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April 81

# Joseph E. Granville: Prophet of Profits?

Mathematics of Gambling Edward O. Thorp

As discussed last month, Joseph Granville forecasts which way the market is going. This month, we try to measure how good his forecasts are if you follow them. Secondly, we are testing how likely it is that his forecasts are luck.

### The First Test

Let $t_0, t_1, \ldots, t_n$ be successive market days during the test period and let $d_0, d_1, \ldots, d_n$ be the corresponding DJIA closing prices. Define $\Delta d_i = d_i - d_{i-1}$ as the change in successive closing prices of the DJIA.

If $\Delta d_i > 0$, think of it as a "head" and if $\Delta d_i < 0$, think of as a "tail." A "no change" day is counted neither as a head nor a tail and is dropped. Think of these heads and tails as labelling balls in an urn.

If Granville is not able to select "up" periods better than chance, then the number of heads found in his set of "buy" days can be expected to be no greater than one might get if he sampled randomly from the urn. The data is listed in the charts marked *Period A* and *Period B*.

Period A had 480 market days. There were 256 up days, 53.3% of the total; and 224 down days, 46.7% of the total. Granville selected 402 of the 480 market days as up. If his predictions are better than chance, we would expect him to have a higher percentage of up days in his chosen set of 402 up days. In fact 56.5% of the days he called "up" actually were up. This is about 13 more days than the number expected from chance. Is it significant?

The relevant probability distribution to use here is the hypergeometric; we compute for periods A and B by using the equations in Table 1 respectively.

Given the numbers of up and down days in both periods as a whole, it seems very unlikely that Granville's "buy" periods would have contained so many up days by chance. For period A, the chance is about 1/751. For period B, it is about 1/134.

### The Second Test

If $d_i$ and $d_{i+1}$ are the DJIA close for two consecutive days, we examine the numbers $\log (d_{i+1}/d_i)$ for the periods under study. We assume that such numbers are normally distributed. If we further assume that Granville *cannot* call the market, then the "log ratios" from his "buy" periods, and his "sell" periods, are really just two samples drawn from the same population. There is no reason to believe that $\mu_B \quad \mu_S$, where $\mu_B$ is the mean log ratio from his periods and $\mu_S$ is the same for his sell periods.

We asked how unlikely it is that by chance $\mu_B$ would exceed $\mu_S$ by the observed account. We found for period A that the chance was 0.0002544 or about 1 in 3931. For subperiod B, it was .006904 or about 1 in 145. (We used a t-test and assumed the variances of the log ratios were the same during the buy and the sell periods.)

Thus, both statistical tests, over the subperiod as well as the full period, show that Granville's predictions were better than chance with significance better than the 0.01 level.

### The Results of the Granville Strategy

Table II will help us estimate the economic consequences of following Granville's advice in the test period.

With this scheme, $1 grows to $1.7364 in 697 days. This is a compound annual growth rate of 33.51% (1.7364 (365/697) = 1.3351). In addition, since we were net long 473 days out of 697 (585 long, 112 short), we would have gained ≈

**Period A: 12/04/78 thru 10/31/80**

| | Number of Market Days | Market Up Days | Market Down Days |
|---|---|---|---|
| DJIA | 480 | 256 or 53.3% | 224 or 46.7% |
| Granville's "up" days | 402 | 227 or 56.5% | 175 or 43.5% |

**Period B: 11/08/79 thru 10/31/80**

| | Number of Market Days | Market Up Days | Market Down Days |
|---|---|---|---|
| DJIA | 248 | 137 or 55.2% | 111 or 44.8% |
| Granville's "up" days | 203 | 120 or 59.1% | 83 or 40.9% |

473/697 (4.5%) = 3.05% annually in dividends.

This corresponds to having a 100% margin on the long side, and having a 100% initial margin on the short side. We could have posted this assumed 100% short side margin in treasury bills. The yield from these bills would add to the return. This yield plus the net dividend yield ought to more than cover commission costs and the implicit costs of the specialist or market maker. It is also possible to receive interest on some of the short sale proceeds by negotiating with a suitable broker.

The actual initial margin for both long and short positions was 50% during the test period. Thus, a position twice as large could have been taken. It could have been maintained since there were no price fluctuations adverse enough to trigger a maintenance margin call. On the long side the debit balance would have led to interest charges.

When all these factors are considered, a fully margined position would have led to a compound annual rate of return. The rate of return would be about twice the 33.51% rate quoted above; less 6% perhaps, for interest on the long side debit, or about 61% per year.

As Sharpe points out in "Likely Gains from Market Timing" (Fin. Analyst Journal March/April 1975, pp. 60-69), instead of buying and selling short the DJIA, we could have used a diversified portfolio of high beta stocks. If the port folio beta were, say, 1.5 times the beta of the DJIA (approximately 1.0), then we would expect to multiply the previous rates of return by about 1.5.

When the DJIA is expected to rise, still another strategy is to buy a diversified portfolio of call options. Especially call options that are at or somewhat out of the money, preferably not overpriced according to the Black-Scholes model, and preferably on high beta stocks.

When the DJIA is expected to fall, adopt a similar strategy with

**TABLE I**

*Period A*

$$\frac{1}{\binom{480}{402}} \cdot \sum_{227 \leq q \leq 256} \binom{256}{q}\binom{224}{402-q} = .001332$$

*Period B*

$$\frac{1}{\binom{248}{203}} \cdot \sum_{120 \leq q \leq 137} \binom{137}{q}\binom{111}{203-q} = .007439$$

puts. (That would have been harder during the test period because, for most of it, there were only 25 put stocks.) Wayne Shapiro, head of the options department at First of Michigan, reports that this approach has been very profitable for both him and his clients.

The investment results from Granville's forecasts are dramatically better than what Sharpe indicates as likely. There are several reasons for this.

First, Sharpe assumes that the market timer is either long or is out of the market; whereas we assume that the Granville trader is short in markets expected to fall. With the accurate market timing of the test period, this accounts for about one third of the annual compound growth rate.

Second, Sharpe limits his market timer to making annual forecasts of the market. On the other hand, Granville may call a market turn at any time during the year. If Granville had been so limited during the test period, and had accurately called each year, or fraction thereof, the calls would have been "up" for each of the periods: (1) December 4, 1978 through December 31, 1978; (2) January 1, 1979 through December 31, 1979; and (3) January 1, 1980 through October 31, 1980.

Market timing would have coincided with buy and hold. The wealth relative would have been 924.49/806.83 = 1.1458; and the compound annual growth rate would have been a modest 7.39%.

A third difference is that our test was over a very short period (under

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**Table II**

| $i$ | $t_i$ | $d_i = t_i - t_{i-1}$ | $DJIA_i$ | $VR_i$* | |
|---|---|---|---|---|---|
| 1 | 12/04/78 | | 806.83 | | Buy |
| 2 | 9/24/79 | 294 | 885.84 | 1.097926 | Sell |
| 3 | 11/08/79 | 45 | 797.61 | 1.099600 | Buy |
| 4 | 2/15/80 | 99 | 884.98 | 1.109540 | Sell |
| 5 | 4/22/80 | 67 | 789.85 | 1.107494 | Buy |
| 6 | 10/31/80 | 192 | 924.49 | 1.170463 | |

Total calendar days = 697 product = 1.7364

**The holding period value relatives* $VR_i$, $i = 2, \ldots, 6$, *are computed as follows:*

*If we buy at* $t_{i-1}$, *then* $VR_i = DJIA_i / DJIA_{i-1}$

*If we sell short at* $t_{i-1}$,

*then* $VR_i = (DJIA_{i-1} + DJIA_{i-1} - DJIA_{i}) / DJIA_{i-1}$

## Mathematics of Gambling

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two years). Sharpe's test covers the 44 year period from 1929 through 1972.

Note that Sharpe refers to the correct yearly choice of whether to be long the market, or long cash equivalents instead, as "perfect timing." He concludes that the gain from perfect timing over buy and hold would have been a modest 5.5%.

Then, he considers the case of "virtually clairvoyant market timing:" That is the timer buys at the low for the year, sells at the next annual high and goes into cash equivalents, buys at the next annual low, etc.

The 1929-1972 gain is 19.9% a year and the excess gain is 16.1% per year. For 1946-1972 the gain is 15.7% a year and the excess gain is 8.8% per year. This strategy is closer to Granville's in the test period and the gains compare more closely with Granville's. **gt**

## New Casino State

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times that number were held.

Ambler's instincts also appear to be supported by a 1978 poll conducted by the Public Affairs Research Center of Clark University in Worchester, Mass. The Clark poll showed 54 percent of its sample reacted positively toward legalizing casino gambling. Unfortunately, less than half (47 percent) said they would attend a casino. Even fewer (44 percent) said they approved of locating a casino in their community.

In the final analysis, it will be the Legislature, not the citizenry, disposing of the casino gambling issue this year. The foremost problem in the minds of lawmakers will be how to cope with Proposition 2-1/2. Will legislators take a chance on including casino gambling as part of the solution to that problem? In a commonwealth of gamblers, MGM and its allies are betting on it. **gt**



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