exhibited a negative statistical relationship with real GDP growth over subsequent quarters, and a positive statistical relationship with the odds of a recession". Using probability models and including the US Federal Funds rate as a way for accounting for the expectations hypothesis, Wright (2006) discovers that the shape of the yield curve, in conjunction with the Federal Funds rate, provide more information on the likelihood of a recession. Furthermore, Bernanke (1990) determines that "both the levels and the spreads between interest rates can be extremely informative for forecasting the economy". Given these investigations, analysing the spreads between various interest rates can prove to be useful for forecasting domestic economic conditions[11].

2.2 Stock Market Indices

Stock prices have long been thought of as indicators of future economic turning points. Mills (1988) explains that this relationship follows the wealth effect where falling stock prices decrease the financial wealth of stockholders which subsequently reduces spending and consumption. Pearce (1983) explains that with no change in consumer prices, an increase in stock prices will increase the real wealth of households, and as wealth changes, consumption changes. Furthermore, consumers who do not hold equity are also affected by stock price changes. For example, falling stock prices reduces a firm's valuations and profitability and as a result they may seek to reduce expenses, possibly by downsizing. Mills (1988) clarifies that during periods of falling stock prices, consumers "lose confidence in the economy and feel their own income prospects are dimmer". Furthermore, Bosworth (1975) argues that the stock market affects consumer demand and economic growth through a "proxy of optimism and pessimism (consumer sentiment)". As a result, stockholders and non-

[9] Furthermore, "the expected declines in short-term rates would tend to reduce current long-term rates and flatten the yield curve (and) this scenario is consistent with the observed correlation between the yield curve and recessions" (Estrella and Trubin, 2006).

[10] In a previous paper, Estrella specifies that "the spread between long-term and short-term government bond rates appears frequently in the literature as a significant regressor in equations that predict inflation – particularly with long horizons – and in equations that predict various measures of future economic activity" (2005).

[11] A theoretical reason why the yield curve spread can be a useful predictor is that based on the expectations hypothesis, the yield curve spread measures the differentials between current short-term rates influenced by monetary policy, and future short-term rates expected by markets. Wright (2006) explains that "the term spread is thus a measure of the stance of monetary policy (relative to long-run expectations). The higher is the term spread, the more restrictive is current monetary policy, and the more likely is a recession over the subsequent quarters".

stockholders may see falling stock prices as a downturn in the financial state of corporations and by extension the economy[12].

Estrella and Mishkin (1995) discuss that financial variables such as stock prices are regularly linked to forecasts of future economic events and that stock prices can be used to determine future profitability of firms. If so, then the major stock market indices can conceivably be used to form expectations of future economic occurrences. In predicting real output growth and recessions using financial and macroeconomic leading indicators, Liu and Moench (2014) follow the guidance of Estrella and Mishkin (1995), and include the S&P 500 common stock price index for its ability to signal peaks and troughs in the business cycle. Their results show that with the inclusion of the S&P 500 index, the model exhibited significant recession predicting ability both in the in-sample analysis and out-of-sample analysis three-months ahead. Furthermore, Estrella and Mishkin (1995) conclude that "stock prices provide information that is not contained in the yield curve spread and which is useful in predicting future recessions". This suggests that stock market data can be used as a leading indicator based on its ability to adjust to investors' perceptions of future performance of markets and the economy.

3. Trends in Macroeconomic & Financial Indicators

3.1 Economic Output & Financial Indicators

Over the 40-year period from 1975 to the end of 2015, the domestic economy experienced two notable recessions (Figure 1). Following the nation's first oil boom spanning the mid-1970s and early 1980s, the economy suffered a complete reversal of fortunes resulting in a major recession lasting eight years from 1983 to 1990. The downturn, spurred by a fall in international crude oil prices and domestic production led to a sharp fall in Government foreign revenues, exhaustion of foreign exchange reserves and a 33.3 per cent devaluation of the Trinidad and Tobago dollar in the fourth quarter of 1985. The deteriorating conditions resulted in Government total debt outstanding increasing from roughly $2.1 billion (10.9 per cent of GDP) in 1982 to $10.5 billion (48.9 per cent of GDP) in 1990. Facing a series of deficits, and depleted foreign exchange reserves, the Government entered into a Standby Agreement with the International Monetary Fund (IMF) in January 1989, under which some of the debt was rescheduled. Through the second half of the recession and into the Structural Adjustment period from 1987 to 1991, the Central Government yield curve spread[13,14] between the 3-month and 10-year treasury instruments remained high and steep, averaging roughly 384 basis points, and peaking at 520 basis points by the end of 1991.

Subsequently, resurgence of activity in exploration, production, and refining rebounded the energy sector, resulting in real GDP rallying in 1991 (3.1 per cent) and 1992 (10.1 per cent). Although this revival assisted the nation in regaining some level of foreign currency reserves, the external credit account remained in deficit. Accordingly, the Central Bank continued to undertake prudent policies; however, economic conditions prompted a steep rise in interest rates. Furthermore, under the Structural Adjustment Programme the Government liberalized the foreign exchange market in April 1993. These conditions resulted in the yield curve exhibiting mixed periods of flattening and inversions as spreads fell into negative territory.

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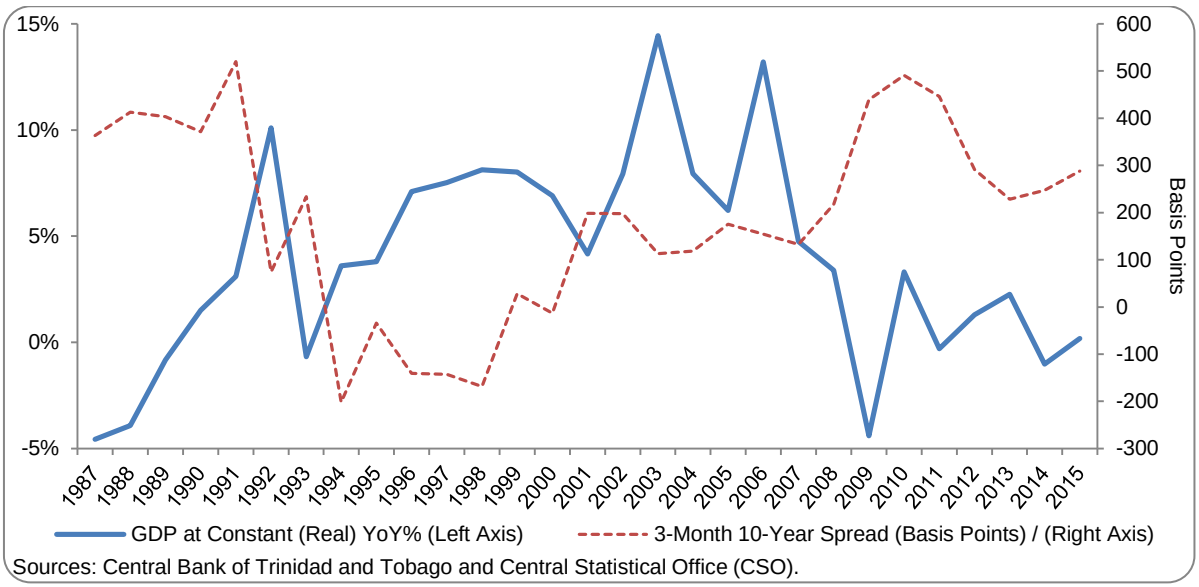
[12] Since the demand for stocks is dependent on expectations of future earnings and the rate of return on substitutable assets, Bosworth proposes that monetary policy can affect the price and demand for stocks by influencing rates on competing assets. Therefore, if the relation between consumption and stock prices characterizes a wealth effect, Bosworth (1975) states that "an explanation for the behaviour of stock prices that includes a link to monetary policy becomes crucial".

[13] In constructing an analytical rational expectations model, Estrella (2005) explains that "the slope of the yield curve is empirically a significant predictor of inflation and real economic activity". The spread according to Estrella, between short-term and long-term interest rates can provide deductions about the slope of the yield curve and from previous literature, the curvature of the slope can be a clear indication of future macroeconomic activity.

[14] In section 3, Trends in Macroeconomic & Financial Indicators, the "spread" refers to the difference between the domestic 3-month and 10-year Treasury rates.

The successful stabilization and structural adjustment policies drove the economy into a new age of prosperity which lasted roughly 15 years starting 1994. During this period, the economy benefitted from increasing energy commodity prices and diversification of the energy sector. However, the sovereign yield curve displayed a negative spread until 2000 when it finally began to trend upwards. Following this, the treasury spread remained relatively stable averaging 158 basis points over the next seven years from the end of 2001 to the end of 2007. Supported by low interest rates and excess liquidity, this new expansionary cycle, in addition to five new company listings and full automation of trading in 2004, boosted the domestic stock market, allowing the All T&T Index (ATI) to climb by roughly 169 per cent over the five year period ending December 2005 (Figure 2). Over the following four years ending 2009, the ATI fell by 17 per cent. This weakened stock market activity was triggered by the absence of major institutional investors[15], however, falling investor enthusiasm, declining performance of domestic energy and non-energy sectors, in addition to record falloffs in international stock markets due to the global financial crisis were contributory.

Figure 1: Trinidad and Tobago – Real GDP (YoY %) & Yield Curve Spread (Basis Points)



Sources: Central Bank of Trinidad and Tobago and Central Statistical Office (CSO).

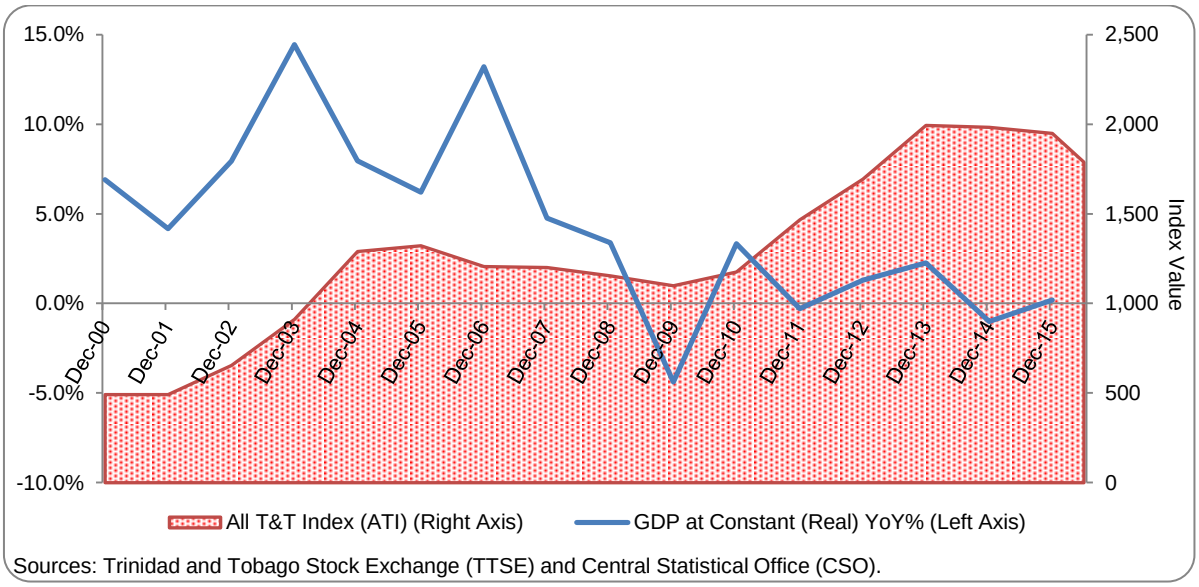
In 2008 as the turmoil in global financial markets intensified, falling commodity prices and reduced demand for energy and non-energy exports began to weaken domestic economic activity. The following year, GDP (-4.4 per cent) contracted for the first time since 1993. Accordingly, the Central Bank of Trinidad and Tobago adopted an accommodative monetary policy stance by reducing the Repo Rate[16]. This policy position reduced short-term rates on the Central Government yield curve; however, long-term rates continued to be elevated. This resulted in the yield curve displaying a steepening trend with the spread increasing from 218 basis points in December 2008 to 491 basis points by the end of 2010. From the end of 2010 to mid-2013, the spread began to fall as economic growth stabilized, albeit at much lower levels than before the financial crisis.

[15] A new regulatory requirement for pension funds which exceeded the 50 per cent limit on equity assets resulted in the funds reducing their equity holdings to within the statutory limits. In the 2005 Stock Exchange Annual Report, then Chairman Mc Eachrane mentioned that, "the limits were exceeded mainly (but not only) by robust increases in market values in recent years. The effect is dramatic, because institutional investors represent some 80 per cent of the investor market, who are now sellers rather than buyers" (2005).

[16] "In May 2002, the Central Bank introduced a new framework for the conduct of monetary policy which focuses on adjustments in its benchmark 'repo rate'. The 'repo rate' is the rate at which the Central Bank provides temporary financing to commercial banks. It provides a signal of the Bank's observed monetary stance and is a means of influencing both short- and long-term market rates" (Central Bank of Trinidad and Tobago – 2002 Annual Economic Survey – Review of the National Economy).

Following two major declines in one decade, the stock exchange once again recovered lost ground as the ATI jumped by 70 per cent during 2010 – 2013[17], supported by a low interest rate environment, excess liquidity in the system, and the successful listing of state owned First Citizens Bank. However, during this period, the economy was relatively flat on account of lower output and increased maintenance-related downtime in the energy sector. Subsequent, anticipation of higher interest rates in the US and rising inflationary pressures caused the Central Bank to adopt a tightening monetary policy position which pushed up treasury spreads. Unexpectedly however, another sharp drop in international energy prices, combined with low domestic energy production ushered in another period of weak economic growth and downturn. Consequentially, over the next two and a half years (January 2014 to June 2016) the ATI fell by roughly 10.0 per cent.

Figure 2: Trinidad and Tobago – Real GDP (YoY %) & TTSE All T&T Price Index (ATI)



Sources: Trinidad and Tobago Stock Exchange (TTSE) and Central Statistical Office (CSO).

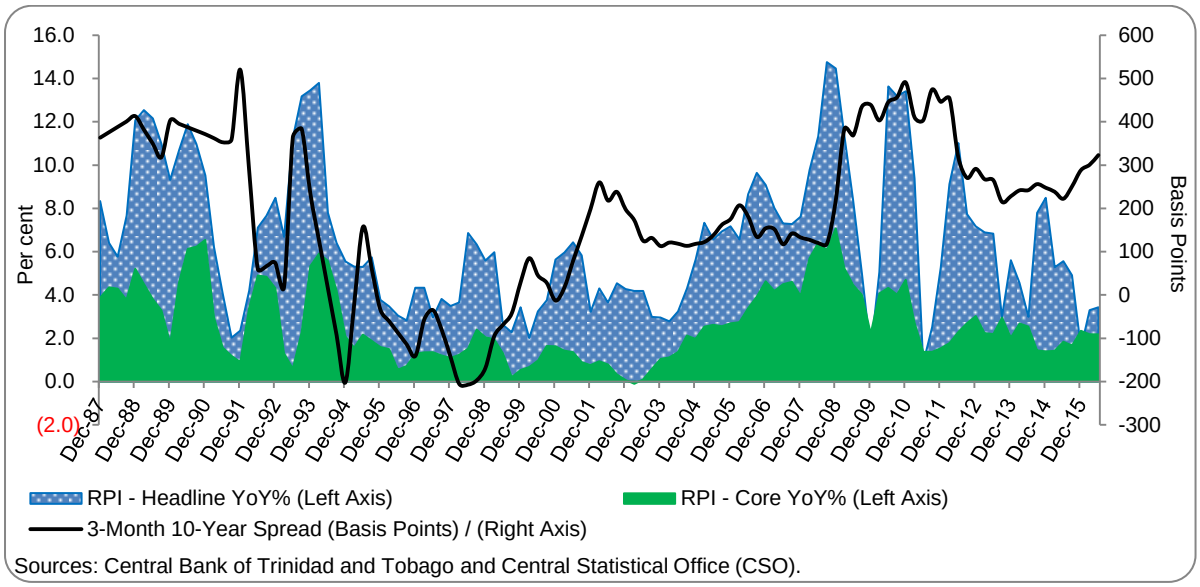
3.2 Inflation & Financial Indicators

During the first half of the 1980's recession, depressed economic conditions weakened headline and core inflation. However, the reduction of local petroleum and other subsidies, in addition to unification of the exchange rate and higher indirect taxes resulted in headline inflation increasing to 8.3 per cent year-on-year in 1987 and maintaining strength throughout the remainder of the recession (Figure 3). During this period, the Treasury spread was significantly high, peaking at 520 basis points by the end of 1991, indicative of the inflationary pressures.

In 1991 following the eight year downturn, inflationary pressures remained calm, suggestive of a more competitive domestic trading environment and considerable spare capacity in the economy. This trend continued until liberalization of the exchange rate at the end of 1993. The first round effects of the foreign exchange adjustment and subsequent currency depreciation (over 20 per cent) was immediately felt by the return to double digit headline inflation (13.4 per cent year-on-year). In line with the adjustments, the Treasury spread jumped considerably (384 basis points) in the second half of 1993. Following this, the foreign exchange rate stabilized in 1994 curtailing inflationary pressures while the yield curve spread continued to fall reflecting contained price pressures.

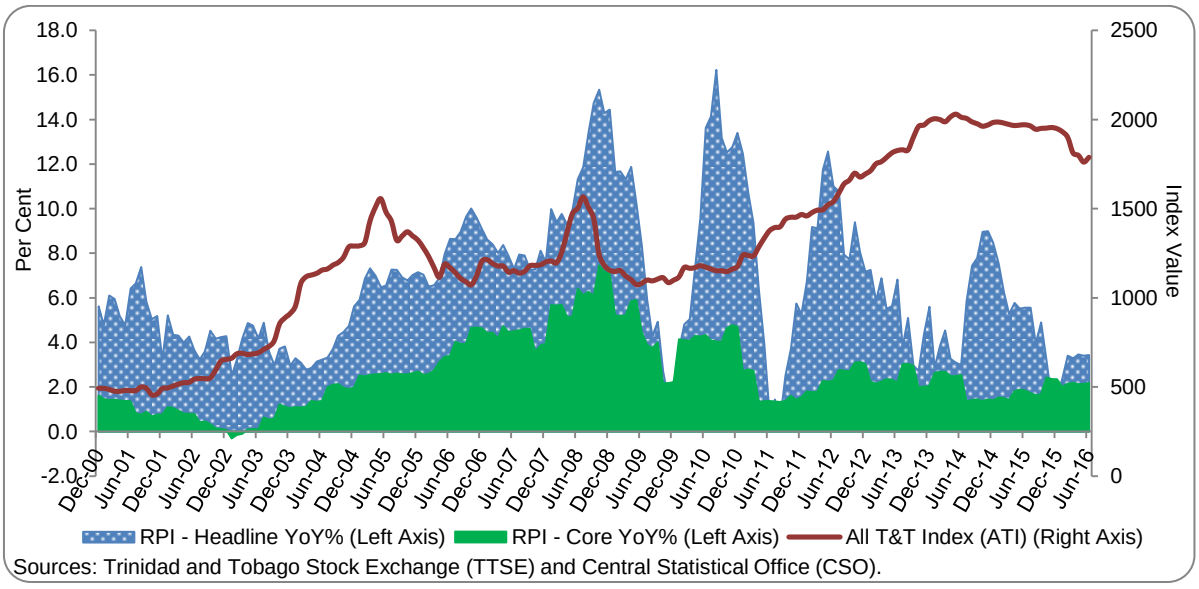
[17] During this period, the Trinidad and Tobago Stock Exchange was recognised as the fifth best performing market in the world and one of only eleven markets to end the year (2011) in positive territory (Platt, 2011).

Figure 3: Trinidad and Tobago – Index of Retail Prices (RPI) (YoY%) & Yield Curve Spread (Basis Points)



Sources: Central Bank of Trinidad and Tobago and Central Statistical Office (CSO).

Figure 4: Trinidad and Tobago – Index of Retail Prices (RPI) (YoY%) & TTSE All T&T Price Index (ATI)



Sources: Trinidad and Tobago Stock Exchange (TTSE) and Central Statistical Office (CSO).

During the early 2000s, inflationary pressures remained subdued, and continued to ease as a result of a reduction in the common external tariff (CET) and the removal of value added tax (VAT) on certain food items. Despite various exogenous influences on price levels, and increased foreign exchange pressures, strong anti-inflationary monetary policy actions assisted in restraining price levels until mid-2000. Strong economic growth and increased domestic demand in 2005 resulted in inflation resurfacing. This inflationary period was buoyed by increased government spending and private consumption, supply bottlenecks, large volumes of merchandise imports, and globally increasing food and energy prices. Prices eventually peaked in 2008 with headline and core inflation reaching 14.7 per cent and 7.1 per cent respectively attributable to weather conditions, increased gasoline prices and a boost in construction costs. Throughout this period, the yield curve spread continued on an upward trajectory reflecting strong economic growth and growing price pressures, while the domestic stock market witnessed robust growth (Figure 4).

Declining economic conditions and lower domestic demand eventually restrained inflationary pressures during 2009, however over the following six years, inflation moderated with some volatility due to fluctuating weather conditions, private demand, and the reduction of the premium gasoline subsidy. Over this period, sluggish economic growth and restricted inflationary pressures resulted in the yield curve flattening somewhat with a lower but stable spread. Additionally, during this time, the All T&T Index (ATI) displayed notable growth until 2014 where it remained relatively flat.

By the end of 2015, the Central Government further reduced fuel subsidies and adjusted VAT; however, as a result of a falloff in economic activity, inflationary pressures were contained. During this time, the yield curve spread expanded mainly on account of previous monetary policy tightening while deteriorating economic conditions placed downward pressures on the performance of the stock market ATI index.

4. Methodology & Dataset

4.1 Methodology

In order to examine the predictive abilities of the financial market indicators the paper employs a three (3) step method designed to estimate the financial indicators predictive probabilities with respect to recession and inflation, followed by statistical evaluations of the probabilities which will determine their success in forecasting macroeconomic conditions. The first step utilizes the probability (probit)[18] model as employed by Estrella and Trubin (2006). This maximum likelihood estimation of a binary choice enables the paper to establish if each financial variable would have predicted a particular macroeconomic condition throughout the period being examined. The second step evaluates the results of the probit model by graphing and calculating the area under the receiver operating characteristic (AUROC)[19] discussed by Liu and Moench (2014). The ROC graphs the sensitivity (portion correctly predicted) versus 1-specificity (portion incorrectly classified), while the AUROC is a measure of the performance of the model. The third and final step conducts a diagnostic sensitivity and specificity analysis explained by Altman and Bland (1994) which provides the overall rates of correct classification, the sensitivity, and the specificity. The following section further describes the methods.

4.2 Probability (Probit) Model

The probability model is determined via a probit equation of the form

$$Macroeconomic\ Variable_{t+x} = \mathcal{F}(\alpha + \beta\ Financial\ Indicator_t)$$

Where the $Macroeconomic\ Variable_{t+x}$ is the probability[20] of a discrete binary proxy represented by a Recession Proxy and Inflation Proxy occurring in *t+x* periods from the viewpoint of information available in period *t.* For probit models, the dependent variables can take the form of only two variables. As such, the discrete binary proxies which are discussed in more detail in the dataset section will follow the following form:

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[18] Most of the literature testing the probability of recessions in the US uses the standard business cycles dating chronology provided by NBER. Since the recession indicator takes the form of a binary variable, and the leading indicators are in the form of continuous data, most empirical literature utilize a probability or probit model to plot changes in the leading indicators with the binary recession variable.

[19] Liu and Moench (2014) explain that since the probit model is hardly ever exactly one or zero, a cut-off range is generally assumed, and any calculated probability above the assumed cut-off value is classified as a predicted recession. Moreover, "in order to objectively evaluate the model's ability to categorize future time periods into recessions versus expansions over an entire spectrum of different cut-offs, one needs to complement the probit model with a classification scheme… that has long been used in the statistics literature but has only recently found its way into economic research is the receiver operating characteristic (ROC) curve" (Liu and Moench, 2014).

[20] In calculating the probability of a recession for a specific value of the term spread, Estrella and Trubin (2006) explain this can be easily calculated using standard spreadsheet programs such as Microsoft Excel®. The probability is computed using the formula

$$Probability = NORMSDIST(\alpha + \beta * (specific\ term\ spread\ value)).$$

Recession_Proxy = 1, if the country is in a recession and 0 otherwise,

RPI_Headline = 1, if the country is experiencing a headline inflationary period and 0 otherwise, and

RPI_Core = 1, if the country is experiencing a core inflationary period and 0 otherwise.

Estrella and Trubin (2006) describe $\mathcal{F}$ as the cumulative normal distribution function represented by:

$$\mathcal{F}(z) = \int_{\infty}^{z} \frac{1}{\sqrt{2\pi}} \exp\left(-x^2/2\right) dx$$

While α and β are constants in the form of the regression residual coefficient and the independent variable coefficient respectively. The dependent variable lead times represented by *t+x* periods are conditional on the time series of the independent variables. As such, the quarterly yield curve spread data is tested with *x = 2 quarters* and *x = 4 quarters* lead times[21] in the dependent variables. Additionally, the monthly stock market index data is tested with *x = 6 months* and *x = 12 months* lead times in the dependent variables. The paper examines out-of-sample since it "provides a much truer test of an indicator's real-world forecasting ability" (Estrella and Mishkin, 1996). In conducting the probit model, robust standard errors were included in the specification. This was used as a cautionary tool in order to guard against the possible presence of heteroscedasticity and possible misspecification of the variance.

4.3 Receiver Operating Characteristic

In discussing the computation and comparison of the ROC[22] curves, Liu and Moench (2014) mentioned that "one method of comparing the predictive ability of classifiers across a spectrum of cut-off values is to integrate the area under the ROC curve, creating the AUROC". Similarly, Christiansen et al (2016) mention that the ROC[23] curve, evaluates a model's ability to distinguish between recessions and expansions. A probit model that results in perfect classification and prediction of recessions across time would "only have true positives and no false positives and an AUROC equal to one". On the other end, a probit model "which is the equivalent of a random guess would have on average an equal number of true and false positives, which corresponds to an AUROC equal to 0.5" (Liu and Moench, 2014). In order to determine if the domestic financial market indicators have any predictive power whatsoever, this paper assumes a cut-off point of an AUROC equal to 0.5.

4.4 Sensitivity and Specificity Classification

Altman and Bland (1994) explain that sensitivity determines "the proportion of true positives that are correctly identified by the test" while specificity determines "the proportion of true negatives that are correctly identified by the test". These tests also scan for Type I errors (false positives) and Type II errors (false negatives). The diagnostic tests will therefore determine how successful the financial market indicators are in predicting macroeconomic conditions given by the recession and inflation proxies. The probit model and diagnostic analysis will be conducted using STATA statistical software, and the results discussed in the following sections.

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[21] A lead time of 1-quarter or 3-months was also examined for both dependent variables with similar results to the 2-quarters or 6-months analysis. However, as the lead times exceeded 4-quarters or 12-months, the predictive power of the financial market variables significantly reduces. As such, the paper follows most literature by examining the indicated lead times.

[22] The receiver operating characteristic (ROC) is commonly used to evaluate the recession predicting ability of numerous leading indicators since it calculates the ability of each probit model to accurately predict economic cycles. Liu and Moench (2014) summarize that "the ROC curve pinpoints the percent of false negatives one would have to trade for one additional percent of true positives. A model with 100% accuracy would draw a ROC curve hugging the top left corner. A model which is the equivalent of a random guess would follow a 45% diagonal that runs from the bottom-left corner to the top-right corner".

[23] Christiansen et al (2016) discuss that "the ROC curve illustrates all potential trade-offs between type 1 and type 2 errors by varying the threshold from 0 to 1. To identify the optimal threshold, a forecaster could move along the ROC curve and analyze relative costs of false alarms and missed signals".

4.5 Dataset - Macroeconomic Variables

The first step is to define a binary proxy for recession from December 1987 to June 2016. Considering that Trinidad and Tobago does not possess a formal system for indicating a recessionary period, the quarterly proxy for a recession was established by reviewing the Central Bank of Trinidad and Tobago (CBTT) publication - Annual Economic Surveys from 1987 to 2015, in addition to yearly constant and current GDP and quarterly CBTT QGDP data. If the publications stated and the data exhibited a recessionary period, then the binary proxy reflected this outcome. The binary recession proxy is used in the probit models to examine the powers of the financial variables in predicting recessions (Table 1).

The second macroeconomic indicators utilized are binary proxies for inflation from December 1987 to June 2016 determined from domestic Retail Price Index (RPI). The first RPI proxy is based on year-on-year headline inflation, and the second proxy is based on year-on-year core RPI inflation. Considering that Trinidad and Tobago lacks a formal inflation targeting strategy, in order to determine an inflationary period, inflation reports in the Central Bank publications were reviewed and an examination of historical RPI data was conducted. Based on the analysis, the paper assumes that an inflationary period was one where the respective year-on-year RPI data point was higher than the long run average of the corresponding RPI variable. In the case of headline inflation, this threshold point was estimated to be 6.6 per cent while the core inflation threshold point was assessed to be 2.6 per cent.

4.6 Dataset – Financial Variables

The various studies on the yield curve's predictive power differ in terms of the selection of the short-term and long-term rate[24], however in this analysis the paper will examine the spread between the 3-month and 10-year Treasury rate. Given the data limitations with respect to historic treasury yields in the domestic economy, the paper utilizes a number of sources for the yield curve spreads in order to maximize the length of the time series being analysed[25]. Quarterly data on the short-term 3-month treasury rate from December 1987 to June 2016 was sourced via the Central Bank of Trinidad and Tobago debt management and open market operations data. Quarterly data on the long-term 10-year Central Government of Trinidad and Tobago bond yield for the same period was sourced from various issues of the Central Bank of Trinidad and Tobago Annual Economic Survey publications (December 1987 to March 2002), in addition to the CBTT Central Government Yield Curve[26,27].

The paper also examines the link between stock prices and forecasts of future macroeconomic changes. For this analysis, monthly data[28] on the All T&T Index (ATI) from the Trinidad and Tobago Stock Exchange (TTSE)[29] was accessed for the period December 2000 to June 2016. The ATI index represents ordinary shares of only locally listed companies on the domestic Exchange and would therefore be the most appropriate to gauge its predictive power of local macroeconomic variables.

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[24] Estrella and Trubin (2006) explain that "in choosing the most appropriate rates, one should consider a number of criteria, including the ready availability of historical data and consistency in the computation of rates over time".

[25] Due to the lack of a standardized yield curve throughout the period being analyzed, actual historic treasury rates were obtained from various sources. For periods with unknown rates, a linear interpolation method was implemented in order to complete the series.

[26] The standardized TT Treasury Yield Curve Is constructed by the Central Bank of Trinidad and Tobago and utilizes domestic market operations data, TTSE Secondary Central Government Bond trade data, and market reads from institutional players.

[27] The 15-year Central Government of Trinidad and Tobago bond yield was also examined with very similar results to the 10-year Central Government bond yield.

[28] Monthly ATI data was used for this analysis due to the shorter time period (2000-2016) available.

[29] Additionally the major Composite Price Index (CPI), which is comprised of all the ordinary shares listed on the domestic Exchange, was examined with similar AUROC results to the ATI Index.

Table 1: Financial and Macroeconomic Variables

Name	Description	Type	Frequency	Period
3_10_Spread	Spread between the 3-month and 10-year rates	Financial	Quarterly	Dec 1987 to June 2016
ATI_MoM_%	All T&T Index (ATI) month on month per cent change	Financial	Monthly	Dec 2000 to June 2016
Recession_Proxy	Binary recession variable	Macroeconomic	Quarterly and Monthly	Dec 1987 to June 2016
RPI_Headline	Binary Headline Retail Price Index variable	Macroeconomic	Quarterly and Monthly	Dec 1987 to June 2016
RPI_Core	Binary Core Retail Price Index variable	Macroeconomic	Quarterly and Monthly	Dec 1987 to June 2016

4.7 Model Specifications

Due to the multiple dependent and independent variables being analysed, the ordering and discussion of the models will be as follows

1. Model 1: Recession Proxy versus Yield Curve Spread
    A. $Recession\_Proxy_{t+2} = \mathcal{F}(\alpha + \beta\ 3\_10\_Spread_t)$
    B. $Recession\_Proxy_{t+4} = \mathcal{F}(\alpha + \beta\ 3\_10\_Spread_t)$
2. Model 2: Recession Proxy versus ATI Index
    A. $Recession\_Proxy_{t+6} = \mathcal{F}(\alpha + \beta\ ATI\_MoM\_\%_t)$
    B. $Recession\_Proxy_{t+12} = \mathcal{F}(\alpha + \beta\ ATI\_MoM\_\%_t)$
3. Model 3: Inflation Proxy versus Yield Curve Spread
    A. $RPI\_Headline_{t+2} = \mathcal{F}(\alpha + \beta\ 3\_10\_Spread_t)$
    B. $RPI\_Headline_{t+4} = \mathcal{F}(\alpha + \beta\ 3\_10\_Spread_t)$
    C. $RPI\_Core_{t+2} = \mathcal{F}(\alpha + \beta\ 3\_10\_Spread_t)$
    D. $RPI\_Core_{t+4} = \mathcal{F}(\alpha + \beta\ 3\_10\_Spread_t)$
4. Model 4: Inflation Proxy versus ATI Index
    A. $RPI\_Headline_{t+6} = \mathcal{F}(\alpha + \beta\ ATI\_MoM\_\%_t)$
    B. $RPI\_Headline_{t+12} = \mathcal{F}(\alpha + \beta\ ATI\_MoM\_\%_t)$

C. $RPI\_Core_{t+6} = \mathcal{F}(\alpha + \beta\ ATI\_MoM\_\%_t)$

D. $RPI\_Core_{t+12} = \mathcal{F}(\alpha + \beta\ ATI\_MoM\_\%_t)$

5. Results

Model 1: Recession Proxy versus Yield Curve Spread

The first model examines if the domestic yield curve spread between the 3-month treasury rate and the 10-year Central Government bond rates displayed any prophetic capabilities in historical recessions. The two models (1A and 1B) tests the predictive power of the 3-month to 10-year spread against a proxy for recession two quarters (t+2) and four quarters (t+4) ahead respectively. The results of the probit model (Table 2), show an AUROC greater than 0.80 for both models indicating that they are significant and perform well in predicting recessions two and four quarters ahead. The AUROC curves for all models can be seen in Appendix 1. However, model 1A examining the predictive capabilities two quarters ahead appears to be stronger with an overall rate of correct classification estimated to be 82.3 per cent with 68.9 per cent (sensitivity) of recessionary periods and 86.9 per cent (specificity) of non-recessionary periods correctly classified. Additionally, the margin analyses for both models indicate that a one unit or one basis-point increase in the spread increases the probability of a recession by roughly 0.001 per cent both two and four quarters ahead. Therefore in terms of a one percentage point increase in the spread (100 basis points), the probability of a recession will rise by roughly 0.1 per cent.

Figure 5 plots the probability of a recession, two and four quarters ahead as predicted by the spread between the 3-month and 10-year treasury rates. In both models, the probability of a recession follows a very similar trend, however, the magnitude of the probabilities seem to be stronger two quarters ahead rather than four quarters ahead. Although the data set starts from 1987, the probit model shows an average of 58.1 per cent chance of a recession two quarters ahead, and 49.2 per cent chance of a recession four quarters ahead during the 1983 to 1990 recession. Following this the economy enters a growth cycle; however the probability of a recession climbs to almost 90.0 per cent and 80.0 per cent respectively in both models during 1991, coinciding with the period of Structural Adjustment and accompanied by economic uncertainty, a growing external deficit, dwindling foreign exchange reserves and the presence of credit rationing. Again in 1993, the probability of a recession leaps to over 50 per cent in both models, which was perhaps reflective of the significant structural changes to the financial and foreign exchange market being undertaken at the time.

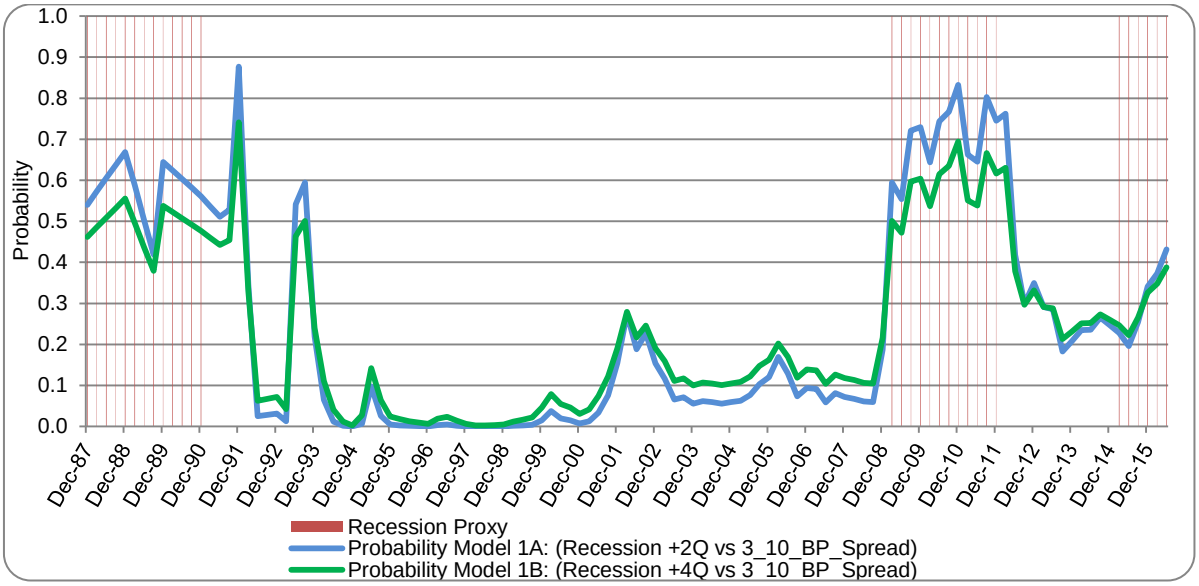
In the midst of the global financial crisis both models revealed a jump in the probability of a recession, averaging 70.3 per cent two quarters ahead and 58.5 per cent four quarters ahead, over the second period of economic weakening in early 2009 to late 2011. Following this, economic activity remained relatively flat. However, from mid-2015, on the heels of weakening conditions in the energy sector and a new economic downturn, both forward looking models peak at roughly 30.0 per cent chance of a recession.

Table 2: Model 1 – Recession Proxy versus Yield Curve Spread – Probit Results Analysis

Model	Dependent Variable	Independent Variable	AUROC	Sensitivity	Specificity	Correctly Classified	Margin
1.A.	Recession Proxy (t+2)	3_10 Spread	0.8828	68.97%	86.90%	82.30%	0.0013972
1.B	Recession Proxy (t+4)	3_10 Spread	0.8137	40.74%	89.29%	77.48%	0.0011316

Source: STATA 11.1 Statistics / Data Analysis Software (2009)

Figure 5: Probability of Recession Two and Four Quarters Ahead, as Predicted by the 3-Month and 10-Year Treasury Spread



Model 2: Recession Proxy versus ATI Index

The following probit model examines if the All T&T Index (ATI) reveals any forewarning of recessions six months and twelve months ahead. Although some false positives are observed in the probabilities, the AUROC results of the probit models (Table 3) indicate that the predictive abilities of the stock market indices are moderate at best, however, still slightly better than a random guess scenario. Model 2A examining the predictive capabilities six months ahead seems to be marginally better with an AUROC of 0.65 and the overall rate of correct classification assessed to be 71.67 per cent. However, with 2.0 per cent (sensitivity) of recessionary periods and 98.46 per cent (specificity) of non-recessionary periods correctly classified, the strength of the stock market accurately predicting recessions is diminished. The margin analysis shows that a one percentage point increase in the index value decreases the probability of a recession by roughly 3.1 per cent and 2.5 per cent respectively. This conforms to the notion that improving stock market performance generally coincides with a growing economy and therefore a reduced chance of an economic downturn.

Figure 6 plots the probability of a recession, six months and twelve months ahead against the All T&T Index (ATI). In this case the models are tested for the 15 year period from December 2000 to December 2015, and as such, only two recessionary periods are noted. In both models, the probability of a recession follows a very similar trend with marginal differences in magnitudes. The first uptick in the probability of a recession occurred in late 2000, likely due to the economy experiencing a slowdown in real GDP growth from 6.9 per cent in 2000 to 4.2 per cent at the end of 2001. The second jump occurred in the second half of 2005 due to the pension fund regulatory requirement reducing equity holdings and resulting in a stock market shock. The third and largest leap in the probability of a recession as predicted by the ATI (78.7 per cent six-months ahead and 70.7 per cent twelve-months ahead) occurred in October 2008, prior to the 2008 to 2011 recessionary period. This was likely due to the domestic stock market anticipating a major decline in stock prices, coinciding with the deteriorating conditions in international stock markets.

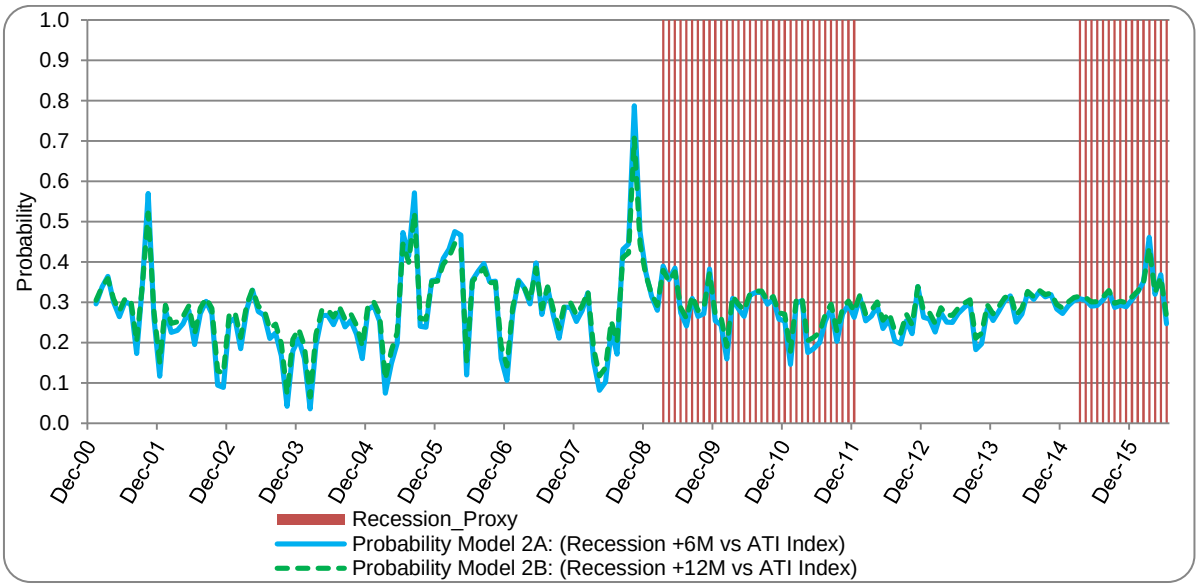
Table 3: Model 2 – Recession Proxy versus ATI – Probit Results Analysis

Model	Dependent Variable	Independent Variable	AUROC	Sensitivity	Specificity	Correctly Classified	Margin
2.A.	Recession Proxy (t+6)	ATI_MoM_%	0.6497	2.00%	98.46%	71.67%	-3.082976
2.B	Recession Proxy (t+12)	ATI_MoM_%	0.6398	2.00%	98.39%	70.69%	-2.51711

Source: STATA 11.1 Statistics / Data Analysis Software (2009)

In the 2015 recession spurred by falling energy-commodity prices, the ATI seems to be somewhat ineffective in predicting a downturn, showing an average of around 30.0 per cent chance six-months and twelve-months ahead respectively during 2015. The limited performance of the ATI in predicting this economic turning point could be due to the effect of the exogenous variable (declining international energy prices), not being anticipated by stock market investors and therefore not being accurately picked up in price changes. However, the probability of a recession jumps to over 40.0 per cent in early 2016 as a result of the transmission of reduced energy revenues displaying a greater effect on domestic firms and subsequently causing the ATI to fall by 9.0 per cent over the first six months of 2016.

Figure 6: Probability of Recession Six and Twelve Months Ahead, as Predicted by the All T&T Index (ATI)



Model 3: Inflation Proxy versus Yield Curve Spread

Model 3 evaluates the abilities of the spread between the 3-month treasury rate with the 10-year Central Government bond rate in predicting periods of strong inflation as defined by headline and core inflation exceeding its long run average, both two quarters and four quarters ahead. The AUROC results indicate that the models perform reasonably well in predicting inflation two and four quarters ahead. Furthermore, the AUROC and classification analysis shows that the 3-month and 10-year spread predicts core inflation more accurately than headline inflation. This could be due to the fact that headline inflation is influenced by volatile food prices, which are essentially exogenous influences not easily detected. Additionally,

the marginal effects indicate that the yield curve spreads exerts a small but positive influence on the probability of headline and core inflation.

Table 4: Model 3 – Inflation RPI Proxy versus Yield Curve Spread – Probit Results Analysis

Model	Dependent Variable	Independent Variable	AUROC	Sensitivity	Specificity	Correctly Classified	Margin
3.A.	RPI Headline (t+2)	3_10 Spread	0.6995	48.00%	69.84%	60.18%	0.0009754
3.B	RPI Headline (t+4)	3_10 Spread	0.6935	48.98%	72.58%	62.16%	0.0009978
3.C	RPI Core (t+2)	3_10 Spread	0.7688	54.55%	82.61%	71.68%	0.0012335
3.D	RPI Core (t+4)	3_10 Spread	0.7271	52.38%	84.06%	72.07%	0.0010822

Source: STATA 11.1 Statistics / Data Analysis Software (2009)

Figure 7 shows the probability of headline inflation, two and four quarters ahead as predicted by the spread between the 3-month and 10-year treasury rates. In both models, the probability of a recession follows almost the same path with minute differences. During the beginning of the economic downturn in 1983 to 1990, inflationary pressures were present due to the reduction of local petroleum and other subsidies. Additionally, the social cost of currency adjustment and the price displacement effects of VAT resulted in headline inflation remaining high. Both probit models (3A and 3B) showed an average of 64.5 per cent and 65.0 per cent probability of headline inflation during this period. Following this, in 1991, the probability of headline inflation jumped to 77.7 per cent and 78.6 per cent two quarters and four quarters ahead respectively, however inflationary pressures remained subdued and well below the long run average. This false positive could be as a result of the domestic treasury yield curve still exhibiting steepness and not accurately adjusting to economic conditions. In 1993 however, the probability of headline inflation in both models jumped to roughly 65.0 per cent as a result of foreign exchange demand pressures, and subsequent system adjustment causing a major TT dollar depreciation. During this time, headline inflation reached double digits and peaked at 13.4 per cent by the end of the year. Subsequent to this, robust anti-inflationary monetary policy actions and the stabilization of the exchange rate assisted in curbing inflationary pressures, however, various exogenous influences during this time would have resulted in the probability models exhibiting some false negatives.

During mid-2005 to mid-2008, headline inflation was higher than its long run average as a result of strong economic growth and expansion in the energy sector. However, the probability models did not reflect this until the end of 2008 to early 2009 when they jumped to over 60.0 per cent, coinciding with the leap in headline inflation to over 14.0 per cent. Over the next three years ending March 2012, the probability of headline inflation averaged roughly 70.0 per cent in both models as the continued effects of high fiscal expenditure and consumption, along with volatile weather conditions and the reduction in fuel subsidies continued to introduce inflationary pressures. The probability and occurrence of headline inflation subsided somewhat over 2012 to 2015, however a slight uptick in the likelihood of headline inflation resurfaced at the end of 2015 and early 2016. This false positive was likely due to tightening monetary policy actions and changing economic conditions steepening the domestic yield curve.

Figure 7: Probability of Headline Inflation Two and Four Quarters Ahead, as Predicted by the 3-Month and 10-Year Treasury Spread

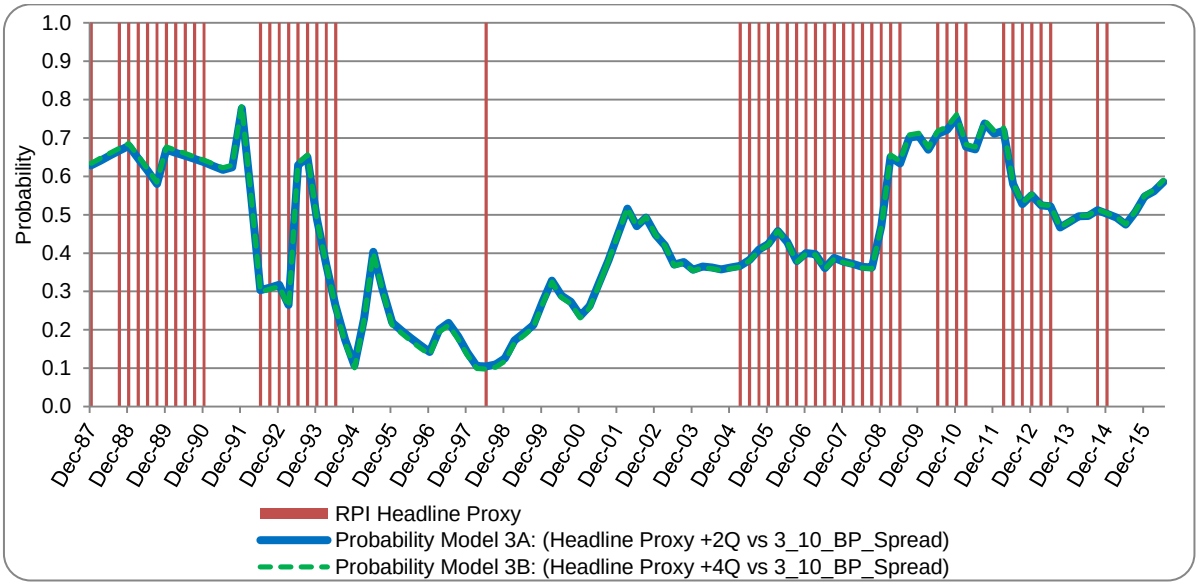
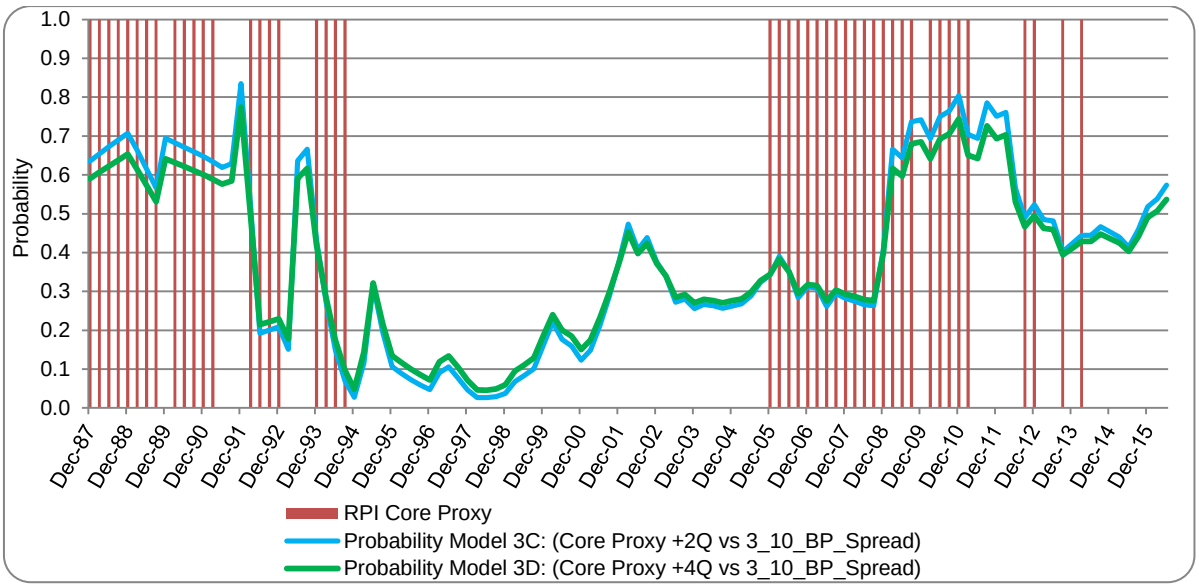


Figure 8: Probability of Core Inflation Two and Four Quarters Ahead, as Predicted by the 3-Month and 10-Year Treasury Spread



The second part of model 3 examines the abilities of the 3-month treasury rate and 10-year bond rate spreads in forecasting core inflation two quarters (t+2) and four quarters (t+4) ahead (Figure 8). Core inflation averaged 4.5 per cent from 1987 to 1990, 190 basis points above its long run average, and as a result of the exchange rate adjustment, price displacement effects of VAT, and correlation with higher headline inflation. The probit models (3C and 3D) seemed to accurately forecast this event, with the probability of core inflation averaging above 60.0 per cent in both models. At the end of 1991, the probability models jumped to 83.5 per cent and 77.4 per cent chance of core inflation, anticipating the resurgence of core inflation in 1992. Furthermore, in 1993 the first round effects of the Structural Adjustment Programme and subsequent currency depreciation added significant inflationary pressures to the domestic economy. Prior to this, the probability models again displayed a strong upswing to around 60.0 per cent, both two quarters and four quarters ahead. The following period

with low and contained core inflation, the models seem to exhibit some volatility and false negatives, however by 2008, the rate spreads would have picked up on inflationary stresses caused by stronger economic growth and higher fiscal and domestic spending. Following this, both the probability and occurrence of core inflation subsided over 2012 to 2015, until a slight uptick was observed at the end of 2015 and early 2016 similar to that of models 3A and 3B.

Model 4: Inflation Proxy versus ATI Index

The final model tests the effectiveness of the stock market's All T&T Index (ATI) in predicting inflationary outcomes six and twelve months ahead. As seen Table 5, headline inflation as predicted by the ATI index, resulted in lower AUROC values which can be considered closely aligned with a random guess. Furthermore, overall correct classification of headline inflation periods recorded lower values than that of the corresponding core inflation classification. In terms of core inflation probit analysis, although the AUROC and overall classification values were higher than headline, the lower sensitivity classification (17.14 per cent and 1.43 per cent) suggests that the ATI does not effectively predict high core inflation periods. Overall, the probit results seem to be varied, however the ATI seems to predict headline and core inflation marginally better six months ahead.

Table 5: Model 4 – Inflation RPI Proxy versus CPI – Probit Results Analysis

Model	Dependent Variable	Independent Variable	AUROC	Sensitivity	Specificity	Correctly Classified	Margin
4.A.	RPI Headline (t+6)	ATI_MoM_%	0.5876	38.82%	78.95%	60.00%	-2.463537
4.B	RPI Headline (t+12)	ATI_MoM_%	0.5112	15.66%	91.21%	55.17%	0.7016989
4.C	RPI Core (t+6)	ATI_MoM_%	0.6256	17.14%	96.36%	65.56%	-3.222407
4.D	RPI Core (t+12)	ATI_MoM_%	0.5755	1.43%	98.08%	59.20%	-1.543152

Source: STATA 11.1 Statistics / Data Analysis Software (2009)

Figure 9 and 10 illustrates the probabilities as given by model 4. As seen, the volatile nature of the probabilities suggests that the model may not be effective in predicting headline or core inflation. The only noticeable peak in likelihood occurred in the second half of 2008, six months ahead for both headline and core inflation. During this time, the domestic stock market experienced robust growth, aided by strong economic expansion in the energy and non-energy sectors. This period also witnessed significant price pressures as headline and core inflation peaked at 14.4 per cent and 7.1 per cent at the end of 2008. During other periods of inflationary pressures, the probit model displays false negatives in the predictive abilities of the All T&T Index.

Figure 9: Probability of Headline Inflation Six and Twelve Months Ahead, as Predicted by the All T&T Index (ATI)

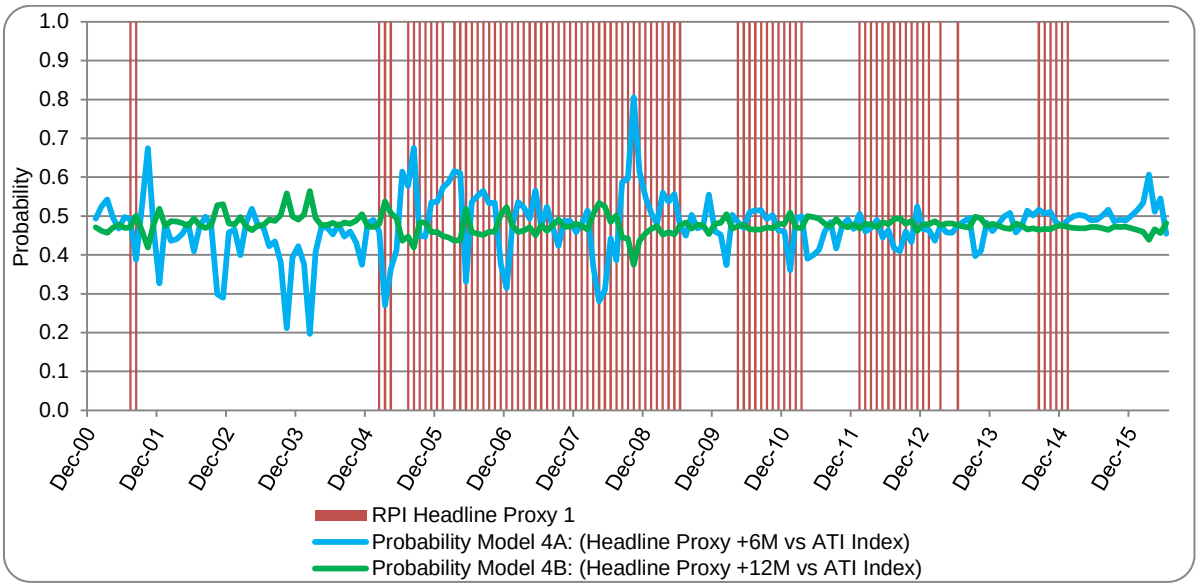
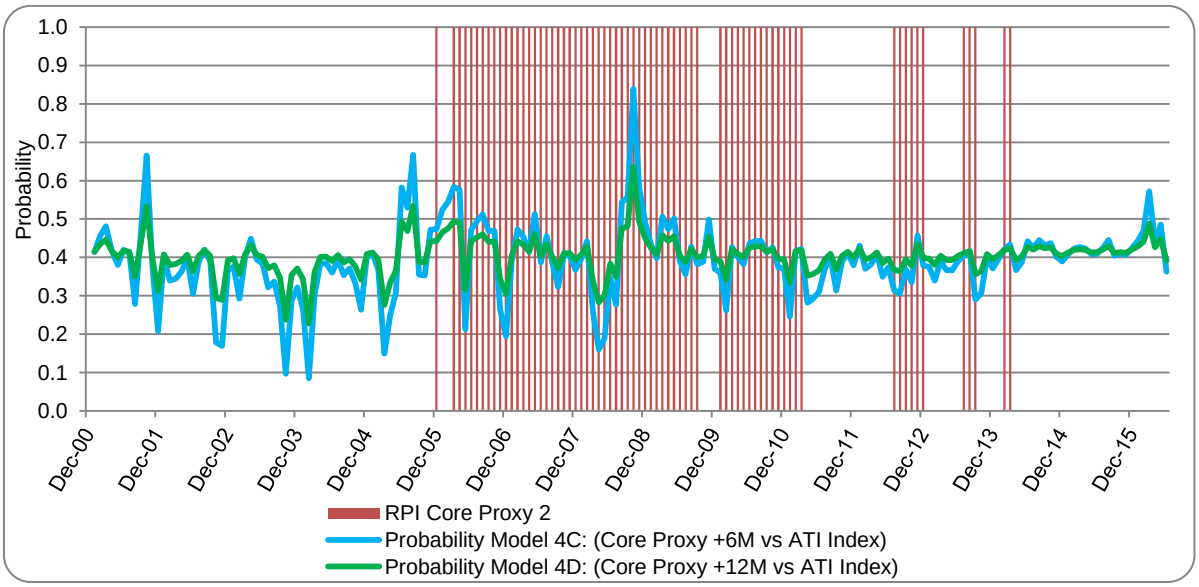


Figure 10: Probability of Core Inflation Six and Twelve Months Ahead, as Predicted by the All T&T Index (ATI)



6. Limitations

Although the paper provides preliminary findings on the predictive powers of financial market indicators, these findings may have been affected by various limitations. The first limitation is the inclusion of the period of the Structural Adjustment Programme from 1989 to 1993. By including this period, the results would be subject to major policy shocks triggering unstable financial market conditions. Notwithstanding, the paper sought to examine the predictive power of these financial market indicators through an extensive time series which included multiple economic turning points in addition to this Standby Agreement period. Alternatively, similar to the examination by Hasegawa and Fukuta (2011), the model could be divided into two periods, pre- and post-Structural Adjustment, to determine if any changes in predictive abilities occurred over the periods. The second constraint involved the lack of available and reliable treasury yield data arising from an ineffective system for price discovery of government securities[30]. Specifically, the lack of a standardized sovereign yield curve throughout the data series resulted in short-term and long-term yields being obtained from various sources which may have different methodologies. Furthermore, available data was not sufficient to cover the entire recessionary period from 1983 to 1990. Considering that the Central Bank of Trinidad and Tobago's key policy rate, the Repo rate, was established in 2002, the paper was also unable to include the policy rate to account for the expectations hypothesis and term premium components of the yield curve slope. The third limitation of this analysis was due to the absence of accessible and reliable stock exchange index data. Available data for the All T&T Index (ATI) spanned from December 2000 to June 2016 resulting in the analysis only covering two economic downturns. As the financial market continues to deepen in Trinidad and Tobago, these variables would eventually possess a sufficiently long time series to re-examine the predictive relationships. A fourth limitation was due to the absence of an official recession definition and announcement. As a result, assumptions were made based on annual real GDP data, quarterly QGDP data, and Central Bank publication statements in order to qualitatively describe a period as recessionary. Finally, the lack of an official inflation targeting structure to outline specific inflationary periods resulted in the paper assuming inflationary periods based on RPI data and by adopting a simple long-run average methodology. A more in-depth analysis into inflationary periods in the domestic economy could provide a more accurate series to examine the predictive abilities of the financial market indicators.

7. Conclusions

This paper provides a preliminary examination of the performance of the domestic sovereign yield curve and the All T&T Index (ATI) in predicting recessions and inflationary periods in the Trinidad and Tobago economy. Similar to the results of Estrella and Mishkin (1995) and Estrella and Trubin (2006), the results obtained from the probit models are encouraging and suggest that the term spread can be useful in predicting possible recessions and inflationary outcomes two to four quarters ahead. This also confirms the findings by Mehl (2006) who determined that the yield curve has information content in Emerging economies. Conversely, the models examining the ATI seem to be average at best in forecasting future recessions, and weak in forecasting inflation. This differs from the findings by Estrella and Mishkin (1995) and Liu and Moench (2014), however, this is likely due to the limited stock market index series and conditions in the domestic stock exchange.

The yield curve spread exhibits robust recession predicting abilities both two and four quarters ahead. However, the magnitude of the probabilities and diagnostic statistics suggests that the spread is better at predicting a recession two quarters ahead. The results also indicate that the yield curve spread is most effective in predicting core inflation, two quarters ahead, however still fairly strong four quarters ahead. Conversely, the yield curve spread's power in predicting

[30] An examination of price discovery within the Trinidad and Tobago government bond market revealed that, "monetary authorities are aware of the shortcomings of the infrastructure (particularly regulatory and supervisory components) which inhibit efficient price discovery in both the primary and secondary market for Government bonds" (Campbell Gill and Birchwood, 2006).

headline inflation is somewhat weaker, likely due to the volatile nature of food prices which can be difficult to predict. The ATI demonstrated varying performances in its macroeconomic predictive abilities. The ATI was marginally stronger in predicting a recession six months compared to twelve months ahead. However, the results indicated a low true positive or sensitivity score, undermining the overall performance of the index. Additionally, the stock market index also proved to be weak in predicting inflation six months ahead and closer to a random guess twelve months ahead. These results suggest that the stock market index may only be partially effective as a leading indicator in predicting recessions, however weak in its ability to predict inflation.

The results of this investigation correlate with evaluations performed by other studies. For example, Mills (1988) found that a "casual observation of stock prices over the post-war period reveals that they do seem to be a leading indicator of recessions, though an imperfect one". Furthermore, on comparing the potentials of bond and stock markets in forecasting economic growth, Harvey (1989) shows that the stock return model has "substantially less explanatory power"[31] when compared to the yield curve spread model that possesses "substantial out-of-sample forecasting power". Since variations in stock price can contain information about future changes in economic conditions in addition to changes in cash flow risks, forecasting using stock prices may be less accurate when compared to that using government bond and yield curve information.

Given that the domestic yield curve spread appears to be a strong predictor of future economic downturns and inflation, it can be adopted as a supplemental forecasting tool. The yield curve simplicity makes it valuable in double-checking[32] major macroeconomic models and even providing preliminary forecasts while major models are being estimated. Furthermore, if the yield curve signals a change in macroeconomic conditions, analysts can then look deeper into major forecasting models for clues on forthcoming changes. Furthermore, Berge (2016) suggests that although "the yield curve is the best-known leading indicator of economic downturns, there are many reasons why conditioning on additional economic indicators is likely to improve forecast ability". According to Berge (2016), considering that the yield curve does not forecast well at all horizons and its predictive power can be affected by risk and term premia in addition to monetary policy actions, "inclusion of other variables that directly measure the real economy likely improve forecast ability". As such, in a growing energy-economy subject to external shocks, utilizing the yield curve as an indicator, in combination with other essential macroeconomic variables, can be a valuable tool in the monetary policy arsenal.

[31] Harvey explains that although earnings are generally positively related to economic growth, fluctuations in stock prices can reflect investors' views about the future performance of firms, and "investors' changing perceptions about the riskiness of cash flows can confound the information about expected economic growth" (Harvey, 1989).

[32] Estrella and Mishkin (1995) mention that "if forecasts from an econometric model and the yield curve agree, confidence in the model's results can be enhanced. In contrast, if the yield curve indicator gives a different signal, it may be worthwhile to review the assumptions and relationships that lead to the prediction".

8. Appendix

Appendix 1: Area Under Receiver Operating Characteristic (AUROC)

Figure 1.A: Recession Proxy (t+2) and 3-10 Spread

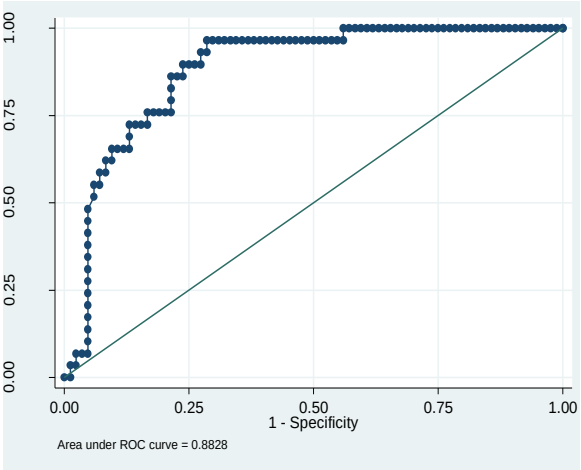


Figure 1.B: Recession Proxy (t+4) and 3-10 Spread

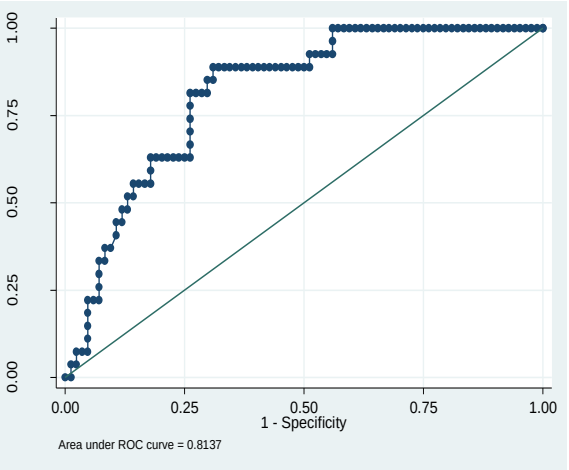


Figure 2.A: Recession Proxy (t+6) and ATI MoM%

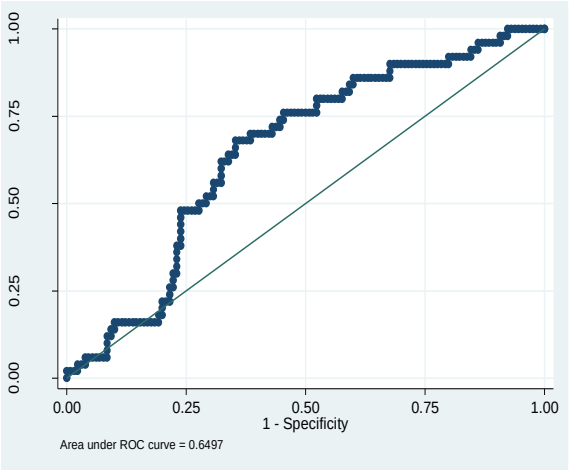


Figure 2.B: Recession Proxy (t+12) and ATI MoM%

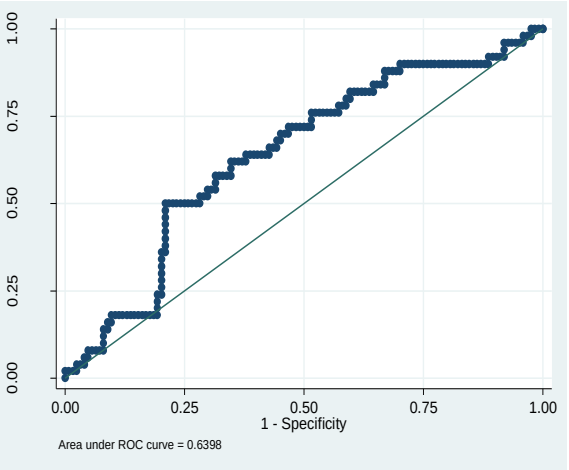


Figure 3.A: RPI Headline (t+2) and 3-10 Spread

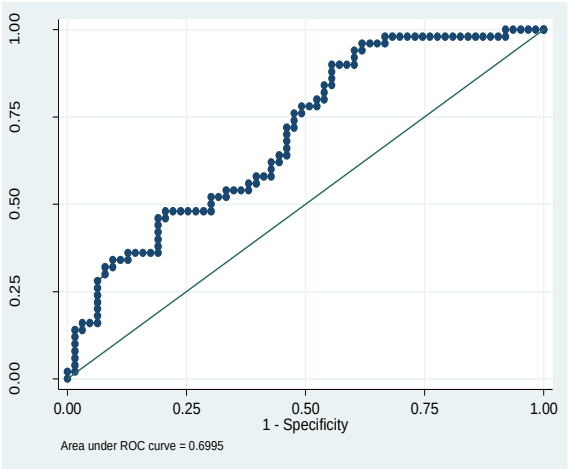


Figure 3.B: RPI Headline (t+4) and 3-10 Spread

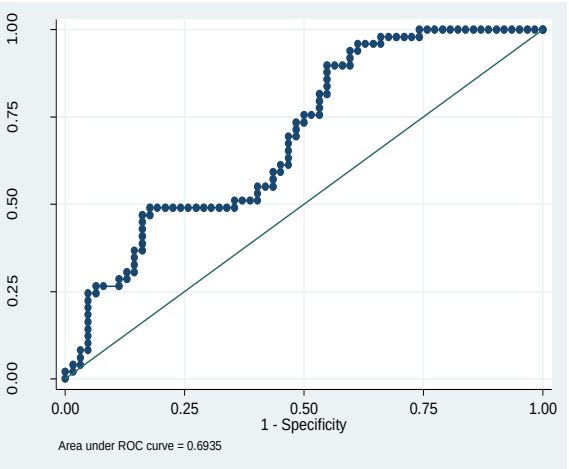


Figure 3.C: RPI Core (t+2) and 3-10 Spread

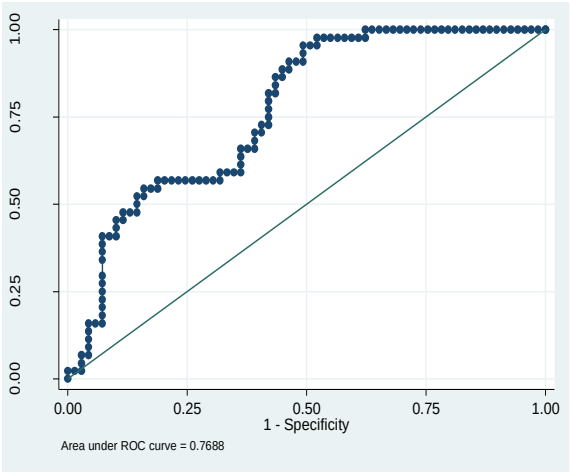


Figure 3.D: RPI Core (t+4) and 3-10 Spread

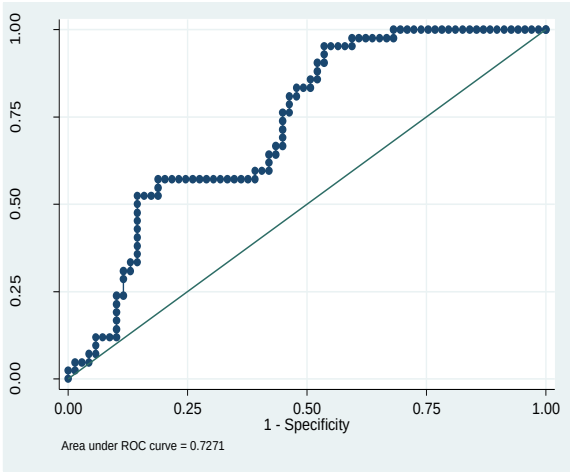


Figure 4.A: RPI Headline (t+6) and ATI MoM%

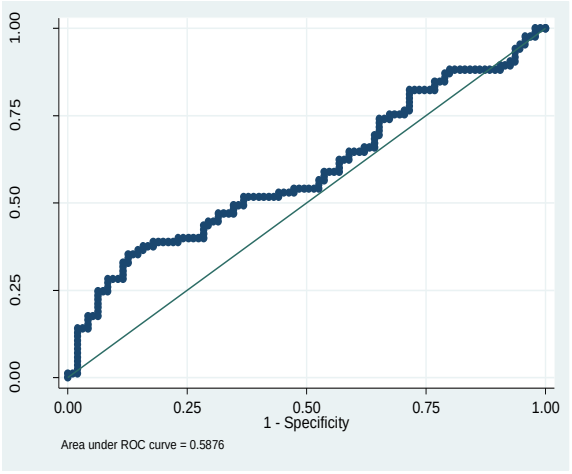


Figure 4.B: RPI Headline (t+12) and ATI MoM%

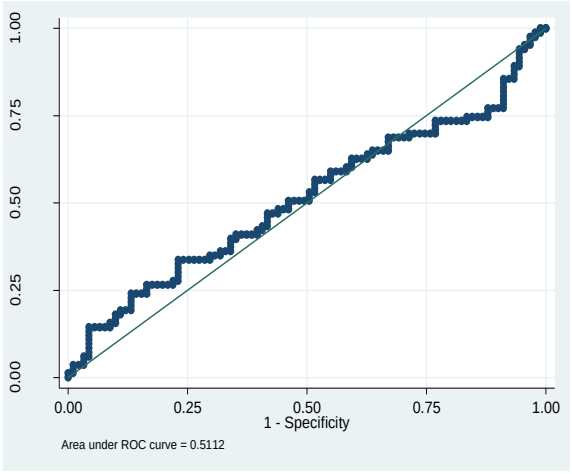


Figure 4.C: RPI Core (t+6) and ATI MoM%

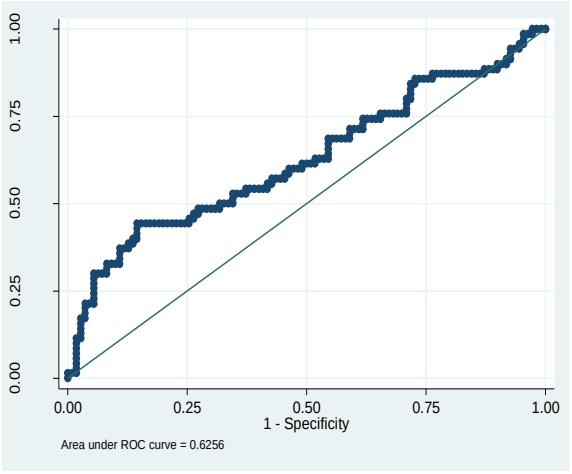
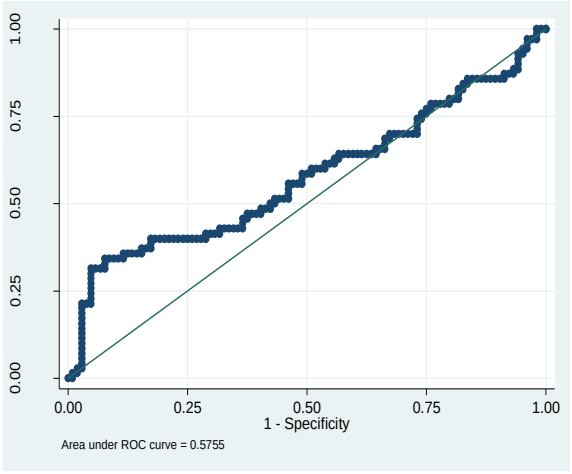


Figure 4.D: RPI Core (t+6) and ATI MoM%



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