Efficient Markets Hypothesis

1

Efficient Market Hypothesis

- If the flow of information is unimpeded
- New information is immediately reflected in the price of a stock
- Tomorrow's price will only reflect new information
- Since new information is unpredictable – stock prices tomorrow are unpredictable
- Price of a stock reflects all available information

2

Implication

- Stock prices are a random walk
  - New information unpredictable
  - Best prediction of a price tomorrow is the price today
- Universal nature of information means that you cannot outsmart the market
  - "A blindfolded chimpanzee throwing darts at the Wall Street Journal could select a portfolio that would do as well as the experts"

3

Three versions

- Weak
  - Cannot predict future prices with current prices
- Semi-strong
  - Current prices reflect all available public information
- Strong form
  - Current prices reflect all information even insider information

4

Focus on weak form

- Standard test – stock prices are a random walk
  - Best predictor of tomorrow's price is today's
  - 1st difference in daily returns is not predictive
- Can test with
  - Single stocks
  - Aggregate indexes
  - At any frequency
- Out data: Daily DJIA closing price, 1/1950 - 2/2007

5

Two models

$$\ln(P_t) = \beta_0 + \ln(P_{t-k})\beta_1 + \varepsilon_t$$

$$define:\ \Delta k \ln(P_t) = \ln(P_t) - \ln(P_{t-k})$$

$$\Delta k \ln(P_t) = \alpha_0 + \Delta k \ln(P_{t-k})\alpha_1 + \xi_t$$

$$Let\ k = 1, 2, 7, 30$$

6

Regress ln(closing price) on 1 day lag

```
. * test for random walk
. * run a regression of change ln(closing price)
. * on one period lag
. reg ln_close ln_close1
      Source |       SS       df       MS              Number of obs =   14361
-------------+------------------------------           F(  1, 14359) =       .
       Model |  18001.7298     1  18001.7298            Prob > F      =  0.0000
    Residual |  1.18771395 14359  .000082716           R-squared     =  0.9999
-------------+------------------------------           Adj R-squared =  0.9999
       Total |  18002.9175 14360  1.25368507           Root MSE      =  .00909
------------------------------------------------------------------------------
    ln_close |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  ln_close1 |   .9999874   .0000678        .   0.000     .9998545     1.00012
      _cons |   .0003808   .0004995     0.76   0.446    -.0005984      .00136
------------------------------------------------------------------------------

. test ln_close1==1
 ( 1)  ln_close1 = 1
       F(  1, 14359) =    0.03
            Prob > F =    0.8520
```

7

Regress Δln(closing price) on 1 day lag

```
. * run a regression of the 1st difference on its lag
. reg dln_close dln_close1
      Source |       SS       df       MS              Number of obs =   14360
-------------+------------------------------           F(  1, 14358) =   69.43
       Model |  .005716048     1  .005716048            Prob > F      =  0.0000
    Residual |  1.18199835 14358  .000082323           R-squared     =  0.0048
-------------+------------------------------           Adj R-squared =  0.0047
       Total |  1.1877144 14359  .000082716            Root MSE      =  .00907
------------------------------------------------------------------------------
   dln_close |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 dln_close1 |   .0693733   .0083254     8.33   0.000     .0530544    .0856921
      _cons |   .0002686   .0000758     3.55   0.000     .0001201    .0004171
------------------------------------------------------------------------------



. * get means of delta daily closing price
. sum dln_close
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   dln_close |     14361    .0002887    .0090945  -.2563152   .0966616
```

8

Regress ln(closing price) at end of month t on ln(closing)
At end of previous month

```
. reg ln_close ln_close1
      Source |       SS       df       MS              Number of obs =     685
-------------+------------------------------           F(  1,   683) =
       Model |  858.494448     1  858.494448            Prob > F      =  0.0000
    Residual |  1.15990765   683  .001698254           R-squared     =  0.9987
-------------+------------------------------           Adj R-squared =  0.9986
       Total |  859.654356   684  1.25680461           Root MSE      =  .04121

------------------------------------------------------------------------------
    ln_close |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  ln_close1 |   .9997576   .0014061   711.00   0.000     .9969967    1.002518
       _cons |   .007807   .0103621     0.75   0.451    -.0125383    .0281524
------------------------------------------------------------------------------
```


Regress Δln(closing price) end of month on
One month lag

```
. * run a regression of the 1st difference on its lag
. reg dln_close dln_close1
      Source |       SS       df       MS              Number of obs =     684
-------------+------------------------------           F(  1,   682) =    0.05
       Model |  .000082068     1  .000082068            Prob > F      =  0.8262
    Residual |  1.15987162   682  .001700692           R-squared     =  0.0001
-------------+------------------------------           Adj R-squared = -0.0014
       Total |  1.15995369   683  .001698322           Root MSE      =  .04124

------------------------------------------------------------------------------
   dln_close |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  dln_close1 |   .0084114   .0382908     0.22   0.826    -.0667706    .0835933
       _cons |   .0059876   .0015937     3.76   0.000     .0028584    .0091168
------------------------------------------------------------------------------
```


	Regression of ln(Close) on lag			Regression of Δln(close)	
Lag	β_1	Std. error	P-value Ho: β_1=0	α_1	Std. error
1 day	0.99999	0.000068	0.85	0.069	0.0083
2 days	0.99997	0.0014	0.84	-0.0028	0.0118
1 week	0.99994	0.00327	0.86	-0.0258	0.0183
1 month	0.99975	0.0014	0.86	0.0084	0.0383

Stock market anomalies

- Stock prices show persistent positive and negative returns on certain days
  - January, Mondays, before holidays, etc.
- Existence of these anomalies demonstrates and arbitrage opportunity
- Therefore, there existence is some evidence against the EMH

```
. reg dln_close time dmonth* tue wed thur fri
      Source |       SS       df       MS              Number of obs =   14361
-------------+------------------------------           F( 16, 14344) =    4.04
       Model |  .005330308    16  .000333144            Prob > F      =  0.0000
    Residual |  1.18238652 14344  .000082431            R-squared     =  0.0045
-------------+------------------------------           Adj R-squared =  0.0034
       Total |  1.18771682 14360   .00008271            Root MSE      =  .00908
------------------------------------------------------------------------------
   dln_close |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        time |   3.87e-09   1.83e-08     0.21   0.832    -3.20e-08    3.97e-08
      dmonth2 |  -.0005082   .0003784    -1.34   0.179    -.0012499    .0002334
      dmonth3 |  -.0001697   .0003656    -0.46   0.643    -.0008863     .000547
      dmonth4 |   .0002654   .0003709     0.72   0.474    -.0004617    .0009924
      dmonth5 |  -.0005825   .0003684    -1.58   0.114    -.0013047    .0001397
      dmonth6 |   -.000632   .0003677    -1.72   0.086    -.0013527    .0000887
      dmonth7 |  -.0001027   .0003692    -0.28   0.781    -.0008264     .000621
      dmonth8 |  -.0006352   .0003647    -1.74   0.082      -.00135    .0000796
      dmonth9 |  -.0011273   .0003726    -3.03   0.002    -.0018577   -.0003969
     dmonth10 |  -.0003567   .0003651    -0.98   0.329    -.0010724     .000359
     dmonth11 |   .0002227   .0003743     0.60   0.552    -.0005109    .0009564
     dmonth12 |   .0002412   .0003692     0.65   0.514    -.0004826    .0009649
          tue |   .0009457    .000241     3.92   0.000     .0004733    .0014181
          wed |    .001302    .000241     5.40   0.000     .0008296    .0017743
         thur |   .0008147   .0002418     3.37   0.001     .0003407    .0012886
          fri |    .001219   .0002421     5.03   0.000     .0007444    .0016936
        _cons |  -.0003209   .0003295    -0.97   0.330    -.0009667    .0003249
------------------------------------------------------------------------------
```

13

```
. test dmonth2 dmonth3 dmonth4 dmonth5 dmonth6 dmonth7 dmonth8 dmonth9 dmonth10
>  dmonth11 dmonth12
 ( 1)  dmonth2 = 0
 ( 2)  dmonth3 = 0
 ( 3)  dmonth4 = 0
 ( 4)  dmonth5 = 0
 ( 5)  dmonth6 = 0
 ( 6)  dmonth7 = 0
 ( 7)  dmonth8 = 0
 ( 8)  dmonth9 = 0
 ( 9)  dmonth10 = 0
 (10)  dmonth11 = 0
 (11)  dmonth12 = 0
       F( 11, 14344) =    2.67
            Prob > F =    0.0020



. test tue wed thur fri
 ( 1)  tue = 0
 ( 2)  wed = 0
 ( 3)  thur = 0
 ( 4)  fri = 0
       F(  4, 14344) =    9.13
            Prob > F =    0.0000
```

14

Exhibit 5

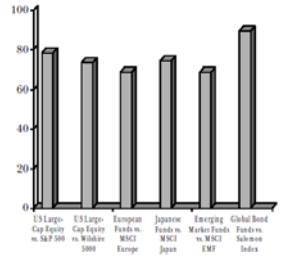
Percentage of Large Capitalization Equity Funds Outperformed by Index Ending 6/30/2002

	1 year	3 years	5 years	10 years
S&P 500 vs. Large Cap Equity Funds	63%	56%	70%	79%
Wilshire 5000 vs. Large Cap Equity Funds	72%	64%	69%	74%

15

Exhibit 7

Percentage of Various Actively Managed Funds Outperformed by Benchmark Index 10 Years to 12/31/01



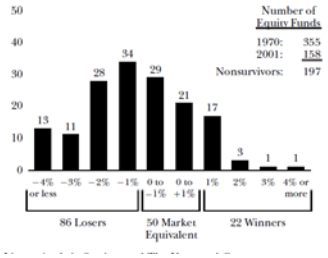
16

Exhibit 8
Getting Burned by Hot Funds

Fund Name	1998–1999 Rank	1998–1999 Average Annual Return	2000–2001 Rank	2000–2001 Average Annual Return
Van Wagoner:Emrg Growth	1	105.52	1106	−43.54
Rydex:OTC Fund:Inv	2	93.43	1103	−36.31
TCW Galileo:AGr Eq:Instl	3	92.78	1098	−34.00
RS Inv:Emerg Growth	4	90.19	1055	−26.17
PBHG:Large Cap 20	5	84.56	1078	−29.03
Janus Olympus Fund	6	77.24	1061	−27.03
Van Kampen Aggr Gro:A	7	76.70	1067	−28.04
Janus Mercury	8	76.31	1057	−26.35
PBHG:Sel Equity	9	76.21	1097	−33.19
WM:Growth:A	10	74.77	1046	−25.82
Berger New Generatn:Inv	11	73.31	1107	−45.96
Janus Enterprise	12	72.28	1101	−35.40
Janus Venture	13	72.22	1091	−30.89
Fidelity Aggr Growth	14	70.56	1105	−38.02
Janus Twenty	15	69.09	1090	−30.83
Amer Cent:New Oppy.	16	67.64	1033	−24.11
Morg Stan Sm Cap Gro:B	17	66.59	1102	−35.96
Van Kampen Emerg Gro:A	18	65.67	1021	−22.70
TCW Galileo:SC Gro:Insd.	19	64.87	1099	−34.77
BlackRock:MdCp Gro:Insd.	20	64.44	1009	−22.18
Average Fund Return		76.72		−31.52
S&P 500 Return		24.75		−10.50

17

Exhibit 9
The Odds of Success: Returns of Surviving Mutual Funds vs. S&P 500, 1970–2001



18

Wall Street Journal "Dart Board"

- Starting in Oct of 1988, asked four professional money managers to select a stock
- Compared that portfolio against 4 randomly selected stocks
- Tracked for 6 months
- Ended after 14 years in 2002 – 142 contests

19

Results

- Average 6 month return
  - Pros 10.2%
  - DJIA 5.6%
  - Darts 3.5%
- Pros beat market 54% of the time
- Pros beat darts 61% of the time
- Does this falsify the EMH?

20

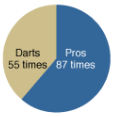
NEARING THE END OF THE MATCH

All the players have left the throw line. Five months from now, The Wall Street Journal's Investment Dartboard competition will end, once results of the five remaining rounds are reported. Below, how the pros have fared so far in the 142 legs of this stock-picking match started in January 1990.

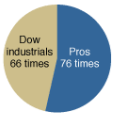
The pros have dominated most contests...

The pros' picks beat those of the darts in the majority of contests and beat the Dow Jones Industrial Average, too.

Pros vs. darts

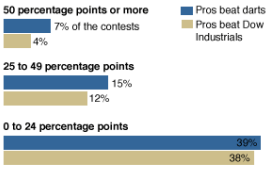


Pros vs. Dow industrials



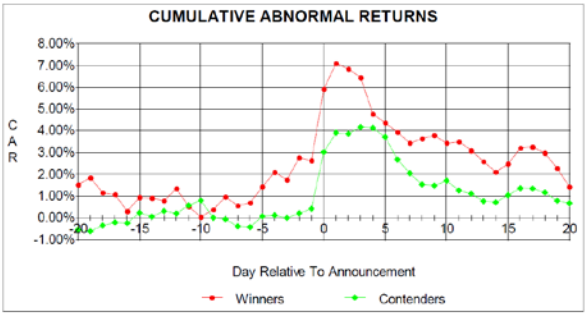
But the margin of victory has varied

The pros swept the darts by 50 percentage points or more in just five, or 7% of the contests.



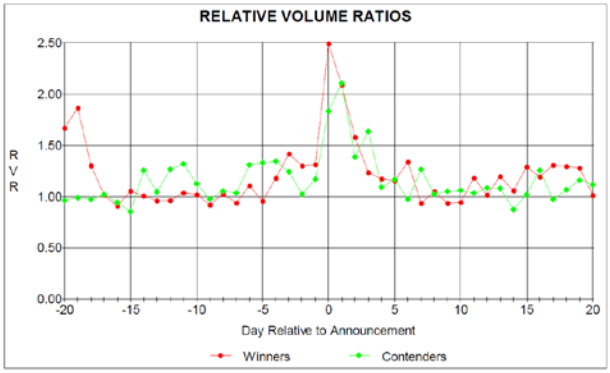
21

CUMULATIVE ABNORMAL RETURNS



22

RELATIVE VOLUME RATIOS



23