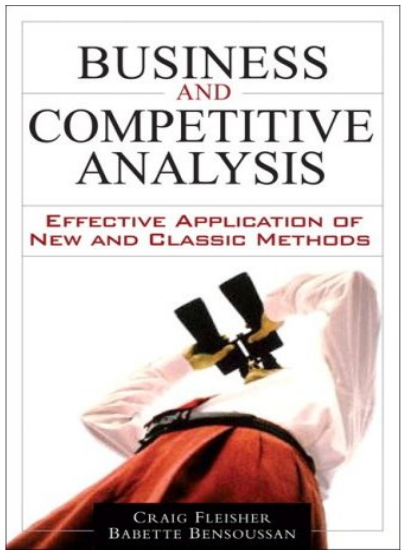

FT Press
FINANCIAL TIMES

Chapter 26

Statistical Analysis

Ch26. Statistical Analysis

- Short Description
- Background
- Strategic Rationale & Implications
- Strengths & Advantages
- Weaknesses & Limitations
- Process for Applying Technique
- FAROUT

Ch26. Statistical Analysis

Short Description

- Statistical analysis involves the manipulation of data using a variety of mathematical formulae and description of situations using mathematical concepts.
- It enables simple description of complex situations and can give predictive insights.

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Background

- Statistics involves summarizing, analysing, and graphing data.
- Introduces objectivity.
- Interpretation is crucial to the value of statistics.
- Reduces uncertainty in decision making.
- The design of the data collection and the method of analysis are very important.

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Strategic Rationale and Implications

- Statistics provide systematic analysis of data to create information.
- Firms exist in data overload- statistics help organize this data.
- A **population** is the entire set of a particular variable, for example every sale you have made.
- A **sample** is a subset of the population.
- Analysis process usually answers a question or need—carefully articulate this before continuing.
- Analysis can be done in-house or by third party depending on intricacy.
- Accurate interpretation is important regardless of complexity.

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Strengths and Weaknesses

- It provides systematic and objective methods for examining data and extracting information.
- Can be used to simplify complex problems.
- Computers make statistical analysis accessible.
- Inferences made by statistical analysis can also inform decision-making.
- Can provide objective information about business' performance, customers, and environment.
- Neutrality removes politics.

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Weaknesses and Limitations

- Statistical analysis is very easy to misuse and misinterpret.
- The process of designing a statistical analysis is very important and complex.
- Interpretation of the results must be quality (causation vs. correlation).
- Results are sometimes "spun" to serve a purpose.
- Statistics are necessarily backwards facing.
- Predicting of probability is difficult.

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Process for Applying the Technique

Percentage changes

- Percentages are some of the most basic statistics used:

$$p = (x-y)/y \times 100$$

where: p is the percentage change
***x* is the new value**
***y* is the old value**

- Interpretation of percentage increases or decreases can be complicated by a couple of circumstances.

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Process for Applying the Technique

- Comparing percentage changes across groups:
  - In town A sales increased from 50 to 65 and in town B sales increased from 50 to 52. The percentage increase for A is 30 per cent, while for B it is 4 per cent.
- Consider population growth in town A and town B to see whether there is more to the story.
  - Per capita rates are generally expressed as a figure per 100,000 and calculated as follows:

$$c = x/p \times 100{,}000$$

where: ***c*** **is the per capita rate**
x **is the value of interest**
p **is the total population**

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Process for Applying the Technique

- If the population of town A had increased from 10,000 to 15,000 over the year and town B had no 8000, what do per capita sales tell us about the performance of the respective teams?

- The other potential complication for interpreting percentage change is where some other factor has had an influence over the time period.
- In other circumstances it may take some research to explain an unusual change.

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Process for Applying the Technique

Percentiles and quartiles

- Percentiles provide a ranking within a range of data.
- Percentiles divide a sample or population into 100 parts.
  - To work out which score represents a particular percentile you must first arrange your data in increasing order.
  - Then work out which score by multiplying *n* (the total number of data points) by *P*/100.
  - The percentile will occur at *m* the nearest whole number greater than or equal to *n* x *P*/100 (either the *m*th value in the list of the mean of the *m*th and the (*m*+1)th values).

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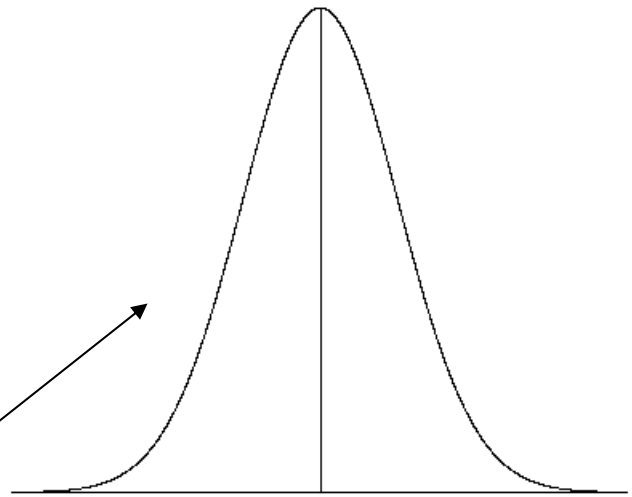
Process for Applying the Technique

Normal distribution and bell curve.

- Distribution refers to the pattern of distribution of measurements for x (along the x-axis) against the number of instances, or the frequency of the measurements (y-axis).
- A normal distribution:



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- Summarizing data with one value — central tendency.
  - The **mean** is a measure for the average value of a set of numeric data.

$$X_{mean} = (X_1 + X_2 + X_3 + \ldots X_n)/n$$

where: x_{mean} is the mean value of the sample
***n* is the total number of values you are looking at in your sample**
X_1 is the first data point, X_2 is the second data point …
X_n is the last data point

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Process for Applying the Technique

- ***Median***
  - The observations you have made are arranged in order of magnitude and the median is the central point in the array.
  - The median can be very useful where your data ranges over a wide set of values, some of which is very large or very small compared with most.
- ***Mode***
  - The mode is the most frequently recorded value for an observation.
  - You can have more than one mode in a distribution.
  - The mode is not generally used to summarise numeric data, but is very useful as a single value summary with categorical information.

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- ***Standard deviation***
  - The standard deviation gives a measure for the distribution of measures within your sample in relation to the mean.
  - Where you are using the mean to describe the 'average' value of your data, the standard deviation assumes a normal distribution of data.
  - Standard deviation is calculated from the residuals, or differences, between each data point and the mean.

$$s = \sqrt{((X_1 - x_{mean})^2 + (X_2 - x_{mean})^2 \ldots (X_n - x_{mean})^2)/(n - 1))}$$

where: *s* is the standard deviation for the sample you are looking at
***n* is the total number of values in the sample**
X_1 is the first data point, X_2 is the second data point … X_n is last data point
X_{mean} is the mean value of the sample

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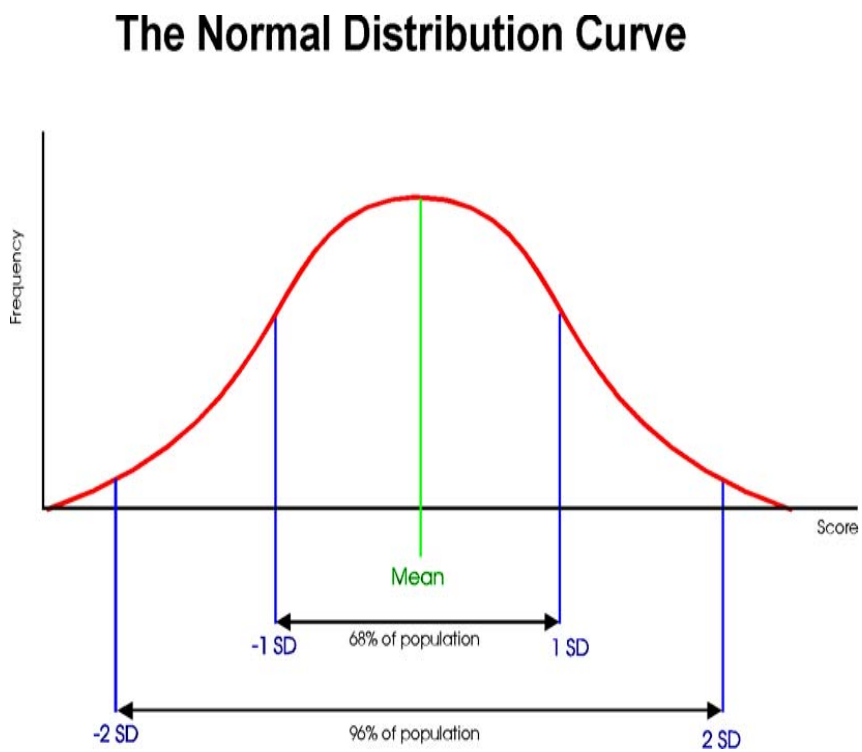
Process for Applying the Technique

- **Standard deviation Cont'd**
  - Can use software to compute standard deviation.
  - 68% value *x* will appear within one standard deviation of the mean.
  - 96% within 2 standard deviations.
  - If the standard deviation is close to the amount of the mean then it would be considered high.



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Process for Applying the Technique

- **Comparing data**
  - Statistics are often used to test whether there is a real (significant) difference between two groups.
  - Example: test whether your attrition rate among your customers had changed over time (or not).
  - A null hypothesis proposes that there is no difference.
  - The test used to compare means of two groups: the t-test.

$t = (mean_1 - mean_2)$/standard error of the difference between the means

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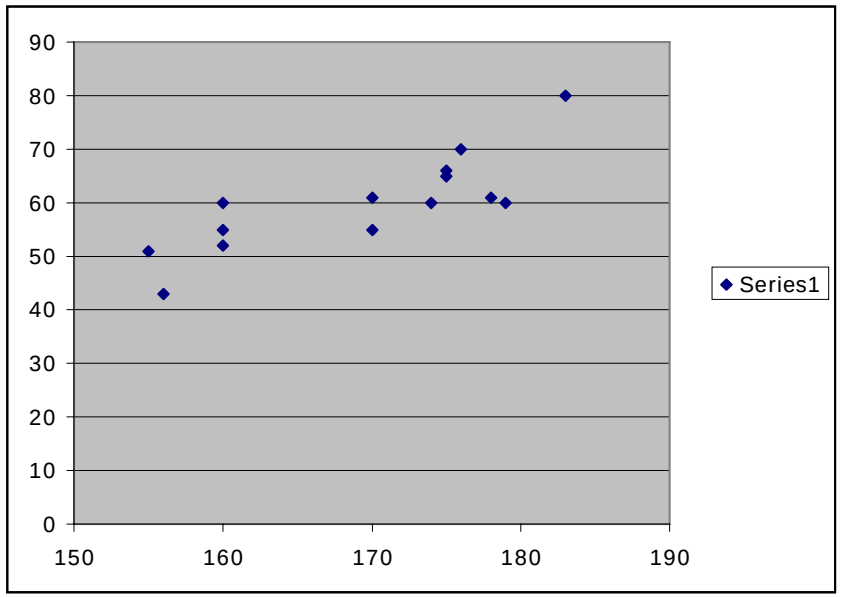
Process for Applying the Technique

- **Regression analysis**
  - Looking at two instances of the same value can be useful for investigating changes in it over time.
  - Ex: height and weight for a sample of people.
  - Relationships between the two properties or values plotted on a scatter plot are summarized by a line. This is called regression analysis of the data.

Scatter plot of weight against height



SOURCE: Adapted from McNeil D, Middledorp J, Petersons M and Shaw P, *Modern statistics: an introduction*, Macquarie University, 1994

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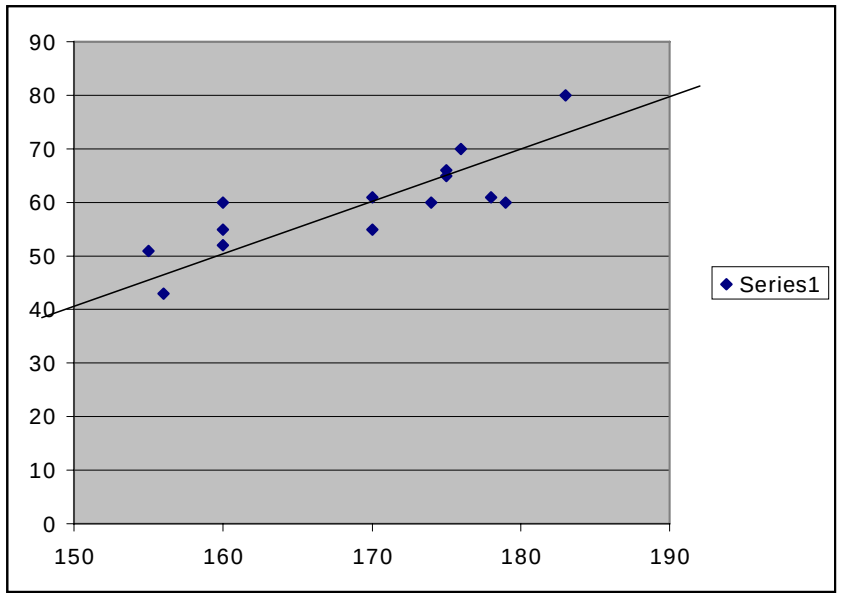
Process for Applying the Technique

- **Regression Analysis Cont'd**
  - Straight lines: draw in a line approximately fitting the data



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Process for Applying the Technique

- **Regression Analysis Cont'd**
  - A point on a straight line is represented by the formula:

$$y_{predicted} = a + bx$$

where: $y_{predicted}$**: value you're predicting**
a is the intercept
b is the slope of the line
***x* is the know value**

  - The value of a and b for any line can be calculated using the co-ordinates of any two points on the line, the coordinates for the points are $x1,y1$ and $x2,y2$.

$$a = (x_2 \times y_1 - x_1 \times y_2) / (x_2 - x_1)$$
$$b = (y_2 - y_1) / (x_2 - x_1)$$

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Process for Applying the Technique

- **Regression Analysis Cont'd**
  - Goodness of Fit
    - The 'goodness-of-fit' of your data to the line tests the accuracy of the formula for your line in predicting new values for *y* by finding the standard deviation of the residuals, or more precisely from the sum of squares of the residuals:

$$S_{residuals} = (y_1 - y_{1 \text{ as predicted by formula}})^2 + (y_2 - y_{2 \text{ as predicted by formula}})^2 \ldots + (y_n - y_{n \text{ as predicted by formula}})^2$$

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Process for Applying the Technique

- **Regression Analysis Cont'd**
  - There is also an actual standard deviation, which is calculated using the same formula as for Sresiduals but uses the mean of the y values rather than the y values as predicted by the formula for the linear relationship.
  - The standard deviation of the residuals is then used to calculate r2:

$$r^2 = 1 - S_{actual\ residuals}/S_{residuals}$$

  - The r^2 value will be between 0 and 1and the closer to 1, the better is the fit and the more accurate the formula for the linear relationship is at predicting *y* values for a given *x* value.

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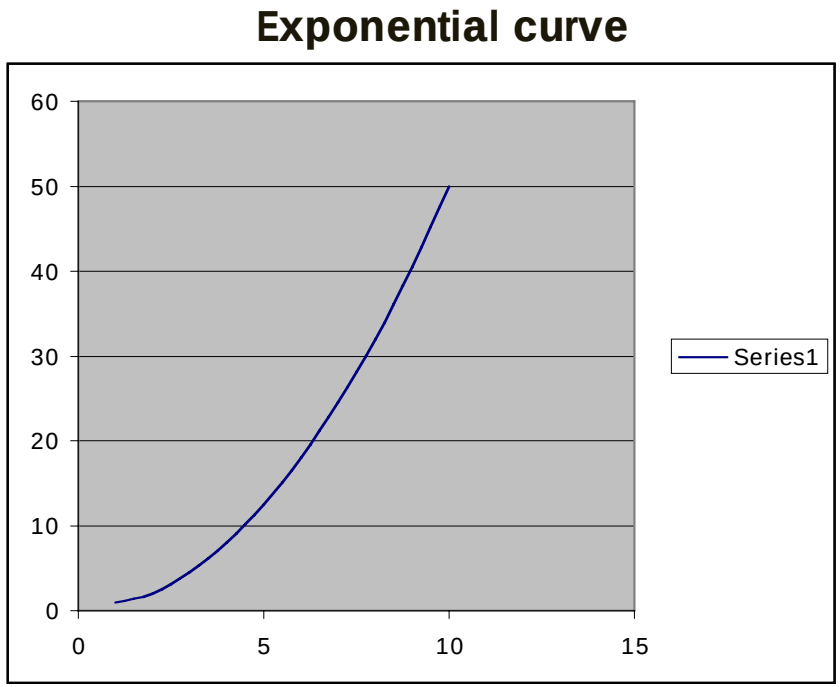
Process for Applying the Technique

- **Regression Analysis Cont'd**
  - Lines that are not straight
    - Ex: exponential curve.
    - Here the relationship is represented by the formula:

$$y_{predicted} = a + b \times x^2$$

    - Reverse of this is the hyperbolic curve.



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- Interpreting relationships found by regression analysis
  - Linear relationships cannot be used to approximate values for *any* possible value of *x.*
  - Should only be used over the range of the original data.
  - Formula for a linear relationship does not imply that changes in *x* cause changes in *y*.

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Process for Applying the Technique

- **Correlation**
  - A form of regression analysis.
  - Widely used.
  - Gives an indication of the tendency for one thing to occur in relation to the tendency for another to occur.
  - The correlation coefficient calculated for the data indicates the strength of the association between the two properties.
  - It will be number between -1 and 1.
  - The closer the absolute value of the correlation coefficient is to 1, the stronger the association.
  - Does not prove the existence of a cause and effect relationship.

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- **P-values**
  - P-values are used to describe the significance of a statistical finding.
  - They relate in part to the number of observations used to reach the conclusion and the magnitude of the observations.
  - A null hypothesis proposes that there is no difference between two groups.
  - Where a p-value is given as 0.05, this means that if the null hypothesis is true you would only have a 5 % chance of getting the results from a sample group that you in fact got.

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- **FAROUT Summary**

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Related Tools and Techniques

- Financial Statement and Ratio Analysis
- Benchmarking
- Competitor Cash Flow Analysis
- Patent Analysis

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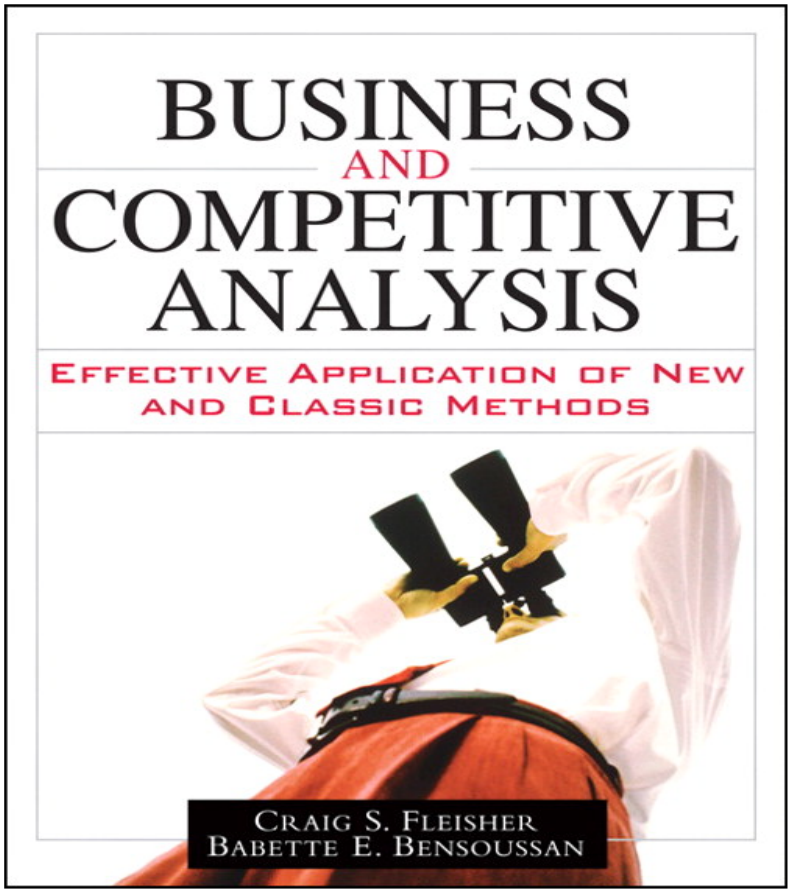

For More About Statistical Analysis and 23 Other Useful Analysis Methods, see:

Fleisher, Craig S. and Babette E. Bensoussan

Business and Competitive Analysis: Effective Application of New and Classic Methods

FT Press
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Upper Saddle River, NJ
2007