Informazioni utili:

Sede del seminario: Collegio Universitario De Filippi
Via Brambilla, 15
21100 Varese

Lingua Ufficiale: Inglese

Quota partecipazione: Lire 150.000

La quota comprende: iscrizione
papers

Pagamento: la quota di partecipazione va versamenta sul c/c n°1231 della Banca Popolare di Brescia cod sportello n°11202 cod.banca n°05437 intestato a Giovanni Zambruno specificando "Iscrizione Seminario Prof. Malliaris"

oppure

la quota verrà versata direttamente il giorno del seminario

Il seminario è a carattere residenziale. Vi è la possibilità di pernottare presso il Collegio Universitario ed è previsto un trattamento a pensione completa in camera singola o doppia.
Per prenotazioni e informazioni si prega di telefonare alla Segreteria del Dipartimento Metodi Quantitativi Università di Brescia (Tel. 030-2988420 chiedere di Tiziana)

Programma:

Lunedì Mattino
Introduction to futures and Options Markets, The Portfolio Approach to Hedging in Futures

Martedì Mattino
Interest Rates and Stock Index Futures

Martedì Pomeriggio
Prof. Mary Malliaris Neural Networks

Mercoledì Mattino
Numerous Options Strategies will be presented and Evaluated

Giovedì Mattino
The Black-Scholes Model and its various modifications
Chaotic Dynamics in Futures Markets

Giovedì Pomeriggio
Prof. Mary Malliaris Neural Networks

Financial Applications of Neural Networks

Dr. Mary Malliaris
Dept. of Management Science
Loyola University Chicago

Dr. Linda Salchenberger
Dept. of Management Science
Loyola University Chicago

Conference on Quantitative Methods in Financial Modeling

Varese, Italy
June 23, 1994

1. Introduction

Both researchers and traders use two estimates of option volatility:

the historical volatility and the implied volatility.

The purpose of this research is to compare these two existing methods of predicting volatility for S&P 100 options with a new approach which uses neural networks .

The historical approach: tomorrow's volatility σ_{t+1} is an estimate obtained from a sample, of a given size, of past prices of the underlying asset. For a sample of n historical prices, we obtain (n-1) rates of daily return. The annualized standard deviation of these rates of return is defined as the historical volatility and can be used as an estimate of σ_{t+1}. The nearby historical volatility uses 30 days of data.

A better estimate comes from the Black-Scholes option pricing model itself. Traders solve the Black-Scholes model for the volatility that yields the observed call price. When volatility is calculated in this way, it is called the "implied volatility". This implied volatility technique has become the standard method of estimating volatility at the moment of trading.

The Black-Scholes option pricing formula

for calculating the equilibrium price

of call options is

$$C = S \cdot N(d_1) - Xe^{-rT} N(d_2)$$

Price

where d_1 and d_2 are given by

$$d_1 = \frac{\ln\left(\frac{S}{X}\right) + \left(r + \frac{\sigma^2}{2}\right) \cdot T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

where σ^2 is the variance rate of return

for the underlying asset.

Chicago Board

S&P 100 INDEX

Strike Price	Calls—Last Jan	Calls—Last Feb	Calls—Last Mar	Puts—Last Jan	Puts—Last Feb	Puts—Last Mar
230	41	....	....	....	1/16	5/16
235	....	....	....	..	1/8	1/2
240	30	30 1/2	....	1/16	1/4	5/8
245	25 3/8	....	....	1/16	3/8	1 1/16
250	20 1/2	20 7/8	....	1/16	9/16	1 9/16
255	15 1/8	16 1/8	18 3/8	1/16	15/16	2 3/16
260	10 3/8	12	14 1/2	1/8	1 3/4	3
265	5 1/2	8 1/4	11	3/8	2 7/8	4 1/2
270	1 11/16	5	7 3/4	1 11/16	4 3/4	6 1/2
275	5/16	2 5/8	5 1/8	5 1/2	7 3/4	9 1/4
280	1/16	1 1/4	3	10 3/4	11	12 1/2
285	....	9/16	1 11/16	16	....	....

The Index: High 270.59; Low 269.17; Close 269.61, +0.26.

2. Methodology

Data have been collected for the most successful options market: the S&P 100 (OEX), traded at the Chicago Board Options Exchange.

Daily closing call and put prices
the associated exercise prices closest to at-the-money
S&P 100 Index prices
call volume
put volume
call open interest
put open interest

were collected from the *Wall Street Journal* for the calendar year 1992.

We used the Black-Scholes model to calculate implied volatilities.

Comparisons were made between the nearby historical, implied and network volatility estimates.

Because the neural network must have sufficient previous data in order to generalize, these estimates were developed using each method for June 22 through December 30, 1992. Trading cycles were used as the prediction periods, with each trading cycle ending on the third Friday of the month.

Historical Volatility

Tomorrow's volatility σ_{t+1} is calculated from the past prices of the underlying asset.

For a sample of n historical prices, we obtain n-1 rates of daily return.

The annualized standard deviation of these rates of return is the historical volatility and is used as an estimate of σ_{t+1}

NETWORK INPUT VARIABLES

1. CHANGE IN CLOSING PRICE OF THE S&P 100 INDEX

2. NUMBER OF DAYS TO EXPIRATION IN THE NEARBY PERIOD

3. CHANGE IN OPEN PUT VOLUME

4. SUM OF THE STRIKE PRICE AND MARKET PRICE FOR THE CALL CLOSEST TO AT-THE-MONEY IN THE NEARBY PERIOD

5. SUM OF THE STRIKE PRICE AND MARKET PRICE FOR THE PUT CLOSEST TO AT-THE-MONEY IN THE NEARBY PERIOD

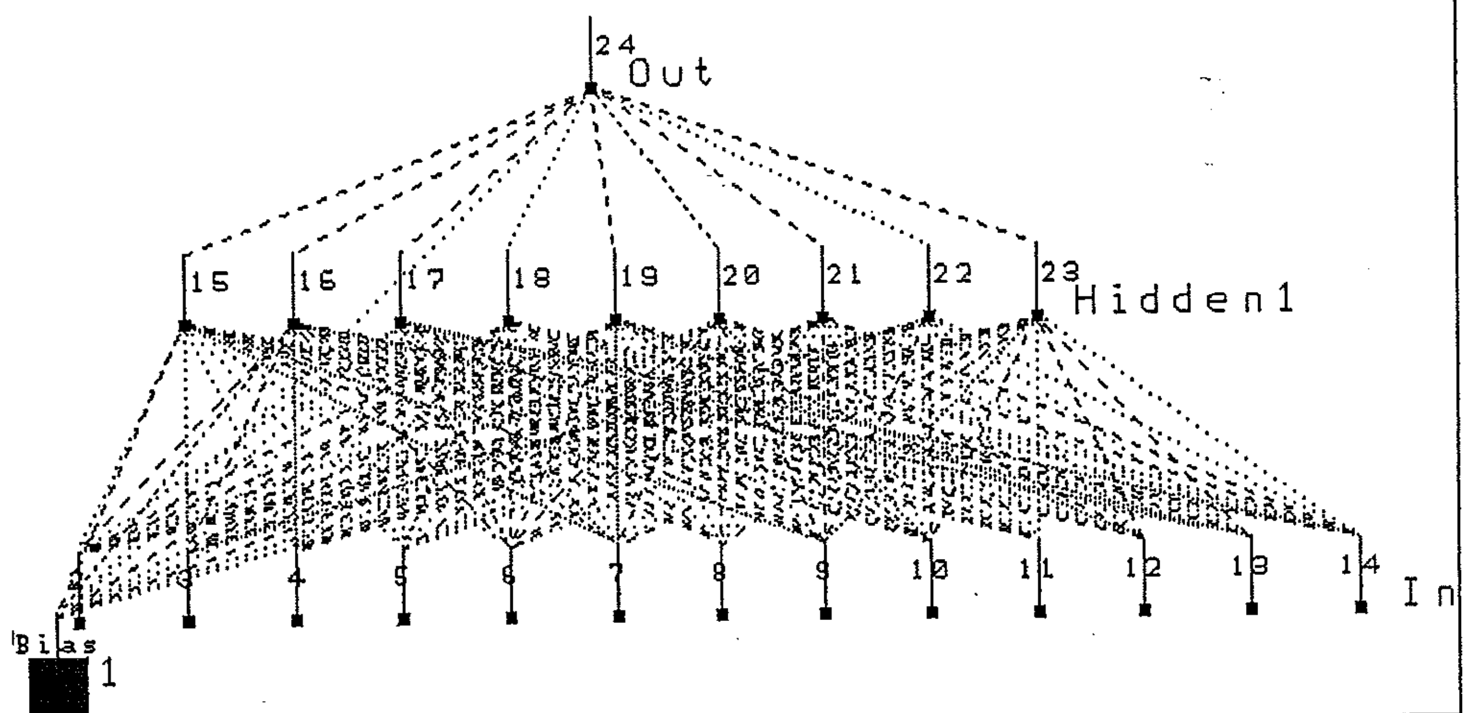
6. SUM OF THE STRIKE PRICE AND MARKET PRICE FOR THE CALL CLOSEST TO AT-THE-MONEY IN THE MIDDLE PERIOD

7. SUM OF THE STRIKE PRICE AND MARKET PRICE FOR THE PUT CLOSEST TO AT-THE-MONEY IN THE MIDDLE PERIOD

8. NEARBY CLOSING VOLATILITY

9. MIDDLE CLOSING VOLATILITY

10. - 13. FOUR LAGS OF THE NEARBY CLOSING VOLATILITY



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Results

The average MAD (mean absolute deviation) and MSE (mean squared error) between the historical and implied volatilities, for the entire forecasting period, from June 22 through Dec. 30 were 0.0331 and 0.0016.

The MAD between the network and implied volatilities for the entire period was .0116 and the MSE was .0001. Furthermore, for each forecasting period, the MAD and MSE were considerably lower.

In each of the time periods, the proportion of correct predictions of direction made by the neural network was greater than that of historical volatility.

The overall proportion of correct direction predictions was 0.794, as compared to .4439 for the historical volatility estimate.

The correlation between the implied volatility and the volatility predicted by the network is 0.85, as compared with 0.31 for the historical volatility, at the 5% level of significance.

The results are encouraging. Because historical estimates are traditionally poor predictors, traders have been forced to rely on formulas like the Black-Scholes which can be solved implicitly for the real-time volatility. But these models are difficult to use and limited since they can only provide estimates to the traders which are valid at that current time. Furthermore, they fail to incorporate knowledge of the history of volatility. The neural network model, on the other hand, employs both short-term historical data and contemporaneous variables to forecast future implied volatility.

Table 1. A Comparision of Historical and Implied Volatilities

Dates of Forecast	MAD	MSE	Proportion of Correct Directions
Jun 22-- Jul 19	.0318	.0012	8/19 = .421
Jul 20-- Aug 21	.0292	.0019	11/25 = .440
Aug 24-- Sep 18	.0406	.0018	12/18 = .667
Sep 21-- Oct 16	.0479	.0027	7/20 = .350
Oct 19-- Nov 20	.0213	.0008	14/25 = .560
Nov 23-- Dec 18	.0334	.0014	8/18 = .444
Dec 21-- Dec 30	.0294	.0009	2/6 = .333

average

.0331 .0016 .4439

Table 2. Neural Network and Implied Volatilities

Dates of Forecast	MAD	MSE	Proportion of Correct Directions
Jun 22-- Jul 19	.0148	.0003	16/19 = .842
Jul 20-- Aug 21	.0107	.0002	16/25 = .640
Aug 24-- Sep 18	.0056	.0001	13/18 = .722
Sep 21-- Oct 16	.0127	.0003	19/20 = .950
Oct 19-- Nov 20	.0059	.0001	20/25 = .800
Nov 23-- Dec 18	.0068	.0001	15/18 = .833
Dec 21-- Dec 30	.0039	.0000	5/6 = .833

Average .0116 .0001 .794

Table 3. Correlation Analysis

	Correlation	P value (5% sig. level)
Historical with Implied Volatility	0.3084	0.0003
Neural Network with Implied Volatility	0.8535	0.0000

the network was usable for a trading period & was then retrained