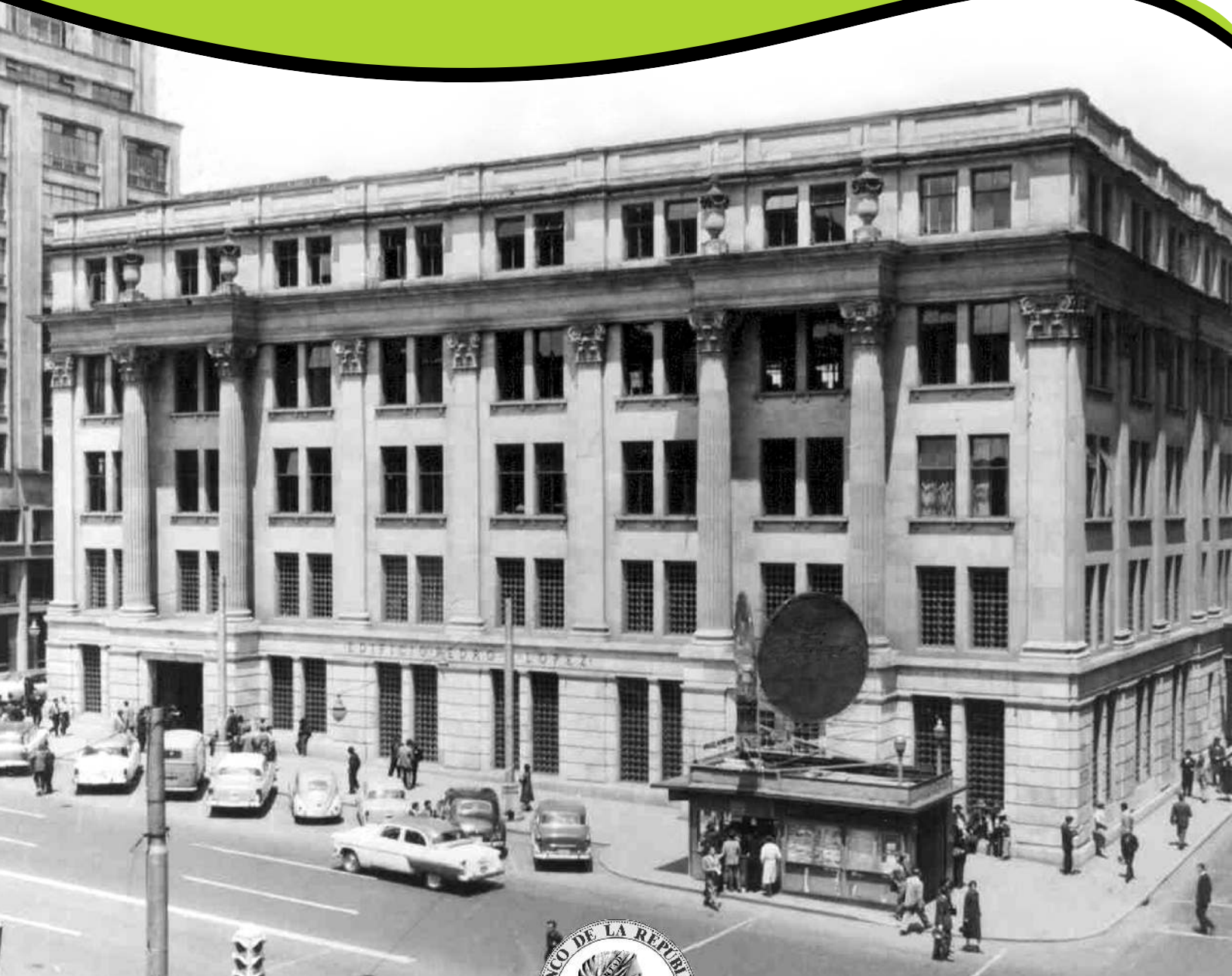Information on Future Monetary Policy in Colombia?

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Borradores de
ECONOMÍA

No. 463

2007

Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Col

DOES THE SPOT CURVE CONTAIN INFORMATION ON FUTURE MONETARY POLICY IN COLOMBIA?

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ABSTRACT. In order to asses the credibility of their targets and policies, inflation targeting central banks always keep an eye on market expectations of the future inflation rates and *short maturity* interest rates. In economies with developed financial markets the prices of financial assets are a prime source of expectations. The spot curve, in particular, is thought to contain a great deal of information on market expectations. In this paper we study the possibility to obtain market expectations on short maturity interest rates, that is, on the future monetary policy. A natural starting point in the program of deriving expectations from the spot curve is the *Expectations Hypothesis of the Term Structure of the Interest Rates*. According to this hypothesis the slope of the spot curve, the forward curve, represents the market expectations on interest rates aside from a negligible or at least time invariant *forward term premium*. For this note we developed a unique database of spot curves spanning the period from Nov-1999 to Sep-2006 in order to test the validity of the Expectations Hypothesis for short maturities in Colombia. Our results indicate that the spot curve contains information on the future behavior of short maturity interest rates only for very short horizons. Moreover, we found that the *forward term premium* tend to be time varying. These result comprise in the rejection of the Expectations Hypothesis. Although these results imply that market expectations on future short maturity interest rates can not be obtained as easily as just applying the prescription of the Expectations Hypothesis, they do not rule out the possibility to obtain market expectations of the future monetary policy from the time series of spot curves.

1. INTRODUCTION

For an inflation targeting Central Banker the transmission mechanism of the interest rates can be *roughly* summarized as follows. The Colombian Central Bank has perfect control on a very short term interest rate, the overnight interbank lending rate, TIB. Policy innovations to this rate transmit to medium and long term rates through the financial markets. Medium to long term rates determine households and firms borrowing costs, which in turn determine the aggregate demand in the economy.

The spot curve, a plot of the interest rates on zero coupon bonds as a function of their maturity, describes the relationship among the very short maturity rate, TIB, medium and long maturity rates. The leverage of the central bank on longer term

rates comes from the fact that the market determines them as averages of expected short run rates over the relevant horizon, aside from the *forward term premium*.

Market expectations of future inflation and interest rates are usually derived by following the prescriptions of the *Expectations Hypothesis of the Term Structure of the Interest Rates* proposed by Hicks [4], and the decomposition of nominal rates into expected inflation and expected real returns proposed by Fisher [3].

Although these two views are compatible in principle, reconciling them is not an easy task in practice. For instance, an increase in the slope of the spot curve may be understood both as a loss of confidence in the Central Bank commitment to low inflation, and as a market expecting a tighter monetary policy in order to reach the inflation target. Only after a careful choice of *identifying* conditions and a sensible analysis of the current economic conditions and markets we can derive a consistent interpretation of the information on expectations contained in the spot curve.

According to the Expectations Hypothesis the slope of the spot curve, the forward curve, equals the market expectations on future interest rates except for a negligible or at least time invariant *forward term premium*. Hence, interest rate expectations dominate the forward curve, and since the forward curve determines the shape of the spot curve, market expectations on future interest rates determine the shape of the spot curve. However, if the Expectations Hypothesis is not true, the dominant force shaping the form of the spot curve is the *forward term premium*.

There are a number of reasons to explain the existence of a time varying and non negligible forward risk premium. For instance, if market agents are risk averse, they are likely to charge a term premium for the uncertainty on future interest rates and a liquidity premium for holding instruments that might not be easily tradeable in the future. These two factors are likely to push the forward curve above the interest rate path expected by the market.

Accordingly, empirical work on the Expectations Hypothesis relates to two particular questions. (i) Is the current forward curve a good forecasts of future interest rates? (b) Does the current forward curve contain information on future interest rates? See Fama and Bliss [2] and Campbell and Schiller [1].

For this note we developed a unique database of spot curves spanning the period from Dec-1999 to Sep-2006 in order to test the Expectations Hypothesis for Colombia. From our estimated spot curves we observe that the TIB rate determines the level of the sot curve, and the EMBI spread generates deviations from this level. Moreover the EMBI spread seems to be related to the slope of the curve.

Our results indicate that the current forward curve contain information on future short maturity interest rates, that is, on expectations on the future monetary policy, only for very short horizons. Moreover, we also found evidence that the forward term premium tends to be time varying and non negligible.

Although these results imply that market expectations on future short run interest rates can not be obtained as easily as just applying the Expectations Hypothesis, they do not rule out the possibility to obtain market expectations from the time series of spot curves.

Apart from this short introduction, this note begins with an elementary review on the spot curve and the Expectations Hypothesis in section 2, where we also establish the basic language and notation. In section 3 we describe the methodology to test the Expectations Hypothesis. In section 4 we present the results, and in section 5 we conclude.

2. Review on The Spot Curve and the Expectations Hypothesis

Following Svensson [9] and Soderlind and Svensson [8], in this section we summarize the most important results on the on the spot and forward curves as well as the Expectations Hypothesis. In subsection 2.1 we describe the relationship and basic elementary formulas for the yield to maturity, the discount, the spot and forward curves. From the decomposition of the forward rate into the market expectations on future interest rates plus the forward term premium, in subsection 2.2 we review the elementary results on the Expectations Hypothesis.

2.1. **A Review on Fixed Income Formulas.**

2.1.1. *The Spot Curve and the Yield to maturity.* A zero coupon bond is a financial instrument in which the issuer commits to pay the owner a pre specified amount of money, the face value, at a preestablished date, the maturity date. On a particular trading day, t, the zero coupon rate, $i(t, T)$, is the secondary market discount rate of a zero coupon bond with maturity date, $T > t$. We will denote the *maturity* of the bond as $m = T - t$.

In our notation time is measured in years and interest rates are continuously compounded percent per year [1].

On a given trading day, t, the spot curve is the relationship between the zero coupon rates, $i(t, T)$, and their maturities, $m = T - t$. This relationship is also known as the Term Structure of the Interest Rates, the zero coupon curve, etc.

Given that the rates are continuously compounded, the present value of a zero coupon bond with a principal of 1 Colombian Peso, COP, payable after $m = T - t$ years is given by

$$(1) \qquad d(t, T) = exp\left(-\frac{i(t, T)}{100}(T - t)\right)$$

where the notation indicates that this present value is also known as the *discount function*. In other words, the discount function is the discount factor at t of a future payment of 1 COP with maturity m.

Coupon bearing bonds are just the union of a preestablished set of zero coupon bonds. For instance, the Colombian treasury bonds, TES, pay annual coupons of c percent up to its maturity m when they pay also the face value, let us say 100 COP. By bringing each of the flows to the present trading day, t, using the discount function 1 we obtain the pricing formula for TES bonds as follows

$$(2) \qquad P(t, t + m) = 100\sum_{k=1}^{m} cd(t, t + k) + 100d(t, t + m)$$

However, in the secondary market quotes are often written in terms of the Yield to Maturity, YTM. The yield to maturity is the internal rate of return of the coupon bond, that is, the unique discount rate that equals the present value of all the flows to the present value in 2. Thus the yield to maturity, $y(t, t + m)$, of a coupon

---

[1]The continuously compounded spot rate, i, and the yearly compounded spot rate, $\widetilde{i}$, measured as percent per year, relate to each other according to $\widetilde{i} = 100\left[\exp\left(\frac{i}{100}\right) - 1\right]$. Thus, $i = 100\left[\ln(\frac{\widetilde{i}}{100}) + 1\right]$

bearing bond like the TES bonds satisfies the equation

$$(3) \quad P(t, t+m) = 100 \sum_{k=1}^{m} c\, exp\left(-\frac{y(t, t+m)}{100}k\right) + 100 exp\left(-\frac{y(t, t+m)}{100}m\right)$$

Sometimes the plot of the yield to maturity of different bonds as a function of their maturity is used to represent the Term Structure. This plot, however, is not a precise representation of the Term Structure because of two facts. First, the yield to maturity depends on the coupon level, and thus two coupon bonds with the same maturity but differing coupon levels will have different YTMs for the same trading day. This is known as the coupon effect. And second, in the pricing formula 3 the time value of money is ignored since all flows are discounted with the same rate, contrary to equation 2 in which the the time value of money is recognized. Moreover, YTMs are recognized to be a complicated average of spot rates.

However, spot rates are not directly observable from the workings of secondary markets except for a few maturities below one year, like those of the short run TES bonds. For maturities beyond one year only a few non liquid zero coupon bonds are available. In this case we can obtain spot curve estimates from treasury coupon bearing bonds, the TES in Colombia, using fairly known techniques.

2.1.2. *The Forward Curve.* For a given trading day, t, the interest rate of a forward contract with settlement $t' > t$ and maturity $T > t'$ is easily computed by noticing that this contract is equivalent to buy and sell zero coupon bonds. That is, selling at market value a zero coupon bond with maturity equal to the date of the forward settlement t', and buying at the same market value a zero coupon bond with maturity equal to the maturity of the forward contract T. The implied forward rate is the return of this portfolio adjustment.

Let $f(t, t', T)$ denote the implied forward rate of an investment on the trading day t, with settlement at $t' > t$ and maturity $T > t'$. We can compute the implied forward rate from the spot rates as follows

$$(4) \qquad f(t, t', T) = \frac{(T-t)i(t, T) - (t'-t)i(t, t')}{T - t'}$$

We define the instantaneous forward rate, that is, the implied forward rate of a forward contract with an infinitesimal investment period as the limit

$$(5) \qquad f(t, t') = \lim_{T \to t'} f(t, t', T)$$

This rate may be understood as a forward overnight rate, that is, the implied forward rate of a forward contract with an investment period of one day after the settlement. By definition, the forward rate on an investment interval (t', T) is the average of the instantaneous forward rates during the investment period,

$$(6) \qquad f(t, t', T) = \frac{\int_{\tau=t'}^{T} f(t, \tau)\, d\tau}{T - t'}$$

Thus, the instantaneous forward rate is the marginal increase of the total return due to an infinitesimally small increase in the duration of the investment period. And hence, the instantaneous forward rate relates to the spot rate according to,

$$(7) \qquad i(t, T) = \frac{\int_{\tau=t}^{T} f(t, \tau)d\tau}{T - t}$$

2.2. **The Expectations Hypothesis.** The *forward term premium* is defined as the expected excess return of a forward investment, that is, the premium of the forward rate over the spot rate that is expected on the forward contract's trade date to rule on the forward contract's settlement date. See Svensson [9].

From this definition the forward rate decomposes as

$$(8) \qquad f(t, \tau, T) = E_t \left[i(\tau, T) \right] + \varphi^f(t, \tau, T)$$

where $E_t \left[i(\tau, T) \right]$ denotes the market expectations at the trading day, t, on the future spot rate $i(\tau, T)$, and $\varphi^f(t, \tau, T)$ denotes the forward term premium.

The *Expectations Hypothesis of the Term Structure of the Interest Rates* is the assumption that the forward term premium is negligible or at least time invariant. Under this assumption equation 8 provides the prescription to extract the market expectations on the future interest rates.

However, if the Expectations Hypothesis does not hold, market expectations depend on both, a time varying forward term premium and the forward rates. There are a number of reasons to explain the existence of a time varying and non negligible forward risk premium. For instance, if market agents are risk averse, they are likely to charge a term premium for the uncertainty on future interest rates and a liquidity premium for holding instruments that might not be easily tradeable in the future. These two factors are likely to push the forward curve above the interest rate path expected by the market.

Under the further assumptions that market expectations are rational, and that bond pricing is carried out with a Stochastic Discount Factor, SDF, financial theorists have derived several expressions for the spot and forward curves, as well as for the forward term premium. See Soderlind and Svensson [8].

Let us denote the SDF of a zero coupon bond with maturity date T as $D(t, T)$. The SDF may be used to price at time t zero coupon bonds with a stochastic payment $X(T)$ at maturity $T > t$ as $V(t, T) = E_t[D(t, T)X(T)]$. Thus, the present value at t of a zero coupon bond that pays 1 COP on maturity is given by

$$B(t, T) = E_t \left[D(t, T) \right]$$

Under the further assumption that $D(t, T)$ is log-normally distributed, the forward risk premium might be written as

$$(9)\, \varphi^f(t, \tau, T) \;=\; -\frac{T - \tau}{2} Var_t\left(i\left(\tau, T\right)\right) - Cov_t\left[d^l\left(t, \tau\right), f\left(t, \tau, T\right) - i\left(\tau, T\right)\right]$$
$$-\frac{Cov_t\left[d^l\left(t, T\right), Var_\tau\left(d^l\left(\tau, T\right)\right)\right]}{2}$$

where the first term on the right hand side of the equation is the Jensen's inequality, the second is the covariance between the log SDF and the forward-spot spread, the third is the covariance between the log SDF and its variance, and $d^l(t, T) = log(D(t, T))$. According to the second and third terms, higher correlations imply a more attractive forward investment and a lower forward term premium. See Soderlind and Svensson [8] and [7]

3. Data and Methodology

3.1. **Testing the Expectations Hypothesis.** Ideally, to test the expectations hypothesis one we would compare the forward rates with interest rate expectations. However, market expectations on future interest rates are not observable and may

not even be rational. Under the assumption that market expectations are rational, any systematic difference between the forward rates and the ex-post observed rates may be attributed to the forward risk premium.

Moreover, in order to compute the expected interest rates using equation 9 we need to know the forward risk premium. According to equation 9 this premium depends on the covariances between the log SDF and the forward-spot spread and the covariance between the log SDF and its variance, aside from the Jensen's inequality term. Unfortunately we do not have direct measurements of these, potentially time varying, covariances, and ex-post data is of little use since the SDF is not observable either.

Empirical evidence on the forward risk premium comes from either one of two types of complementary regressions. The interpretation of these regressions follows from the identity

$$
(10) \quad f(t, t+x-1, t+x) - i(t, t+1) = [E_t[i(t+1, t+x)] - i(t, t+x-1)]
$$
$$
+ [E_t[h(t, x, x-1)] - i(t, t+1)]
$$

where $f(t, t+x-1, t+x) - i(t, t+1)$ is the forward-spot spread, $h(t, x, x-1)$ is the ex-post return, at $t+1$, of buying at t a zero coupon bond with maturity x and selling it at $t+1$ when the maturity is $x-1$,

$$
(11) \qquad h(t, x, x-1) = 100 \left(log(P(t+1, t+x)) - log(P(t, t+x)) \right)
$$

where $P(t, T) = 100 \exp(-\frac{i(t,T)}{100}(T-t))$ is the price at t of a zero coupon bond that pays 100 COP at T. Then

$$
(12) \qquad h(t, x, x-1) = xi(t, t+x) - (x-1)i(t+1, t+x)
$$

Equation 10 holds for realized returns as well as for expected values. See Fama and Bliss [2], Campbell and Schiller [1], and Soderling and Svensson [8].

The first regression explains the change in the spot rates as a function of the forward-spot spread,

$$
(13) \quad i(t+1, t+x) - i(t, t+x-1) = \beta_1 [f(t, t+x-1, t+x) - i(t, t+1)]
$$
$$
+\alpha_1 + u_1(t+1)
$$

where $i(t+1, t+x) - i(t, t+x-1)$ is the change in one period of time of the spot rates with maturity $x-1$.

The second regression relates the difference between the ex-post return of keeping a spot bond with maturity of x during a single period of time and the spot rate with maturity of one period of time, with the forward-spot spread,

$$
(14) \quad h(t, x, x-1) - i(t, t+1) = \beta_2 [f(t, t+x-1, t+x) - i(t, t+1)]
$$
$$
(15) \qquad\qquad +\alpha_2 + u_2(t+1)
$$

where $h(t, x, x-1) - i(t, t+1)$ is known as the term premium in the 1 period of time return on a bond with maturity x over the spot rate.

From the basic identity 10 we can easily observe that $\beta_1 = 1 - \beta_2$, $\alpha_1 = -\alpha_2$, and that the parameter β_2 can be interpreted as the share of forward-spot spread variation between the expected forward term premium and the change in the spots rates. See Fama and Bliss [2].

Evidence that $\beta_2 > 0$ indicates the the expected forward term premium is time varying, while evidence that $\beta_2 \neq 1$ means that the forward-spot spread contains information to forecast the changes in the spot rate.

3.2. **Data.** In order to obtain evidence on the forward term premium we built a unique database of estimated spot curves spanning the period Nov-1999 to Sep-2006 for Colombia. On a particular month the estimated spot curve is the one corresponding to the 15th day of the month or the nearest day available.

For a particular day in the sample, spot curve estimation was carried out by using the unrestricted version of the Nelson and Sieguel [5] instantaneous forward rate specification by minimizing the yield to maturity sum of squared errors. See also Svensson [9].

For a particular day, the sample consists of the weighted average yields for the bonds traded in the secondary market. The sample includes both the wholesale bond market, SEN, and the retail market, MEC. The yield of a particular trade is weighted according to its volume relative to the bond's total volume traded that day.

Ex post returns $h(t, x, x-1)$ were computed by using equation 12 and forward rates using equation 4.
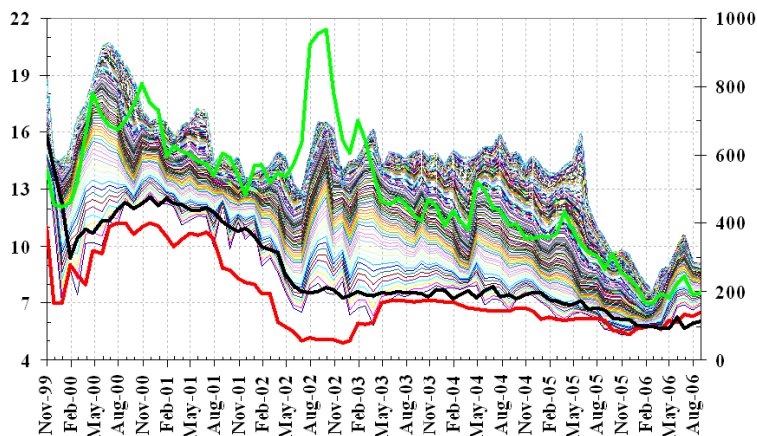
4. RESULTS

FIGURE 1. Continuously compounded extrapolated spot rates, TIB, CD90 and the EMBI Colombia Spread

4.1. **Estimated Spot Curves.** Figure 1 contains the time series of extrapolated estimated continuously compounded spot curves for the monthly sample. The thin lines from the bottom up represent the time series of estimated spot rates for maturities of one day, 30 days, 60 days, ..., up to 15 years. The thick red line corresponds to the continuously compounded TIB rate, the thick black line corresponds to the 90 day CDs continuously compounded rate issued by commercial banks, corporates and commercial financing companies, the CDT90 rate. The green thick line corresponds to the EMBI Colombia spread whose scale, measured in basic points, is on the right of the figure.

Spot rates are extrapolated up to 15 years even for the periods of time when there were no bonds issued at this maturity. In fact, the longest maturity bond available in Nov-1999 was a 3 year bond. TES with maturities of 5 years were issued for the first time on Feb-2000, bonds with maturity of 7 years were introduced in

Aug-2001, 10 year bonds were issued on Jan-2002, and 15 year bonds were not issued until Jul-2005. These extrapolated spot rates are shown just for illustration but are not used in the actual estimation and testing procedures.

The figure reveals some important facts:

(1) The TIB rate follows closely the rate with maturity 1 day only after Mar-2003. Before that, the difference may be as high as 400 basic points.
(2) The CDT90 rate follows closely the spot series with maturity 90 days, but presents differences as high as 200 basic points particularly at the end of the sample.
(3) The spread between the CDT90 and TIB rates varies along the time and at present it is negative. This shows a divorce between the money market and the bond market.
(4) The EMBI Colombia spread has a very close relationship with the spot curve at all maturities. For short to middle maturities where the response to innovations to the EMBI Colombia spread is immediate. For longer rates there seems to be a delay in the response. Although the lag does not appear to be constant.
(5) The TIB rate seems to determine the mean level of the spot rates, and the EMBI generate deviations from this mean level. Moreover, the EMBI spread seems to be related to the slope of the curve.
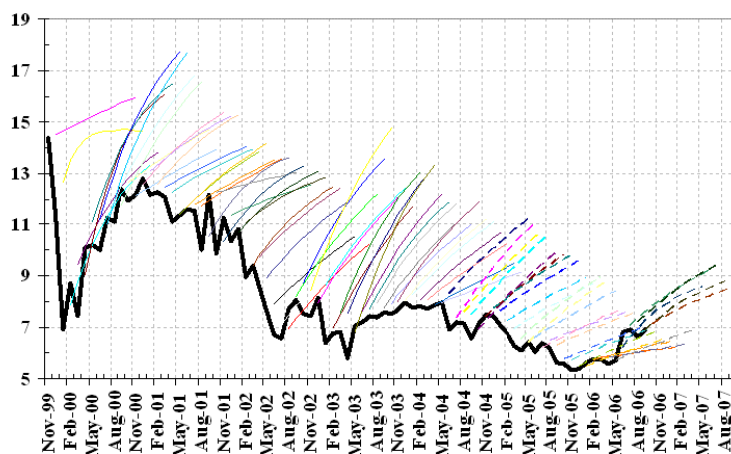

FIGURE 2. 30 Days observed spot curve and one year ahead forecasts under the Expectations Hypothesis

4.2. **Market Expectations Under the Expectations Hypothesis.** Were the Expectations Hypothesis true, market expectations on the future short maturity interest rates could be computed from equation 8, that is from the forward rates.

Figure 2 displays the time series of the observed 30 days spot rate, thick black line, and the forecasts up to one year ahead under the Expectations Hypothesis, the thin hairs that come out from the thick line. Remarkably, market expectations are always increasing and rarely match the ex post observed rates. Moreover, the trend is varies along the time.

These results may be interpreted as either, market agents making consistent expectations errors or evidence of a sizable time varying forward term premium, or both.

One might argue that even if market expectations are not rational, continuous upward trending expectations errors of this size are not likely, thus an important component of these upward trends corresponds to a time varying forward term premium. Moreover, since expectations errors increase with the forecasting horizon, this evidence suggests that the forward term premium is not only time varying but also sizable.
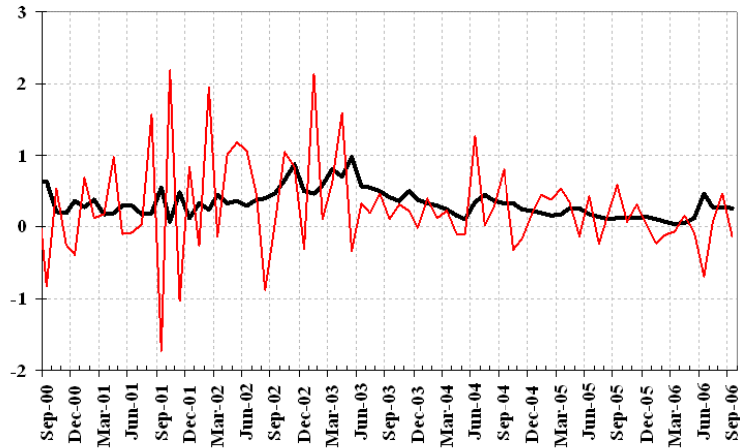

FIGURE 3. Ex post return premium and forward term spread

4.3. **Formal Test.** Figure 3 contains the ex post return premium, red line, after a month of buying at t a zero coupon bond with maturity 2 months and selling it after a month when its maturity is one month over the one month spot rate at t, and the forward term spread at t with settlement after a month and maturity two months over the one month spot rate at t.

This figure suggests a direct relationship between the two variables. However, the ex post return premium shows higher volatility than the forward spread and also a high degree of negative first order autocorrelation. Moreover, both variables show a stationary behavior, a requirement for the validity of our regression results.

Table 1 contains the estimation and testing results of equation 14 for one month spot rates. Each line of the table refers to forecasting horizons from one to twelve months. The standard errors for each of the regression coefficients are heteroscedasticy and auto correlation robust. See Newey West [6].

The estimated β_2 values increase with the forecasting horizon. This pattern is followed by the significance t statistics. Moreover, the t statistics show that the β_2 coefficient are significantly different from zero at all forecasting horizons after 9 months, which means that the forward term premium up to forecasting horizons of 9 for the one month spot rate are time invariant. However, the t statistics for the null $\beta_2 = 1$ reveals that only for a horizon of one month this coefficients is significantly different from one, which means that the one month spot curve is forecastable from the spot curves only for one month.

Dependent	α_2	$t_{\alpha_2=0}$	β_2	$t_{\beta_2=0}$	$t_{\beta_2=1}$	R^2	ρ_1	ρ_2	ρ_3	ρ_4
$h(t,2,1) - i(t,t+1)$	0.34	1.80	-0.22	-0.37	-2.07	0.00	-0.34	0.28	0.00	0.17
$h(t,3,2) - i(t,t+1)$	0.68	1.92	-0.07	-0.12	-1.94	0.00	-0.33	0.26	-0.03	0.14
$h(t,4,3) - i(t,t+1)$	0.92	1.86	0.08	0.16	-1.79	0.00	-0.32	0.25	-0.06	0.12
$h(t,5,4) - i(t,t+1)$	1.07	1.73	0.22	0.47	-1.61	0.00	-0.30	0.23	-0.09	0.09
$h(t,6,5) - i(t,t+1)$	1.14	1.57	0.36	0.80	-1.40	0.01	-0.28	0.21	-0.12	0.07
$h(t,7,6) - i(t,t+1)$	1.15	1.38	0.50	1.15	-1.16	0.02	-0.25	0.19	-0.16	0.05
$h(t,8,7) - i(t,t+1)$	1.10	1.17	0.63	1.49	-0.89	0.03	-0.21	0.17	-0.19	0.03
$h(t,9,8) - i(t,t+1)$	1.00	0.95	0.75	1.81	-0.59	0.04	-0.18	0.15	-0.23	0.01
$h(t,10,9) - i(t,t+1)$	0.85	0.73	0.87	2.09	-0.30	0.05	-0.15	0.13	-0.25	0.00
$h(t,11,10) - i(t,t+1)$	0.67	0.52	0.99	2.31	-0.02	0.06	-0.12	0.12	-0.28	-0.01
$h(t,12,11) - i(t,t+1)$	0.46	0.32	1.11	2.47	0.24	0.07	-0.09	0.10	-0.30	-0.02
$h(t,13,12) - i(t,t+1)$	0.21	0.13	1.22	2.57	0.46	0.07	-0.06	0.09	-0.32	-0.02

TABLE 1. Term premium regressions: One month spot rates

Dependent	α_2	$t_{\alpha_2=0}$	β_2	$t_{\beta_2=0}$	$t_{\beta_2=1}$	R^2	ρ_1	ρ_2	ρ_3	ρ_4
$h(t,3,1) - i(t,t+1)$	0.11	1.40	0.47	2.23	-2.50	0.06	0.31	-0.01	0.18	-0.07
$h(t,4,2) - i(t,t+1)$	0.28	1.69	0.56	2.71	-2.12	0.08	0.34	-0.01	0.14	-0.10
$h(t,5,3) - i(t,t+1)$	0.39	1.55	0.65	3.15	-1.72	0.10	0.37	-0.02	0.08	-0.13
$h(t,6,4) - i(t,t+1)$	0.46	1.33	0.73	3.51	-1.28	0.12	0.40	-0.02	0.03	-0.16
$h(t,7,5) - i(t,t+1)$	0.48	1.08	0.82	3.77	-0.84	0.14	0.42	-0.03	-0.03	-0.18
$h(t,8,6) - i(t,t+1)$	0.46	0.83	0.90	3.93	-0.42	0.15	0.45	-0.04	-0.08	-0.20
$h(t,9,7) - i(t,t+1)$	0.40	0.60	0.99	4.00	-0.05	0.16	0.46	-0.05	-0.13	-0.21
$h(t,10,8) - i(t,t+1)$	0.31	0.39	1.07	4.00	0.27	0.17	0.48	-0.06	-0.17	-0.22
$h(t,11,9) - i(t,t+1)$	0.19	0.20	1.16	3.96	0.54	0.18	0.49	-0.07	-0.20	-0.23
$h(t,12,10) - i(t,t+1)$	0.04	0.04	1.24	3.88	0.76	0.18	0.50	-0.07	-0.23	-0.23
$h(t,13,11) - i(t,t+1)$	-0.14	-0.11	1.33	3.80	0.94	0.18	0.51	-0.08	-0.25	-0.23
$h(t,14,12) - i(t,t+1)$	-0.34	-0.25	1.41	3.71	1.08	0.18	0.52	-0.08	-0.27	-0.23

TABLE 2. Term premium regressions: Two months spot rates

The residual autocorrelations show also a significant and homogeneous degree of negative autocorrelation or order one, which is the result of the alternating jump behavior observed in the dependent variable.

Finally, R^2 adjusted for degrees of freedom indicates a poor but increasing global adjustment.

Table 2 contains the estimation results of equation 14 for the two month spot rate. At all horizons the test for $\beta_2 \leq 0$ is rejected indicating that that the forward premium is time varying. However, The test for $\beta \neq 0$ is rejected only up to a forecasting horizon of 2 months.

These results show that the spot curve contains information to forecast the two months spot rate up to two months ahead, but the forward term premium is time varying.

Finally, table 3 contains the results for the three months spot rate. At all horizons above 2 months the test for $\beta_2 \leq 0$ is rejected indicating that that the forward premium is time varying for these horizons. However, The test for $\beta \neq 0$ is rejected only up to a forecasting horizon of 1 month.

Dependent	α_2	$t_{\alpha_2=0}$	β_2	$t_{\beta_2=0}$	$t_{\beta_2=1}$	R^2	ρ_1	ρ_2	ρ_3	ρ_4
$h(t,4,1) - i(t,t+1)$	0.12	1.25	0.42	1.53	-2.13	0.07	0.39	0.46	-0.08	0.08
$h(t,5,2) - i(t,t+1)$	0.29	1.48	0.52	1.92	-1.78	0.10	0.41	0.43	-0.11	0.03
$h(t,6,3) - i(t,t+1)$	0.41	1.37	0.61	2.28	-1.44	0.13	0.43	0.40	-0.14	-0.01
$h(t,7,4) - i(t,t+1)$	0.47	1.18	0.71	2.63	-1.09	0.16	0.45	0.37	-0.17	-0.05
$h(t,8,5) - i(t,t+1)$	0.49	0.97	0.80	2.95	-0.75	0.18	0.47	0.34	-0.19	-0.08
$h(t,9,6) - i(t,t+1)$	0.46	0.76	0.89	3.24	-0.40	0.20	0.49	0.32	-0.21	-0.11
$h(t,10,7) - i(t,t+1)$	0.40	0.55	0.98	3.48	-0.07	0.22	0.50	0.29	-0.23	-0.14
$h(t,11,8) - i(t,t+1)$	0.30	0.36	1.07	3.68	0.24	0.23	0.52	0.27	-0.25	-0.15
$h(t,12,9) - i(t,t+1)$	0.17	0.17	1.16	3.84	0.53	0.24	0.53	0.25	-0.26	-0.16
$h(t,13,10) - i(t,t+1)$	0.00	0.00	1.25	3.95	0.79	0.25	0.54	0.23	-0.27	-0.17
$h(t,14,11) - i(t,t+1)$	-0.19	-0.15	1.34	4.02	1.02	0.25	0.54	0.22	-0.27	-0.18
$h(t,15,12) - i(t,t+1)$	-0.40	-0.30	1.43	4.06	1.21	0.25	0.55	0.21	-0.28	-0.18

TABLE 3. Term premium regressions: Three months spot rates

The results are mixed but clear. Even if the forward term premium is time invariant, the spot curve contains information to forecast the spot rates with maturities up to three months at horizons of up to 2 months ahead, that is only for very short horizons, but since forward spreads tend to be time varying the prescriptions of the Expectations Hypothesis is not useful.

5. CONCLUSION

In monetary policy the slope of the spot curve, the forward curve, is a prime source of the market expectations on the future short maturity interest rates, that is, market expectations on the future monetary policy. A natural starting point in the program of obtaining market expectations on the future interest rates is the *Expectations Hypothesis of the Term Structure of the Interest Rates*. According to the Expectations Hypothesis the forward curve equals the market expectations on future interest rates aside from a negligible or at least time invariant *forward term premium*. Testing this hypothesis entails answering two particular questions. (i) Does the forward curve represent a good forecast of future interest rates? (ii) Does the forward curve contain any information to forecast future interest rates?

In order to test the Expectations Hypothesis for Colombia, we built a unique database of monthly spot curves which spans the period Nov-1999 to Sep-2006. From our estimated spot curves we observe that the TIB rate determines the level of the sot curve, and the EMBI spread generates deviations from this level. Moreover the EMBI spread seems to be related to the slope of the curve.

Our results indicate that the spot curve does contain information on the future behavior of short maturity interest rates in Colombia only for very short horizons. We also found that the *forward term premium* tends to be time varying. These two results leads us to reject the Expectations Hypothesis for shorter maturity rates.

There are a number of reasons to explain the existence of a time varying and non negligible forward risk premium. For instance, if market agents are risk averse, they are likely to charge a term premium for the uncertainty on future interest rates and a liquidity premium for holding instruments that might not be easily tradeable in the future. These two factors are likely to push the forward curve above the interest rate path expected by the market.

Our results imply that a particular cross section of spot rates do not help in forecasting the future monetary policy. This result, however, does not rule out the possibility to obtain market expectations of the future monetary policy from the time series of spot rates.

REFERENCES

1. J. Campbell and R. Schiller, *Yield spreads and interest rates movements: A bird's eye view*, The Review of Economic Studies **58** (1991), no. 3, 4995–514.
2. E. Fama and R. Bliss, *The information in long maturity forward rates*, The American Economic Review **77** (1987), 56–76.
3. I. Fisher, *Appreciation and interest*, The American Economic Review **11** (1896), 331–442.
4. J. Hicks, *Value and capital*, second ed., Oxford university Press, Oxford, UK, 1939.
5. C. Nelson and A. Siegel, *Parsimonious modelling of yield curves*, Journal of Business **60** (1987), 473–489.
6. W. Newey and K. West, *A simple positive definite, heteroscedasticity and autocorrelation consistent covariance matrix*, Econometrica **55** (1987), 703708.
7. P. Soderlind and L. Svensson, *New techniques to extract market expectations from financial instruments: Corrections.*
8. _____, *New techniques to extract market expectations from financial instruments*, NBER Working Paper (1997), no. 5877.
9. L. Svensson, *Estimating and interpreting forward interest rates: Sweden 1992-1994*, NBER Working Paper (1994), no. 4871.

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