Estimation of the Term Structure of Interest Rates and Its Characteristics

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This paper seeks to estimate the term structure of interest rates from Korean data, Monetary Stabilization Bonds and Treasury Bonds, and examine its features to see whether it can be a useful information variable for monetary policy purposes.

It was found that the implied forward interest rates derived from the estimated term structure of interest rates are informative for monetary policies in that they provide information about market expectations of future spot interest rates for, at least, a three-month horizon. Further, empirical results, based on both the implied forward rates and survey forecasts, show that imbalances between supply and demand seem to play a crucial role in determining risk premiums.

One policy implication from this paper is that employing the term structure of interest rates is, indeed, useful for conducting monetary policy. Another is that the central bank should also keep an eye on supply and demand for Treasury Bonds, such as evenly distributed periods to maturity in their issuance and government funds portfolios, as the risk premiums due to persistent imbalances between supply and demand increase the volatility of interest rates, which, in turn, constrains the effectiveness of monetary policy.

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I. Introduction

The purpose of this paper is to analyse the usefulness of the yield curve as an indicator for monetary policy in the Korean case. In particular, I am interested in the ability of the forward interest rates to provide relevant information on agents' expectations about the future course of interest rates.

For this purpose, I estimate hypothetical zero-coupon prices from available coupon bonds for longer maturities, Treasury Bonds and zero-coupon bonds for shorter maturities, Monetary Stabilization Bonds. Spot interest rates and implicit forward interest rates are then derived from these. I employ statistical techniques by fitting data to describe the term structure of interest rates without investigating the factors deriving it. In particular, I follow McCulloch(1971, 1975) in estimating a discount function by fitting model prices to observed bond prices. Among several approximating functional forms that have been suggested, I employ Nelson and Siegel's(1987) parsimonious functional form.

Several papers have tried to estimate the term structure of interest rates from Korean data. Yum, Kim, Oh, and Choi(1999) employs Nelson and Siegel's(1987) method to estimate a term structure of Industrial Finance Bonds issued by Korean Development Bank. Kim and Jang(2000) and Oh, Kim, and Jang(2000) adopt Cox, Ingersoll, and Ross'(1985) model to estimate respectively the Monetary Stabilization Bonds yield curve and that for Treasury Bonds. Lee and Hyun(2002) use Heath, Jarrow, and Morton's(1992) model to estimate the term structure of Monetary Stabilization Bonds. Those papers depend on equilibrium term structure models[1] which make explicit assumptions about the evolution of state variables deriving the term structure of interest rates except for Yum et al.(1999) who rely on statistical techniques to measure the term structure.

Unlike Yum et al.(1999) who use Industrial Finance Bonds, this paper focus on estimating Treasury Bonds' term structure. Oh et al.(2002) also estimate Treasury Bonds' term structure, but unlike their approach which employs an equilibrium term structure model, I adopt a statistical approach to estimate it.

One practical reason for choosing Nelson and Siegel's(1987) functional form is that the number of parameters to be estimated is relatively small compared to others. It has only four parameters to be estimated.[2] Nelson and Siegel(1987),

Note : 1) For a more detailed explanation about equilibrium term structure models, see Anderson, Breedon, Deacon, Derry, and Murphy (1996)

2) According to Bliss (1997), the average numbers of parameters to be estimated in his empirical results are, for example, 11 for the cubic spline function and 98 for the piecewise function.

however, show that their functional form is flexible enough to represent the range of shapes generally associated with the term structure of interest rates; monotonic, humped, and S shaped. This flexibility comes from the existence of three components in the function; short term, medium term, and long term. With appropriate choices of weights for these components, it can generate various shapes of the term structure of interest rates.

Another advantage is that, as Juha and Viertio(1996) point out, there is a close correspondence between the three components and the findings of Litterman and Scheinkman(1991), who using a factor analytic approach, find that three factors, termed as level, slope, and curvature, explain most of the observed variation in bond returns. Diebold and Li(2002) explicitly show that the three time-varying components of Nelson and Siegel′s(1987) function may be interpreted respectively as factors corresponding to level, slope, and curvature.

There is an argument that the parsimonious functional form fits data less accurately than other models such as cubic splines. However, as Svensson(1994) points out, somewhat less precision is acceptable to gain a glimpse of expectation as far as monetary policy is concerned unlike financial analysis such as pricing securities. Due to this smoothness, most central banks have adopted either the Nelson and Siegel′s (1987) function or the extended version suggested by Svensson (1994), with the exceptions of US, Japan and United Kingdom which apply the smoothing splines approach. (see, BIS (1999).) Further, Bliss (1997) tests different estimation methodologies from the US Treasury bills′ pricing point of view. He defines fitted price errors both inside and outside the issues′ bid-ask ranges and compares them for each functional form. His results show that the performance of Nelson and Seigel′s (1987) function does not fall short of that of others.

Several empirical results are worth mentioning here. First, spot rates, yields to maturity on zero-coupon bonds of different maturities, are directly estimated from yields to maturity on coupon bonds to represent precisely the time value of money.

Second, the predictive power of forward rates for future interest rates is statistically significant. In particular, the forward rates are proved to be potentially useful as indicators of market expectations of interest rates at least, three months ahead.

Third, the yield curve responds sensitively to announcements about monetary policy and Treasury Bonds issuance planning rather than those about economic fundamentals, such as consumer prices and industrial production.

Fourth, estimated risk premiums seem to be largely dependent upon the conditions of the supply and demand for bonds. This implies that a persistent imbalance between supply and demand causing the increased volatility of long-term interest rates has the potential to overwhelm Central Bank's attempts to affect market interest rates.

The rest of the paper is organized as follows. Section 2 provides estimation results based on Nelson and Siegel's (1987) functional form. Section 3 discusses several features of the estimated yield curve. Final conclusions are given in Section 4.

II. Estimation of the yield curve

1. Nelson and Siegel(1987) method

Let $s(t, n)$ be the continuously compounded spot interest rates[3] for a zero-coupon bond traded at time t with a period to maturity, n. Let $d(t, n)$, the discount function, denote the price at time t of a zero-coupon bond paying 1 won at the maturity date. This is related to the spot rate by

$$d(t, n) = exp[-s(t, n)n] \tag{1}$$

where exp denotes the exponential function. A yield curve is a plot of interest rates $s(t, n)$ as a function of different times to maturity, for a given trade date t.

Let $f(t, m, n)$ denote the continuously compounded forward rates at trade t, for a forward contract which will be settled after m years and mature after n years.[4] The absence of arbitrage requires that the forward rate fulfills

$$f(t, m, n) = \frac{s(t, n)n - s(t, m)m}{n - m} \tag{2}$$

The instantaneous forward rate, $f(t, m)$, is defined as the limit

$$\begin{aligned} f(t, m) &= \lim_{n \to m} f(t, m, n) \\ &= \frac{-\partial \ln d(t, m)}{-\partial m} \end{aligned} \tag{3}$$

3) The interest rates are expressed in decimal form unless specially mentioned otherwise.

4) Here, $n > m$ and the time to maturity for this forward contract is $(n - m)$ years .

and refers to forward contracts of infinitesimal maturity.[5)]

Nelson and Siegel (1987) obtain a specific functional form of $d(t, m)$ by explicitly assuming that the instantaneous forward rate at time t with the settlement date denoted $f(t, m)$, is the solution to a second-order differential equation with equal roots;

$$f(t, m) = \theta_1 + \theta_2 \cdot exp(-\frac{m}{\tau}) + \theta_3 \cdot exp(-\frac{m}{\tau}) \cdot \frac{m}{\tau} \tag{4}$$

where $(\theta_1, \theta_2, \theta_3, \tau)$ are parameters to be estimated.

Having specified a functional form for the instantaneous forward rate, a spot interest rates function, $s(t, m)$, is derived.

$$\begin{aligned} s(t, m) &= \theta_1 + \theta_2 \cdot \frac{\tau}{m}\{1 - exp(-\frac{m}{\tau})\} \\ &\quad + \theta_3[\frac{\tau}{m}\{1 - exp(-\frac{m}{\tau})\} - exp(-\frac{m}{\tau})] \end{aligned} \tag{5}$$

The spot rate, $s(t, m)$, is sometimes called the zero coupon yield since it represents the yield to maturity on a pure discount or zero coupon bond. A spot yield curve is a plot of the interest rate $s(t, m)$ as a function of different maturity dates m, for a given trade date t. By the term structure of interest rates in this paper, I mean the spot yield curve.[6)]

The impact of parameters, $(\theta_1, \theta_2, \theta_3, \tau)$, on the shape of the spot rates curve can be described as follows.[7)] For long maturities, $s(t, m)$, approaches asymptotically the value θ_1 which must be positive. As it is a coefficient of constant that does not decay to zero in the limit, θ_1 may be viewed as a long-term factor governing the level of the term structure of interest rates. Svensson (1994) favors this characteristic since it seems reasonable to restrict forward rates for settlement very far into the future to constant. It seems unlikely that market agents have information that allows them to have different expectations for, say, 25 or 30 years into the future.

A parameter, θ_2, represents the deviation from the asymptote θ_1, as $(\theta_1 + \theta_2)$

5) It can be identified with an overnight forward rate, that is, a forward rate with maturity one day after settlement.

6) Since the spot rate at maturity is the average of the instantaneous forward rates, they are related in the same manner as the marginal and average cost of production are related so that the quantity produced corresponds to time to maturity. This relationship is a key element in using the yield curve as an indicator for market expectations of the future interest rates path. As long as the current term structure of spot interest rates is obtained, we can extract the implied forward rate curve describing the marginal one period interest rates. Given a current term structure, this produces the implied expected shape of yield curve in one period's future time.

7) For more information, see Bolder and Streliski (1999) and Diebold and Li (2002).

determines the starting value of the term structure at maturity zero. Here, $(\theta_1 + \theta_2)$ must also be positive. θ_2 is a coefficient of a term decaying monotonically and quickly to zero; hence it can be viewed as a short-term factor, which is closely related to the slope of the term structure. The yield curve will have a positive (negative) slope if θ_2 is negative (positive).

The other parameter, θ_3, determines the magnitude and direction of the shape. Whereas the sign of θ_3 determines whether it is hump (positive) or U shape (negative), the absolute size of θ_3 governs the magnitude of the shape. It is a coefficient of a term starting at zero, increasing, and then decaying to zero; hence θ_3 may be viewed as a medium-term factor, which is closely related with the term structure's curvature.

Finally, τ determines the position of either hump or U shape and it should be positive to prevent θ_1, the level of the term structure, being infinite. Small values of τ allow the term structure to reflect the short-end of the yield curve relatively well compared to the long-end of the yield curve.

The discount function employed by Nelson and Siegel (1987) is

$$d(t, m) = exp(-\theta_1 \cdot m - \theta_2 \cdot \tau\{1 - exp(-\frac{m}{\tau})\}$$

$$- \theta_3(\tau\{1 - exp(-\frac{m}{\tau})\} - m \cdot - exp(-\frac{m}{\tau}))] \qquad (6)$$

This is used to determine the price of a set of bonds as the present value of a cash flow is calculated by taking the product of this cash flow and its corresponding discount factor.

However, we cannot directly infer the spot rate from the prices of coupon bonds. It should be estimated from yields on coupon bonds.[8)] For coupon bearing bond with a maturity of m years, its model price[9)], $g_t(\theta, \tau)$ can be approximated by the sum of the discounted future cash flows;

$$g_t(\theta, \tau) = \sum_{k=1}^{h \cdot M} c_{t,k} \cdot d(l + \frac{1}{h} \cdot (k-1); \theta, \tau) + fv \cdot d(M; \theta, \tau) \qquad (7)$$

where, M is the number of years to maturity, k is the sequence of coupon payments, h is the number of coupon payments a year, $h \cdot M$ is $h \cdot M$ if it is an

8) The basic idea is to simply treat each future cash flow of coupon bonds as an independent zero coupon bond paying the same amount of cash flow. The Law of One Price says that the price of coupon bonds should be the same as that of this replicating portfolio.

9) This price is a dirty price, i.e., it includes the payment of accrued interest to compensate the seller for the period since the last coupon payment during which the seller has held the bond but for which they will receive no coupon payment.

integer, integral part of $h \cdot M$ plus one otherwise, $c_{t,k}$ is expected kth coupon payment, $d(\cdot\,;\theta,\tau)$ is the discount function employed by Nelson and Siegel(1987), l is the number of years from trading date to first coupon payment, and fv is face value.

The model prices, $g_t(\theta,\tau)$, are compared with the observed prices, p_t. It is assumed that the observed prices differ from the model prices by an error term, ε_t. By minimizing this, we obtain parameters (θ_1, θ_2, θ_3, τ),

$$\varepsilon_t = p_t - g_t(\theta,\tau) \tag{8}$$

BIS (1999) points out that using bond prices in the estimation irrespective to their durations will lead to over-fitting of the long-term bond prices at the expense of the short-term prices. To meet this issue, I employ two corrections. First, I weight the price error of each bond by the value related to the inverse of its duration. Second, I impose a restriction that the estimated spot rates should go through the overnight call rate.

Then, the objective function to be minimized is;

$$\min_{(\theta_1,\theta_2,\theta_3,\tau)} \sum_{j=1}^{r} [\psi_j \cdot \varepsilon_j]^2 \tag{9}$$

where, j refers to the jth bond traded at each day, r is the daily total number of bonds traded in the market, $\psi_j = \dfrac{1/w_j}{\sum_{j=1}^{r} 1/w_j}$ is the weight given to jth bond traded at each day, w_j is the duration of the th bond, and ε_j is the price error for the jth bond.

The nonlinear least squares method is employed to estimate these parameters by minimizing the sum of squared weighted price errors in equation (9). To obtain an economically reasonable parameter τ, I impose a restriction that τ lies between 0 and 10 years considering that the longest maturity of bonds traded in the Korean market is 10 years.

Once the estimated parameters are obtained, the implied forward rate and the spot rate curve are computed by substituting these parameters into equation (4) and equation (5), respectively.

2. Estimation results

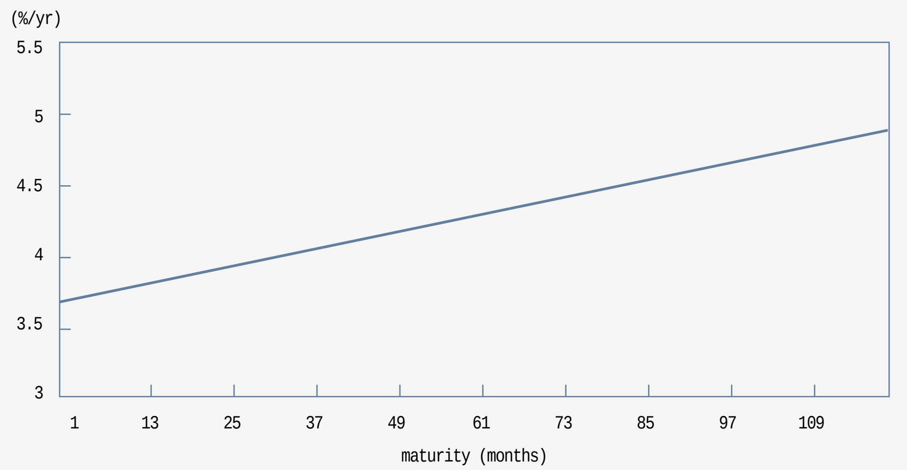
I employ data filtering criteria based on market convention to select only bonds that are indicative of the current market yields by excluding bonds suspected of creating distortions in the estimation of the yield curve. Only bonds whose traded volume is more than 10 billion won are included to avoid the liquidity problem. Further, I only use bonds with more than one year remaining maturity to capture only reliable indicators of market expectations. All data used to estimate the yield curve are traded at a daily basis during year 2004.

Table 1 Type of bonds (daily average in 2004)

	the number of bonds	the number of transaction
Monetary Stabilization Bonds	13	70
Treasury Bonds	11	324

The daily average yield curve in 2004, Figure 1, is upward sloping and flat to the extent that the term spread between 10 years and 3 months remaining to maturity is only 116 basis points. This positive slope may be due either to the market's rising rate expectations or positive risk premiums. A following chapter investigates this issue.

Figure 1 The yield curve in 2004



[Table 2] shows estimation results and says that parameters are fairly precisely estimated by using nonlinear least square estimation. The employed functional form accounts for a large fraction of the variations in government bonds and the average price error per 10,000 won remains a range of 26 ~ 33 won.

Table 2 Estimation results

	estimated parameters				measures of fit		
	$\hat{\theta}_1$(%/year)	$\hat{\theta}_2$(%/year)	$\hat{\theta}_3$(%/year)	$\hat{\tau}$(year)	R^2	MAE(%)	RMSE(%)
mean	6.47	−2.86	−2.22	4.18	0.93	0.26	0.33
standard error	2.00	2.12	3.23	2.74	0.08	0.14	0.15
max	11.60	−0.70	3.15	10.00	0.99	0.59	0.82
min	4.20	−8.35	−9.50	0.50	0.43	0.00	0.01

Note: 1) R^2 comes from the regression of actual observed prices on estimated prices yields
2) MAE and RMSE denote Mean Absolute price Error and the Root Mean Square price Error, respectively, in percent of the principal, 10,000 won.
3) Heteroskedasticity-consistent standard errors are reported.

[Table 3] shows both variability and persistence of interest rates at each maturity of the estimated yield curve. Those at the long end of the yield curve are larger than those at the short end of yield curve. While the standard errors for maturities less than 1 year are in a range of 0.24 ~ 0.37, those for 3 ~ 10 years are a range of 0.55 ~ 0.61. Auto-correlation becomes higher as bond maturities get longer.

One of the main reasons of these facts seems to be the sharp drop in long-term interest rates since the second half the year due to the sluggishness of the economy, as [Figure 2] shows.

Table 3 Summary statistics

maturity (months)	mean (%/yr)	standard errors	max (%/yr)	min (%/yr)	$\hat{\rho}$(1W)	$\hat{\rho}$(1M)	$\hat{\rho}$(2M)	$\hat{\rho}$(3M)
3	3.72	0.24	4.07	3.22	0.92	0.76	0.52	0.40
6	3.77	0.29	4.25	3.23	0.93	0.78	0.55	0.41
12	3.85	0.37	4.49	3.18	0.93	0.80	0.58	0.42
24	3.99	0.49	4.79	3.14	0.94	0.81	0.61	0.43
36	4.11	0.55	4.93	3.15	0.95	0.83	0.63	0.45
60	4.31	0.61	5.17	3.27	0.95	0.84	0.65	0.46
120	4.71	0.55	5.62	3.77	0.92	0.80	0.61	0.41
$\infty(\hat{\theta}_1)$	6.47	2.00	11.60	4.20	0.79	0.39	0.03	−0.21

Note: $\hat{\rho}$ refers to auto correlation coefficient and W and M denote week and month, respectively.

Figure 2 Daily interest rates by each maturity

III. Characteristics of the yield curve

1. Response to news announcements

I estimate the impact of news announcements on the yield curve by comparing the two yield curves for the day before and the day after news release. In particular, I investigate 4 cases, i.e., news about a Monetary Policy Committee decision, economic fundamentals, such as industrial production and consumer price index, and Treasury Bond issuance.

I found several interesting facts from this event study as [Figure 3] shows. First, market participants are concerned more with news about monetary policy and bond issuance rather than that about economic fundamentals. This implies that uncertainties about monetary policy and supply and demand for bonds may be greater than those surrounding economic fundamentals as the recovery of economy stalls out.

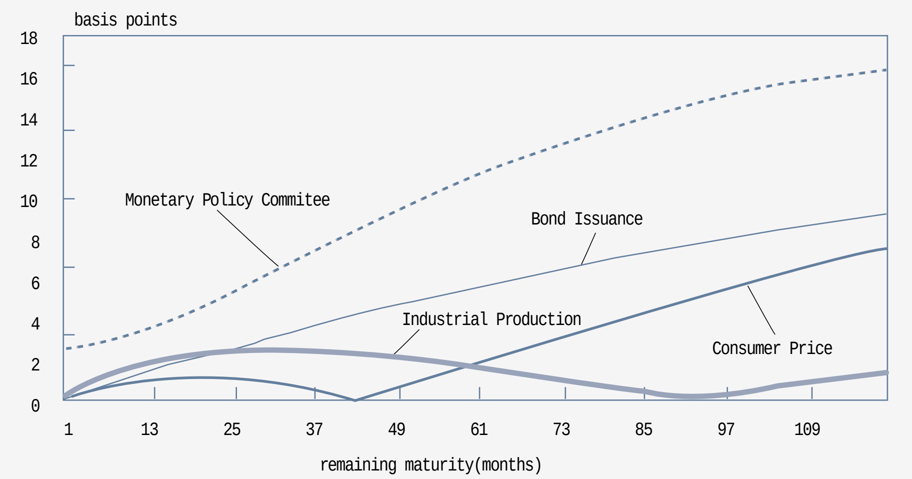
Second, in particular, the impact of monetary policy on the yield curve is great enough to produce large variations of interest rates across maturities. This implies that lowering the overnight rate, as was done twice in year 2004, was unexpected by market participants.

Table 4 Dates for news announcements in 2004 year

	Monetary Policy Committee	Industrial Production	Consumer Price Index	Bond Issuance
January	8th	30th	–	29th
February	12th	27th	2nd	26th
March	11th	30th	2nd	–
April	8th	29th	1st	1st, 29th
May	6th	28th	3rd	–
June	10th	29th	1st	3rd
July	8th	29th	1st	1st, 29th
August	12th[1]	27th	2nd	–
September	9th	–	1st	1st
October	7th	4th, 29th	5th	1st, 28th
November	11th[1]	29th	1st	29th
December	9th	29th	1st, 30th	–

Note: 1) The Bank of Korea lowered the target rate for the overnight rate by 25 basis points, in both cases.

Figure 3 Average changes of interest rates at each maturity in response to news announcements



Third, with regard to economic fundamentals, industrial production has its maximum impact on interest rates for less than 5-year maturities whereas the consumer price index affects interest rates for above 5-year remaining maturities. This shows that medium- and long term interest rates mainly reflect inflation scares through the expected inflation channel.

2. The predictive power for future interest rates

I employ two regression equations[10] under the rational expectations hypothesis to investigate whether forward interest rates extracted from the estimated yield curve have forecasting power for subsequent movement in rates. The first measures the "cumulative" predictive power of the slope of the yield curve between short and long-term rates at various maturities. The second estimates the "marginal" ability of small sections of the yield curve to forecast the subsequent movements in rates over a corresponding future period.

The cumulative regression equation is

$$s(t+n-1,\,1) - s(t,\,1) = \alpha_0 + \alpha_1[f(t,\,n-1,\,n) - s(t,\,1)] + \varepsilon(t+n-1) \qquad (10)$$

where, the dependent variable is the change in the spot rates for one month remaining to maturity over the following $(n-1)$ months and the independent variables are constant and the difference between one-month forward rates $(n-1)$ months in the future and the current spot rates a month remaining to maturity.

[Table 5] says that coefficients less than one but significantly greater than zero provide evidence that the yield curve from one to six months has forecasting power for the subsequent movement of rates.

Table 5 Estimates of cumulative regression

$$s(t+m \text{ months},\ 1 \text{ month}) - s(t,\ 1 \text{ month})$$
$$= \alpha_0 + \alpha_1[f(t, m \text{ months}, m+1 \text{ month}) - s(t,\ 1 \text{ month})] + \varepsilon(t+m \text{ months})$$

m (months)	$\hat{\alpha}_1$	R^2	the number of data
1	0.69* (0.26)	0.08	230
2	0.86* (0.14)	0.31	210
3	0.85* (0.05)	0.61	190
4	0.78* (0.10)	0.43	170
5	0.84* (0.12)	0.55	150
6	0.72* (0.10)	0.52	130

Notes: 1) Standard errors are in parentheses. They are heteroskedasticity and autocorrelation consistent standard error based on the Newey and West(1987) method.
2) * denotes the statistical significance with 5% significance level.

The marginal regression equation is

10) See Cook and Hahn(1990) for detailed derivations for two regressions.

$$s(t+n-1,\,1)-s(t+n-2,\,1)$$
$$=\beta_0+\beta_1[f(t,\,n-1,\,n)-f(t,n-2,n-1)]+v(t+n-1) \qquad (11)$$

where, the dependent variable is the change in the spot rates for one month remaining maturity from $(n-1)$ and $(n-2)$ months in the future, and the independent variables are constant and the difference between one-month forward rates $(n-1)$ months in the future and the one-month forward rates $(n-2)$ months in the future.

Estimated coefficients less than one but significantly greater than zero provide evidence that the yield curve from one to three months has predictive power for the movements of the one-month rate one to two months in the future.

Table 6 Estimates of marginal regression

$$s(t+m\text{ months},\,1\text{ month})-s(t+m-1\text{ months},\,1\text{ month})$$
$$=\beta_0+\beta_1[f(t,m\text{ months},m+1\text{ months})-f(t,\,m-1\text{ months},\,m\text{ months})]+v(t+m\text{ months})$$

m (months)	$\hat{\beta}_1$	R^2	the number of data
1	0.69* (0.26)	0.08	230
2	0.95* (0.33)	0.12	210
3	1.06* (0.40)	0.10	190
4	0.33 (0.49)	0.01	170
5	0.92 (0.69)	0.04	150
6	0.72 (1.07)	0.01	130

Notes: 1) Standard errors are in parentheses. They are heteroskedasticity and autocorrelation consistent standard error based on Newey and West(1987) method.
2) * denotes the statistical significance with 5% significance level.

Based on the results of regressions, it is not unreasonable to say that forward rates have forecasting power for the subsequent movement of rates for, at least, a three-month horizon.

3. The estimated risk premiums

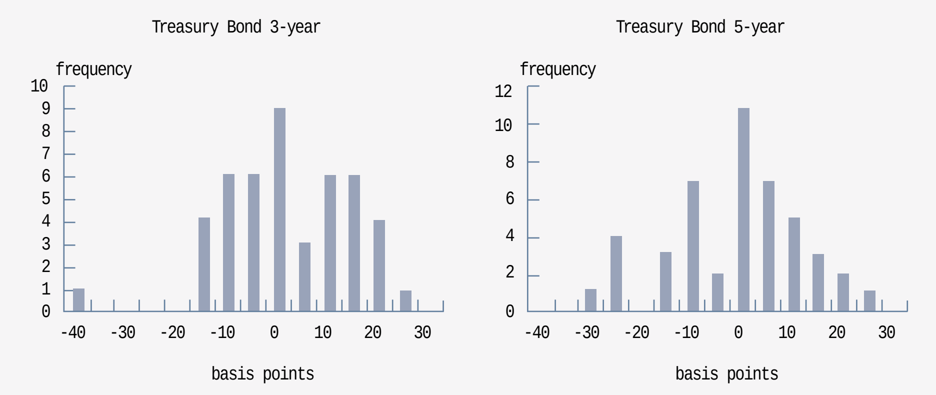
Estimated coefficients less than one but significantly greater than zero in the above regressions imply that term premiums are not constant. To investigate how risk premiums vary over time, I directly estimate them using both the forward rates and survey data published every Monday by an on-line newspaper, Edaily News.[11] The survey data are based on a weekly survey of 6 ~ 8 analysts

11) Home page address is http://www.edaily.co.kr

on the interest rates they expect every week. The survey collects forecasts of three-year and five-year rates of Treasury Bonds. Risk premiums are obtained by simply subtracting survey data from the corresponding forward rates extracted from the yield curve.

[Figure 4] says that risk premiums are indeed time-varying and 40 % of them show positive sign. This time-varying character implies that the bond supply and demand conjuncture is also important in addition to the time value of money.

Figure 4 The distribution of the estimated risk premiums



Second, Jarque-Bera statistics shows that we cannot reject the null hypothesis that risk premiums follow normal distribution. This implies that risk premiums estimated on a weekly basis largely reflect short term shocks showing a strong mean reversion process.

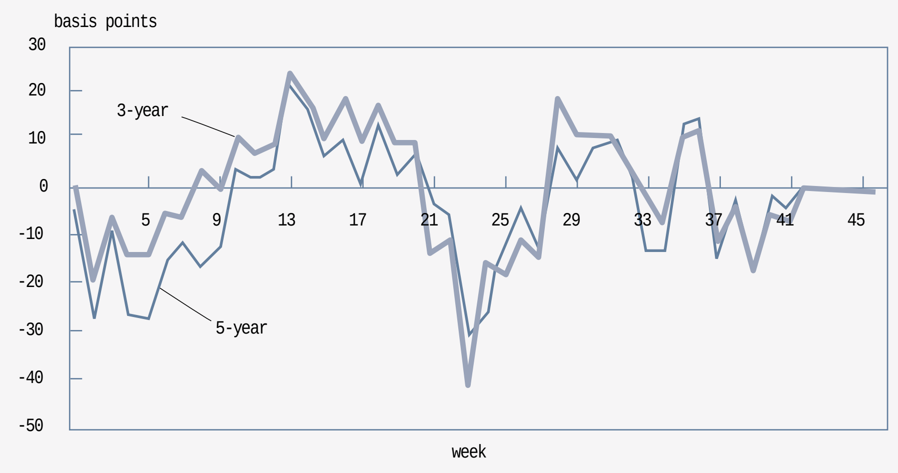
Table 7 Tests for normal distribution

H_0: Normal distribution

	Treasury Bonds (3-year)	Treasury Bonds (5-year)
Jarque-Bera statistics	2.7914	1.3453
p value	0.2476	0.5103

Third, the correlation between risk premiums of three-year and those of five-year is high, being close to 0.88. In particular, at the end of the year when the supply and demand of bonds is a less important factor due to book-closing, risk premiums are negligible. This supports the view that much of the variation of risk premiums reflects short term shocks coming from imbalances between the supply and demand for bonds.

Figure 5 Estimated weekly risk premiums



IV. Conclusion

This paper investigates whether the yield curve can be a useful information variable for monetary policy purposes. For this, I estimate the spot rates curve from Monetary Stabilization Bonds and Treasury Bonds by employing a Nelson and Siegel(1987) functional form.

It was found that the implied forward rates derived from the estimated yield curve are informative for monetary policies as they provide information about market expectations of future rates for, at least, three-month horizons.

I also estimate the risk premiums of Treasury bonds and show that they are indeed time-varying with mean zero distribution. As weekly survey data are used, they mainly reflect the short-term shocks due to imbalance, between the supply and demand for bonds.

These results carry two policy implications. The first is that making use of the yield curve is, indeed, useful for implementing monetary policy. The second is that lessening the imbalance between the supply and demand for bonds is critical for reducing the volatility of interest rates.

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