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THE YIELD CURVE INFORMATION UNDER UNCONVENTIONAL MONETARY POLICIES*

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Abstract

This paper attempts to address the question of how unconventional monetary policies affected the market expectations in both the future paths of the monetary policy rate and economic growth implicit in interest rates in the period 2007-2013 for several developed and developing countries where these kind of policies were applied. The approach used in this paper is to compare the implicit expectations in the yield curve with market surveys and econometric models to see whether the first ones were affected. We conclude that in the period where unconventional monetary policies were applied, the yield curve provided relevant additional information to forecast the monetary policy rate and economic growth, especially in developed economies.

Resumen

Este artículo intenta abordar la interrogante sobre cómo las políticas monetarias no convencionales afectaron las expectativas de mercado sobre los futuros valores de la tasa de política monetaria y el crecimiento, implícitos en las tasas de interés en el periodo 2007-2013 en economías desarrolladas y emergentes en las cuales se aplicaron dichas políticas. El enfoque utilizado en este trabajo compara las expectativas implícitas de la curva de rendimiento con encuestas para la tasa y modelos econométricos para el crecimiento, de modo de evaluar si las dichas expectativas derivadas de la estructura de tasas de interés fueron afectadas. Se concluye que en dicho periodo donde se aplicaron políticas no convencionales, la curva de rendimiento entregó información relevante a la hora de proyectar tanto la tasa de política monetaria como el nivel de crecimiento, especialmente en países desarrollados.

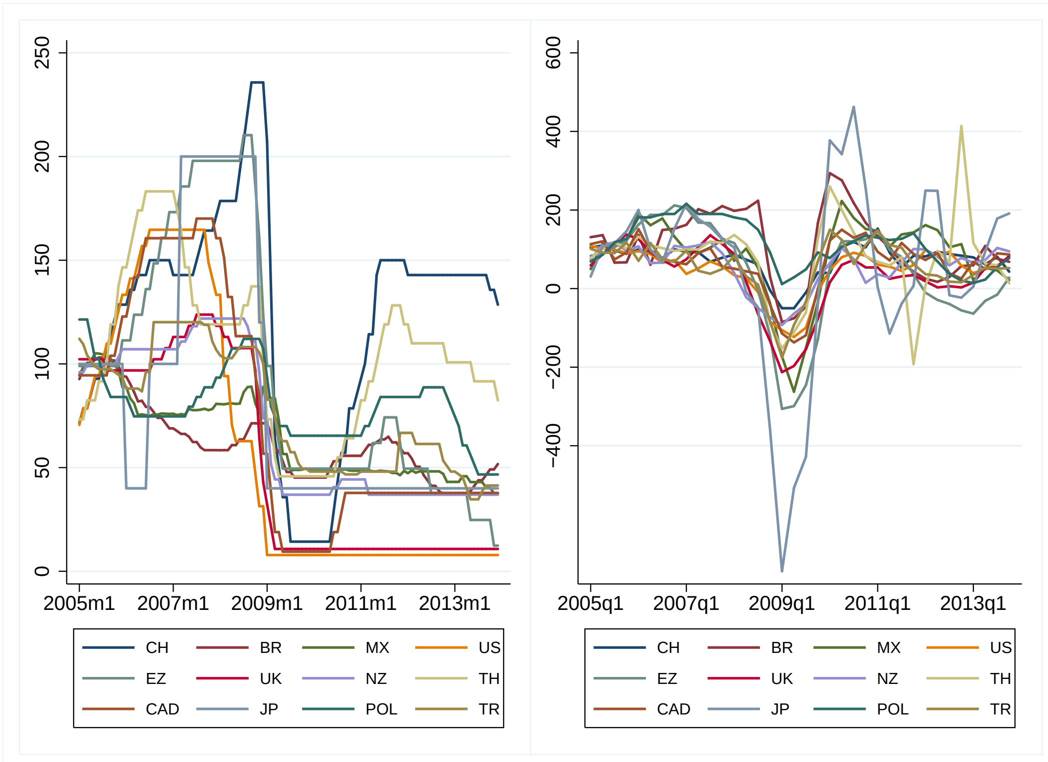
* We thank the comments and suggestions of Pablo Pincheira and María Consuelo Edwards. The views expressed in this paper do not necessarily represent those of the Central Bank of Chile or its authorities. Emails: lceballos@bcentral.cl y dromero@bcentral.cl.

1 Introduction

The conventional monetary policy (understood as changes in the level of the monetary policy interest rate) seeks to influence the expectations of market participants about the future path of interest rates, affecting asset prices and therefore the level of output in the economy. The transmission mechanism can be summarized in two processes. The first process involves the propagation of changes in monetary policy through the financial system. Therefore movements in the monetary policy rate (MPR) lead to changes in asset prices (i.e. bond and bank loans) affecting the spending decisions of individuals and firms. The second process is related to the propagation of the MPR from financial assets to the real economy in both aggregate output and prices.

However, after the onset of the financial crisis in 2008 caused by the subprime mortgage crisis in the U.S., conventional monetary policy described above gave way to a new form of so-called unconventional monetary policy. During this period different economies experienced a contraction of output while some countries reached a lower bound for the monetary policy rate as figure 1 illustrates for a selected group of countries that applied unconventional monetary policies. Also during this period, some governments took actions to provide liquidity in foreign currency and monetary markets and additional unconventional policies were adopted to reinforce the credibility of announcements that the monetary policy rate would be kept low for a long time. All the financial turmoil exhibited during that period might have affected the information derived from bonds related to the future path of the MPR and therefore future economic growth.

FIGURE 1: Monetary Policy Rate and Gross Domestic Product growth for selected countries



Both figures include Chile (CH), Brazil (BR), Mexico (MX), United States (US), Eurozone (EZ), United Kingdom (UK), New Zealand (NZ), Thailand (TH), Canada (CAD), Poland (POL), Japan (JP) and Turkey (TR). Left chart correspond to monthly monetary policy rate expressed as index (2005 = 100). Right chart correspond to quarterly Gross Domestic Product growth expressed as index (2005 = 100) Sources: Centrals Banks and Bloomberg.

The different unconventional policies adopted by various central banks, especially during the period 2008-2009[1] can be grouped into (1) liquidity and exchange rate easing, (2) credit and quantitative easing, and (3) forward guidance as Ishi et al. (2009) and IMF (2013) enumerate. It is important to remark that the last two types of unconventional policies affected directly the structure of interest rates, and therefore, the information regarding the future path of the MPR and economic growth.

The aim of this study is to assess whether the information contained in the structure of interest rates (in particular whether the adoption of unconventional monetary policies) affected expectations of future MPR path and activity derived from bonds. We evaluate and compare the expectation of MPR and economic growth for a group of countries that applied uncon-

[1]For instance, Céspedes et al. (2011) compile a list of fifty-six policy announcements regarding unconventional policies, in the period from September 2008 to October 2009, for a group of thirteen central banks.

ventional monetary policies based on interest rates, and other benchmarks as surveys (for the MPR) and autoregressive models (for economic growth). Those countries are characterized by having adopted some type of unconventional monetary policy in the period 2005-2013. We found that unconventional monetary policies helped to improve the expectation derived from the yield curve, specially in developed countries.

Section 2 presents the methodology used in this paper. Section 3 presents the results and section 4 concludes.

2 Methodology

2.1 The yield curve

Both market players and policymakers use the information contained in the yield curve to extract expectations about future movements of the MPR, inflation expectations and output growth. Since we lack rates for all maturities, we use a parametric approach to compute the yield curve. Typically, we can compute three factors of the yield curve defined as the level, slope and curvature (see Diebold & Li (2006) for a detailed revision) and use them to analyze their relation with the rest of the economy. To compute the factors of the yield curve, we employed the Nelson & Siegel (1987) model which according to the BIS (2005) is one of the most used models by different central banks due to its easy computation and good fit to observed interest market rates. The model can be written as:

$$y_t^\tau = \beta_{0,t} + \beta_{1,t}[(1 - e^{-\lambda\tau})/\lambda\tau] + \beta_{2,t}\{[(1 - e^{-\lambda\tau})/\lambda\tau] - e^{-\lambda\tau}\} \tag{1}$$

where y_t^τ corresponds to the interest rate observed at maturity τ in time t. The model (1) calibrates parameters $\{\beta_0, \beta_1, \beta_2, \lambda\}$, such that the error between the market rates and the estimated rates derived from the model are minimized. The parameter β_0 denotes the level, β_1 the slope and β_2 the curvature of the yield curve (see Nelson & Siegel (1987), Diebold & Li (2006) and Diebold et al. (2006) for details).

In order to obtain the parameters from (1), we proceed to fix the λ parameter of the model[2] for two reasons: (a) When this parameter is fixed, the model is linear and can be estimated by OLS for each date, generating a time series for each factor, and (b) changes in the parameters (factors) in (1) can be interpreted as changes in the level, slope and curvature of the yield curve,

[2]The parameter calibrated ranges from 0.07 to 0.12 for different countries. Different values of this parameter do not change our results qualitatively. Note that Diebold & Li (2006) as well as for example Dolan (1999) and Fabozzi et al. (2005) first fix λ to a pre-specified value and then proceed with analyzing the three-factor model.

and those are the relevant elements to take into account when analyzing their importance in the economy.

2.2 Monetary policy rate expectations

To assess the MPR forecast, we consider two sources of information. The first refers to the expected MPR implicit in the yield curve based on the forward rate structure proposed by Nelson & Siegel (1987) denoted in (1). Thus, the expected forward rate at maturity τ (f_t^τ) is denoted as:

$$f_t^\tau = \beta_{0,t} + \beta_{1,t} e^{-\lambda\tau} + \beta_{2,t}\lambda e^{-\lambda\tau} \tag{2}$$

This information corresponds to the expectations that the market has regarding future changes in the MPR. The second source is the estimation of analysts and investment banks in each economy reported by Consensus Forecast Survey (CF). The latter reflects the MPR's expected future path based on a survey. In both cases we consider the forecast horizon at three and twelve months (the periods for which we have available data for CF). Thus, we proceed to compute the forecast error measured as:

$$e_t^j = MPR_{t+h} - E_{t+h}^j(MPR) \tag{3}$$

where MPR_{t+h} denotes the effective policy rate at period $t+h$, E_{t+h}^j indicates the expectation in time t for MPR h months months ahead based on forecast source j (either bond prices or CF). In each case, we estimate the model and produce forecasts for both horizons (three and twelve months ahead), evaluating the accuracy of the forecast as:

$$d_t = g(e_t^{Bond}) - g(e_t^{CF}) \tag{4}$$

where $g(\cdot)$ is the loss function represented by the squared error, as is usual in the literature. Then using the series generated in (4), we run a Diebold & Mariano (1995) test using the small sample correction proposed by Harvey et al. (1997) and evaluate the accuracy of each forecast at different horizons.

2.3 Economic growth expectations

Following the literature (Estrella & Hardouvelis (1991) and Hamilton & Kim (2002) among others), we use the slope factor of the yield curve to predict output growth at different horizons. To do this, we estimate regressions of the $t + h$ periods ahead year-on-year growth rate of industrial production on a set of regressors in time t. For parsimony, we follow Estrella

& Hardouvelis (1991) and Hamilton & Kim (2002), among others, and estimate the following model:

$$y_{t+h} = \alpha_0 + \alpha_1 y_{t-1} + \alpha_3 \Delta MPR_t + \alpha_4 slope_t + \epsilon_t \tag{5}$$

where y_{t+h} is the yearly growth of industrial production h periods ahead, ΔMPR_t, is the change in monetary policy rate between period t and $t-1$ and $slope_t$ is the slope of the yield curve denoted by β_1 in model (1). We evaluate the forecasting power of the slope, comparing model (5) with a modified version given by equation (6):

$$y_{t+h} = \alpha_0 + \alpha_1 y_{t-1} + \alpha_3 \Delta MPR_t + \epsilon_t \tag{6}$$

Equation (6) is the same as equation (5) but imposing the constraint $\alpha_4 = 0$. The specification (5) attempts to capture the additional information contained in the interest rates of bonds through the slope factor of the yield structure.

Our procedure is recursive, so we first estimate both models in monthly frequency for the period January 2005-November 2007. Then the models incorporate new observations and are recalibrated in order to make a forecast h-steps ahead. Finally, to evaluate the relative performance of each model, we compute the modified Diebold & Mariano (1995) test described in the previous section. The horizons taken in consideration are three, six, and twelve months ahead.

3 Data and results

For our empirical exercise, we use the same countries presented in figure 1 for the period 2005-2013 (see footnote in that figure). We use monthly data taken from Bloomberg. Besides analyzing market expectations in the whole period, we take into consideration two subsamples which were characterized by different expectation disruptions as a way to get robust results. The first subsample, spanning December 2007 to July 2009, was characterized by historical increase in the risk indicators, episodes of turbulence in financial markets, significant slowdown in production and a decrease to the lowest MPR level in each economy. Also during this period the first types of unconventional monetary policies aimed to normalize the functioning of financial markets and stimulate the economy began being implemented. The second subsample, spanning August 2009 to December 2013, was characterized by decreases in the risk levels as well as a gradual recovery of output in most countries. Table 1 presents the Diebold-Mariano tests over the MPR forecast based on interest rates and those reported by CF taking into consideration the different subsamples.

For developed countries, the evidence suggests that for Japan the information contained in bond interest rates outperforms the market expectations informed by CF considering the different samples at both short and longer horizon. For the U.S., the evidence indicates that the information contained in market interest rates have no better predictive power for future path of MPR regarding reported by CF. Considering the subsample, where significant turbulence were recorded in the financial markets as well as the beginning of the application of unconventional monetary policies, it appears that just in Japan the information in financial markets might be relevant, while in the case of Poland and United States the information of CF provides a more accurate forecast at short horizons. Finally, considering the final subsample is observed for Japan and the UK that the information contained in market rates has a lower error forecast than those reported by CF, while for the Euro area the opposite is reported.
In the case of emerging economies, only Turkey shows that the information derived from bonds allows a better forecast of the MPR in both short and long horizon considering the total sample. However, by considering the first subsample, there is no evidence that information contained in bond interest rate leads an accuracy estimation of future MPR movements. In fact, a lower forecast error based CF in the three-month horizon is evidenced in the Poland case. Meanwhile, when considering the second subsample shows that there is no gain from information rates except for Poland.

In the economic growth forecasting evaluation presented in Table 2, we find evidence of predictive ability of the slope on output growth in most of the countries. As we can see, we find some cases when the forecast of the alternative model (equation 6) is more accurate, like the Chilean case at the full sample with $h = 24$. However, these results are not statistically significant. Second, we find several cases when the performance of the slope is relevant to predict output growth, and these are statistically significant. For instance, in developed countries as Canada, Eurozone, New Zealand and U.S. there are a marginal gains considering bond information depending horizon, as well in emerging countries as Mexico, Poland, Thailand and Turkey.

Table 1: Monetary Policy Rate forecast evaluation

	Full sample		Subsample A		Subsample B	
	$h=3$	$h=12$	$h=3$	$h=12$	$h=3$	$h=12$
Brazil	1,02	0,91	1,42	0,69	-0,33	-0,33
	0,31	0,36	0,17	0,50	0,75	0,75
Canada	-1,10	-1,02	-1,16	-0,56	-0,60	-0,59
	0,27	0,31	0,26	0,58	0,55	0,56
Chile	-0,74	-0,68	-0,47	-0,23	-0,28	-0,35
	0,45	0,50	0,65	0,82	0,78	0,73
Eurozone	-0,16	-0,25	-1,50	-0,73	5,85	4,30
	0,87	0,80	0,15	0,48	0,00	0,00
Japan	-4,21	-4,26	-5,22	-2,53	-2,95	-2,30
	0,00	0,00	0,00	0,02	0,00	0,03
Mexico	0,99	0,94	1,17	0,57	0,79	1,29
	0,33	0,35	0,26	0,58	0,44	0,20
New Zealand	1,61	1,50	1,48	0,72	0,60	0,28
	0,11	0,14	0,16	0,48	0,55	0,78
Poland	-0,93	-0,87	2,61	1,26	-0,75	-0,26
	0,35	0,39	0,02	0,22	0,45	0,79
Thailand	-1,10	-0,78	-1,15	-0,56	-1,44	-0,31
	0,27	0,44	0,26	0,58	0,16	0,76
Turkey	-4,66	-4,21	-0,43	-0,21	-5,34	-3,36
	0,00	0,00	0,67	0,84	0,00	0,00
UK	1,03	1,00	1,60	0,78	-3,88	-3,30
	0,31	0,32	0,13	0,45	0,00	0,00
US	1,77	1,74	2,38	1,15	1,24	1,63
	0,08	0,09	0,03	0,26	0,22	0,11

Reports the modified Diebold-Mariano test and p-values. Under the null, both models have the same predictive power, while under the alternative is different. When the Diebold-Mariano statistic is negative and statistically significant, this represents evidence in favor of the predictive power of model based bond interest rates. Full sample corresponds to December 2007 to December 2013, Subsample A corresponds to December 2007 to July 2009 and Subsample B corresponds to August 2009 to December 2013.

Table 2: Economic growth forecast evaluation

	Full sample			Subsample A			Subsample B		
	$h = 3$	$h = 6$	$h = 12$	$h = 3$	$h = 6$	$h = 12$	$h = 3$	$h = 6$	$h = 12$
Brazil	-0,47	-0,56	-0,14	-0,52	0,23	-0,44	-0,35	-0,61	0,72
	0,64	0,58	0,89	0,61	0,82	0,66	0,73	0,55	0,48
Canada	0,38	-1,08	-1,91	-3,34	0,14	-0,56	1,96	-1,20	-1,60
	0,70	0,28	0,06	0,00	0,89	0,58	0,06	0,23	0,12
Chile	-0,54	-1,22	-0,70	-0,58	-1,02	-0,72	-0,11	-0,61	-0,14
	0,59	0,23	0,48	0,57	0,32	0,48	0,91	0,54	0,89
Eurozone	-1,89	-1,01	-0,07	0,63	-4,30	-1,74	-2,20	0,02	1,57
	0,06	0,32	0,95	0,54	0,00	0,10	0,03	0,99	0,12
Japan	0,38	-0,11	0,01	-0,28	-2,84	-1,64	0,97	1,00	1,36
	0,71	0,91	0,99	0,78	0,01	0,12	0,34	0,32	0,18
Mexico	-1,28	-1,26	-2,44	0,56	-0,07	0,19	-1,56	-1,25	-2,86
	0,21	0,21	0,02	0,58	0,95	0,85	0,12	0,22	0,01
New Zealand	-3,83	-0,89	-0,27	-0,58	-0,76	0,18	-4,47	-0,41	-0,78
	0,00	0,38	0,79	0,57	0,45	0,86	0,00	0,69	0,44
Poland	-0,78	-1,08	-1,89	0,13	-0,46	-0,78	-1,22	-0,92	-1,21
	0,44	0,28	0,06	0,90	0,65	0,45	0,23	0,36	0,23
Thailand	-0,53	-2,27	-1,41	0,26	-1,43	-0,91	-1,19	-2,16	-0,78
	0,60	0,03	0,16	0,80	0,17	0,37	0,24	0,04	0,44
Turkey	-1,72	-1,55	-0,90	-1,66	-0,77	-0,25	-1,46	-1,20	-0,77
	0,09	0,13	0,37	0,11	0,45	0,81	0,15	0,23	0,44
UK	0,80	-0,74	-0,60	1,23	-2,95	-1,24	0,13	-0,05	1,18
	0,42	0,46	0,55	0,23	0,01	0,23	0,90	0,96	0,24
US	0,12	-0,99	-2,47	0,84	-0,85	-0,59	-0,02	-0,70	-2,21
	0,91	0,33	0,02	0,41	0,40	0,56	0,98	0,49	0,03

Reports the modified Diebold-Mariano test and p-values. Under the null, both models have the same predictive power, while under the alternative is different. When the Diebold-Mariano statistic is negative and statistically significant, this represents evidence in favor of the predictive power of model based bond interest rates. Full sample corresponds to December 2007 to December 2013, Subsample A corresponds to December 2007 to July 2009 and Subsample B corresponds to August 2009 to December 2013.

4 Conclusions

Given the target of monetary policy to affect the expectations of economic agents and the economic performance of a country, we evaluate empirically the informational content of the yield curve in the period were unconventional monetary policies were applied. Computing the yield curve with a simple and well known parametric method like the Nelson & Siegel (1987) model, we compute three factors of the yield curve (level, slope and curvature) and test the quality of their predictions for monetary policy rate and yearly economic growth for twelve economies, against market survey and standard autoregressive models. Evaluating this prediction for the pre-crisis and the post-crisis period, we found significant gains in the prediction of monetary policy rate and even more important gains in the forecast of output growth in developed economies for medium term horizons (six to twelve months). For developing economies, those gains are moderated or are not statistically significant. All these evidence reflects that unconventional monetary policies did not deteriorate the informational content implicit on interest rates and even improve it especially in developed economies.

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