

Chapter 3 Forecasting

- Qualitative Forecasting Methods
- Moving Averages and Smoothing
- Trend and Seasonal Factors

Demand Forecasting

A statement about the future value of a variable of interest such as demand.

- 國外推出新一代的產品，該不該爭取代理進口？
- 景氣逐漸轉好，何時該擴充產量？
- 下週有促銷活動，各分店各種款式應準備多少庫存？



72種款式×五種顏色×六種尺寸 **不能補貨、不能退貨**

Features Common to Demand Forecasts

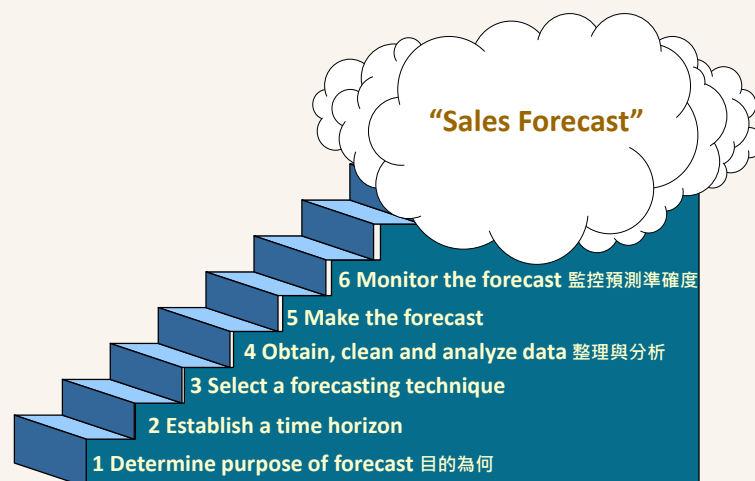
1. Assume that the same underlying causal system that existed in the past will continue to exist in the future.
過去的變動型態會持續到未來進行 (樂透號碼)
2. Forecasts are not perfect. 預測永遠是錯誤的
3. Forecasts for groups of items tend to be more accurate 整體預測比個別品項準確
4. Forecast accuracy decreases as the time horizon increases. 越久遠的預測越不準確



US forecast

3

Steps in the Forecasting Process



4

Qualitative Techniques

Consumer Survey: 以面談或電話對消費者進行調查

Sales Force Opinions: 調查基層業務人員的意見

Executive and Outside Opinions: 主管自行判斷或與專家討論

Historical Analogy: 根據相同客層的產品經驗進行預測 movie sales

Strengths

- 可針對缺乏市場數據的新產品進行預測
- 可加入無法量化的資訊

Weaknesses

- 需要良好的問卷設計與調查方式
- 意見可能偏頗、分歧、或受到不當影響

5

Accuracy of Forecasts

Forecast error $e_t = A_t - F_t$

Mean Absolute Deviation = $\frac{\sum_{t=1}^i |A_t - F_t|}{i}$

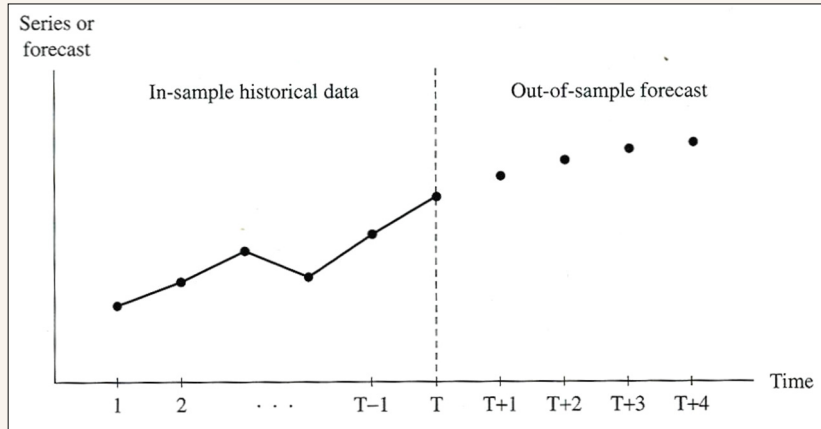
MAPE = $\frac{\sum_{t=1}^i |A_t - F_t| / A_t}{i}$



Example 1

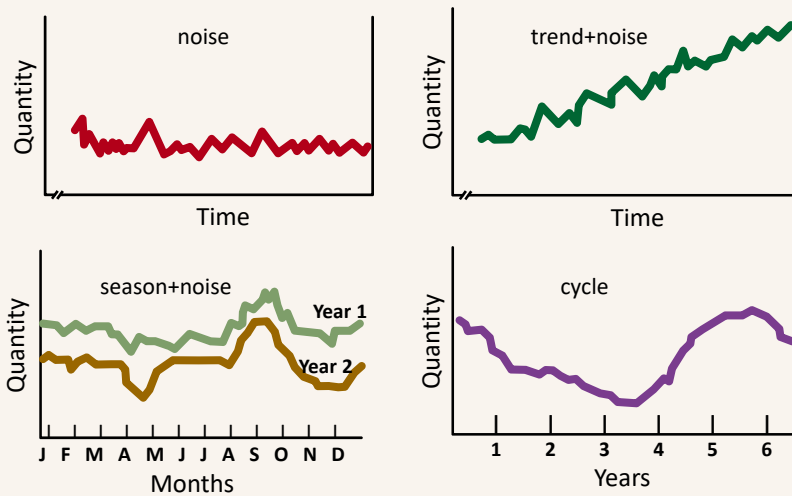
6

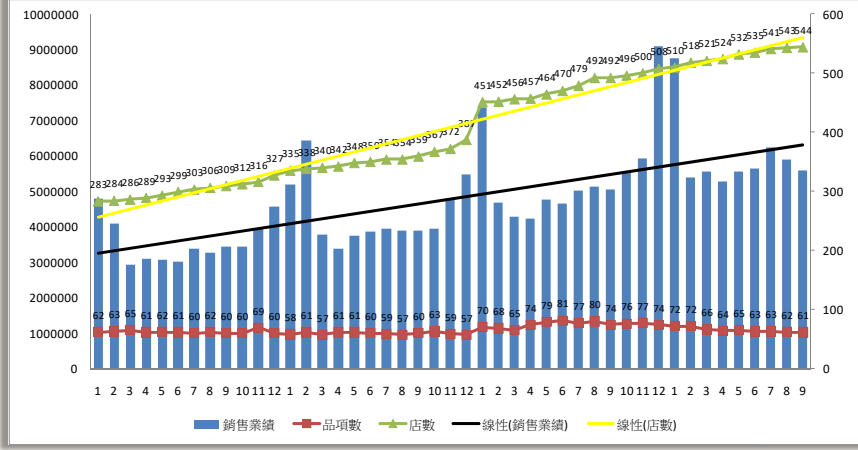
Time Series Forecasting: predict the future based on past data



7

Demand Patterns





Naive Forecasts

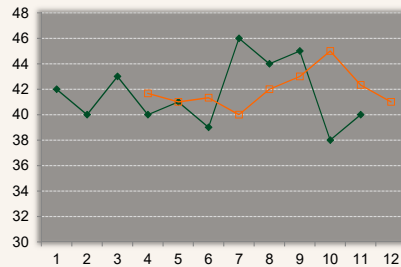
The forecast for any period equals the previous period's actual value.

- Stable time series data
 $F(t) = A(t-1)$
- Seasonal variations 去年同期
 $F(t) = A(t-n)$
- Data with trends
 $F(t) = A(t-1) + (A(t-1) - A(t-2))$ 外插法

Moving Averages

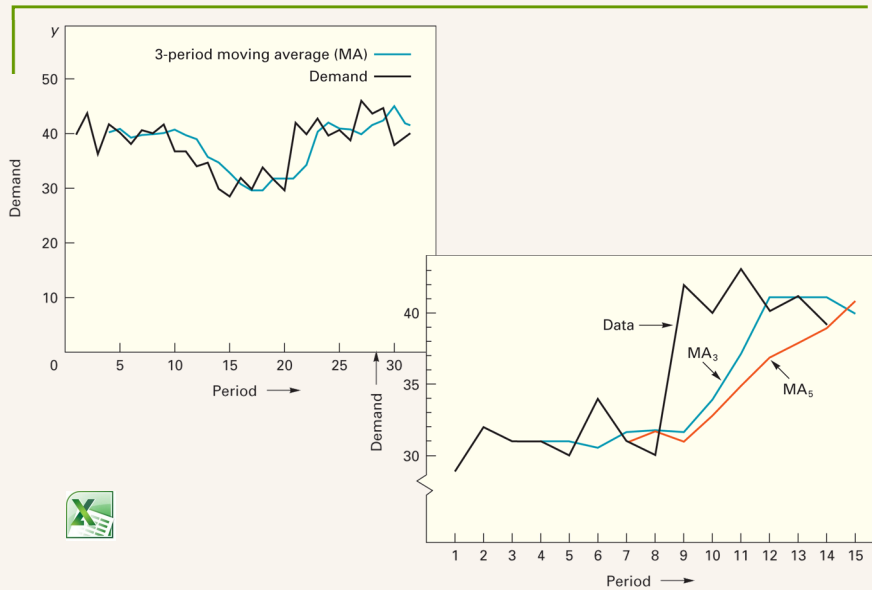
$$F_t = \frac{A_{t-1} + A_{t-2} + \dots + A_{t-n}}{n}$$

1		A ₁ =42	}
2		A ₂ =40	
3		A ₃ =43	
4	F ₄ =41.7	A ₄ =40	}
5	F ₅ =41.0		



The longer the moving average period, the more random variations are smoothed.

11



12



□ 當短期的5天平均線升破長期的20天平均線便為買入訊號，而當短期線跌破長期線便為沽出訊號。

□ 若以250天線作為好淡分界，則當股價在250天線之上，代表正處於長期升勢；相反，當股價在250天線之下，則代表處於長期跌勢。

Exponential Smoothing 指數平滑法

Most recent occurrences are more indicative of the future.

$F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$ 依據前一期的預測誤差進行調整
調整幅度

Period	Actual	$\alpha = 0.1$	Error	$\alpha = 0.4$	Error
1	42				
2	40	42	-2.00	42	-2.00
3	43	41.8	1.20	41.2	1.80
4	40	41.92	-1.92	41.92	-1.92
5	41	41.73	-0.73	41.15	-0.15
6	39	41.66	-2.66	41.09	-2.09
7	46	41.39	4.61	40.25	5.75
8	44	41.85	2.15	42.55	1.45



Using Exponential Smoothing

Approaches to obtain a starting forecast

$$F_2 = A_1$$

F_2 = 先前幾期的平均銷售量

F_2 = a subjective estimate

smoothing constant α : 市場波動劇烈時應加大調整的幅度

15

Trend Patterns using Linear Regression

A *trend* in a time series is a systematic increase or decrease in the average of the series over time.

Indep. variable X (time) \Rightarrow dependent variable Y (demand)

Regression 估計市場需求(Y)隨著時間(X)演進的線性關係

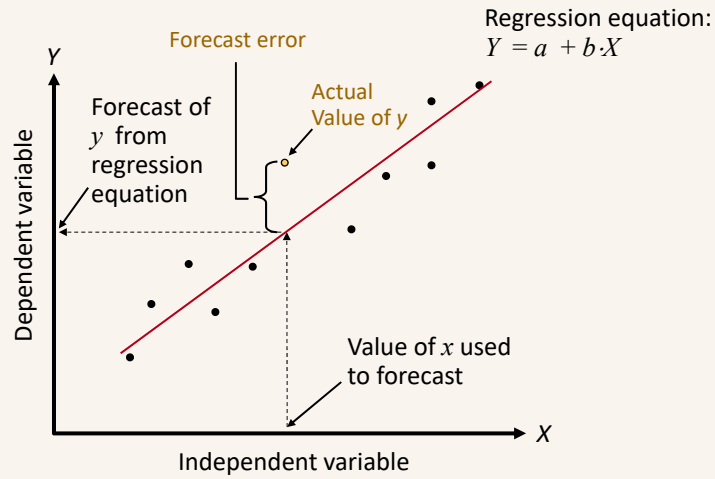
$$Y = a + b \cdot X$$

該期的產品需求預測 \swarrow \nwarrow 要預測之未來的時期編號

趨勢(斜率) $\rightarrow b = \frac{\sum_i x_i y_i - n \bar{x} \bar{y}}{\sum_i x_i^2 - n \bar{x}^2}$ $a = \bar{y} - b \bar{x}$

16

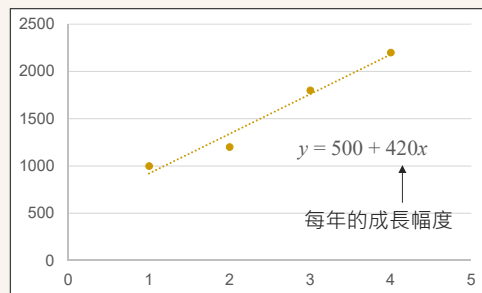
Linear Regression



Example 8.6

使用Trend Regression對全年的總需求進行預測

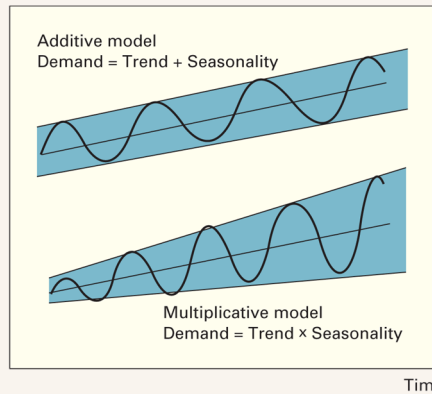
Year	Total Demand
1	1000
2	1200
3	1800
4	2200



$$\text{Total Demand for Year 5} = 500 + 420 \times 5 = 2600$$

Trend and Seasonal Factors

四季變化 $n=4$ 12個月變化 $n=12$



第1季	第2季	第3季	第4季
200	350	300	150
200/250	350/250	300/250	150/250

如果次年的全年預測=1100

第1季	$275 \times 0.8 = 220$
第2季	$275 \times 1.4 = 385$
第3季	$275 \times 1.2 = 330$
第4季	$275 \times 0.6 = 165$

19

Example

The carpet cleaning business is seasonal, with a peak in the third quarter and a trough in the first quarter.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4
Q1	45	70	100	100
Q2	335	370	585	725
Q3	520	590	830	1160
Q4	100	170	285	215
Total	1,000	1,200	1,800	2,200

The manager wants to forecast demand for each quarter of year 5.

(2600)

Example

	YEAR 1		YEAR 2		YEAR 3		YEAR 4	
Q	Demand	Seasonal Factor (1)	Demand	Seasonal Factor (2)	Demand	Seasonal Factor (3)	Demand	Seasonal Factor (4)
1	45	$45/250 = 0.18$	70	$70/300 = 0.23$	100	$100/450 = 0.22$	100	$100/550 = 0.18$
2	335	$335/250 = 1.34$	370	$370/300 = 1.23$	585	$585/450 = 1.30$	725	$725/550 = 1.32$
3	520	$520/250 = 2.08$	590	$590/300 = 1.97$	830	$830/450 = 1.84$	1160	$1160/550 = 2.11$
4	100	$100/250 = 0.40$	170	$170/300 = 0.57$	285	$285/450 = 0.63$	215	$215/550 = 0.39$
Total	1,000		1,200		1,800		2,200	
Average	$1,000/4 = 250$		Average 300		Average 450		Average 550	

Example 8.6

Average Seasonal Factor

Quarter	Average Seasonal Factor
1	0.2043
2	1.2979
3	2.0001
4	0.4977

Quarterly Forecasts for Year 5

($2600/4=650$)

Quarter	Forecast
1	$650 \times 0.2043 = 132.795$
2	$650 \times 1.2979 = 843.635$
3	$650 \times 2.001 = 1,300.06$
4	$650 \times 0.4977 = 323.505$

Causal Forecasting (using Linear Regression)

(x_1, \dots, x_n)

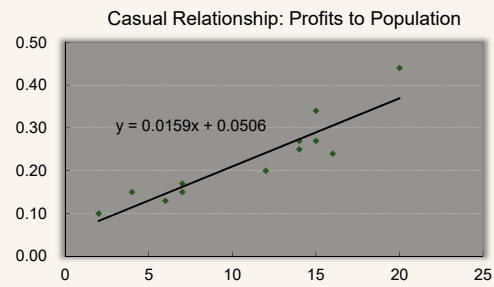
可事先觀察的數值
如房地產銷售

(y_1, \dots, y_n)

要預測的數值
如家電銷售

- 假設兩者之間存在線性的因果關係 $\Rightarrow Y = a + b \cdot X$

Population	Profits
7	0.15
2	0.10
6	0.13
4	0.15
14	0.25
15	0.27
16	0.24
12	0.20
14	0.27
20	0.44
15	0.34
7	0.17

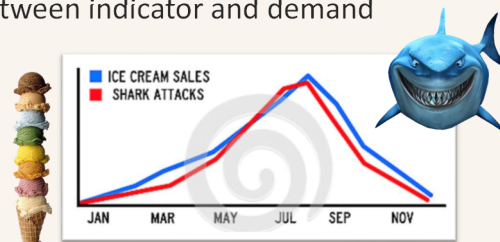


\Rightarrow 設新設分店的當地人口為10
 \Rightarrow 預測利潤為 $0.0506 + 0.0159 \times 10 = 0.21$

23

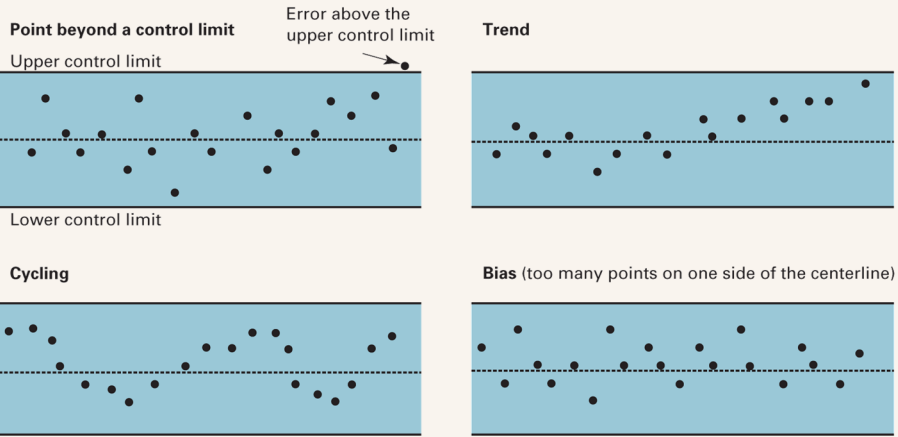
Choosing Valid Indicators

- Must be a preceding indicator
 - 生產量、出貨量、庫存量
 - 氣候、原物料盤價
 - 消費者信心指數、股市指數、房地產交易量
- A logical explanation between an indicator and demand
- **High correlation** between indicator and demand



24

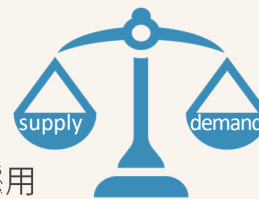
Monitoring the Forecast



25

Conclusion

- 並用需求管理與銷售預測
- 每種預測方法都有弱點，企業會同時採用多種方法進行預測，綜合各種預測
- 供應鏈上下游廠商合作進行市場與訂單預測



“A good forecaster is not smarter than everyone else, he merely has his ignorance better organized” – **Anonymous**

26