Chapter 1

Introduction

The Nature and Purpose of Econometrics

- What is Econometrics?

  Literal meaning is "measurement in economics".

- Definition of financial econometrics:

  The application of statistical and mathematical techniques to problems in finance.

Econometrics according to Ragnar Frisch

A word of explanation regarding the term econometrics may be in order. Its definition is implied in the statement of the scope of the [Econometric] Society, in Section I of the Constitution, which reads: "The Econometric Society is an international society for the advancement of economic theory in its relation to statistics and mathematics.... Its main object shall be to promote studies that aim at a unification of the theoretical-quantitative and the empirical-quantitative approach to economic problems...."

But there are several aspects of the quantitative approach to economics, and no single one of these aspects, taken by itself, should be confounded with econometrics. Thus, econometrics is by no means the same as economic statistics. Nor is it identical with what we call general economic theory, although a considerable portion of this theory has a defininitely quantitative character. Nor should econometrics be taken as synonomous with the application of mathematics to economics. Experience has shown that each of these three view-points, that of statistics, economic theory, and mathematics, is a necessary, but not by itself a sufficient, condition for a real understanding of the quantitative relations in modern economic life. It is the *unification* of all three that is powerful. And it is this unification that constitutes econometrics.

Ragnar Frisch, *Econometrica*, (1933), 1, pp. 1-2.

Examples of the kind of problems that may be solved by an Econometrician

1. Testing whether financial markets are weak-form informationally efficient.
2. Testing whether the CAPM or APT represent superior models for the determination of returns on risky assets.
3. Measuring and forecasting the volatility of bond returns.
4. Explaining the determinants of bond credit ratings used by the ratings agencies.
5. Modelling long-term relationships between prices and exchange rates.
6. Determining the optimal hedge ratio for a spot position in oil.

Examples of the kind of problems that may be solved by an Econometrician (Cont'd)

7. Testing technical trading rules to determine which makes the most money.
8. Testing the hypothesis that earnings or dividend announcements have no effect on stock prices.
9. Testing whether spot or futures markets react more rapidly to news.
10. Forecasting the correlation between the returns to the stock indices of two countries.

What are the Special Characteristics of Financial Data?

- *Frequency & quantity of data*

  Stock market prices are measured every time there is a trade or somebody posts a new quote.

- *Quality*

  Recorded asset prices are usually those at which the transaction took place. No possibility for measurement error but financial data are "noisy".

Types of Data and Notation

- There are 3 types of data which econometricians might use for analysis:
  1. Time series data
  2. Cross-sectional data
  3. Panel data, a combination of 1. & 2.

- The data may be quantitative (e.g. exchange rates, stock prices, number of shares outstanding), or qualitative (e.g. day of the week).

- Examples of *time series data*

Series	*Frequency*
GNP or unemployment	monthly, or quarterly
government budget deficit	annually
money supply	weekly
value of a stock market index	as transactions occur

Time Series versus Cross-sectional Data

- *Examples of Problems that Could be Tackled Using a Time Series Regression*
  - How the value of a country's stock index has varied with that country's macroeconomic fundamentals.
  - How the value of a company's stock price has varied when it announced the value of its dividend payment.
  - The effect on a country's currency of an increase in its interest rate

- Cross-sectional data are data on one or more variables collected at a single point in time, e.g.
  - A poll of usage of internet stock broking services
  - Cross-section of stock returns on the New York Stock Exchange
  - A sample of bond credit ratings for UK banks

Cross-sectional and Panel Data

- *Examples of Problems that Could be Tackled Using a Cross-Sectional Regression*
  - The relationship between company size and the return to investing in its shares
  - The relationship between a country's GDP level and the probability that the government will default on its sovereign debt.

- Panel Data has the dimensions of both time series and cross-sections, e.g. the daily prices of a number of blue chip stocks over two years.

- It is common to denote each observation by the letter t and the total number of observations by T for time series data, and to denote each observation by the letter i and the total number of observations by N for cross-sectional data.

Continuous and Discrete Data

- Continuous data can take on any value and are not confined to take specific numbers.
- Their values are limited only by precision.
  - For example, the rental yield on a property could be 6.2%, 6.24%, or 6.238%.
- On the other hand, discrete data can only take on certain values, which are usually integers
  - For instance, the number of people in a particular underground carriage or the number of shares traded during a day.
- They do not necessarily have to be integers (whole numbers) though, and are often defined to be count numbers.
  - For example, until recently when they became ‘decimalised‘, many financial asset prices were quoted to the nearest 1/16 or 1/32 of a dollar.

Cardinal, Ordinal and Nominal Numbers

- Another way in which we could classify numbers is according to whether they are cardinal, ordinal, or nominal.
- *Cardinal numbers* are those where the actual numerical values that a particular variable takes have meaning, and where there is an equal distance between the numerical values.
  - Examples of cardinal numbers would be the price of a share or of a building, and the number of houses in a street.
- *Ordinal numbers* can only be interpreted as providing a position or an ordering.
  - Thus, for cardinal numbers, a figure of 12 implies a measure that is 'twice as good' as a figure of 6. On the other hand, for an ordinal scale, a figure of 12 may be viewed as 'better' than a figure of 6, but could not be considered twice as good. Examples of ordinal numbers would be the position of a runner in a race.

Cardinal, Ordinal and Nominal Numbers (Cont'd)

- Nominal numbers occur where there is no natural ordering of the values at all.
  - Such data often arise when numerical values are arbitrarily assigned, such as telephone numbers or when codings are assigned to qualitative data (e.g. when describing the exchange that a US stock is traded on).
- Cardinal, ordinal and nominal variables may require different modelling approaches or at least different treatments, as should become evident in the subsequent chapters.

Returns in Financial Modelling

- It is preferable not to work directly with asset prices, so we usually convert the raw prices into a series of returns. There are two ways to do this:

Simple returns	or	log returns
$R_t = \frac{p_t - p_{t-1}}{p_{t-1}} * 100\%$		$R_t = \ln \frac{p_t}{p_{t-1}} * 100\%$

where, R_t denotes the return at time t, P_t denotes the asset price at time t and ln denotes the natural logarithm

- We also ignore any dividend payments, or alternatively assume that the price series have been already adjusted to account for them.

Log Returns

- The returns are also known as log price relatives, which will be used throughout this book. There are a number of reasons for this:

  1. They have the nice property that they can be interpreted as continuously compounded returns.
  2. Can add them up, e.g. if we want a weekly return and we have calculated daily log returns:

$$
\begin{aligned}
r_1 &= \ln p_1/p_0 &&= \ln p_1 - \ln p_0 \\
r_2 &= \ln p_2/p_1 &&= \ln p_2 - \ln p_1 \\
r_3 &= \ln p_3/p_2 &&= \ln p_3 - \ln p_2 \\
r_4 &= \ln p_4/p_3 &&= \ln p_4 - \ln p_3 \\
r_5 &= \ln p_5/p_4 &&= \ln p_5 - \ln p_4 \\
\hline
& &&\ln p_5 - \ln p_0 = \ln p_5/p_0
\end{aligned}
$$

A Disadvantage of using Log Returns

- There is a disadvantage of using the log-returns. The simple return on a portfolio of assets is a weighted average of the simple returns on the individual assets:

$$R_{pt} = \sum_{i=1}^{N} w_i R_{it}$$

- But this does not work for the continuously compounded returns.

Real Versus Nominal Series

- The general level of prices has a tendency to rise most of the time because of inflation
- We may wish to transform nominal series into real ones to adjust them for inflation
- This is called *deflating* a series or displaying a series *at constant prices*
- We do this by taking the nominal series and dividing it by a price deflator:

  $\textit{real series}_t = \textit{nominal series}_t * 100/\textit{deflator}_t$
  (assuming that the base figure is 100)
- We only deflate series that are in nominal price terms, not quantity terms.

Deflating a Series

- If we wanted to convert a series into a particular year's figures (e.g. house prices in 2010 figures), we would use:

  $$real\ series_t = nominal\ series_t * deflator_{reference\ year} / deflator_t$$

- This is the same equation as the previous slide except with the deflator for the reference year replacing the assumed deflator base figure of 100
- Often the consumer price index, CPI, is used as the deflator series.

Steps involved in the formulation of econometric models