Statistical Testing of the Random-Walk Theory

The random-walk theory of stock prices is the best-tested and best-verified theory in economics!

Many statistical tests support the random-walk theory.

Difficulty of Statistical Testing

Most theories in economics are difficult to test with data.

The key problem is that typically a controlled experiment is not possible. The economist makes inferences from observed data.

(Astronomy shares this trait with economics.)

Ceteris Paribus

Economic theory postulates a relationship between two economic variables, with other things held constant. Yet in practice many things change simultaneously, and the alleged relationship cannot be isolated.

Downward-Sloping Demand?

A simple example is the theory of demand. Although all economists believe that the demand curve for a good is downward-sloping, to establish this relationship by data is extremely difficult.

Success

Perhaps the success of the statistical testing of the random-walk theory is that the theory applies regardless of whether other things change.

Surprising Result

This success has surprised many people, as many have believed that skillful use of technical analysis (charting) allows one to make economic profits.

Statistical Testing

The random-walk theory asserts that there is no pattern to stock-price changes. In particular, past stock-price changes do not enable one to predict future price changes.

One tests the theory by investigating whether any forecasting is possible. Do past stock-price changes enable one to forecast future price changes? Even a small ability to forecast would contradict the random-walk theory.

Graph of Stock Prices

A simple non-statistical test is just to graph a stock price as a function of time. The jagged appearance of the graph conforms with the random-walk theory. As the price change at one moment is uncorrelated with past price changes, the incessant up-and-down movement makes the graph jagged.

If the graph were smooth, this finding would contradict the random-walk theory. A movement up or down would continue, perhaps only for a brief time, but this continuation would create an opportunity for economic profit.

Correlation

A simple statistical test of the random walk theory is to calculate the correlation of the stock-price change during a period with the stock-price change during a previous period. For example, one can calculate the correlation of the daily stock-price change with the change on the previous day, or with the change two days ago.

The random-walk theory says that this correlation must be zero. Any non-zero correlation would allow one to forecast the future stock-price change somewhat, and one could make an economic profit.

Critique

Some economists say that the efficient-market theory does not require that the stock price follow a random walk. The theory of market equilibrium can allow a risk premium. The expected rate of return on an asset is the risk-free rate of return plus a risk premium.

If either the risk-free rate of return or the risk premium is not constant, then the expected rate of return is changing, so the stock price does not follow a random walk exactly.

At their most extreme, these critics maintain that the efficient-market theory is untestable.

This critique demeans the many tests that support a random walk and market efficiency.

Contrast the efficient-market theory with the alternative point-of-view, held by many. Assets are mispriced, sometimes overpriced and sometimes underpriced. Opportunities for economic profit exist. A moderately clever person can readily become wealthy.

This point-of-view maintains that stock market and other returns are quite predictable. The contribution of the efficient-market research is to find little predictability.

Variability of the Expected Return

See the return on an asset as the expected return, which can be forecasted, plus the unexpected return, which cannot be forecasted, by definition.

The point-of-view that financial markets are inefficient is a contention that there is considerable variability of the expected return. Sometimes the expected return is high, and sometimes low. Exploiting this variability allows one to make substantial profit.

In contrast, the point-of-view that financial markets are efficient is a contention that the variability of the expected return is small.

An alternative statement involves the excess return, defined as the return on an asset relative to the return on a risk-free asset. Efficiency is a contention that the variability of the expected excess return is small.

Low Unconditional Variance

The efficient-market research finds little variability of the expected return.

Specifically, the claim is that the unconditional variance of the conditional expected return is low.

Short-Run or Long-Run Predictability?

Compare two possible alternatives for the time pattern of the expected return: short-run variability versus long-run variability.

Short-Run Variability

One possibility is that the expected return varies considerably in the short run. One could then make short-run trading profits by buying and selling depending on whether the expected return is high or low.

The efficient-market research shows conclusively that short-run trading profits are not there to be had.

Long-Run Variability

Some economists contend that there is long-run variability (but not short-run variability) in the expected return. Although the expected return varies little in the short run, during certain periods the expected return is high (when stock prices are "low") and during other periods the expected return is low or negative (when stock prices are "high").

In a boom, prices may get too high. And a big drop in stock prices furnishes a good buying opportunity, as in the past stock prices have eventually recovered after a drop.

According to this point-of-view, the unconditional variance of the conditional expected return is significant, even though the expected return changes slowly.

Although one cannot make reliable short-run trading profits, to buy when the expected return is high will on average yield a superior return, if one holds the investment for a number of years.

Difficulty of Statistical Testing

Such long-run variability is difficult to establish statistically. For example, perhaps the expected return stays high for five years and then is low for five years. For a fifty-year period, one then has only $50/5 = 10$ independent observations, too few for a meaningful statistical test.

Testing for long-run variability depends crucially on whether one includes the 1930's Great Depression and the 1990's stock boom. In each case stock prices fell greatly after a spectacular boom, but eventually recovered.