How do Investors Respond to Apocalypse Scares?

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1 Introduction and Literature Review

In light of the recent financial crisis, there has been a great deal of focus on high impact, low probability events. Books like Nassim Taleb's 'Black Swan' describe how humans often think unreasonably about such low probability events. There is also a great deal of academic literature, such as Taleb (2009), Zikovic et al (2010), Chichilnisky (2009) [17] [16] [2] which studies these phenomena. All this work focuses on unexpected tail events, since in general things like the 2008 crisis are so unlikely they aren't even seen as possible. This paper contributes to the existing literature by examining how people think about such high impact events when they are known to be possible ahead of time. For example, in the recent fiscal cliff deals, the public was very aware of the possibility of automatic spending cuts that might trigger a recession, not to mention the possibility of default if the debt ceiling was not raised. Since these would be so politically devastating to the party that allowed them to occur, the public (and particularly investors), viewed such events as extremely unlikely.

To study such situations where the unlikely but devastating risk is known ahead of time, I examine apocalypse scares. For highly publicized apocalypse predictions, this creates exactly the circumstance described above: the public is aware of the unlikely possibility of an extremely high impact event. I use two apocalypse scares, each unlikely but one more plausible than the other.

First, I examine the response to the Y2K scare of 2000. It was widely believed and publicized that many computer systems (and in particular banking software) were not capable of handling dates after 12/31/1999. Many believed that the failure of this software could possibly lead to a global shutdown of automated banking systems. Reactions to this scare have been examined by Sundaresan and Wang (2009), who find that the Federal Reserve issued 'Y2K options' successfully assuaged bond investor fears as demonstrated by the drop in the liquidity premium of treasury bonds [15]. Kaul and Sapp (2006) find evidence that foreign investors moved funds into US dollars to protect against the Y2K bug and see a resulting spread increase in the dollar-Euro market [10]. Garcia-Feijoo and Wingender (2007) [8] run

an event study on Y2K announcements and find that investors favored companies with Y2K contracts and sold off companies which claimed to be Y2K prepared. They attribute this to investors being able to accurately determine which companies would do well post Y2K. They use an event study methodology but, as will be described in the methodology section, the event study in this paper is different. Finally, King and Winters (2008) runs a Y2K event study on banks to determine whether those which fixed the problem early saw abnormal returns, and found support for this hypothesis.

The second event studied in this paper is the Mayan apocalypse. This is in some sense a more extreme case, since it was less plausible but, should it have occurred, would have had much more disastrous consequences. It might seem outrageous that an apocalypse scare like this would affect investors decisions, but other authors have found superstition to have a palpable effect on asset prices. In a famous note by Kolb and Rodriguez (1987) the authors found significant negative abnormal returns on Fridays falling on the 13th as opposed to other Fridays, and the topic was further discussed by Lucey (2000, 2001), Chamberlain et al, Dyl (1998) and Coutts(1997) [12] [13] [1] [6] [3] [11].

I will study responses to these events in two senses. First, I will run an event study on assets that are typically seen as apocalypse safe havens. In particular, I examine companies which produce bottled water, guns, ammunition, or other related goods. [1] Using the classic event study methodology outlined by Mackinlay (1991) [14] , I will estimate a Fama French regression using data on these assets in an estimation window that uses approximately 5 years of daily returns. I will then estimate counterfactual returns over the event window, which includes the predicted date of the apocalypse and the 5 days following it, and compare these estimated returns with the actual returns.

Since the asset prices might not capture responses to such events, I will also look at how interest rate expectations changed from these events by examining changes in the yield curve. Under the rational expectation hypothesis, [4] [5] the long term interest rates should move

[1] A full list can be found in table 1

with anticipated shorter term interest rates to prevent arbitrage. However, it is possible that traders anticipated volatility and uncertainty in the short term lending markets in the period after a high impact event like Y2K. If such a trader believed that, in the long term, markets would return to normal, this belief would lead to higher short term rates than if the apocalypse were not being anticipated. When the apocalyptic event does not occur, it seems that reasonable that the short term rates would fall to their 'non-apocalypse' level while long term rates would remain at the same level. In light of the expectation hypothesis, we look for the short term rate falling relative to the long term rate, rather than in absolute terms. Using constant maturity US treasury rates I examine whether the yield curve changed in this manner or whether it continued to follow the expectation hypothesis throughout the scare.

2 Apocalypse Stock Event Study

2.1 Data

The intent of the event study is to select companies whose products would be desirable in an apocalypse, to study whether these prices had been inflated due to demand (or at least perceived demand by traders) by apocalypse fearing consumers. To accomplish this, I selected Standard Industrial Classification codes for industries I thought matched this description. Anecdotal evidence suggested looking for companies which sell bottled water and or canned foods, for consumers stocking their garage panic rooms. I also looked for companies selling guns or ammunition for more pessimistic apocalypse anticipators. The full list of SIC codes used can be found in table 1.

Once I settled on these SIC codes, I used stock return data from the CRSP database at Wharton Research Data Services for all firms with one of these SIC codes. I dropped all the firms which did not have data for the Mayan Apocalypse nor Y2K. This left me with

daily returns for 130 firms for the Mayan apocalypse and 123 firms for Y2K. The returns are adjusted by CRSP to account for stock splits and dividends.

To create the counterfactual series, I use the Fama French 3 factor model, which is explained in the methodology section. The daily time series for these factors (including the risk free rate) is taken from Kenneth Frenchs data library. [2] On the webpage, he writes the market return is calculated as the

"value-weight return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ that have a CRSP share code of 10 or 11 at the beginning of month t, good shares and price data at the beginning of t, and good return data for t."

The risk free rate provided is the daily rate which continuously compounds to the"one-month treasury bill rate (from Ibbotson Associates)." Finally, of the two size and book-to-market factors, the website writes

"The Fama/French factors are constructed using the 6 value-weight portfolios formed on size and book-to-market. (See the description of the 6 size/book-to-market portfolios.) SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios,

SMB = $\frac{1}{3}$ (Small Value + Small Neutral + Small Growth) - $\frac{1}{3}$ (Big Value + Big Neutral + Big Growth).

HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios,

[2] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french.html

HML = $\frac{1}{2}$ (Small Value + Big Value) - $\frac{1}{2}$ (Small Growth + Big Growth). ”

Table 1: Apocalypse Friendly Industries	
SIC Code	Industry
	Bottled Water / Canned Food
2011	Meat Packing Plants
2013	Sausages and Other Prepared Meat Proucts
2032	Canned Specialties
2033	Canned Fruits, Vegetables, Preserves, Jams, and Jellies
2034	Dried and Dehydrated Fruits, Vegetables, and Soup Mixes
2038	Frozen Specialties, Not Elsewhere Classified
2082	Malt Beverages
2086	Bottled and Canned Soft Drinks and Carbonated Waters
2087	Flavoring Extracts and Flavoring Syrups, Not Elsewhere Classified
5149	Groceries and Related Products, Not Elsewhere Classified
2821	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers
	Guns / Ammunition
3482	Small Arms Ammunition
3483	Ammunition, Except for Small Arms
3484	Small Arms
3489	Ordnance and Accessories, Not Elsewhere Classified
	Other
5013	Motor Vehicle Supplies and New Parts
5099	Durable Goods, Not Elsewhere Classified
5451	Family Clothing Stores

2.2 Methodology

In an event study, one hopes to isolate the effect of a particular event on a security, individual firm, or group of market participants. MacKinlay (1997) presents a number of standard econometric procedures by which one can determine this effect. All of these procedures require one to estimate a model for conditional returns using data in the estimation window (time period prior to the event), which is used to forecast a counterfactual version of how a stock price (or security, etc.) might have continued if the market variation in the event window were due to some exogenous cause unrelated to the event itself. MacKinlay defines the estimation window to be $(T_0, T_1]$ and the event window to be (T_1, T_2). The lengths of the estimation window is $L_1 = T_1 - T_0$. To determine the counterfactual returns $\hat{R_{it}}$ I use the Fama French three factor model proposed in Fama et al(1992) [7] . This model predicts that the excess of returns over the risk free rate, $R_{it} - r_t^f$, are a function of the excess of market returns over the risk free rate, $R_{mt} - r_t^f$, a factor encapsulating size of the firm (SMB), and a factor encapsulating book to market ratio (HML). The corresponding regression equation is

$$R_{it} - r_t^f = \alpha + \beta_1[R_{mt} - r_t^f] + \beta_2 SMB + \beta_3 HML + \epsilon_{it}$$

I estimate these parameters with pooled OLS with data in the estimation window, then use the actual values of the factors to predict the fitted values $\hat{R_{it}} - r_t^f$ over the estimation window. The abnormal returns are then calculated as the difference between the actual values of the excess returns minus the predicted values:

$$AR_{it} = (R_{it} - r_t^f) - (\hat{R_{it}} - r_t^f) = R_{it} - \hat{R_{it}}$$

I then calculate the average abnormal return across the N firms for each day in the event window:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it}$$

As MacKinlay 1991 [14] shows, for large L_1 the asymptotic variance of this average is

$$var(AAR_t)\frac{1}{N^2}\sum_{i=1}^{N}\sigma_{\epsilon_i}^2$$

where we estimate

$$\hat{\epsilon_i} = \frac{1}{L_1 - 4}\sum_{t=T_0+1}^{T_1} AR_{it}^2.$$

We then accumulate across days to calculate cumulative average abnormal returns

$$CAAR(T_1, T_2) = \sum_{t=T_1}^{T_2} AAR_t,$$

with asymptotic variance

$$var(CAAR(T_1, T_2)) = \sum_{t=T_1}^{T_2} var(AAR_t).$$

Then, a rejection of the null hypothesis that:

$\theta_1 = \frac{CAAR(T_1,T_2)}{\sqrt{var(CAAR(T_1,T_2))}} : t_{\theta_1, L_1-4} \rightarrow N(0,1)$

is evidence of statistically significant abnormal returns across the N firms during the event window. Sample abnormal returns and cumulative abnormal returns can be found in tables 2 and 3 following the references.

Table 4: Z values for Cumulative Abnormal Returns		
	Y2K	Mayan
All	0.68	-0.15
Bottled Water/ canned food	1.01	1.50
Guns/ammunition	1.51	-0.11
Other	-0.98	-4.73

2.3 Results

Table 4 shows the z-statistics produced using the above methodology. I calculate these statistics for both the Mayan apocalypse and Y2K as events. For each event, I calculate the statistics for four samples, corresponding to the categories of SIC codes described in table 1.

As the table shows, there is no clear significant result. The firms in the 'other' category produce negative abnormal returns in both apocalypse scares. The bottled water companies surprisingly produce positive abnormal returns the event window, but these are not statistically significant. Over all it appears that if investors do respond to apocalypse scares, it is not by buying stock in the companies that produce 'survival goods'.

If there is disagreement on the plausibility of the apocalypse (i.e some investors think there is a 0 probability of the event occurring) then it makes sense there are no significant abnormal returns. If these companies are being bought up by those who believe the prediction, it will be sold/shorted by those who do not believe the prediction as they now find it to be overvalued. In the next section, I look at whether there is a discernible impact on interest rates.

3 Interest Rate Expectations

3.1 Data

While Jordan et al (2000) [9] argue that constant maturity Treasury rates are not the best estimate of the on-the-run term structure, I nonetheless use them due to lack of availibility of better alternatives. The constant maturity treasury rates come from the Federal Reserve Board of Governors. In their H15 Select Interest Rates data set, they give daily rates for what rates constant maturity treasury bonds would pay for 1-month, 3-month, 6-month, 1-year, 3-year, 5-year, 7-year, 10-year, 20-year, and 30-year bonds.

3.2 Methodology

As a starting point, I look at the thirty observations [3] before and after each apocalypse scare and run Welch's t-tests on the difference in means. I do this for each bond maturity to see the magnitude and significance of the change in each interest rate. Table 3 presents the results of these t-tests.

3.3 Results

In the Mayan apocalypse, we find strong support for the hypothesis that short term interest rates were artificially high in anticipation of a drying up of the short term lending market in the event of an apocalyptic event. Not only is there a statistically significant drop in short term rates following the predicted date, we see the all the long term rates increase in this period, so according to the expectation hypothesis the short term rate fell even further from the rate it 'would have been' without the apocalypse prediction. For Y2K, we see all the rates increase in the time after the predicted date. However, there is slight evidence that

[3] For the Mayan apocalypse I only had data for 28 days after the event due to how recently it occurred.

short term rates dropped relative to what they would have been, since the long term rates increase a great deal more than the short term rates do.

Mayan Apocalypse			Y2K Apocalypse	
Term	Pre mean - Post mean	2-sided P value	Pre mean - Post mean	2-sided P value
1	0.05	0.00		
3	0.01	0.00	-0.22	0.00
6	0.02	0.00	-0.19	0.00
12	0.02	0.00	-0.36	0.00
24	0.00	0.20	-0.44	0.00
36	-0.04	0.00	-0.45	0.00
60	-0.13	0.00	-0.47	0.00
84	-0.20	0.00	-0.38	0.00
120	-0.23	0.00	-0.41	0.00
360	-0.24	0.00	-0.20	0.00

It is obviously surprising that the p-values are so small for every term. To investigate whether these significant results are caused by type 1 error, I chose 5 dates at random for the period during which I had interest rate data. I excluded any dates which were within 30 days of the start or end of the period, or within 30 days of either Y2K or the Mayan apocalypse. I then treated these dates as 'apocalypse scares' and tested for changes in the interest rate in the same manner as above. The results of these t-tests are shown in the following figures. The p-values are almost exclusively 0, indicating that it would be foolish to trust the above results as statistically significant. However, it is worth noting that in each of these 5 dates, the direction of the change in interest rates is the same for each term. Hence, of all these dates, the expectation hypothesis is only violated for the Mayan apocalypse.

Interest Rate t-tests for 02-03-1969		
Term	Pre mean - Post mean	2-sided P value
1		
3		
6		
12	-0.02	0.36
24		
36	-0.10	0.00
60	-0.12	0.00
84		
120	-0.15	0.00
240	-0.15	0.00
360		

Interest Rate t-tests for 06-11-1980		
Term	Pre mean - Post mean	2-sided P value
1		
3		
6		
12	0.91	0.00
24	0.60	0.00
36	0.42	0.00
60	0.58	0.00
84	0.45	0.00
120	0.20	0.01
240	0.36	0.00
360	0.36	0.00

Interest Rate t-tests for 07-02-1982		
Term	Pre mean - Post mean	2-sided P value
1		
3	1.75	0.00
6	1.31	0.00
12	1.05	0.00
24	0.86	0.00
36	0.66	0.00
60	0.44	0.00
84	0.45	0.00
120	0.39	0.00
240	0.44	0.00
360	0.38	0.00

Interest Rate t-tests for 06-26-1974		
Term	Pre mean - Post mean	2-sided P value
1		
3		
6		
12	-0.25	0.00
24		
36	-0.32	0.00
60	-0.34	0.00
84	-0.33	0.00
120	-0.30	0.00
240	-0.20	0.00
360		

Interest Rate t-tests for 01-18-1994		
Term	Pre mean - Post mean	2-sided P value
1		
3	-0.14	0.00
6	-0.14	0.00
12	-0.18	0.00
24	-0.19	0.00
36	-0.21	0.00
60	-0.18	0.00
84	-0.17	0.00
120	-0.15	0.00
240		
360	-0.18	0.00

4 Conclusion

I do not find evidence that apocalypse scares produce abnormal returns for companies which produce survival goods. However, I do find some evidence that short term interest rates respond to apocalypse scares. In particular, investors might anticipate volatility in the short term lending market following an apocalypse and push up short term rates before the predicted date. This result should be treated with caution as it appears that interest rates frequently change in magnitudes which appear statistically significant. Future work could try to replicate this using a data set that shows actual transactions (i.e bids and asks) rather than the Federal Reserve constant maturity treasuries to better see the effect on the on-the-run term structure.

References

[1] Trevor W. Chamberlain, C. Sherman Cheung, and Clarence C. Y. Kwan. The friday the thirteenth effect: Myth or reality?. *Quarterly Journal of Business and Economics*, 30(2):111 – 117, 1991.

[2] Graciela Chichilnisky. Catastrophic risks. *International Journal of Green Economics*, 3(2):130 – 141, 2009.

[3] J. Andrew Coutts. Friday the thirteenth and the financial times industrial ordinary shares index 1935-94. *Applied Economics Letters*, 6(1):35 – 37, 1999.

[4] Selva Demiralp. Monetary policy surprises and the expectations hypothesis at the short end of the yield curve. *Economics Letters*, 101(1):1 – 3, 2008.

[5] Selva Demiralp and Kamil Yilmaz. Asymmetric response to monetary policy surprises at the long-end of the yield curve. *Journal of Macroeconomics*, 34(2):404 – 418, 2012.

[6] Edward A. Dyl and Edwin D. Maberly. The anomaly that isn't there: A comment on friday the thirteenth. *Journal of Finance*, 43(5):1285 – 1286, 1988.

[7] Eugene F. Fama and Kenneth R. French. The cross-section of expected stock returns. *Journal of Finance*, 47(2):427 – 465, 1992.

[8] Luis Garcia-Feijoo and Jr. Wingender, John R. Y2k: Myth or reality?. *Quarterly Journal of Business and Economics*, 46(3):27 – 44, 2007.

[9] James V. Jordan and Sattar A. Mansi. How well do constant-maturity treasuries approximate the on-the-run term structure? *Journal of Fixed Income*, 2000.

[10] Aditya Kaul and Stephen Sapp. Y2k fears and safe haven trading of the u.s. dollar. *Journal of International Money and Finance*, 25(5):760 – 779, 2006.

[11] Robert W. Kolb and Ricardo J. Rodriguez. Friday the thirteenth: 'part vii'–a note. *Journal of Finance*, 42(5):1385 – 1387, 1987.

[12] Brian M. Lucey. Friday the 13th and the philosophical basis of financial economics. *Journal of Economics and Finance*, 24(3):294 – 301, 2000.

[13] Brian M. Lucey. Friday the 13th: International evidence. *Applied Economics Letters*, 8(9):577 – 579, 2001.

[14] A. Craig MacKinlay. Event studies in economics and finance. *Journal of Economic Literature*, 35(1):13 – 39, 1997.

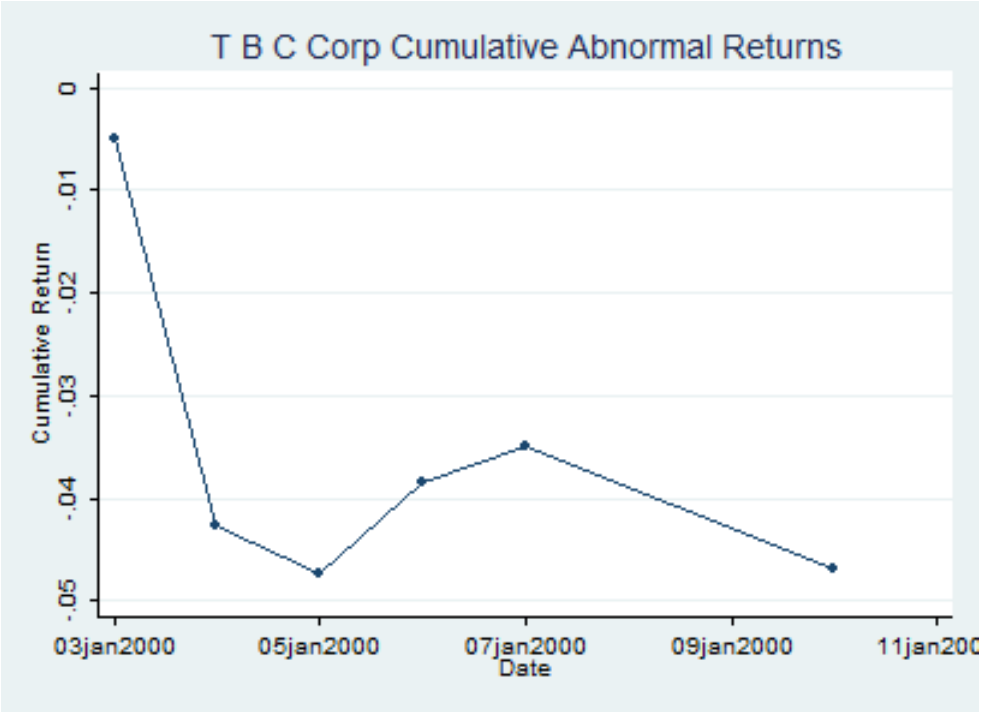
[15] Suresh Sundaresan and Zhenyu Wang. Y2k options and the liquidity premium in treasury markets. *Review of Financial Studies*, 22(3):1021 – 1056, 2009.

[16] Nassim Nicholas Taleb. Errors, robustness, and the fourth quadrant. *International Journal of Forecasting*, 25(4):744 – 759, 2009. ¡ce:title¿Special section: Decision making and planning under low levels of predictability¡/ce:title¿.

[17] Sasa Zikovic and Mario Pecaric. Modelling extreme events: Application to zagreb stock exchange. *Ekonomski Pregled*, 61(1-2):19 – 37, 2010.

5 Appendix

Table 2: Abnormal Returns by date for Y2K, Sample firms from each SIC group			
	DOLE FOOD Canned Fruits, Vegetables	ALLIED RESEARCH CORP Ammunition	HANDLEM CO Durable Goods
Date	Abnormal Returns	Abnormal Returns	Abnormal Returns
3-Jan-00	-0.04	0.12	-0.05
4-Jan-00	-0.02	-0.01	-0.01
5-Jan-00	0.01	0.03	-0.04
6-Jan-00	-0.02	-0.04	-0.01
7-Jan-00	0.02	0.02	0.01
10-Jan-00	-0.01	-0.02	-0.05



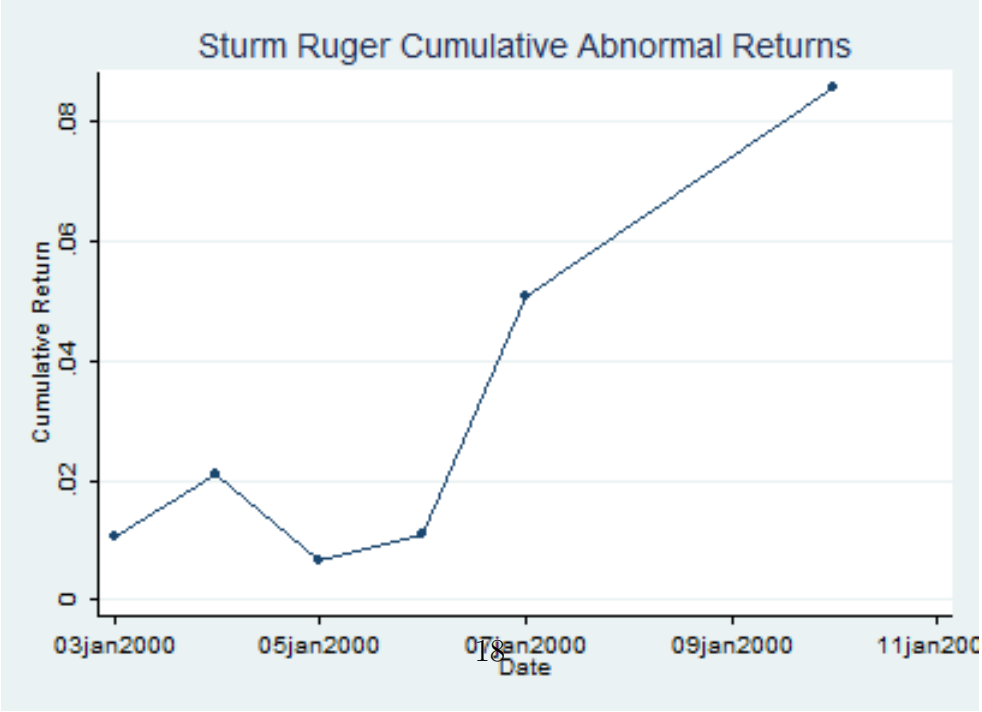


Table 3: Abnormal Returns by date for Mayan Apocalypse, Sample firms from each SIC group			
	OVERHILL FARMS Dried Fruits, Vegetables, Soup	STURM RUGER Small Arms	COAST DISTRIBUTION SYSTEM Motor Vehicle Supplies
Date	Abnormal Returns	Abnormal Returns	Abnormal Returns
21-Dec-12	0.01	0.00	0.08
24-Dec-12	0.00	0.02	0.03
26-Dec-12	0.01	-0.03	-0.06
27-Dec-12	-0.01	0.01	0.02
28-Dec-12	0.00	0.02	0.06
31-Dec-12	-0.03	0.02	0.00