財金計量方法

「計量」的意義及其與「統計」的關連

- 何謂「計量」(Econometrics)？ (以下取自 Brooks (2014) 3ed)

1.1 What is econometrics?

The literal meaning of the word econometrics is 'measurement in economics'. The first four letters of the word suggest correctly that the origins of econometrics are rooted in economics. However, the main techniques employed for studying economic problems are of equal importance in financial applications. As the term is used in this book, financial econometrics will be defined as the *application of statistical techniques to problems in finance*. Financial econometrics can be useful for testing theories in finance, determining asset prices or returns, testing hypotheses concerning the relationships between variables, examining the effect on financial markets of changes in economic conditions, forecasting future values of financial variables and for financial decision-making. A list of possible examples of where econometrics may be useful is given in box 1.1.

The list in box 1.1 is of course by no means exhaustive, but it hopefully gives some flavour of the usefulness of econometric tools in terms of their financial applicability.

Box 1.1 Examples of the uses of econometrics

(1) Testing whether financial markets are weak-form informationally efficient
(2) Testing whether the capital asset pricing model (CAPM) or arbitrage pricing theory (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
(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 stock indices of two countries.

1.2 Is financial econometrics different from 'economic econometrics'?

As previously stated, the tools commonly used in financial applications are fundamentally the same as those used in economic applications, although the emphasis and the sets of problems that are likely to be encountered when analysing the two sets of data are somewhat different. Financial data often differ from macroeconomic data in terms of their frequency, accuracy, seasonality and other properties.

In economics, a serious problem is often a *lack of data at hand* for testing the theory or hypothesis of interest – this is often called a 'small samples problem'. It might be, for example, that data are required on government budget deficits, or population figures, which are measured only on an annual basis. If the methods used to measure these quantities changed a quarter of a century ago, then only at most twenty-five of these annual observations are usefully available.

Two other problems that are often encountered in conducting applied econometric work in the arena of economics are those of *measurement error* and *data revisions*. These difficulties are simply that the data may be estimated, or measured with error, and will often be subject to several vintages of subsequent revisions. For example, a researcher may estimate an economic model of the effect on national output of investment in computer technology using a set of published data, only to find that the data for the last two years have been revised substantially in the next, updated publication.

These issues are usually of less concern in finance. Financial data come in many shapes and forms, but in general the prices and other entities that are recorded are those at which trades *actually took place*, or which were *quoted* on the screens of information providers. There exists, of course, the possibility for typos or for the data measurement method to change (for example, owing to stock index re-balancing or re-basing). But in general the measurement error and revisions problems are far less serious in the financial context.

Similarly, some sets of financial data are observed at much *higher frequencies* than macroeconomic data. Asset prices or yields are often available at daily, hourly or minute-by-minute frequencies. Thus the number of observations available for analysis can potentially be very large – perhaps thousands or even millions, making financial data the envy of macro-econometricians! The implication is that more powerful techniques can often be applied to financial than economic data, and that researchers may also have more confidence in the results.

Box 1.2 Time series data

Series	*Frequency*
Industrial production	Monthly or quarterly
Government budget deficit	Annually
Money supply	Weekly
The value of a stock	As transactions occur

- 你理解的「統計學」(Statistics)是什麼?

  - 母體 vs 樣本
  - 敘述統計 vs 推論統計
  - 估計 vs 檢定 (什麼是估計式? 什麼是檢定統計量?)
  - 統計學與機率論有什麼關連?
  - 統計學常被視為是數學的分支，它與數學有什麼關連?
  - 統計學與(經濟，財務)計量有什麼關連?

➢ 古典統計學(Classical statistics) vs 貝氏統計學(Bayesian statistics)

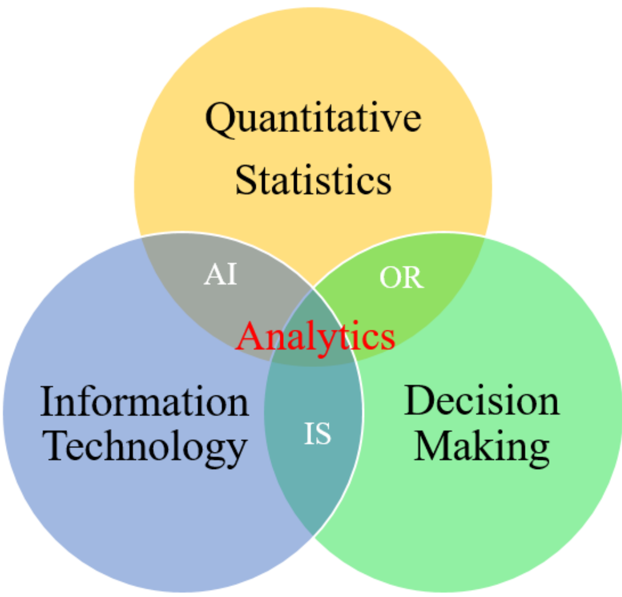
(下表取自 陳旭昇 統計學)

表 19.5: 貝氏統計與古典統計之不同

	貝氏統計	古典統計
基本觀察	μ 未知。根據我的主觀機率評估,一連串的試驗並非獨立,亦即觀察到的樣本不是 i.i.d. 樣本。	μ 未知但是依據客觀機率,一連串的試驗爲 i.i.d.。
基本原理	將我對未知參數 μ 的信念以隨機變數 B 來表示。以我的信念作爲統計分析的基礎。	統計分析立基於以上的客觀觀察,不帶任何主觀信念。
機率性質	主觀機率。	客觀機率。
統計分析方式	(a) 首先將我的主觀信念以隨機變數 B 來表示,形成先驗分配。 (b) 觀察樣本後,以貝氏法則再塑我對 B分配的信念,形成事後分配。 (c) 最後,利用 B 的事後分配做統計分析。	由於一連串的試驗爲 i.i.d.,即使我不知道 μ,只要我觀察的樣本夠多,WLLN 提供我猜測 μ 的準度。
主要應用	個人決策	提供諮詢,說服他人

- 新興學科: Analytics (資料分析學),Data Science (資料科學)

➢ Analytics (資料分析學) 與 Statistics (統計學) 有相似性,但被賦與更為廣義且更符合時代潮流的解釋



➢ 以下幾句話出自英國一位資料分析學教授的演講，我覺得很有道理…

✧ Analytics is a vocation, not a discipline.

✧ Data analytics = Purpose-led analysis, rather than discipline-led.

✧ We must avoid creating a “Master-of-the-Universe” mindset.

● 本課程仍專注在基礎「統計」的部分:

➢ 統計學可分為敘述統計 (descriptive statistics) 和推論統計 (inferential statistics)，後者也常稱為統計推論 (statistical inference)

➢ 敘述統計僅針對所取得樣本 (sample) 的分配作描述，推論統計則意圖藉由分析樣本來對母體 (population) 的參數 (例如母體的平均值或變異數) 進行推論

➢ 敘述統計觀察一組樣本分配的大致樣貌，常用前四階的統計量(平均值=mean，變異數=variance，偏態=skewness，峰態=kurtosis)來描繪

歷史典故 **Karl Pearson–現代統計學的奠基者**

Karl Pearson

一般認為現代統計學的奠基者為 Karl Pearson（1857~1936），他是英國統計學大師。他在 1890 年代的研究成果，開啟了現代統計的新觀念與新方法。他最先瞭解到統計數據會呈現出隨機散佈的特性。

Pearson 雖是政治學博士，但他最感興趣的是科學、哲學與數學模型的本質。他發現偏態分配，並認為科學家可能從數據得到任何一種分配形式，每種分配都能用四個數值來衡量，這四個數值（參數）是：

①平均數：觀察值散佈的中央值

②標準差：觀察值偏離平均數的情形

③偏　度：觀察值在平均數的兩側堆積的程度

④峰　度：觀察值偏離平均數的速度

（以上取自林惠玲，陳正倉 統計學）

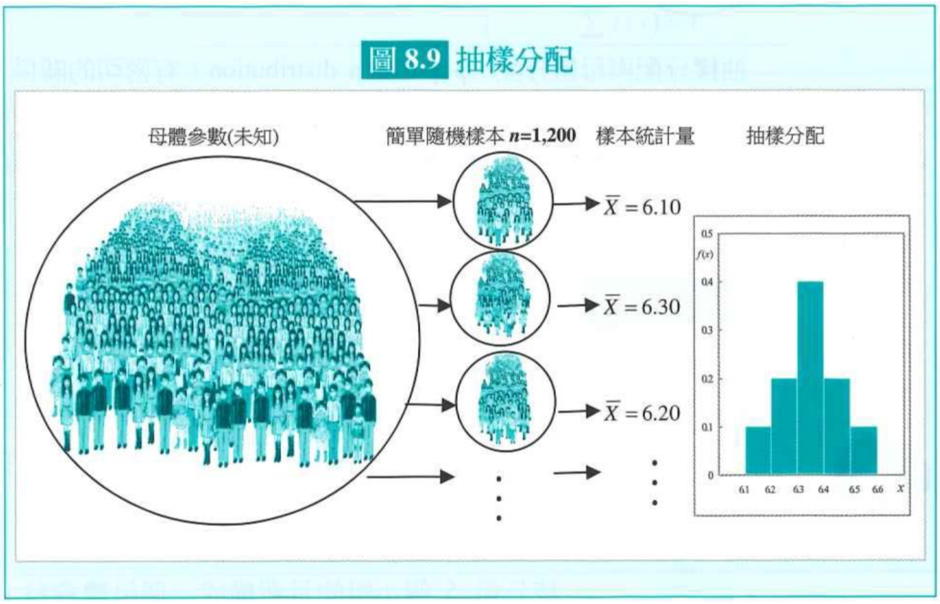
➢ 推論統計可再分為「估計」(estimation) 和「檢定」(test) 兩大部分，前者的估計問題亦可再區分為點估計 (point estimation) 和區間估計 (interval estimation)

➢ 在管理或財經的研究上，為了推出某個結論，往往「檢定」是最為重要的工具 (例如:在美國 NYSE 股票市場中觀察所抽取若干檔股票的本益比 (P/E ratio)，來推論整個 NYSE 市場中所有股票本益比的平均值是否大於 30)

➢ 我們的課程將以最重要的六種基本「檢定」為核心，並先探討學習這些檢定所需要的四種基礎的「機率分配」及其彼此間的關連，此處所指的機率分配，除了指「母體」的機率分配，亦特別指「抽樣分配」(sampling distribution)，這四種必學的機率分配是「常態，*t*，卡方，*F* 分配」。

➢ 問題討論:

1. 請區分「母體分配」,「樣本分配」,「抽樣分配」三個詞的差異
2. 「抽樣分配」(sampling distribution)的意義，可以下圖視之



3. 檢定與抽樣分配有何關係?

最初階的比例檢定 (基於 Z 分配)

	單一母體 one population	兩個母體 two populations
proportion	H_0: $p = 0.5$ Z-統計量	H_0: $p_1 = p_2$ Z-統計量

$$\begin{tikzcd} N \arrow[d, "standardize"] & \\ Z \arrow[r, "square"] & \chi^2_{(1)} \arrow[d, "sum"] \\ T \arrow[u, "n\to\infty"] & \chi^2_{(k)} \arrow[l, "\frac{Z}{\sqrt{\chi^2_{(k)}/k}}"'] \end{tikzcd}$$

$$\frac{\chi^2_a}{\chi^2_b} \to F$$

基本核心四大檢定 (用到 t，χ^2，F 分配)

	單一母體 one population	兩個母體 two populations
mean	H_0: $\mu = 5$ t-統計量	H_0: $\mu_1 = \mu_2$ t-統計量
variance	H_0: $\sigma^2 = 10$ χ^2-統計量	H_0: $\sigma_1^2 = \sigma_2^2$ F-統計量

● 上述三種「檢定」在「量化交易」上的應用

➢ 量化交易: 將交易的法則用數學規則予以明確化
(基於統計回溯測試的結果)

➢ 找到一個交易策略，欲進行回溯測試

1. 勝率 → (報酬率>0 的)比例檢定
2. 報酬率 → (報酬率的)平均值檢定