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Measuring Market Sentiment and the Three Stock Market Crashes of the New York Stock Exchange

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ABSTRACT

This research embarked on the development of a method to determine and measure market sentiment or the bullishness-bearishness of the stock market. This was done using trigonometry by combining the percentage change in the stock market index and the percentage change in the volume of transactions. The method yielded a formula that unified the stock market index and volume of transactions and was tested on the three market crashes of 1987, 1989 and 1997 of the New York Stock Exchange. Then the data produced by the measurement were tested as to their randomness in regard to prediction of the Efficient Market Theory using autocorrelation. As envisioned, the lines yielded spikes in the bull region and dives in the bear area. The deep dive of the 1987 crash resulted in a spike of bullish sentiment but the spike was not as high compared to the 1989 and 1997 crashes which registered high bullish spikes due to slight dives in the bear region. The data produced by the measurement predominantly yielded insignificant autocorrelation coefficients which indicate randomness as the Efficient Market Theory would have predicted.

Keywords: *market sentiment, weighted percentage change in negotiated factors, weighted percentage change in volume of transactions, unified line, standard line, angle of sweep*

JEL: C58, C65, G01

1. INTRODUCTION

At the end of every trading day we hear of stock market analysts articulate that the stock market has been a bull or a bear, indicating an advancing or retreating market. But they do not express how bullish or bearish the market has been. There is no means to measure the degree of bullishness or bearishness of the market. The paper of Pagan and Sossounov [1] developed a method for analyzing the bull and bear periods of the stock market using an algorithm that could recognize the bull and bear episodes or the rise and fall of US equity prices. This method relies on time series measurement that would characterize the bull and bear period over a length of time. But this measurement only considers the prices of stocks and not the volume of transactions. This paper has developed a method of measuring the bullishness or bearishness (market sentiment) of the stock market by uniting the percentage changes in stock market index and the percentage changes in the volume of transactions. This measurement can account for inter-day trading. Section 2 of this paper reviews other measurement of market sentiment while Sections 3 and 4 lay down the mathematical procedures for the measurement of market sentiment combining the stock market index and volume of transactions. Section 6 applies this mathematical procedure to the US Stock Market. With the method of measurement that the researcher has developed, the measurement is tested on the behaviour of the line produced by the stock market crashes of 1987, 1989 and 1997 of the New York Stock Exchange (NYSE). Then, the data produced were tested as to their randomness using

autocorrelation as the Efficient Market Theory would have predicted.

2. REVIEW OF MARKET SENTIMENT MEASUREMENT

Market or investor sentiment is an indicator of the aggregate attitude of the investment community at a given time [2]. There are three ways to measure market sentiment: a) the put-call ratio, b) the bull-bear ratio, and c) the volatility index. The put-call ratio is computed by dividing the volume of put contracts against the volume of call contracts within an established period of time. Investors buying put contracts are speculating that the market will fall while those placing call contracts are expecting that the market will rally. A high put-call ratio would indicate a pessimistic or retreating market while a low put-call ratio would mean a rather optimistic or advancing market. The bull-bear ratio is a survey that solicits and monitors the direct opinion of investment advisors whether the market would be bullish, bearish or neutral. Levels beyond 60% had indicated optimism (which is bearish for the market) and surveys less than 40% showed pessimism (which is bullish for the market). Robert Whaley in 1993 introduced the volatility index or VIX which is the estimated or implied volatility of the S&P 500 for the next 30 days. The volatility index is used by S&P 500 investors to ascertain the daily range for the index and market derivatives. An increasing VIX reading suggests a bullish signal that the market will dive and soon follow an uphill trend. On the other hand, a low VIX would mean a sluggish market that a bearish reversal is about to occur [3].

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In the paper of Ip-wing and Chi-sang [4] entitled "Measuring Market Sentiment in Hong Kong's Stock Market," Yu and Tam developed two indicators to measure investors' attitude towards risk in the Hong Kong stock market. These are risk appetite index and investment sentiment index. The researchers found out that although the risk appetite index can capture episodes of extreme optimism and pessimism between 1996 and 2006, it is volatile and could give inaccurate signals. The investment sentiment indicator, on the other hand, which is derived by combining the current realized return and expected short-term return of the stock market has the power to predict the returns from the stock market over a period of 6 to 12 months.

These measurements are meant to predict market sentiment in order to provide indicative promise of what to do with present or future investments. But these measurements are short of actually measuring the performance of the day's trading or market performance. The method and the series of formulae of this research will provide for this gap.

Pagan and Sossounov's [1] work "A Simple Framework for Analyzing Bull and Bear Markets" introduced an algorithm that could spot the bull episodes in the US equity prices. This algorithm was inspired by the works of Bry and Boshan [5]. The local peaks and troughs were subjected into random walk and GARCH models and found out that random walks could provide a good explanation of bull and bear markets. While this research is directly concerned with the creation of a framework for analyzing the bull and bear markets, the framework is only concerned with prices but never the volume of transactions. The method which the present paper has developed integrates both.

3. THE BULL-BEAR MEASUREMENT

With the measurement that this paper devised, *market sentiment or bull-bear-market measurement can be defined as, a measure of market performance or activity through the combined movement of negotiated factors (price, index, rate, etc.) and their volume of transactions in order to indicate the degree or appetite of investors in acquiring or buying, disposing or selling their investments.* This measurement is also intended for other markets where prices or rates are derived together with the volumes of transactions.

The measurement devised by the author is trigonometric. The location of the line produced by uniting the percentage change in negotiated factors (price, index, rate etc.) and percentage change in volume signify the kind of market behaviour while the length of the line and its angle of sweep, which can be used as the radius of a half circle, can indicate the degree of the market behaviour. This measurement is *a posteriori*. It is a measure of how the trading fared at the end of the day. It is not *a priori*. It is not a means of predicting market outcomes to aid future investments. The formula is:

$$M = \pm \frac{r^2 \theta_{\gamma n}}{180^\circ s^2} \times 100$$

Where: M = market sentiment
 r = unified line combining the weighted percentage change in negotiated factors L and the weighted percentage change in volume of transactions V
 s = unified line of the set standard
 θ = angle of sweep
 γ = subscript of θ indicating the kind of market
 n = subscript of θ pertaining to the location of the given angle θ

Hall [6] explained the dynamics of the Index and Volume in terms of determining market sentiment as provided for in Table 1.

Table 1. Dynamics of the Price and Volume in a Bull or Bear Market [6]

Price	Volume	Market Sentiment	Explanation
↑	↑	Bull	Price will continue to rise. The increasing trading volume reflects growing demand to buy the security, which adds momentum to or supports the upward direction of the market.
↓	↑	Bear	Price will continue to decline. Increasing volume indicates more and more investors are selling, leading to greater downward momentum.
↑	↓	Moderate Bear	The price increases is losing momentum, as indicated by the decline in trading volume. The price rise is unsupported and will soon reverse itself becoming a decline.
↓	↓	Moderate Bull	The decreasing trading indicates that the price decline is losing some of its steam. Demand is still relatively low. Soon, however, the market will reach its bottom, the price will again be attractive to new investors, and the resulting increased demand will cause the price to rally

If we situate the above table into the Cartesian coordinate, bearing the dynamics of index or rate on the X axis and volume on the Y axis, we would arrive at Figure 1 which illustrates the location of the bull and bear market on the coordinate system. The weighted percentage change in negotiated factors (L) on the X axis and the weighted percentage change in volume of transactions (V) on the Y axis can be united in a single line (r) through the

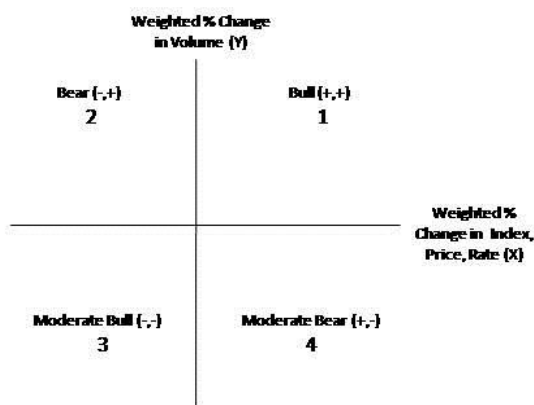
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Pythagorean formula which will constitute the radius of the unified line r .

$$r = [(L_o W_x)^2 + (V_o W_y)^2]^{1/2}$$

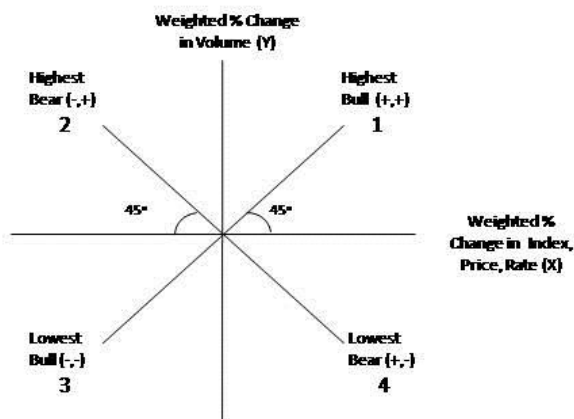
Where: r = unified line of the percentage change of negotiated factor and percentage change of volume of transaction
 L_o = observed percentage change in negotiated factors
 V_o = observed percentage change volume of transactions
 W_x = weight of negotiated factors
 W_y = weight of volume of transactions

Figure 1. Bull-Bear Dynamics in the Coordinate System



An ideal 45° line s can be drawn across each quadrant to indicate a standard percentage change of both variables (Figure 2). This standard line would indicate the highest and lowest possible scenarios of bull and bear markets. The 45° line would also show that both the negotiated factors and volume of transactions are increasing at the same rate.

Figure 2. The Standard 45° Line in Bull-Bear Dynamics



$$s = (L_s^2 + V_s^2)^{1/2}$$

$$L_s = L_h W_x$$

$$V_s = V_h W_y$$

Where: s = unified line of the set standard

L_s = standard weighted percentage change in negotiated factors

V_s = standard weighted percentage change in volume of

transactions

L_h = highest observed percentage change of negotiated factors

V_h = highest observed percentage change of volume of transactions

W_x = weight of negotiated factors

W_y = weight of volume of transactions

The standard line s generates an angle α on the X axis using the absolute value of the function of the standard weighted change in negotiated factors on the unified standard line. This would be 45° or closely approximate to it to be exact.

$$\cos \alpha = |L_s/s|$$

Where : α = angle of s

s = unified line of the set standard

L_s = standard weighted percentage change in negotiated factors

The 45° line would mean that the weighted percentage change in negotiated factors and the weighted percentage change in volume of transactions are increasing in the same degree. But actually, that is not so in real life. The volume of transactions changes at a higher rate than that of negotiated factors. In order to equalize the two variables and arrive at a standard 45° line, two different weights for negotiated factors and volume of transactions are calculated using the following formulae.

$$W_x = V_h / (L_h + V_h)$$

$$W_y = 1 - W_x$$

Where: L_h = highest observed percentage change in negotiated factors

V_h = highest observed percentage change in volume of transactions

W_x = weight of negotiated factors

W_y = weight of volume of transactions

These formulae were arrived using simple algebraic procedure. It would be assumed that the percentage change in negotiated factors and the percentage in volume of transactions are equal in order to arrive at a 45° line. This

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would mean that the two variables are increasing in the same degree or level.

Where $L_h = V_h$

The two variables are increasing in the same degree

Where: $W_x + W_y = 1$

The two weights when added will equal to 1, when translated to percentage will equal to 100%

$$W_x = 1 - W_y$$

$$W_y = 1 - W_x$$

$$L_h W_x = V_h W_y$$

$$L_h W_x = V_h (1 - W_x)$$

$$L_h W_x = V_h - V_h W_x$$

$$L_h W_x + V_h W_x = V_h$$

$$(L_h + V_h) W_x = V_h$$

$$(L_h + V_h) W_x \div (L_h + V_h) = V_h \div (L_h + V_h)$$

The angle β of the unified line r can be derived through the cosine function of the absolute value of β .

$$\cos \beta = |L_o W_x / r|$$

Where: β = angle of r

r = unified line of the percentage change in negotiated factor

and

percentage change in volume of transaction

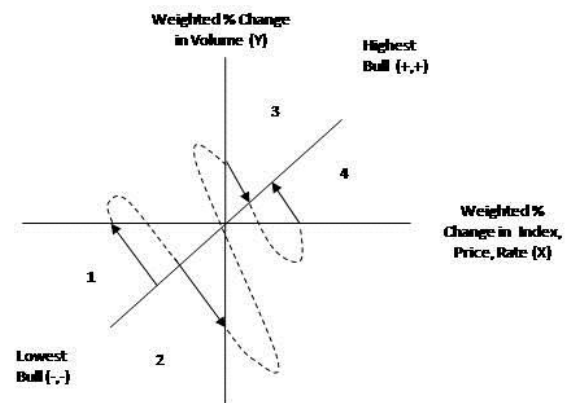
L_o = observed percentage change of negotiated factors

W_x = weight of negotiated factors

Wherever the line r would be located, together with the angle β that it generates, different formulae would indicate the angle of sweep ($\theta_{\gamma n}$) according to the direction indicated by its location from the standard line s (Figure 3). The angle of sweep ($\theta_{\gamma n}$) is the total angle covered by the line r if it is swept from the lowest possible level up to where r ends. The rationale behind the angle of sweep is that the length of r indicates the degree of change of both volume and negotiated factors but it can be located in any quadrant depending on the type of the market. In order to find out the degree of how this change can account for the other changes from the lowest possible change, the line r is swept from the lowest possible level. This would be true for both the bull and the bear markets. For the bull market,

the following formulae can be derived in order to ascertain the angle of sweep ($\theta_{\gamma n}$) according to the specific areas where r is situated. The subscript γ pertains to the kind of market sentiment and the subscript n refers to the number where the given angle is located.

Figure 3. The Areas Covered by the Angles of a Bull Market



1. $\theta_{\gamma n} = \theta_{bull1} = \cos \alpha - \cos \beta$
2. $\theta_{\gamma n} = \theta_{bull2} = \cos \beta$
3. $\theta_{\gamma n} = \theta_{bull3} = 90^\circ - \cos \beta + 90^\circ$
4. $\theta_{\gamma n} = \theta_{bull4} = \cos \beta + 180^\circ - \cos \alpha$

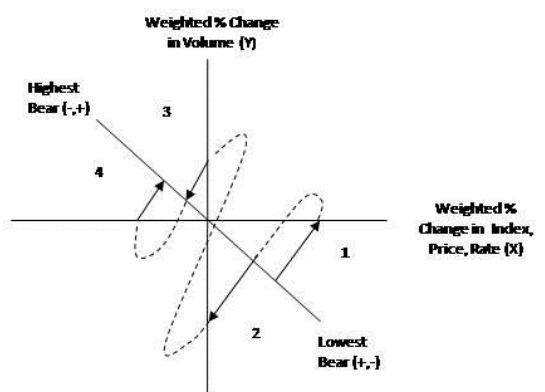
Where: θ = angle of sweep

γ = kind of market, bull or bear

n = location of angle on the coordinate depending on standard line

For the bear market, the following formulae can be derived in order to ascertain the angle of sweep ($\theta_{\gamma n}$) according to the specific areas where r is situated (Figure 4):

Figure 4. The Areas Covered by the Angles of a Bear Market



5. $\theta_{\gamma n} = \theta_{\text{bear } 1} = \cos \alpha - \cos \beta$
6. $\theta_{\gamma n} = \theta_{\text{bear } 2} = \cos \beta$
7. $\theta_{\gamma n} = \theta_{\text{bear } 3} = 90^\circ - \cos \beta + 90^\circ$
8. $\theta_{\gamma n} = \theta_{\text{bear } 4} = \cos \beta + 180^\circ - \cos \alpha$

Where: θ = angle of sweep

γ = kind of market, bull or bear

n = location of angle on the coordinate depending on standard line

One-half of the square of the radius (r) multiplied with pi (π) can account for half of the circle produced by the unification of the percentage change in negotiated factors and volume.

$$\frac{\pi r^2}{2}$$

If the angle of sweep ($\theta_{\gamma n}$) is divided by 180° then the result multiplied by half-circle covered by the unified percentage of negotiated factors and volume can give the total area of the half-circle covered by r .

$$\frac{\pi r^2}{2} * \frac{\theta_{\gamma n}}{180^\circ}$$

If this is divided by the area of the half-circle covered by the standard (s) then we can arrive at the degree of the market behaviour.

$$\frac{\pi r^2}{2} * \frac{\theta_{\gamma n}}{180^\circ} \div \frac{\pi s^2}{2}$$

$$\frac{\pi r^2}{2} * \frac{\theta_{\gamma n}}{180^\circ} * \frac{2}{\pi s^2}$$

$$\frac{r^2 \theta_{\gamma n}}{180^\circ s^2}$$

In order to distinguish between bear and bull, negative (-) would denote the bear and positive (+) would signify the bull. It is multiplied with 100 to convert it to percentages.

$$M = \pm \frac{r^2 \theta_{\gamma n}}{180^\circ s^2} \times 100$$

4. SETTING THE STANDARDS

The lowest observed percentage change in Dow Jones Industrial Averages (DJIA) during the three periods being studied was recorded on October 19, 1987 at -22.6102% and the highest observed percentage change in the volume of transactions was observed on November 30, 1987 at 211.3826%. The standard line (s) can be set using the values of these percentage changes. The weights which can be set as the benchmark can then be calculated.

$$\begin{aligned} W_x &= V_h / (L_h + V_h) \\ &= 211.3826 / (22.6102 + 211.3826) \\ &= 0.9034 \end{aligned}$$

$$\begin{aligned} W_y &= 1 - W_x \\ &= 1 - 0.912 \\ &= 0.0966 \end{aligned}$$

The standard weighted percentage change of negotiated factors (L_s) and the standard weighted percentage change of volume of transactions (V_s) can now be computed. In the same manner the standard line (s) can be calculated.

$$\begin{aligned} L_s &= L_h W_x \\ &= 22.6102 * 0.9034 \\ &= 20.4261 \end{aligned}$$

$$\begin{aligned} V_s &= V_h W_y \\ &= 211.3926 * 0.0966 \\ &= 20.4205 \end{aligned}$$

$$\begin{aligned} s &= (L_s^2 + V_s^2)^{1/2} \\ &= (20.4261^2 + 20.4205^2)^{1/2} \\ &= 28.8829 \end{aligned}$$

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The angle of the standard line (s) then can also be determined.

$$\cos \alpha = |L_s/s| = 0.7072$$

$$\cos \alpha = 44.9021^\circ$$

5. PROCEDURE FOR THE TREATMENT OF DATA

With the standards set, data treatment can now proceed.

1) Compute the percentage changes of the negotiated factors (L) and volume of transactions (V) from the data.

$$L = [(l_2 - l_1)/l_1] * 100$$

$$V = [(v_2 - v_1)/v_1] * 100$$

Where: L = percentage change of negotiated factors
 V = percentage change of volume of transactions
 l = negotiated factor from data
 v = volume of transactions from data

2) Compute the unified line (r) with the absolute weighted percentage changes of negotiated factors and volume of transactions.

$$r = [(L_o W_x)^2 + (V_o W_y)^2]^{1/2}$$

3) Find the cosine of the absolute value of β by dividing the weighted percentage changes of negotiated factors ($L_o W_x$) over the unified line (r).

$$\cos \beta = |L_o W_x / r|$$

4) Locate r in the coordinate and determine on which quadrant it is located to find out if it is a bear or bull.

5) Having known on which quadrant r is located and knowing where exactly it is on the standard line (s), find the angle of sweep (θ_{yn}).

6) Market sentiment (M) can now be computed using the formula:

$$M = \pm \frac{r^2 \theta_{yn}}{180^\circ s^2} \times 100$$

The complete set of data and the market sentiment computations can be found in Appendices 1-3.

6. RANDOMNESS TEST

The data generated from the measurement of the bull-bear market that would characterize the 1987, 1989 and 1997 US stock market crashes will be subjected to randomness test using autocorrelation. Eugene Fama's Efficient Market Theory suggests that "security prices accurately reflect available information and respond rapidly to new information as soon as it becomes available." This efficient market theory comes in three flavours corresponding to different definitions of "available information." The weak form (or random walk theory) says that prices reflect all the information in past prices the semi-strong form says that prices reflect all publicly available information and the strong form holds that prices reflect all acquirable information [7]. Since security prices would exhibit randomness even at any type of market, it would naturally have its natural property which autocorrelation can analyze in a time series data. A theoretical property of the random-walk model is that the autocorrelations of the sequence are zero [8].

7. FINDINGS

The stock market crashes when the stock market index (prices) hastily dives with the sudden surge in the volume of transactions. This would mean a sell-off. This phenomenon can be captured by locating the steep dive of market sentiment within the bear region. The sudden dip in the line pattern produced by combining price or index with volume of transactions would depict a crash while the sudden spike of the line pattern would picture a bullish market. A sluggish market will picture waves of tiny fluctuations in the zero region. A market that ends flat would then picture a flat line which would mean zero change in the prices or index and volumes of transactions. And just like a person who suffered cardiac arrest and registers a flat line in the cardiogram, a continuous flat line in market sentiment would mean a dead market. To spot a stock market crash a sudden dive in market sentiment will have to be registered.

7.1. THE 1987 STOCK MARKET CRASH

On October 19, 1987, the New York Stock Market took a deep dive (Figure 5) with a market sentiment of -49.1573% (or 49.1573% bearish). The plunge was brought about by the hasty dip of the DJIA at -22.6102% (Figure 6) with a corresponding surge in the volume of transactions on the same day at 78.5229% (Figure 7). A slight bullish trading happened the next day with only a market sentiment of 2.533% (or 2.533% bullish) (Table 2). But another drop in the market sentiment happened on November 30, 1987 with a market sentiment of -28.6793% (or 28.6793% bearish) (Figure 5). But this does not merit a crash since the DJIA only declined by -4.0267% though the volume of transactions soared wildly at 211.3826%.

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Figure 5. Market Sentiment
(Sep. 2 to Nov. 30, 1987)

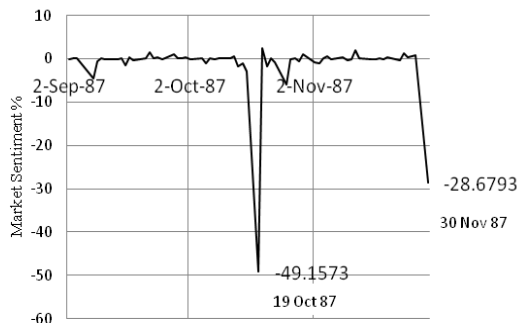


Figure 6. Dow Jones Industrial Averages
(Sep. 1 to Nov. 30, 1987)

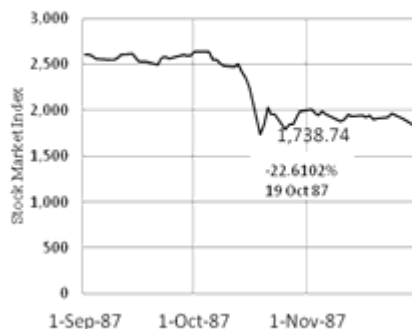
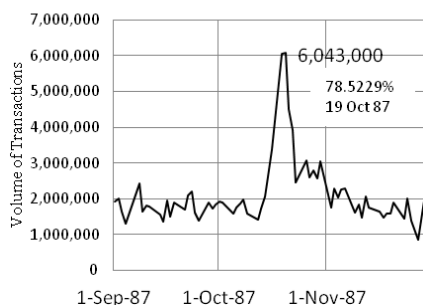


Figure 7. Volume of Transactions
(Sep. 1 to Nov. 30, 1987)



The Black Monday crash of October 19, 1987 was a confluence of several factors. Two months prior to the crash, the NYSE was wildly bullish with the DJIA surging at a record high of 2722.44 points [9]. Going a little far back, the Securities and Exchange Commission embarked on tedious investigations of shady Initial Public Offerings (IPOs) and insider trading. These investigations created wariness among investors which was even more aggravated by inflation. As a result, the Federal Reserves

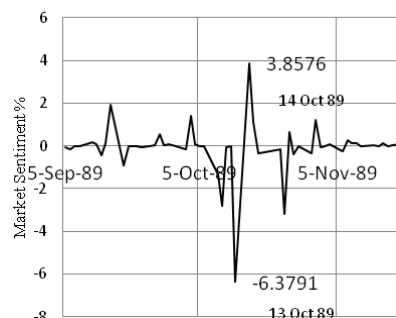
raised interest rates to tighten the valve on the money supply that could aggravate inflation. As a consequence, institutional trading firms utilized portfolio insurance that used stock index futures to hedge against future dips in the stock market and protect against market losses. As interest rates rose, many money managers hedged their portfolios and started selling. The stock market and futures market was swamped with sell orders pushing the market to crash [10].

The main culprit of the crash was the program trading done in computers which was being used by index arbitrage and portfolio insurance. Index arbitrage was being utilized by large investors to buy bundles of stocks and to simultaneously sell them in futures contract. The contract obliges the buyer to purchase the bundles of stocks on a predetermined date at a predetermined price. This will significantly hedge the funds of investors against future losses. At the same time, large investors and brokerage houses which were trading on their own accounts banked on portfolio insurance by utilizing the options market which grants the purchaser the right of a future purchase of the bundles of stocks but not obliging the purchaser to do so. The simultaneous sell orders from these markets triggered a deluge of sale which the computer program automatically facilitated without the possibility of renegeing from the automatic sale [11].

7.2. THE 1989 STOCK MARKET CRASH

The NYSE again took a slight dip of market sentiment at -6.3791% (or 6.3791% bearish) (Figure 8) on October 13, 1989, according to the measurement. This was brought about by the plunge in the DJIA at -6.955% (Figure 9) with a commensurate upsurge of the volume of transactions at 56.8636% (Figure 10). The market sentiment that dived on October 13 made a rebound the next day with a market sentiment of 3.8576% (or 3.8576% bullish) (Table 3). The market sentiment line from September to November was marked with significant spikes that pictured the bull market and interspersed with harrowing depressions that pictured the bear market (Figure 8).

Figure 8. Market Sentiment
(Sep. 5 to Nov. 30, 1989)



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Figure 9. Dow Jones Industrial Averages
(Sep. 1 to Nov. 30, 1989)

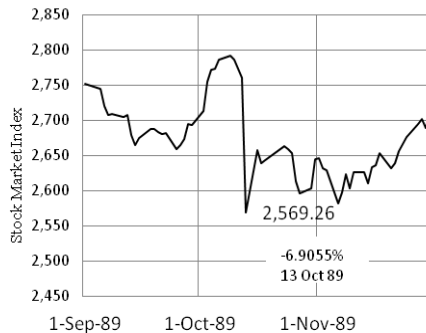


Figure 11. Market Sentiment
(Sep. 3 to Nov. 28, 1997)

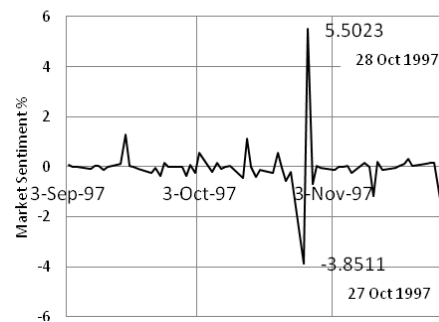


Figure 12. Dow Jones Industrial Averages
(Sep. 2 to Nov. 28, 1997)

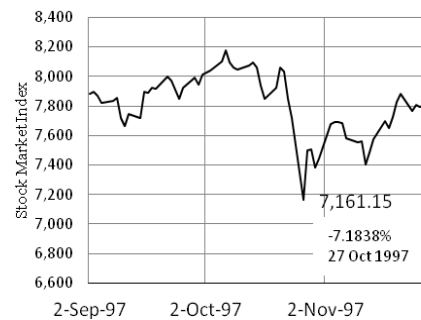


Figure 10. Volume of Transactions
(Sep. 10 to Nov. 30, 1989)

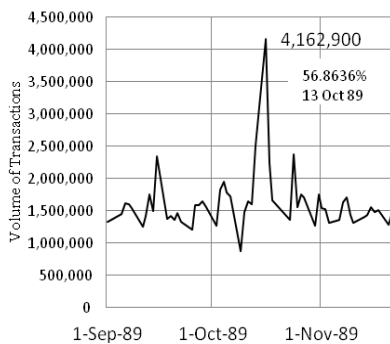
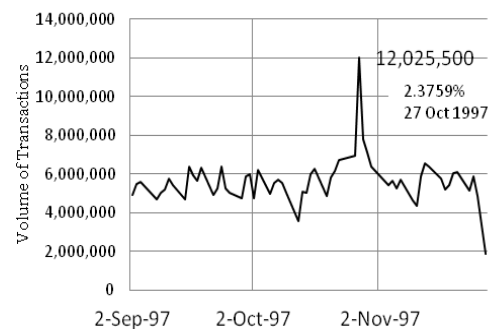


Figure 13. Volume of Transactions
(Sep. 2 to Nov. 28, 1997)



The mini-crash of October 13, 1989 was believed to have been brought about by the failed leverage buyout deal of the United Airlines (UAL) Corporation. This happened when the Association of Flight Attendants (AFA) pulled out of the deal after the management of the company refused to agree on the terms of the labor unions regarding the Employee Stock Ownership plan which would have financed the buyout [12].

7.3. THE 1997 STOCK MARKET CRASH

The ripples of the Asian financial crisis took its toll on the NYSE with a slight dive at -3.8511% (or 3.8511% bearish) (Figure 11) on October 27, 1997 (Table 4). This coincided with the plunge of the DJIA at -7.1838% (Figure 12) and the surge of market volume at 2.3759% (Figure 13). But the sudden dive delivered a sudden spike in market sentiment the next day with 5.5023% (or 5.5023% bullish).

The ripples of the Asian financial meltdown started as early as May 14, 1997 when the Thai government poured in billions of US dollars from its foreign reserves to defend the Baht against speculators. On July 2, the Thai government devalued the Baht by as much as 20% and was compelled to borrow \$17 billion from the International Monetary Fund. Meanwhile, Malaysia also pulled out millions of US dollars from its foreign reserves to defend the Ringgit from speculators. At that time, the Philippine Peso was devalued as Indonesia widened its trading band to discourage speculators. In July 24, Singaporean dollar also started its gradual decline. Malaysian Prime Minister

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Mahatir Mohammad singled out George Soros as the culprit behind the speculative attacks. Indonesia abandoned the trading band for its Rupiah and allowed the currency to float, triggering the plunge. On October 8, Indonesia asked the IMF for fresh funds while the Rupiah plunged 30% of its value despite efforts of its central bank to fend off attacks. On October 23, the Hong Kong stocks index fell 10.4% after Hong Kong raised bank lending rates to 300% to defend the Hong Kong dollar against speculative attacks. Then the South Korean won also began to weaken. On October 27, the NYSE was rattled that DJIA plunged 554 points [13].

It was the 1997 bull-bear-market measurement (Table 4) that significant autocorrelation coefficients were derived from lag 1 to lag 7 at 0.0001 to 0.042 level. But the autocorrelation coefficients were too low at 0.057 at lag 2 to 0.026 at lag 7. It was only at lag 1 or the adjacent series where the autocorrelation coefficient at -0.449 is in a comparatively moderate fit. This would mean that the upward movement at the bull region of the market sentiment is moderately fitted to its adjacent downward spike at the bear region.

Table 2. Autocorrelation Function Coefficients of the 1987 Bull-Bear-Market Sentiment of the Dow Jones Industrial Averages

Lag	Autocorrelation Coefficient	Box-Ljung Statistic		
		Value	Degrees of Freedom	Significance
1	-0.029	0.054	1	0.817
2	0.009	0.059	2	0.971
3	-0.015	0.074	3	0.995
4	-0.029	0.134	4	0.998
5	0.063	0.412	5	0.995
6	-0.021	0.444	6	0.998
7	-0.028	0.500	7	0.999
8	-0.020	0.529	8	1.000
9	-0.031	0.602	9	1.000
10	-0.027	0.659	10	1.000

Table 3. Autocorrelation Function Coefficients of the 1989 Bull-Bull-Market Sentiment of the Dow Jones Industrial Averages

Lag	Autocorre-lation Coefficient	Box-Ljung Statistic		
		Value	Degrees of Freedom	Significance
1	-0.243	3.734	1	0.053
2	-0.072	4.062	2	0.131
3	0.165	5.850	3	0.119
4	-0.133	7.025	4	0.135
5	0.077	7.426	5	0.191
6	-0.061	7.686	6	0.262
7	0.034	7.765	7	0.354
8	-0.009	7.771	8	0.456
9	0.163	9.701	9	0.375
10	-0.101	10.455	10	0.402

8. AUTOCORRELATION TEST OF THE MEASUREMENT

No significant autocorrelation coefficients were derived in the 1987 and 1989 bull-bear-market measurement data (Tables 2 and 3). With insignificant and very low autocorrelation coefficients, it would mean that the measurement of the bull-bear-market exhibits randomness.

But even then, an autoregressive model (Table 5) which was hoped to be derived to model lag 1 yielded a Pearson coefficient of only 0.467 with an R-square of only 0.218. This would mean that the prospective model can account for only 21.8% of the cases, too low to make the model usable. Moreover, while the beta coefficient of lag 1 at -0.485 possesses a significant t-statistic at over 0.001 level its constant at -0.012 does not incur significant t-statistic, making the model irrelevant.

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Table 4. Autocorrelation Function Coefficients of the 1997 Bull-Bear-Market Sentiment of the Dow Jones Industrial Averages

Lag	Autocorrelation Coefficient	Box-Ljung Statistic		
		Value	Degrees of Freedom	Significance
1	-0.449	13.137	1	0.000
2	0.057	13.349	2	0.001
3	-0.067	13.651	3	0.003
4	-0.051	13.831	4	0.008
5	0.089	14.378	5	0.013
6	-0.046	14.527	6	0.024
7	0.026	14.577	7	0.042
8	-0.070	14.935	8	0.060
9	-0.040	15.053	9	0.089
10	0.119	16.126	10	0.096

Table 5. Autoregressive Model Test of the Bear-Bull Sentiment of the 1997 Dow Jones Industrial Averages from September 2 to November 28 for Lag 1

Model for Lag 1	Values	F-statistics	Significance
Pearson r	0.467	15.603	0.000**
R- Square	0.213		
Standard error	0.8866444		
Variables	Values	T-statistics	Significance
Beta	-0.485	-3.950	0.000**
Constant	-0.012	-0.104	0.917

**Correlation significant at 0.01 level or higher (2 tailed)

*Correlation significant at 0.05 level (2 tailed)

9. CONCLUSION

This research embarked on the development of a method to measure the bullishness or bearishness of the market (market sentiment). The line patterns that the measurement tried to create were similar to that of a cardiogram that pulsate up and down a zero baseline where zero means no change in negotiated factors (rate, index or price) and volume of transactions. This condition depicts a straight line. The measurement was later tested on the 1987, 1989 and 1997 market crashes of the New York Stock Exchange in order to graphically depict the pattern of market sentiment during the three NYSE crashes. The line patterns showed a deep dive of market sentiment within the bear region. Common for the three crashes was that the dive of market sentiment was followed by a spike in the bull region in the next day of trading. Thus a sudden crash was followed by a bullish market sentiment. But the deep dive during the 1987 crash made it difficult to have a high bullish spike unlike the 1989 and 1997 mini-crashes which resulted in the sudden bullish upbeat of market sentiment during the next day of trading. This could be attributed to the degree of the crash. The 1987 crash was more severe than the mini-crash during the 1987 and 1997 crashes. The 1987 crash was also institutional in origin. The accelerating inflation that happened that year and the computer program that was

used in the trading contributed to the crash. The 1987 could be singled out as more company driven. The appetite of investors was doused and a bandwagon occurred due to a dismal performance of a huge company buyout. On the other hand, the 1997 crash was an external fallout of Asian currencies that simply rippled through the NYSE.

The bull-bear market measurement for the three cases exhibits randomness as Efficient Market Theory would suggest of the security prices in a stock market. This would mean that hardly was there a pattern to indicate the occurrence of a crash. With such randomness, it would suggest that stock market crashes are hardly predictable.

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Appendix 1. Processed Data for the 1987 Stock Market Crash of the NYSE

Date	DJIA (X)	Volume (Y)	L (X)	Lw _x	V (Y)	Vw _y	r	Cos (x/r)	Cos β	Angle of Sweep (θ _m)	Market Sentiment	
Standard			22.6102	20.4261	211.3826	20.4196	28.8822	0.7072	44.9021	45.0979		
1-Sep-87	2,61 0.97	1,935,0 00		0.0000		0.0000	0.0000					
2-Sep-87	2,60 2.04	1,999,0 00	-0.3420	-0.3090	3.3075	0.3195	0.4445	-0.6952	45.9594	134.0406	-0.0176	Bear
3-Sep-87	2,59 9.49	1,652,0 00	-0.0980	-0.0885	-17.3587	-1.6768	1.6792	-0.0527	86.9777	86.9777	0.1633	Bull
4-Sep-87	2,56 1.38	1,291,0 00	-1.4661	-1.3244	-21.8523	-2.1109	2.4920	-0.5315	57.8951	57.8951	0.2394	Bull
8-Sep-87	2,54 5.12	2,429,0 00	-0.6348	-0.5735	88.1487	8.5152	8.5345	-0.0672	86.1470	93.8530	-4.5527	Bear
9-Sep-87	2,54 9.27	1,649,0 00	0.1631	0.1473	-32.1120	-3.1020	3.1055	0.0474	87.2812	87.2812	-0.5606	Bear
10-Sep-87	2,57 6.05	1,798,0 00	1.0505	0.9490	9.0358	0.8729	1.2894	0.7360	42.6062	177.7037	0.1968	Bull
11-Sep-87	2,60 8.74	1,780,0 00	1.2690	1.1464	-1.0011	-0.0967	1.1505	0.9965	4.8219	40.0802	-0.0353	Bear
14-Sep-87	2,61 3.04	1,544,0 00	0.1648	0.1489	-13.2584	-1.2808	1.2894	0.1155	83.3683	83.3683	-0.0923	Bear
15-Sep-87	2,56 6.58	1,362,0 00	-1.7780	-1.6063	-11.7876	-1.1387	1.9689	-0.8158	35.3330	9.5691	0.0247	Bull
16-Sep-87	2,53 0.19	1,957,0 00	-1.4178	-1.2809	43.6858	4.2200	4.4101	-0.2904	73.1158	106.8842	-1.3845	Bear
17-Sep-87	2,52 7.90	1,507,0 00	-0.0905	-0.0818	-22.9944	-2.2213	2.2228	-0.0368	87.8919	87.8919	0.2892	Bull
18-Sep-87	2,52 4.64	1,881,0 00	-0.1290	-0.1165	24.8175	2.3974	2.4002	-0.0485	87.2178	92.7822	-0.3560	Bear
21-Sep-87	2,49 2.82	1,701,0 00	-1.2604	-1.1386	-9.5694	-0.9244	1.4666	-0.7764	87.2178	87.2178	0.1249	Bull
22-Sep-87	2,56 8.05	2,095,0 00	3.0179	2.7263	23.1628	2.2375	3.5270	0.7730	39.3760	174.4735	1.4454	Bull
23-Sep-87	2,58 5.67	2,203,0 00	0.6861	0.6198	5.1551	0.4980	0.7951	0.7796	38.7786	173.8761	0.0732	Bull
24-Sep-87	2,56 6.42	1,622,0 00	-0.7445	-0.6726	-26.3731	-2.5476	2.6349	-0.2553	75.2115	75.2115	0.3478	Bull
25-Sep-87	2,57 0.17	1,380,0 00	0.1461	0.1320	-14.9199	-1.4413	1.4473	0.0912	84.7670	95.2330	-0.1329	Bear
28-Sep-87	2,60 1.50	1,881,0 00	1.2190	1.1012	36.3043	3.5070	3.6758	0.2996	72.5672	107.4328	0.9668	Bull
29-Sep-87	2,59 0.57	1,735,0 00	-0.4201	-0.3796	-7.7618	-0.7498	0.8404	-0.4516	63.1508	63.1508	0.0297	Bull
30-Sep-87	2,59 6.28	1,831,0 00	0.2204	0.1991	5.5331	0.5345	0.5704	0.3491	69.5677	110.4323	0.0239	Bull
1-Oct-87	2,63 9.20	1,932,0 00	1.6531	1.4934	5.5161	0.5329	1.5857	0.9418	19.6363	154.7338	0.2591	Bull
2-Oct-87	2,64 0.99	1,891,0 00	0.0678	0.0613	-2.1222	-0.2050	0.2140	0.2864	73.3593	106.6407	-0.0033	Bear
5-Oct-87	2,64 0.18	1,597,0 00	-0.0307	-0.0277	-15.5473	-1.5019	1.5021	-0.0184	88.9431	88.9431	0.1337	Bull
6-Oct-87	2,54 8.63	1,756,0 00	-3.4676	-3.1326	9.9562	0.9618	3.2769	-0.9560	17.0675	152.1650	-1.0882	Bear
7-Oct-87	2,55 1.08	1,863,0 00	0.0961	0.0868	6.0934	0.5886	0.5950	0.1460	81.6073	98.3927	0.0232	Bull
8-Oct-87	2,51 6.64	1,987,0 00	-1.3500	-1.2196	6.6559	0.6430	1.3787	-0.8846	27.7977	162.8952	-0.2062	Bear
9-Oct-87	2,48 2.21	1,583,0 00	-1.3681	-1.2359	-20.3322	-1.9641	2.3206	-0.5326	57.8191	57.8191	0.2074	Bull
12-Oct-87	2,47 1.44	1,419,0 00	-0.4339	-0.3920	-10.3601	-1.0008	1.0748	-0.3647	68.6114	68.6114	0.0528	Bull
13-Oct-87	2,50 8.16	1,729,0 00	1.4858	1.3422	21.8464	2.1104	2.5010	0.5367	57.5425	122.4575	0.5101	Bull
14-Oct-87	2,41 2.70	2,074,0 00	-3.8060	-3.4383	19.9537	1.9275	3.9418	-0.8723	29.2751	164.3726	-1.7009	Bear
15-Oct-87	2,35 5.09	2,632,0 00	-2.3878	-2.1571	26.9045	2.5990	3.3776	-0.6387	50.3077	129.6923	-0.9853	Bear
16-Oct-87	2,24 5.09	3,385,0 00	-4.6011	-4.1566	28.6094	2.7637	4.9915	-0.8327	33.6192	168.7167	-2.7996	Bear

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Oct-87	6.73	00											
19-Oct-87	1.73	6,043.0											
Oct-87	8.74	00	-22.6102	-20.4260	78.5229	7.5853	21.7890	-0.9374	20.3727	155.4702	-49.1573		Bear
20-Oct-87	1.84	6,081.0											
Oct-87	1.01	00	5.8818	5.3137	0.6288	0.0607	5.3140	0.9999	0.6550	135.7525	2.5530		Bull
21-Oct-87	2.02	4,496.0											
Oct-87	7.85	00	10.1488	9.1684	-26.0648	-2.5179	9.5079	0.9643	15.3562	29.5459	-1.7788		Bear
22-Oct-87	1.95	3,922.0											
Oct-87	0.43	00	-3.8178	-3.4490	-12.7669	-1.2333	3.6629	-0.9416	19.6757	25.2264	0.2254		Bull
23-Oct-87	1.95	2,456.0											
Oct-87	0.76	00	0.0169	0.0153	-37.3789	-3.6108	3.6108	0.0042	89.7575	89.7575	-0.7794		Bear
26-Oct-87	1.79	3,088.0											
Oct-87	3.93	00	-8.0394	-7.2628	25.7329	2.4858	7.6764	-0.9461	18.8942	153.9917	-6.0434		Bear
27-Oct-87	1.84	2,602.0											
Oct-87	6.49	00	2.9299	2.6469	-15.7383	-1.5203	3.0524	0.8671	29.8726	15.0295	-0.0933		Bear
28-Oct-87	1.84	2,794.0											
Oct-87	6.82	00	0.0179	0.0161	7.3789	0.7128	0.7130	0.0226	88.7024	91.2976	0.0309		Bull
29-Oct-87	1.93	2,581.0											
Oct-87	8.33	00	4.9550	4.4764	-7.6235	-0.7364	4.5365	0.9867	9.3423	35.5598	-0.4874		Bear
30-Oct-87	1.99	3,034.0											
Oct-87	3.53	00	2.8478	2.5727	17.5513	1.6955	3.0811	0.8350	33.3855	168.4830	1.0652		Bull
2-Nov-87	2.01	1,760.0											
Nov-87	4.09	00	1.0313	0.9317	-41.9908	-4.0563	4.1619	0.2239	77.0639	77.0639	-0.8890		Bear
3-Nov-87	1.96	2,278.0											
Nov-87	3.53	00	-2.5103	-2.2678	29.4318	2.8431	3.6368	-0.6236	51.4223	128.5777	-1.1326		Bear
4-Nov-87	1.94	2,025.0											
Nov-87	5.29	00	-0.9289	-0.8392	-11.1062	-1.0729	1.3621	-0.6161	51.9671	51.9671	0.0642		Bull
5-Nov-87	1.98	2,260.0											
Nov-87	5.41	00	2.0624	1.8632	11.6049	1.1210	2.1744	0.8569	31.0343	166.1318	0.5231		Bull
6-Nov-87	1.95	2,282.9											
Nov-87	9.05	00	-1.3277	-1.1994	1.0133	0.0979	1.2034	-0.9967	4.6654	139.7629	-0.1348		Bear
9-Nov-87	1.90	1,606.9											
Nov-87	0.20	00	-3.0040	-2.7138	-29.6115	-2.8605	3.9430	-0.6883	46.5070	46.5070	0.4815		Bull
10-Nov-87	1.87	1,843.1											
Nov-87	8.15	00	-1.1604	-1.0483	14.6991	1.4199	1.7650	-0.5939	53.5623	126.4377	-0.2623		Bear
11-Nov-87	1.89	1,478.5											
Nov-87	9.20	00	1.1208	1.0125	-19.7819	-1.9109	2.1626	0.4682	62.0829	62.0829	-0.1934		Bear
12-Nov-87	1.96	2,062.8											
Nov-87	0.21	00	3.2124	2.9021	39.5198	3.8176	4.7954	0.6052	52.7585	127.2415	1.9487		Bull
13-Nov-87	1.93	1,749.2											
Nov-87	5.01	00	-1.2856	-1.1614	-15.2026	-1.4686	1.8723	-0.6203	51.6621	51.6621	0.1206		Bull
16-Nov-87	1.94	1,643.4											
Nov-87	9.10	00	0.7282	0.6578	-6.0485	-0.5843	0.8798	0.7477	41.6118	3.2903	-0.0017		Bear
17-Nov-87	1.92	1,482.4											
Nov-87	2.25	00	-1.3776	-1.2445	-9.7968	-0.9464	1.5634	-0.7960	37.2511	7.6510	0.0125		Bull
18-Nov-87	1.93	1,582.6											
Nov-87	9.16	00	0.8797	0.7947	6.7593	0.6529	1.0286	0.7727	39.4069	174.5044	0.1229		Bull
19-Nov-87	1.89	1,571.4											
Nov-87	5.39	00	-2.2572	-2.0391	-0.7077	-0.0684	2.0403	-0.9994	1.9202	2.9819	0.0083		Bull
20-Nov-87	1.91	1,891.7											
Nov-87	3.63	00	0.9623	0.8694	20.3831	1.9690	2.1524	0.4039	66.1772	113.8228	0.3512		Bull
23-Nov-87	1.92	1,431.6											
Nov-87	3.08	00	0.4938	0.4461	-24.3220	-2.3495	2.3915	0.1865	79.2487	79.2487	-0.3019		Bear
24-Nov-87	1.96	1,995.2											
Nov-87	3.53	00	2.1034	1.9002	39.3685	3.8030	4.2513	0.4470	63.4505	116.5495	1.4029		Bull
25-Nov-87	1.94	1,397.8											
Nov-87	6.95	00	-0.8444	-0.7628	-29.9419	-2.8924	2.9913	-0.2550	75.2254	75.2254	0.4483		Bull
27-Nov-87	1.91	863,600											
Nov-87	0.48	00	-1.8732	-1.6922	-38.2172	-3.6918	4.0611	-0.4167	65.3743	65.3743	0.7181		Bull
30-Nov-87	1.83	2,689.1											
Nov-87	3.55	00	-4.0267	-3.6378	211.3826	20.4196	20.7411	-0.1754	79.8987	100.1013	-28.6793		Bear

Data lifted from "Dow Jones Industrial Averages, Historical Prices", *Yahoo Finance*. (<http://finance.yahoo.com/q/hp?s=^DJI+Historical+Prices>)

Appendix 2. Processed Data for the 1989 Stock Market Crash of the NYSE

Date	DJIA (X)	Volume (Y)	L (X)	Lw _x	V (Y)	Vw _y	r	Cos (x/r)	Cos β	Angle of Sweep (θ _m)	Market Sentiment	
Standard			22.6102	20.4261	211.3826	20.4196	28.8822	0.7072	44.9021	45.0979		
1-Sep-89	2.75 2.09	1,333, 000		0.0000		0.0000	0.0000					
5-Sep-89	2.74 4.68	1,451, 800	-0.2692	-0.2432	8.9122	0.8609	0.8946	-0.2719	74.2232	105.7768	-0.0564	Bear
6-Sep-89	2.71 9.79	1,618, 000	-0.9068	-0.8192	11.4479	1.1059	1.3763	-0.5953	53.4683	126.5317	-0.1596	Bear
7-Sep-89	2.70 6.88	1,601, 600	-0.4747	-0.4288	-1.0136	-0.0979	0.4399	-0.9749	12.8621	32.0400	0.0041	Bull
8-Sep-89	2.70 9.54	1,540, 900	0.0983	0.0888	-3.7900	-0.3661	0.3767	0.2357	76.3698	76.3698	-0.0072	Bear
11-Sep-89	2.70 4.41	1,260, 200	-0.1893	-0.1710	-18.2166	-1.7597	1.7680	-0.0967	84.4484	84.4484	0.1758	Bull
12-Sep-89	2.70 7.26	1,421, 400	0.1054	0.0952	12.7916	1.2357	1.2393	0.0768	85.5943	94.4057	0.0966	Bull
13-Sep-89	2.67 9.52	1,753, 300	-1.0247	-0.9257	23.3502	2.2556	2.4382	-0.3797	67.6876	112.3124	-0.4447	Bear
14-Sep-89	2.66 4.89	1,492, 500	-0.5460	-0.4933	-14.8748	-1.4369	1.5192	-0.3247	71.0541	71.0541	0.1092	Bull
15-Sep-89	2.67 4.58	2,348, 700	0.3636	0.3285	57.3668	5.5416	5.5514	0.0592	86.6076	93.3924	1.9168	Bull
18-Sep-89	2.68 7.50	1,369, 400	0.4831	0.4364	-41.6954	-4.0278	4.0513	0.1077	83.8162	83.8162	-0.9162	Bear
19-Sep-89	2.68 7.31	1,416, 100	-0.0071	-0.0064	3.4103	0.3294	0.3295	-0.0194	88.8893	91.1107	-0.0066	Bear
20-Sep-89	2.68 3.89	1,366, 400	-0.1273	-0.1150	-3.5096	-0.3390	0.3580	-0.3212	71.2674	71.2674	0.0061	Bull
21-Sep-89	2.68 0.28	1,469, 300	-0.1345	-0.1215	7.5307	0.7275	0.7375	-0.1648	80.5171	99.4829	-0.0360	Bear
22-Sep-89	2.68 1.61	1,333, 500	0.0496	0.0448	-9.2425	-0.8928	0.8939	0.0501	87.1256	87.1256	-0.0464	Bear
25-Sep-89	2.65 9.19	1,211, 300	-0.8361	-0.7553	-9.1639	-0.8852	1.1637	-0.6491	49.5283	49.5283	0.0447	Bull
26-Sep-89	2.66 3.94	1,583, 500	0.1786	0.1614	30.7273	2.9683	2.9726	0.0543	86.8882	93.1118	0.5480	Bull
27-Sep-89	2.67 3.06	1,584, 000	0.3424	0.3093	0.0316	0.0031	0.3093	1.0000	0.5651	135.6626	0.0086	Bull
28-Sep-89	2.69 4.91	1,642, 400	0.8174	0.7385	3.6869	0.3562	0.8199	0.9007	25.7477	160.8452	0.0720	Bull
29-Sep-89	2.69 2.82	1,553, 000	-0.0776	-0.0701	-5.4433	-0.5258	0.5305	-0.1321	82.4104	82.4104	0.0154	Bull
2-Oct-89	2.71 3.72	1,274, 100	0.7761	0.7012	-17.9588	-1.7348	1.8712	0.3747	67.9929	67.9929	-0.1585	Bear
3-Oct-89	2.75 4.56	1,825, 500	1.5049	1.3596	43.2776	4.1806	4.3961	0.3093	71.9851	108.0149	1.3902	Bull
4-Oct-89	2.77 1.09	1,945, 900	0.6001	0.5421	6.5955	0.6371	0.8366	0.6480	49.6055	130.3945	0.0608	Bull
5-Oct-89	2.77 3.56	1,778, 900	0.0891	0.0805	-8.5821	-0.8290	0.8329	0.0967	84.4523	84.4523	-0.0390	Bear
6-Oct-89	2.78 5.52	1,725, 200	0.4312	0.3896	-3.0187	-0.2916	0.4866	0.8006	36.8170	8.0851	-0.0013	Bear
9-Oct-89	2.79 1.41	868,10 0	0.2115	0.1910	-49.6812	-4.7992	4.8030	0.0398	87.7206	87.7206	-1.3477	Bear
10-Oct-89	2.78 5.33	1,475, 600	-0.2178	-0.1968	69.9804	6.7601	6.7630	-0.0291	88.3327	91.6673	-2.7923	Bear
11-Oct-89	2.77 3.36	1,640, 700	-0.4298	-0.3882	11.1887	1.0808	1.1484	-0.3381	70.2415	70.2415	-0.0617	Bear
12-Oct-89	2.75 9.84	1,601, 200	-0.4875	-0.4404	-2.4075	-0.2326	0.4980	-0.8843	27.8374	17.0647	0.0028	Bull
13-Oct-89	2.56 9.26	2,511, 700	-6.9055	-6.2384	56.8636	5.4930	8.3121	-0.7505	41.3645	138.6355	-6.3791	Bear
16-Oct-89	2.65 7.38	4,162, 900	3.4298	3.0985	65.7403	6.3505	7.0661	0.4385	63.9919	116.0081	3.8576	Bull
17-Oct-89	2.63	2,240,	-0.7018	-0.6340	-46.1745	-4.4605	4.5053	-0.1407	81.9100	81.9100	1.1073	Bull

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89	8.73	700											
89	18-Oct- 3.65	2,64 000	1,669,	0.1865	0.1684	-25.5143	-2.4647	2.4704	0.0682	86.0904	86.0904	-0.3499	Bear
89	23-Oct- 2.91	2,66 600	1,358,	0.7285	0.6582	-18.5980	-1.7966	1.9133	0.3440	69.8800	69.8800	-0.1704	Bear
89	24-Oct- 9.22	2,65 600	2,379,	-0.1386	-0.1252	75.1509	7.2596	7.2607	-0.0172	89.0121	90.9879	-3.1945	Bear
89	25-Oct- 3.28	2,65 500	1,556,	-0.2234	-0.2018	-34.5898	-3.3414	3.3475	-0.0603	86.5439	86.5439	0.6459	Bull
89	26-Oct- 3.73	2,61 400	1,752,	-1.4906	-1.3466	12.5859	1.2158	1.8143	-0.7422	42.0775	177.1750	-0.3884	Bear
89	27-Oct- 6.72	2,59 300	1,703,	-0.6508	-0.5879	-2.8019	-0.2707	0.6472	-0.9084	24.7197	20.1824	0.0056	Bull
89	30-Oct- 3.48	2,60 300	1,266,	0.2603	0.2352	-25.6561	-2.4784	2.4895	0.0945	84.5793	84.5793	-0.3491	Bear
89	31-Oct- 5.08	2,64 000	1,761,	1.5979	1.4435	39.0666	3.7738	4.0405	0.3573	69.0679	110.9321	1.2061	Bull
89	1-Nov- 5.90	2,64 400	1,542,	0.0310	0.0280	-12.4134	-1.1991	1.1995	0.0233	88.6621	88.6621	-0.0850	Bear
89	2-Nov- 1.56	2,63 400	1,524,	-0.5420	-0.4896	-1.1670	-0.1127	0.5024	-0.9745	12.9663	31.9358	0.0054	Bull
89	3-Nov- 9.51	2,62 000	1,315,	-0.0779	-0.0704	-13.7366	-1.3270	1.3288	-0.0530	86.9641	86.9641	0.1023	Bull
89	6-Nov- 2.17	2,58 800	1,354,	-1.8003	-1.6264	3.0266	0.2924	1.6525	-0.9842	10.1908	145.2883	-0.2642	Bear
89	7-Nov- 7.13	2,59 000	1,630,	0.5794	0.5234	20.3130	1.9622	2.0308	0.2577	75.0650	104.9350	0.2882	Bull
89	8-Nov- 3.36	2,62 500	1,701,	1.0100	0.9124	4.3865	0.4237	1.0060	0.9070	24.9111	160.0086	0.1078	Bull
89	9-Nov- 3.69	2,60 900	1,433,	-0.7498	-0.6774	-15.7273	-1.5193	1.6634	-0.4072	65.9700	65.9700	0.1216	Bull
89	10-Nov- 5.61	2,62 000	1,318,	0.8419	0.7606	-8.0829	-0.7808	1.0900	0.6978	45.7526	45.7526	-0.0362	Bear
89	13-Nov- 6.43	2,62 500	1,407,	0.0312	0.0282	6.7906	0.6560	0.6566	0.0430	87.5372	92.4628	0.0265	Bull
89	14-Nov- 0.25	2,61 700	1,431,	-0.6160	-0.5565	1.7194	0.1661	0.5808	-0.9582	16.6170	151.7145	-0.0341	Bear
89	15-Nov- 2.58	2,63 300	1,551,	0.8555	0.7728	8.3537	0.8070	1.1173	0.6917	46.2377	133.7623	0.1112	Bull
89	16-Nov- 5.66	2,63 700	1,483,	0.1170	0.1057	-4.3576	-0.4209	0.4340	0.2435	75.9052	75.9052	-0.0095	Bear
89	17-Nov- 2.66	2,65 200	1,510,	0.6450	0.5827	1.7861	0.1725	0.6077	0.9588	16.4940	151.5915	0.0373	Bull
89	20-Nov- 2.04	2,63 700	1,281,	-0.7773	-0.7022	-15.1304	-1.4616	1.6215	-0.4331	64.3375	64.3375	0.1127	Bull
89	21-Nov- 9.29	2,63 000	1,479,	0.2755	0.2488	15.3936	1.4870	1.5077	0.1650	80.5000	99.5000	0.1506	Bull
89	22-Nov- 6.78	2,65 300	1,457,	0.6627	0.5987	-1.4672	-0.1417	0.6152	0.9731	13.3194	31.5827	-0.0080	Bear
89	24-Nov- 5.55	2,67 0	862,90	0.7065	0.6382	-40.7878	-3.9401	3.9915	0.1599	80.7987	80.7987	-0.8573	Bear
89	27-Nov- 4.97	2,69 900	1,493,	0.7258	0.6557	73.1255	7.0639	7.0943	0.0924	84.6967	95.3033	3.1944	Bull
89	28-Nov- 2.01	2,70 700	1,537,	0.2612	0.2360	2.9319	0.2832	0.3687	0.6401	50.1977	129.8023	0.0117	Bull
89	29-Nov- 8.78	2,68 700	1,472,	-0.4896	-0.4423	-4.2271	-0.4083	0.6020	-0.7348	42.7112	2.1909	0.0005	Bull
89	30-Nov- 6.27	2,70 000	1,532,	0.6505	0.5876	4.0266	0.3890	0.7047	0.8339	33.5012	168.5987	0.0558	Bull

Data lifted from "Dow Jones Industrial Averages, Historical Prices", *Yahoo Finance*. (<http://finance.yahoo.com/q/hp?s=^DJI+Historical+Prices>)

Appendix 3. Processed Data for the 1997 Stock Market Crash of the NYSE

Date	DJIA (X)	Volume (Y)	L (X)	Lw _x	V (Y)	Vw _y	r	Cos (x/r)	Cos β	Angle of Sweep (θ _m)	Market Sentiment
Standard			22.6102	20.4261	211.3826	20.4196	28.8822	0.7072	44.9021	45.0979	
2-Sep-97	7,879.78	4,918,700		0.0000		0.0000	0.0000				
3-Sep-97	7,894.64	5,490,600	0.1886	0.1704	11.6271	1.1232	1.1360	0.1500	81.3749	98.6251	0.0848 Bull
4-Sep-97	7,867.24	5,593,100	-0.3471	-0.3135	1.8668	0.1803	0.3617	-0.8668	29.9055	165.0030	-0.0144 Bear
5-Sep-97	7,822.41	5,364,000	-0.5698	-0.5148	-4.0961	-0.3957	0.6493	-0.7929	37.5473	7.3548	0.0021 Bull
8-Sep-97	7,835.18	4,664,300	0.1632	0.1475	-13.0444	-1.2601	1.2687	0.1162	83.3245	83.3245	-0.0893 Bear
9-Sep-97	7,851.91	5,022,000	0.2135	0.1929	7.6689	0.7408	0.7655	0.2520	75.4051	104.5949	0.0408 Bull
10-Sep-97	7,719.28	5,176,200	-1.6891	-1.5260	3.0705	0.2966	1.5545	-0.9816	10.9997	33.9024	0.0546 Bull
11-Sep-97	7,660.98	5,750,200	-0.7553	-0.6823	11.0892	1.0712	1.2701	-0.5372	57.5056	122.4944	-0.1316 Bear
12-Sep-97	7,742.97	5,441,500	1.0702	0.9668	-5.3685	-0.5186	1.0971	0.8812	28.2083	16.6938	-0.0134 Bear
15-Sep-97	7,721.14	4,680,300	-0.2819	-0.2547	-13.9888	-1.3513	1.3751	-0.1852	79.3260	79.3260	0.0999 Bull
16-Sep-97	7,895.92	6,363,800	2.2637	2.0450	35.9699	3.4747	4.0318	0.5072	59.5216	120.4784	1.3043 Bull
17-Sep-97	7,886.44	5,905,500	-0.1201	-0.1085	-7.2017	-0.6957	0.7041	-0.1540	81.1383	81.1383	0.0268 Bull
18-Sep-97	7,922.72	5,668,300	0.4600	0.4156	-4.0166	-0.3880	0.5686	0.7310	43.0338	43.0338	-0.0093 Bear
19-Sep-97	7,917.27	6,310,400	-0.0688	-0.0621	11.3279	1.0943	1.0960	-0.0567	86.7496	93.2504	-0.0746 Bear
22-Sep-97	7,996.83	4,909,000	1.0049	0.9078	-22.2078	-2.1453	2.3294	0.3897	67.0633	67.0633	-0.2424 Bear
23-Sep-97	7,970.06	5,229,300	-0.3348	-0.3024	6.5248	0.6303	0.6991	-0.4326	64.3678	115.6322	-0.0376 Bear
24-Sep-97	7,906.71	6,394,600	-0.7948	-0.7181	22.2841	2.1526	2.2692	-0.3164	71.5526	108.4474	-0.3719 Bear
25-Sep-97	7,848.01	5,248,800	-0.7424	-0.6707	-17.9182	-1.7309	1.8563	-0.3613	68.8196	68.8196	0.1579 Bull
26-Sep-97	7,922.18	5,053,400	0.9451	0.8538	-3.7228	-0.3596	0.9264	0.9216	22.8410	22.0611	-0.0126 Bear
29-Sep-97	7,991.43	4,771,000	0.8741	0.7897	-5.5883	-0.5398	0.9566	0.8255	34.3566	10.5455	-0.0064 Bear
30-Sep-97	7,945.26	5,875,000	-0.5777	-0.5219	23.1398	2.2353	2.2954	-0.2274	76.8572	103.1428	-0.3619 Bear
1-Oct-97	8,015.50	5,986,600	0.8840	0.7986	1.8996	0.1835	0.8195	0.9746	12.9398	148.0373	0.0662 Bull
2-Oct-97	8,027.53	4,747,600	0.1501	0.1356	-20.6962	-1.9993	2.0038	0.0677	86.1202	86.1202	-0.2303 Bear
3-Oct-97	8,038.58	6,233,700	0.1377	0.1244	31.3021	3.0238	3.0263	0.0411	87.6450	92.3550	0.5633 Bull
6-Oct-97	8,100.22	4,956,200	0.7668	0.6927	-20.4934	-1.9797	2.0974	0.3303	70.7139	70.7139	-0.2072 Bear
7-Oct-97	8,178.31	5,519,700	0.9640	0.8709	11.3696	1.0983	1.4017	0.6213	51.5867	128.4133	0.1680 Bull
8-Oct-97	8,095.06	5,731,100	-1.0179	-0.9196	3.8299	0.3700	0.9912	-0.9277	21.9156	157.0131	-0.1027 Bear
9-Oct-97	8,061.42	5,518,400	-0.4156	-0.3754	-3.7113	-0.3585	0.5191	-0.7232	43.6806	1.2215	0.0002 Bull
10-Oct-97	8,045.21	5,006,800	-0.2011	-0.1817	-9.2708	-0.8956	0.9138	-0.1988	78.5336	78.5336	0.0437 Bull
13-Oct-97	8,072.22	3,548,000	0.3357	0.3033	-29.1364	-2.8146	2.8309	0.1071	83.8496	83.8496	-0.4475 Bear
14-Oct-97	8,096.29	5,103,300	0.2982	0.2694	43.8360	4.2346	4.2431	0.0635	86.3601	93.6399	1.1228 Bull

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97	15-Oct-97	98	8,057.00	5,053,100	-0.4732	-0.4275	-0.9837	-0.0950	0.4379	-0.9762	12.5326	32.3695	0.0041	Bull
97	16-Oct-97	88	7,938.00	5,970,100	-1.4780	-1.3353	18.1473	1.7530	2.2036	-0.6059	52.7039	127.2961	-0.4117	Bear
97	17-Oct-97	03	7,847.00	6,249,800	-1.1570	-1.0452	4.6850	0.4526	1.1390	-0.9177	23.4126	158.5101	-0.1369	Bear
97	20-Oct-97	44	7,921.00	4,838,800	0.9483	0.8567	-22.5767	-2.1809	2.3431	0.3656	68.5553	68.5553	-0.2507	Bear
97	21-Oct-97	44	8,060.00	5,823,100	1.7547	1.5852	20.3418	1.9650	2.5247	0.6279	51.1061	128.8939	0.5472	Bull
97	22-Oct-97	65	8,034.00	6,134,900	-0.3200	-0.2890	5.3545	0.5172	0.5925	-0.4878	60.8026	119.1974	-0.0279	Bear
97	23-Oct-97	77	7,847.00	6,732,700	-2.3259	-2.1012	9.7443	0.9413	2.3024	-0.9126	24.1310	159.2285	-0.5622	Bear
97	24-Oct-97	41	7,715.00	6,776,300	-1.6866	-1.5237	0.6476	0.0626	1.5250	-0.9992	2.3511	137.4486	-0.2129	Bear
97	27-Oct-97	15	7,161.00	6,937,300	-7.1838	-6.4898	2.3759	0.2295	6.4939	-0.9994	2.0254	137.1229	-3.8511	Bear
97	28-Oct-97	32	7,498.500	12,025,500	4.7083	4.2535	73.3455	7.0852	8.2639	0.5147	59.0220	120.9780	5.5023	Bull
97	29-Oct-97	67	7,506.00	7,776,600	0.1114	0.1006	-35.3324	-3.4131	3.4146	0.0295	88.3117	88.3117	-0.6857	Bear
97	30-Oct-97	67	7,381.00	7,122,300	-1.6652	-1.5043	-8.4137	-0.8128	1.7099	-0.8798	28.3816	16.5205	0.0322	Bull
97	31-Oct-97	08	7,442.00	6,380,700	0.8184	0.7393	-10.4124	-1.0058	1.2483	0.5923	53.6828	53.6828	-0.0557	Bear
97	3-Nov-97	39	7,674.00	5,647,400	3.1216	2.8200	-11.4925	-1.1102	3.0307	0.9305	21.4883	23.4138	-0.1432	Bear
97	4-Nov-97	13	7,689.00	5,415,900	0.1921	0.1735	-4.0992	-0.3960	0.4323	0.4013	66.3379	66.3379	-0.0083	Bear
97	5-Nov-97	57	7,692.00	5,656,800	0.0447	0.0404	4.4480	0.4297	0.4316	0.0936	84.6264	95.3736	0.0118	Bull
97	6-Nov-97	24	7,683.00	5,228,900	-0.1213	-0.1096	-7.5643	-0.7307	0.7389	-0.1483	81.4721	81.4721	0.0296	Bull
97	7-Nov-97	32	7,581.00	5,699,800	-1.3265	-1.1984	9.0057	0.8700	1.4809	-0.8092	35.9774	171.0749	-0.2498	Bear
97	10-Nov-97	59	7,552.00	4,641,400	-0.3790	-0.3424	-18.5691	-1.7938	1.8261	-0.1875	79.1948	79.1948	0.1759	Bull
97	11-Nov-97	73	7,558.00	4,356,600	0.0813	0.0734	-6.1361	-0.5927	0.5973	0.1230	82.9368	82.9368	-0.0197	Bear
97	12-Nov-97	32	7,401.00	5,853,400	-2.0825	-1.8813	34.3571	3.3189	3.8150	-0.4931	60.4531	119.5469	-1.1588	Bear
97	13-Nov-97	76	7,487.00	6,539,600	1.1679	1.0551	11.7231	1.1325	1.5478	0.6817	47.0257	132.9743	0.2122	Bull
97	14-Nov-97	48	7,572.00	6,357,600	1.1314	1.0221	-2.7830	-0.2688	1.0569	0.9671	14.7360	149.8335	-0.1115	Bear
97	17-Nov-97	22	7,698.00	5,765,400	1.6605	1.5001	-9.3148	-0.8998	1.7493	0.8576	30.9571	13.9450	-0.0284	Bear
97	18-Nov-97	82	7,650.00	5,213,800	-0.6157	-0.5562	-9.5674	-0.9242	1.0787	-0.5157	58.9579	58.9579	0.0457	Bull
97	19-Nov-97	74	7,724.00	5,427,200	0.9662	0.8728	4.0930	0.3954	0.9582	0.9109	24.3698	159.4673	0.0975	Bull
97	20-Nov-97	61	7,826.00	6,026,100	1.3187	1.1914	11.0352	1.0660	1.5987	0.7452	41.8213	176.9188	0.3011	Bull
97	21-Nov-97	07	7,881.00	6,110,000	0.6958	0.6286	1.3923	0.1345	0.6428	0.9779	12.0765	147.1740	0.0405	Bull
97	24-Nov-97	92	7,767.00	5,149,200	-1.4357	-1.2970	-15.7250	-1.5190	1.9974	-0.6493	49.5077	49.5077	0.1315	Bull
97	25-Nov-97	95	7,808.00	5,878,900	0.5282	0.4772	14.1711	1.3689	1.4497	0.3292	70.7828	109.2172	0.1529	Bull
97	26-Nov-97	78	7,794.00	4,877,500	-0.1815	-0.1639	-17.0338	-1.6455	1.6536	-0.0991	84.3107	84.3107	0.1535	Bull
97	28-Nov-97	13	7,823.00	1,890,700	0.3637	0.3286	-61.2363	-5.9154	5.9245	0.0555	86.8208	86.8208	-2.0296	Bear

Data lifted from "Dow Jones Industrial Averages, Historical Prices", *Yahoo Finance*. (<http://finance.yahoo.com/q/hp?s=DJI+Historical+Prices>)