Predictability of Economic Activity Using Yield Spreads: The Case of Brazil

Mateus A. Feitosa*
and
Benjamin M. Tabak **,+

* Universidade de Brasília
** Banco Central do Brasil/Universidade Catolica de Brasilia

Abstract

The present paper studies the informational content of the Brazilian yield spread. For this purpose, a univariate regression between the industrial production and the term spread is estimated. It is also analyzed if all the predictive power of the term spread is due to the role that monetary policy plays in the determination of the yield spread. Additionally, the spread is decomposed into two parts, aiming to investigate which part of the Brazilian term structure is relevant in the prediction of future economic activity, the market's expectations for future short-term rates or the term spread. The results indicate that the spread is significant in the prediction of future economic activity, and that this spread possesses information that is not totally explained by the monetary policy. Finally, the spread decomposition indicates that the major part of the informational content is due to the market's expectations of future short-term rates, but the term spread is, for shorter horizons, also significant.

Resumo

O presente artigo estuda o conteúdo informacional da curva de juros no Brasil. Para isso, uma regressão entre a produção industrial e o spread da taxa de juros é estimada. Também é analisado se o poder preditivo do spread é totalmente explicado pelo papel que a política monetária possui na formação da curva de juros. Adicionalmente, o spread é decomposto em duas partes, com a intenção de se investigar qual parte da estrutura a termo da taxa de juros brasileira, a previsão do mercado para as taxas de juros de curto prazo futuras ou o prêmio pago pelo risco, é relevante na previsão da atividade econômica. Os resultados indicam que o spread é significante na previsão da atividade econômica futura, e que o mesmo possui informação que não é totalmente explicada pela política monetária. Finalmente, a decomposição do spread indica que a maior parte do conteúdo informacional é explicada pelas previsões do mercado para as taxas de juros de curto prazo futuras, mas o termo referente ao prêmio também é significante para previsões de curto prazo.

JEL Classification: C22, E43, E44

Palavras-Chave: Spread da taxa de juros; Previsão da atividade econômica

Keywords: Yield spread; Prediction of economic activity.

+ Corresponding author: E-mail: Benjamin.Tabak@bcb.gov.br.
Mailing address: Banco Central do Brasil, DEPEP, SBS Quadra 3, Bloco B., Ed. Sede, 70074-900, Brasília, DF, Brazil.

1. Introduction

The path followed by output plays an important role on the financial system. With accurate information, investors can plan optimal decisions and policymakers can make appropriate policy.

Bernanke and Woodford (1997) argue that on an inflation target framework, an evaluation of monetary policy cannot be easily done due to a lag response of inflation to changes. This way, they affirm that an interesting possibility to Central Bank is target inflation forecasts, putting forecasts on the center of decisions, while Nordhaus (1987) states that output forecasts play a central role when governments plan budgets, corporations make investment decisions and individuals make savings decisions.

Aiming to possess accurate forecasts, several variables have long been tested by researchers, such as the lagged values of output, monetary aggregates, interest rates, among others. One of the variables that may help predict inflation and output growth is the yield spread- that is, the difference between long and short-term interest rate.

The spread can be an useful variable because, theoretically, the short-term rates do not concentrate all the information that can help predict future economic activity, since investment decisions are made considering the loan credits, which by its turn depends of different maturity rates.

In this paper, the Brazilian term structure of interest rates is accessed in order to analyze the information content of the yield spread. Regressions between the term spread and output are estimated aiming to verify if there is significant information in the Brazilian interest rate spread. The performance of the yield spread when other variables are present will also be investigated, in order to evaluate if there is information in the term spread that is not totally explained by the monetary policy. Finally, the spread will be decomposed aiming to verify what part of the term structure possess relevant information, the expectations of the future short-term rates or the term premium.

The rest of the paper will be structured as follows: in section 2 it is presented a brief literature review, the data description is presented in section 3, the informational content of the yield spread is analyzed in section 4, in section 5 an investigation of the role of other variables is presented, section 6 contents the spread decomposition and finally section 7 concludes the paper.

2. Brief literature review

A great attention is given by the literature for the term structure of interest rates[1]. Its informational content is a highly studied issue, and particularly its contribution to the prediction of future inflation and economic growth receives special attention.

On the context of the Consumer Capital Asset Pricing Model (CCAPM), Harvey (1988) found that the term spread contains information about real consumption and economic growth.

Bernanke (1990) and Estrella and Mishkin (1997) found evidence that the predictability of the term spread is strictly related to the stance of monetary policy, and the latter also suggest that the term spread can be a useful tool for the European Central Bank. Estrella (2005) also confirms this influence of monetary policy over the yield spread, but he reports that in most cases other information beyond the yield spread can be useful in forecasting output and inflation

[1] Studies about the term structure can be found in: Fama (1984), Mankiw and Miron (1986), Fama and Bliss (1987), Robertson (1992) and Edmister and Madan (1993).

Estrella and Hardouvelis (1991) firstly found that the term structure can help predict economic growth, and secondly tested if there is information in the yield spread that is beyond the influence of monetary policy. After adding a variable representing monetary policy, they concluded that the spread remains statistically significant, indicating that the correlation between term spread and economic activity is not totally due to the monetary policy.

Analyzing the U.S., Germany and U.K., Plosser and Rouwenhorst (1994) found that the long end of the term structure has information about future growth of industrial production beyond expectations about future monetary policy. The authors also stated that the yield spread of one country can help predict the industrial production of the others.

Smets and Tsatsaronis (1997) investigated why the slope of the yield curve predicts future economic activity in Germany and the United States. Using a VAR model and the impulse-response function, they reported that either monetary policy or demand shocks are relevant in both countries, while the impact of supply shocks play an important role in the Germany case.

Testing the ability of the yield spread to predict real economic activity in 11 industrial countries[2], Bonser and Morley (1997) found that the yield spread is a good predictor for the majority of the countries, specially for U.S., Canada and Germany, while for Japan and Switzerland the term spread possess a weak predictive content.

Analyzing the same industrial countries- with the exception of Netherlands- of Bonser and Morley (1997), Kozicki (1997) reported that the maximal contribution of the spread to predict GDP growth is at a horizon of four-quarters. Testing for the ability of the term spread to predict inflation, the paper suggests that the spread helps predict inflation, but the results for inflation are less strong than those for real growth.

Testing the ability of the yield spread to predict inflation, Schich (1999) concluded that there is significant informational content in the term structure of interest rates of the United States, Germany, Canada, and the United Kingdom, and that its usefulness may vary over time, especially with policy regime changes.

Using a nonlinear regression, Venetis et al. (2003), affirmed that the relation between spread and future product activity is sufficiently strong if past spread values did not exceed a threshold value.

Hamilton and Kim (2002) using the expectation hypothesis as a framework, found evidence that either the market expectations for future short-term interest rate or the term premium possess useful information that can help predict economic growth. Nakaota (2003) and Kim and Limpaphayon (1991) testing for Japan also concluded that the term spread contain relevant information, but the former also found evidence that the expected short-term interest rate is the only source of the predictability, indicating that for Japan the term premium does not contribute to the predictive content of the yield spread.

Using a VAR approach, Ang et al. (2006) found that maximal maturity difference is the best measure of slope and also that the short rate dominates the slope of the yield curve in forecasting GPD growth.

Wright (2006) considered a number of probit models using the term spread to forecast recessions and concluded that the shape of the yield spread more than the term spread alone provides accurate information about future recessions.

[2] The countries analyzed are: Australia, Canada, France Germany, Italy, Japan, Netherlands, Sweden, Switzerland, U.K and U.S.

Diebold et al. (2006) testing hypothesis regarding dynamic interactions between the macroeconomic variables (output, inflation and the stance of monetary policy) and the yield curve suggests that there is a bi-directional causality, but find stronger evidence that macroeconomic effect over the yield curve.

There are very few works about the predictive content of the yield spread in emerging markets. Kanagasabapathy and Goyal (2002) test if this relation holds for India, and their conclusion is that there is informational content in the Indian yield spread, and they also use a probit model to show that the yield spread can be useful to help predict future recessions. For Brazil, Shousha (2002) analyzes the informational content of the yield spread for the Brazilian economy and his conclusion is that the yield has predictive content and in relation to other macroeconomic values, such as inflation and lagged GDP, this predictive content still significant.

The overall conclusion is that the information content of the yield curve depends on a variety of factors such as country under examination, monetary policy framework and sample. Furthermore, it is not clear whether this information content in the yield curve is present in emerging markets. The focus of this paper is to analyze this issue for the Brazilian economy.

3. Data Description

In the first test of this paper, data from the Brazilian industrial production and the spread of the interest rates will be used. Our focus is on the industrial production aggregating all the industrial sectors, but aiming to make a complete analysis, the predictive power of the yield spread in relation to the industrial sectors[3] separately will also be estimated. Additionally, 22 industries individually will be studied[4]. All the series used are composed by 91 observations from July 1999 to February 2007.

The slope of the yield curve will be formed by the difference between the prefixed DI swaps[5] of one and six-months maturities. It is worth mention that the comparison between the results of the tests here employed and the results of other papers should be done with caution, since in our tests it will be used medium-term rates (six months), while the majority of the tests use long-term rates.

The reason of this difficulty to compare the results is because when medium-term rates are used, the estimated coefficient tends to be negative, while for long-term rates, the coefficient tends to be positive. This difference, according to Shousha (2002), is due to the fact that monetary tightening are seen as transitory for long-term rates, and as permanent for medium-term rates.

In the second test, data from the Brazilian short-term interest rate, Selic, and the monetary aggregate are introduced in our analysis in order to test if the information available in the term spread is due solely to known information about other monetary

[3] In this case, the sectors analyzed are the ones formed by the capital goods, the consumer goods, the durable goods, immediate goods and the semi and non-durable goods.

[4] These industries are: the beverage industry, cellulose, clothing, other chemicals, cosmetics, electrical equipment, extractive, food, foot wear, machinery, metallurgy, metal except machinery, non-metal mineral, pharmaceutic, plastic and rubber, oil and refine, communication, textile, manufacture, vehicles and wood.

[5] The difference between the twelve-month and one-month prefixed DI swap was also estimated, and the results are qualitatively similar to the ones that will be used in our tests.

variables. Both the number of observations and the period of the sample are the same of the first test. It is worth mention that all the series were taken from Bloomberg. Table 1 shows the descriptive statistics of the series.

Table 1. Descriptive statistics of the series

	Y	i1	i6	Selic	M1
Mean	3.690.487	1.845.278	1.928.433	1.831.978	9.182.144
Median	2.359.591	1.844.500	1.865.500	1.828.000	8.660.500
Maximum	5.320.635	2.677.000	2.820.000	2.632.000	1.740.800
Minimum	-3.573.202	1.308.000	1.260.000	1.318.000	4.699.000
Std. Dev.	1.793.711	3.000.496	3.725.756	2.925.530	2.926.338
Skewness	0.26828	0.986411	0.570453	1.137.353	0.390754
Kurtosis	3.317.071	4.091.974	2.672.195	4.465.874	2.339.617

This table presents the descriptive statistics of the series used in the tests, where Y stands for the industrial production, i1 and i6 are the prefixed DI swaps of one and six-months maturities, Selic represents the Brazilian short-term interest rate and M1 is the monetary aggregate.

4. The informational content of the yield spread

In order to evaluate the informational content of the yield spread, a regression between the industrial production and the yield spread will be estimated. The idea is to test if the yield spread in period t can be useful to predict the economic activity in the periods t+k. Following the approach of Estrella and Hardouvellis (1991), Plosser and Rowenhorst (1994), Bonser and Morley (1997), among others, the regression will be estimated as follows:

$$y_t^k = \alpha_0 + \alpha_1 Spread + \varepsilon_t \qquad (1)$$

where, $y_t^k \equiv (1200/k)*(\ln Y_{t+k} - \ln Y_t)$ and $Spread \equiv i_t^n - i_t^1$.

The equations indicate that the industrial production will be formed by the difference between the indexes of industrial production in period t+k and period t, while the spread is composed by the difference between the interest rate in period k and the interest rate in period 1.

The results, presented in table 2, indicate that for the industrial production and for all the industrial sectors, the yield spread possess better prediction in the six-month-ahead forecasts relatively to the nine-months-ahead predictions. It is interesting to notice that analyzing only the industrial production, which is the best proxi for the economic activity, the yield spread is statistically significant in both the horizons, indicating that indeed the yield spread can be a useful tool to help predict future economic activity.

In relation to the industrial sectors, with exception of the intermediate goods sector, the results for the six and nine-months horizon are similar to the ones obtained for the industrial production, since the term spread is significant for all cases.

When investigating the industries, it can be noticed that the predictive power enhances over the time. For the six-month horizon it is significant for five industries, and for the nine-month-ahead, it is significant for nine industries. Despite this increase in the number of industries that the spread can help predict future activity, the results report that the term spread has a limited performance, since even in the horizon that presents the best results, the spread is significant for less than 50% of the analyzed industries.

Finally, we can notice that the initially expected idea, that the coefficient would be negative because of the use of medium-term rates, is corroborated by the results of the regression, which indicates that, despite the good performance of the yield spread to predict future economic activity, the comparison with results that use long-term spread should be carefully done.

Table 2. Estimation results for the six and nine-months-ahead predictions

	6 months			9 months		
	α_0	α_1	adj R^2	α_0	α_1	adj R^2
Industrial production	4.682849*	-1.424182*	0.195757	4.245945*	-0.899877*	0.122759
	(-0.927829)	(-0.498846)		(-0.98953)	(-0.432384)	
Industrial sector	α_0	α_1	adj R^2	α_0	α_1	adj R^2
Capital goods	11.13264*	-3.984825*	0.278668	9.854045*	-2.639234*	0.170091
	(-2.646292)	(-1.358073)		(-2.571812)	(-109.392)	
Consumer goods	3.848677*	-1.272936*	0.11763	3.82133*	-1.13951*	0.184242
	(-1.052576)	(-0.503186)		(-0.961522)	(-0.410031)	
Durable goods	10.15322*	-2.342889*	0.051193	9.361997*	-1.477658**	0.034904
	(-3.103679)	(-1.352543)		(-3.141664)	(-1.075702)	
Intermediate goods	3.51415*	-0.500471	0.014574	3.327309*	-0.295565	0.002767
	(-1.065761)	(-0.449475)		(-1.157241)	(-0.425534)	
Semi and non-dur. Goods	2.149447*	-0.847822*	0.070531	2.391074*	-0.964679*	0.172224
	(-0.842766)	(-0.390744)		(-0.677463)	(-0.332777)	
Industries	α_0	α_1	adj R^2	α_0	α_1	adj R^2
Beverage	4.240268*	-3.543856*	0.083888	3.127034**	-2.2482*	0.073774
	(2.472077)	(1.675096)		(1.726717)	(1.170952)	
Cellulose	3.444052*	-0.104875	-0.010494	3.535696*	-0.066019	-0.011224
	(0.846584)	(0.444501)		(0.956201)	(0.373117)	
Other chemicals	-0.733922	0.236053	-0.011259	-0.870611	0.488928	-0.007112
	(2.478681)	(2.073759)		(2.378491)	(0.961353)	
Clothing	-5.567582**	3.290522*	0.037833	-5.646743*	2.677172*	0.065015
	(3.960931)	(1.984905)		(3.024412)	(1.705455)	
Cosmetics	5.178803*	-2.263938*	0.06482	4.615559*	-1.402406*	0.054037
	(2.227418)	(0.872173)		(2.011635)	(0.473414)	
Electrical equipment	7.872038*	-0.690435	-0.004471	8.029251*	-0.765363	0.004069
	(275.458)	(0.916244)		(2.480888)	(0.475961)	
Extractive	6.873372*	1.054516	0.004076	6.653997*	1.528692*	0.063677

	(2.553486)	(1.161266)		(1.587179)	(1.058369)	
Food	-0.653713	1.988455	0.017046	0.913105	0.797193	0.001275
	(3.562372)	(1.883301)		(2.060282)	(1.232135)	
Foot wear	-3.179858**	-0.095076	-0.011615	-2.926237*	-0.222106	-0.010208
	(213.701)	(0.868497)		(1.649561)	(0.513439)	
Machinery	8.146725*	-1.174679	0.013748	7.653428*	-1.073042**	0.025492
	(2.422504)	(1.272626)		(2.459903)	(0.866299)	
Metallurgy	2.722317*	0.447823	-0.005116	3.005172*	0.137757	-0.010835
	(1.743615)	(0.621588)		(1.654954)	(0.305293)	
Metal except machin.	2.150239	-1.111595	0.019923	2.561343*	-1.472928*	0.095286
	(1.986682)	(0.836696)		(1.797228)	(0.83524)	
Non-metal mineral	1.298279	-0.582062	0.002943	1.638736**	-1.016718*	0.106969
	(1.296967)	(0.644969)		(1.020246)	(0.331533)	
Pharmaceutic	2.300848	0.898332	-0.007767	3.287314	0.565156	-0.008181
	(3.458516)	(2.423366)		(2.161983)	(1.746164)	
Plastic and rubber	152.219	-1.083445**	0.021429	1.344574	-0.957854**	0.049223
	(1.524022)	(0.985921)		(1.520358)	(0.647366)	
Oil and refine	-0.026012	-1.063824	-0.00408	0.477243	-0.026381	-0.012178
	(3.803141)	(1.764470)		(1.671720)	(0.750203)	
Communication	5.597574	-1.675162	-0.004036	3.556554	0.539574	-0.010673
	(6.792673)	(2.500175)		(5.619192)	(1.231114)	
Textile	0.308083	-0.087167	-0.011662	1.080726	-0.968053	0.019352
	(2.672552)	(1.312211)		(2.189745)	(0.934459)	
Manufacture	3.061233*	-0.420373	-0.00617	3.266435*	(-0.485823	0.007837
	(1.622635)	(0.772432)		(1.297901)	(0.370492)	
Vehicles	8.873917*	-2.268345**	0.022324	9.481853*	-2.942272*	0.100748
	(4.301585)	(2.092746)		(4.382627)	(159.919)	
Wood	0.128192	0.232782	-0.01028	0.211612	0.062421	-0.012015
	(2.403090)	(0.871272)		(2.487022)	(0.738961)	

** and * indicate the significance level at 10% and 5%, respectively.

In parentheses are the Newey-West heteroscedasticity and autocorrelation consistent standard errors.

5. The role of monetary policy

It is believed that a big part of the predictive content of the yield spread is due to the monetary policy. The general idea (see Estrella and Hardouvelis (1991) and Estrella and Mishkin (1997)), is that there is a "common trend" among these variables: a tightening in the monetary policy increase short-term interest rates, leaving the long-term relatively intact, thus causing a flatten in the yield curve. At the same time, this tightening in the monetary policy generates a reduction in the incentive to invest, what generates a reduction of the future economic activity. Thus we can see that the monetary policy is an element that "connects" economic activity and the yield spread.

Intending to investigate if there is information in the yield spread that is not totally explained by the monetary policy, the follow regression will be estimated:

$$y_t^k = \alpha_0 + \alpha_1 Spread_t + \beta_1 Selic_t + \beta_2 M1 + \varepsilon_t, \quad (2)$$

where, $Selic_t$ represents the Brazilian short-term interest rate, and *M1* is the Brazilian monetary aggregate. The regressions were estimated using the GMM, and the instruments are the spread and Selic in period t-1, and the rate of inflation, represented by the CPI, in period t-1. Tables 3 and 4 present the results of the regressions for six and nine-months-ahead, respectively.

The results indicate that, in the presence of variables that represent the monetary policy, the spread still relevant to the prediction of future economic activity. What is more important is that the spread is the most important variable in comparison to Selic and the M1. In the case of the six-month horizon predictions, the variables present a better performance. For the industrial production, the spread still relevant, and the only industrial sector that the spread is not significant is for the intermediate goods. For the M1, the results do not present an improvement, since it is still relevant only for the industrial production and for the capital goods sector.

The spread and the M1 have their significance reduced in the nine-months horizon. For this horizon, the spread cannot be helpful for the durable and immediate goods. Inasmuch, despite the fact that the spread is significant for a few industries, the number of industries where it is relevant, relatively to the total, is very reduced. For this horizon, the M1 is not significant for any industrial sector, being relevant only for a few industries.

The Selic has its best performance for this horizon. This variable becomes significant for almost the entire industrial sector, and mainly for the industrial production. This results indicates that the Selic tends to get a better performance as the horizon increases.

Finally, we can conclude that the spread has informational content that is not explained by the monetary policy, and consequently can aggregate information that can help predict the path followed by the economic activity.

Table 3. Results for the predictive power of the spread relatively to monetary variables for the six-months-ahead predictions

	α_0	α_1	β_1	β_2	adj R^2	J-stat
Industrial production	27.36476	-2.150997*	0.304518	-6.221922*	0.288568	7.23E-28
	(19.70555)	(0.572411)	(0.352109)	(3.129046)		
Industrial sector	α_0	α_1	β_1	β_2	adj R^2	J-stat
Capital goods	79.02196*	-5.994332*	0.701371	-17.78218*	0.401616	1.45E-28
	(27.60421)	(1.349085)	(0.542854)	(6.376743)		
Consumer goods	18.24249	-1.953611*	-0.084047	-2.752618	0.100834	1.39E-27
	(21.83211)	(0.745386)	(0.421305)	(3.865007)		
Durable goods	10.16414	-3.022712*	1.691877	-6.901708	0.108495	8.42E-29
	(69.40618)	(1.674446)	(1.151337)	(11.42663)		
Intermediate goods	8.820592	-0.780603	0.421998	-2.892019	0.045049	2.44E-28
	(25.33986)	(0.576154)	(0.470914)	(3.861304)		
Semi and non-dur. Goods	18.03664	-1.456627*	-0.492395	-1.405019	0.099065	2.39E-28
	(15.21857)	(0.615795)	(0.313282)	(3.023524)		
Industries	α_0	α_1	β_1	β_2	adj R^2	J-stat
Beverage	-23.94311)	-1.945035	-0.435993	7.833820	0.057210	2.54E-28

	(59.51788	(2.266943)	(0.834824)	(10.48106)		
Cellulose	-8.079911)	-0.135912	0.524487*	0.416493	0.022832	2.15E-27
	(13.49886)	(0.63232)	(0.253389)	(2.348936)		
Other chemicals	-105.0864	2.756169	0.936638	19.06987	-0.021263	2.59E-28
	(77.92266)	(2.421190)	(1.275442)	(12.88891)		
Clothing	-83.4424	5.848875*	0.458862	15.09619	-0.012309	2.30E-29
	(102.6397)	(2.956634)	(1.789224)	(16.26233)		
Cosmetics	-5.690618	-2.044818*	0.141391	1.812659	0.040322	2.48E-28
	(45.00865)	(1.155191)	(0.742317)	(7.832048)		
Electrical equipment	44.15466	-1.233122	-0.458593	-6.143436	-0.008861	9.43E-29
	(58.07073)	(1.644933)	(0.674067)	(11.04928)		
Extractive	-18.83635	2.559424	0.247046	4.456916	-0.044781	1.15E-28
	(52.12561)	(1.617976)	(0.712891)	(9.989522)		
Food	-64.36542	3.897555	-0.470765	15.90419	0.017061	2.56E-28
	(101.5177)	(2.620746)	(1.321731)	(17.51239)		
Foot wear	16.67770	-0.017140	-1.004603	-0.303351	0.007241	6.59E-28
	(29.65675)	(1.030044)	(0.634384)	(5.578974)		
Machinery	59.32982	-2.697095*	0.389582	-12.82627	0.058191	3.39E-28
	(43.73265)	(1.320565)	(0.871129)	(8.055417)		
Metallurgy	5.468127	0.138380	0.267616	-1.668885	-0.025265	5.47E-28
	(47.73765)	(0.857636)	(0.762969)	(7.883713)		
Metal except machin.	47.64183	-2.280445	-0.618015	-7.427887	0.051141	5.32E-29
	(36.33279)	(1.242792)	(0.630833)	(6.048045)		
Non-metal mineral	-15.21870	-0.215810	-0.452997	5.524095	0.033739	7.87E-28
	(31.59539)	(0.979625)	(0.599323)	(4.814347)		
Pharmaceutic	-28.72417	1.663183	-0.781952	10.07460	-0.021592	1.03E-29
	(78.88498)	(3.477394)	(1.233696)	(15.02538)		
Plastic and rubber	-1.391527	-1.730682	0.789987	-2.501649	0.011913	6.33E-28
	(35.44830)	(1.302834)	(0.732837)	(5.252660)		
Oil and refine	8.825405	-0.584429	-0.535280	0.141056	-0.035689	1.89E-29
	(66.85677)	(2.089854)	(1.181719)	(14.21594)		
Communication	-92.04472	-0.973181	4.680496*	2.35612	0.09906	1.09E-28
	(149.6317)	(3.23728)	(2.289756)	(25.30162)		
Textile	-3.708625	-1.214794	0.361007	-0.376098	-0.055644	2.85E-28
	(56.30616)	(1.846143)	(1.056762)	(8.878197)		
Manufacture	-9.998974	-0.235301	0.247150	1.872220	-0.036840	1.74E-29
	(43.77461)	(1.109535)	(0.708178)	(7.118405)		
Vehicles	45.73934	-4.857026*	1.252255	-12.9841	0.019464	1.71E-28
	(77.30669)	(2.288591)	(1.401444)	(12.267)		
Wood	46.90494	-1.219444	0.462209	-12.15141	0.014478	8.55E-30
	(39.08059)	(1.005047)	(0.515887)	(7.625785)		

This table presents results for testing the informational content of the yield spread (coefficient α_1) controlling Selic (coef. β_1) and M1 (coef. β_2). The samples used in this test are formed by 91 observations, from July 1999 to February 2007.
** and * indicate the significance level at 10% and 5%, respectively.
In parentheses are the Newey-West heteroscedasticity and autocorrelation consistent standard errors.

Table 4. Results for the predictive power of the spread relatively to monetary variables for the nine-months-ahead predictions

	α_0	α_1	β_1	β_2	adj R^2	J-stat

Industrial production	5.741717	-1.147927*	0.653366*	-3.034649	0.278492	1.52E-25
	(18.97758)	(0.554353)	(0.302568)	(3.193072)		
Industrial sector	α_0	α_1	β_1	β_2	adj R^2	j-stat
Capital goods	25.06964	-3.46274*	1.759935*	-10.66666	0.392956	7.95E-28
	(32.02493)	(0.947005)	(0.393445)	(6.756215)		
Consumer goods	6.355037	-1.485899*	0.143878	-1.105481	0.169929	3.98E-27
	(17.21778)	(0.612321)	(0.272682)	(3.438332)		
Durable goods	-20.44651	-1.409837	2.052787*	-1.921919	0.17681	1.94E-28
	(55.90061)	(1.284198)	(0.885101)	(9.960382)		
Intermediate goods	-0.450693	-0.469333	0.682828*	-1.983781	0.127556	9.18E-28
	(23.67003)	(0.607627)	(0.407675)	(3.731798)		
Semi and non-dur. Goods	12.1559	-1.368798*	-0.317277	-0.785616	0.1777	9.10E-28
	(9.6622)	(0.458503)	(0.18248)	(2.22251)		
Industries	α_0	α_1	β_1	β_2	adj R^2	J-stat
Beverage	-35.32992	-1.699075	-0.149379	9.193566	0.073449	1.62E-27
	(38.39846)	(1.039063)	(0.621082)	(6.759467)		
Cellulose	-6.957966	-0.153978	0.534573*	0.137646	0.079692	2.38E-26
	(12.91714)	(0.308191)	(0.19694)	(2.196387)		
Other chemicals	-75.45576	1.461661	0.971211	12.54554	0.026219	1.90E-27
	(58.45739)	(1.306795)	(0.951257)	(9.693808)		
Clothing	-38.85618	3.300569	0.017651	7.291437	0.030614	5.64E-28
	(71.40869)	(2.552672)	(1.155683)	(11.80789)		
Cosmetics	-17.38660	-1.194326	0.536927	2.663751	0.037766	4.24E-28
	(43.54761)	(0.950282)	(0.604369)	(7.820639)		
Electrical equipment	52.84288	-1.658093	-0.224984	-8.982429	0.032956	1.04E-26
	(47.84955)	(1.125515)	(0.410134)	(9.473541)		
Extractive	-18.55345	2.858415*	-0.132571	5.971708	0.002291	5.11E-27
	(39.49848)	(1.470942)	(0.541878)	(7.078376)		
Food	5.495273	0.716583	-0.996363	3.173666	0.012456	3.00E-28
	(55.61299)	(1.908029)	(0.606169)	(10.34619)		
Foot wear	26.66293	-0.947776	-0.804488	-3.143599	0.019958	1.74E-27
	(21.52254)	(0.733561)	(0.466129)	(3.704909)		
Machinery	38.41149	-2.281528*	1.232344*	-11.87541	0.18292	6.91E-28
	(40.22724)	(0.740122)	(0.655981)	(7.590002)		
Metallurgy	8.393683	-0.260964	0.502130	-3.245867	-0.004114	2.13E-27
	(39.41340)	(0.648662)	(0.690795)	(6.813519)		
Metal except machin.	39.0545	-2.376242*	-0.042735	-7.869172*	0.150179	1.85E-27
	(26.5184)	(1.054786)	(0.357341)	(4.670033)		
Non-metal mineral	-5.309043	-1.23569*	-0.239332	2.619829	0.107763	2.74E-26
	(23.3164)	(0.629046)	(0.401735)	(3.55568)		
Pharmaceutic	2.273233	0.873914	-1.248374*	5.416245	-0.003325	9.84E-29
	(48.83931)	(2.049189)	(0.609825)	(9.645854)		
Plastic and rubber	-12.97833	-1.394346*	1.059376*	-1.133782	0.130035	2.40E-27
	(27.14172)	(0.829475)	(0.476034)	(4.156214)		
Oil and refine	4.591946	0.677846	-0.778010	2.198664	-0.037951	3.91E-28
	(34.98274)	(0.946127)	(0.518471)	(7.172513)		
Communication	-125.9099	2.369369	4.123551*	11.49373	0.128433	1.45E-27
	(121.6626)	(2.303653)	(1.590769)	(22.96755)		
Textile	6.567594	-2.261106*	0.668889	-3.784891	-0.012109	2.20E-26
	(37.70587)	(1.10002)	(0.58469)	(6.12531)		

Manufacture	0.036451	-0.790226	0.397954	-0.882198	0.004635	5.54E-28
	(31.11554)	(0.679524)	(0.423079)	(5.256456)		
Vehicles	28.81679	-4.742758*	2.131106*	-12.95587	0.223344	1.15E-27
	(60.10812)	(1.415986)	(0.916026)	(10.31143)		
Wood	46.85362**	-1.310469**	0.7574*	-13.4282*	0.103456	9.57E-28
	(29.87245)	(0.569816)	(0.254869)	(6.225828)		

This table presents results for testing the informational content of the yield spread (coefficient α_1) controlling Selic (coef. β_1) and M1 (coef. β_2). The samples used in this test are formed by 91 observations, from July 1999 to February 2007.
** and * indicate the significance level at 10% and 5%, respectively.
In parentheses are the Newey-West heteroscedasticity and autocorrelation consistent standard errors.

6. The spread decomposition

Following the approach developed by Hamilton and Kim (2002) the interest rate spread will be decomposed into two parts, one representing the market's expectations for the future short-term rates, and the other representing the premium for risk and liquidity present in the term structure.

The term structure of interest rates states that rates of long-term are formed by the average of the expectations for the future short-term rates, plus a term premium. This way, we have the following equation:

$$i_t^n = \frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1 + TP_t \tag{3}$$

Where $E_t i_{t+j}^1$ denotes the market's expectations at time t for short-term rates at period t+j, and TP_t indicates the term premium. Equation (3) can also be written as:

$$i_t^n - i_t^1 = \left(\frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1 - i_t^1\right) + TP \tag{4}$$

Equation (4) indicates that the spread can be decomposed into two parts, one is formed by the difference between the average of the market's expectations and the spot short-term rate, and the second part is the time-varying term premium.

Isolating the term premium in equation (3) and replacing the value in (4) yields:

$$i_t^n - i_t^1 = \left(\frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1 - i_t^1\right) + \left(i_t^n - \frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1\right) \tag{5}$$

Based on this equation we can ask in what extent a change in the spread is due to a change in the market's expectations for the future short-term rates, or an increase/decrease in the term premium? This question can be answered if we estimate

regression (1) substituting the spread initially used for the spread represented in (5). This substitution yields:

$$y_t^k = \alpha_0 + \alpha_1\left(\frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1 - i_t^1\right) + \alpha_2\left(i_t^n - \frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1\right) + \varepsilon_t \quad (6)$$

The great contribution of this regression is that now each term has different implications in the prediction of future economic activity.

Denoting ω_{t+n} the error in forecasting short-term interest rates, we have:

$$\omega_{t+n} = \frac{1}{n}\sum_{j=0}^{n-1} i_{t+j}^1 - \frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1$$

This way, we have the regression that will be estimated:

$$y_t^k = \varphi_0 + \varphi_1\left(\frac{1}{n}\sum_{j=0}^{n-1} i_{t+j}^1 - i_t^1\right) + \varphi_2\left(i_t^n - \frac{1}{n}\sum_{j=0}^{n-1} E_t i_{t+j}^1\right) + e_t \quad (7)$$

where $e_t = \varepsilon_t + (\varphi_2 - \varphi_1) * \omega_{t+1}$. The regressions are estimated using the GMM, where the instrumental variables used are the one and six-months interest rates.

The results for the six and nine-months horizon are shown in tables 5 and 6, respectively. For the six-months horizon, the market's expectations for the future short-term rates is significant to help predict future industrial production, and it is also relevant in the case of some industrial sectors. The term premium is also significant for the industrial production, and also for some industrial sectors.

In table 6 we see the results for the nine-month horizon predictions, and they indicate that the informational content of the market's expectations increases, since it still relevant to predict the industrial production, but now it is significant for all the industrial sectors, with the exception of the non-durable goods. On the other hand, the term premium looses its informational content, since for this horizon it is not significant to predict future industrial production, and it is significant only for two industrial sectors.

From this test we can conclude that the market's expectations increases its significance as the time horizon increases, indicating that this variable can be helpful especially when we have predictions for medium and long time horizons.

Table 5. Results of the spread decomposition for the six-month horizon

	φ_0	φ_1	φ_2	adj R^2	J-stat
Industrial production	4.825929*	-1.941462*	-1.45708**	-0.00228	5.77E-30
	(1.000717)	(0.814489)	(0.802261)		
Industrial sector	φ_0	φ_1	φ_2	adj R^2	J-stat
Capital goods	11.49573*	-5.584158*	-4.000818*	0.012664	4.61E-30
	(2.880315)	(2.480727)	(1.925254)		
Consumer goods	3.726163*	-1.026939	-1.469888*	0.079397	3.42E-29
	(1.100299)	(0.951463)	(0.665869)		
Durable goods	10.94063*	-5.104619*	-1.890641	-0.367455	2.77E-30

	(3.384099)	(2.484194)	(2.651308)		
Intermediate goods	3.662906*	-1.028705	-0.419505	-0.163694	2.18E-29
	(1.114083)	(0.914437)	(0.693025)		
Semi and non-dur. Goods	1.807948**	0.14083	-1.188055**	-0.301203	1.11E-29
	(0.930658)	(0.876222)	(0.678074)		
Industries	φ_0	φ_1	φ_2	adj R^2	J-stat
Beverage	3.649597	-2.066911	-4.292934*	0.012459	6.57E-30
	(2.490422)	(1.865386)	(1.835296)		
Cellulose	3.718473*	-0.987532	0.107753	-0.198594	8.80E-29
	(0.977158)	(0.674721)	(0.581509)		
Other chemicals	-0.605109	-0.146259	0.357915	-0.000717	6.99E-31
	(2.193330)	(2.984344)	(2.128454)		
Clothing	-5.651582	3.926264	3.477331	0.020928	2.83E-30
	(3.534124)	(3.304265)	(2.248612)		
Cosmetics	5.097844*	-2.261001	-2.504073*	0.028098	4.11E-29
	(2.070687)	(1.580527)	(1.05064)		
Electrical equipment	7.646033*	-0.050656	-0.925601	-0.049502	1.43E-30
	(2.735027)	(1.81077)	(1.126747)		
Extractive	7.064538*	0.566144	1.289804	0.043512	1.27E-30
	(2.4996)	(1.839389)	(1.255335)		
Food	-1.076566	3.553488	1.802044	-0.206786	3.10E-30
	(3.399781)	(2.826262)	(2.767332)		
Foot wear	-3.876595*	2.105391	-0.662859	-0.277707	6.65E-30
	(2.012309)	(1.596825)	(1.462905)		
Machinery	8.16528*	-1.365349	-1.250563	-0.017254	5.22E-30
	(2.505603)	(2.374901)	(1.458902)		
Metallurgy	2.807369**	0.228146	0.550855	-0.032104	2.04E-29
	(1.570379)	(1.410533)	(0.760404)		
Metal except machin.	1.668345	0.293016	-1.585148	-0.130582	8.01E-30
	(1.807949)	(1.408659)	(1.222144)		
Non-metal mineral	0.771790	1.023481	-1.050551	-0.242621	2.67E-31
	(1.252689)	(1.252421)	(1.011543)		
Pharmaceutic	1.978886	2.020883	0.708801	-0.081771	4.81E-31
	(3.664471)	(2.853776)	(2.983456)		
Plastic and rubber	1.763154	-1.969711	-0.973377	-0.146989	3.63E-30
	(1.741031)	(1.670584)	(1.470590)		
Oil and refine	0.078138	-1.513699	-1.062288	0.015370	1.93E-31
	(3.822086)	(2.726044)	(1.853751)		
Communication	8.318257	-10.49734**	0.383772	-0.428267	4.92E-30
	(5.827691)	(5.64736)	(5.587537)		
Textile	0.324064	-0.147661	-0.081051	-0.026810	2.07E-29
	(2.699592)	(2.324809)	(1.678928)		
Manufacture	3.069363**	-0.493336	-0.446331	-0.015231	1.25E-30
	(1.52834)	(1.485306)	(0.88364)		
Vehicles	9.24241*	-3.692263	-2.147296	-0.121551	1.26E-30
	(4.670186)	(3.796894)	(2.780964)		
Wood	0.456233	-0.782159	0.514643	-0.195644	8.20E-30
	(2.668370)	(1.832798)	(1.113531)		

** and * indicate the significance level at 10% and 5%, respectively
In parentheses are the Newey-West heteroscedasticity and autocorrelation consistent standard errors.

Table 6. Results of the spread decomposition for the nine-month horizon

	φ_0	φ_1	φ_2	adj R^2	J-stat
Industrial production	4.535712*	-1.934731*	-0.73066	-0.727052	9.04E-29
	(1.109677)	(0.670959)	(0.990016)		
Industrial sector	φ_0	φ_1	φ_2	adj R^2	J-stat
Capital goods	10.64022*	-5.635774*	-2.133461	-0.818754	8.03E-30
	(2.809796)	(2.083627)	(2.441586)		
Consumer goods	3.859138*	-1.397517*	-1.193355*	0.048035	2.02E-29
	(0.904625)	(0.500951)	(0.644785)		
Durable goods	10.27603*	-4.782584*	-0.766829	-1.002201	4.80E-30
	(3.463027)	(2.03013)	(2.771536)		
Intermediate goods	3.618242*	-1.327849**	-0.05582	-0.801557	6.58E-30
	(1.305151)	(0.731883)	(0.930993)		
Semi and non-dur. Goods	2.2099*	-0.451055	-1.202656*	-0.026848	2.13E-29
	(0.603315)	(0.522814)	(0.44085)		
Industries	φ_0	φ_1	φ_2	adj R^2	J-stat
Beverage	2.803651	-1.39062	-2.713601*	0.011421	2.44E-30
	(1.76124)	(1.709253)	(1.172227)		
Cellulose	3.807498*	-1.006787**	0.17418	-0.567244	6.79E-29
	(1.091626)	(0.554536)	(0.574137)		
Other chemicals	-0.481165	-0.793396	0.878139	0.019754	4.50E-30
	(2.221115)	(1.846503)	(0.974209)		
Clothing	-5.695822*	3.146849	2.839547	0.045007	3.50E-30
	(2.613447)	(1.764236)	(2.127726)		
Cosmetics	4.786072*	-2.145681*	-1.356782**	0.033322	2.32E-28
	(1.858255)	(0.858449)	(0.765912)		
Electrical equipment	8.003753*	-0.7639	-0.847457	-0.011843	4.29E-30
	(2.364941)	(0.704803)	(0.620887)		
Extractive	6.602202*	1.878507	1.599957	0.035995	1.07E-29
	(1.544089)	(1.359955)	(1.205943)		
Food	0.523177	2.225842	0.506831	-0.408170	1.62E-30
	(1.900460)	(1.604335)	(2.076808)		
Foot wear	-3.376343*	1.298534**	-0.645465	-0.232851	8.78E-30
	(1.079873)	(0.751734)	(0.918391)		
Machinery	8.157965*	-2.926275**	-0.700542	-0.681565	3.77E-30
	(2.680731)	(1.56739)	(1.841596)		
Metallurgy	3.189626*	-0.480147	0.314857	-0.202509	2.13E-29
	(1.619677)	(1.145167)	(0.639418)		
Metal except machin.	2.473302**	-1.336287	-1.666087**	0.050373	7.90E-30
	(1.714199)	(0.831762)	(1.033811)		
Non-metal mineral	1.412641**	-0.354693	-1.299252*	0.047138	2.32E-30
	(0.798544)	(0.526543)	(0.551548)		
Pharmaceutic	2.841751	2.158750	0.206672	-0.169969	1.61E-30
	(1.982678)	(1.945008)	(2.096855)		
Plastic and rubber	1.808852	-2.659888*	-0.612794	-0.973699	4.39E-30
	(1.7453)	(1.105672)	(1.509969)		
Oil and refine	0.261354	0.711994	-0.223253	-0.129750	3.29E-30

	(1.685849)	(1.189540)	(1.131159)		
Communication	5.67144	-6.66206**	2.489874	-0.590183	3.81E-30
	(5.632882)	(4.044851)	(4.616937)		
Textile	1.380250	-2.105481	-0.772468	-0.294678	2.99E-29
	(2.326264)	(1.198697)	(1.513345)		
Manufacture	3.450096*	-1.171146	-0.357576	-0.09655	1.14E-30
	(1.291744)	(0.644931)	(0.662694)		
Vehicles	10.40433*	-6.440942*	-2.336885	-0.767488	2.50E-30
	(4.918619)	(2.677499)	(3.153303)		
Wood	0.668510	-1.499503	0.479582	-0.466190	3.53E-29
	(2.740559)	(1.148064)	(1.226455)		

** and * indicate the significance level at 10% and 5%, respectively
In parentheses are the Newey-West heteroscedasticity and autocorrelation consistent standard errors.

7. Conclusion

The term structure of interest rates is a very studied issue because of its relevance to a good comprehension of the functioning of the financial system and the role that it plays in the relation with macroeconomical variables.

In this paper, the spread between short and long-term interest rates is studied in order to evaluate the power of the spread in predict future economic activity. For this purpose, a regression between these variables was estimated, and the results indicate that the spread is significant for the horizons studied, and consequently it is a useful tool to help predict future industrial production.

Additionally, the role that monetary variables play in this predictive content was analyzed, aiming to investigate if all the predictive power of the spread is due to the monetary policy and its relation with short and long-term rates. The results indicate that there is information in the spread that is not explained by the monetary policy, suggesting that this spread can even be used jointly with variables that represent the monetary policy to perform a better prediction industrial production.

Finally, the spread was decomposed in two parts, one representing the market's expectations for future short-term rates, and the other representing the time-variant term premium present in the term structure, and the results indicate that the major part of the informational content of the term spread is due to the market's expectations, but the term premium is also relevant, but only for the shorter horizon studied.

A natural extension of this paper would be to analyze the predictive power of the term spread in other emerging markets, in particular the Latin America, because with these tests, the importance of the term spread as a variable that can be used as a forecasting tool can be consolidated.

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