

Indian Sovereign Yield Curve using Nelson-Siegel-Svensson Model

Of the three methods of valuing a Fixed Income Security – Current Yield, YTM and the Coupon, the most common method followed is the Yield To Maturity. The YTM measure is akin to the NPV method of measuring the Hurdle Rate for Long Term Projects. It finds an *average yield* that will equate the present value of the periodic cash flows upto the maturity of the security to its cost of procurement. The principle of discounting (compounding) all cash flows at a constant rate implies reinvestment of the coupons also at the *average yield*; which is however not the case in practice. Moreover, the cost of funds as implied by the YTM of a bond will be specific to the bond as it includes the Coupon Effect of the bond; hence, the YTM estimate is not universal in nature.

These demerits of the YTM measure led to the extraction of the yield of each cash flow of the traded bonds as implied by the traded YTM's of various bonds. This is the Zero Coupon Yield Curve (ZCYC) measurement, which identifies the cost (return) of a cash flow of a particular tenor for a bond. Agglomerating the cost (return) of every cash flow of the various bonds traded gives the ZCYC of the day.

The Time Value of Money obtained from the ZCYC enables valuation of fixed income securities. As per the Expectations Hypothesis, it also indicates the expected future rate of interest for various tenors as implied by the Forward Curve derived from the ZCYC. ZCYC is now used extensively in valuing securities.

Commonly adopted methods to extract the ZCYC from the traded YTM are the Bootstrap and the Parametric form of ZCYC models.

Bootstrap technique is the process of extracting the Discount Factors (and thus the Zero rates) from the prices of sequentially ordered traded securities along the timeline. The Zero rates for the shorter tenors (less than 1 year) are obtained from the traded prices of T-Bills (which are Zero instruments). Beyond the 1 year tenor zone, a relation is assumed between the Discount Factors (Zero rates) of the intermediate cash flows of the traded securities such that the resultant theoretical price is closest to the trade price. The relation between the Zero rates of intermediate cash flows may be linear, exponential, et. al. A curve is then fit through the extracted Zero rates for various tenors usually by a Line or Spline.

In the Indian Securities market, interest of market participants has been found to be in a select few bonds (2 to 5 in no.). As a result, yields for intermediate tenors cannot be ascertained from the trade data. One has then to rely on interpolation for arriving at the Zero rates of intermediate tenors. This causes the Zero curve to depend heavily on the kind of securities and the type of interpolation methodology considered for development of the Curve. The model also is very sensitive to the data filtering parameters – a relatively illiquidity which is considered for development of the Zero Curve may cause the sovereign Zero rates to be raised higher as compared to the rates prevailing in the market for the respective tenors. Hence, different data filtering criteria may yield different ZCYCs.

Parametric models specify a functional form for the instantaneous Forward Rate for various tenors in future. Integration of the various instantaneous forward rates over a

specific period gives the Zero Rate curve. The functional forms are defined by a set of parameters. The parameters can be determined using optimization algorithms like Sum of Squares minimization or Maximum Likelihood. Knowing the values of the parameters, Zero rates and Forward rates can then be found for any tenor.

One of the common parametric models which has found the interest of users is the **Nelson-Siegel** model. This was first proposed by Charles Nelson and Andrew Siegel of the University of Washington in 1987. This is a parametric function with four parameters for estimating the Forward Rate.

$$f(m, \beta) = \beta_0 + \beta_1 \times \exp\left(-\frac{m}{\tau_1}\right) + \beta_2 \times \frac{m}{\tau_1} \times \exp\left(-\frac{m}{\tau_1}\right)$$

The integration of the Forward Rates across a continuum of maturities upto a tenor point yields the Spot Rate function as

$$r = \beta_0 + (\beta_1 + \beta_2) \times (1 - e^{-(m/\tau)}) / (m/\tau) - \beta_2 \times e^{-(m/\tau)}$$

where $\beta_0, \beta_1, \beta_2, \tau$ - are the parameters to be estimated

r - Zero Rate

m - Maturity

These parameters are related to the long term and short term interest rates, slope of the yield curve and the extent of hump in the curve. The function yields a smooth continuous curve with a hump along the entire tenor spectrum.

Since the Zero rates of the possible tenors were defined by one function, the model was easier for application to valuation of fixed income securities and estimation of VaR. With an intuitive understanding of the model, one can modulate the Zero Curve on a given day for application in various scenarios for Stress Testing; the scenarios can be a parallel movement or non-parallel movement of the curve and its impact on the valuation of the portfolio of fixed income securities.

CCIL introduced a Zero Coupon Sovereign Rupee Yield Curve based on Nelson & Siegel equation in September 2002. CCIL considers all Outright trades of more than Rs. 5 crores for development of the yield curve. The data is screened for any outliers and fed into a mathematical software. Cash flows are laid down for the traded bonds with their respective Cash Flow Dates. A set of parameters are considered as the starting point for generating the Spot Rates for each cash flow date; the Model Price is computed as the sum of the present values of each cash flow for each traded security. The difference between the Deal Price and the Model Price (Price Error) is weighed by the inverse of the Duration (in years). This process is iterated through various sets of Parameters until the sum of the squared weighted price errors attains the lowest possible level for the portfolio of the securities. CCIL has been disseminating the N-S ZCYC through its website since Feb-15th, 2003. It has gradually found acceptance with the market due to its goodness of fit and its simplicity.

However, one of the demerits of the Nelson-Siegel model is that it is not flexible to take different shapes as one traverses along the tenor axis. In this model, the shape of the curve in various tenor zones is to a great extent determined by the slope and curvature in

the preceding tenors. Hence, the change in the shape (slope & curvature) along the tenors is not adequately captured by the model.

The 6-month forward rate after 15 years will be different from the forward rate for a 6-month tenor 5 years hence. This is usually evident in terms of the proportion of change in the YTM of securities with respect to the change in their term to maturity (i.e. Yield Spread between tenors for a change in the tenor). Such an effect is displayed in the Zero Curve as *Twists*. Depiction of the Zero Rates for different tenor points hence gets distorted somewhat with the N-S model.

We, hence, examined the feasibility of generating an yield curve using Nelson-Siegel-Svensson (N-S-S) model. This is an extension of the N-S model with two additional parameters (to be estimated) which can take an additional hump (or U-Shape).

Lars **Svensson** in his Research Paper for the National Bureau of Economic Research (NBER), Cambridge, in September 1994, extended the N-S functional form to enable it to take one more hump along the tenors.

$$r = \beta_0 + (\beta_1 + \beta_2) \times (1 - e^{-(m/\tau_1)}) / (m/\tau_1) - \beta_2 \times e^{-(m/\tau_1)} + \beta_3 \times (1 - e^{-(m/\tau_2)}) / (m/\tau_2) - \beta_3 \times e^{-(m/\tau_2)}$$

where β_3, τ_2 are the additional parameters to incorporate an additional slope change and a hump(or U-Shape)

The impact of the parameters on the shape of the forward curve are as follows:

- β_0 = This parameter, which must be positive, is the long term Zero Rate (rate of a return on a Zero Coupon Consol)
- β_1 = This parameter along with β_0 determines the short term Zero Rate (the *vertical intercept*)
- τ_1 = This parameter, which must also be positive, positions the first hump
- β_2 = This parameter determines the magnitude and direction of the hump occurring at τ_1 .
- τ_2 = This parameter, which must also be positive, positions the second hump on the curve.
- β_3 = This parameter, which is analogous to β_2 , determines the magnitude and direction of the second hump.

The basic process of determining the optimal parameters for the Zero Rate function that best fits the traded data is as follows:

- i. A vector of starting parameters [$\beta_0, \beta_1, \beta_2, \beta_3, \tau_1, \tau_2$] is selected.
- ii. The zero rates are determined, using these starting parameters.
- iii. The present value of the various bond cash flows and a vector of theoretical bond prices is determined.
- iv. Price errors are calculated by taking the difference between the theoretical and traded prices.

Steps i through iv are repeated until the sum of the squares of the Price Errors weighted by the inverse of the respective bond's duration (which is the Objective Function) is minimized.

The **Goodness of Fit** as measured by the Per Trade Error statistic has consistently been better for the N-S-S model as compared to the N-S model. This has been analyzed for the Zero Curves developed using the two models for traded data of more than a year. An illustrative list of the Per Trade Errors for the period of July'05 is provided as **Annexure I**. This is also validated by the Standard Deviation of the Price Errors of the traded securities for each of the trading days in July'05.

The N-S-S model can take another hump along the timeline. This can be illustrated by way of a comparison of the Price Errors of securities in the medium term and in the longer tenor for both the models. The N-S-S provides a better price error for the longer term securities while maintaining the goodness-of-fit for the shorter to medium term securities. This comparison has been done for the securities – 7.37% GS 2014 and 10.25% GS 2021 – which have found trading interest in the past couple of months, which is placed in **Annexure II**.

We also examined the quality of fit of N-S-S based equation on data for normal period (from 01st Nov to 16th Nov, 2004) using N-S-S equations. This period was different from the period of July'05; the two periods have different interest rate regimes as measured by the 1-day Rate and the 30 year Zero rate; the 1-day zero rate ranged between 4.50 and 5.00% in Jul-05 and between 5.00 & 5.40% in Nov-04; the 30-year zero rate ranged between 7.00 and 7.7% in Feb-05 and between 7.75 & 8.20% in Nov-04.

For the month of Nov'04:	N-S-S Statistics				N-S Statistics			
	Max.	Min.	Per Trade Error	Std. Dev.	Max.	Min.	Per Trade Error	Std. Dev.
01/11/2004	1.26	(0.79)	0.18	0.43	1.02	(2.28)	1.01	0.87
02/11/2004	0.94	(1.43)	0.21	0.46	2.11	(2.14)	1.16	0.97
03/11/2004	1.22	(0.84)	0.25	0.50	2.03	(2.83)	1.68	1.19
04/11/2004	1.33	(1.23)	0.23	0.49	2.41	(2.50)	1.11	0.94
05/11/2004	1.29	(2.33)	0.50	0.71	2.63	(2.68)	1.75	1.11
06/11/2004	1.93	(1.60)	0.60	0.79	3.85	(2.00)	1.53	1.27
08/11/2004	2.33	(1.26)	0.36	0.61	2.34	(1.68)	0.65	0.76
09/11/2004	1.33	(1.24)	0.22	0.47	0.91	(4.05)	0.86	0.87
10/11/2004	1.36	(0.98)	0.21	0.46	0.95	(3.49)	1.25	1.00
11/11/2004	1.12	(0.52)	0.12	0.35	0.58	(3.22)	0.95	0.87
13/11/2004	0.08	(0.05)	0.00	0.04	0.57	(1.20)	0.36	0.59
16/11/2004	1.27	(1.40)	0.26	0.52	1.28	(2.39)	1.12	0.94

The analysis of the price error and per trade error revealed that the N-S-S model gave a considerably better fit than the N-S model. The N-S-S model gave a Per Trade Error of Re. 0.00 to Re. 0.60 while the N-S model had an error ranging between Re. 0.36 and Re. 1.75. The maximum and the minimum price errors of the various days under test were also lower for the N-S-S model compared to the N-S model; the dispersions were of the order of between Rs. (2.30) and Rs. 2.35 for the N-S-S as against between Rs. (3.50) and Rs. 3.5 for the N-S model.

We also observed a better fit for the 10-year benchmark security (7.38% GS 2015) of about Re. 0.80 to Rs. 1.50 without losing the goodness-of-fit for the longer tenor securities like 7.50% GS 2034 where the Price Error ranged between Re.0.50 (-ve) and Re. 0.50 (+ve).

Placed in **Annexure III** is a comparison of the Error Statistics for various days between March'05 and August'05 (6 months) based on the ZCYC developed using the two Parametric models. The monthly summary of Minimum and Maximum Per Trade Error and the Standard Deviation are consistently lower for N-S-S ZCYC with respect to the N-S ZCYC. This clearly depicts the efficiency of the N-S-S model in providing a better goodness-of-fit as compared to the N-S model.

In Indian Fixed Income Securities market, players have traditionally found trading interest in a few securities which are bunched in select tenor zones like 5 yrs., 7 yrs., 10 yrs., 25 yrs., and 30 yrs. The dynamics of the Yield Spreads within tenors will be different for Short, medium and long tenors. N-S-S model appears to better capture the Spread dynamics as per our analysis. The ability of the N-S-S model to incorporate a *twist* in the curve along the tenor scores over the N-S model which takes only one hump.

CCIL has been simultaneously developing ZCYC using the N-S-S model on an experimental basis since 19th Aug, 2005. The same is made available for public information and feedback in our website. Based on market feedback and response, CCIL would consider implementing the N-S-S model for Valuation and Margining in the near future.

Comparison of the Error Statistics for the month of July-2005

	N-S-S Statistics				N-S Statistics			
	Max.	Min.	Per Trade Error	Std. Dev.	Max.	Min.	Per Trade Error	Std. Dev.
01/07/2005	1.27	(1.30)	0.48	0.71	1.19	(1.74)	0.70	0.85
02/07/2005	0.84	(1.62)	0.37	0.63	1.04	(2.06)	0.68	0.86
04/07/2005	1.46	(2.09)	0.33	0.59	1.56	(2.23)	0.48	0.71
05/07/2005	0.86	(2.80)	0.39	0.63	1.11	(2.85)	0.53	0.72
06/07/2005	1.03	(2.23)	0.30	0.56	1.13	(2.53)	0.43	0.67
07/07/2005	1.20	(2.44)	0.29	0.54	1.22	(2.27)	0.29	0.54
08/07/2005	1.01	(2.64)	0.42	0.66	1.15	(2.42)	0.40	0.65
09/07/2005	0.51	(2.70)	0.52	0.74	0.75	(2.37)	0.46	0.70
11/07/2005	2.92	(1.53)	0.55	0.74	1.90	(2.47)	0.41	0.64
12/07/2005	1.26	(1.83)	0.36	0.60	1.19	(2.44)	0.44	0.67
13/07/2005	0.74	(1.85)	0.28	0.54	0.83	(2.42)	0.39	0.64
14/07/2005	1.09	(1.77)	0.24	0.50	0.83	(2.46)	0.31	0.56
15/07/2005	2.23	(2.60)	0.58	0.77	1.57	(3.15)	0.57	0.77
16/07/2005	0.95	(2.12)	0.58	0.79	0.83	(3.28)	1.05	1.05
18/07/2005	1.13	(2.67)	0.39	0.64	1.17	(3.49)	0.63	0.81
19/07/2005	1.11	(2.50)	0.40	0.64	1.15	(3.33)	0.59	0.78
20/07/2005	0.86	(2.58)	0.41	0.65	0.91	(3.41)	0.64	0.81
21/07/2005	0.66	(2.54)	0.32	0.57	2.23	0.00	0.47	0.50
22/07/2005	0.90	(2.06)	0.49	0.72	0.96	(3.18)	1.08	1.07
23/07/2005	0.74	(1.93)	0.41	0.66	0.99	(3.38)	1.07	1.07
25/07/2005	1.46	(1.87)	0.36	0.62	0.97	(3.38)	0.65	0.82
26/07/2005	1.84	(1.75)	0.58	0.75	1.24	(3.32)	0.88	0.96
27/07/2005	1.84	(1.75)	0.58	0.75	1.24	(3.31)	0.88	0.96
28/07/2005	1.84	(1.75)	0.58	0.75	1.24	(3.31)	0.88	0.96
29/07/2005	1.87	(1.63)	0.49	0.70	2.07	(2.77)	1.00	1.02
30/07/2005	0.66	(1.89)	0.28	0.54	0.84	(2.80)	0.55	0.76

Comparison of Error Statistics for 2 representative securities using N-S and N-S-S model for the period July – 2005

	7.37% GS 2014		10.25% GS 2021	
	N-S-S	N-S	N-S-S	N-S
1/Jul/05	0.28	0.44	(1.30)	(1.74)
2/Jul/05	(0.30)	0.29	(1.62)	(2.06)
4/Jul/05	(0.26)	0.29	(2.09)	(2.23)
5/Jul/05	0.07	0.27	(2.80)	(2.85)
6/Jul/05	0.03	0.23	(2.23)	(2.53)
7/Jul/05	0.12	0.21	(2.44)	(2.27)
8/Jul/05	0.19	0.25	(2.64)	(2.42)
9/Jul/05	0.04	0.36	(2.70)	(2.37)
11/Jul/05	0.12	0.13	(1.53)	(2.47)
12/Jul/05	0.03	0.10	(1.83)	(2.44)
13/Jul/05	0.00	0.04	(1.85)	(2.42)
14/Jul/05	0.05	0.06	(1.77)	(2.46)
15/Jul/05	0.04	0.23	(2.60)	(3.15)
16/Jul/05	0.31	0.23	(2.12)	(3.28)
18/Jul/05	(0.07)	0.29	(2.67)	(3.49)
19/Jul/05	(0.04)	0.35	(2.50)	(3.33)
20/Jul/05	(0.10)	0.26	(2.58)	(3.41)
21/Jul/05	0.01	0.77	(2.54)	1.01
22/Jul/05	0.14	0.40	(2.06)	(3.18)
23/Jul/05	0.44	0.37	(1.93)	(3.38)
25/Jul/05	0.52	0.36	(1.87)	(3.38)
26/Jul/05	0.63	0.63	(1.75)	(3.32)
27/Jul/05	0.63	0.63	(1.75)	(3.31)
28/Jul/05	0.63	0.63	(1.75)	(3.31)
29/Jul/05	0.60	0.70	(1.63)	(2.77)
30/Jul/05	0.49	0.63	(1.89)	(2.80)
1/Aug/05	0.34	0.57	(1.51)	(2.85)
2/Aug/05	0.28	0.59	(1.63)	(2.81)
3/Aug/05	0.60	0.67	(1.57)	(2.71)
4/Aug/05	0.84	0.70	(1.33)	(2.71)
5/Aug/05	0.70	0.70	(1.60)	(2.73)
6/Aug/05	0.73	0.67	(1.71)	(2.76)
8/Aug/05	0.67	0.61	(1.60)	(2.69)
9/Aug/05	0.34	0.46	(2.19)	(2.75)
10/Aug/05	0.40	0.45	(1.83)	(2.76)

15/04/2005	1.80	-2.70	0.38	0.61	0.93	-0.74	0.07	0.27
16/04/2005	2.33	-0.17	0.52	0.66	0.80	-0.99	0.08	0.29
19/04/2005	1.47	-0.41	0.14	0.36	1.03	-0.65	0.10	0.32
20/04/2005	1.89	-2.86	0.50	0.71	0.58	-1.94	0.17	0.41
21/04/2005	1.78	-2.15	0.33	0.58	0.81	-1.43	0.17	0.41
23/04/2005	1.61	-1.53	0.32	0.56	0.99	-1.03	0.14	0.38
25/04/2005	1.59	-1.53	0.29	0.54	1.05	-1.02	0.13	0.37
26/04/2005	1.60	-1.57	0.22	0.47	1.08	-0.96	0.12	0.35
27/04/2005	1.57	-1.54	0.28	0.54	1.00	-0.90	0.12	0.35
28/04/2005	1.49	-1.51	0.27	0.52	1.10	-1.13	0.15	0.39
29/04/2005	1.44	-0.75	0.16	0.40	1.10	-1.03	0.14	0.38
30/04/2005	1.05	-0.50	0.13	0.37	0.74	-0.84	0.12	0.35

Minimum **0.13** **0.36** **0.07** **0.27**
Maximum **0.72** **0.84** **0.65** **0.80**

May-05	Nelson-Siegel Statistics				Nelson-Siegel-Svensson Statistics			
Date	Max. Error	Min. Error	Per Trade Error	Std. Deviation	Max. Error	Min. Error	Per Trade Error	Std. Deviation
02/05/2005	1.19	-1.03	0.20	0.46	0.85	-1.46	0.23	0.49
03/05/2005	1.53	-2.38	0.33	0.58	0.90	-1.32	0.19	0.44
04/05/2005	1.51	-2.40	0.34	0.59	0.80	-1.30	0.18	0.42
05/05/2005	1.15	-2.10	0.22	0.48	0.75	-0.76	0.08	0.28
06/05/2005	1.28	-1.98	0.28	0.53	0.70	-1.14	0.13	0.36
07/05/2005	0.87	-2.06	0.24	0.50	0.64	-0.66	0.07	0.27
09/05/2005	1.36	-2.01	0.24	0.50	1.35	-1.89	0.23	0.49
10/05/2005	1.34	-2.04	0.29	0.54	1.31	-1.62	0.25	0.50
11/05/2005	1.38	-1.78	0.26	0.52	1.24	-1.03	0.14	0.38
12/05/2005	1.39	-1.80	0.22	0.48	1.23	-0.98	0.10	0.33
13/05/2005	1.38	-1.84	0.25	0.50	1.05	-1.50	0.18	0.42
14/05/2005	1.01	-1.80	0.30	0.56	0.96	-0.92	0.17	0.42
16/05/2005	1.26	-1.78	0.33	0.58	1.13	-0.87	0.21	0.47
17/05/2005	1.32	-1.85	0.28	0.53	1.06	-1.11	0.16	0.41
18/05/2005	1.32	-1.85	0.31	0.56	1.14	-0.90	0.18	0.43
19/05/2005	1.40	-1.79	0.35	0.60	1.13	-0.99	0.23	0.49
20/05/2005	1.52	-1.94	0.44	0.67	1.26	-1.54	0.28	0.54
21/05/2005	1.43	-2.01	0.51	0.72	1.19	-1.41	0.24	0.50
24/05/2005	1.61	-1.60	0.40	0.63	1.33	-1.47	0.29	0.54
25/05/2005	1.62	-2.23	0.79	0.82	1.47	-2.11	0.48	0.69
26/05/2005	1.63	-1.84	0.52	0.70	1.48	-1.65	0.32	0.56
27/05/2005	1.68	-1.80	0.62	0.73	1.61	-1.26	0.33	0.58
28/05/2005	1.68	-2.09	0.87	0.93	1.30	-1.50	0.46	0.69
30/05/2005	1.66	-1.96	0.58	0.75	1.48	-1.35	0.26	0.52
31/05/2005	1.71	-1.82	0.60	0.74	1.62	-1.34	0.31	0.56

Minimum **0.20** **0.46** **0.07** **0.27**
Maximum **0.87** **0.93** **0.48** **0.69**

Jun-05	Nelson-Siegel Statistics	Nelson-Siegel-Svensson
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15/07/2005	1.57	-3.15	0.57	0.77	2.23	-2.60	0.58	0.77
16/07/2005	0.83	-3.28	1.05	1.05	0.95	-2.12	0.58	0.79
18/07/2005	1.17	-3.49	0.63	0.81	1.13	-2.67	0.39	0.64
19/07/2005	1.15	-3.33	0.59	0.78	1.11	-2.50	0.40	0.64
20/07/2005	0.91	-3.41	0.64	0.81	0.86	-2.58	0.41	0.65
21/07/2005	2.23	0.00	0.47	0.50	0.66	-2.54	0.32	0.57
22/07/2005	0.96	-3.18	1.08	1.07	0.90	-2.06	0.49	0.72
23/07/2005	0.99	-3.38	1.07	1.07	0.74	-1.93	0.41	0.66
25/07/2005	0.97	-3.38	0.65	0.82	1.46	-1.87	0.36	0.62
26/07/2005	1.24	-3.32	0.88	0.96	1.84	-1.75	0.58	0.75
27/07/2005	1.24	-3.31	0.88	0.96	1.84	-1.75	0.58	0.75
28/07/2005	1.24	-3.31	0.88	0.96	1.84	-1.75	0.58	0.75
29/07/2005	2.07	-2.77	1.00	1.02	1.87	-1.63	0.49	0.70
30/07/2005	0.84	-2.80	0.55	0.76	0.66	-1.89	0.28	0.54

Minimum **0.29** **0.50** **0.24** **0.50**
Maximum **1.08** **1.07** **0.58** **0.79**

Aug-05 Date	Nelson-Siegel Statistics				Nelson-Siegel-Svensson Statistics			
	Max. Error	Min. Error	Per Trade Error	Std. Deviation	Max. Error	Min. Error	Per Trade Error	Std. Deviation
01/08/2005	1.18	-2.85	1.40	1.26	0.61	-1.51	0.41	0.68
02/08/2005	0.88	-2.81	0.55	0.74	1.38	-1.63	0.51	0.71
03/08/2005	0.87	-2.71	0.50	0.71	1.70	-1.57	0.37	0.62
04/08/2005	0.84	-2.71	0.42	0.62	1.78	-1.33	0.30	0.48
05/08/2005	0.80	-2.73	0.42	0.64	1.75	-2.19	0.26	0.51
06/08/2005	0.85	-2.76	0.51	0.71	0.83	-1.60	0.25	0.51
08/08/2005	0.76	-2.69	0.41	0.63	1.75	-2.19	0.26	0.51
09/08/2005	0.80	-2.75	0.27	0.52	0.81	-1.60	0.24	0.50
10/08/2005	0.68	-3.39	0.71	0.80	0.95	-1.83	0.31	0.56
11/08/2005	0.69	-2.61	0.28	0.52	1.50	-1.63	0.21	0.46
12/08/2005	0.71	-2.32	0.30	0.53	1.49	-1.55	0.27	0.52
13/08/2005	0.73	-2.48	0.50	0.72	0.47	-1.50	0.17	0.42
16/08/2005	0.64	-2.19	0.20	0.46	0.53	-1.43	0.11	0.34
17/08/2005	0.67	-2.56	0.35	0.59	0.64	-1.14	0.12	0.34
18/08/2005	0.65	-2.57	0.40	0.62	1.06	-1.30	0.17	0.42
19/08/2005	0.58	-2.21	0.26	0.48	1.07	-1.04	0.13	0.36
22/08/2005	0.91	-1.91	0.29	0.55	1.05	-1.08	0.11	0.34
23/08/2005	0.90	-1.82	0.26	0.52	1.05	-1.12	0.13	0.36
24/08/2005	0.89	-1.93	0.30	0.55	1.25	-1.25	0.20	0.45
25/08/2005	0.93	-1.95	0.22	0.47	1.15	-1.87	0.19	0.44
26/08/2005	1.02	-1.79	0.29	0.55	1.35	-1.11	0.24	0.49
27/08/2005	0.89	-1.65	0.30	0.56	0.78	-1.81	0.27	0.53
29/08/2005	1.05	-1.62	0.21	0.47	0.74	-1.61	0.15	0.40
30/08/2005	1.38	-1.69	0.35	0.60	1.91	-1.32	0.31	0.57
31/08/2005	0.95	-1.76	0.32	0.57	1.77	-1.10	0.24	0.50

Minimum **0.20** **0.45** **0.11** **0.34**
Maximum **1.39** **1.25** **0.51** **0.70**