Popper's three worlds

波普爾將世界分成三個種類：

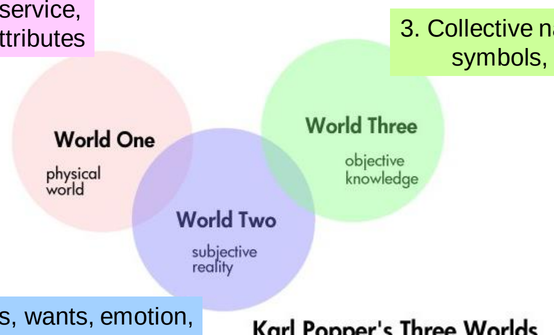
- 世界一：由物理客體和事件組成，包括生物的存在。
- 世界二：由心靈主體和其感知事件組成的世界。
- 世界三：客觀知識組成的世界。

- 波普爾指出世界一與二的劃分源自笛卡兒的心物問題；而世界二與三的劃分源自於康德的對客觀知識的追求‧
- The theory of interaction between World 1 and World 2 is an alternative theory to Cartesian dualism, which is based on the theory that the universe is composed of two essential substances: res cogitans and res extensa. Popperian cosmology rejects this essentialism, but maintains the common sense view that physical and mental states exist, and they interact.

Application: What is the value of luxury brands?

1. Goods and service, materials, attributes

3. Collective narratives, symbols, images



2. needs, wants, emotion, perceptions, thoughts

Tautology 恆真式

- Tautology在語言學、命題邏輯及述詞邏輯中，定義都略有不同。有些人把它音譯成套套邏輯。也有學者意譯為恆真句、恆真式、重言式。
- 修辭上的理解宜稱作同義反覆、重言句、套套句，是指「把一件事換句話說」，例如#考前預測、#鴉片引人入睡、#肝火旺、#未婚的單身漢、#適當的娛樂、#努力必有好成績、#對症下藥、#人性本善、#適者生存、#產品生命週期(PLC)。
- Strategy: resource-based view (RBV), RBV proposes that firms are heterogeneous because they possess heterogeneous (VRIN) resources, meaning firms can have different strategies because they have different resource mixes (Barney 1991)
- Tautological Fallacy in economics
- Tautological statistics: 50% of married people are women, 100% of smokers die. 40% of all sick days are taken on Mondays and Fridays. 40% of banks will be destroyed by FinTech.

因果關係（causality 或 causation)

- 因果關係指一系列因素（因）和一個現象（果）之間的關係。對某個結果產生影響的任何事件都是該結果的一個因素。直接因素是直接影響結果的因素，也即無需任何介入因素（介入因素又稱中介因素）。
- 原因和結果通常和變化或事件有關，還包括客體、過程、性質、變量、事實、狀況；概括因果關係爭議很多。對因果關係的哲學研究歷史悠久，佛教和西方哲學家如亞里士多德在2000多年前就已經提出了因果，該問題仍是現代哲學的重要課題。
- Causality is an abstraction that indicates how the world progresses, so basic a concept that it is more apt as an explanation of other concepts of progression than as something to be explained by others more basic. The concept is like those of agency and efficacy. For this reason, a leap of intuition may be needed to grasp it. Accordingly, causality is implicit in the logic and structure of ordinary language.

7. Causal Research

16. Analysis of Variance (ANOVA)

Ex Post Facto Research

- *ex post facto* is "from what is done afterward," i.e., something done or occurring after an event with a retroactive effect on the event.
- 事後孔明：After this, therefore caused by this.
- Examples
  - Disasters & the tallest buildings in the world
  - "Master" of Stock price analysis
  - Boys are more creative than girls

Self-selection and *Ex Post Facto* Research

- Self-selection versus control (on event)
  - (survey vs. experiment, GMBA admission)
- Example: mobile phone and brain cancer
  - Divide the respondents into have and have no brain cancer, and investigate whether the respondents use mobile phone.
  - The incidence of brain cancer rose with the number of mobile phone usage.
  - Mobile phone causes brain cancer
- Why this conclusion may or may not be true?

7

Evaluation of *Ex Post Facto* Research

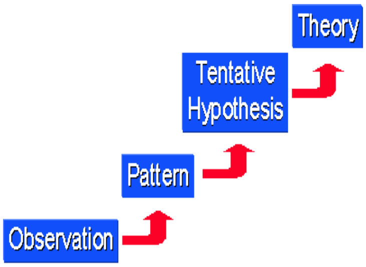
- Weakness
  - The inability to manipulate independent variables
  - The lack of power to randomize
  - the risk of improper interpretation
- Solution?
  - Research unguided by hypotheses, research "to find out thing," is most often ex post facto research
  - Ex post facto research that is conducted without hypotheses, without predictions, research is which data are just collected and then interpreted, is even more dangerous in its power to mislead.

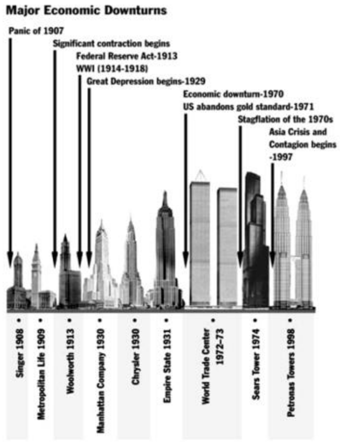
8

Taiwan's economic problem

- Solving wrong questions (type III error)
- Low salary, economic slowdown, low TOFEL, labor moving out, no new investment, "luxurious" taxed solution for income in-equality, decline competitiveness
- "Construct": capitalism vs. socialism, if the objective is to solve justice (not economic growth)
- Data analysis, solving the past (justification) vs. innovation (discovery) in solving the future, economy unfortunately is an empirical testing ground for wicked politicians/economists

Evidence as the best teacher?





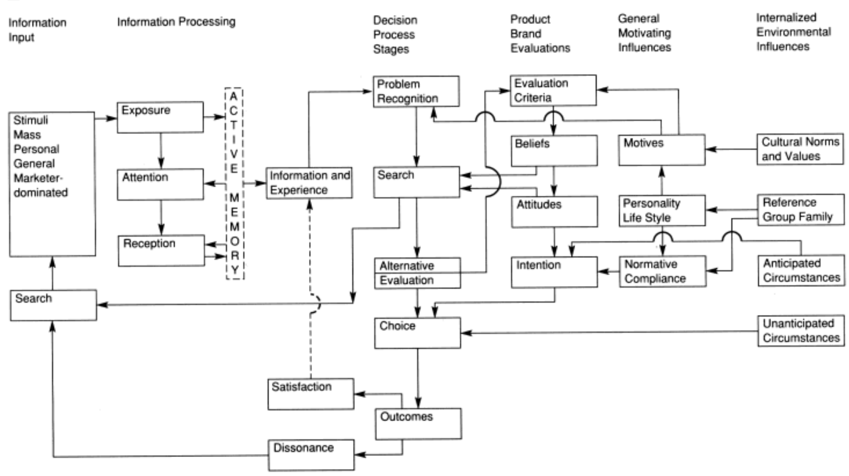
Positive vs. Normative statement

- In the social sciences and philosophy, a positive or descriptive statement concerns what "is", "was", or "will be", and contains no indication of approval or disapproval (what should be). Positive statements are thus the opposite of normative statements.在經濟學及哲學上，實證陳述是關於過去、現在或未來事實的陳述，當中不包含應該與否的價值判斷。實證陳述是可試驗的，或至少可通過想像的事實來反證，但在事實上可以是錯誤的。
- Positive statements are distinct from normative statements. Positive statements are based on empirical evidence, can be tested, and involve no value judgements. Positive statements refer to what is and contain no indication of approval or disapproval. When values or opinions come into the analysis, then it is in the realm of normative economics. A normative statement expresses a judgment about whether a situation is desirable or undesirable, which can carry value judgements. These refer to what ought to be.

Problem of Normative Model

FIGURE 1-1

Engel, Blackwell, Kollat Model A Comprehensive Model of Consumer Behavior



Source: Consumer Behavior, 3/e, by James F. Engle, Rodger D. Blackwell and David T. Kollat. Copyright © 1978 by the Dryden Press. Reprinted by permission of Holt, Rinehart and Winston, Inc.

Review: Inductive vs. Deductive Logic

學術貢獻

- 價值鏈（*Value chain*）
- 產業競爭的五力分析（*5 forces analysis*），又稱鑽石理論 ("Diamond Model")
- 市場定位（*market positioning*）-區分爲差異化基礎（*variety base*）、需求基礎（*need base*）、和經由特殊管場定位
- 策略群組（*strategic groups*，*strategic sets*）
- 競爭策略（*generic strategies*）-區分爲成本領先、差異化和集中化
- 區域經濟發展的波特聚類（*Porter's clusters*）

主要著作

- 管理學領域堪稱經典的「競爭」三部曲：
  - 《競爭策略》，Competitive Strategy，ISBN 957-621-438-6，1980年
  - 《競爭優勢》，1985年
  - 《國家競爭優勢》，1990年

批評

- 波特的論述與主張遭到一些學術人士批評，認爲其邏輯辯證前後矛盾[1]，另外也被人認爲其結論缺乏實務經驗

13

Review: 波特競爭優勢的套套因果邏輯

TAUTOLOGY IN THE RESOURCE-BASED VIEW

「差異化」(product Differentiation) 與「相對低成本」(relative low cost) 戰略能創造和保持公司的競爭優勢。

Hong Kong Polytechnic University

差異化 → 競爭優勢

- *"The fundamental basis of above-average performance in the long run is sustainable competitive advantage. Though a firm can have a myriad of strengths and weaknesses vis-à-vis its competitors, there are two basic types (sources) of competitive advantage a firm can possess: low cost or differentiation. The significance of any strength or weakness a firm possesses is ultimately a function of its impact on relative cost or differentiation."*

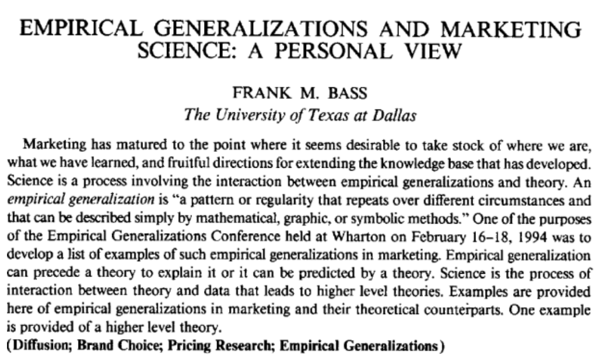
14

森林大火的起因

- 「香煙蒂（差異化）→ 森林大火(競爭優勢→價值創造或企業成長)」的結論可能是錯的，因為引起森林大火的充分但非必要條件還需要包括有人抽煙、抽煙附近的草木是乾燥易燃的、抽煙者的口袋正好有一包香煙和一盒火柴、所有的火柴頭是乾燥的、抽煙附沒有救火設備。

15

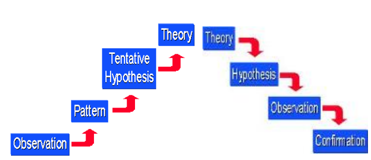
An iterative process in your thesis **re**-search



EMPIRICAL GENERALIZATIONS AND MARKETING SCIENCE: A PERSONAL VIEW

FRANK M. BASS
The University of Texas at Dallas

Marketing has matured to the point where it seems desirable to take stock of where we are, what we have learned, and fruitful directions for extending the knowledge base that has developed. Science is a process involving the interaction between empirical generalizations and theory. An *empirical generalization* is "a pattern or regularity that repeats over different circumstances and that can be described simply by mathematical, graphic, or symbolic methods." One of the purposes of the Empirical Generalizations Conference held at Wharton on February 16–18, 1994 was to develop a list of examples of such empirical generalizations in marketing. Empirical generalization can precede a theory to explain it or it can be predicted by a theory. Science is the process of interaction between theory and data that leads to higher level theories. Examples are provided here of empirical generalizations in marketing and their theoretical counterparts. One example is provided of a higher level theory.
(**Diffusion; Brand Choice; Pricing Research; Empirical Generalizations**)



16

Concept of Causality (p. 218)

A statement such as "*X* causes *Y*" will have the following meaning to an ordinary person and to a Scientist (e.g., lung cancer, ad-sales, stock price, consumer satisfaction)

Ordinary Meaning	Scientific Meaning
***X* is the only cause of *Y*.**	***X* is only one of a number of possible causes of *Y*.**
***X* must always lead to *Y* (*X* is a deterministic cause of *Y*).**	**The occurrence of *X* makes the occurrence of *Y* more probable (*X* is a probabilistic cause of *Y*).**
It is possible to prove that *X* is a cause of *Y*.	**We can never prove that *X* is a cause of *Y*. At best, we can infer that *X* is a cause of *Y*.**

Conditions for Causality (p. 219)

1. **Concomitant variation** is the extent to which a cause, *X*, and an effect, *Y*, occur together or vary together in the way predicted by the hypothesis under consideration.
2. The **time order of occurrence** condition states that the causing event must occur either before or simultaneously with the effect; it cannot occur afterwards.
3. The **absence of other possible causal factors** means that the factor or variable being investigated should be the only possible causal explanation.

Conditions for Causality (Causation)

4. **Theoretical Support.** If X causes Y is consistent with theory T, and if theory T has been successfully used to explain other phenomenon, then theory T provides theoretical support for assertion that X causes Y.
   - e.g., Psychological involvement, retailer productivity, TCA (opportunisms), Flow (Web navigation), Porter's competitive advantage, efficient market (assumption), long-tail theory, herding effect

Evidence of **Concomitant Variation** between Purchase of Fashion Clothing and Education

Table 7.1

		Purchase of Fashion Clothing, Y		
		High	Low	
Education, X	High	363 (73%)	137 (27%)	500 (100%)
	Low	322 (64%)	178 (36%)	500 (100%)

20

Purchase of Fashion Clothing By Income and Education

Low Income — Purchase

Education	High	Low	
High	122 (61%)	78 (39%)	200 (100%)
Low	171 (57%)	129 (43%)	300 (100%)

High Income — Purchase

Education	High	Low	
High	241 (80%)	59 (20%)	300
Low	151 (76%)	49 (24%)	200

21

Spurious Association (correlation)

TABLE 1

	Cured	Not cured	Total	Success rate
Day-care	20	20	40	**50%**
Residential care	16	24	40	**40%**
Total	36	44	80	

TABLE 2

	Easy cases				Hard cases			
	Cured	Not Cured	Total	Success rate	Cured	Not cured	Total	Success rate
Day-care	18	12	30	**60%**	2	8	10	**20%**
Residential care	7	3	10	**70%**	9	21	30	**30%**
Total	25	15	40		11	29	40	

22

Definitions and Concepts (p. 221)

- **Independent variables** are variables or alternatives that are manipulated and whose effects are measured and compared, e.g., price levels.
- **Test units** are individuals, organizations, or other entities whose response to the independent variables or treatments is being examined, e.g., consumers or stores.
- **Dependent variables** are the variables which measure the effect of the independent variables on the test units, e.g., sales, profits, and market shares.
- **Extraneous variables** are all variables other than the independent variables that affect the response of the test units, e.g., store size, store location, and competitive effort.

23

Experimental Design

An **experimental design** is a set of procedures specifying

- the test units and how these units are to be divided into homogeneous subsamples,
- what independent variables or treatments are to be manipulated,
- what dependent variables are to be measured, and
- how the extraneous variables are to be controlled.
- e.g., different CFs "cause" sales

24

Validity in Experimentation (p. 222)

- **Internal validity** refers to whether the manipulation of the independent variables or treatments actually caused the observed effects on the dependent variables. Control of extraneous variables is a necessary condition for establishing internal validity.
- **External validity** refers to whether the cause-and-effect relationships found in the experiment can be generalized. To what populations, settings, times, independent variables and dependent variables can the results be projected?

Validity in Research

- TV Call-in program, concludes the general public do not support purchase-weapon
- The voter votes for Mr. A because he receives a gift/favor from him
- Consumer generally marks 4 in a 7-point scale
- A suspect admits his crime because he is tired of being examined

Extraneous Variables (p. 223)

- **History** refers to specific events that are external to the experiment but occur at the same time as the experiment (confounded treatment effect)
- **Maturation** (*MA*) refers to changes in the test units themselves that occur with the passage of time (learning effect)
- **Testing effects** are caused by the process of experimentation. Typically, these are the effects on the experiment of taking a measure on the dependent variable before and after the presentation of the treatment.
  - The **main testing effect** (*MT*) occurs when a prior observation affects a latter observation (e.g., subject's cognition consistency in pre- and post- measurement)

27

Extraneous Variables

  - In the **interactive testing effect** (IT), a prior measurement affects the test unit's response to the independent variable (prior measurement influence the treatment, Guinea pig effect)
- **Instrumentation** (I) refers to changes in the measuring instrument, in the observers or in the scores themselves.
- **Statistical regression** effects (SR) occur when test units with extreme scores move closer to the average score during the course of the experiment.
- **Selection bias** (SB) refers to the improper assignment of test units to treatment conditions.
- **Mortality** (MO) refers to the loss of test units while the experiment is in progress.

28

Controlling Extraneous Variables

- **Randomization** refers to the random assignment of test units to experimental groups by using random numbers. Treatment conditions are also randomly assigned to experimental groups.
- **Matching** involves comparing test units on a set of key background variables before assigning them to the treatment conditions.
- **Statistical control** involves measuring the extraneous variables and adjusting for their effects through statistical analysis.
- **Design control** involves the use of experiments designed to control specific extraneous variables.

29

A Classification of Experimental Designs

- **Pre-experimental designs** do not employ randomization procedures to control for extraneous factors: the one-shot case study, the one-group pretest-posttest design, and the static-group.
- In **true experimental designs**, the researcher can randomly assign test units to experimental groups and treatments to experimental groups: the pretest-posttest control group design, the posttest-only control group design, and the Solomon four-group design.

30

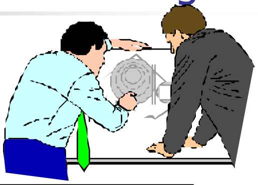
A Classification of Experimental Designs

- **Quasi -experimental designs** result when the researcher is unable to achieve full manipulation of scheduling or allocation of treatments to test units but can still apply part of the apparatus of true experimentation: time series and multiple time series designs.
- A **statistical design** is a series of basic experiments that allows for statistical control and analysis of external variables: randomized block design, Latin square design, and factorial designs.

31

A Classification of Experimental Designs

Figure 7.1 **(p. 226)**



Experimental Designs

Pre-experimental	True Experimental	Quasi Experimental	Statistical
One-Shot Case Study	Pretest-Posttest Control Group	Time Series	Randomized Blocks
One Group Pretest-Posttest	Posttest: Only Control Group	Multiple Time Series	Latin Square
Static Group	Solomon Four-Group		Factorial Design

32

How objective knowledge and financial information to affect financial decision in certain cognitive style.

在認知風格下
客觀知識與金融資訊
對金融決策之影響

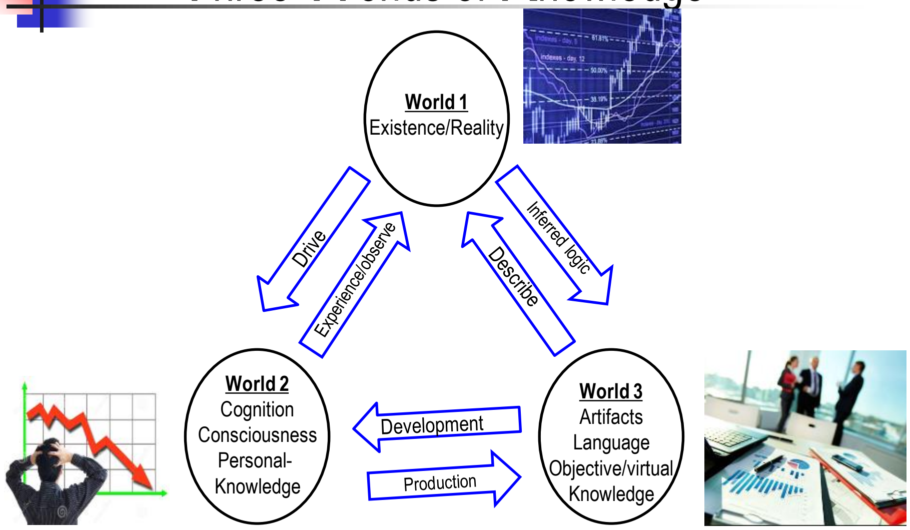
指導教授：唐瓔璋
口試學生：劉揚榕

Research Objective

This paper reports the findings of a field experiment in investigating the effects of objective knowledge and information cues (inner vs. environmental) posed on consumer financial decisions, and to aim to examine the moderating effects of field dependence-independence on ambivalence (uncertainty) of cognitive ability.

Is it time to invest or withdraw?

Three Worlds of Knowledge



Source: *Three Worlds* by Karl Popper (1978) - The Tanner Lecture on Human Values – The University of Michigan

Field Dependent-Independent Cognition

Embedded Figures Test (EFT)

In the EFT (Witkin, 1971), individuals must locate a previously seen simple figure within the context of a larger and more complex figure that has been purposefully designed to embed and obscure.

Field-independent

Field-independent people with shrewd eyes are able to quickly find the hidden figures.

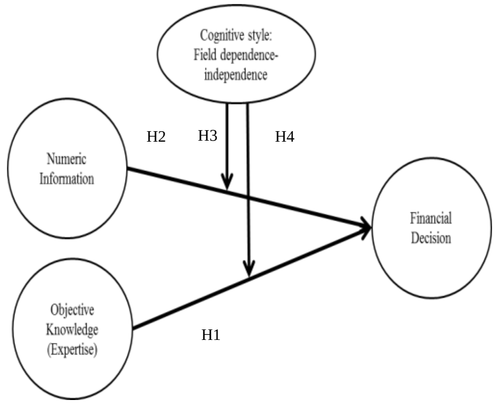
Field-dependent

Field-dependent people will have trouble locating the simple figures embedded within the more complex surroundings.

Facing complex and uncertain situations

Field-dependent (FD) people tend to seek information from others as an aid to structuring situations, and reflecting their greater need for external guidance while field-independent (FID) people show greater autonomy from others.

Research Hypothesis



Hypothesis 1 **:** ***Objective knowledge has effects on subjective financial decisions.***

Hypothesis 2: The content of information cues has effects on subjective financial decisions.

Hypothesis 3: Field dependent-independent cognitions have effects on the financial decision process of calibrating information cues.

Hypothesis 4: Field dependent- dependent cognitions have effects on the financial decision process of calibrating objective knowledge.

Sampling & Data Collection

Table 4: Difference of Two Questionnaires

	Experiment I	Experiment II
Volatility	V	V
Beta	V	_
Sharp Ratio	V	_
Cumulative Return	Three months, six months, One year, two year, three year, five year, ten year.	One year, two year, three year
year return	2004-2013	2009-2013
Trend of net value	The past 48months	The past 12 months

Factorial design

Table4-1: Experiment Design							
Numeric Information							
High				Low			
Cognitive style				*Cognitive style*			
Field dependence		Field independence		Field dependence		Field independence	
Objective Knowledge		*Objective Knowledge*		*Objective Knowledge*		*Objective Knowledge*	
High	Low	High	Low	High	Low	High	Low

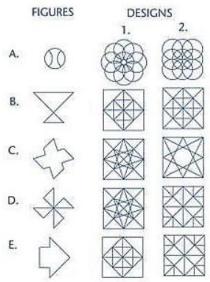
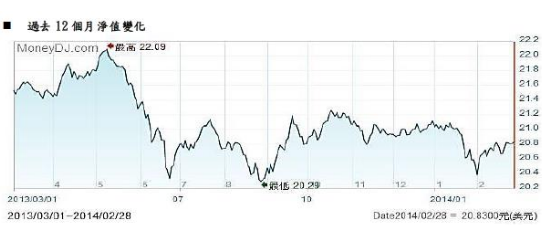


Table4-2: Difference of two experiments		
	Experiment A	Experiment B
Volatility	V	V
Beta	V	X
Sharp Ratio	V	X
Cumulative Return	Three months, six months, One year, two year, three year, five year, ten year.	One year, two year, three year
Single-year return	2004-2013	2009-2013
Trend of net value	The past 48months	The past 12 months



Results 1/2

ANOVA Test

Table 5: ANOVA Analysis for Stage1

Source	F Value	Pr > F	R-Square	Mean of B Fund
Model	2.28	**0.0615***	0.041693	12.10698
Risk Appetite	0.49	0.4858		
Numeric information	0.11	0.7417		
Cognitive Style	1.03	0.3104		
Numeric information* Cognitive Style	**6.33**	**0.0126****		

*at 0.1 level of significant, ** at 0.05 level of significant, *** at 0.01 level of significant.

Table 6: ANOVA Analysis for Stage2

Source	F Value	Pr > F	R-Square	Mean of B Fund
Model	**2.15**	**0.0325****	0.077147	12.10698
Risk Appetite	0.37	0.5462		
Numeric information	0.05	0.8216		
Cognitive Style	1.21	0.2717		
Numeric information*Cognitive Style	**4.94**	**0.0274****		
Objective Knowledge	**5.08**	**0.0253****		
Objective Knowledge *Numeric information	0.12	0.7263		
Objective Knowledge * Cognitive Style	0.2	0.6553		
Objective Knowledge *Numeric information * Cognitive Style	0.08	0.7746		

*at 0.1 level of significant, ** at 0.05 level of significant, *** at 0.01 level of significant.

Every subject has NT$100K to purchase 20 units of funds and can decide allocating the capital between two funds, and also choose to invest in full capital. The financial decisions for the number of higher risk commodities, i.e., B fund, is dependent variable.

Result shows that field-independent people with proficiency in EFT are more sensitive to catch complicate numeric information than field-dependent people do, but having no interaction with objective knowledge.

One-Shot Case Study

$X \quad O_1$

- A single group of test units is exposed to a treatment *X.*
- A single measurement on the dependent variable is taken (O_1).
- There is no random assignment of test units.
- The one-shot case study is more appropriate for exploratory than for conclusive research.

42

One-Group Pretest-Posttest Design

$O_1 \quad X \quad O_2$

- A group of test units is measured twice.
- There is no control group.
- The treatment effect is computed as $O_2 - O_1$.
- The validity of this conclusion is questionable since extraneous variables are largely uncontrolled.
- History, maturation, testing (ME & ITE), instrumentation, selection

43

Static Group Design

EG: $X \quad O_1$

CG: O_2

- A two-group experimental design.
- The experimental group (EG) is exposed to the treatment, and the control group (CG) is not.
- Measurements on both groups are made only after the treatment.
- Test units are not assigned at random.
- The treatment effect would be measured as O_1 - O_2.

44

True Experimental Designs: Pretest-Posttest Control Group Design

EG:	R	O_1	X	O_2
CG:	R	O_3		O_4

- Test units are randomly assigned to either the experimental or the control group.
- A pretreatment measure is taken on each group.
- The treatment effect (TE) is measured as: $(O_2 - O_1) - (O_4 - O_3)$.
- Selection bias is eliminated by randomization.
- The other extraneous effects are controlled as follows:
  $O_2 - O_1 = TE + H + MA + MT + IT + I + SR + MO$
  $O_4 - O_3 = H + MA + MT + I + SR + MO$
  $= EV$ (Extraneous Variables)
- The experimental result is obtained by:
  $(O_2 - O_1) - (O_4 - O_3) = TE + IT$
- Interactive testing effect is not controlled.

45

Quasi-Experimental Designs: Time Series Design

$O_1 \quad O_2 \quad O_3 \quad O_4 \quad O_5 \quad X \quad O_6 \quad O_7 \quad O_8 \quad O_9 \quad O_{10}$

- There is no randomization of test units to treatments.
- The timing of treatment presentation, as well as which test units are exposed to the treatment, may not be within the researcher's control.

46

Multiple Time Series Design

EG : O_1 O_2 O_3 O_4 O_5 X O_6 O_7 O_8 O_9 O_{10}

CG : O_1 O_2 O_3 O_4 O_5 O_6 O_7 O_8 O_9 O_{10}

- If the control group is carefully selected, this design can be an improvement over the simple time series experiment.
- Can test the treatment effect twice: against the pretreatment measurements in the experimental group and against the control group.

47

Sources of Invalidity of Experimental Design

	History	Maturation	Test	Instrument	regression	Selection
X O	–	–				–
O X O	–	–	–	–	?	
X O O	+	?	+	+	+	–

48

Statistical Designs (p. 220)

Statistical designs consist of a series of basic experiments that allow for statistical control and analysis of ***external variables*** and offer the following advantages:

- The effects of more than one independent variable can be measured.
- Specific extraneous variables can be statistically controlled.
- Economical designs can be formulated when each test unit is measured more than once.

The most common statistical designs are the randomized block design, the Latin square design, and the factorial design.

49

Randomized Block Design

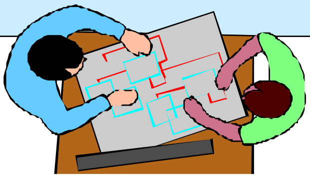
- Is useful when there is only one major external variable, such as store size, that might influence the dependent variable.
- The test units are blocked, or grouped, on the basis of the external variable.
- By blocking, the researcher ensures that the various experimental and control groups are matched closely on the external variable.

50

Randomized Block Design

Table 7.4

		Treatment Groups		
Block Number	Store Patronage	Commercial A	Commercial B	Commercial C
1	Heavy	A	B	C
2	Medium	A	B	C
3	Low	A	B	C
4	None	A	B	C



51

Latin Square Design

- Allows the researcher to statistically control two noninteracting external variables as well as to manipulate the independent variable.
- Each external or blocking variable is divided into an equal number of blocks, or levels.
- The independent variable is also divided into the same number of levels.
- A Latin square is conceptualized as a table (see Table 7.5), with the rows and columns representing the blocks in the two external variables.
- The levels of the independent variable are assigned to the cells in the table.
- The assignment rule is that each level of the independent variable should appear only once in each row and each column, as shown in Table 7.5.

52

Latin Square Design

Table 7.5

	Interest in the Store		
Store Patronage	High	Medium	Low
Heavy	B	A	C
Medium	C	B	A
Low and none	A	C	B

53

Factorial Design

- Is used to measure the effects of two or more independent variables at various levels.
- A factorial design may also be conceptualized as a table.
- In a two-factor design, each level of one variable represents a row and each level of another variable represents a column.

54

Factorial Design

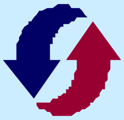
Table 7.6

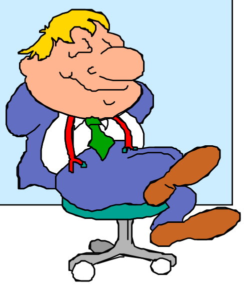
Amount of Store Information	Amount of Humor: No Humor	Amount of Humor: Medium Humor	Amount of Humor: High Humor
Low	A	B	C
Medium	D	E	F
High	G	H	I

Laboratory versus Field Experiments

Table 7.7

Factor	Laboratory	Field
Environment	Artificial	Realistic
Control	High	Low
Reactive Error	High	Low
Demand Artifacts	High	Low
Internal Validity	High	Low
External Validity	Low	High
Time	Short	Long
Number of Units	Small	Large
Ease of Implementation	High	Low
Cost	Low	High



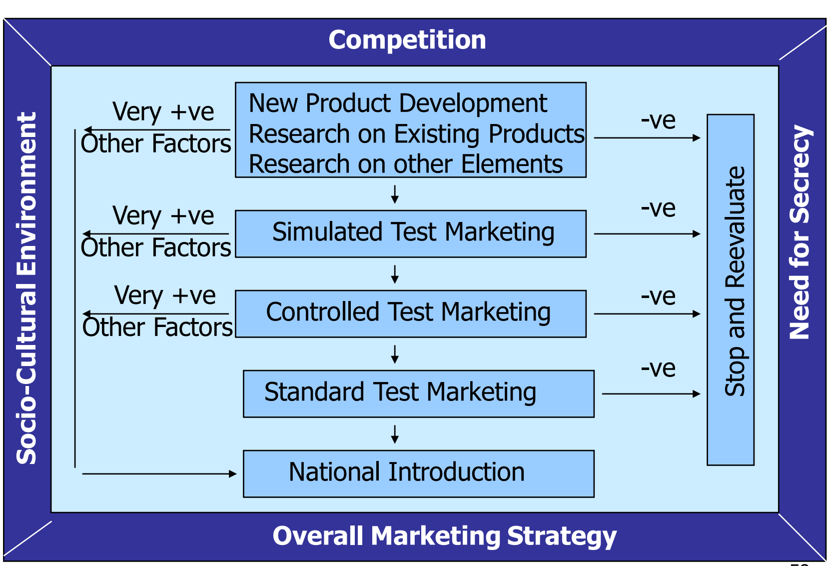


Limitations of Experimentation

- Experiments can be time consuming, particularly if the researcher is interested in measuring the long-term effects.
- Experiments are often expensive. The requirements of experimental group, control group, and multiple measurements significantly add to the cost of research.
- Experiments can be difficult to administer. It may be impossible to control for the effects of the extraneous variables, particularly in a field environment.
- Competitors may deliberately contaminate the results of a field experiment.

57

Selecting a Test-Marketing Strategy



58

Criteria for the Selection of Test Markets

Test Markets should have the following qualities:

1) Be large enough to produce meaningful projections. They should contain at least 2% of the potential actual population.
2) Be representative demographically.
3) Be representative with respect to product consumption behavior.
4) Be representative with respect to media usage.
5) Be representative with respect to competition.
6) Be relatively isolated in terms of media and physical distribution.
7) Have normal historical development in the product class
8) Have marketing research and auditing services available
9) Not be over-tested

59

Chapter Sixteen (p.496)

Analysis of Variance and Covariance
(ANOVA, ANCOVA, MANOVA)

60

One-way Analysis of Variance (p. 500)

Marketing researchers are often interested in examining the differences in the mean values of the dependent variable for several categories of a single independent variable or factor. For example:

- Do the various segments differ in terms of their volume of product consumption?
- Do the brand evaluations of groups exposed to different commercials vary?
- What is the effect of consumers' familiarity with the store (measured as high, medium, and low) on preference for the store?

61

Conducting One-way ANOVA

Fig. 16.2

Identify the Dependent and Independent Variables

↓

Decompose the Total Variation

↓

Measure the Effects

↓

Test the Significance

↓

Interpret the Results

62

One-Way ANOVA

- I.V. = CF1, CF2, CF3
- D.V. = 10-point scale on informativeness

CF1	CF2	CF3
10	4	2
9	5	3
8	3	7
10	4	4
9	5	8
$\bar{y}_1$	$\bar{y}_2$	$\bar{y}_3$

The ANOVA Procedure

The following example studies the effect of bacteria on the nitrogen content of red clover plants. The treatment factor is bacteria strain, and it has six levels. Five of the six levels consist of five different *Rhizobium trifolii* bacteria cultures combined with a composite of five *Rhizobium meliloti* strains. The sixth level is a composite of the five *Rhizobium trifolii* strains with the composite of the *Rhizobium meliloti*. Red clover plants are inoculated with the treatments, and nitrogen content is later measured in milligrams. The data are derived from an experiment by Erdman (1946) and are analyzed in Chapters 7 and 8 of Steel and Torrie (1980). The following DATA step creates the SAS data set Clover:

64

ANOVA

- Variance = (Observation – Mean)^2
  $= (y_{ij} - \bar{y})^2$
- Adding one category variable $\bar{y}_j$
  $= (y_{ij} - \bar{y} + \bar{y}_j - \bar{y}_j)^2$
- Analysis of Variance
  $(y_{ij} - \bar{y})^2 = (y_{ij} - \bar{y} + \bar{y}_j - \bar{y}_j)^2$
  $= (\bar{y}_j - \bar{y}) + (y_{ij} - \bar{y}_j)^2$
- Total SS = Between SS + Within SS

Decomposition of the Total Variation: One-way ANOVA (p. 502)

Table 16.1

Independent Variable					X
		Categories			Total Sample
X_1	X_2	X_3	…	X_c	
Y_1	Y_1	Y_1		Y_1	Y_1
Y_2	Y_2	Y_2		Y_2	Y_2
⋮					⋮
Y_n	Y_n	Y_n		Y_n	Y_N
$\bar{Y}_1$	$\bar{Y}_2$	$\bar{Y}_3$		$\bar{Y}_c$	$\bar{Y}$

Within Category Variation $=SS_{within}$

Total Variation $=SS_y$

Between Category Variation $= SS_{between}$

Conducting One-way Analysis of Variance
Decompose the Total Variation

The total variation in *Y*, denoted by SS_y, can be decomposed into two components:

$$SS_y = SS_{between} + SS_{within}$$

where the subscripts *between* and *within* refer to the categories of *X*. $SS_{between}$ is the variation in *Y* related to the variation in the means of the categories of *X*. For this reason, $SS_{between}$ is also denoted as SS_x. SS_{within} is the variation in *Y* related to the variation within each category of *X*. SS_{within} is not accounted for by *X*. Therefore it is referred to as SS_{error}.

67

Conducting One-way Analysis of Variance
Decompose the Total Variation (p. 502)

The total variation in *Y* may be decomposed as:

$$SS_y = SS_x + SS_{error}$$

where

$$SS_y=\sum_{i=1}^{N} (Y_i-\overline{Y}^{\,2}$$

$$SS_x=\sum_{j=1}^{c} n\,(\overline{Y}_j-\overline{Y}$$

$$SS_{error}=\sum_{j}^{c} \sum_{i}^{n} (Y_{ij}-\overline{Y}_j)^2$$

Y_i = individual observation
$\overline{Y}_j$ = mean for category *j*
$\overline{Y}$ = mean over the whole sample, or grand mean
Y_{ij} = *i* th observation in the *j* th category

68

Conducting One-way Analysis of Variance

In analysis of variance, we estimate two measures of variation: within groups (SS_{within}) and between groups ($SS_{between}$). Thus, by comparing the *Y* variance estimates based on between-group and within-group variation, we can test the null hypothesis.

Measure the Effects

The strength of the effects of *X* on *Y* are measured as follows:

$$\eta^2 = SS_x / SS_y = (SS_y - SS_{error}) / SS_y$$

The value of η^2 varies between 0 and 1.

69

Conducting One-way Analysis of Variance
Test Significance

In one-way analysis of variance, the interest lies in testing the null hypothesis that the <u>category means are equal in the population</u>.

$$H_0: \mu_1 = \mu_2 = \mu_3 = \ldots\ldots\ldots = \mu_c$$

Under the null hypothesis, SS_x and SS_{error} come from the same source of variation. In other words, the estimate of the population variance of *Y*,

$$\begin{aligned} S_y^2 &= SS_x/(c - 1) \\ &= \text{Mean square due to } X \\ &= MS_x \end{aligned}$$

or

$$\begin{aligned} S_y^2 &= SS_{error}/(N - c) \\ &= \text{Mean square due to error} \\ &= MS_{error} \end{aligned}$$

70

Conducting One-way Analysis of Variance
Test Significance (p. 502)

The null hypothesis may be tested by the *F* statistic based on the ratio between these two estimates:

$$F = \frac{SS_x/(c - 1)}{SS_{error}/(N - c)} = \frac{MS_x}{MS_{error}}$$

This statistic follows the *F* distribution, with (c - 1) and (N - c) degrees of freedom (df).

71

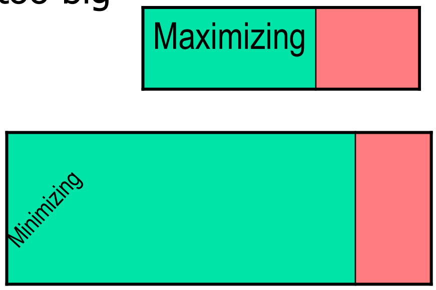
Conducting One-way Analysis of Variance
Interpret the Results

- If the null hypothesis of equal category means is not rejected, then the independent variable does not have a significant effect on the dependent variable.
- On the other hand, if the null hypothesis is rejected, then the effect of the independent variable is significant.
- A comparison of the category mean values will indicate the nature of the effect of the independent variable.

72

Why F is not significant?

- MS_X (between SS) is too small
  - Why too small?
  - What can we do about it?
- MS_{error} (within SS) is too big
  - Why too big?
  - What can be done?



73

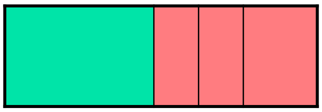
Why F is not significant?

- Randomized Block Design
  - Decompose error term into

    $\varepsilon_{ij} = b_i + \varepsilon'_{ij}$
- Latin Square Design
  - Decompose error term into

    $\varepsilon_{ij} = b_1 + b_2 + \varepsilon''_{ij}$
- Factorial Design (N-way ANOVA)
  - Decompose treatment term into

    $\tau_j = \alpha_i + \beta_j + (\alpha\beta)_{ij}$



74

Concluding Remarks

- Research Design as variance control
  - Maximize systematic (experimental) variance
  - Control extraneous systematic variance
  - Minimize error variance

The ANOVA Procedure

```
title1 'Nitrogen Content of Red Clover Plants';
data Clover;
   input Strain $ Nitrogen @@;
   datalines;
3DOK1  19.4 3DOK1  32.6 3DOK1  27.0 3DOK1  32.1 3DOK1  33.0
3DOK5  17.7 3DOK5  24.8 3DOK5  27.9 3DOK5  25.2 3DOK5  24.3
3DOK4  17.0 3DOK4  19.4 3DOK4   9.1 3DOK4  11.9 3DOK4  15.8
3DOK7  20.7 3DOK7  21.0 3DOK7  20.5 3DOK7  18.8 3DOK7  18.6
3DOK13 14.3 3DOK13 14.4 3DOK13 11.8 3DOK13 11.6 3DOK13 14.2
COMPOS 17.3 COMPOS 19.4 COMPOS 19.1 COMPOS 16.9 COMPOS 20.8
;
```

The variable Strain contains the treatment levels, and the variable Nitrogen contains the response. The following statements produce the analysis.

```
proc anova data = Clover;
   class strain;
   model Nitrogen = Strain;
run;
```

ANOVA-Family

- One way ANOVA: one grouping (independent) variable, one dependent variable
- Within-Subjects ANOVA: scores are obtained from the same subject measured on separate occasions
- Factorial (n-way) ANOVA: more than one grouping (independent) variable, one dependent variable
- Analysis of Covariance (ANCOVA): scores are obtained both before and after a treatment intervention, and pre-treatment scores are used to adjust post-treatment scores
- Multivariate Analysis of Variance (MANOVA): two or more dependent variables
- MANCOVA

Exercise (悲喜交加對決策的影响)

- Use the example in p. 505 to identify eight different interaction patterns for a two factors ANOVA, both X_1 and X_2 have two levels.