Actuarial Forecasting

By Brian Costello

Introduction

Often investors assume that any share prediction ultimately carries elements of chance or fate, yet the future of the market can be forecast successfully. The value of the forecast lies in its accuracy. The accuracy can be measured in both time and price as well as by the probability that the outcome will be as forecast.

Common forecasting methods or techniques include:

- Physical laws
- Technical analysis
- Actuarial forecasting

i) Physical laws

Physical laws allow for definitive outcomes. Forecasts of this type include natural processes such as sunrise and sunsets, phases of the moon, high and low tides, the melting point of steel, and the freezing point of water.

Physical laws are very accurate, although the timing of the results may not be perfect. Events such as sunrises and sunsets may be calculated precisely, but a particular location may vary due to topographical features. For example, living at either the bottom or eastern side of a mountain will result in earlier sunsets. Other examples include how imperfections in a steel bar can change the melting point; or strong winds can advance or delay a particular tidal level by a small amount.

ii) Technical analysis

Technical forecasting employs a variety of techniques such as Elliott Wave theory, Gann analysis and Geometric analysis. One of the characteristics of this type of forecasting is the amazing accuracy that can occasionally be achieved. The lower probability of success requires that the use of such forecasts be tempered with considerable caution.

iii) Actuarial forecasting

The science of the actuary, which is in turn derived from statistical analysis, defines this type of forecasting. When irregularities need to be accounted for, actuarial forecasting techniques become appropriate. Actuarial forecasts predict a broader target area with an extremely high probability of being correct.

The best-known application of actuarial forecasting relates to the insurance industry. The calculation of the premium required for life insurance involves an awareness of the average life span while observing the variation from the average that occurs. The life span is determined from an examination of historical records of deaths. The age of death for each person comprising part of the data sample is added together and divided by the total number of participants; thus providing the average age at death. If the sample is large enough to represent the community, the average will accurately reflect the age of death within the population as a whole.

Of course, not all people will die at that particular age, but a large percentage of deaths will occur close to the average. Deaths that occur a long way from the average will be many times fewer than those occurring a moderate distance from the average.

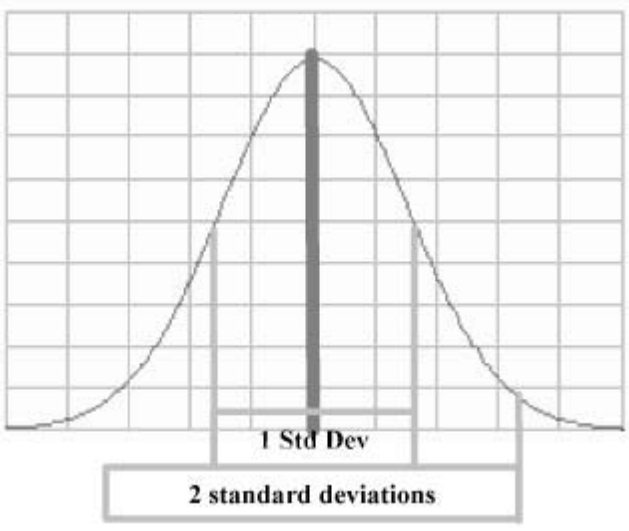

Figure 1: Bell Curve

The tendency for events to cluster around an average is called distribution and follows rigid mathematical rules. Distribution diagrams are the familiar bell curve patterns (figure 1, page 5).

The number of times an event will occur will decrease in proportion to the amount that the event is above or below average. Outcomes that are well above or well below the average are infrequent. Some 68 per cent of the events will cluster around the average within one standard deviation. Some 95 per cent of all events will occupy the area inside the bell curve within two standard deviations.

The bell curve shows that similar events tend to have similar outcomes. The occasions when an outcome is exceptionally different from another tend to be very rare.

Distribution Theory

Distribution theory is used to determine the probability of an event occurring within a specific parameter such as time or price.

Some examples of when this theory can be applied include the following:

- The average life span of people
- The mean reaction of a large group to a recurring event
- The probability of the occurrence of a particular event

Distribution Theory in Share Trading

Distribution theory can be applied to the reaction of a large group of traders who make up the markets. Charts provide the average reaction reflected in prices. This data has considerable validity as prices represent actions actually taken that expose the individual to financial pain or gain. The price is an accurate reflection of the average of all of the reasons why a decision is made to buy or sell.

Given the huge amount of data that occurs during an average economic cycle, it is not surprising that distribution principles are applicable.

The change in the different personality types from extreme to average, within the participating group during each cycle, is small and the differences are easily assimilated into the average with little change from one cycle to the next. The events the group is subjected to change from one cycle to the next, and will be the major determinant in the variation of the time and price balance that occurs during the cycle.

The factors used in actuarial forecasting of share markets are:

- Price
- Time
- Ratio
- Variance
- Deviation

Over 125 years the economic cycles have been subjected to the influences of:

- Political events
- World wars
- Economic depressions
- National disasters
- National scandals
- High interest rates/ high inflation rates (shorter cycles)
- Low interest rates/ low inflation rates (longer cycles)

As a consequence, the parameters of future cycles are exceedingly likely to be contained within the extremes of previous cycles. At worst, any new extremes should only surpass the old by a small margin. Extreme events or events that result in an increase to the existing parameters are quite obvious.

Variation and Deviation in Distribution Theory

The expressions, variation and deviation, are often used in distribution theory and other forms of statistical analysis.

For clarification, these are defined as:

Variation is the difference between the average and the extreme.

Deviation is the average of the variation.

Market Types

Different market types can have an influence on any particular index dependant upon the strength of that particular classification.

Some influential market categories are:

i) Grain markets

Price movement reflects seasonal conditions. Price ranges reflect supply and demand. Good seasons in all of the major grain growing areas of the world result in lower prices (greater supply). Prices are sensitive to meteorological phenomena such as cyclones (or typhoons or hurricanes depending upon location). Corn is often used as a benchmark due to its sensitivity to weather conditions. Prices for United States grains usually peak from June to August and fall from November to February.

ii) Stock indices

Indices such as the All Ordinaries Index demonstrate a slow long-term growth as they reflect the basic value of the assets of a country.

iii) Resource markets

Gold, silver and oil experience volatility as the result of political instability, wars (real or threatened) and technology advances.

iv) Financial markets

Bonds and currencies tend to oscillate in a range contained within upper and lower boundaries.

Note: All markets have cyclic characteristics, which provide some ability to forecast future market movements.

Australian Share Market Highs

Table 1 on page 8 examines the data relating to significant highs of the Australian share market (ASX All Ordinaries Index) between 1879 and 2002. The number of days between the market low and market high are calculated using the first day of the month. Analysis such as this can be used to understand how the economic cycles have operated over time and can be used to learn more about the characteristics of Australian "bull" markets. This information provides background for the forecast later in this article.

	Low at the bottom of the bull market	Date of the low (mm/yyyy)	High at top of the bull market	Date of the high (mm/yyyy)	Number of days from low to high	Number of days (low to high) as a % of the total number of days in the data sample	% increase from low to high	Number of days elapsed for each 1% rise
Market Events (9)	3.89	2/1879	10.18	11/1888	3561	7.93%	161.70%	22.02
	6.49	3/1894	22.52	6/1914	7396	16.46%	247.00%	29.94
	17.47	12/1916	51.72	7/1929	4595	10.23%	196.05%	23.44
	27.80	8/1931	74.5	3/1937	2039	4.54%	167.99%	12.14
	50.60	3/1942	139.3	5/1951	3348	7.45%	175.30%	19.10
	92.60	12/1952	443	1/1970	6240	13.89%	378.40%	16.49
	193.70	10/1974	746	11/1980	2223	4.95%	285.13%	7.80
	461.40	7/1982	2306	10/1987	1918	4.27%	399.78%	4.80
	1151.00	1/1991	3444	2/2002	4049	9.01%	199.22%	20.32

Table 1 - An examination of significant highs in the Australian share market

Calculation	Result
(a) Total number of days in the data sample	44,925
(b) Number of days to achieve the average rise	3,930
(c) Total number of days from low to high as a % of the total number of days in the data sample (bull market)	78.72%
(d) Average number of days from low to high as a %	8.75%
(e) Average increase from low to high as a %	245.62%
(f) Average number of days elapsed for each 1% rise	17.34 days

Table 2 - Summary of data from Table 1

Workings and Notes from Table 2

(a) The total number of days (total data sample) is calculated from 1 February 1879 to 1 February 2002.

(b) Total number of days in the data sample (44,925) × Average number of days from low to high as a percentage (8.75%) = 3,930 days. This is the average number of days per cycle to achieve the average gain.

(c) Sum of "Number of days from low to high" (35,369) ÷ Total days in the data sample (44,925) × 100 = 78.72%. This calculation represents the percentage of bull markets for the total period.

d) Sum of "Number of days (from low to high) as a % of the total number of days in the data sample" ÷ Number of events (9) = 8.75%.

e) Sum of "% increase from low to high" (2,210.58) ÷ Number of events (9) = 245.62%.

f) This calculation shows on average how many days it took for the market to make a 1% rise/gain.

Data available for most years is the closing price on a monthly chart. Hence some highs and lows may not correspond precisely with actual levels. These variations are acceptable for this style of analysis. The end figures were rounded down to two-decimal places for the purpose of this analysis.

Australian Share Market Lows

Table 3 examines data relating to significant lows that have occurred in the Australian share market from 1894 to 1991. This analysis can be used to learn more about the characteristics of Australian "bear" markets. This information provides background for the forecast later in this article.

	Low following the bull market	Date of the low (mm/yyyy)	Number of days from high to low	Number of days (high to low) high as a % of the total number of days in the data sample	% Decrease from market high to low	Number of days elapsed for each 1% fall
Market Events (8)	6.49	3/1894	**1946**	4.33%	36.25%	53.69
	17.5	12/1916	914	2.03%	22.42%	40.76
	27.8	8/1931	761	1.69%	46.25%	16.45
	50.6	3/1942	**1826**	4.06%	32.08%	56.92
	92.6	12/1952	580	1.29%	33.52%	17.30
	194	10/1974	**1734**	3.86%	56.28%	30.81
	461	7/1982	607	1.35%	38.15%	15.91
	1151	1/1991	1188	2.64%	50.09%	23.72

Table 3 - An examination of significant lows in the Australian share market

Calculation	Result
(g) Number of days to achieve the average fall	1194.5 days
(h) Average number of days elapsed for each 1% fall	31.95 days
(i) Total number of days from high to low as a % of the total number of days in the data sample (bear market)	21.27%
(j) Average decrease from high to low as a %	39.38%

Table 4 - Summary of results from Table 3

Workings and Notes from Table 4

(g) Sum of "Number of days from high to low" ÷ Number of events (8) = 1194.50 days.

(h) Sum of "Number of days elapsed for each 1% fall" ÷ 8 = 31.95 days.

(i) Sum of "Number of days from high to low" (9556) ÷ data sample (44,925) = 21.27%. This calculation represents the percentage of bear markets for the total period.

(j) Sum total "Number of days elapsed for each 1% fall" ÷ 8 = 39.38%

All Cycles and Non Extreme Cycles

Economic cycle classifications also assist in share market forecasting. Economic cycle classifications will provide more meaning and improve the quality of the data sample.

The calculations using the cycles marked as "non extreme cycles" remove those cycles that have had extreme passages of time or were in extreme price ranges. An example of this is the 1894 to 1914 cycle. This cycle was most likely two cycles but the parameters of cycle analysis require that it be counted as one.

Conversely, cycles labelled "all cycles" contain all information from that period. There is no attempt to smooth out the data in "all cycles".

Table 5 below compares projections for TIME to a share market high, using all cycles and non extreme cycles.

	Number of days from low to high	Date of projected high
Minimum time to a high	1918 days	2 Apr 1996 (all cycles)
Minimum time to a high	2039 days	1 Aug 1996 (non extreme cycles)
Maximum time to a high	7396 days	2 Apr 2011 (all cycles)
Maximum time to a high	4595 days	1 Apr 2003 (non extreme cycles)
Average time to a high	3930 days	5 Oct 2001 (all cycles)
Average time to a high	3302 Days	15 Jan 2000 (non extreme cycles)

Table 5 - Projections for TIME to a share market high (assumed start date January 1991)

Table 6 below compares projections for PRICE to the top of the share market using all cycles and non extreme cycles.

	% Rise (low to high)	Projected high
Minimum rise to a high	161.7%	3140 (all cycles)
Minimum rise to a high	167.99%	3216 (non extreme cycles)
Maximum rise to a high	399.78%	5997 (all cycles)
Maximum rise to a high	196.05%	3553 (non extreme cycles)
Average rise to a high	251.42%	4045 (all cycles)
Average rise to a high	179.78%	3357 (non extreme cycles)

Table 6 - Projections for PRICE to a share market high (assumed cycle low is 1,200)

Table 7 below compares projections for TIME to a share market low from the 3444 double top completed June 2001 and February 2002. This table once again uses all cycles and non extreme cycles.

	Number of days from high to low	Date projections using June 2001 as the reference point	Date projections using February 2002 as the reference point
Minimum time to a low	580 days	2 Jan 03	4 Sep 03 (all cycles)
Minimum time to a low	580 days	2 Jan 03	4 Sep 03 (non extreme cycles)
Maximum time to a low	1946 days	29 Sep 06	1 Jun 07 (all cycles)
Maximum time to a low	1188 days	1 Sep 04	4 May 05 (non extreme cycles)
Average time to a low	1195 days	8 Sep 04	11 May 05 (all cycles)
Average time to a low	810 Days	20 Aug 03	21 Apr 04 (non extreme cycles)

Table 7 - Projections for TIME to a share market low from the 3444 double top completed June 2001, and February 2002.

The All Ordinaries Index has made double tops; as a consequence the time calculations can be made with reference to either top. Argument can be made for either top being technically correct as the top, which represents the exhaustion of positive sentiment. For completeness, the calculation tables are applied to both tops. The calculations are presented using all cycles and also the non-extreme cycles.

Table 8 below compares projections for TIME to the bottom of the share market from the 3444 double top completed June 2001 and February 2002. This table uses all cycles and non extreme cycles.

	% Fall (high to low)	Projected low
Minimum fall to a low	22.42%	2672 (all cycles)
Minimum fall to a low	22.42%	2672 (non extreme cycles)
Maximum fall to a low	56.28%	1505 (all cycles)
Maximum fall to a low	50.09%	1725 (non extreme cycles)
Average fall to a low	39.38%	2087 (all cycles)
Average fall to a low	38.08%	2132 (non extreme cycles)

Table 8 - Projections for PRICE to the share market low from the 3444 double top completed June 2001, and February 2002.

Using the information displayed in Table 5, Table 6, Table 7 and Table 8, the trader is able to identify potential time and price targets on the chart of the All Ordinaries Index.

The rectangles in Figure 2 on page 12 are the boundaries defined by the non extreme cycles. The crosses represent the intersection of the averages for all cycles and the non-extreme cycles.

The peak of the share market cycle terminated within the rectangle of probabilities shown on the chart below. The price achieved the parameters using the non extreme cycles but, the time target was better predicted by the all cycles averages. Note the tendency for the final outcome to be biased away from non extreme cycles' targets toward all cycles' target areas.

Conclusion

It should be appreciated that actuarial forecasting averages out abnormal data relevant to the size of the data sample. The nature of this technique results in a broad target area with an extremely high probability of termination within that area.

Using Actuarial Forecasting, it can be concluded that a very high probability exists that the All Ordinaries has not yet completed a cycle correction. Probabilities suggest that the market will decline during 2004 to somewhere below 2300.

Brian Costello *is the Managing Director of the National Institute of Financial Studies.*
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Figure 2 - Projected ASX All Ordinaries time and price targets based on actuarial forecasting technique