

The Berkeley Options Data Base  
User's Guide

The Berkeley Options Data Base  
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# 1 Introduction

The Berkeley Options Data Base (BODB) is a complete record of trading activity on the floor of the Chicago Board Options Exchange (CBOE). Derived from the CBOE's Market Data Retrieval (MDR) tapes, the database contains every bid-ask quote and every trade recorded on the floor of that exchange, time-stamped to the nearest second. The database begins on August 23, 1976 and is updated annually, usually in March or April. At the time of this printing (June 1, 1995), the database is available through December 31, 1994.

This document is intended to be a comprehensive user's guide to the Berkeley Options Data Base. It describes the database in detail, and contains valuable information on how to acquire, access, and conduct research using the database. As the database is currently designed to be accessed through a unix workstation, specific technical details are offered only for the unix platform. For use on other systems, it is necessary to find a utility that can read a unix tarfile. Alternatively, it may be possible, through special arrangement with the database manager, to acquire the data in flat ascii format. If you have any further questions about the database, or comments about this guide, please contact the database manager.

This guide is organized as follows. Section 2 describes the MDR file, which contains the raw data from which BODB is derived. It explains how the MDR file is created, how the tapes may be purchased, how the information is stored, and how the data are organized. Section 3 describes the BODB, how it may be purchased, how it is stored, and how the data are organized. Section 4 contains some historical information about the BODB, that may help you understand things you have read elsewhere about the database. It describes former BODB products that have been discontinued, such as the "consolidated format" and the "supplemental tape" and describes format changes in the "resorted" data. Section 5 is a research guide, containing pointers on how to identify ticker symbols, how stock splits are treated, and other such matters. It also describes various other data sources that may be of interest. Section 6 contains technical advice on how to read the data off the tapes and sample computer programs (in various languages) that may be used to read and manipulate the data. The appendix contains a bibliography of research papers that have employed the BODB or MDR data, a complete list of all BODB files and the calendar dates contained in each, and a list of ticker symbols.

## 2 The Market Data Retrieval File

The Market Data Retrieval (MDR) file is produced by the CBOE, and constitutes a complete record of bid-ask quotes and trades recorded on the floor of that exchange. Each record is time-stamped to the nearest second, and contains the contemporaneous price of the underlying security.

### 2.1 Availability

The entire MDR may be purchased from the CBOE, by the month, on 6250 bpi magnetic tapes. As of January, 1995, the rate was \$500 per month of data, with a 10% discount on orders of six months or more, and a 15% discount on orders of one year or more. The MDR data for S&P 100 (OEX) index options may be purchased separately at a price of \$450 for three years of data. Data for S&P 500 (SPX) index options may be purchased at the same rate. Other individual securities from the MDR may be purchased at the rate of \$100 per month for the first security and \$30 per month for each additional security.

The CBOE also offers various summary files. The "Option Summary" file contains daily high, low, and closing prices, trading volume and open interest, since October 1, 1985. One year of the Option Summary file for up to ten securities may be purchased for \$125 on 6250 bpi tapes or \$100 on floppy disk or hardcopy. The "Expanded Option Summary" file contains all the information in the Option Summary file plus the underlying stock price. One year of the Expanded Option Summary file for up to ten securities may be purchased for \$150 on 6250 bpi tapes or \$125 on floppy disk or hardcopy. The "Index Summary" file contains daily information for the various indexes on which options are traded at the CBOE, including the daily high, low, and closing index value, the change from the previous close, total trading volume on calls, total trading volume on puts, total open interest on calls, and total open interest on puts. The Index Summary file may be purchased at the rate of \$25 per index on floppy disk, in which case data are available beginning October 1, 1985, or \$15 per index hardcopy, in which case the data are available beginning March 11, 1983. The "Volume Summary" file contains a daily observations of total calls volume, total puts volume, total calls open interest, and total puts open interest for any option class trading on the CBOE. One year of data on up to ten securities may be purchased on hardcopy or floppy disk for \$75. Finally, the "Total CBOE Volume Summary" file contains daily observations of total call volume and total put volume on the CBOE. The entire file, which begins in January, 1978, may be purchased on floppy disk for \$25 or hardcopy for \$15. For ordering information, contact the CBOE data sales hotline at (312) 786-7426. To obtain information on contract specifications and ticker symbols, call the CBOE marketing department at (312) 786-7434.

## 2.2 Data Entry

The MDR contains four main types of records: trade records, quote records, cancel records, and underlying records. Quote records contain bid and ask prices, while trade records contain transaction price and volume. Cancel records, as the name indicates, cancel previous records on the same underlying contract. Trade, quote, and cancel records are all time-stamped, and contain a contemporaneous observation of the underlying stock price. Underlying records contain information about the underlying stock that is recorded on the MDR without a trade, quote, or cancel having occurred.

Some quote records are recorded on the floor of the exchange by a Quote Reporting Terminal Operator, who enters bid-ask quotes as they are shouted in the trading crowd. The reporting lag for quotes should be very short, only as long as is required for the terminal operator to enter the option identification and the quote, which should be less than five seconds. In addition, many options are now quoted through the “autoquote” system. In this case, a market maker chooses the input parameters for a Black-Scholes or Cox-Ross-Rubinstein pricing model, and bid-ask quotes are automatically updated by computer whenever the underlying stock price changes. The autoquote system has led to a large increase in the volume of data recorded on the MDR over the last few years. A large portion of the recent MDR data is made up of quotes on index options, where the underlying index is recalculated every 15 seconds, and the autoquote system continually spits out fresh quotes.

Trade records are recorded by a Price Reporting Terminal Operator. The reporting delay for trades may be considerably longer than for quotes. After a verbal agreement to a trade has been consummated between two members of the trading crowd, the seller writes up the trade on a blank ticket he is carrying, and deposits a copy of the sell ticket on a conveyor belt at the post. This process generally takes from 5 to 40 seconds, depending on the number of traders involved, how fast they write, and how far they are from the conveyor belt. When trading is particularly active, traders might hold onto these tickets for up to several minutes before depositing them on the conveyor belt. Upon receiving the ticket, the Terminal Operator immediately removes the ticket from the bin, with a single key stroke simultaneously enters the stock symbol, expiration month, and strike price, and then separately enters the number of contracts traded, the transaction price, and the identifying symbols of the buying and selling floor traders.<sup>1</sup> The computer completes the record by automatically registering the time of day and the most recent transaction price of the underlying stock. One terminal operator handles call options and another puts, at separate terminals. In special circumstances, the Terminal Operator will also enter a “transaction prefix,”

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<sup>1</sup>These identifying symbols are not included in the publicly available MDR file.

indicating, for example, that the trade is known to be part of a spread order, or is known to be out of sequence. Because trades take longer to record than quotes, great care should be taken in interpreting the time sequence reported in the MDR or Berkeley Options Data Base.

### 2.3 Storage Format

The MDR may be acquired from the CBOE on standard or non-labelled 6250 bpi magnetic tapes. The Berkeley Options Data Base receives the MDR on non-labelled tapes, on which the MDR is stored as a large fixed-length EBCDIC file, on multiple tapes, with record length 61 and blocksize 32757. Because the file is stored as a multiple-tape file, each MDR tape is crammed full of data. On a unix system, with 9-track tape drive designated /dev/rst1, the data may be transferred to hard disk using the command:

```
dd if=/dev/rst1 of=mdrdata bs=32757 cbs=61 conv=ascii
```

The **if=** option specifies the input file or device, the **of=** option specifies the output file, **bs** designates the blocksize, **conv** instructs the program to convert the data (in this case from EBCDIC to ASCII), and **cbs** (conversion buffer size) tells the program to split the file into lines as it converts it. Note that the **cbs** option only works when the **conv** option is specified. This will create a fixed-length file of around 257,000,000 bytes. This number is slightly larger than the capacity of a 9-track tape because the conversion program adds end-of-line characters.

### 2.4 Sorting Order

Within the MDR, records are sorted first by date, then by underlying security. Within each underlying security calls are listed before puts. The calls (puts) are sorted in order of expiration month, within each expiration month by strike price, and within each strike price the records are listed chronologically. In summary, records are sorted according to the scheme

DATE : UNDERLYING ASSET : CALL/PUT : EXPIRATION : STRIKE : TIME

## 2.5 Record Layout

The MDR file contains fixed-length records with the following (undelimited) fields:

Description	Field Type	Length
Trade Date	Numeric	6
Option Class	Alpha	3
Expiration Month Symbol	Alpha	1
Strike Price Symbol	Alpha	1
Trade Price Integer	Numeric	3
Trade Price Fraction	Numeric	3
Volume	Numeric	5
Bid Price Integer	Numeric	3
Bid Price Fraction	Numeric	3
Ask Price Integer	Numeric	3
Ask Price Fraction	Numeric	3
Stock Price Integer	Numeric	5
Stock Price Fraction	Numeric	1
Extra Space		1
Security Type Symbol	Numeric	1
Record ID	Numeric	2
Prefix Code	Alpha	4
Put/Call Code	Alpha	1
Expiration Month	Alpha	3
Strike Price	Alpha	3

Here are a few sample lines from the MDR file:

```

920922GPSOG142911000000000000040000040040003320102    PMAR035
920922GPSOG143914000000000000040000040120003310102    PMAR035
920922GPSOG14404900400400005000000000000003310101    PMAR035
920922GPSOH083237000000000000070120070240003330102    PMAR040
920922GPSOH083602000000000000070160070280003330102    PMAR040
920922GPSOH083651000000000000070120070240003330102    PMAR040
920922GPSOH084614000000000000070080070200003340102    PMAR040
920922GPSOH085117000000000000070120070240003350102    PMAR040
920922GPSOH085611000000000000070080070200003350102    PMAR040

```



### 2.5.1 Date and Time

These transactions were recorded on September 22, 1992. This can be ascertained from the first six characters of each line [1-6], which contain the date in the form YYMMDD.

Characters [12-17] contain the timestamp, recorded in Central standard time, in the form HH-MMSS. Thus, the third record was recorded at 2:40:49 P.M., and the fourth record was recorded at 8:32:37 A.M.

### 2.5.2 Ticker Symbol

Between the date and time are five characters [7-11] containing a ticker symbol that completely identifies the option contract. Note that only the first three of these characters appear in the Berkeley Options Data Base.

The first three letters are unique to the underlying asset. One or two of these characters may be blank. In the example above, the letters GPS signify that these are equity options on Gap Stores stock. For options on stocks traded on the New York Stock Exchange or the American Stock exchange, these three letters will generally be the same as the underlying stock market ticker symbol. For options on NASDAQ stocks, the option ticker usually contains two letters from the NASDAQ ticker (not necessarily the first two), plus the letter Q. So, for example, NASDAQ ticker symbol AAPL might become AAQ. Other ticker symbols indicate index options, LEAPS, interest rate options, or other types of options. For more details, see the section on ticker symbols, below.

The fourth letter of the ticker symbol identifies the contract type and expiration date. The letters A through L designate call options expiring in January (A) through December (L). The letters M through X represent put options expiring in January (M) through December (X). In this example, the letter O designates a March put option.

The fifth letter identifies the last two digits in the option's strike price. The letter A signifies a strike price ending in 05, B is a strike ending in 10, and so on. In the example above, the first three records are for options with a strike price ending in 35 (G), and the last six are for options with a strike price ending in 40 (H).

The five-letter ticker symbols provide a convenient way to sort the data. In fact, the MDR file is sorted, within each calendar day, according to the five-letter ticker symbol. This means that, as described above, the data are sorted by underlying firm, and within each firm the calls are separated from the puts, calls and puts are each sorted by expiration month, and within each expiration month in order of strike price. The information contained in the fourth and fifth letters of the ticker symbol is duplicated in the last seven characters of each line [55-61], where it is presented in a more intuitive format. In this case, the last seven characters are PMAR035 or PMAR040,

indicating the March 35 and March 40 puts.

### 2.5.3 Record Type and Prefix Code

Immediately to the left of these last seven characters is a six-character field [49-54] including a numeric record type, (indicating whether it is a trade, quote, cancel, or underlying record) and on occasion a four-letter “Prefix” code, indicating additional information about the record. The four record types are:

Number	Type
01	Trade
02	Quote
03	Cancel
04	Underlying

and the prefix codes are:

Code	Meaning
ROTA	Opening Rotation
ENDR	End of Opening Rotation
AUTO	Start of RAES, the Electronic Execution System
RAES	Transaction was Executed Electronically
ENDA	End of RAES
OPEN	Opening Trade, Recorded Late, Out of Sequence
OPNL	Opening Trade, Recorded Late, In Sequence
OSEQ	Recorded Late, Out of Sequence
LATE	Recorded Late, In Sequence
SPRD	Record is Part of a Combination Trade
STDL	Record is Part of a Straddle
FAST	Recorded under Fast Trading Conditions
HALT	Reopen After Trading Halt
CLOS	Closing Record
CNCO	Cancel the Opening Trade
CANC	Cancel the Last Trade, if it is not the Opening Trade
CNCL	Cancel Another Trade, not the Last or Opening Trade
CNOL	Cancel the Only Trade of the Day

In the sample above, the third record is a trade record, and the others are all quote records.

### 2.5.4 Trade Price and Contract Volume

For trade records, the transaction price is recorded at [18-23], with the integer portion of the price recorded in the first three bytes [18-20] and the fractional part, recorded in thirty-seconds of a

dollar, in the next three [21-23]. For example, in the third record in the above sample, the price is recorded as 004004, which translates to \$4 1/8. Contract volume is recorded in the field [23-28], which in this case is 00005, or 5 contracts. Both the trade price field and the contract volume field will be empty for quote records.

### **2.5.5 Bid and Ask Prices**

For quote records, the bid price is recorded in the field [29-34] and the ask price is recorded in the field [35-40]. As for trade prices, bid and ask prices are recorded as a three-digit integer followed by a three-digit fraction, denominated in thirty-seconds of a dollar. The first record in the sample above has a bid price of \$4 (004000) and ask price of \$4 1/8 (004004). The last record has a bid of \$7 1/4 (007008) and an ask of \$7 5/8 (007020). The bid and ask fields will be empty for trade records.

### **2.5.6 Underlying Asset Price**

The underlying asset price is recorded at locations [41-46]. For equity options, the integer portion of the stock price is contained in the first five bytes, and the sixth byte contains the fractional portion of the price, denominated in eighths of a dollar. Thus, the first record in the sample data above was recorded when the current stock price for Gap Stores was \$33 1/4 (000332), and the second was recorded when the underlying was at \$33 1/8 (000331). For index options, the underlying value is usually recorded with the hundreds digit left-justified in this field, so that an OEX value of 455.31 would be recorded as 451310. The MDR database is not always consistent in the way index options are recorded.

### 2.5.7 Option Type Identifier

In byte [48] of the MDR record is a number that identifies the type of underlying security, according to the following table:

Number	Security Type
1	EQTY
2	GNMA
3	TBND
4	EQTY Group
5	EQTY Index
6	INDEX
7	FCO

### 3 The Berkeley Options Data Base

The Berkeley Options Data Base (BODB) is associated with the Institute of Business and Economic Research at the University of California, Berkeley. Through a contractual arrangement with the CBOE, BODB offers a reprocessed version of the Market Data Report, beginning August 23, 1976. The database is updated annually, and is currently available through December 31, 1994. The database is managed by a graduate student in the finance group at the Haas School of Business, under the direction of professor Mark Rubinstein. At the time of this printing, (June 1, 1995) the current database manager is Stewart Mayhew. You may contact BODB via e-mail to options@haas.berkeley.edu, by phone at (510) 643-8893, by fax at (510) 642-5018, or by mail to the Berkeley Options Data Base, Institute of Business and Economic Research MC #1922, Berkeley, CA 94720-1922.

#### 3.1 Availability

The Berkeley Options Data Base is available on 8mm magnetic tapes, sometimes known as “Exabyte” tapes. For data prior to 1990, one year of data are stored on a single 8mm tape. Beginning with 1990, six months of data are stored on a single tape. To access the data, it is necessary to use the unix “tar” (tape archive) utility. In addition, at least 200 megabytes of hard disk space are required. Normally, the tapes are written using an Exabyte 8500 drive, and cannot be read by the (lower-density) Exabyte 8200 drive. However, the tapes may be written at low-density through special arrangement with the database manager. Due to the increasing volume of data, data beginning in January 1994, will be compressed using the **gzip** compression facility.

Plans are underway to also offer the database on 4mm “dat” tapes and eventually, CD ROM. Through special arrangement, the data may also be purchased through the internet via ftp. The database is no longer available on 6250 bpi 9-track tapes.

The Berkeley Options Data Base may be purchased at the rate of \$200 per month of historical data, with a minimum purchase of six months. In addition, there is a processing charge of \$80 per 8mm tape.

Customers in California must also pay sales tax. Academic institutions may acquire the data at a special rate of \$150 per month. Academic institutions qualify for a volume discount rate of \$120 per month if they have cumulatively purchased 36 months of data. BODB does not currently offer subsets of the database. If you want more than one copy of the tape, for example if one of your tapes is lost or damaged, there is a processing charge of \$80 per tape.

To purchase the data, it is necessary to sign a “subscription agreement” contract. If your

institution already has a contract on file at the BODB from a previous purchase, it is not necessary to sign another contract. To obtain a contract and order form, contact the database manager.

### 3.2 Storage Format

The BODB is stored in fixed-length ASCII files, archived in unix tarfiles on 8mm tapes. To restore a file onto hard disk on a unix system where the 8mm tape drive is designated `/dev/rst5`, place the tape in the drive, make sure there is more than 161 MB of disk space in the current partition, and issue the command

```
tar xvf /dev/rst5 filename
```

where *filename* is the name of the file you wish to restore. To list all the files on a tape, issue the command

```
tar tvf /dev/rst5
```

This might take as long as two hours. If the filenames end with a `.gz` suffix, they have been compressed, and must be uncompressed using the publicly available program **gunzip**.

Prior to December, 1993, the filenames on the tape are of the form `resXXX`, and are the same as the names of the 6250 bpi tapes on which the data were previously stored. The first file (from 1976) is `res01`, the December, 1993 file is `res227`, and the file numbers in between are consecutive. The only anomalies are the files for August, September, and October, 1987 (the first three months that originally required more than one 6250 bpi tape), which are named `res98A` and `res98B`, `res99A` and `res99B`, `res100A` and `res100B`. For a complete listing of filenames, see Appendix B. Beginning in January, 1994, filenames are of the form `resYYXXX`, so the first file in 1994 is `res94001`, and the last is `res94046`.

### 3.3 Sorting Order

The Berkeley Options Data Base is currently available only in the “resorted” format. It is called the resorted format because it is little more than a resorted version of the MDR. The processing program alters certain fields of the MDR records to make them easier to interpret, performs a few screens for bad or duplicate records, and changes the sorting order. While the MDR is sorted according to five-letter ticker symbol, BODB is sorted according to three-letter ticker symbol. This means that in the BODB, all the day’s records on the same underlying stock are ordered chronologically, regardless of expiration or strike, unlike the MDR, where records are further sorted by option contract. In summary, the BODB is sorted according to the scheme

DATE : UNDERLYING ASSET : TIME

Beginning in January, 1994, records occurring in the same second are further sorted according to record type and option contract. The new sorting scheme is: DATE : UNDERLYING ASSET : TIME : RECORD TYPE : EXPIRATION : PUT/CALL : STRIKE

### 3.4 Record Layout

The resorted data are contained in a fixed-length file with the following (undelimited) fields:

Description	Field Type	Length
Record Type	Numeric	2
Ticker Symbol	Alpha	3
Date	Numeric	6
Time	Numeric	6
Expiration Month	Numeric	2
Strike Price	Numeric	6
Bid Price or Trade Price	Numeric	5
Ask Price or Volume	Numeric	5
Underlying Asset Price	Numeric	5

Here are a few sample records from the Berkeley Options Data Base:

```
43IBM930104084001 1-08500033500337505140
2IBM930104084014 2 04500007500080005140
1IBM930104084021 1-05500003880000305140
2IBM930104084021 2-04500001250013105140
2IBM930104084034 2 05000004000042505140
1IBM930104084038 2 05000004000000405140
2IBM930104084040 2-05000002880031305140
1IBM930104084044 1 05500000630004105140
2IBM930104084052 2 05500001750018105140
1IBM930104084053 1 05500000630001005140
```



### 3.4.1 Record Type

The first field [1-2] determines whether the record is a trade or a quote, and also incorporates the information in the MDR prefix code. The MDR data type and prefix codes are translated into BODB record types according to the following table:

MDR Code	BODB Record Type
04HALT	0
01	1
02	2
01SPRD	3
01STDL	4
02HALT	5
01LATE	6
01OSEQ	7
01OPEN	8
01OPNL	9
03LATE	20
03OSEQ	21
03OPEN	22
03SPRD	23
03STDL	24
03CNCO	25
03CNCL	26
03CANC	27
03CNOL	28
03OPNL	29
04AUTO	40
01RAES	41
04END	42
02ROTA	43
04ROTA	44
04ENDR	45
02AUTO	46
04END	47
04ENDF	48
04FAST	60
01FAST	61
02FAST	62
01CLOS	63
02CLOS	64
04CLOS	65
03REOP	66
02ZZZZ	67

### **3.4.2 Ticker Symbol**

In the Berkeley Options Data Base, the underlying ticker symbol, which is located in field [3-5], is copied directly from the first three characters of the MDR ticker symbol. As mentioned above, this ticker usually corresponds to the stock exchange ticker symbol for NYSE and AMEX stocks, but not for NASDAQ stocks. More details on ticker symbols are given in the “Research Guide” section of this document, and a list of CBOE ticker symbols is contained in Appendix C.

### **3.4.3 Date and Time**

The BODB date and time fields are copied exactly from the corresponding fields in the MDR. Thus, the date and time, recorded in characters [6-17], are given in the form YYMMDDHHMMSS.

### **3.4.4 Expiration Month**

Instead of using the CBOE’s alphabetic expiration codes, the Berkeley Options Data Base reports the expiration month in numeric form in characters [18-19]. The records in the above sample are all for options expiring in January ([space]1) or February ([space]2). Details on how to determine exact expiration dates is contained in the “research guide” section below.

### **3.4.5 Strike Price and Call/Put Indicator**

The BODB contains the strike price, denominated in cents, in location [21-25]. Puts are indicated by a negative sign in location [20]. Thus, the first record above is for a (January) 85 put, and the last record is for a (January 55 call).

### 3.4.6 Trade Prices, Contract Volume, Bid and Ask Prices

Because the MDR trade fields are always empty for quote records, and its quote fields are empty for trade records, the BODB is able to save space by recording both fields in the same location. For trade records, the price is recorded at [26-30] and contract volume is recorded at [31-35]. For quote records, the bid price is recorded at [26-30] and the ask price is recorded at [31-35]. Instead of recording prices in thirty-seconds of a dollar, the BODB converts the fractional portion of the MDR bid, ask, and transaction prices to pennies, rounding off according to the following rule:

Thirty-Seconds	Cents
001	03
002	06
003	09
004	13
005	16
006	19
007	22
008	25
009	28
010	31
011	34
012	38
013	41
014	44
015	47
016	50
017	53
018	56
019	59
020	63
021	66
022	69
023	72
024	75
025	78
026	81
027	84
028	88
029	91
030	94
031	97
000	00

The second record in the above sample is a quote record on a February 45 call, with bid price of \$7 1/2 (00750) and ask price of \$8 (00800). The third is a trade record on a January 55 put, where at a price of 3 7/8 (00388), three contracts (00003) were traded.

### **3.4.7 Underlying Asset Price**

For most ticker symbols, the Berkeley Options Data Base contains an exact copy of the last four digits of the MDR's underlying price field, plus an additional zero as a place-holder. Thus, the price of IBM in the above records was \$51 1/2 (05140). You may notice that some of the previous BODB documentation describes this field as being recorded in dollars and cents. This is no longer correct—beginning with the January, 1986 data, the field is recorded in dollars and eighths for equity options.

For index options such as the OEX and SPX series, the BODB contains an exact copy of the first five digits of the MDR's underlying price field, so that an OEX value of 455.31 would be recorded as 45531. Not all underlying values for index options are recorded correctly in release 2.01 of BODB (January 1986–December 1993). In some cases, such as the SPZ overflow ticker, the version 2.01 processing program mistakenly treated the MDR record as an equity option. Consequently, the BODB contains only the last three digits of the underlying price. An SPZ value of 415.65, for example, was mistakenly recorded as 56500. This problem has been corrected in the new version 3.0 program, so data beginning in January, 1994 are fine.

## **4 Historical Information**

A brief account of the origin of the Berkeley Options Data Base is described in a paper by Rubinstein and Vijh (see the Bibliography, below). The Berkeley Options Data Base was created by Mark Rubinstein and others at the University of California, Berkeley, in cooperation with the Chicago Board Options Exchange, and with a grant from the National Science Foundation. Several other individuals have helped create, develop, or maintain BODB over the years, including Anand Vijh, Mihir Bhattacharaya, Mark Garman, Robert Geske, Rachid Laraqui, Frederic Sipiery, Richard Lindsay, Gail Belonsky, Rakesh Chandra, and Stewart Mayhew. The Berkeley Options Data Base operates under the auspices of the Institute for Business and Economic Research at the University of California, Berkeley.

### **4.1 Versions**

As changes occur in the MDR tapes, or as errors are discovered in the data, new versions of the BODB are sometimes released. BODB does not guarantee the accuracy of the data, and has no

responsibility to replace old data when a new version is released. However, under our current policy we will replace data for anyone who has purchased our data, at any time, and for any reason. The replacement charge is \$80 per 8mm tape. Unfortunately, we can no longer sent replacement data on 9-track tapes.

Version numbers for the BODB correspond to the processing program used to convert MDR data to BODB format. It is costly and difficult for us to go back and process old MDR data with a new processing program. Consequently, different periods of the database were processed using different programs, and there are slight format differences. The current processing program, version 3.0 is written in PERL and runs under a sunOS implementation of unix system V release 4. Currently, the version 3.0 release begins in January, 1994. Unlike previous versions, version 3 does not alter record types to indicate an underlying stock split.

Moving to the unix platform involved a lot of new programming, and we are still debugging the processing program. We are aware of one error in version 3.0: there are a few extra unidentified control records in the MDR data, which should have been discarded but were included in the BODB with no record type or with type 4. These records contain no useful information and should be disregarded. If you find any other problems with the data, please contact the database manager.

The processing program for Version 2.1, which is the current release from January 1986 through December 1993, was written in FORTRAN and REXX, and operated under VM/CMS. This and previous versions altered the record type for options whose specifications had been modified because of an underlying stock split. The procedure for affecting this modification was imperfect, however, and not all splits were correctly specified. Rather than continuing to provide faulty split information, we elected to discontinue this practice. To obtain correct information on stock splits, you must contact the exchange and obtain the memo corresponding to the split. For more information, see the section on stock splits, below. Another problem with version 2.1 was its incorrect treatment of underlying prices for index options, descibed in the "underlying asset" section above. Plans are underway to reprocess this data under version 3.

Version 2.0, which covers December 1979 through December 1985, differs from version 2.1 in that (1) the unused portion of each numeric field is filled with blank spaces instead of zeros, and (2) underlying stock prices are recorded in dollars and cents instead of dollars and eighths. Starting September 30, 1985, the market began opening at 8:30 instead of 9:00. In version 2.0, time stamps for the first half hour of trading were incorrect: transactions occuring X seconds before 9:00 A.M. were mistakenly recorded as having occurred X seconds after 9:00 A.M. This problem only exists from September 30, 1985 through December 31, 1985.

Version 1, which covers August, 1976 through November, 1979, has a slightly different format,

with one fewer character in the strike price and underlying asset fields.

## **4.2 The Consolidated Format**

Until 1987, BODB offered a condensed version of the MDR file, called the consolidated format. Instead of reporting each individual record, this format summarized all trades and quotes occurring within each block of time during which the underlying asset price did not change. Each record contained the date, ticker, strike price, and time to expiration, a beginning and ending time, the underlying stock price, high and low quoted prices, a summary of all trades during the period, information on the stock prices preceding and following the record and the approximate elapsed time between these price changes, and the number of original transaction records from which the consolidated record was created. The consolidated format was discontinued due to lack of interest. All the information in the consolidated format may be derived from the resorted format.

## **4.3 The Supplemental Tape**

BODB formerly offered a “supplemental” tape which included several daily interest rate series, dividend information on all CBOE underlying stocks, and daily closing levels of stock market indexes. This service was discontinued due to high maintenance costs. Dividend information is available from CRSP. Interest rates may be obtained from the Wall Street Journal, or else implied interest rates may be calculated from the prices of S&P 500 index options using the put-call parity relationship. Daily index information may be purchased from the CBOE.

# **5 Research Guide**

## **5.1 Why Use Transactions Data?**

Transactions data is ideal for empirically testing market-microstructure models, and extremely useful for any type of research investigating bid-ask spreads, order flow, trading volume, price discovery and the lead-lag relationship between options and their underlying stocks, price discreteness, or intraday dynamics. It is also very useful in more traditional asset pricing, in that it can be used to measure the biases introduced by microstructural frictions.

In options markets, it is particularly important to recognize the severe problems associated with asynchronous data. Since option prices are so sensitive to the underlying asset price, unobserved intraday movements in the underlying price will render asynchronously recorded closing prices incomparable. In fact, it is not uncommon to observe apparent static arbitrage opportunities among reported closing prices. Results of studies based on closing option prices without correcting

for changes in the contemporaneous stock price are often viewed as highly suspicious, and are unlikely to be accepted for publication. Thus, if your research calls for daily observations of option prices, it is strongly recommended that you carefully construct your daily observations from transactions data.

## **5.2 Ticker Symbols**

Appendix C of this document contains information to help match options to their underlying security. However, the list is constantly changing, and you may wish to update it yourself. This section describes how to obtain information on ticker symbols, and describes conventions used by the exchanges in choosing ticker symbols.

### **5.2.1 Obtaining Ticker Symbol Information**

The best way to identify option ticker symbols is to contact the options clearing corporation and obtain their pamphlet “Directory of Exchange Listed Options.” This pamphlet contains the ticker symbols for options traded on the CBOE, as well as those trading on the New York, American, Philadelphia, and Pacific stock exchanges. The pamphlet may also be obtained through the CBOE, and is also available, for a fee, in electronic form.

One drawback is that this pamphlet contains only currently traded options. For historical research, there is another list, available from the CBOE, that contains listing and delisting dates of equity options, along with some name change information that can be helpful for identifying tickers. Appendix C contains a subset of this list, containing only ticker symbols, listing and delisting dates, and company names for options trading on the CBOE. Appendix C also contains lists of ticker symbols for other options trading on the CBOE, including index options, index LEAPS, interest rate options, and equity LEAPS.

### **5.2.2 Ticker Symbol Conventions**

The New York and American Stock Exchanges use three-letter ticker symbols to identify securities. Options on stocks traded on these exchanges generally use the same three-letter symbol. NASDAQ ticker symbols are longer than three letters, and for these stocks, options are traded using a ticker symbol consisting of two letters from the NASDAQ ticker plus the letter Q.

Index options are normally given a three letter ticker symbol ending in X, with the first two letters chosen to describe the underlying security. For instance, the ticker symbol for the S&P 500 index is SPX, And the ticker symbol for the S&P 100 index, originally known as the CBOE 100 index, is OEX.

Because options are traded using a single letter to designate the option's strike price, there is a limit to the number of different strike prices that may be assigned to a single ticker symbol. For the most popular option contracts, such as the SPX and OEX indexes, it became necessary to assign a second ticker symbol to accommodate the wide range of strike prices. Secondary ticker symbols are usually created by changing the last letter of the ticker symbol to Z. Ticker SPZ serves as the overflow symbol for SPX, and OEZ is the overflow for OEX. Sometimes, additional option classes are added that are similar to an existing class, and these are assigned ticker symbols that are as descriptive as possible. For example, options on the SPX index that expire at the end of each quarter rather than the customary dates were given the ticker symbol SPQ.

Options with long-term expiration dates, known as LEAPS, are also assigned their own ticker symbols, which resemble the original tickers. LEAPS are traded with one expiration date per year, either in December or January depending on whether they are Equity or Index LEAPS. Generally a letter is chosen to designate all LEAPS expiring in the same year, such as "V" for 1995 or "L" for 1996, and each LEAPS ticker symbol is created, if possible, by substituting this letter for one of the letters in the original ticker. For example, the IBM 1995 LEAPS are traded under the ticker symbol VIB, and IBM 1996 LEAPS under the symbol LIB. Sometimes the letters have to be twisted around to avoid duplicating another ticker symbol. Ticker symbols for some Index and Equity LEAPS are listed in Appendix C. You may wish to contact the exchange for a more current list.

### **5.3 Stock Splits**

Another reason for introducing new ticker symbols is to differentiate between options on pre- and post-split shares. Because exchange-traded options are protected against splits, the terms of the existing option contracts must be adjusted whenever a stock splits. A call option contract with a strike price of 80 gives its owner the right to buy 100 shares of the underlying stock for 80 dollars a share. If the stock then splits 2-1, the contract is adjusted so that the owner now holds a call on 200 shares with a strike price of 40. After the split, however, new options will also be written with a strike price of 40, but the newly-written options are on 100 shares. Under the standard ticker-symbol nomenclature, traders would be unable to distinguish between options written on 200 shares and those written on 100 shares. To solve this problem, the exchange introduces a secondary ticker symbol whenever there is a stock split. The split-adjusted options are assigned a new ticker symbol, usually constructed from two letters of the original ticker symbol plus the letter Z. If IBM were to split, the old options might begin trading under the ticker symbol IBZ, and newly-written options will trade under the usual ticker symbol. In addition, traders must



remember that the strike prices on the old options will be spaced at unconventional strike-price intervals. After a 2-for-1 split, the old options will trade at two-and-a-half dollar increments. To avoid confusion, the exchange prepares a special memorandum whenever a stock splits, specifying exactly the 5-letter trading code for each old option, and each new option.

#### 5.4 Option Expiration

Nearly all options expire on the Saturday following the third Friday of the expiration month. One exception are the S&P 500 end-of-quarter options (SPQ). Equity options are listed for the nearest two exercise dates, plus the next two expiration dates in the option's expiration "cycle."

Cycle	Expiration Months
January	JAN, APR, JUL, OCT
February	FEB, MAY, AUG, NOV
March	MAR, JUN, SEP, DEC

For example, at the beginning of April, a January-cycle stock will have options expiring in April, May, July, and October, a February-cycle stock will have options expiring in April, May, August, and November, and a March-cycle stock will have options expiring in April, May, Jun, and September. On the Saturday following the third Friday of April, the April options expire, and a new set of contracts is introduced (June contracts are opened for January-cycle and February-cycle stocks, and December contracts are opened for March-cycle stocks).

Some index options, such as SPX, are assigned to expiration cycles like equity options. Others, such as the OEX, are always traded for the closest four expiration dates. In addition, long-term options with maturities of up to three years are traded on popular securities. A list of index and equity LEAPS is contained in Appendix C. These options expire once a year, in December or January.

#### 5.5 Other Data Sources

Organized exchanges are usually required to keep a permanent record of all their transactions. Many of these exchanges have made their transactions data available to the public, or at least to academics for research purposes. In general, the only way to acquire this data is directly from the exchange, usually on 9-track tapes.

### **5.5.1 Stock Market Transactions Data**

Prior to January, 1993, transactions data for stocks traded in the United States were available on 9-track magnetic tapes from the Institute for the Study of Securities Markets (ISSM). Beginning in January 1993, the New York Stock Exchange instituted the "Trades And Quotes" (TAQ) database, containing trades and quotes for all stocks on the New York and American Stock Exchanges, as well as the Regional exchanges and NASDAQ. The TAQ database comes on PC-readable CD-ROM, with built-in access programs that run under DOS. The FORTRAN source code is included for these access programs. The data may be purchased from the New York Stock Exchange for \$200/month, with each month stored on a separate CD.

In addition to the TAQ, the New York Stock Exchange has more extensive databases which are not currently available to the public, but which are often used by researchers at the exchange. A small sample of this data, known as TORQ for "Trades, Orders, Reports, and Quotes," was publicly released on a single CD-ROM. This CD contains a few months of data for a small number of firms. In addition to the trade and quote data available on TAQ, this database contains the so-called "audit trail" data, a rich source of information about the institutional structure of order flow in the stock market.

### **5.5.2 Options on Futures**

Options on futures are traded primarily at the Chicago Mercantile Exchange and the Chicago Board of Trade. Transactions data may be obtained from these exchanges on 9-track tapes. Especially of interest are their options on S&P index futures, bond futures, Eurodollar futures, and currency futures.

### **5.5.3 Currency Options**

The Berkeley Options Data Base contains some data on currency options, which were traded on the CBOE during part of 1985 and 1986. European-style options were traded on the Japanese Yen, Deutchemark, British Pound, Swiss Franc, and Canadian Dollar. Due to the low trading volume on these contracts, the CBOE sold them to the Philadelphia Stock Exchange (PHLX), where they are still traded. American-style currency options are also traded at the PHLX. For a charge of \$75, academic researchers may purchase either a daily summary database on 30 floppy disks or a transactions database on one 9-track magnetic tape. The transactions database begins in 1984, and contains only trades, not quotes. The PHLX stores their quote data on microfiche, and it is inaccessible for technical reasons.

#### 5.5.4 How to Contact the Exchanges

American Stock Exchange

Derivative Securities

86 Trinity Place

New York, NY 10006

1-800-THE-AMEX

Chicago Board Options Exchange

LaSalle at Van Buren

Chicago, IL 60605

1-800-OPTIONS

(312) 786-5600

New York Stock Exchange

Options and Index Products

11 Wall Street

New York, NY 10005

1-800-692-6973

(212) 656-8533

The Options Clearing Corporation

440 South LaSalle Street

Suite 2400

Chicago, IL 60605

1-800-537-4258

(312) 322-6200

Pacific Stock Exchange

Options Marketing

115 Sansome Street, 7th Floor

San Francisco, CA 94104

1-800-TALK-PSE

(415) 393-4028

Philadelphia Stock Exchange  
1900 Market Street  
Philadelphia, PA 19103  
1-800-THE-PHLX  
(215) 496-5404

Chicago Board of Trade Market Data Services [Larsenia R. Williams] 141 W. Jackson, Ste.  
2313 Chicago, IL 60604-2994. (312) 341-3163

Chicago Mercantile Exchange Records Management [André Gibson] 30 South Wacker Drive  
Chicago, IL 60606-7499 (312) 930-3178

## 6 Computer Programs

### 6.1 Extracting a List of Ticker Symbols

If you are using a unix system, it is very easy to extract a list of ticker symbols contained in a BODB file. To create a new file ticklist from BODB file res227, containing an alphabetical list of all ticker symbols in that file, simply type the following at the unix command line:

```
cut -c 3-5 res227 | sort -u -o ticklist &
```

This command “cuts” out columns 3 through 5 from the file res227, and sends the result to a sorting program. The -u option instructs the sorting program to throw away duplicate observations, and -o ticklist specifies the name of the output file. The asterisk makes the program run in the background. You could use the same type of command to extract a list of record types [1-2], expiration dates [18-19], strike prices [20-25], or any other field in the data.

### 6.2 Extracting Columns

Suppose you are not interested in all the data fields, but only wish to extract a few fields. You can accomplish this from the unix command line using the **cut** and **paste** utilities. For example, suppose that you only want the ticker symbol, date, time, and stock price. Because the ticker, date, and time are adjacent, you can cut them out and place them in a separate file with a single command,

```
cut -c 3-17 res227 > firsthalf
```

then cut out the stock prices with a similar command,

```
cut -c 35-40 res227 > secondhalf
```

and glue them back together in a single file:

```
paste firsthalf secondhalf > outfile
```

### 6.3 Extracting Records

The simplest way to extract records from a BODB file is using a computer program that reads the file one line at a time, checks to see whether the line meets the selection criteria, and if so, writes the line to an output file. Simple jobs, such as extracting all records for a single ticker symbol, can easily be handled using built-in unix utilities such as **grep**. For example, to extract all OEX records from BODB file res193 and place them in a new file called oex193, simply type

```
grep OEX res193 > oex193
```

at the unix command line. When extracting one- or two-letter ticker symbols using **grep**, you may accidentally extract unwanted symbols. For example, if you were to try **grep T res193**, you would not only extract ticker symbol T but also every other ticker symbol containing the letter T. To get around this problem, you must tell the **grep** program to look for the string T preceded by a number from 0 to 9 and followed by a space. How you specify this may depend on the syntax for regular expressions in your unix shell. In the **sh** shell, issue the command

```
grep [0-9]T[ ] > t193
```

The **grep** command is limited to string comparison, and is adequate only for the simplest extraction problems. For more complicated extraction criteria, you may wish consider using a unix programming language such as **sed**, **awk**, or **perl**, an SQL or other database package, or a compiled language such as FORTRAN or C.

Following is a template extraction program in C. The program takes, as input from the command line, an input file name, a starting record number, and an ending record number. It reads the designated records from the input file, and outputs them to standard output. You may insert whatever selection criteria you wish, setting the variable `keepdummy=1` if you wish to output the record. To read the entire input file, you may either modify the program or run the program with beginning record number 1 and an ending record number larger than the number of records in the file.

```

/*      Extractor
C Program to Extract Records from the Berkeley Options Data Base
Copyright (C) Stewart Mayhew, March 1995.  */

#include <string.h>
#include <stdlib.h>
#include <stdio.h>

/* Main Function Begins Here  */

main (int argc, char **argv)
{
char    buf[256];
FILE    *fp;
char    record[60];
long    date,thisdate=0,count,ibegin=1,iend;
long    offsetnum, numrecs, beginp, endp;
int     keepdummy;

/*      Check for proper input      */

if (argc != 4) {
printf("usage: %s <input file> <first record> <last record>\n"
, argv[0]);
exit(0);
}
if ((fp = fopen(argv[1], "r")) == NULL) {
printf("Can't Find file %s\n",argv[1]);
exit(0);
}

beginp=atol(argv[2]);
endp=atol(argv[3]);
offsetnum=(beginp-1)*41;

```

```

fseek(fp,offsetnum,SEEK_SET);
numrecs=endp-beginp+1;

/*  Loop Begins Here  */

for (count=1;count<=numrecs;count++) {
if (fgets(buf,256,fp)==NULL)
exit(0);
keepdummy=0;

/*  Read Record  */

sscanf(buf, "%41c",
record);
record[41]='\0';

/*  .....Insert Search Criteria Here.....

Set keepdummy=1 to output the record  */

/*  Write Record to Standard Output  */

if (keepdummy) printf("%s",record);

}  /* End of Loop through records  */

fclose (fp);
return(0);
}

```



## 6.4 Creating an Index File

Both `grep` and the Extractor template program will tend to be slow, because they have to read each record sequentially. A single BODB file may contain up to 4 million records, and since you will probably be running the program multiple times on different files, it may take quite a long time to extract all the data you need. In the long run, you can save a lot of time by creating an index that stores information about where the different ticker symbols are located within the file. You will have to read the data sequentially to create the index file, but once created it will dramatically decrease extraction time.

Following is a program that reads a BODB file and writes an index to standard output. The index is simply a list of beginning and ending record numbers for each date/ticker symbol combination.

```

/*      MakeIndex

C Program to create an index for a BODB file
Copyright (C) Stewart Mayhew, March 1995      */

#include <string.h>
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

/* Main Function Begins Here */

main (int argc, char **argv)
{
char    buf[256];
FILE    *fp;
char    rtype[10];
char    ticker[10];
char    thisticker[10];
char    datebuf[10];
long    date,thisdate=0,count,ibegin=1,iend;

/*      Check for proper input      */

if (argc != 2) {
printf("usage: %s <input file> \n", argv[0]);
exit(0);
}
if ((fp = fopen(argv[1], "r")) == NULL) {
printf("Can't Find file %s\n",argv[1]);
exit(0);
}

/*      Loop Begins Here      */

```

```

for (count=1;;count++) {
if (fgets(buf,256,fp)==NULL)
break;

/* Read Record */

sscanf(buf, "%2c%3c%6c",
rtype, ticker, datebuf);
rtype[2]='\0';
ticker[3]='\0';
datebuf[6]='\0';
date=atol(datebuf);

/*      Check to see if there is a new ticker. If so, output index info. */

if ((strcmp(ticker,thisticker)!=0) || (date != thisdate)) {
iend=count-1;
if (iend>0)
printf("%ld %s %ld %ld\n",thisdate,thisticker,ibegin,iend);
ibegin=count;
strcpy(thisticker,ticker);
thisdate=date;
}
} /* End of Loop through records */

if (count>=1) {
iend=count-1;
if (iend>0)
printf("%ld %s %ld %ld\n",thisdate,thisticker,ibegin,iend);
}
fclose (fp);
return(0);
}

```

## 6.5 Using the Index File to Extract Data

This section contains a unix shell program and a modified version of the template Extractor program, that together with an index file, may be used to extract data from the Berkeley Options Data Base. The shellscript reads in a list of ticker symbols from the file “bodbread.in” and a list of BODB filenames from the file “bodbread.files.” For each BODB file resXXX, it assumes there exists an index file “index.resXXX,” created by the program MakeIndex above. For each file named in bodbread.files, the shellscript creates a temporary extraction file called “templist” by grepping the appropriate lines out of the index file. Then, it calls the C program “IndexExtractor,” which extracts the specified records from the BODB file.

To extract data, modify the IndexExtractor program as you wish, compile the code using an ANSI-C compiler, create the input files bodbread.in and bodbread.data, then run the shell script:

```
#!/bin/sh
XX='cat bodbread.in'
YY='cat bodbread.files'
for Y in $YY
do
for X in $XX
do
egrep [\ ]$X[\ ] index.$YY | cut -c 12-26 >>templist
done
IndexExtractor $YY templist > bodbread.out
rm templist
done
```

Here is the code for the Extraction Program:

```
/*  IndexExtractor

      C Program to Extract Data from an indexed BODB file
      Copyright (C) Stewart Mayhew, March 1995.

#include <string.h>
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

/* Main Function Begins Here  */

main (int argc, char **argv)
{
char    buf[256];
char    buftix[256];
FILE    *fp;
FILE    *fp2;
char    record[60];
long    date,thisdate=0,count,ibegin=1,iend;
long    offsetnum, numrecs, beginp, endp;
int     loop;

/*      Check for proper input      */

if (argc != 3) {
printf("usage: %s <datafile> <extractionfile>\n"
, argv[0]);
exit(0);
}
if ((fp = fopen(argv[1], "r")) == NULL) {
printf("Can't find data file %s\n",argv[1]);
```

```

exit(0);
}
if ((fp2 = fopen(argv[2], "r")) == NULL) {
printf("Can't find extraction file %s\n",argv[2]);
exit(0);
}

for (loop=1;;loop++) {

if (fgets(buftix,256,fp2)==NULL) exit(0);
sscanf(buftix, "%ld %ld", &beginp, &endp);
offsetnum=(beginp-1)*41;

fseek(fp,offsetnum,SEEK_SET);
numrecs=endp-beginp+1;

/* Inner Loop Begins Here */

for (count=1;count<=numrecs;count++) {
if (fgets(buf,256,fp)==NULL)
exit(0);

/* Read Record */

sscanf(buf, "%41c%",record);
record[41]='\0';
printf("%s",record);

} /* End of Loop through records */
}
fclose (fp);
fclose (fp2);
return(0);
}

```

## 6.6 Economizing Storage Space

You can decrease the amount of space required to store BODB files by a factor of about 8:1 using a simple compression program. The unix **compress** program will work fine for this purpose, but we recommend using **gzip**, which is nearly as universal as **compress** but uses a more efficient compression algorithm.

In addition, you can reduce storage space by reducing the amount of redundant information in the database. For example, each record contains the date and ticker symbol. If you use the indexing program suggested above, dates and ticker symbols can be recovered from the index file, so you can remove nine characters [3-11] from each record, reducing storage size by 1/4.

If you resort the data by option series, you can modify the index program to create one entry for each series. This will greatly increase the size of the index file, but will save you another eight characters per record. In the vast majority of cases, the last two digits in the strike price field are "00". Exceptions are for options on low-priced stocks with strikes separated by \$2.50, and options on stocks which have recently split. If you are storing a subset of data that only contains even-dollar-incremented strike prices, you can remove these two characters. If you are storing only equity options, you can remove character [40], which is always zero. If you try hard enough you should be able to reduce a 150 megabyte BODB file to about 10 megabytes. Please be sure to carefully document all formatting changes you make, and be sure never to disturb the data on the original tapes.

## A Bibliography of Papers Using Options Transaction Data

A large number of published articles and working papers have used BODB or MDR data to study securities pricing, market microstructure, and other similar topics. Here is a partial list of these many papers. [This section of the user's guide is still under construction.]

Aggarwal, Raj and Edward Gruca, "Intraday Trading Patterns in the Equity Options Markets," *Journal of Financial Research* v14 n4 (Winter 1993): 285-297.

*Examines intraday patterns in Volume, proportion of small trades, proportion of transactions on upticks, quoted price levels, and bid-ask spreads in the options market.*

Data: BODB (Jul-Dec, 1986)

Ancel, Esther Weinstock and Ramash K. S. Rao, "Stock Returns and Option Prices: An Exploratory Study," *Journal of Financial Research* v13 n3 (Fall 1990): 173-185.

*Uses Options Data to back out implied parameters of an option pricing model*

Data: BODB (Feb-Jul, 1979)

Bhattacharya, Mihir, "Empirical Properties of the Black-Scholes option-pricing Formula Under Ideal Conditions," *Journal of Financial and Quantitative Analysis* v15 n5 (Dec 1980): 1081-1105.

*Uses stock returns data on CBOE traded options to test whether the discretely-rebalanced Black-Scholes hedging strategy truly replicates the option*

Bhattacharya, Mihir, "Transactions Data Tests of Efficiency of the Chicago Board Options Exchange," *Journal of Financial Economics* v12 (1983): 161-185.

*Uses transactions data to test the arbitrage boundary conditions imposed by rational option pricing and the uniformity of implied volatilities across options imposed by the Black-Scholes model*

Data: BODB (Aug 1976-Jun 1977)

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Data: BODB (Jan 1986-Sep 1987)

## B List of BODB Files

Filename	Dates
res01	760823-761119
res02	761122-770218
res03	770222-770520
res04	770523-770819
res05	770822-771021
res06	771024-771230
res07	Jan-Feb 1978
res08	Mar-Apr 1978
res09	May-Jun 1978
res10	Jul-Aug 1978
res11	Sep-Dec 1978
res12	Jan-Mar 1979
res13	Apr-Jul 1979
res14	Aug-Sep 1979
res15	Oct-Nov 1979
res16	Dec 1979
res17	Jan-Feb 1980
res18	Mar-Apr 1980
res19	May-Jun 1980
res20	Jul-Aug 1980
res21	Sep 1980
res22	Oct 1980
res23	Nov-Dec 1980
res24	Jan-Feb 1981
res25	Mar 1981
res26	Apr 1981
res27	May 1981
res28	Jun 1981
res29	Jul 1981
res30	Aug 1981
res31	Oct 1981
res32	Nov 1981
res33	Dec 1981
res34	Jan 1982
res35	Feb 1982
res36	Mar 1982
res37	Apr 1982
res38	May 1982
res39	Jun 1982
res40	Jul 1982

Filename	Dates
res41	Aug 1982
res42	Sep 1982
res43	Oct 1982
res44	Nov 1982
res45	Dec 1982
res46	Jan 1983
res47	Feb 1983
res48	Mar 1983
res49	Apr 1983
res50	May 1983
res51	Jun 1983
res52	Jul 1983
res53	Aug 1983
res54	Sep 1983
res55	Oct 1983
res56	Nov 1983
res57	Dec 1983
res58	Jan 1984
res59	Feb 1984
res60	Mar 1984
res61	Apr 1984
res62	May 1984
res63	Jun 1984
res64	Jul 1984
res65	Aug 1984
res66	Sep 1984
res67	Oct 1984
res68	Nov-Dec 1984
res69	Jan 1985
res70	Feb 1985
res71	Mar-Apr 1985
res72	May-Jun 1985
res73	Jul 1985
res74	Aug 1985
res75	Sep 1985
res76	Oct 1985
res77	Nov 1985
res78	Dec 1985
res79	Jan 1986
res80	Feb 1986

Filename	Dates
res81	Mar 1986
res82	Apr 1986
res83	May 1986
res84	Jun 1986
res85	Jul 1986
res86	Aug 1986
res87	Sep 1986
res88	Oct 1986
res89	Nov 1986
res90	Dec 1986
res91	Jan 1987
res92	Feb 1987
res93	Mar 1987
res94	Apr 1987
res95	May 1987
res96	Jun 1987
res97	Jul 1987
res98A	Aug I 1987
res98B	Aug II 1987
res99A	Sep I 1987
res99B	Sep II 1987
res100A	Oct I 1987
res100B	Oct II 1987
res101	Nov 1987
res102	Dec 1987
res103	Jan 1988
res104	Feb 1988
res105	Mar 1988
res106	Apr 1988
res107	May 1988
res108	Jun 1988
res109	Jul 1988
res110	Aug 1988
res111	Sep 1988
res112	Oct 1988
res113	Nov 1988
res114	Dec 1988
res115	Jan 1989
res116	Feb 1989
res117	Mar 1989

Filename	Dates
res118	Apr 1989
res119	May 1989
res120	Jun 1989
res121	Jul 1989
res122	Aug 1989
res123	Sep 1989
res124	Oct 1989
res125	Nov 1989
res126	Dec 1989
res127	Jan 1990
res128	Feb 1990
res129	Mar 1990
res130	Apr 1990
res131	May 1990
res132	Jun 1990
res133	Jul I 1990
res134	Jul II 1990
res135	Aug I 1990
res136	Aug II 1990
res137	Sep I 1990
res138	Sep II 1990
res139	Oct I 1990
res140	Oct II 1990
res141	Nov I 1990
res142	Nov II 1990
res143	Dec 1990
res144	Jan I 1991
res145	Jan II 1991
res146	Feb I 1991
res147	Feb II 1991
res148	Mar I 1991
res149	Mar II 1991
res150	Apr I 1991
res151	Apr II 1991
res152	May I 1991
res153	May II 1991
res154	Jun I 1991
res155	Jun II 1991
res156	Jul I 1991
res157	Jul II 1991

Filename	Dates
res158	Aug I 1991
res159	Aug II 1991
res160	Sep I 1991
res161	Sep II 1991
res162	Oct I 1991
res163	Oct II 1991
res164	Nov I 1991
res165	Nov II 1991
res166	Dec I 1991
res167	Dec II 1991
res168	Jan I 1992
res169	Jan II 1992
res170	Feb I 1992
res171	Feb II 1992
res172	Mar I 1992
res173	Mar II 1992
res174	Apr I 1992
res175	Apr II 1992
res176	May I 1992
res177	May II 1992
res178	Jun I 1992
res179	Jun II 1992
res180	Jul I 1992
res181	Jul II 1992
res182	Aug I 1992
res183	Aug II 1992
res184	Sep I 1992
res185	Sep II 1992
res186	Oct I 1992
res187	Oct II 1992
res188	Nov I 1992
res189	Nov II 1992
res190	Dec I 1992
res191	Dec II 1992
res192	Jan I 1993
res193	Jan II 1993
res194	Jan III 1993
res195	Feb I 1993
res196	Feb II 1993
res197	Mar I 1993

Filename	Dates
res198	Mar II 1993
res199	Mar III 1993
res200	Apr I 1993
res201	Apr II 1993
res202	Apr III 1993
res203	May I 1993
res204	May II 1993
res205	May III 1993
res206	Jun I 1993
res207	Jun II 1993
res208	Jun III 1993
res209	Jul I 1993
res210	Jul II 1993
res211	Jul III 1993
res212	Aug I 1993
res213	Aug II 1993
res214	Aug III 1993
res215	Sep I 1993
res216	Sep II 1993
res217	Sep III 1993
res218	Oct I 1993
res219	Oct II 1993
res220	Oct III 1993
res221	Oct IV 1993
res222	Nov I 1993
res223	Nov II 1993
res224	Nov III 1993
res225	Dec I 1993
res226	Dec II 1993
res227	Dec III 1993

## C Ticker Symbol Identification

### C.1 Ticker Symbols for CBOE Index Options

Ticker	Index	Exercise Style
OEX	S&P 100 Index	American
OEZ	S&P 100 Index - OEX strike overflow	
CPO	S&P 100 Index - CAPS	European
SPX	S&P 500 Index	European
SPZ	S&P 500 Index - SPX strike overflow	
NSX	S&P 500 Index - PM Expiration	European
SPL	S&P 500 Index - Long-Dated	European
SPQ	S&P 500 Index - End-of-Quarter	European
CPS	S&P 500 Index - CAPS	European
BIX	S&P Banking Index	European
BGX	CBOE BioTech Index	European
CEX	S&P Chemical Index	European
CWX	CBOE Computer Software Index	European
EVX	CBOE Environmental Index	European
GAX	CBOE Gaming Index	European
GTX	CBOE Global Telecommunications Index	European
HCX	S&P Health Care Index	European
IUX	S&P Insurance Index	European
RIX	CBOE REIT Index	European
RLX	S&P Retail Index	European
TCX	CBOE U. S. Telecommunications Index	European
TRX	S&P Transportation Index	European
FSX	FT-SE 100 Index	European
ISX	CBOE Israel Index	European
MEX	CBOE Mexico Index	European
MZX	CBOE Mexico Index (MEX strike overflow)	
NIK	Nikkei 300 Index	European
NDX	NASDAQ 100 Index	European
RUT	Russell 2000 Index	European
SGX	S&P/Barra Growth Index	European
SVX	S&P/Barra Value Index	European

## C.2 Ticker Symbols for Index LEAPS

Ticker	Index	Expiration
OAX	S&P 100 Index	1993
OBX	S&P 100 Index	1994
OLX	S&P 100 Index	1992, 1995
OCX	S&P 100 Index	1996
LSW	S&P 500 Index	1993
LSY	S&P 500 Index	1994
LSX	S&P 500 Index	1992, 1995
LSZ	S&P 500 Index	1996
WRU	Russell 2000 Index	1994
VRU	Russell 2000 Index	1995
LRU	Russell 2000 Index	1996
WBG	CBOE BioTech Index	1994
VBG	CBOE BioTech Index	1995
LBG	CBOE BioTech Index	1996
VEX	CBOE Mexico Index	1995
VNX	Nikkei 300 Index	1995

## C.3 Ticker Symbols for Interest Rate Options

Ticker	Underlying
IRX	13-week T-bill
VXB	13-week T-bill (1995 LEAP)
LXB	13-week T-bill (1996 LEAP)
FVX	5-year Note
VXV	5-year Note (1995 LEAP)
LXV	5-year Note (1996 LEAP)
TNX	10-year Note
VXN	10-year Note (1995 LEAP)
LXN	10-year Note (1996 LEAP)
TYX	30-year Bond
VYY	30-year Bond (1995 LEAP)
LTY	30-year Bond (1996 LEAP)
LTX	Weighted Average Long-Term Rate (discontinued)

#### C.4 Ticker Symbols for CBOE Equity Options (As of July 28, 1993)

Ticker	Listed	Delisted	Company Name
KKQ	921006		ACCLAIM ENTERTAINMENT, INC.
ACT	881027		ACTUA GROUP
ADT	911021		ADT LIMITED
AVQ	920508		ADVANTA CORPORATION CL. A
ABQ	930313		ADVANTA CORP., CLASS B
AFP	881219		AFFILIATED PUBLICATIONS INC.
AFQ	920618		AFFYMAX N.V.
AQG	930709		AGNICO-EAGLE MINES LTD.
ABF	901030		AIRBORNE FREIGHT CORPORATION
ALC	930423		ALC COMMUNIATIONS CORP.
ALA	921204		ALCATEL ALSTHOM ADR
AAL	840221		ALEXANDER & ALEXANDER SERVICES
AEG	750922		ALLEGIS
AYQ	911121		ALLIANCE PHARMACEUTICAL CORP.
ATK	910301		ALLIANT TECHSYSTEMS INC
ALS	841226	861231	ALLIED STORES
AA	741217		ALUMINUM CO. OF AMERICA
AU	930503		AMAX GOLD INC.
AMH	810629		AMDAHL CORPORATION
AEP	750523		AMERICAN ELECTRIC POWER CO.
AXP	770518		AMERICAN EXPRESS CO.
AGC	850730		AMERICAN GENERAL
AGQ	850603	910722	AMERICAN GREETINGS
AHS	750623	851125	AMERICAN HOSPITAL SUPPLY
AIT	850813		AMERICAN INFO TECHNOLOGY
AIG	841022		AMERICAN INT'L GROUP
PWQ	910816		AMERICAN POWER CONVERSION CORP
ASC	880810		AMERICAN STORES
T	730426		AMERICAN TELEPHONE AND TELEGRA
AIT	850813		AMERITECH
ATQ	900123	920629	AMER. T.V. & COMMUNICATIONS CL
AN	750624		AMOCO
AMP	750926		AMP INCORPORATED
APC	870420		ANADARKO PETROLEUM
AQN	930503		ANDREW CORP.
APA	800725	880915	APACHE CORPORATION
APQ	850603	860703	APOLLO COMPUTER INC.
AAQ	850603	910521	APPLE COMPUTER INC.
APM	881219		APPLIED MAGNETICS CORP.
ARA	841022	841219	ARA SERVICES
OIQ	920928		ARTISOFT, INC.

Ticker	Listed	Delisted	Company Name
ARC	730426		ATLANTIC RICHFIELD CORP.
AIQ	920319		ATLANTIC SOUTHEAST AIRLINES
AQT	930604		ATMEL CORPORATION
URQ	920131		AURA SYSTEMS, INC.
TQO	930707		AUTOTOTE (CLASS A)
AZO	920127		AUTOZONE, INC.
AVP	730801		AVON PRODUCTS INC.
AQR	930406		AZTAR CORP.
JBQ	920928		BAKER (J), INC.
BLY	930709		BALLY MANUFACTURING CORPORATIO
BLY	770301	910521	BALLY MANUFACTURING CORP.
BDG	930201		BANDAG, INC.
BK	881219		BANK OF NEW YORK COMPANY, INC.
BKQ	930218		BANK SOUTH CORP.
BAC	760701		BANKAMERICA CORPORATION
BLH	930701		BANKERS LIFE HOLDING CORP.
BNQ	930210		BANYAN SYSTEMS INC.
BTI	921204		BAT INDUSTRIES ADR
BMG	870717		BATTLE MOUNTAIN GOLD CORP.
BAX	750523		BAXTER INTERNATIONAL, INC.
BBQ	900417		BAYBANKS, INC.
BCE	901204	920118	BCE INC.
BSC	860327		BEAR STEARNS
BEC	890828		BECKMAN INSTRUMENTS INC
BHQ	930728		BED BATH AND BEYOND INC.
BEL	851014		BELL ATLANTIC
BMS	910415	910722	BEMIS CO., INC.
BBC	891201		BERGEN BRUNSWIG CORPORATION
BBY	920319		BEST BUY CO., INC.
BES	881006	890206	BEST PRODUCTS CO., INC.
BS	730601		BETHLEHEM STEEL CORPORATION
BHC	900402	911115	BHC COMMUNICATIONS INC.
BGQ	900119		BIOGEN, INC.
BIQ	890320		BIOMET, INC.
GCQ	911205		BIO-TECHNOLOGY GENERAL CORP.
BJS	930702		BJ SERVICES COMPANY
BDK	750522		BLACK & DECKER MANUFACTURING C
BV	880722		BLOCKBUSTER ENTERTAINMENT CORP
BCQ	911021		BMC SOFTWARE, INC.
BTQ	901204		BOATMEN'S BANCSHARES
BA	750522		BOEING COMPANY
BCC	760209		BOISE CASCADE CORPORATION
BLR	880610	911018	BOLAR PHARMACEUTICAL CO., INC.



Ticker	Listed	Delisted	Company Name
BLR	920206		BOLAR PHARMACEUTICAL CO., INC.
BQM	930604		BOOMTOWN INC.
BLQ	900613		BORLAND INTERNATIONAL
BSX	920824		BOSTON SCIENTIFIC CORP.
BMV	800602		BRISTOL MEYERS SQUIBB
BTY	921208		BRITISH GAS ADR
BDQ	921231		BRODERBUND SOFTWARE
BRQ	880705		BRUNO'S, INC.
BC	730426		BRUNSWICK CORP.
BOQ	920422		BUFFETS, INC.
BNI	760329		BURLINGTON NORTHERN INC.
BTI	891030	920118	B.A.T. INDUSTRIES PLC ADR'S
GR	880202		B.F. GOODRICH COMPANY
CWP	921204		CABLE AND WIRELESS ADR
CDN	900716		CADENCE DESIGN SYSTEMS
CAL	930503		CALIFORNIA FEDERAL BANK, INC.
ELY	930325		CALLAWAY GOLF COMPANY
BXQ	911112		CAMBRIDGE BIOTECH CORPORATION
CCB	820628		CAPITAL CITIES COMMUNICATIONS
CK	930308		CAREMARK INTERNATIONAL, INC.
CCL	881219		CARNIVAL CRUISE LINES, INC.
CAR	920221		CARTER-WALLACE, INC.
CMQ	930625		CASINO MAGIC CORP.
CDX	910605		CATELLUS DEVELOPMENT CORPORATI
CBS	750624		CBS INC
CZ	820628	870227	CELANESE
CQP	930301		CELLPRO, INC.
CMQ	900516	910906	CELLULAR COMMUNICATIONS
COQ	900312		CENTOCOR, INC.
CEN	750922		CERIDIAN CORP.
CQN	930330		CERNER CORP.
CEA	800801	860303	CESSNA
CDV	900802		CHAMBERS DEVELOPMENT CO., INC.
CHA	800602		CHAMPION INT'L CORPORATION
CRQ	920601		CHECKERS DRIVE-IN RESTAURANTS,
CYE	921007		CHEYENNE SOFTWARE, INC.
CNW	830829	900120	CHICAGO & NORTHWESTERN CO.
HPQ	921130		CHIPCOM
CIQ	910809		CHIRON CORP.
CCN	871123	921016	CHRIS-CRAFT INDUSTRIES
C	841226		CHRYSLER CORPORATION
CI	730601		CIGNA CORPORATION
CSN	900122		CINCINNATI BELL INC.

Ticker	Listed	Delisted	Company Name
RXC	920206		CIRCA PHARMACEUTICALS
CUQ	911021		CIRRUS LOGIC, INC.
CYQ	910625		CISCO SYSTEMS, INC.
CCI	731003		CITICORP
CSA	930330		COAST SAVINGS FINANCIAL, INC.
CGP	800602		COASTAL CORPORATION
KO	750522		COCA-COLA COMPANY
CCE	870316		COCA-COLA ENTERPRISES
CDE	930313		COEUR d'ALENE MINES CORP.
CL	750523		COLGATE-PALMOLIVE COMPANY
CF	901204		COLLINS FOODS INTERNATIONAL
HOQ	930621		COLUMBIA HOSPITAL CORP.
CWE	750624		COMMONWEALTH EDISON COMPANY
KLQ	910711		COMPRESSION LABS, INCORPORATED
CPU	920611		COMPUSA INC.
CA	870505		COMPUTER ASSOCIATES INT'L
CSC	800801		COMPUTER SCIENCE CORP.
CWQ	930428		COMPUWARE CORP.
CQV	930322		COMVERSE TECHNOLOGY, INC.
CNC	911021		CONSECO, INC.
CBK	891201		CONTINENTAL BANK CORPORATION
CIC	820825	840926	CONTINENTAL ILLINOIS
CDA	750922		CONTROL DATA CORPORATION
CQD	930428		CONTROL DATA SYSTEMS, INC.
GLW	800602		CORNING INC. (WAS CORN.GLASS W
CQT	930129		COTT CORPORATION
OVQ	921106		COVENTRY CORP.
RFQ	921109		CREATIVE TECHNOLOGY
CRA	910307		CRITICAL CARE AMERICA
CQM	930201		CRYOMEDICAL SCIENCES, INC.
CUL	830829	880715	CULLINET SOFTWARE
CY	890717		CYPRESS SEMICONDUCTOR
CYM	880513		CYPRUS MINERALS CO.
CTQ	920309	930618	CYTRX CORPORATION
DAQ	920221		DANEK GROUP, INC.
DPT	810714	860221	DATAPPOINT
DWD	930601		DEAN WITTER, DISCOVER & CO.
DAL	741217		DELTA AIRLINES
DLW	920221		DELTA WOODSIDE INDUSTRIES, INC
DRM	890213		DIAMOND SHAMROCK INC.
DBD	820526		DIEBOLD INC..
DEC	770223		DIGITAL EQUIPMENT CORPORATION
DIS	770223		DISNEY (WALT) PRODUCTIONS

Ticker	Listed	Delisted	Company Name
DOW	741217		DOW CHEMICAL COMPANY
DPS	930504		DR PEPPER/SEVEN-UP COMPANIES,
DBQ	890320		DRESS BARN (THE)
DRY	860421		DREYFUS CORPORATION
DIQ	850603	861017	DSC COMMUNICATIONS
DD	770223		DUPONT (E.I.) DEMEMOURS & COMP
DUR	910905	920619	DURACELL INTERNATIONAL, INC.
HGQ	930125		EAGLE HARDWARE & GARDEN, INC.
EK	730426		EASTMAN KODAK CO.
ETN	870204		EATON CORP.
ECQ	920422		ECI TELECOMMUNICATIONS LTD.
EEQ	920501		ECOGEN CORP.
AGE	830325		EDWARDS, A.G. & SONS INC.
EGQ	910616	910906	EGGHEAD, INC.
ELN	900906		ELAN CORPORATION, PLC ADR
EZQ	911119		ELECTRONIC ARTS CORP.
EFQ	930503		ELECTRONICS FOR IMAGING, INC.
EMC	920601		EMC CORPORATION
EC	820628		ENGLEHARD CORPORATION
ENE	851014		ENRON CORP
EOG	930330		ENRON OIL & GAS
ETR	800602		ENTERGY CORP
EPT	911021		EPITOPE, INC.
ESM	800725	840807	ESMARK
EVP	800602	820521	EVANS PRODUCTS
EVQ	890901	910419	EVEREX SYSTEMS
EXQ	910603		EXABYTE CORP.
XON	730601		EXXON CORPORATION
FDX	800801		FEDERAL EXPRESS CORPORATION
FNM	741217	820416	FEDERAL NATIONAL MORTGAGE ASSO
FD	920512		FEDERATED DEPARTMENT STORES
FHQ	910517		FHP INTERNATIONAL CORPORATION
ILQ	920928		FILENET CORP.
BSQ	911119		FILENE'S BASEMENT CORP.
FBS	910201		FIRST BANK SYSTEM, INC.
FBC	830610	881223	FIRST BOSTON INC.
FNB	830829		FIRST CHICAGO CORPORATION
FDC	920716		FIRST DATA CORPORATION
FFB	900308		FIRST FIDELITY BANCORP
I	860707		FIRST INTERSTATE BANCORP
FQN	930205		FIRST PACIFIC NETWORKS, INC.
FSH	920422		FISHER SCIENTIFIC INTERNATIONA
FQC	921130		FLEET CALL

Ticker	Listed	Delisted	Company Name
FLR	760329		FLUOR CORPORATION
FM	920928		FOODMAKER, INC.
F	730426		FORD MOTOR CO.
FRX	871123		FOREST LABORATORIES
FEQ	921027		FRAME TECHNOLOGY
FAU	900122	900326	FREEPORT-MCMORAN GOLD CO.
FTX	800602		FREEPORT-MCMORAN INC.
FFC	871123		FUND AMERICAN COS.
FQA	881027		FUQUA INDUSTRIES INC.
GHC	930312		GALEN HEALTH CARE, INC.
GPS	870625		GAP STORES
GY	851223		GENCORP
XRQ	930301		GENDEX CORP.
LBQ	920123		GENELABS TECHNOLOGIES INC.
GNE	850603	910419	GENENTECH INC.
GAO	820628	830308	GENERAL AMERICAN OIL, TEX.
GCN	861229		GENERAL CINEMA CORP.
GDC	930608		GENERAL DATACOM INDUSTRIES, IN
GD	750922		GENERAL DYNAMICS CORP.
GE	741218		GENERAL ELECTRIC COMPANY
GF	750624	851101	GENERAL FOODS
GM	741218		GENERAL MOTORS CORPORATION
GMH	920904		GENERAL MOTORS CORP. CLASS H
GAQ	911203		GENSIA PHARMACEUTICALS
GZQ	911021		GENZYME CORPORATION
GQL	930313		GERRITY OIL AND GAS CORP.
GNR	920221		GLOBAL NATURAL RESOURCES, INC.
GRQ	930601		GRAND CASINOS, INC.
GSQ	891121	910722	GRAPHIC SCANNING CORPORATION
GLK	891201		GREAT LAKES CHEMICAL CORPORATI
GNN	870204	900626	GREAT NORTHERN NEKOOSA
GWF	730801		GREAT WESTERN FINANCIAL CORP.
GNT	911021		GREEN TREE FINANCIAL CORP.
GPQ	911028		GREENWICH PHARMCEUTICALS INC.
BUS	930608		GREYHOUND LINES INC.
GQ	851014		GRUMMAN CORP
GTK	921029		GTECH HOLDINGS
GW	730426		GULF WESTERN INC.
HAE	930121		HAEMONETICS CORP.
HAL	750318		HALLIBURTON COMPANY
HDL	891201		HANDLEMAN COMPANY
HAN	871123		HANSON TRUST ADR
H	861229		HARCOURT GENRAL

Ticker	Listed	Delisted	Company Name
HRS	800808		HARRIS CORPORATION
HSC	900122		HARSCO CORP.
HUQ	930121		HAUSER CHEMICAL RESEARCH, INC.
HPI	930608		HEALTH PROFESSIONALS INC.
HLQ	911014		HEALTHCARE COMPARE CORP.
HTI	920320		HEALTHTRUST, INC. - THE HOSPIT
HTQ	920902		HEART TECHNOLOGY, INC.
HNZ	851223		HEINZ (H.J.)
HEM	930615		HEMLO GOLD MINES INC.
HEQ	880811	881230	HENLEY GROUP INC., THE
HWP	750522		HEWLETT-PACKARD COMPANY
HIT	820421		HITACHI LTD.
HMO	920601		HMO AMERICA, INC.
HIA	750922		HOLIDAY CORPORATION
HFF	881215	890809	HOLLY FARMS CORP.
HQP	930708		HOLLYWOOD PARK INC.
HFD	871123		HOME FEDERAL S&L
HSN	861003	890421	HOME SHOPPING NETWORK
HSN	930330		HOME SHOPPING NETWORK, INC.
HFD	871123	911018	HOMEFED CORP.
HM	750318		HOMESTAKE MINING COMPANY
HON	750522		HONEYWELL INC.
HKT	930226		HONG KONG TELECOM ADR
HSM	930309		HORSHAM CORP.
HCA	920603		HOSPITAL CORP. OF AMERICA
	761122	810424	HOUSTON OIL & MINERALS
HT	800602	870403	HUGHES TOOL COMPANY
HUM	811002		HUMANA INC.
ICX	860120		IC INDUSTRIES
ICN	920106		ICN PHARMACEUTICALS, INC.
ICQ	911217		ICOS CORPORATION
IQD	930604		IDB COMMUNICATIONS GROUP INC.
IMA	750318		IMCERA GROUP, INC.
IMQ	911028		IMMUNE RESPONSE CORPORATION
IQQ	911119		IMMUNOMEDICS, INC.
IMO	901204	911018	IMPERIAL OIL LTD. CLASS A
INA		820000	INA CORPORATION
IRQ	880829		INFORMATION RESOURCES
IFQ	911206		INFORMIX CORPORATION
ITQ	930624		INTEGRATED DEVICE TECHNOLOGY
ITQ	930728		INTEGRATED HEALTH SERVICES, IN
INQ	850603	860703	INTEL

Ticker	Listed	Delisted	Company Name
IEQ	910417		INTELLIGENT ELECTRONICS, INC.
IGQ	850603	860703	INTERGRAPH
IMQ	900312	911018	INTERMEC CORPORATION
INI	851101	860411	INTERNORTH
IBM	731003		INT'L BUSINESS MACHINES CORP.
IFF	750926		INT'L FLAVORS & FRAGRANCES INC
HR	730601	821015	INT'L HARVESTER
ILQ	900117	900904	INT'L LEASE FINANCE CORPORATIO
IGL	750318		INT'L MINERALS & CHEMICALS COR
IP	741218		INT'L PAPER COMPANY
ITL	881031		ITEL CORPORATION
ITT	730801		ITT
IVX	910813		IVAX CORPORATION
ECK	820628	860430	JACK ECKERD
J	930422		JACKPOT ENTERPRISES
JBM	900316		JAN BELL MARKETING
JNJ	750318		JOHNSON & JOHNSON
JNY	930319		JONES APPAREL GROUP
KM	730601		K MART CORPORATION
KOQ	930313		KELLY OIL CORP.
	741217	810603	KENNECOTT CORP.
KMG	730801		KERR-MCGEE CORPORATION
KLM	910204		KLM ROYAL DUTCH AIRLINES
KSS	920824		KOHL'S CORP.
LAC	851014		LAC MINERALS
LE	891201		LANDS' END, INC.
LQT	930201		LATTICE SEMICONDUCTOR CORP.
LGQ	900529		LEGENT CORPORATION
LQB	930303		LIBERTY MEDIA CORP.
	820413	840120	LIFEMARK
LTD	840227		LIMITED INC.
LPQ	911028		LIPOSOME COMPANY, INC.
LIT	800602		LITTON INDUSTRIES INC.
LIZ	850603		LIZ CLAIBORNE INC
LTR	840820		LOEW'S CORPORATION
LTR	730426	781020	LOEW'S CORPORATION
LQS	921130		LONE STAR STEAKHOUSE
LFB	891201		LONGVIEW FIBRE
LOR	820628		LORAL CORPORATION
LT	860611	890721	LORIMAR-TELEPICTURES
LOQ	850701	870417	LOTUS DEVELOPMENT CORP
LSI	850603		LSI LOGIC CORP

Ticker	Listed	Delisted	Company Name
LUB	901204	920416	LUBY'S CAFETERIAS, INC.
LA	891030		L.A. GEAR INC.
MCU	920629		MAGMA COPPER COMPANY
MGA	911028		MAGNA INTERNATIONAL INC.
MAN	911028		MANPOWER INC.
QMAN	750624	830520	MANVILLE CORP.
MRG	920601		MARGARETTEN FINANCIAL CORP.
MRV	920311		MARVEL ENTERTAINMENT GROUP, IN
MKY	820322	851214	MARY KAY
MJQ	920629		MASCO INDUSTRIES, INC.
MXQ	920309		MAXTOR CORPORATION
MA	860602		MAY DEPARTMENT STORES
KRB	910726		MBNA CORP.
MWQ	900514		MCCAW CELLULAR COMMUNICATIONS
MCD	730426		MCDONALDS CORPORATION
MCQ	850614		MCI COMMUNICATIONS CORP
MEA	870204		MEAD CORP.
MDV	921204		MEDEVA ADR
MQV	930514		MEDIA VISION TECHNOLOGY, INC.
MRX	920917		MEDICAL CARE AMERICA
ME	901115		MEDICAL CARE INTERNATIONAL
MDT	820413		MEDTRONIC INC.
MRK	730426		MERCK AND COMPANY INC.
LSQ	920319		MERISEL, INC.
MER	770223		MERRILL LYNCH & CO INC.
MGR	910319		MERRY-GO-ROUND ENTERPRISES, IN
EAQ	921027		MESA AIRLINES
MXP	920909		MESA INC.
	761214	820309	MGIC INVESTMENT CORP.
MU	880621		MICRON TECHNOLOGY, INC.
MCN	851014	860519	MIDCON
MSU	800602		MIDDLE SOUTH UTILITIES INC.
MDW	880601	910722	MIDWAY AIRLINES
MMM	731003		MINNESOTA MINING AND MANUFACTU
MPQ	900615	920629	MIPS COMPUTER SYSTEMS, INC.
MNC	920408		MNC FINANCIAL, INC.
MOB	750623		MOBIL CORPORATION
MMQ	911028		MOBILE TELCOMMUNICATION TECHS.
MOQ	880829		MOLEX INC.
MTC	731003		MONSANTO COMPANY
SIX	900122	900817	MOTEL 6 L.P.
MFQ	921230		MTC ELECTRONICS
NEC	881219	910118	NATIONAL EDUCATION CORP.

Ticker	Listed	Delisted	Company Name
NSM	750926		NATIONAL SEMICONDUCTOR CORP.
NS	930625		NATIONAL STEEL CORP.
NVQ	930201		NATIONAL VISION ASSOCIATES, IN
NAV	930709		NAVISTAR INTERNATIONAL CORPORA
NBI	830829	880520	NBI INC.
NCR	760329	920416	NCR CORPORATION
NFQ	930330		NETFRAME SYSTEMS, INC.
NWQ	920629		NETWORK GENERAL CORPORATION
NEQ	910307		NEW ENGLAND CRITICAL CARE, INC
FQC	921130		NEXTELL
NSC	820322		NORFOLK SOUTHERN CORPORATION
NVX	920206		NORTH AMERICAN VACCINE, INC.
NT	820413		NORTHERN TELECOM LTD.
NRQ	901204		NORTHERN TRUST CORPORATION
NOC	820413		NORTHROP CORPORATION
NWT	800602	850729	NORTHWEST INDS.
NRT	880627	900918	NORTON CO.
NPQ	920309	920904	NOVA PHARMACEUTICAL CORP.
NLQ	911021		NOVELLUS SYSTEMS, INC.
NLQ	880810	891130	NOXELL CORPORATION
NUE	901204		NUCOR CORPORATION
NWA	730426	890804	NWA INC
NWN	901107		NWNL COMPANIES
OXY	750922		OCCIDENTAL PETROLEUM CORP.
OG	870315		OGDEN CORP.
OQL	930426		OLICOM A/S
ORQ	880208		ORACLE SYSTEMS
ORG	920127		ORGANOGENESIS, INC.
ORX	900724		ORYX ENERGY COMPANY
GOQ	891108	910521	OSHKOSH B'GOSH, INC.
OSQ	921023		OUTBACK STEAKHOUSE
OM	890515		OUTBOARD MARINE CORPORATION
OI	920324		OWENS-ILLINOIS, INC.
OI	800602	870331	OWENS-ILLINOIS INC.
OQX	930503		OXFORD HEALTH PLANS, INC.
PWJ	821115		PAINE WEBBER INC.
PLL	871123		PALL CORP.
PNS	881219	911101	PANSOPHIC SYSTEMS
PDN	820322	861017	PARADYNE CORPORATION
PTB	930430		PARAGON TRADE BRANDS, INC.
PCI	730426		PARAMOUNT COMMUNICATIONS
PCI	860611	881007	PAYLESS CASHWAYS
PCS	930614		PAYLESS CASHWAYS, INC.



Ticker	Listed	Delisted	Company Name
PGU	880322		PEGASUS GOLD INC.
PZL	730426		PENNZOIL COMPANY
PEP	760329		PEPSICO
POQ	920320		PERRIGO CO.
PT	910703		PET INCORPORATED
PHI	920629		PHILIPPINE LONG DISTANCE TELEP
PVH	920601		PHILLIPS VAN HUESEN CORP.
PQC	930728		PHYSICIAN CORP. OF AMERICA
PLX	920225		PLAINS RESOURCES, INC.
FLQ	920928		PLATINUM TECHNOLOGY
PQL	930710		PLAYERS INTERNATIONAL, INC.
PRD	730426		POLAROID CORPORATION
PCP	880829		PRECISION CASTPARTS
PMI	890717		PREMARK INTERNATIONAL
PQZ	930423		PRESIDENT RIVERBOAT CASINOS, I
PRI	900226		PROMUS CORP.
PQN	930201		PROTEON INC.
QAQ	921027		QUALCOM
QDQ	911217	930618	QUARTERDECK OFFICE SYSTEMS
RTG	900122		RACAL TELECOM PLC
RYQ	921005		RALLY'S INC.
RAL	800602		RALSTON PURINA COMPANY
RTN	750922		RAYTHEON COMPANY
RCA	730601	860610	RCA
RDA	900601		READER'S DIGEST ASSOCIATION, I
RDQ	920323		READ-RITE CORPORATION
RXQ	921027		RETIX
RTQ	890914		REUTERS HOLDINGS PLC ADR'S
REV	800602	841226	REVLON
IBQ	920123		RIBI IMMUNOCHEM RESEARCH
RQH	930330		RIO HOTEL & CASINO, INC.
RN	911021		RJR NABISCO HOLDINGS CORP
RNP	911021	920619	RJR NABISCO HOLDINGS CORP PREF
RJR	750623	890616	RJR NABISCO INC.
RBQ	920904		ROBERTS PHARMACEUTICAL CORP.
ROK	800602		ROCKWELL INT'L CORPORATION
RLM	820322	841121	ROLM
RQS	930330		ROSS SYTEMS, INC.
ROQ	891121		ROUSE COMAPANY
RAM	920727		ROYAL APPLIANCE MANUFACTURING
RPQ	880829		RPM INC
RUS	930406		RUSS BERRIE & CO., INC.
RAQ	920629		RYAN FAMILY STEAK HOUSES, INC.

Ticker	Listed	Delisted	Company Name
SAA	891201	901221	SAATCHI & SAATCHI COMPANY PLC
SAB	820628	880510	SABINE CORPORATION
SWY	900801		SAFEWAY INC.
SA	800602	861124	SAFEWAY STORES INC.
SJQ	880606		SAINT JUDE MEDICAL
SFR	901205	910521	SANTA FE ENERGY RESOURCES, INC
SLB	750523		SCHLUMBERGER LIMITED
SCH	891201		SCHWAB (CHARLES) CORPORATION
SSQ	880829		SCI SYSTEMS INC
SMQ	900529		SCIMED LIFE SYSTEMS, INC.
ONQ	920506		SCOTTS CO. (THE)
SCR	890406	910419	SEA CONTAINERS
S	731003		SEARS ROEBUCK & COMPANY
ERQ	920624		SEPRACOR INC.
SHX	900613		SHAW INDUSTRIES
SC	871123		SHELL TRANSPORT & TRADING
SHW	870127		SHERWIN WILLIAMS
SBO	930330		SHOWBOAT, INC.
EMQ	920804		SIERRA SEMICONDUCTOR CORP.
IAQ	901108		SIGMA ALDRICH CORPORATION
SZ	901204		SIZZLER INTERNATIONAL
SKY	750522		SKYLINE CORPORATION
SBH	921204		SMITHKLINE BEECHAM ADR
SQP	930621		SNAPPLE BEVERAGE CORP.
ELF	921208		SOCIETE NAT'L ELF AQUITAINE AD
SLR	920424		SOLECTRON CORPORATION
GNQ	920821		SOMATOGEN, INC.
BID	900122	910521	SOTHEBY'S HOLDINGS INC.
STB	900409	910919	SOUTHEAST BANKING CORPORATION
SO	750922		SOUTHERN COMPANY
	820628	831223	SOUTHERN PACIFIC
LUV			ROUTHWEST AIRLINES COMPANI
SY	730426	860925	SPERRY CORPORATION
SQB	781023	891004	SQUIBB CORPORATION
STA	870204	880607	STALEY CONTINENTAL
OMQ	920930		STANDARD MICROSYSTEMS CORP.
SQX	921230		STARBUCKS
STA	930715		STARTER CORPORATION
STK	781023	850730	STORAGE TECH
STK	891201		STORAGE TECH
SLM	871123		STUDENT LOAN MARKETING
SPC	861104		ST. PAUL COS.
SUL	920309		SULCUS COMPUTER CORP.

Ticker	Listed	Delisted	Company Name
SOC	921127		SUNBEAM OSTER
SUP	921130		SUPERIOR INDUSTRIES
	800602	840928	SUPERIOR OIL
SQC	930503		SUPERMAC TECHNOLOGY, INC.
YPQ	921005		SYNOPSIS, INC.
SNQ	910415		SYNOPTICS COMMUNICATIONS, INC.
SYN	750318		SYNTEX CORPORATION
TAD	921130		TADIRAN
TNQ	850603	860703	TANDEM COMPUTERS INC
TAN	770223		TANDY CORPORATION
TEK	800801		TEKTRONIX INC.
TLQ	880810	910624	TELECREDIT, INC.
TDY	770223		TELEDYNE
TMX	910905		TELEFONOS DE MEXICO S.A. DE C.
TNQ	880829		TELXON CORP
TDQ	900719	920228	TERADATA CORPORATION
TSO	750318	781020	TESORO PETROLEUM
	750523	810925	TEXAS GULF
TXN	730426		TEXAS INSTRUMENTS INC.
TWQ	930308		THE SOFTWARE TOOLWORKS, INC.
TDW	820628	870220	TIDEWATER INC.
TJX	860519		TJX COMPANY
TOT	921208		TOTAL ADR
TOY	820322		TOYS "R" US INC
TRB	871123		TRIBUNE CO.
TMQ	920319		TRIMEDYNE, INC.
OIL	911021		TRITON ENERGY CORPORATION
NIQ	911119	930820	TSI CORP.
TBS	920629		TURNER BROADCASTING SYSTEM, IN
UAL	750922		UAL (ALLEGIS)
UJB	900716		UJB FINANCIAL CORP
	800808	820820	UNC RESOURCES
UCC	870204		UNION CAMP
UIS	770223	910419	UNISYS (BURROUGHS)
UNH	910306		UNITED HEALTHCARE CORPORATION
UTX	750922		UNITED TECHNOLOGIES CORP.
UNQ	900926		UNITRIN, INC.
UXC	900906	920416	UNOCAL EXPLORATION CORPORATION
UPJ	730426		UPJOHN COMPANY
USG	861020	900316	USG CORP.
UST	871123		UST INC.
	750623	761220	UTAH INTERNATIONAL, INC.
VYQ	921130		VALENCE TECHNOLOGY

Ticker	Listed	Delisted	Company Name
VH	921027		VALUE HEALTH
VAT	920928		VARITY CORP.
VEQ	920630		VENTRITEX, INC.
VIA	820322	861201	VIACOM INTERNATIONAL INC.
VIQ	920501		VICOR CORP.
VWQ	921230		VIEWLOGIC
VSH	930201		VISHAY INTERTECHNOLOGY INC.
VLQ	911021		VLSI TECHNOLOGY, INC.
VOD	900122		VODAFONE GROUP PLC
WBN	891201		WABAN, INC.
JWC	750523	880108	WALTER (JIM) INCORPORATED
WMT	820628		WAL-MART STORES INC.
WCI	800725	900110	WARNER COMMUNICATIONS INC.
WME	921208		WASTE MANAGEMENT ADR
WII	930608		WEATHERFORD INTERNATIONAL, INC
WEL	921208		WELCOME ADR
WFQ	911217		WELLFLEET COMMUNICATIONS
WLP	930505		WELLPOINT HEALTH NETWORKS, INC
WPM	880527	891020	WEST POINT-PEPPERELL
WSN	930408		WESTERN COMPANY OF N. AMERICA
WY	730601		WEYERHAUSER COMPANY
WHX	930604		WHEELING-PITTSBURGH CORP.
WHR	870204		WHIRLPOOL CORP.
WH	860120		WHITMAN CORP.
WMB	750926		WILLIAMS COMPANIES
WIN	901204		WINN DIXIE STORES INC.
WGO	830829		WINNEBAGO INDUSTRIES
XRX	730426		XEROX
XLQ	910520		XILINX, INC.
XMQ	911021		XOMA CORPORATION
YLQ	861020		YELLOW CORPORATION
YLQ	861020		YELLOW FREIGHT SYSTEMS
YRK	921130		YORK INTERNATIONAL
ZY	860519		ZAYRE CORP

## C.5 Ticker Symbols for Equity LEAPS

Ticker	Underlying Asset	Expiration
LRH	AirTouch	1996
ZRH	AitTouch	1997
VAO	Amoco	1995
LAO	Amoco	1996
ZAO	Amoco	1997
VT	AT&T	1995
LT	AT&T	1996
ZT	AT&T	1997
VFR	Atlantic Richfield	1995
LFR	Atlantic Richfield	1996
ZFR	Atlantic Richfield	1997
VVP	Avon	1995
LVP	Avon	1996
ZVP	Avon	1997
VBA	BankAmerica	1995
LBA	BankAmerica	1996
ZBC	BankAmerica	1997
VBU	Bell Atlantic	1995
LEU	Bell Atlantic	1996
ZLE	Bell Atlantic	1997
VBY	Best Buy	1995
LBS	Best Buy	1996
ZBY	Best Buy	1997
VBV	Blockbuster	1995
LBV	Blockbuster	1996
ZBV	Blockbuster	1997
VBO	Boeing	1995
LBO	Boeing	1996
ZBO	Boeing	1997
VOB	Borland	1995
LOB	Borland	1996
ZOB	Borland	1997
VBM	Bristol-Myers	1995
LBM	Bristol-Myers	1996
ZBM	Bristol-Myers	1997
VCT	Centocor	1995
LCO	Centocor	1996
ZCT	Centocor	1997

Ticker	Underlying Asset	Expiration
VHR	Chiron	1995
LHR	Chiron	1996
ZHR	Chiron	1997
VCY	Chrysler	1995
LCR	Chrysler	1996
ZCR	Chrysler	1997
VYC	Cisco	1995
LCY	Cisco	1996
ZCY	Cisco	1997
VCP	Citicorp	1995
LCC	Citicorp	1996
ZCC	Citicorp	1997
VKO	Coca-Cola	1995
LKO	Coca-Cola	1996
ZKO	Coca-Cola	1997
LEC	Conseco	1996
ZCE	Conseco	1997
VDA	Delta	1995
LDA	Delta	1996
ZDA	Delta	1997
VDO	Dow	1995
LDO	Dow	1996
ZDO	Dow	1997
VEK	Eastman Kodak	1995
LEK	Eastman Kodak	1996
ZEK	Eastman Kodak	1997
VEY	Eastman Kodak (adjusted)	1995
LEZ	Eastman Kodak (adjusted)	1996
VXO	Exxon	1995
LXO	Exxon	1996
ZXO	Exxon	1997
VFX	FedEx	1995
LFX	FedEx	1996
ZFX	FedEx	1997
VFO	Ford	1995
LFO	Ford	1996
ZFO	Ford	1997
VGS	Gap	1995

Ticker	Underlying Asset	Expiration
LGS	Gap	1996
ZGS	Gap	1997
VGE	General Electric	1995
LGE	General Electric	1996
ZGR	General Electric	1997
VGN	General Motors	1995
LGM	General Motors	1996
ZGM	General Motors	1997
VHN	Heinz	1995
LHN	Heinz	1996
ZHN	Heinz	1997
VHP	Hewlett-Packard	1995
LWP	Hewlett-Packard	1996
ZHP	Hewlett-Packard	1997
VHM	Homestake Mining	1995
LHM	Homestake Mining	1996
ZHM	Homestake Mining	1997
VIB	IBM	1995
LIB	IBM	1996
ZIB	IBM	1997
VNP	International Paper	1995
LNP	International Paper	1996
ZNP	International Paper	1997
VJN	Johnson & Johnson	1995
LJN	Johnson & Johnson	1996
ZJN	Johnson & Johnson	1997
VKM	K Mart	1995
LKM	K Mart	1996
ZKM	K Mart	1997
VLD	Limited	1995
LLD	Limited	1996
ZLT	Limited	1997
VLI	Liz Claiborne	1995
LLI	Liz Claiborne	1996
ZLI	Liz Claiborne	1997
VAG	Magna	1995
LGA	Magna	1996
ZGA	Magna	1997

Ticker	Underlying Asset	Expiration
VMD	McDonald's	1995
LMC	McDonald's	1996
ZMC	McDonald's	1997
VTU	MCI	1995
LTU	MCI	1996
ZTI	MCI	1997
VMK	Merck	1995
LMK	Merck	1996
ZMK	Merck	1997
VGY	Micron	1995
LGY	Micron	1996
ZGY	Micron	1997
VMU	3M	1995
LMU	3M	1996
ZMM	3M	1997
VML	Mobil	1995
LML	Mobil	1996
ZMB	Mobil	1997
VM	Monsanto	1995
LCT	Monsanto	1996
ZM	Monsanto	1997
VXY	Occidental	1995
LXY	Occidental	1996
ZXY	Occidental	1997
VOR	Oracle	1995
LRO	Oracle	1996
ZOR	Oracle	1997
VPT	Paramount	1995
LPT	Paramount	1996
VP	PepsiCo	1995
LPP	PepsiCo	1996
ZPP	PepsiCo	1997
VRD	Polaroid	1995
LRD	Polaroid	1996
ZRD	Polaroid	1997
LOS	Promus	1996
ZPR	Promus	1997
VRJ	RJR Nabisco	1995

Ticker	Underlying Asset	Expiration
LRJ	RJR Nabisco	1996
ZRJ	RJR Nabisco	1997
VRS	Sears Roebuck	1995
LS	Sears Roebuck	1996
ZS	Sears Roebuck	1997
VPL	Snapple	1995
LPL	Snapple	1996
ZLP	Snapple	1997
VSK	Storage Technology	1995
LSK	Storage Technology	1996
ZSK	Storage Technology	1997
VSX	Syntex	1995
LSN	Syntex	1996
VTE	TeleMex	1995
LMX	TeleMex	1996
ZTE	TeleMex	1997
VXT	Texas Instruments	1995
LTN	Texas Instruments	1996
ZTN	Texas Instruments	1997
VOI	Triton	1995
LOI	Triton	1996
ZOI	Triton	1997
VUA	UAL	1995
LUA	UAL	1996
ZUA	UAL	1997
LUH	United Healthcare	1996
ZUH	United Healthcare	1997
VUP	Upjohn	1995
LUP	Upjohn	1996
ZUP	Upjohn	1997
LVM	Viacom	1996
ZVM	Viacom	1997
VWT	Wal-Mart	1995
LWT	Wal-Mart	1996
ZWT	Wal-Mart	1997
LWH	Wellfleet	1996
ZWH	Wellfleet	1997
VXR	Xerox	1995
LXX	Xerox	1996
ZXR	Xerox	1997