THE YIELD CURVE AS A PREDICTOR OF REAL OUTPUT AND INFLATION: EVIDENCE FROM EMERGING MARKETS

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Abstract

For developed economies, it has been shown that the slope of the yield curve is a good indicator of the future path of real output and inflation. This paper investigates the predictive abilities of the yield curve slope for domestic growth and inflation in emerging market economies. Given the sovereign risk premia in these economies, it also assesses whether adding the sovereign risk spread to the yield curve spread improves the predictive content of the yield curve. It finds that the yield curve can predict real output at both the short and long forecasting horizons in emerging economies, the extent of which differs across countries. It also finds that the predictive performance for inflation is weaker than that of output growth, especially in the shorter forecasting horizons, and that the sovereign risk spread has additional predictive content for growth and inflation. This suggests that market participants and monetary policy makers in these economies should supplement their forecasting models with information contained in the yield curve to forecast domestic growth and inflation.

Declaration

I, Sylvester Bokganetswe Kobo, declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted to fulfil the partial requirements for the Master of Management in Finance and Investments degree at the University of the Witwatersrand, Johannesburg. This thesis has not, either in whole or in part, been submitted for a degree or diploma to any other institution or university for a similar qualification. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Signature of candidate: ________________________ Date:______________________

Dedication

This thesis is dedicated to my wife, Renoldah Kobo, who supported and encouraged me throughout this journey and to my boys, Gosego and Kabo Kobo, for having to endure long periods of time without seeing and playing with their daddy. To my parents, Daniel and Johanna Kobo, and my siblings, without you I would not be where I am today. Thank you.

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To Stanlib Asset Management, thank you for making it possible for me to do this course. Victor Mphaphuli and Henk Viljoen, my bosses, thank you for the support, the understanding that I could not always be at work and for challenging and pushing me to always do better.

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1. Introduction

This paper investigates the forecasting abilities of the term structure of interest rates for real output growth and inflation in emerging market economies. Empirical studies over the last three decades have demonstrated that the term spread, which is the spread between the long and short rates, is a good indicator of the future path of real economic activity and inflation, the extent of which differs across countries. Most of the literature on this topic, however, focuses on developed market economies such as the United States and Germany. For instance, (Estrella & Hardouvelis, 1991) provide strong evidence that the slope of the yield curve outperforms an array of leading indicators in forecasting future real activity in the US. (Mishkin, 1990a) and (Mishkin, 1990b) finds that the term spread has predictive content for inflation in the US, especially for longer predictive horizons . Subsequently, (Estrella & Mishkin, 1997) and (Estrella, Rodrigues, & Schich, 2003) extended this study to other OECD countries with generally similar results. This paper builds on this work by extending it to 8 emerging economies to test these relationships.

Studies have shown that effects of monetary policy actions on macroeconomic variables have a lag of one to two years, hence the need for monetary policy makers to make decisions based on expectations of future economic conditions. Although monetary policy decisions have largely been influenced by forecasts of macro-econometric models, (Estrella & Mishkin, 1997) show that financial indicators like the term spread can supplement these models. (Stock & Watson, 2003) assert that financial asset prices are forward looking-in nature and contain information about future economic developments. To this end, market participants will benefit from the predictive nature of the yield curve on inflation and output as these variables feed into asset pricing models.

Very few studies investigated the predictive abilities of the yield curve for emerging economies. (Mehl, 2006) notes that the main reason for this is that the bond markets in these economies were not developed and deep enough until the turn of the century. He investigated these relationships even though he faced challenges with the data; he only had data for the ten years prior and uniformity in the available data was also an issue. Liquidity and depth of emerging economies' bond markets have since improved significantly post the year 2000. For some of these countries, the liquidity was improved by the inclusion and increased weightings of their bonds into Citi Bank's World Government Bond Index and JPMorgan's Emerging Markets Bond Indices. We are now in a position to improve on the work of (Mehl, 2006) since we have over twenty years of data for most of the countries we are studying.

We believe the biggest contribution of this paper will come from the consideration of sovereign risk. Since most of the studies focused on countries like the US and Germany where sovereign risk is considered minimal, none of them considered sovereign spreads in their models. We are going to augment the traditional spread equations as specified in (Stock & Watson, 2003) by adding the sovereign spread to see if it has any additional predictive content for inflation and output in emerging economies. We are also going to investigate if the yield curves of the US and Euro area, as major economies with sizeable financial linkages to emerging markets, has information content for the emerging economies.

The structure for the remainder of this paper is as follows. In section 2 we review the extensive literature on the predictive abilities of the term structure of interest rates. We then formulate the empirical methodology on how to measure these predictive abilities in section 3. In section 4 we describe the data, techniques and empirical tests we use, and then discuss the results obtained. Section 5 concludes.

2. Literature review

There is extensive literature on the predictive abilities of the yield curve dating back to the early 1990s. Many of these studies show that the slope of the yield curve contains information about the future path of real output and inflation. There are at least two possible explanations of why this relationship exists: the effects of monetary policy and market participants' expectations. (Bernanke & Blinder, 1992) find that high short rates cause an economic slowdown, thus if the central bank raises short-term interest rates the expectation is that this will slow down economic activity in the near future. Participants will thus expect future short rates to rise by less than current short rates, leading to a flattening yield curve as long rates rise by less than current short rates. (Dueker, 1997) notes that if investors suspect a recession is near they will expect future short-term interest rates to decline, due to countercyclical monetary policies, until economic activity improves. This will also lead to the flattening or in extreme cases the inversion of the yield curve.

Most of the earlier studies of this relationship focused on the US economy. (Estrella & Hardouvelis, 1991) regress the growth in real GNP on the term spread using OLS and demonstrate that the term spread can predict future real activity and recessions in the US. They found that the term spread outperforms survey forecasts, both in-sample and out-of-sample, for up to four years. (Estrella & Mishkin, 1996) extended this study and found that the yield curve outperformed other financial variables such as stock prices and monetary aggregates in predicting future recessions. They use a probit model, estimated by maximum likelihood, to show that the slope of the yield curve is an accurate predictor of real output between two and six quarters. In support of these findings, (Dueker, 1997) shows that the slope of the yield curve is the best predictor of recessions in the US beyond one quarter.

(Mishkin, 1990a) shows that a flattening (steepening) yield curve indicates expectations of a decreasing (increasing) inflation rate. Using US data from 1964 to 1986, he finds that a term spread has significant information in the future path of inflation for maturities longer than six months. For shorter time horizons, however, he finds no predictive content of term spreads for inflation. (Kozicki, 1997) examined this relationship further by investigating a collection of industrialised countries and acknowledges that the evidence on the term spread's predictive power on inflation is weaker compared to that of real output. She finds that the yield curve has maximum predictive power for inflation at horizons of about three years.

Subsequent studies focused on whether this relationship holds for non-US OECD countries. (Estrella & Mishkin, 1997) and (Estrella, Rodrigues, & Schich, 2003) use post-1970 data and show that the yield curve generally has in-sample predictive content for future growth in these countries as well. (Bernard & Gerlach, 1998) use the probit models as outlined in (Estrella & Mishkin, 1996) to show that the term spread is useful in predicting the probability of a recession in the next eight quarters for all countries surveyed, except Japan. They attributed the lack of the significant relationship to the tight regulation of Japanese financial markets, which limited the role of market expectations in the determination of interest rates in the earlier part of the sample period.

Recent studies, however, are questioning the stability of the predictive powers of the yield curve. (Chinn & Kucko, 2010) point to the deterioration of the relationship between the term spread and economic activity in the ten years since 1998. They find that in-sample results point to the term spread having significant predictive power when forecasting industrial production over a one year horizon, but deteriorating when forecasting two years ahead. (Stock & Watson, 2003) also note that finding an indicator that predicts well in one period is no guarantee that it will predict well in later periods. (Estrella, Rodrigues, & Schich, 2003) test the stability of the predictive power of the yield curve using continuous models, which predict economic growth or inflation, and binary models, which predict recessions. They find that models that predict inflation are more unstable than models that predict real activity, and that binary models are more stable than continuous models.

Literature on the yield curve's predictive powers for emerging economies is scarce. (Mehl, 2006) is the one paper that investigates the relationship between the yield curve and output and inflation in these economies. He follows the methodology outlined in (Stock & Watson, 2003) and finds that the yield curve slope has information content for future output growth and inflation at both short and long forecast horizons in almost all countries studied. In examining spillovers, he finds that the slope of the US yield curve has information content for growth and inflation in all economies. He also finds that the slope of the US or Euro area yield curve is a better predictor than the emerging economies' own domestic slope for most of the countries.

3. Empirical methodology

3.1 In-Sample measures of predictive content

We follow (Stock & Watson, 2003) and (Mehl, 2006) to assess whether the term spread predicts real output growth and inflation. Let X_t denote the term spread and Y_t denote either real output growth or inflation. We use a linear regression relating the value of Y_{t+1} to the value of X_t as follows

$$Y_{t+1} = \alpha + \beta X_t + u_{t+1}, \qquad (1)$$

where α and β are unknown parameters and u_{t+1} is the error term. The test of predictive content of X_t is done by calculating the *t*-statistic on β, and the economic significance of X_t as a predictor is assessed using the regression adjusted-R^2 and the standard error of the regression. In our regression model X_t represents the yield curve spread in month *t,* which is generally defined as the difference between the 10 year local currency government bond yield and the yield on the 3 month treasury bill. The dependent variable, denoted by Y_{t+1}, represents inflation and real output growth interchangeably in month *t+1*. As empirically proven by literature, an increase (decrease) in the yield curve spread leads to a future increase (decrease) in output or inflation.

As noted by (Mehl, 2006) if Y_{t+1} is serially correlated, as is typically the case for time series variables such as inflation and growth, its own past values are themselves useful predictors. Therefore, we test if X_t has predictive content for Y_{t+1} over and above what is already captured in the past values of Y_{t+1}. Past values of X_t can also have predictive content for Y_{t+1} as well, so we extend (1) to include lagged values of both X_t and Y_t:

$$Y_{t+1} = \alpha + \sum_{k=0}^{q} \beta_k X_{t-k} + \sum_{i=0}^{p} \varphi_i Y_{t-i} + u_{t+1} \qquad (2)$$

where α, β_k, φ_i's are unknown parameters, u_{t+1} is an error term and where the maximum lags of X_t and Y_t are of order q and p, respectively. As noted in (Mehl, 2006), if $\beta_k \neq 0$ then the k^{th} lag of X can be used to forecast the future value of Y. This is tested using the Granger causality test statistic.

Equation (2) applies to forecasts 1-period ahead, but can be readily extended to multistep-ahead forecasts by replacing Y_{t+1} with the corresponding h-period ahead value. Thus Y_{t+1} is replaced with the cumulative growth or inflation over the next h months being defined, following (Stock & Watson, 2003) and (Mehl, 2006), as

$$Y_{t+h}^{h} = \alpha + \sum_{k=0}^{q} \beta_k X_{t-k} + \sum_{i=0}^{p} \varphi_i Y_{t-i} + u_{t+h}^{h} \qquad (3)$$

Our forecasting horizon, h, varies from 1 to 24 months ahead. (Stock & Watson, 2003) note that because the error term u_{t+h}^{h} can be heteroskedastic and, due to data overlapping, the error term in (3) is also serially correlated, the test of predictive content based on (3) should be calculated using heteroskedasticity- and autocorrelation-consistent (HAC) standard errors by (Newey & West, 1987).

To test if the sovereign risk has additional predictive content for output and inflation, over and above that of the yield curve spread, we augment equation (3) by adding the country's credit default swap spread, Z_t:

$$Y_{t+h}^{h} = \alpha + \sum_{k=0}^{q} \beta_k X_{t-k} + \sum_{l=0}^{s} \delta_l Z_{t-l} + \sum_{i=0}^{p} \varphi_i Y_{t-i} + u_{t+h}^{h} \qquad (4)$$

If $\delta_l \neq 0$ then the l^{th} lag of Z_t has additional predictive content for the future value of Y. To test for international financial linkages we modify equation (3) by replacing the slope of the yield curve in emerging economies X_t by that of the US or the Euro area, denoted X_t^*:

$$Y_{t+h}^{h} = \alpha + \sum_{k=0}^{q} \beta_k X_{t-k}^{*} + \sum_{i=0}^{p} \varphi_i Y_{t-i} + u_{t+h}^{h} \qquad (5)$$

This equation measures the predictive content of the slope of the yield curve in the US and the Euro area for future growth and inflation in emerging market economies. We are going to use the German yield curve spread as a proxy for the Euro area spread. (Mehl, 2006) notes that since X_t and X_t^* are potentially collinear, having both of them on the right-hand side of (5) would result in a misspecification.

3.2 Pseudo out-of-sample measures of predictive content

Pseudo out-of-sample forecasts closely simulate real-time forecasting using only data available prior to making the forecast. It is a way of testing whether the yield curve is a better predictor of inflation or output than a certain benchmark. (Stock & Watson, 2003) note that a common way to measure pseudo out-of-sample forecast performance is to compute the mean squared forecast error (MSFE) of a candidate forecast (denoted forecast i), relative to a benchmark (denoted forecast 0). We use the forecasting models (3) and (4) as the candidate forecasts and the autoregressive part with 2 lags, AR(2), of (3) as the benchmark. We also use the constant term of (3) as the benchmark, to test if the predicted output or inflation is just an average number. Let $\hat{Y}^h_{0,t+h|t}$ and $\hat{Y}^h_{i,t+h|t}$ be the benchmark and i^{th} candidate pseudo out-of-sample forecasts of Y^h_{t+h}, made using data through time $T_1 - 1$. Then, the h-step ahead mean squared forecast error of the candidate forecast, relative to that of the benchmark forecast, is

$$\frac{\frac{1}{T_2 - T_1 - h + 1}\sum_{t=T_1}^{t=T_2-h}(Y^h_{t+h} - \hat{Y}^h_{i,t+h|t})^2}{\frac{1}{T_2 - T_1 - h + 1}\sum_{t=T_1}^{t=T_2-h}(Y^h_{t+h} - \hat{Y}^h_{0,t+h|t})^2}$$

where T_1 and $T_2 - h$ are respectively the first and last dates of the pseudo out-of-sample forecast. If the relative MSFE is less than one, the candidate forecast is estimated to have performed better than the benchmark.

Since the benchmark models are each nested within model *i*, we also use methods developed by (Clark & McCracken, 2001) and (Clark & West, 2007) to test for predictive accuracy of nested models. We use rolling regressions, in line with literature, to test predictive accuracy using these methods. Let model 0 be the benchmark model and model *i* the larger model that nests model 0. Again, let $\hat{Y}^h_{0,t+h|t}$ and $\hat{Y}^h_{i,t+h|t}$ be the benchmark and i^{th} candidate pseudo out-of-sample forecasts of Y^h_{t+h} with corresponding $t + h$ forecast errors $Y^h_{t+h} - \hat{Y}^h_{0,t+h|t}$ and $Y^h_{t+h} - \hat{Y}^h_{i,t+h|t}$. (Clark & West, 2007) use the adjusted mean squared prediction error (MSPE-adjusted) statistic to compare forecasts of the two models, which is derived as follows:

Let $\hat{\sigma}_0^2$ and $\hat{\sigma}_i^2$ be the sample means of $(Y^h_{t+h} - \hat{Y}^h_{0,t+h|t})^2$ and $(Y^h_{t+h} - \hat{Y}^h_{i,t+h|t})^2$, respectively, and define the adjustment term, "adj", as the sample mean of $(\hat{Y}^h_{0,t+h|t} - \hat{Y}^h_{i,t+h|t})$. Now we define $\hat{\sigma}_i^2$-adj as the difference between $\hat{\sigma}_i^2$ and the adjustment term. To test if the candidate model forecasts are better predicators than the more parsimonious benchmark model forecasts, we compare the mean square prediction errors (MSPE) of the two models. The null hypothesis is that the two have equal MSPE and the alternative is that model *i* has a smaller MSPE than model 1. We test this null by examining $\hat{\sigma}_i^2 - (\hat{\sigma}_i^2 - \text{adj})$ and rejecting it if the difference is significantly positive. (Clark & West, 2007) note that a more computationally convenient way of testing this null is by defining $\hat{f}_{t+h}$ as

$$\hat{f}_{t+h} = (Y_{t+h}^h - \hat{Y}_{0,t+h|t}^h)^2 - [\left(Y_{t+h}^h - \hat{Y}_{i,t+h|t}^h\right)^2 - \left(\hat{Y}_{0,t+h|t}^h - \hat{Y}_{i,t+h|t}^h\right)^2]$$

We then regress $\hat{f}_{t+h}$ on a constant and compare the resulting t-statistic against the critical values +1.282 (for a 10% level of significance) and +1.645 (5% level of significance), using HAC standard errors. We reject the null if the t-statistic is greater than the critical value.

4. Empirical Analysis

Our analysis will be restricted to the following 8 emerging market countries: Hungary, India, Malaysia, Poland, Russia, Singapore, South Africa and South Korea. The criteria for country selection were two-fold: countries with sufficient data samples and geographical representation. We use monthly data from 1999M01 to 2015M12 obtained from Bloomberg, the International Monetary Fund and Federal Reserve Economic Data (St. Louis Fed). For pseudo out-of-sample tests we use the data sample 1999M01 to 2013M12 as our in-sample and 2014M01 to 2015M12 for our out-of-sample analyses. We use the 10-year local currency bond yield as our long rate and the 3-month treasury bill yield as the short rate. The exception to this, due to data constraints, is that for Russia and South Korea we use the 3-month deposit rate instead of the treasury bill yield.

Due to insufficient data samples in emerging economies, we are going to use the industrial production index (ipi) as a measure of output, which is available monthly as opposed to quarterly GDP data. Inflation will be measured by the consumer price index (cpi) of each country, which is also available monthly. We use the 5-year credit default swap (CDS) spread to capture the sovereign risk for each country. India and Singapore are excluded from the sovereign risk analysis due to insufficient CDS spread data. The annual growth rate of inflation and output in month t, respectively, are defined as

$$Y_t = \ln(cpi_t/cpi_{t-12})$$

and $Y_t = \ln(ipi_t/ipi_{t-12})$

where cpi_t is the level of the consumer price index and ipi_t is the level of the industrial production index at month t. These equations can be extended to h-period ahead values, with cumulative growth or inflation over the next h months being defined respectively as

$$Y_{t+h}^{h} = \ln(cpi_{t+h}/cpi_{t-12})$$

$$\text{or } Y_{t+h}^{h} = \ln(ipi_{t+h}/ipi_{t-12})$$

In terms of data transformation, industrial production index and consumer price index data were transformed by taking logarithms. Some of the data also showed significant seasonality, and these series were seasonally adjusted. We also test for unit roots in the logarithms of industrial production and consumer price indices using the Augmented Dickey-Fuller test to determine the order of differencing suitable for the data generating process. We find that all the industrial production data series is I(1) and almost all consumer price data series is also I(1), except for that of Poland which is trend stationary and Hungary which is I(2). As noted by (Mehl, 2006), we treat the yield curve spread as I(0) in line with the literature.

Table 1: Description of the data used in the regressions

Country	Long-term rate	Short-term rate	Sample start date	Sample end date	Sovereign spread start date
Hungary	10-year government bond yield	3-month treasury bill yield	January 1999	December 2015	March 2003
India	10-year government bond yield	3-month treasury bill yield	May 2000	December 2015	
Malaysia	10-year government bond yield	3-month treasury bill yield	October 1999	December 2015	October 2001
Poland	10-year government bond yield	3-month treasury bill yield	May 1999	December 2015	October 2000
Russia	10-year government bond yield	3-month deposit rate	January 1999	December 2015	October 2000
Singapore	10-year government bond yield	3-month treasury bill yield	January 1999	December 2015	
South Africa	10-year government bond yield	3-month treasury bill yield	January 1999	December 2015	October 2000
South Korea	10-year government bond yield	3-month deposit rate	January 1999	December 2015	February 2002

Table 1 outlines the data description in detail and Table 2 below contains the selected data descriptive statistics. The mean inflation rate is 3.73% throughout the sample period, with the dispersion ranging from -0.18% for Russia to 8.30% for Hungary. The negative inflation number for Russia possibly reflects the disinflationary period in Russia following the Russian crisis of 1998, and the same possibly explains the high inflation volatility of 74.54%. Post the 2008 Financial Crisis, inflation lowered to 3.50% (from 4.01% pre-crisis) reflecting the slowdown in activity across the world. Growth also followed a similar trend to inflation, printing 6.84% prior to the crisis and slowing down to 3.01% post the crisis. The median print for growth for the entire sample period is 4.80%, with Malaysia and Singapore showing double-digit volatility in these numbers. As expected, sovereign risks increased after the Financial Crisis, with the median CDS spread almost tripling from 55 basis points before the crisis to 162 basis points after.

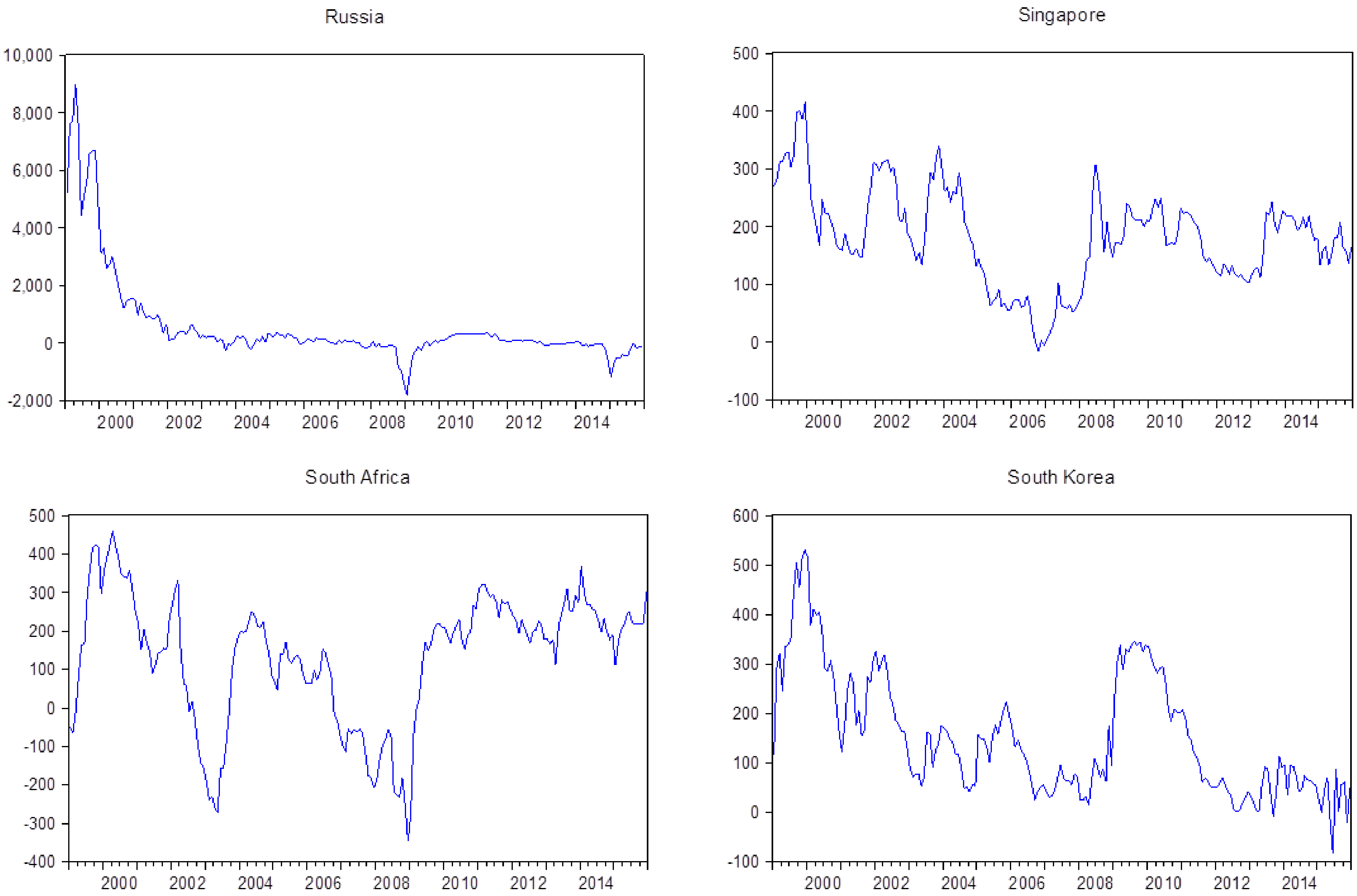
Table 2: Descriptive statistics of the data

Entire Sample Period								
Country	Inflation (YoY, %)		Industrial production (YoY, %)		Credit default swap spread (Basis points)		Yield curve spread (Basis points)	
	Mean	*Std Deviation*	*Mean*	*Std Deviation*	*Mean*	*Std Deviation*	*Mean*	*Std Deviation*
Hungary	8.30	6.59	4.41	8.66	179	163	48	150
India	6.51	2.99	5.46	4.29			100	112
Malaysia	2.21	1.46	4.23	20.96	94	57	135	85
Poland	3.02	2.62	5.18	6.00	82	70	41	234
Russia	-0.18	74.54	2.91	5.89	273	225	587	1637
Singapore	4.43	0.11	5.27	12.70			182	84
South Africa	5.54	2.44	1.09	5.42	157	77	134	168
South Korea	2.57	1.19	6.36	8.23	84	67	154	123
All Countries								
Median	3.73		4.80		126		135	
Average	4.05		4.36		145		173	
Pre-Crisis Period								
Country	Inflation (YoY, %)		Industrial production (YoY, %)		Credit default swap spread (Basis points)		Yield curve spread (Basis points)	
	Mean	*Std Deviation*	*Mean*	*Std Deviation*	*Mean*	*Std Deviation*	*Mean*	*Std Deviation*
Hungary	8.19	6.20	7.85	5.12	30	10	-36	123
India	4.84	1.69	6.86	2.84			128	54
Malaysia	2.33	1.56	5.49	22.51	64	54	167	93
Poland	3.66	3.00	6.81	5.53	41	38	-74	281
Russia	-1.30	87.65	5.78	2.88	304	284	1167	2058
Singapore	4.35	0.04	7.22	11.34			183	107
South Africa	5.15	2.74	2.54	3.35	117	67	108	176
South Korea	2.69	1.02	9.15	6.98	46	27	187	123
All Countries								
Median	4.01		6.84		55		148	
Average	3.74		6.46		100		229	
Post-Crisis Period								
Country	Inflation (YoY, %)		Industrial production (YoY, %)		Credit default swap spread (Basis points)		Yield curve spread (Basis points)	
	Mean	*Std Deviation*	*Mean*	*Std Deviation*	*Mean*	*Std Deviation*	*Mean*	*Std Deviation*
Hungary	8.44	7.05	0.53	10.11	288	134	143	119
India	8.67	2.62	4.13	4.98			73	142
Malaysia	2.05	1.32	2.93	19.26	117	47	100	58
Poland	2.33	1.91	3.42	6.01	130	68	141	111
Russia	1.41	-98.08	0.41	6.67	245	147	-66	376
Singapore	4.55	0.06	3.09	13.81			180	45
South Africa	5.98	1.97	-0.54	6.73	194	68	163	154
South Korea	2.45	1.37	3.21	8.42	112	77	116	112
All Countries								
Median	3.50		3.01		162		129	
Average	4.49		2.15		181		106	

Figure 1 shows the yield curve spread evolution for the sample countries throughout our sample period. What is clear from these graphs is the flattening of the yield curves for all countries prior to the Financial Crisis and the steepening (which is more pronounced) of yield curves after the crisis, due to countercyclical measures employed by central banks.

Figure 1: The evolution of the yield curve slopes of a sample of emerging market countries

Figure 1: *(cont.)*



We are going to estimate our equations using Ordinary Least Squares (OLS). We first run the regressions without any lags and then run them again with lags of the order determined using the Schwarz' Bayesian Information Criterion (SBIC) to adapt the model to the countries' dynamics. For the pseudo out-of-sample analysis, we run rolling regressions with the lag length chosen using the SBIC. For all the forecasts, the SBIC-determined lag length is restricted to be between zero and 12 for each of the independent variables. We also ran robustness checks to test the argument that the predictive power of the yield curve spread has weakened post the Great Financial Crisis of 2008, given the zero-to-negative interest rate environment in developed economies. We define the pre-crisis period as 1999M01 to 2007M12 and the post-crisis period as 2010M01 to 2015M12.

4.1 Results

4.1.1 Estimations of the domestic yield curve in emerging market economies

Tables 3 and 4 present the regression results for the model with no lags and the model with lags of both the dependent and independent variables, respectively, for real output. We find that the slope of the yield curve has predictive content for growth for all countries except Hungary and Malaysia. Consistent with literature, the steepening (flattening) yield curve implies increasing (decreasing) future economic growth and inflation. Looking at the results for South Africa as an example, Table 3 shows that if the yield curve spread is 1% predicted cumulative growth for the next 6 months is 1.55% (-0.01% + (1.56 x 1%) = 1.55%). We find that the slope of the yield curve explains most of the growth in the shorter forecasting horizons and that this economic significance improves for the model with lags (e.g. For Poland, adjusted-R^2 increases from 0.09 for the model without lags to 0.62 when lags are added). Standard errors of the regressions do not change when we increase forecasting horizons for the model with no lags but increases when lags are added.

Table 3: Growth estimates without lagged variables

	Hungary				India				Malaysia			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α					0.04	0.03	0.04					
					(0.01)	(0.01)	(0.01)					
β	*NS*	*NS*	*NS*	*NS*	0.00	0.00	0.00	*NS*	*NS*	*NS*	*NS*	*NS*
					(0.00)	(0.00)	(0.00)					
Adjusted-R^2					0.29	0.38	0.13					
SE of regression					0.04	0.03	0.04					

Table 3: *(cont.)*

	Poland				Russia				Singapre			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.05	0.05		0.06	0.03	0.03	0.03			0.01	0.01	
	(0.01)	(0.01)		(0.01)	(0.01)	(0.01)	(0.01)			(0.03)	(0.03)	
β	0.79	0.77	*NS*	-0.64	0.00	0.00	0.00	*NS*	*NS*	2.78	2.21*	*NS*
	(0.28)	(0.17)		(0.32)	(0.00)	(0.00)	(0.00)			(1.28)	(1.26)	
Adjusted-R^2	0.09	0.08		0.06	0.03	0.06	0.01			0.03	0.02	
SE of regression	0.06	0.06		0.06	0.06	0.06	0.06			0.13	0.13	

	South Africa				South Korea			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.00	-0.01	0.00		0.01	0.01	0.02	
	(0.00)	(0.01)	(0.01)		(0.01)	(0.01)	(0.02)	
β	0.91	1.75	1.17	*NS*	3.48	3.59	1.97	*NS*
	(0.23)	(0.59)	(0.58)		(0.84)	(0.68)	(0.88)	
Adjusted-R^2	0.07	0.29	0.12		0.26	0.29	0.10	
SE of regression	0.05	0.05	0.05		0.07	0.07	0.07	

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

Table 4: Growth estimates with lagged variables

	Hungary				India				Malaysia			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α		0.02			0.01	0.02						
		(0.01)			(0.00)	(0.01)						
β	*NS*	0.91	*NS*	*NS*	0.77	1.86	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
		(0.41)			(0.24)	(0.52)						
ϕ		0.73			0.37	0.30						
		(0.13)			(0.07)	(0.12)						
					0.38							
					(0.08)							
Adjusted-R^2		0.33			0.65	0.45						
SE of regression		0.07			0.03	0.03						

	Poland				Russia				Singapore			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.01	0.03	0.06	0.07	0.00	0.02		0.03	0.00	0.00	0.03	
	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)		(0.01)	(0.01)	(0.03)	(0.03)	
β	0.28	0.51	0.42	-0.49	0.18*	0.53	*NS*	0.47	1.10*	2.53	2.60	*NS*
	(0.08)	(0.16)	(0.20)	(0.25)	(0.10)	(0.22)		(0.20)	(0.63)	(1.21)	(1.46)	
ϕ1	0.37	0.40	-0.18	-0.24	0.85	0.34		-0.28	0.60	0.22	-0.35	
	(0.07)	(0.09)	(0.09)	(0.12)	(0.04)	(0.16)		(0.14)	(0.08)	(0.10)	(0.09)	
ϕ2	0.44		-0.18									
	(0.06)		(0.09)									
Adjusted-R^2	0.62	0.12	0.03	0.12	0.81	0.32		0.08	0.36	0.07	0.13	
SE of regression	0.04	0.06	0.06	0.06	0.03	0.05		0.06	0.10	0.13	0.12	

Table 4: *(cont.)*

	South Africa				South Korea			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.00	-0.01	0.00		0.00	0.00	0.03	
	(0.00)	(0.00)	(0.01)		(0.00)	(0.01)	(0.02)	
β	0.43	1.56	1.36	*NS*	0.65	2.81	3.18	*NS*
	(0.12)	(0.19)	(0.59)		(0.19)	(0.75)	(0.91)	
ϕ1	0.60	0.30	-0.30		0.88	0.76	-0.35	
	(0.07)	(0.06)	(0.08)		(0.04)	(0.18)	(0.15)	
ϕ2	0.27					-0.56		
	(0.07)					(0.19)		
Adjusted-R^2	0.77	0.38	0.21		0.86	0.38	0.23	
SE of regression	0.03	0.04	0.05		0.03	0.06	0.07	

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

The predictive content is not as strong for inflation as it is for growth, especially in the shorter forecasting horizons. Tables 5 and 6 present estimation outputs for the yield curve spread on inflation. We find that when lags of the dependent variable are added to the model, the yield curve has no information content for inflation in most countries. Where there is some information content, the results are inconsistent as coefficient signs are different for different time horizons. The forecasting ability is better when lags of the independent and dependent variables are not included, and in this case we find that slope of the yield curve performs better in longer forecasting horizons for inflation prediction than we saw in predicting growth. The predictive abilities of the yield curve spread for inflation are stronger for Poland and South Africa, while Russia shows predictive content across all forecasting horizons but with high regression standard errors.

Table 5: Inflation estimates without lagged variables

	Hungary				India				Malaysia			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α		0.05							0.03	0.03		
		(0.00)							(0.00)	(0.00)		
β	*NS*	-0.49	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	-0.45	-0.37*	*NS*	*NS*
		(0.23)							(0.19)	(0.22)		
Adjusted-R^2		0.07							0.06	0.04		
SE of regression		0.02							0.06	0.01		

	Poland				Russia				Singapore			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α				0.02	-0.07	-0.13	-0.11	-0.04		0.03	0.03	
				(0.00)	(0.11)	(0.08)	(0.08)	(0.06)		(0.01)	(0.01)	
β	*NS*	*NS*	*NS*	0.18	0.00	0.00	0.00	0.01	*NS*	-0.52*	-0.73	*NS*
				(0.07)	(0.00)	(0.00)	(0.00)	(0.00)		(0.31)	(0.31)	
Adjusted-R^2				0.06	0.04	0.03	0.01	0.03		0.05	0.09	
SE of regression				0.02	0.72	0.59	0.53	0.41		0.02	0.02	

Table 5: *(cont.)*

	South Africa				South Korea			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.07	0.06		0.05			0.02	0.02
	(0.00)	(0.00)		(0.00)			(0.00)	(0.00)
β	-0.85	-0.31	*NS*	0.21	*NS*	*NS*	0.26	0.37
	(0.09)	(0.10)		(0.10)			(0.13)	(0.13)
Adjusted-R^2	0.33	0.04		0.02			0.08	0.15
SE of regression	0.02	0.02		0.02			0.01	0.01

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

Table 6: Inflation estimates with lagged variables

	Hungary				India				Malaysia			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α											0.04	
											(0.01)	
β	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	-0.59*	*NS*
											(0.31)	
											-0.41	
											(0.18)	
Adjusted-R^2											0.19	
SE of regression											0.01	

	Poland				Russia				Singapore			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.02	0.01	0.06	0.07								
	(0.00)	(0.00)	(0.01)	(0.01)								
β	0.19	0.18	0.42	-0.49	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
	(0.07)	(0.06)	(0.20)	(0.25)								
ϕ1	0.27	0.67*	-0.18	-0.24								
	(0.11)	(0.07)	(0.09)	(0.12)								
ϕ2	0.41											
	(0.10)											
ϕ3	0.37											
	(0.10)											
ϕ4	-0.19											
	(0.09)											
Adjusted-R^2	0.69	0.49	0.03	0.12								
SE of regression	0.04	0.01	0.06	0.06								

	South Africa				South Korea			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.00	0.01					0.01	
	(0.00)	(0.01)					(0.01)	
β	0.08	0.34	*NS*	*NS*	*NS*	*NS*	0.39	*NS*
	(0.03)	(0.11)					(0.15)	
ϕ	1.00	0.70					0.29	
	(0.02)	(0.08)					(0.17)	
Adjusted-R^2	0.95	0.34					0.17	
SE of regression	0.01	0.02					0.01	

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

4.1.2 Predictive content of the sovereign risk spread

Table 7: Growth estimates for the model with CDS spread

Without lags	**Hungary**				**Malaysia**				**Poland**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.09	0.09	0.06		0.21	0.12	-0.06	-0.09	0.08	0.08		
	(0.01)	(0.01)	(0.01)		0.06	(0.04)	(0.10)	(0.11)	(0.01)	(0.01)		
β	1.81*	2.92	1.44	*NS*	*NS*	*NS*	*NS*	*NS*	1.20	1.10	*NS*	*NS*
	(0.95)	(1.08)	(0.67)						(0.29)	(0.20)		
δ	-0.04	-0.04	-0.02	*NS*	-0.16	-0.06	0.11	0.09	-0.04	-0.04	*NS*	*NS*
	(0.01)	(0.01)	(0.01)		(0.06)	(0.03)	(0.05)	(0.05)	(0.01)	(0.01)		
Adjusted-R^2	0.32	0.36	0.06		0.24	0.02	0.10	0.10	0.31	0.24		
SE of regression	0.08	0.07	0.09		0.16	0.18	0.18	0.18	0.05	0.06		

	Russia				**South Africa**				**South Korea**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.06	0.05			0.06	0.06	0.02	-0.03	0.07	0.03		
	(0.01)	(0.01)			(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)		
β	0.94	0.81	*NS*	*NS*	0.75	1.81	1.35	*NS*	3.36	4.60	*NS*	*NS*
	(0.13)	(0.13)			(0.24)	(0.38)	(0.26)		(1.15)	(0.95)		
δ	-0.02	-0.01	*NS*	*NS*	-0.04	-0.04	-0.01	0.02	-0.07	-0.04	*NS*	*NS*
	(0.01)	(0.00)			(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)		
Adjusted-R^2	0.49	0.31			0.32	0.63	0.17	0.11	0.54	0.39		
SE of regression	0.04	0.05			0.05	0.04	0.05	0.06	0.05	0.06		

With lagged coeffs.	**Hungary**				**Malaysia**				**Poland**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.02	0.08	0.08						0.02	0.06	0.10	
	(0.01)	(0.03)	(0.01)						(0.01)	(0.01)	(0.02)	
β	0.76		1.71	*NS*	*NS*	*NS*	*NS*	*NS*	0.44	0.90	0.88	*NS*
	(0.36)		(0.78)						(0.09)	(0.20)	(0.18)	
$\delta 1$	-0.01	-0.02	-0.03	*NS*	*NS*	*NS*	*NS*	*NS*	-0.01	-0.03	-0.03	*NS*
	(0.00)	(0.01)	(0.01)						(0.00)	(0.01)	(0.01)	
$\delta 2$		-0.01							0.33	0.37	-0.19	
		(0.01)							(0.07)	(0.10)	(0.09)	
$\phi 1$	0.80	0.16							0.40	-0.17	-0.24	
	(0.05)	(0.07)							(0.06)	(0.07)	(0.08)	
$\phi 2$		-0.19										
		(0.08)										
Adjusted-R^2	0.78	0.80	0.12						0.63	0.30	0.13	
SE of regression	0.04	0.04	0.09						0.04	0.05	0.06	

	Russia				**South Africa**				**South Korea**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.01	0.03			0.02	0.05	0.05		0.02			
	(0.00)	(0.02)			(0.01)	(0.01)	(0.01)		(0.01)			
β	0.29	0.73	*NS*	*NS*	0.47	1.75	1.56	*NS*	1.51	*NS*	*NS*	*NS*
	(0.10)	(0.20)			(0.13)	(0.39)	(0.24)		(0.43)			
$\delta 1$	0.00	-0.01	*NS*	*NS*	-0.12	-0.04	-0.03	*NS*	-0.02	*NS*	*NS*	*NS*
	(0.00)	(0.00)			(0.00)	(0.01)	(0.01)		(0.01)			
ϕ	0.76	0.43			0.53	0.17	-0.03		0.73			
	(0.07)	(0.13)			(0.08)	(0.08)	(0.07)		(0.04)			
					0.28	-0.13*						
					(0.07)	(0.08)						
Adjusted-R^2	0.82	0.37			0.80	0.63	0.34		0.84			
SE of regression	0.03	0.05			0.03	0.04	0.05		0.03			

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

Arguably the biggest finding of this paper is found in Tables 7 and 8, which present the regression results of the domestic yield curve spread augmented with the credit default swap spread for the emerging market economies. We find that the CDS spread has additional predictive content for growth, especially in the short to medium forecast horizons, and also for inflation mostly in the longer forecasting horizons for most countries. The results show that, as expected, an increase (decrease) in the sovereign risk spread leads to a decrease in future growth and inflation. Economic significance of the forecasts, as measured by the adjusted-R^2, is higher for the spread model augmented with the sovereign risk spread than the one without. Exceptions to this are Malaysia, where we find that augmenting the spread equation with sovereign risk has no additional predictive benefit for growth, Poland and Russia where we find that there is still predictive content in the augmented model except that it performs worse than the clean spread model.

This is a significant finding as, in line with our expectations, we find that higher sovereign risks slow down a country's economic activity. This is possibly due to higher borrowing costs for the government and its banking sector and the weaker currency that come with high cds spreads. As with the model in section 5.1, the information content weakens when we include lags of the dependent and independent variables.

Table 8: Inflation estimates for model with CDS spread

Without lags	**Hungary**				**Malaysia**				**Poland**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α			0.05	0.06		0.04	0.04		0.02	0.02		
			(0.01)	(0.01)		(0.01)	(0.01)		(0.00)	(0.00)		
β	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	-0.22	0.01	*NS*	*NS*
									(0.10)	(0.11)		
δ	*NS*	*NS*	-0.01	-0.01	*NS*	-0.01	-0.02	*NS*	0.01	0.01	*NS*	*NS*
			(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)		
Adjusted-R^2			0.11	0.38		0.20	0.32		0.20	0.07		
SE of regression			0.02	0.02		0.01	0.01		0.01	0.01		

	Russia				**South Africa**				**South Korea**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α			0.043		0.05	0.05		0.08	0.03		0.03	
			(0.09)		(0.01)	(0.00)		(0.01)	(0.00)		(0.00)	
β	*NS*	*NS*	0.891	*NS*	-0.85	-0.40	*NS*	*NS*	*NS*	*NS*	0.40	*NS*
			(0.89)		(0.19)	(0.12)					(0.14)	
δ	*NS*	*NS*	-0.051	*NS*	0.01	0.01	*NS*	-0.01	0.00	*NS*	0.00	*NS*
			(0.01)		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	
Adjusted-R^2			0.081		0.48	0.09		0.22	0.07		0.13	
SE of regression			0.350		0.02	0.02		0.02	0.01		0.01	

Table 8: *(cont.)*

With lagged coeffs.	**Hungary**				**Malaysia**				**Poland**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α			0.00		0.0037	0.03	0.05					
			(0.00)		(0.00)	(0.01)	(0.01)					
β	*NS*	*NS*	0.15	*NS*	*NS*	*NS*	*-0.58**	*NS*	*NS*	*NS*	*NS*	*NS*
			(0.06)				(0.30)					
δ	*NS*	*NS*	0.00	*NS*	0.00	-0.01	-0.01	*NS*	*NS*	*NS*	*NS*	*NS*
			(0.00)		(0.00)	(0.00)	(0.00)					
ϕ			-0.34		0.93	0.30	-0.35					
			(0.00)		(0.05)	(0.07)	(0.14)					
Adjusted-R²			0.15		0.86	0.28	0.44					
SE of regression			0.00		0.01	0.01	0.01					

	Russia				**South Africa**				**South Korea**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α					0.00	0.01				0.01	0.01	
					(0.00)	(0.01)				(0.00)	(0.01)	
β	*NS*	*NS*	*NS*	*NS*	0.11*	0.43	*NS*	*NS*	*NS*	0.28	0.54	*NS*
					(0.06)	(0.12)				(0.11)	(0.14)	
δ	*NS*	*NS*	*NS*	*NS*	0.00	-0.01	*NS*	*NS*	*NS*	-0.01	-0.01	*NS*
					(0.00)	(0.00)				(0.00)	(0.00)	
					1.04	0.89				0.83	0.44	
					(0.04)	(0.09)				(0.12)	(0.21)	
Adjusted-R²					0.96	0.44				0.47	0.23	
SE of regression					0.01	0.02				0.01	0.01	

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

4.1.3 Predictive content of the US and Euro area yield curve in emerging economies

Tables 9 and 10 below present the results for the US and Euro yield curves respectively. Contrary to previous literature findings, we find mixed results for the slope of the US yield curve for these emerging market economies. This is to be expected since the US Federal Reserve (Fed) officials employed accommodative monetary policy, in the form of quantitative easing and near-zero interest rates, for many years since the financial crisis without the benefit of resultant high growth and inflation. For inflation there is no information content for half of the countries we are investigating, and where we find predictive content we mostly find that there is an inverse relationship to what previous literature reports (i.e. an increase in the yield curve spread leads to a decrease in inflation). For growth, we also find significant predictive content for half of the countries we investigate, especially in the longer horizons (12 and 24 months). The significance worsens when we add lags of the dependent variable to the model for both inflation and growth predictions.

The predictive content for growth is stronger for the Euro area yield curve as it has information content for all countries. For Hungary and Malaysia we find that the slope of the Euro area yield curve is a better predictor of their growth than their domestic yield curve spread, as we earlier noted that their domestic spread had no predictive content for growth. It can be argued that

Table 9: Estimates of the US yield curve's predictive abilities in emerging markets

Growth	**Hungary**				**India**				**Malaysia**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.10	0.08										-0.06
	(0.01)	(0.01)										(0.07)
β	-0.03	-0.02	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	0.05
	(0.01)	(0.01)										(0.03)
Adjusted-R^2	0.18	0.08										0.09
SE of regression	0.08	0.09										0.19

	Poland				**Russia**				**Singapore**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α				0.01				0.00			0.00	-0.01
				(0.02)				(0.02)			(0.03)	(0.03)
β	*NS*	*NS*	*NS*	0.02	*NS*	*NS*	*NS*	0.02	*NS*	*NS*	0.03	0.03
				(0.01)				(0.00)			(0.01)	(0.01)
Adjusted-R^2				0.15				0.13			0.08	0.07
SE of regression				0.06				0.06			0.12	0.12

	South Africa				**South Korea**			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.04	0.03		-0.02				
	(0.01)	(0.01)		(0.01)				
β	-0.01	-0.01	*NS*	0.02	*NS*	*NS*	*NS*	*NS*
	(0.01)	(0.00)		(0.00)				
Adjusted-R^2	0.08	0.03		0.11				
SE of regression	0.05	0.06		0.05				

Inflation	**Hungary**				**India**				**Malaysia**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.07	0.07	0.07	0.05	0.05	0.05						
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)						
β	-0.01	-0.01	-0.01	-0.01	0.01	0.01*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)						
Adjusted-R^2	0.17	0.24	0.19	0.06	0.10	0.07						
SE of regression	0.02	0.02	0.02	0.02	0.03	0.03						

	Poland				**Russia**				**Singapore**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α		0.04	0.04									
		(0.01)	(0.01)									
β	*NS*	-0.01*	-0.01	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
		(0.00)	(0.00)									
Adjusted-R^2		0.07	0.07									
SE of regression		0.02	0.02									

	South Africa				**South Korea**			
	1M	6M	12M	24M	1M	6M	12M	24M
α		0.06	0.07	0.08	0.02			
		(0.00)	(0.01)	(0.00)	(0.00)			
β	*NS*	-0.00*	-0.01	-0.02	0.00	*NS*	*NS*	*NS*
		(0.00)	(0.00)	(0.00)	(0.00)			
Adjusted-R^2		0.01	0.11	0.58	0.09			
SE of regression		0.03	0.02	0.02	0.01			

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

European yield curve spread's better performance is due to the European Central Bank (ECB) only adopting quantitative easing years after their US counterparts' program. For inflation we obtain similar results to the US yield curve.

Table 10: Estimates of the EU yield curve's predictive abilities in emerging markets

Growth	**Hungary**				**India**				**Malaysia**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α	0.09		-0.02			0.04		0.08	-0.10	-0.13	-0.05	
	(0.02)		(0.04)			(0.01)		(0.01)	(0.09)	(0.09)	(0.03)	
β	-0.04*	*NS*	0.04	*NS*	*NS*	0.02	*NS*	-0.02	0.10	0.12	0.06	*NS*
	(0.02)		(0.02)			(0.01)		(0.01)	(0.05)	(0.05)	(0.02)	
Adjusted-R^2	0.09		0.12			0.07		0.08	0.11	0.17	0.05	
SE of regression	0.09		0.08			0.04		0.04	0.22	0.21	0.21	

	Poland				**Russia**				**Singapore**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α		0.02	0.01				-0.01		0.01	-0.06	-0.06	
		(0.02)	(0.02)				(0.03)		(0.03)	(0.03)	(0.04)	
β	*NS*	0.02	0.03	*NS*	*NS*	*NS*	0.03	*NS*	0.04	0.08	0.07	*NS*
		(0.01)	(0.01)				(0.01)		(0.02)	(0.02)	(0.02)	
Adjusted-R^2		0.08	0.10				0.13		0.04	0.23	0.18	
SE of regression		0.06	0.06				0.05		0.13	0.12	0.12	

	South Africa				**South Korea**			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.00		0.00	0.00		0.01	0.02	
	(0.00)		(0.01)	(0.01)		(0.03)	(0.03)	
β	0.91	*NS*	1.17	0.58	*NS*	0.04	0.03	*NS*
	(0.23)		(0.58)	(0.23)		(0.01)	(0.01)	
Adjusted-R^2	0.07		0.12	0.03		0.13	0.08	
SE of regression	0.05		0.05	0.06		0.08	0.07	

Inflation	**Hungary**				**India**				**Malaysia**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α		0.07			0.04	0.05	0.06		0.03	0.03		
		(0.01)			(0.01)	(0.01)	(0.00)		(0.00)	(0.01)		
β	*NS*	-0.01	*NS*		0.02	0.01*	0.01*	*NS*	-0.01	-0.01*	*NS*	*NS*
		(0.00)			(0.01)	(0.01)	(0.00)		(0.00)	(0.00)		
Adjusted-R^2		0.06			0.16	0.09	0.02		0.10	0.09		
SE of regression		0.02			0.03	0.03	0.03		0.01	0.01		

	Poland				**Russia**				**Singapore**			
	1M	6M	12M	24M	1M	6M	12M	24M	1M	6M	12M	24M
α						0.30	0.06					
						(0.13)	(0.13)					
β	*NS*	*NS*	*NS*	*NS*	*NS*	-0.29	-0.14*	*NS*	*NS*	*NS*	*NS*	*NS*
						(0.09)	(0.09)					
Adjusted-R^2						0.14	0.05					
SE of regression						0.54	0.49					

Table 10: *(Cont.)*

	South Africa				South Korea			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.08	0.08	0.08	0.08				
	(0.01)	(0.01)	(0.01)	(0.01)				
β	-0.01	-0.01	-0.01	-0.01	*NS*	*NS*	*NS*	*NS*
	(0.00)	(0.00)	(0.00)	(0.00)				
Adjusted-R^2	0.16	0.17	0.18	0.20				
SE of regression	0.02	0.02	0.02	0.02				

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the *5% level of confidence*

4.1.4 **Robustness checks**

Inspections of Tables 11 and 12 below reveal that yield curve slope's predictive powers for growth has improved for all countries except Poland and South Africa after the global financial crisis. This is contrary to expectations that, since central banks across the world cut short rates to zero or even negative for some countries and growth and inflation still remained subdued for protracted periods, the shape or slope of the yield curve's performance as a predictor of growth and inflation would have worsened. For South Africa and Poland, we find that the slope of the yield has no predictive content across all forecasting horizon. This is possibly due to both Countries' central banks cutting and keeping interest rates low for longer, similar to the ECB and the Fed, even when inflation was bridging their target on the upper side and growth was improving from the financial crisis lows. For inflation, the performance of the spread has worsened as expected for all countries except Korea and South Africa.

4.1.5 **Forecasts evaluation**

Looking at the results of MSFEs as the forecasting evaluation tool (Tables 13 and 14), we see that our forecasting models generally perform better that the constant when it comes to forecasting accuracy, across all horizons. We also find that the mean squared forecasting errors of the spread model with the CDS spread are consistently smaller than those of the pure spread model, meaning the CDS spread performs better than the pure spread model across all horizons. The autoregressive process is a better forecaster of growth and inflation that the constant term and in some cases, especially in the shorter horizons, the AR model performs better than our candidate forecasts models. This is more the case for inflation than growth.

The results also reveal that, in terms of forecasting accuracy, the yield curve spread is a better predictor of growth than inflation given the lower MSFEs of growth forecasts. For growth, the yield curve's performance as a predictor is best seen in Hungary, South Africa and Korea. The yield curves

Table 11: Robustness checks for growth

Hungary	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α		0.08	0.07		-0.02	-0.03	0.00	
		(0.01)	(0.01)		(0.02)	(0.01)	(0.02)	
β	*NS*	0.89	0.90*	*NS*	3.39	3.38	1.40	*NS*
		(0.52)	(0.52)		(0.96)	(0.82)	(0.82)	
Adjusted-R^2		0.04	0.02		0.19	0.19	0.03	
SE of regression		0.05	0.06		0.05	0.05	0.05	

India	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.09			0.02	0.02	0.02	0.02	0.02
	(0.01)			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β	-1.66	*NS*	*NS*	-0.51*	2.95	1.85	1.13	-0.51*
	(0.85)			(0.26)	(0.49)	(0.27)	(0.25)	(0.26)
Adjusted-R^2	0.09			0.04	0.49	0.32	0.17	0.04
SE of regression	0.03			0.03	0.03	0.03	0.03	0.03

Malaysia	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α		0.21	0.15		-0.07	0.02		
		(0.07)	(0.10)		(0.04)	(0.03)		
β	*NS*	-10.62	-9.07	*NS*	17.95	5.37	*NS*	*NS*
		(4.21)	(5.07)		(3.90)	(2.64)		
Adjusted-R^2		0.23	0.13		0.44	0.05		
SE of regression		0.18	0.21		0.08	0.08		

Poland	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.08	0.01	0.07					
	(0.01)	(0.01)	(0.01)					
β	1.35	1.13	0.50*	*NS*	*NS*	*NS*	*NS*	*NS*
	(0.33)	(0.22)	(0.29)					
Adjusted-R^2	0.44	0.31	0.05					
SE of regression	0.42	0.05	0.06					

Russia	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.07	0.07	0.06		0.02	0.07	0.01	-0.01
	(0.00)	(0.00)	(0.01)		(0.01)	(0.00)	(0.01)	(0.01)
β	-0.43	-0.28	-0.13	*NS*	0.92	-0.28	0.58	0.79
	(0.09)	(0.07)	(0.05)		(0.27)	(0.07)	(0.18)	(0.37)
Adjusted-R^2	0.29	0.21	0.07		0.50	0.21	0.27	0.16
SE of regression	0.02	0.03	0.03		0.03	0.03	0.03	0.03

Singapore	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α		0.03			-0.17	-0.11		
		(0.03)			(0.07)	(0.06)		
β	*NS*	1.99	*NS*	*NS*	12.81	7.57	*NS*	*NS*
		(1.04)			(4.93)	(3.67)		
Adjusted-R^2		0.03			0.18	0.11		
SE of regression		0.11			0.11	0.09		

South Africa	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.02	0.02						
	(0.00)	(0.01)						
β	0.53	0.85	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
	(0.18)	(0.26)						
Adjusted-R^2	0.07	0.23						
SE of regression	0.03	0.03						

South Korea	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.03	0.05			-0.02	-0.01	-0.01	
	(0.01)	(0.01)			(0.01)	(0.01)	(0.01)	
β	3.53	2.22	*NS*	*NS*	5.87	3.50	2.16	*NS*
	(0.74)	(0.79)			(0.57)	(0.37)	(0.46)	
Adjusted-R^2	0.38	0.17			0.82	0.65	0.40	
SE of regression	0.05	0.06			0.02	0.02	0.02	

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the 5% level of confidence

Table 12: Robustness checks for inflation

Hungary

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.06		0.06	0.06		0.05	0.06	
	(0.00)		(0.00)	(0.00)		(0.01)	(0.00)	
β	0.98	*NS*	0.84	0.70	*NS*	-1.43	0.84	*NS*
	(0.19)		(0.19)	(0.15)		(0.40)	(0.20)	
Adjusted-R^2	0.31		0.22	0.18		0.21	0.22	
SE of regression	0.02		0.02	0.02		0.02	0.02	

India

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.04				0.08			
	(0.01)				(0.01)			
β	1.50	*NS*	*NS*	*NS*	0.88*	*NS*	*NS*	*NS*
	(0.61)				(0.47)			
Adjusted-R^2	0.24				0.15			
SE of regression	0.03				0.02			

Malaysia

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α								
β	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Adjusted-R^2								
SE of regression								

Poland

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.02			0.03				-0.01
	(0.00)			(0.00)				(0.00)
β	-0.33	*NS*	*NS*	0.21	*NS*	*NS*	*NS*	1.18
	(0.09)			(0.07)				(0.22)
Adjusted-R^2	0.30			0.16				0.57
SE of regression	0.01			0.01				0.01

Russia

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α			0.03		0.08	0.06		
			(0.07)		(0.09)	(0.11)		
β	*NS*	*NS*	-1.99	*NS*	-10.55	-5.16	*NS*	*NS*
			(0.29)		(2.58)	(2.83)		
Adjusted-R^2			0.60		0.29	0.06		
SE of regression			0.33		0.45	0.52		

Singapore

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α			0.03	0.03				
			(0.01)	(0.01)				
β	*NS*	*NS*	-0.83	-0.88	*NS*	*NS*	*NS*	*NS*
			(0.38)	(0.38)				
Adjusted-R^2			0.19	0.19				
SE of regression			0.02	0.02				

South Africa

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.06				0.04	0.03		
	(0.00)				(0.00)	(0.00)		
β	-0.79	*NS*	*NS*	*NS*	0.40	0.77	*NS*	*NS*
	(0.13)				(0.20)	(0.19)		
Adjusted-R^2	0.25				0.04	0.17		
SE of regression	0.02				0.01	0.01		

South Korea

	Pre-crisis				Post-Crisis			
	1M	6M	12M	24M	1M	6M	12M	24M
α	0.03	0.03			0.01	0.01	0.01	0.01
	(0.00)	(0.00)			(0.00)	(0.00)	(0.00)	(0.00)
β	-0.33	-0.21	*NS*	*NS*	0.67	0.92	1.10	0.54
	(0.11)	(0.10)			(0.17)	(0.19)	(0.12)	(0.10)
Adjusted-R^2	0.15	0.06			0.25	0.48	0.73	0.64
SE of regression	0.01	0.01			0.01	0.01	0.01	0.00

Notes: NS = not significant. Coefficients values with * denotes significance at the 90% confidence level, the rest show significance at the 5% level of confidence

Table 13: Growth forecast evaluation statistics

		Hungary				India				Malaysia			
		Spread		Spread with CDS		Spread				Spread		Spread with CDS	
Horizon		Constant	AR	Constant	AR	Constant	AR			Constant	AR	Constant	AR
1M	MFSE	0.994	3.311	0.196	0.651	0.706	1.750			0.895	2.662	0.481	1.430
	MSPE-Adj.(Clark & West)	0.522	-0.081	2.141	2.403	2.513	1.879			-0.020	-0.523	1.891	0.663
6M	MFSE	0.677	0.814	0.663	0.798	0.549	0.685			0.820	0.941	0.072	0.082
	MSPE-Adj.(Clark & West)	1.692	3.128	1.890	2.581	3.605	2.387			1.084	0.696	3.110	3.315
12M	MFSE	0.988	0.999	0.954	0.965	0.867	0.897			0.875	1.160	0.672	0.891
	MSPE-Adj.(Clark & West)	0.899	0.797	0.895	0.730	2.829	1.969			1.186	0.717	1.709	0.709
24M	MFSE	0.919	0.962	0.848	0.887	1.003	1.005			0.766	0.787	0.719	0.739
	MSPE-Adj.(Clark & West)	2.802	1.519	2.224	1.225	0.587	0.584			1.295	0.777	2.203	1.913

		Poland				Russia				Singapore			
		Spread		Spread with CDS		Spread		Spread with CDS		Spread			
Horizon		Constant	AR	Constant	AR	Constant	AR	Constant	AR	Constant	AR		
1M	MFSE	0.936	2.289	0.464	1.135	0.797	2.601	0.130	0.425	0.986	1.398		
	MSPE-Adj.(Clark & West)	2.463	0.285	3.852	3.079	1.294	1.317	2.095	2.095	0.423	0.287		
6M	MFSE	0.946	1.020	0.781	0.843	0.877	1.019	0.552	0.642	2.324	1.017		
	MSPE-Adj.(Clark & West)	2.402	1.322	4.105	3.579	1.309	1.690	1.878	2.338	2.256	1.089		
12M	MFSE	0.997	1.028	0.915	0.944	0.999	0.956	0.924	0.885	0.857	0.889		
	MSPE-Adj.(Clark & West)	1.636	1.692	2.628	2.623	0.388	0.467	2.361	2.323	3.572	3.829		
24M	MFSE	0.972	0.916	0.932	0.879	1.000	0.915	0.870	0.795	0.993	1.033		
	MSPE-Adj.(Clark & West)	2.635	3.211	3.053	3.135	0.071	-0.013	2.057	2.152	0.462	0.266		

		South Africa				South Korea			
		Spread		Spread with CDS		Spread		Spread with CDS	
Horizon		Constant	AR	Constant	AR	Constant	AR	Constant	AR
1M	MFSE	0.227	0.654	0.215	0.620	0.118	0.405	0.102	0.348
	MSPE-Adj.(Clark & West)	2.067	3.522	2.060	2.769	2.825	3.639	2.404	2.853
6M	MFSE	0.670	0.746	0.392	0.436	0.488	0.570	0.391	0.456
	MSPE-Adj.(Clark & West)	2.409	2.966	1.992	2.299	3.691	3.459	3.053	2.991
12M	MFSE	0.780	0.817	0.716	0.749	0.710	0.737	0.567	0.588
	MSPE-Adj.(Clark & West)	2.373	2.029	2.814	2.576	2.509	3.238	2.213	2.559
24M	MFSE	0.933	0.947	0.950	0.964	0.981	0.988	1.105	1.112
	MSPE-Adj.(Clark & West)	1.293	1.316	1.352	1.371	1.779	1.572	1.239	1.211

Notes: The spread model performs better than the benchmark models if:

- MSFE values are less than 1
- MSPE-Adj.(Clark & West) values are greater than 1.282(for 10% level of significance) and 1.645 (for 5% level of significance)

Table 14: Inflation forecast evaluation statistics

		Hungary				India				Malaysia			
		Spread		Spread with CDS		Spread				Spread		Spread with CDS	
Horizon		Constant	AR	Constant	AR	Constant	AR			Constant	AR	Constant	AR
1M	MFSE	1.642	9.146	0.061	0.339	0.100	6.529			0.939	3.126	1.057	3.517
	MSPE-Adj.(Clark & West)	3.749	1.177	4.287	2.341	0.209	0.031			2.356	0.339	1.757	0.269
6M	MFSE	0.929	0.787	7.922	6.711	0.323	2.059			0.970	3.227	0.191	0.635
	MSPE-Adj.(Clark & West)	3.817	4.618	3.798	3.326	5.885	-2.162			1.511	-1.616	1.989	-2.637
12M	MFSE	0.979	0.948	0.845	0.819	0.401	0.687			1.047	0.987	0.822	0.774
	MSPE-Adj.(Clark & West)	2.503	2.999	2.306	2.799	6.645	3.009			1.267	0.936	3.158	3.195
24M	MFSE	0.691	0.706	1.079	1.103	0.552	0.651			1.025	0.988	1.012	0.976
	MSPE-Adj.(Clark & West)	3.142	3.519	2.049	2.102	6.347	3.470			0.491	0.294	2.156	2.081

		Poland				Russia				Singapore	
		Spread		Spread with CDS		Spread		Spread with CDS		Spread	
Horizon		Constant	AR	Constant	AR	Constant	AR	Constant	AR	Constant	AR
1M	MFSE	0.018	0.244	0.019	0.267	0.845	4.313	0.011	0.055	0.986	1.398
	MSPE-Adj.(Clark & West)	5.432	6.356	5.462	6.717	0.852	0.016	4.703	4.892	5.051	4.987
6M	MFSE	0.147	2.021	0.142	1.949	0.404	1.295	0.185	0.594	0.965	1.017
	MSPE-Adj.(Clark & West)	4.069	0.099	4.156	0.374	1.291	-1.022	4.144	0.274	4.086	-2.782
12M	MFSE	0.288	0.381	0.286	0.379	0.383	0.820	0.262	0.562	0.857	0.889
	MSPE-Adj.(Clark & West)	3.310	3.370	3.341	3.362	1.855	2.709	3.645	3.680	2.339	2.026
24M	MFSE	0.514	0.528	0.553	0.568	1.187	1.225	1.075	1.109	0.993	1.033
	MSPE-Adj.(Clark & West)	3.599	3.462	2.854	2.633	0.944	0.609	0.832	0.879	1.464	1.359

		South Africa				South Korea			
		Spread		Spread with CDS		Spread		Spread with CDS	
Horizon		Constant	AR	Constant	AR	Constant	AR	Constant	AR
1M	MFSE	0.051	0.453	0.043	0.381	0.119	0.378	0.083	0.263
	MSPE-Adj.(Clark & West)	4.448	5.951	4.077	5.652	4.895	6.612	4.172	7.862
6M	MFSE	0.052	0.467	0.442	3.984	0.568	1.641	0.402	1.161
	MSPE-Adj.(Clark & West)	4.347	5.219	3.709	-1.225	3.829	-1.616	4.599	1.548
12M	MFSE	0.998	1.036	0.477	0.495	0.747	0.761	0.676	0.689
	MSPE-Adj.(Clark & West)	0.175	-0.029	3.927	3.881	3.054	3.002	2.979	2.946
24M	MFSE	0.968	1.011	0.812	0.848	0.818	0.933	1.084	1.237
	MSPE-Adj.(Clark & West)	1.271	0.418	3.777	4.248	2.301	1.863	1.516	0.809

Notes: The spread model performs better than the benchmark models if:

- MSFE values are less than 1
- MSPE-Adj.(Clark & West) values are greater than 1.282(for 10% level of significance) and 1.645 (for 5% level of significance)

of Poland, South Africa and South Korea are the best predictors of their domestic inflation, especially in the longer forecasting horizons.

Using the MSPE-Adjusted statistic by (Clark & West, 2007) to evaluate the forecasting abilities of our models, we find that the yield curve spread performs worse than when using MSFEs in predicting growth and inflation. Unlike when using MSFE, here we see that the constant and AR(2) models are generally better predictors of growth and inflation for countries like Malaysia and Russia. The yield curves of Poland, South Africa and Korea are still better predictors of growth and inflation than the benchmark models across all horizons and the performance of the CDS model as a predictor also still performs better than the pure spread model.

5. Conclusions

This paper investigates the predictive abilities of the slope of the yield curve in a collection of 8 emerging market economies. For in-sample analyses, we use OLS to regress the growth in industrial production and consumer price indices on the term spread to determine if there is significant relationship in these economies. First we run our regressions without any lags of the dependent and independent variables, and then we run them with SBIC-determined lags to adapt the model to the countries' dynamics. We then augment the traditional spread equation with each country's corresponding sovereign spread, under the argument that higher sovereign spreads slow down a country's economic activity, to test the significance of these relationships again.

To test for spillovers between the yield curves, we test if the slope of the US or Euro area yield curves has any predictive content for the emerging economies' growth and inflation given the financial linkages between the US and the Euro area and these countries. We then test how robust this predictive ability of the yield curve is, as recent literature questions the stability of this relationship, by checking how the yield curve as a predictor of growth and inflation performed before and after the global financial crisis of 2008/2009. For out-of-sample analyses, we run rolling regressions using OLS to assess the forecasting accuracy of our models against some benchmark models. We use a constant as one of the benchmarks, to test the argument that future growth or inflation is just an average number, and an autoregressive part of our models of order 2. Our empirical analysis leads us to 4 main conclusions:

First, the slope of the domestic yield curve has predictive content for future inflation and real output in all countries we investigated except for 2. We present evidence that the yield curve spread can predict real output for up to 24 months into the future, although this predicting ability weakens after 12 months. The predictive performance of the yield curve for inflation is weaker than that of output growth, especially in the shorter foresting horizons. Empirical evidence also reveals that the yield curve's predictive powers for inflation weaken when lags of inflation are added to the model. In the longer forecasting horizons, the yield curve spread performs better when predicting inflation than growth. The yield curve spread's predictive powers was is found to perform better after the global financial crisis for all countries except South Africa and Poland, which had no predictive content across all forecasting horizons.

Second, we find that the sovereign risk spread has additional predictive content for growth and inflation in emerging market economies. When augmenting the traditional spread equation with sovereign risk spread, the forecasting performance of the model improves considerably for most countries. Third, the slope of the US yield curve no longer has strong predictive content for emerging market economies we investigate, as previously reported by literature. This is the case more so for inflation than growth. For the Euro area yield curve, however, there is still strong predictive content for most of the countries, and we find that this yield curve is a better predictor of growth for Hungary and Malaysia than their own domestic yield curve.

Fourth, when evaluating the strength of our model forecasts we find that our models perform better than the constant and AR process in forecasting inflation and real output when using MSFEs but the performance is not as pronounced when evaluating with the (Clark & West, 2007) MSPE-Adjusted statistic. The model with the CDS spread, however, performs better than the benchmark models regardless of which evaluation tool we use.

In closing, in line with literature we find that the yield curve slope still has predictive content for growth and inflation in emerging market economies, the extent of which differs across countries. We also find that sovereign risk has additional predictive abilities for growth and inflation in these economies. We recommend, in line with literature, that market participants and monetary policy makers in these countries supplement their forecasting models with information contained in the yield curve to forecast domestic growth and inflation. Assessing whether the sovereign risk spread has predictive abilities on its own is beyond the scope of this paper and can be a topic for future research.

6. References

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