**Review**

**Correlation** (between two metric-scaled variables)
- whether the two variables are related (existence)
- negatively or positively (directionality)
- how strong is the relation (strength)

- correlation coefficient: $r$
  $-1 \leq r \leq 1$

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**Objective**

**Analysis of “Association”**

1. Correlation
   - association between two metric variables

2. Regression
   - Simple regression
   - Multiple regression

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**II. Regression**

- **Introductory Example (Beer)**
  Variable 1: purchase quantity (1, 2, 3, …..)
  Variable 2: purchase intention for ‘Foster’

Q: Do consumers’ purchase intention for ‘Foster’ change as purchase quantity varies?

*Significantly related?*

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**Marketing Research Process**

1. Problem Definition
2. Development of an Approach to the Problem
3. Research Design Formulation
4. Data Collection
5. Data Analysis
6. Report Preparation and Presentation

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**Data Analysis III**

**Chap. 18**

**Regression**

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**II. Regression**

- **Introductory Example (Beer)**
  Variable 1: purchase quantity (1, 2, 3, …..)
  Variable 2: purchase intention for ‘Foster’

Q: Do consumers’ purchase intention for ‘Foster’ change as purchase quantity varies?

*Significantly related?*
What value of $b$ tells us that:

- there’s no relationship between $X$ and $Y$  
  ($=X$ has no influence on $Y$)  
  ($=Y$ is not affected by $X$)

$Y = a + bX$

1. Simple Regression

- **Variables**: 2 variables  
  - Variable 1: metric scale (dependent var.)  
  - Variable 2: metric / nonmetric scale (one independent var.)

- **Measuring**:  
  - the association (linear relationship) between one dependent var. and one independent var.  
  - the effect of Variable 2 on variable 1  
  - the direction (positive or negative relation) of the association

$H_0$: $b = 0$  (Y is NOT related to X; Y is NOT affected by X)  
$H_1$: $b \neq 0$  (Y is related to X; Y is affected by X)
Purpose

1. Explaining and Understanding:
   – Relationship between X and Y
     \[ Y = a + b \times X \]

2. Predicting
   – Y
   – ex. If a = 1 and b=2, then Y is predicted to be 5 when x=2.

What to do in regression - (1)

[1] Estimation of ‘a’ and ‘b’
   – Least square method
   \[
   \hat{Y} = \hat{a} + \hat{b} \times X
   \]

What to do in regression - (2)

[2] Hypothesis testing

- Hypothesis
  – \( H_0: \) Y(depend. var.) is not related to X(indep. var.).
    \[ \text{[or } H_0: \ b = 0 \text{]} \]
  – \( H_1: \) Y(depend. var.) is related to X(indep. var.).
    \[ \text{[or } H_1: \ b \neq 0 \text{]} \]

- Decision rule
  – reject \( H_0 \) if \( \alpha > p\)-value
  – Not reject \( H_0 \) if \( \alpha < p\)-value

Procedure of Simple Regression

Identify variables:
1. Independent variable(X) ? Metric scale or Nominal scale
2. dependent variable(Y) ? Should be measured by metric scales.

Procedure:
1. Write the regression model
   \[ Y = a + b \times X \]
2. State Hypotheses:
   1. \( H_0: \) X and Y are not related (\( b=0 \))
   2. \( H_1: \) X and Y are related (\( b \neq 0 \))
3. Get the computer output
4. Find the regression coefficients: ‘a’ and ‘b’
5. Compare the p-value with \( \alpha \)
   \[ \text{If } p\text{-value} < \alpha, \text{ Reject } H_0 \]
   \[ \text{If } p\text{-value} > \alpha, \text{ Do not reject } H_0 \]

Review

Analysis of “Association”

1. Correlation (association between two metric var’s)
   – the magnitude and direction of the association between two variables
   – \([-1, 1]: r < 0, r = 0, r > 0\)
Review

2. (Simple) Regression

- relationship between independent and dependent variable

<table>
<thead>
<tr>
<th>Y (dep.)</th>
<th>X (indep.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>simple regression</td>
<td>one</td>
</tr>
<tr>
<td>multiple regression</td>
<td>one more than one</td>
</tr>
</tbody>
</table>

- \[ Y = a + bX \]
- (1) Explaining/Understanding and (2) prediction
- \[ H_0: b=0 \quad \text{vs} \quad H_1: b \neq 0 \]
- \[ SS_r = SS_p + SS_e \Rightarrow R^2 = SS_r / SS_t \]

Multiple Regression

Objective

Multiple Regression
- Estimation
- Hypothesis Testing

Marketing Research Process

1. Problem Definition
2. Development of an Approach to the Problem
3. Research Design Formulation
4. Data Collection
5. Data Analysis
6. Report Preparation and Presentation

Multiple Regression

- Introductory Example
  Marketing decision variable: price, product quality
  Managerial Interest: consumer’s attitude

Q: Do the price and quality of my brand influence consumer’s attitude toward my brand?

Significantly related(associated)?

<table>
<thead>
<tr>
<th>Price(X1)</th>
<th>Quality(X2)*</th>
<th>Attitude(Y)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>$8.05</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>$7.50</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>$7.99</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>$9.00</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>$8.25</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>$6.99</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* 1 2 3 4 5 6 7
(Worst) | | | | | | | | (Best)
** 1 2 3 4 5 6 7
(Not like) | | | | | | | | (Like it very much)
Structure of Multiple regression

- **Variables**
  - Dependent var.: metric scale (Y) one
  - Independent var.: metric / nonmetric scale (X) more than one X’s

- **Measuring**
  - the association (linear relationship) between one dependent var. and multiple independent var’s
  - the effect of indep. var’s on dependent var.
  - the direction (positive or negative relation) of the association

Purpose

1. Explaining and Understanding:
   - Relationship between multiple X’s and Y
     \[ Y = a + b_1 X_1 + \ldots + b_k X_k \]

2. Predicting
   - Y
     - ex. If \( a = 0.5 \), \( b_1 = 1 \), and \( b_2 = 0.5 \), then Y is predicted to be 4 when \( x_1 = 2 \) and \( x_2 = 1 \).

What to do in regression - (1)

1. Estimation of ‘a’ and ‘b1, ….., bk’
   - Least square method
   \[ \text{min.} \sum (Y-(a+b_1X_1+\ldots+b_kX_k))^2 \]

2. Hypotheses Testing on:
   - (1) Individual coefficients
   - (2) Regression equation

[2]-1 Hypothesis testing on Individual coefficient(\( b_j \), \( j=1,\ldots,k \))

- **Hypothesis**
  - \( H_0: \ Y \text{ is not related to } X_j (b_j = 0) \)
  - \( H_1: \ b_j \neq 0 \)

- **Decision rule**
  - reject \( H_0 \) if \( \alpha > p\text{-value} \)
  - Not reject \( H_0 \) if \( \alpha < p\text{-value} \)

[2]-2 Hypothesis testing on Regression equation

- **Hypothesis**
  - \( H_0: \ b_1 = 0, b_2 = 0, \ldots, \text{ and } b_k = 0 \)
  (Y is not related to any of the independent variables)
  - \( H_1: \ At \text{ least one } b_j \neq 0 \text{ for } j=1,\ldots,k \)
  (Y is related to at least one of the independent variables)

- **Decision rule**
  - Reject \( H_0 \) if \( \alpha > p\text{-value} \)
  - Not reject \( H_0 \) if \( \alpha < p\text{-value} \)
Multiple Regression Using SPSS

Go to the other handout

– How to do multiple regression in SPSS

– How to interpret the results (computer output)