# ภาคผนวก 1

ตัวอย่างการใช้โปรแกรมสำเร็จรูป SPSS for Windows

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<u>หมายเหตุ</u> นักศึกษาอาจอ่านรายละเอียดการใช้ SPSS for Windows ได้จากหนังสือ การวิเคราะห์ข้อมูลด้วย SPSS for Windows โดย รศ.ดร.กัลยา วานิชย์บัญชา โรงพิมพ์แห่งจุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพ, 2541.

1. **ตัวอย่างที่ 4.12**

**ตัวอย่างที่ 4.12** ในการทดลองให้สารกระตุ้นหัวใจ 4 ชนิดแก่หนูตะเภา (Guinea pig) จำนวนหนึ่งในห้องทดลอง แล้วบันทึกปริมาณสารที่ให้จนหนูแต่ละตัวตาย (dosage of death) ผลปรากฏดังนี้

| | สารชนิดที่ 1 | สารชนิดที่ 2 | สารชนิดที่ 3 | สารชนิดที่ 4 |
|---|---|---|---|---|
| | 29,28,23, 26,26,19 25,29,26, 28 | 17,25,24, 19,28,21, 20,25,19, 24 | 17,16,21, 22,23,18 20,17,25, 21 | 18,20,25, 24,16,20 20,17,19, 17 |
| Total : $T_i$ | 259 | 222 | 200 | 196 |
| mean : $\bar{x}_i$ | 25.9 | 22.2 | 20.0 | 19.6 |
| $n_i$ | 10 | 10 | 10 | 10 |

SPSS **Commands และ Output**

```
ONEWAY
 y BY x
 /CONTRAST= 1 -1 1 -1  /CONTRAST= 3 -1 -1 -1  /CONTRAST= 1 1 -1 -1
 /CONTRAST= 1 0 0 -1  /CONTRAST= 1 0 -1 0  /CONTRAST= 1 -1 0 0
 /CONTRAST= 0 1 0 -1  /CONTRAST= 0 1 -1 0  /CONTRAST= 0 0 1 -1
 /STATISTICS DESCRIPTIVES HOMOGENEITY
 /MISSING ANALYSIS
 /POSTHOC = DUNCAN SCHEFFE LSD ALPHA(.05).
```

A:\st204ex412.sav

| | x | y |
|---|---|---|
| 1 | 1 | 29 |
| 2 | 1 | 28 |
| 3 | 1 | 23 |
| 4 | 1 | 26 |
| 5 | 1 | 26 |
| 6 | 1 | 19 |
| 7 | 1 | 25 |
| 8 | 1 | 29 |
| 9 | 1 | 26 |
| 10 | 1 | 28 |
| 11 | 2 | 17 |
| 12 | 2 | 25 |
| 13 | 2 | 24 |
| 14 | 2 | 19 |
| 15 | 2 | 28 |
| 16 | 2 | 21 |
| 17 | 2 | 20 |
| 18 | 2 | 25 |
| 19 | 2 | 19 |
| 20 | 2 | 24 |
| 21 | 3 | 17 |
| 22 | 3 | 16 |
| 23 | 3 | 21 |
| 24 | 3 | 22 |
| 25 | 3 | 23 |
| 26 | 3 | 18 |
| 27 | 3 | 20 |
| 28 | 3 | 17 |
| 29 | 3 | 25 |
| 30 | 3 | 21 |
| 31 | 4 | 18 |
| 32 | 4 | 20 |
| 33 | 4 | 25 |
| 34 | 4 | 24 |
| 35 | 4 | 16 |
| 36 | 4 | 20 |
| 37 | 4 | 20 |
| 38 | 4 | 17 |
| 39 | 4 | 19 |
| 40 | 4 | 17 |

## Oneway

**Descriptives**

| | | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Dosage of death | drug 1 | 10 | 25.90 | 3.07 | .97 | 23.70 | 28.10 |
| | 2 | 10 | 22.20 | 3.49 | 1.10 | 19.70 | 24.70 |
| | 3 | 10 | 20.00 | 2.94 | .93 | 17.89 | 22.11 |
| | 4 | 10 | 19.60 | 2.95 | .93 | 17.49 | 21.71 |
| | Total | 40 | 21.93 | 3.92 | .62 | 20.67 | 23.18 |

| | | Minimum | Maximum |
|---|---|---|---|
| Dosage of death | drug 1 | 19 | 29 |
| | 2 | 17 | 28 |
| | 3 | 16 | 25 |
| | 4 | 16 | 25 |
| | Total | 16 | 29 |

**Test of Homogeneity of Variances**

| | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| Dosage of death | .509 | 3 | 36 | .679 |

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Dosage of death | Between Groups | 249.875 | 3 | 83.292 | 8.545 | .000 |
| | Within Groups | 350.900 | 36 | 9.747 | | |
| | Total | 600.775 | 39 | | | |

**Contrast Coefficients**

| Contrast | drug | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | 1 | -1 | 1 | -1 |
| 2 | 3 | -1 | -1 | -1 |
| 3 | 1 | 1 | -1 | -1 |
| 4 | 1 | 0 | 0 | -1 |
| 5 | 1 | 0 | -1 | 0 |
| 6 | 1 | -1 | 0 | 0 |
| 7 | 0 | 1 | 0 | -1 |
| 8 | 0 | 1 | -1 | 0 |
| 9 | 0 | 0 | 1 | -1 |

Contrast Tests

| | | Contrast | Value of Contrast | Std. Error | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| Dosage of death | Assume equal variances | 1 | 4.10 | 1.97 | 2.076 | 36 | .045 |
| | | 2 | 15.90 | 3.42 | 4.649 | 36 | .000 |
| | | 3 | 8.50 | 1.97 | 4.305 | 36 | .000 |
| | | 4 | 6.30 | 1.40 | 4.512 | 36 | .000 |
| | | 5 | 5.90 | 1.40 | 4.226 | 36 | .000 |
| | | 6 | 3.70 | 1.40 | 2.650 | 36 | .012 |
| | | 7 | 2.60 | 1.40 | 1.862 | 36 | .071 |
| | | 8 | 2.20 | 1.40 | 1.576 | 36 | .124 |
| | | 9 | .40 | 1.40 | .286 | 36 | .776 |
| | Does not assume equal variances | 1 | 4.10 | 1.97 | 2.076 | 35.235 | .045 |
| | | 2 | 15.90 | 3.38 | 4.700 | 15.705 | .000 |
| | | 3 | 8.50 | 1.97 | 4.305 | 35.235 | .000 |
| | | 4 | 6.30 | 1.35 | 4.677 | 17.972 | .000 |
| | | 5 | 5.90 | 1.35 | 4.385 | 17.968 | .000 |
| | | 6 | 3.70 | 1.47 | 2.517 | 17.714 | .022 |
| | | 7 | 2.60 | 1.45 | 1.799 | 17.518 | .089 |
| | | 8 | 2.20 | 1.44 | 1.524 | 17.503 | .145 |
| | | 9 | .40 | 1.32 | .303 | 18.000 | .765 |

## Homogeneous Subsets

Dosage of death

| | drug | N | Subset for alpha = .05 | |
|---|---|---|---|---|
| | | | 1 | 2 |
| Duncan[a] | 4 | 10 | 19.60 | |
| | 3 | 10 | 20.00 | |
| | 2 | 10 | 22.20 | |
| | 1 | 10 | | 25.90 |
| | Sig. | | .086 | 1.000 |
| Scheffe[a] | 4 | 10 | 19.60 | |
| | 3 | 10 | 20.00 | |
| | 2 | 10 | 22.20 | 22.20 |
| | 1 | 10 | | 25.90 |
| | Sig. | | .340 | .090 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000

## Post Hoc Tests

**Multiple Comparisons**

Dependent Variable: Dosage of death

| | (I) drug | (J) drug | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Scheffe | 1 | 2 | 3.70 | 1.396 | .090 | -.39 | 7.79 |
| | | 3 | 5.90* | 1.396 | .002 | 1.81 | 9.99 |
| | | 4 | 6.30* | 1.396 | .001 | 2.21 | 10.39 |
| | 2 | 1 | -3.70 | 1.396 | .090 | -7.79 | .39 |
| | | 3 | 2.20 | 1.396 | .487 | -1.89 | 6.29 |
| | | 4 | 2.60 | 1.396 | .340 | -1.49 | 6.69 |
| | 3 | 1 | -5.90* | 1.396 | .002 | -9.99 | -1.81 |
| | | 2 | -2.20 | 1.396 | .487 | -6.29 | 1.89 |
| | | 4 | .40 | 1.396 | .994 | -3.69 | 4.49 |
| | 4 | 1 | -6.30* | 1.396 | .001 | -10.39 | -2.21 |
| | | 2 | -2.60 | 1.396 | .340 | -6.69 | 1.49 |
| | | 3 | -.40 | 1.396 | .994 | -4.49 | 3.69 |
| LSD | 1 | 2 | 3.70* | 1.396 | .012 | .87 | 6.53 |
| | | 3 | 5.90* | 1.396 | .000 | 3.07 | 8.73 |
| | | 4 | 6.30* | 1.396 | .000 | 3.47 | 9.13 |
| | 2 | 1 | -3.70* | 1.396 | .012 | -6.53 | -.87 |
| | | 3 | 2.20 | 1.396 | .124 | -.63 | 5.03 |
| | | 4 | 2.60 | 1.396 | .071 | -.23 | 5.43 |
| | 3 | 1 | -5.90* | 1.396 | .000 | -8.73 | -3.07 |
| | | 2 | -2.20 | 1.396 | .124 | -5.03 | .63 |
| | | 4 | .40 | 1.396 | .776 | -2.43 | 3.23 |
| | 4 | 1 | -6.30* | 1.396 | .000 | -9.13 | -3.47 |
| | | 2 | -2.60 | 1.396 | .071 | -5.43 | .23 |
| | | 3 | -.40 | 1.396 | .776 | -3.23 | 2.43 |

*. The mean difference is significant at the .05 level.

## 2. ตัวอย่างที่ 4.14

**ตัวอย่างที่ 4.14** ช่างถ่ายรูปต้องการจะปรับปรุงความชัดเจนของการล้างฟิล์ม ได้เพิ่ม Metol 2 ระดับ (1.5 กรัมและ 2.5 กรัม) และ Hydroquinone 2 ระดับ (4 กรัมและ 6 กรัม) ลงในของเหลวที่ใช้ล้างฟิล์ม 1 ลิตร ผลของการวัดความชัดเจนของภาพแสดงในตารางต่อไปนี้

| | | Hydroquinone | | Total |
|---|---|---|---|---|
| | | 4 | 6 | |
| Metol | 1.5 | 28, 30 | 33, 33 | |
| | | $y_{11.} = 58$ | $y_{12.} = 66$ | $y_{1..} = 124$ |
| | 2.5 | 42, 38 | 40, 42 | |
| | | $y_{21.} = 80$ | $y_{22.} = 82$ | $y_{2..} = 162$ |
| Total | | $y_{.1.} = 138$ | $y_{.2.} = 148$ | $y_{...} = 286$ |

SPSS Commands และ Output

```
GLM
  clear BY hydro met
  /METHOD = SSTYPE(3)
  /INTERCEPT = INCLUDE
  /CRITERIA = ALPHA(.05)
  /DESIGN .
```

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| | met | hydro | clear |
|---|---|---|---|
| 1 | 1 | 1 | 28 |
| 2 | 1 | 1 | 30 |
| 3 | 1 | 2 | 33 |
| 4 | 1 | 2 | 33 |
| 5 | 2 | 1 | 42 |
| 6 | 2 | 1 | 38 |
| 7 | 2 | 2 | 40 |
| 8 | 2 | 2 | 42 |

# General Linear Model

**Between-Subjects Factors**

| | | Value Label | N |
|---|---|---|---|
| Hydroquinone | 1 | 4 Grams | 4 |
| | 2 | 6 Grams | 4 |
| Metol | 1 | 1.5 Grams | 4 |
| | 2 | 2.5 Grams | 4 |

**Tests of Between-Subjects Effects**

Dependent Variable: Clear value of film

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Noncent. Parameter | Observed Power[a] |
|---|---|---|---|---|---|---|---|
| Corrected Model | 197.500[b] | 3 | 65.833 | 21.944 | .006 | 65.833 | .983 |
| Intercept | 10224.500 | 1 | 10224.500 | 3408.167 | .000 | 3408.167 | 1.000 |
| HYDRO | 12.500 | 1 | 12.500 | 4.167 | .111 | 4.167 | .347 |
| MET | 180.500 | 1 | 180.500 | 60.167 | .001 | 60.167 | 1.000 |
| HYDRO * MET | 4.500 | 1 | 4.500 | 1.500 | .288 | 1.500 | .159 |
| Error | 12.000 | 4 | 3.000 | | | | |
| Total | 10434.000 | 8 | | | | | |
| Corrected Total | 209.500 | 7 | | | | | |

a. Computed using alpha = .05

b. R Squared = .943 (Adjusted R Squared = .900)

3. **แบบฝึกหัดข้อ 4.6**

วิชาคณิตศาสตร์เบื้องต้นถูกแบ่งเป็น 3 กลุ่ม แต่ละกลุ่มสอนโดยครูแต่ละคน (นักเรียนใน 3 กลุ่มมีความรู้พื้นฐานและความสามารถทางสมองพอ ๆ กันหมด) ผลการสอบไล่ (โดยใช้ข้อสอบเดียวกัน) เป็นดังนี้

| ครู | | |
|---|---|---|
| A | B | C |
| 73, 60 | 88, 31 | 68, 41 |
| 89, 45 | 78, 78 | 79, 59 |
| 82, 93 | 48, 62 | 56, 68 |
| 43, 36 | 91, 76 | 91, 53 |
| 80, 77 | 51, 96 | 71, 79 |
| 73, 66 | 85, 80 | 71, 15 |
| | 74, 56 | 87 |
| | 77 | |

จงทดสอบที่ $\alpha$ = .05 ว่าคะแนนเฉลี่ยของนักเรียนทั้ง 3 กลุ่มต่างกันอย่างมีนัยยะสำคัญหรือไม่ เราจะสรุปได้ไหมว่าครูทั้ง 3 คนสอนดีพอ ๆ กัน

SPSS Commands และ Output

```
ONEWAY
  score BY teacher
  /STATISTICS HOMOGENEITY
  /MISSING ANALYSIS
  /POSTHOC = DUNCAN ALPHA(.05).
```

| | teacher | score |
|---|---|---|
| 21 | 2 | 51 |
| 22 | 2 | 96 |
| 23 | 2 | 85 |
| 24 | 2 | 80 |
| 25 | 2 | 74 |
| 26 | 2 | 56 |
| 27 | 2 | 77 |
| 28 | 3 | 68 |
| 29 | 3 | 41 |
| 30 | 3 | 79 |
| 31 | 3 | 59 |
| 32 | 3 | 56 |
| 33 | 3 | 68 |
| 34 | 3 | 91 |
| 35 | 3 | 53 |
| 36 | 3 | 71 |
| 37 | 3 | 79 |
| 38 | 3 | 71 |
| 39 | 3 | 15 |
| 40 | 3 | 87 |

| | teacher | score |
|---|---|---|
| 1 | 1 | 73 |
| 2 | 1 | 60 |
| 3 | 1 | 89 |
| 4 | 1 | 45 |
| 5 | 1 | 82 |
| 6 | 1 | 93 |
| 7 | 1 | 43 |
| 8 | 1 | 36 |
| 9 | 1 | 80 |
| 10 | 1 | 77 |
| 11 | 1 | 73 |
| 12 | 1 | 66 |
| 13 | 2 | 88 |
| 14 | 2 | 31 |
| 15 | 2 | 78 |
| 16 | 2 | 78 |
| 17 | 2 | 48 |
| 18 | 2 | 62 |
| 19 | 2 | 91 |
| 20 | 2 | 76 |

# Oneway

**Test of Homogeneity of Variances**

| | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| Math score | .012 | 2 | 37 | .988 |

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Math score | Between Groups | 335.353 | 2 | 167.676 | .465 | .632 |
| | Within Groups | 13349.747 | 37 | 360.804 | | |
| | Total | 13685.100 | 39 | | | |

# Post Hoc Tests

# Homogeneous Subsets

**Math score**

Duncan[a,b]

| Math teacher | N | Subset for alpha = .05 |
|---|---|---|
| | | 1 |
| Teacher C | 13 | 64.46 |
| Teacher A | 12 | 68.08 |
| Teacher B | 15 | 71.40 |
| Sig. | | .383 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 13.220

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

4. <u>แบบฝึกหัดข้อ 4.10</u>

ขนมปัง 3 แถว แต่ละแถวใช้ส่วนผสมต่างกัน นำเข้าไปอบในเตาอบพร้อม ๆ กัน เนื่องจากสิ่งที่ควบคุมไม่ได้นั้นทำให้เตาอบทำงานไม่เหมือนกันในแต่ละครั้งของการอบ ได้ทำการอบขนมปังทีละ 3 แถว 5 ครั้ง และวัดความแน่นของขนมปังไว้ดังนี้

| ครั้งที่อบ (block) | สูตร | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 1 | .95 | .71 | .69 |
| 2 | .86 | .85 | .68 |
| 3 | .71 | .62 | .51 |
| 4 | .72 | .72 | .73 |
| 5 | .74 | .64 | .44 |

กำหนด $\sum_{i=1}^{5}\sum_{j=1}^{3} x_{ij}^2 = 7.6763$ , CF = 7.4483

$\sum_{i=1}^{5} x_{i.}^2 = 22.6415$ , $\sum_{i=1}^{3} x_{.j}^2 = 37.6745$

จงทำการวิเคราะห์ความแปรปรวนของข้อมูลชุดนี้ ($\alpha$ = .05)

<u>SPSS Commands และ Output</u>

```
GLM
  density BY formula time
  /METHOD = SSTYPE(3)
  /INTERCEPT = INCLUDE
  /CRITERIA = ALPHA(.05)
  /DESIGN = formula time .
```

| | time | formula | density |
|---|---|---|---|
| 1 | 1 | 1 | .95 |
| 2 | 1 | 2 | .71 |
| 3 | 1 | 3 | .69 |
| 4 | 2 | 1 | .86 |
| 5 | 2 | 2 | .85 |
| 6 | 2 | 3 | .68 |
| 7 | 3 | 1 | .71 |
| 8 | 3 | 2 | .62 |
| 9 | 3 | 3 | .51 |
| 10 | 4 | 1 | .72 |
| 11 | 4 | 2 | .72 |
| 12 | 4 | 3 | .73 |
| 13 | 5 | 1 | .74 |
| 14 | 5 | 2 | .64 |
| 15 | 5 | 3 | .44 |

# General Linear Model

**Between-Subjects Factors**

| | | Value Label | N |
|---|---|---|---|
| Bread formula | 1 | | 5 |
| | 2 | | 5 |
| | 3 | | 5 |
| Baking order | 1 | | 3 |
| | 2 | | 3 |
| | 3 | | 3 |
| | 4 | | 3 |
| | 5 | | 3 |

**Tests of Between-Subjects Effects**

Dependent Variable: Bread density

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Noncent. Parameter | Observed Power[a] |
|---|---|---|---|---|---|---|---|
| Corrected Model | .185[b] | 6 | 3.090E-02 | 5.809 | .013 | 34.852 | .887 |
| Intercept | 7.448 | 1 | 7.448 | 1400 | .000 | 1400.061 | 1.000 |
| FORMULA | 8.657E-02 | 2 | 4.329E-02 | 8.137 | .012 | 16.273 | .848 |
| TIME | 9.884E-02 | 4 | 2.471E-02 | 4.645 | .031 | 18.579 | .738 |
| Error | 4.256E-02 | 8 | 5.320E-03 | | | | |
| Total | 7.676 | 15 | | | | | |
| Corrected Total | .228 | 14 | | | | | |

a. Computed using alpha = .05

b. R Squared = .813 (Adjusted R Squared = .673)

5. ตัวอย่างที่ 5.8

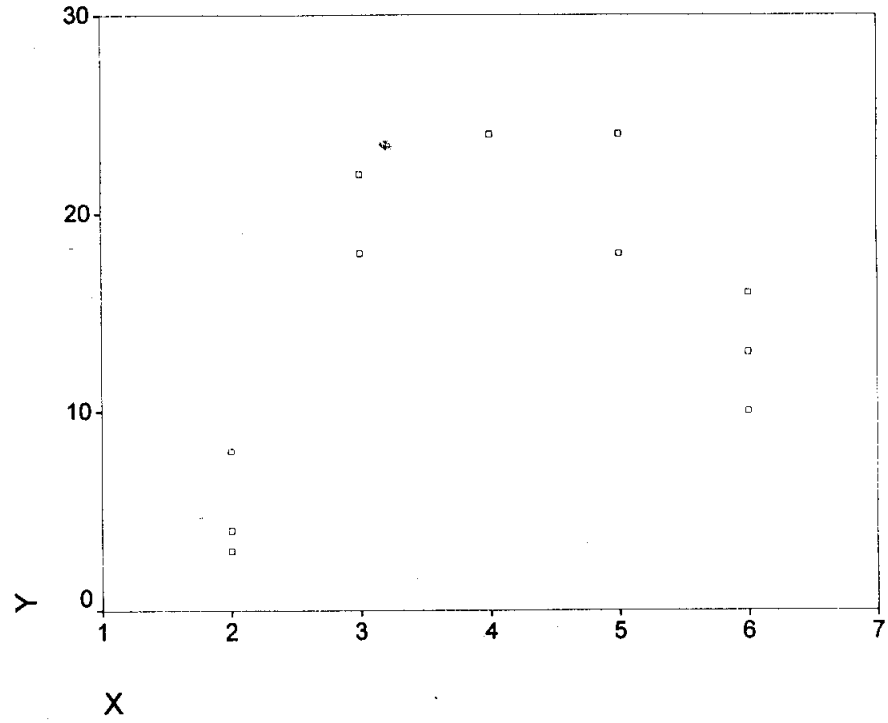
**ตัวอย่างที่5.8** จากข้อมูลข้างล่างนี้ จงหา sample regression equation และทดสอบ lack of fit

| x | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 6 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| y | 4 | 3 | 8 | 18 | 22 | 24 | 24 | 18 | 13 | 10 | 16 |

SPSS Commands และ Output

```
COMPUTE x2 = x*x .
EXECUTE .
GRAPH
 /SCATTERPLOT(BIVAR)=x WITH y
 /MISSING=LISTWISE .
REGRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT y
 /METHOD=ENTER x .
REGRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT y
 /METHOD=ENTER x x2 .
REGRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT y
 /METHOD=ENTER x2 .
```

## Graph




## Regression

**Variables Entered/Removed[b]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X[a] | | Enter |

a. All requested variables entered.

b. Dependent Variable: Y

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .396[a] | .156 | .063 | 7.31 |

a. Predictors: (Constant), X

**ANOVA[b]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 89.286 | 1 | 89.286 | 1.669 | .229[a] |
| | Residual | 481.442 | 9 | 53.494 | | |
| | Total | 570.727 | 10 | | | |

a. Predictors: (Constant), X

b. Dependent Variable: Y

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 7.403 | 5.952 | | 1.244 | .245 |
| | X | 1.786 | 1.382 | .396 | 1.292 | .229 |

a. Dependent Variable: Y

**Variables Entered/Removed[b]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X2, X[a] | | Enter |

a. All requested variables entered.

b. Dependent Variable: Y

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .941[a] | .885 | .856 | 2.87 |

a. Predictors: (Constant), X2, X

**ANOVA[b]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 504.937 | 2 | 252.469 | 30.7 | .000[a] |
| | Residual | 65.790 | 8 | 8.224 | | |
| | Total | 570.727 | 10 | | | |

a. Predictors: (Constant), X2, X

b. Dependent Variable: Y

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -43.776 | 7.568 | | -5.785 | .000 |
| | X | 32.216 | 4.315 | 7.136 | 7.467 | .000 |
| | X2 | -3.804 | .535 | -6.794 | -7.109 | .000 |

a. Dependent Variable: Y

# Regression

**Variables Entered/Removed[b]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X2[a] | . | Enter |

a. All requested variables entered.

b. Dependent Variable: Y

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .285[a] | .081 | -.021 | 7.63 |

a. Predictors: (Constant), X2

**ANOVA[b]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 46.422 | 1 | 46.422 | .797 | .395[a] |
| | Residual | 524.305 | 9 | 58.256 | | |
| | Total | 570.727 | 10 | | | |

a. Predictors: (Constant), X2

b. Dependent Variable: Y

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 11.584 | 4.037 | | 2.869 | .019 |
| | X2 | .160 | .179 | .285 | .893 | .395 |

a. Dependent Variable: Y

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| | x | y | x2 |
|---|---|---|---|
| 1 | 2 | 4 | 4.00 |
| 2 | 2 | 3 | 4.00 |
| 3 | 2 | 8 | 4.00 |
| 4 | 3 | 18 | 9.00 |
| 5 | 3 | 22 | 9.00 |
| 6 | 4 | 24 | 16.00 |
| 7 | 5 | 24 | 25.00 |
| 8 | 5 | 18 | 25.00 |
| 9 | 6 | 13 | 36.00 |
| 10 | 6 | 10 | 36.00 |
| 11 | 6 | 16 | 36.00 |

## 6. ตัวอย่างที่ 5.14

**ตัวอย่างที่ 5.14** เพื่อทดสอบความสามารถสูงสุดของการหยุดของรถยนต์เมื่อเหยียบเบรคเต็มที่ รถ 10 คันได้ถูกขับด้วยอัตราความเร็วที่ระบุไว้สำหรับแต่ละคัน และวัดระยะทางที่ต้องใช้ก่อนหยุดรถได้สนิท ความเร็วที่ขับสำหรับรถแต่ละคันและระยะทางที่ใช้หยุด เป็นดังนี้

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Initial speed : | x | 20 | 20 | 30 | 30 | 30 | 40 | 40 | 50 | 50 | 60 |
| Stopping distance : | y | 16.3 | 26.7 | 39.2 | 63.5 | 51.3 | 98.4 | 65.7 | 104.1 | 155.6 | 217.2 |

### SPSS Commands และ Output

```
COMPUTE sqy= SQRT(y) .
EXECUTE .
GRAPH
 /SCATTERPLOT(BIVAR)=x WITH y
 /MISSING=LISTWISE .
GRAPH
 /SCATTERPLOT(BIVAR)=x WITH sqy
 /MISSING=LISTWISE .
REGRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT y
 /METHOD=ENTER x .
REGRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT sqy
 /METHOD=ENTER x .
```

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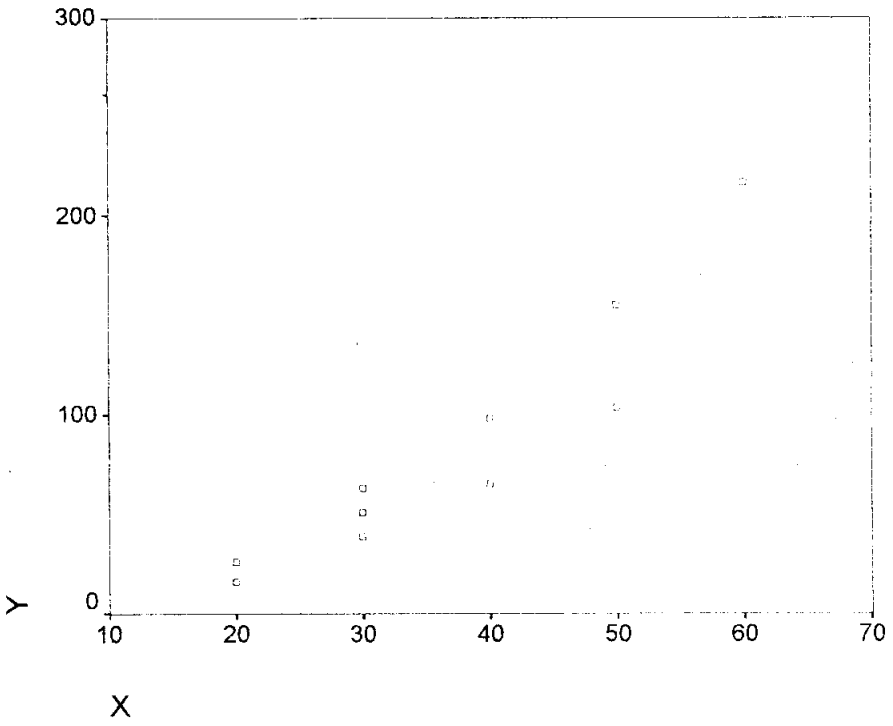
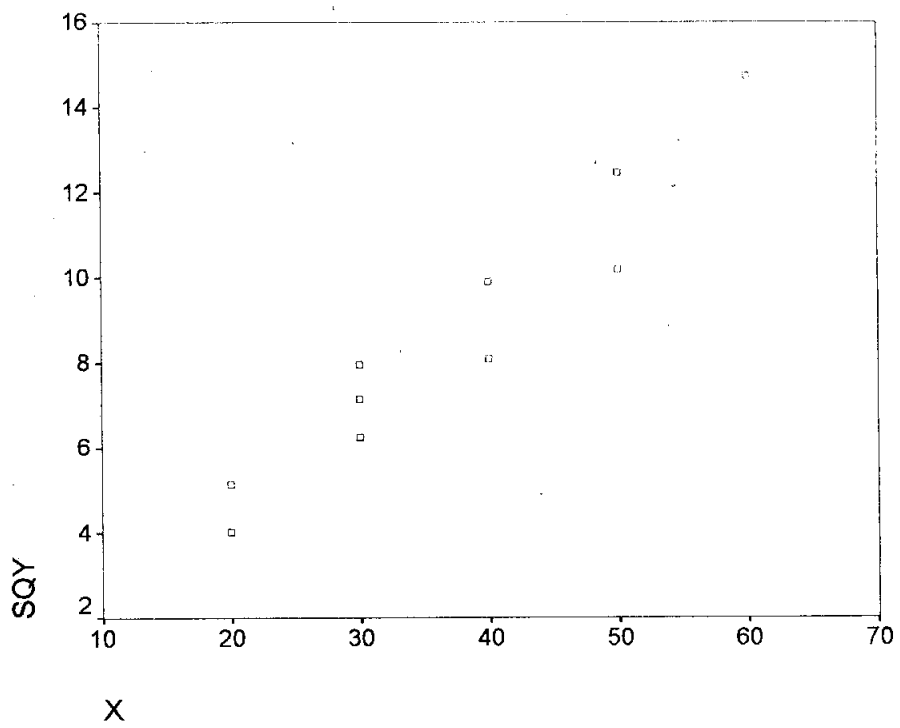
| | x | y | sqy |
|---|---|---|---|
| 1 | 20 | 16.30 | 4.04 |
| 2 | 20 | 26.70 | 5.17 |
| 3 | 30 | 39.20 | 6.26 |
| 4 | 30 | 63.50 | 7.97 |
| 5 | 30 | 51.30 | 7.16 |
| 6 | 40 | 98.40 | 9.92 |
| 7 | 40 | 65.70 | 8.11 |
| 8 | 50 | 104.10 | 10.20 |
| 9 | 50 | 155.60 | 12.47 |
| 10 | 60 | 217.20 | 14.74 |

## Graph


300
200
100
0
Y
10
20
30
40
50
60
70
X

## Graph


16
14
12
10
8
6
4
2
SQY
10
20
30
40
50
60
70
X

# Regression

**Variables Entered/Removed[b]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X[a] | . | Enter |

a. All requested variables entered.

b. Dependent Variable: Y

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .937[a] | .879 | .864 | 23.0838 |

a. Predictors: (Constant), X

**ANOVA[b]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 30914.92 | 1 | 30914.92 | 58.017 | .000[a] |
| | Residual | 4262.898 | 8 | 532.862 | | |
| | Total | 35177.82 | 9 | | | |

a. Predictors: (Constant), X

b. Dependent Variable: Y

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -78.334 | 22.503 | | -3.481 | .008 |
| | X | 4.382 | .575 | .937 | 7.617 | .000 |

a. Dependent Variable: Y

# Regression

**Variables Entered/Removed[b]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X[a] | . | Enter |

a. All requested variables entered.

b. Dependent Variable: SQY

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .962[a] | .925 | .916 | .9563 |

a. Predictors: (Constant), X

**ANOVA[b]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 90.456 | 1 | 90.456 | 98.909 | .000[a] |
| | Residual | 7.316 | 8 | .915 | | |
| | Total | 97.773 | 9 | | | |

a. Predictors: (Constant), X

b. Dependent Variable: SQY

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -.167 | .932 | | -.179 | .863 |
| | X | .237 | .024 | .962 | 9.945 | .000 |

a. Dependent Variable: SQY

7. **ตัวอย่างที่ 5.15**

**ตัวอย่างที่ 5.15** เราสนใจว่าความดันโลหิต y มีความสัมพันธ์กับน้ำหนัก ($x_1$) และอายุ ($x_2$) ในกลุ่มผู้ชายที่มีความสูงเท่า ๆ กันหรือไม่ จากชาย 13 คนซึ่งมีน้ำหนักและอายุที่เราเลือกไว้ก่อน วัดความดันโลหิตของชายทั้ง 13 คนได้ข้อมูลในตารางที่ 5.4 ให้ fit multiple regression model

$$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + E_i,\ i = 1, \ldots, 13$$

**ตารางที่ 5.4**

แสดงน้ำหนัก อายุและความดันโลหิตของชาย 13 คน

| คนที่ | $x_1$ | $x_2$ | y |
|---|---|---|---|
| 1 | 152 | 50 | 120 |
| 2 | 183 | 20 | 141 |
| 3 | 171 | 20 | 124 |
| 4 | 165 | 30 | 126 |
| 5 | 158 | 30 | 117 |
| 6 | 161 | 50 | 129 |
| 7 | 149 | 60 | 123 |
| 8 | 158 | 50 | 125 |
| 9 | 170 | 40 | 132 |
| 10 | 153 | 55 | 123 |
| 11 | 164 | 40 | 132 |
| 12 | 190 | 40 | 155 |
| 13 | 185 | 20 | 147 |

```
REGRESSION
 /DESCRIPTIVES MEAN STDDEV CORR SIG N
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS CI BCOV R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT y
 /METHOD=ENTER x1 x2
 /RESIDUALS DURBIN .
```

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| | x1 | x2 | y |
|---|---|---|---|
| 1 | 152 | 50 | 120 |
| 2 | 183 | 20 | 141 |
| 3 | 171 | 20 | 124 |
| 4 | 165 | 30 | 126 |
| 5 | 158 | 30 | 117 |
| 6 | 161 | 50 | 129 |
| 7 | 149 | 60 | 123 |
| 8 | 158 | 50 | 125 |
| 9 | 170 | 40 | 132 |
| 10 | 153 | 55 | 123 |
| 11 | 164 | 40 | 132 |
| 12 | 190 | 40 | 155 |
| 13 | 185 | 20 | 147 |

# Regression

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Blood pressure | 130.31 | 11.13 | 13 |
| weight | 166.08 | 13.16 | 13 |
| Age | 38.85 | 13.87 | 13 |

**Correlations**

| | | Blood pressure | weight | Age |
|---|---|---|---|---|
| Pearson Correlation | Blood pressure | 1.000 | .903 | -.362 |
| | weight | .903 | 1.000 | -.700 |
| | Age | -.362 | -.700 | 1.000 |
| Sig. (1-tailed) | Blood pressure | . | .000 | .112 |
| | weight | .000 | . | .004 |
| | Age | .112 | .004 | . |
| N | Blood pressure | 13 | 13 | 13 |
| | weight | 13 | 13 | 13 |
| | Age | 13 | 13 | 13 |

**Variables Entered/Removed[b]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Age, weight[a] | . | Enter |

a. All requested variables entered.

b. Dependent Variable: Blood pressure

**Model Summary[b]**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .979[a] | .958 | .949 | 2.51 | 2.213 |

a. Predictors: (Constant), Age, weight

b. Dependent Variable: Blood pressure

**ANOVA[b]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1423.838 | 2 | 711.919 | 113.13 | .000[a] |
| | Residual | 62.931 | 10 | 6.293 | | |
| | Total | 1486.769 | 12 | | | |

a. Predictors: (Constant), Age, weight

b. Dependent Variable: Blood pressure

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | -65.10 | 14.94 | | -4.356 | .001 | -98.40 | -31.801 |
| | weight | 1.077 | .077 | 1.274 | 13.975 | .000 | .905 | 1.249 |
| | Age | .425 | .073 | .530 | 5.815 | .000 | .262 | .588 |

a. Dependent Variable: Blood pressure

**Coefficient Correlations[a]**

| Model | | | Age | weight |
|---|---|---|---|---|
| 1 | Correlations | Age | 1.000 | .700 |
| | | weight | .700 | 1.000 |
| | Covariances | Age | 5.351E-03 | 3.948E-03 |
| | | weight | 3.948E-03 | 5.940E-03 |

a. Dependent Variable: Blood pressure

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 117.84 | 156.57 | 130.31 | 10.89 | 13 |
| Residual | -3.59 | 4.33 | -2.51E-14 | 2.29 | 13 |
| Std. Predicted Value | -1.144 | 2.411 | .000 | 1.000 | 13 |
| Std. Residual | -1.432 | 1.725 | .000 | .913 | 13 |

a. Dependent Variable: Blood pressure

8. <u>แบบฝึกหัดข้อ 5.1</u>

พนักงานป่าไม้ต้องการทราบว่าเขาจะใช้เส้นผ่าศูนย์กลางในการทำนายความสูงของต้นไม้ได้หรือไม่ เขาได้ทำการวัดเส้นผ่าศูนย์กลางของต้นไม้ตรงส่วนสูง 4.5 ฟุตจากพื้นดิน และความสูงของต้นเมเปิลที่ให้น้ำตาล 12 ต้น ผลปรากฏดังนี้

| x : เส้นผ่าศูนย์กลาง (นิ้ว) | .9 | 1.2 | 2.3 | 3.1 | 3.3 | 3.9 | 4.3 | 6.2 | 9.6 | 12.6 | 16.1 | 25.8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| y : ความสูง (ฟุต) | 18 | 26 | 32 | 36 | 44.5 | 35.6 | 40.5 | 57.5 | 67.3 | 84 | 67 | 87.5 |

ก) จงสร้าง Scatter diagram เพื่อดูว่าควรใช้ Straight line model หรือไม่

ข) ถ้ากำหนดให้ $x' = \log_{10} x$ และ $y' = \log_{10} y$ จงสร้าง Scatter diagram ของ $(x', y')$

| x' | -.05 | .08 | .36 | .49 | .52 | .59 | .63 | .79 | .98 | 1.10 | 1.21 | 1.41 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| y' | 1.26 | 1.41 | 1.51 | 1.56 | 1.65 | 1.55 | 1.61 | 1.76 | 1.83 | 1.92 | 1.83 | 1.94 |

ค) จาก model $Y_i' = \beta_0 + \beta_1 x_i' + E_i$ จงหา Sample regresion equation

```
COMPUTE xp = LG10(x) .
EXECUTE .
COMPUTE yp = LG10(y) .
EXECUTE .
GRAPH
 /SCATTERPLOT(BIVAR)=x WITH y
 /MISSING=LISTWISE .
GRAPH
 /SCATTERPLOT(BIVAR)=xp WITH yp
 /MISSING=LISTWISE .
REGRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT y
 /METHOD=ENTER x .
REGRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT yp
 /METHOD=ENTER xp .
```

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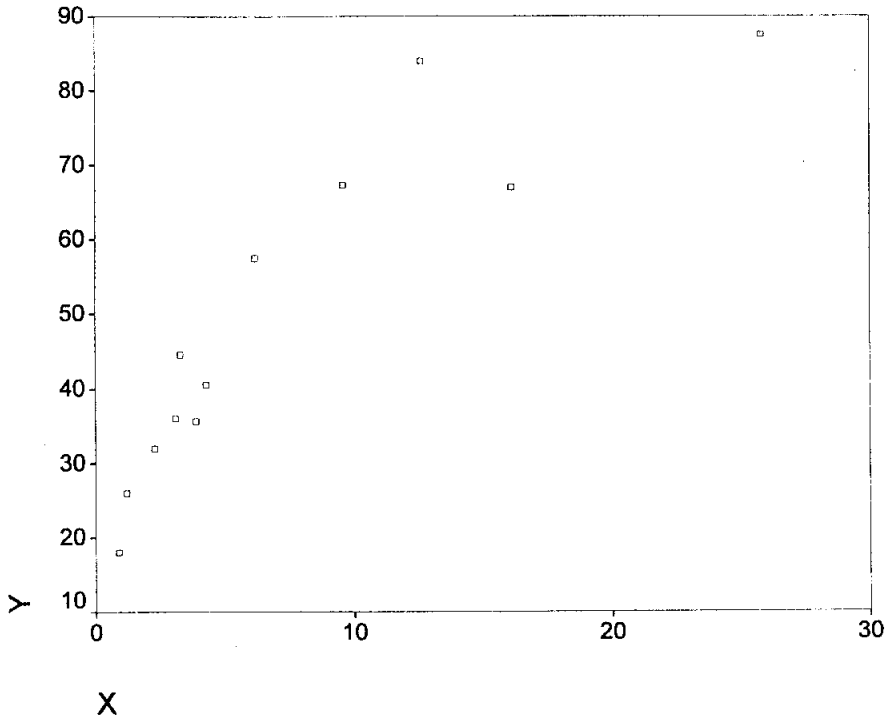
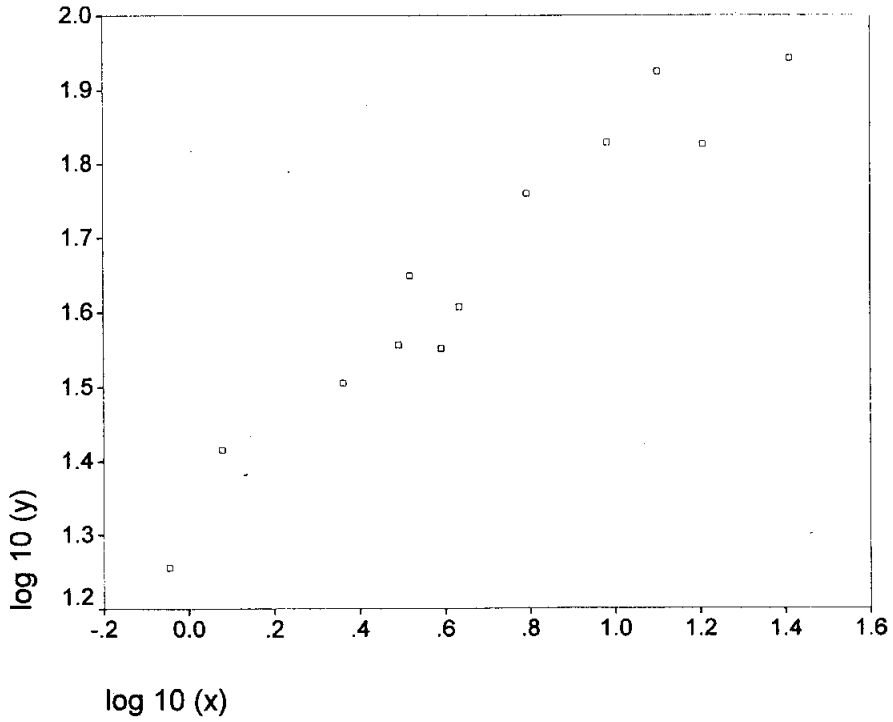
| | x | y | xp | yp |
|---|---|---|---|---|
| 1 | .90 | 18.00 | -.0457575 | 1.2552725 |
| 2 | 1.20 | 26.00 | .0791812 | 1.4149733 |
| 3 | 2.30 | 32.00 | .3617278 | 1.5051500 |
| 4 | 3.10 | 36.00 | .4913617 | 1.5563025 |
| 5 | 3.30 | 44.50 | .5185139 | 1.6483600 |
| 6 | 3.90 | 35.60 | .5910646 | 1.5514500 |
| 7 | 4.30 | 40.50 | .6334685 | 1.6074550 |
| 8 | 6.20 | 57.50 | .7923917 | 1.7596678 |
| 9 | 9.60 | 67.30 | .9822712 | 1.8280151 |
| 10 | 12.60 | 84.00 | 1.1003705 | 1.9242793 |
| 11 | 16.10 | 67.00 | 1.2068259 | 1.8260748 |
| 12 | 25.80 | 87.50 | 1.4116197 | 1.9420081 |

**Graph**


90
80
70
60
50
40
30
20
10
Y
0
10
20
30
X

**Graph**


2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
log 10 (y)
-.2
0.0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
log 10 (x)

**Regression**

## Variables Entered/Removed[b]

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X[a] | . | Enter |

a. All requested variables entered.

b. Dependent Variable: Y

## Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .890[a] | .793 | .772 | 10.8291 |

a. Predictors: (Constant), X

## ANOVA[b]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4480.564 | 1 | 4480.564 | 38.208 | .000[a] |
| | Residual | 1172.685 | 10 | 117.268 | | |
| | Total | 5653.249 | 11 | | | |

a. Predictors: (Constant), X

b. Dependent Variable: Y

## Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 29.513 | 4.516 | | 6.5 | .00 |
| | X | 2.707 | .438 | .890 | 6.2 | .00 |

a. Dependent Variable: Y

**Regression**

## Variables Entered/Removed[b]

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | *log 10 (x)*[a] | | *Enter* |

a. All requested variables entered.

b. Dependent Variable: log 10 (y)

## Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | *.966*[a] | *.934* | *.927* | *5.67488934E-02* |

a. Predictors: (Constant), log 10 (x)

## ANOVA[b]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | *.455* | *1* | *.455* | *141.38* | *.000*[a] |
| | Residual | *3.220E-02* | *10* | *3.220E-03* | | |
| | Total | *.488* | *11* | | | |

a. Predictors: (Constant), log 10 (x)

b. Dependent Variable: log 10 (y)

## Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | *1.340* | *.031* | | *43.410* | *.000* |
| | log 10 (x) | *.460* | *.039* | *.966* | *11.890* | *.000* |

a. Dependent Variable: log 10 (y)