

Developments In Business Simulation & Experiential Learning, Volume 24, 1997

PREDICTING AND REVIEWING NYSE STOCK PRICES BY USE OF BASIC STATISTICAL ANALYSIS AND LOGIC

Craig G. Harms, University of North Florida

ABSTRACT

This paper presents a three week in-class case that empowers the class to predict weekly stock prices for a group of NYSE stocks. After each Friday close, the data base is updated and the process to predict stock prices for the next week begins again. Minimal statistical background is required in this junior/senior level quantitative methods course which develops predictive models using techniques such as regression analysis. After completing several introductory cases, which develop the student's understanding of normal curve theory, trend analysis, seasonal adjustment, and residual analysis, they attack the very real problem of stock price prediction.

Perceived as "real-real" by students, interest soars as students discuss predicted stock price for their chosen stock. A good discussion commences about quantitative models versus guessing the movement of stock prices (random walk theory). In the end, a discussion dealing with how these quantitative models can be used today by the students is enthusiastically joined.

Topics included in the paper: model building, simple regression, time series analysis, statistical and residual analysis, graphical analysis, and investor decision making.

INTRODUCTION

Today's students (as well as department chairs) are putting great amounts of pressure on faculty to make the class more realistic. Today's textbooks are working toward that goal, yet sometimes a real "angle" is needed to make the majority of students "sit up and listen."

Methods such as using real data, using multi-media, or using special business speakers help to attain this

desired goal. But nothing does more to engage the current crop of students than to present a case where they perceive beneficial use in making money right now or in their personal lives when they have money to invest. This case has stirred their interest. Even if they have no money to invest today, they seem to absorb everything and are anxious to interact in an attempt to gain insight to the topic at hand.

This case presents some basic technical analysis of stock prices, yet does not ignore the fundamental information pertaining to a stock. Although not a finance course, the idea of using an interesting finance topic is a vehicle to gain everybody's attention while relating the appropriate quantitative techniques to many other functional areas of business.

MODEL BUILDING

It amazes me how many students know nothing about stocks and the stock market. I try to stress that they have no hope of social security and without a good investment program, they will have very poor golden years. With their interest perked up, we start by building a basic stock price model.

In the short term, the price of a stock depends upon five independent variables:

- 1) earnings per share (e.p.s.);
- 2) analyst's revelations;
- 3) news-real or rumor;
- 4) the market, and
- 5) the flow of time.

The easiest independent variable to collect is "time." The only data that is required includes a list of the historic price information for the stock--the values of the dependent variable.

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THE FIRST COMPUTER DATABASE

Each student must pick a stock to analyze with a goal of predicting the stock price next week. A group of 38 NYSE stocks and two market indicators (DMA and SP500) are available. (The faculty member did expend a lot of time collecting data.) Stocks are randomly chosen by the students. The 38 stocks are considered "blue chip," with two examples being Coca-Cola and Pfizer. However, Motorola has the variability of a "high flyer."

Each student receives a data disk, which contains the latest 65 weeks of data-the close, high, and low-for each of the stocks and the weekly close for the two market indicators. The data is real-time, i.e., the disks are passed out on Monday, after the database is updated over the weekend to include the last week's Friday closing information. From personal experience, the time involved to update the 40 files is 75 minutes.

THE TIME SERIES MODEL

Using only the historic data, a time series model with trend and seasonal adjustment is developed. This is a short-term forecast model and assumes that the market is acting normally. The seasonally adjusted time series model is presented as follows:

$$\text{Stock Price} = [B(O) + (B(J) * \text{Time})] SI(1)$$

where: B(1) represents the trend adjustment;

SI is the seasonal adjustment, two types are available-additive and multiplicative.

Students want to know:

- 1) What does this model mean in English?; and
- 2) How can I use this model to make money?

A SEASONALLY ADJUSTED TIME SERIES MODEL FOR FIRST UNION BANK

The trend and seasonal information for the First Union

model is presented in Table One. In addition, two plots are presented. Data includes information for 65 weeks ending August 23, 1996:

Exhibit One: Residual Plot of First Union versus Time. Residual analysis is used to gain insight into the momentum of the stock, and

Exhibit Two: Plot of First Union price: weekly close, high, and low. In addition, + and - two standard deviations are included. These are called "Bollinger Bands" (Bollinger).

TABLE ONE

Trend and Seasonal Analysis for First Union Bank

B Zero = 46.35
Regression line Slope (B One) = .29302
Forecast = 46.35330 + (.29302 * X)

One Standard Deviation = 1.70807 with N-2 DF
Coefficient of Determination, R² = .91444 with N-2 DF
One Std Dev on last 2 patterns = 1.76985 with N-2 DF

13 Periods in a season--Seasonal factors

Period	Additive	Multiplicative
1	1.160	1.0229
2	.617	1.0110
3	-.201	.9975
4	-1.419	.9738
5	-.812	.99844
6	-.405	.9924
7	-.623	.9894
8	-1.166	.9795
9	-.434	.9921
10	.198	1.0026
11	.505	1.0093
12	1.187	1.0206
13	1.394	1.0239

Standard Deviation	1.4523	1.4574
R-Squared9382	.9377
Std Dev last 2 years	1.5823	1.6042

CASE ANALYSIS

EXHIBIT ONE

Residual Plot For First Union Bank Versus Time

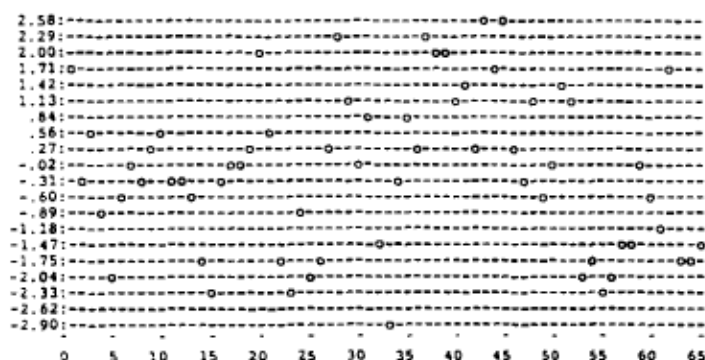


Table One and Exhibits One and Two reveal a wealth of information. The students can predict the expected price of First Union stock this week as follows:

$$Price = [B(0) + (B(1) \times Time)] + SI (wk\#1) \quad (2)$$

$$66.85 = [46.35 + (0.29302 \times 66)] + 1.160 \quad (3)$$

The students can develop a 95% confidence interval for the price of the stock:

$$P[FTU - 2(\sigma) \leq E(FTU) \leq FTU + 2(\sigma)] = 0.95 \quad (4)$$

$$[66.85 - 2(1.4523) \leq E(FTU) \leq 66.85 + 2(1.4523)] \quad (5)$$

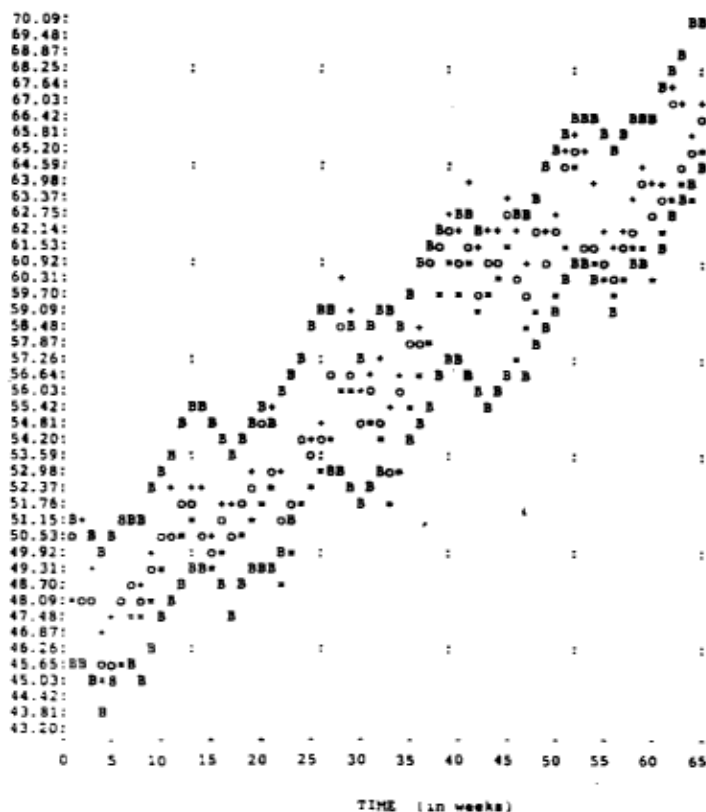
$$P[63.95 \leq E(FTU) \leq 69.75] = 0.95 \quad (6)$$

The reduction in the value of the standard error in the best seasonal model over the trend model is slight. However, when you multiply a small improvement by 200 or 1,000 shares, the dollar amount is quite large.

The “B’s” or Bollinger Bands in Exhibit Two represent the end points of a 95% confidence interval using the seasonally adjusted model. The seasonal model contains 13 indices since we are using accounting periods. Why? Because firms release earnings and dividend information every quarter or 13 weeks. These figures affect the price of the stock. But remember actual earnings release is an unknown and the expected earnings are already factored into the price of the stock. The residual plot, Exhibit One, shows the cyclical nature of the movement of the stock price. Since stocks are purchased and sold by hundreds of institutions and thousands of individual investors, the price ebbs and flows, usually within the end points of the 95% confidence interval.

EXHIBIT TWO

First Union High/Low/Close Versus Time



ANSWERING THE KEY QUESTION

Using the First Union Bank information, what is happening currently and what should I do as an investor?

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The key analysis is very logical and begins with three key statements:

- 1) We assume that normal curve theory applies---i.e., the theory of central tendency; and that a normal market is in effect.
- 2) We are concerned about the price of the stock recently-in the last two to four weeks-and its relationship to the seasonally adjusted forecast.
- 3) We are concerned about the momentum of the stock-what part of the cyclical pattern is the stock currently and in which direction is the momentum moving.

USING TILE FIRST UNION EXAMPLE TO MAKE MONEY

Before making any purchases, we need to do two key things:

- 1) Look at a plot of the data. Andrews (1995) states very clearly that before quantitative analysis is undertaken, a plot of the data is analyzed to see if there is a visual relationship. We can do this with Exhibit Two. The addition of the Bollinger Bands merely helps with the later buy/sell decision.
- 2) Look at the fundamental analysis. A Standard and Poors "tear sheet" or "hot news" from your broker is absolutely invaluable.

The discussion with the students now moves into high gear. An investment decision concerning First Union is at hand. "What do you do now, before the market opens on Monday, August 26, 1996?" A quick look at the fundamentals for the stock is in order. The First Union "hot news" reveals that an individual or institution sold a block of 3,450,000 shares in week #63 (two weeks ago). That is a \$220 million dollar transaction. Needless to say, the stock price dipped into the lower \$63s and penetrated the lower end point of the 95% confidence interval. This is good news and a buying opportunity because this price dip was not an earnings related adjustment. A student chimes in: "Buy

First Union if the price drops below \$64.00 for the following reasons:"

- 1) The lower stock price is not a fundamental problem and therefore there should be price recovery.
- 2) At \$64 we should be very close to -2 standard deviations and there is little probability that we will go down further.
- 3) Central limit theorem would lead us to believe we should be near the center of the distribution.
- 4) The residual shows us that the momentum is starting to turn-the residuals are off their lows of weeks #53-56.
- 5) The trend factor of the time series equation is plus \$0.29 per week and the seasonal component for week #66 is \$1.16 (index #1).
- 6) And, if you look at the plot of the lows for the week, every time FTU penetrated the minus two standard deviations (weeks #22, #32, and #60), it has bounced up to highs (weeks #28, #41, and #62).

Not all of the students are convinced to place a buy order, even at a limit price of \$64. They state very clearly that First Union did not close Friday, August 23 near the lower Bollinger Band. The Friday close was 65 1/2. In addition, a further look at the residual plot indicates a less than promising future. Comparing week 20 with the following six weeks (#21-26) against week 62 and the following three weeks (#63-65) seems to indicate that the stock price may languish at this lower or even a lower level for several more weeks. "Hold!"

ROLLING OVER THE DATABASE

After the Friday close (August 30, 1996) and the Saturday morning paper arrives, the 38 stock files and the two market indicator files are updated and new disks are passed out in class on Tuesday. We have the same questions to answer:

- 1) Where is the stock price going this week?
- 2) Do we buy, sell, or hold?

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With the market closed for Labor Day, a decision is needed before the market opens at 9:30 a.m. on Tuesday, September 1, 1996. Students make the following points:

- 1) FTU (new week #66)=[B(0)+B(1)xTime] ST (7)
 $\$66.68 = [46.51 + 0.29496(66)] + 0.704$ (8)
- 2) The majority of students believe that FTU will not reach the forecast. Looking at the plot, FTU is still very close to -2 standard deviations below the mean.
- 3) The momentum as shown on the residual plot has continued to deteriorate.
- 4) The seasonal indices indicate that week #66 is the last week before the seasonality turns negative.

Nobody is ready to buy, not just yet. They are learning to take all of the information in-from the raw data plots, to the statistics, to the forecasts, to the residual plots.

ROLLING OVER TUE DATA AGAIN

Files are updated and disks are prepared for handout on Monday, September 9, 1996. Another decision must be made before the opening bell. The low for last week (62 5/8) did penetrate the lower Bollinger Band. (Those who placed a buy order at that lower level probably now own the stock.)

What do we do now? Table Two and Exhibits Three and Four help the analysis. At this point the class is clearly divided. Part of the class says, "Do not buy; do not even put in an order." The other portion is more aggressive. They want to buy at the opening for the following reasons:

- 1) FTU penetrated the lower Bollinger Band and although the stock is slightly above that level, it is close. Quite possibly it is going to go up in price. (See weeks 20-26, 31-39, 55-60, Exhibit Four.)
- 2) Although the residual plot looks bleak, we are at the low levels of the past-and went up from there as shown in Exhibit Three (Week 3, 20-21, 30-31, 53-54).

TABLE TWO
Trend and Seasonal Analysis for
First Union Bank, 09/06/96

B Zero =	46.84
Regression line Slope (B One) =	.29267
Forecast =	$46.83810 + (.29267 * X)$
One Standard Deviation =	1.69500 with N-2DF
Coefficient of Determination, R ² =	.91545 with N-2DF
One Std Dev on last 2 patterns =	1.71004 with N-2DF

13 Periods in a season--Seasonal factors

Period	Additive	Multiplicative
1	-.090	.9995
2	-1.308	.9758
3	-.700	.9864
4	-.293	.9944
5	-.511	.9914
6	-1.053	.9815
7	-.321	.9941
8	.311	1.0046
9	.619	1.0113
10	1.301	1.0226
11	1.508	1.0259
12	.291	1.0060
13	.248	1.0053
Standard Deviation	1.4864	1.4893
R-Squared9350	.9347
Std Dev last 2 years	1.5867	1.6162

EXHIBIT THREE
Residual Plot For First Union Bank Versus Time

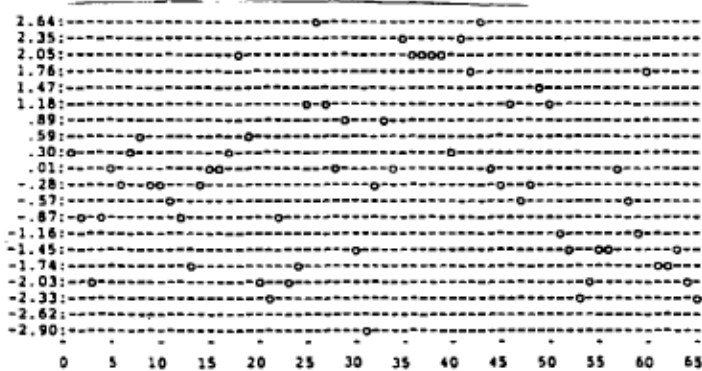
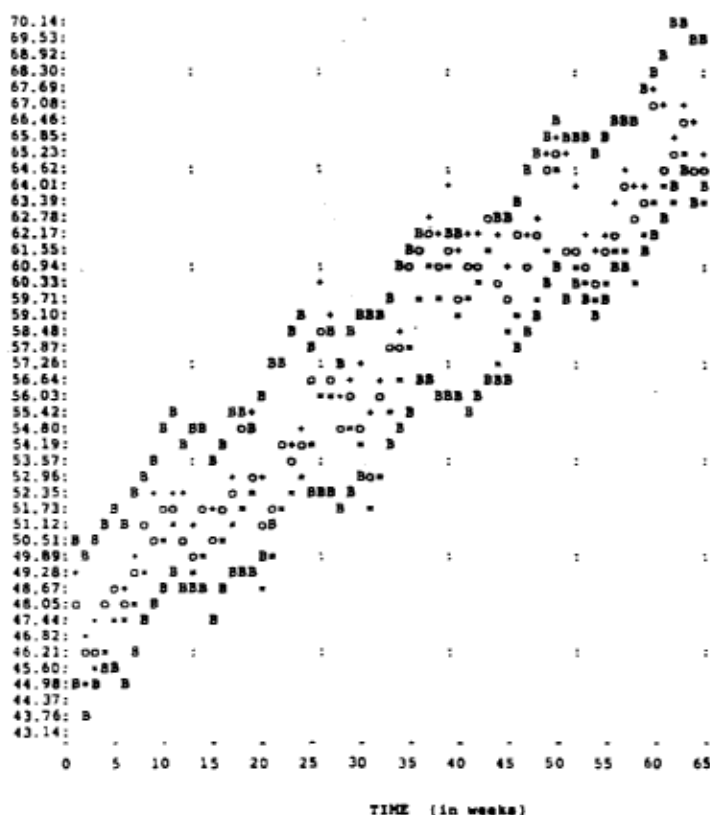


EXHIBIT FOUR

First Union High/Low/Close Versus Time



The “do not buy” people do have the last word:
 “Look at the seasonal indices for the next SEVEN weeks--all negative and two of them are larger than \$1.00 (Table Two). Steer clear.”

THE MOMENTUM OF THE TOPIC

The momentum of the topic carries itself. We can discuss stock after stock with invariably the same exciting analysis and many outcomes. If students remember to look at the fundamental analysis-if something dramatic happens, the technical analysis does not hold-stock price prediction is reasonably accurate. And above all, if they remember what they have learned about regression, time series, seasonal adjustment, residual analysis, and look at the price plots, they have a good handle of price prediction.

CONCLUSION

This is a wonderful exercise in the practical application of topics that students have been exposed to in basic regression and forecasting- nothing highly mathematical or deeply theoretical. Students rave about what they have learned and want to learn more. Why is this such a good case for the quantitative classroom?

- 1) The data is real and timely.
- 2) The situation is realistic and not just a “classroom exercise.”
- 3) The computer is used extensively.
- 4) Sophisticated models are developed- by computer.
- 5) Several plots are analyzed-data and residual.
- 6) Many steps are needed to reach the goal.
- 7) There is one and only one correct answer.
- 8) The students enjoy the realistic and far-reaching discussions.
- 9) Even the “bored” students are enthusiastic by mid-project.
- 10) This faculty member enjoys this real and very challenging case.

This is will, however, create a large time sink for the faculty member who must update the stock files over the weekend. Such is dedication!

REFERENCES

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