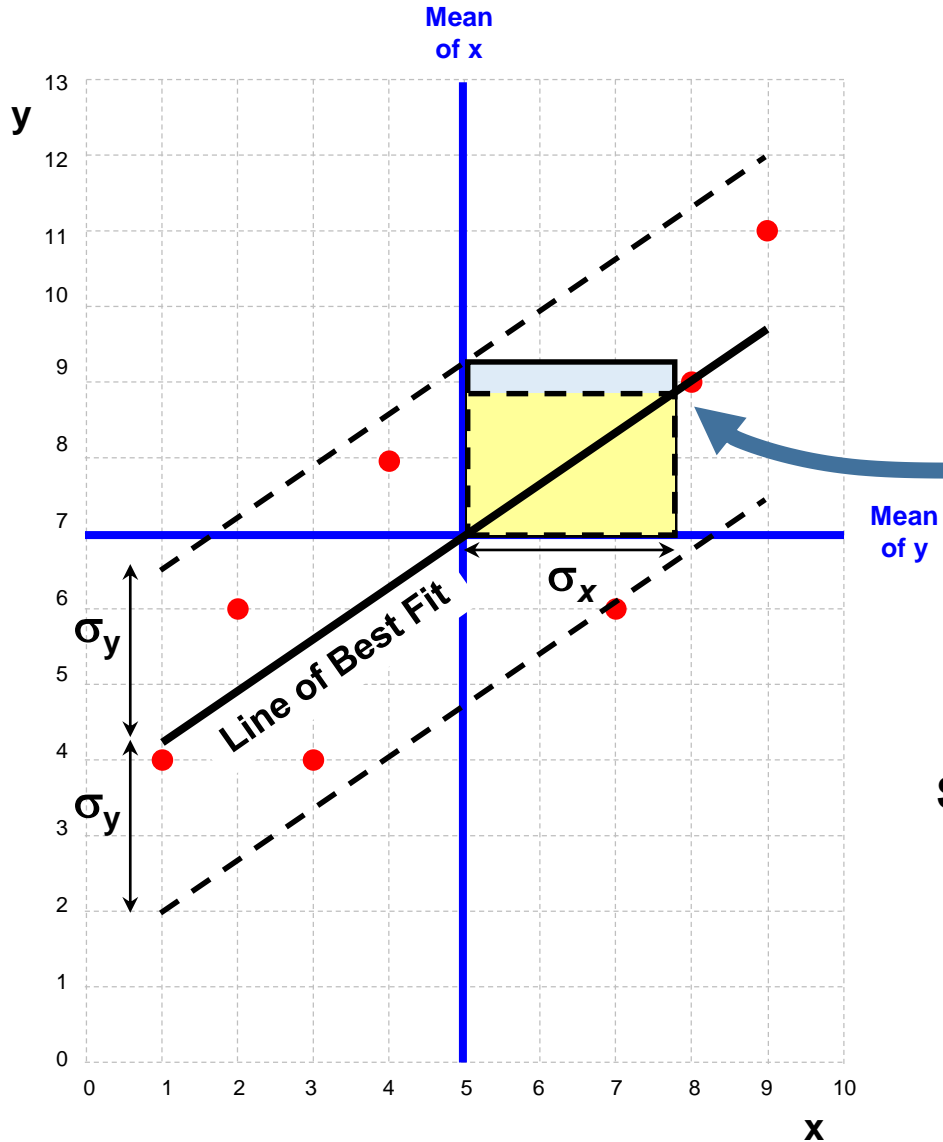


# Correlation, Covariance and the Line of Best Fit



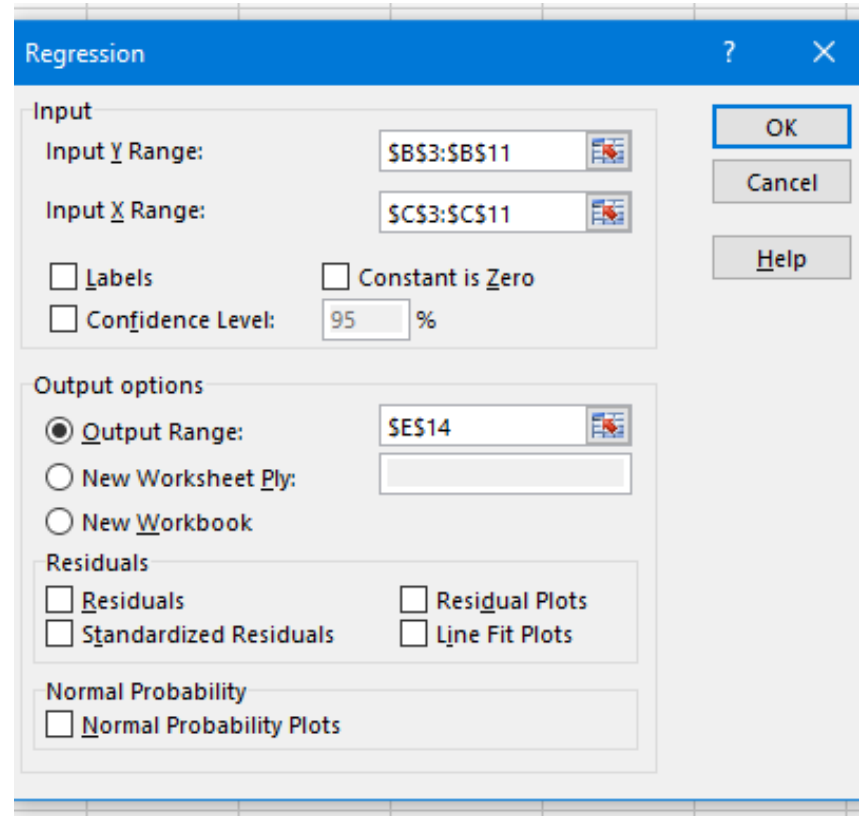
The Line of Best Fit through the paired Means coincides with the diagonal formed by the Covariance Rectangle with a side equal to the Standard Deviation of x

Correlation is defined as the ratio of the Covariance of x and y divided by the Standard Deviation of x and the Standard Deviation of y:

$$\text{Slope}_{y/x} = \text{Correlation}(x,y) \frac{\text{Std.Dev}(y)}{\text{Std.Dev}(x)}$$

Figure 4-5

	A	B	C
1		<b>y</b>	<b>x1</b>
2	Obs	Cost £	Weight Kg
3	1	5123	10
4	2	6927	21
5	3	4988	34
6	4	9253	42
7	5	7022	59
8	6	10182	63
9	7	8348	71
10	8	10702	85
11	9	12092	97
12			
13	Average	8293.000	53.556



**Figure 4-6**

	A	B	C	D
1		<b>y</b>	<b>x1</b>	<b>x2</b>
2	Obs	Cost £	Weight Kg	Tests
3	1	5123	10	1
4	2	6927	21	2
5	3	4988	34	1
6	4	9253	42	3
7	5	7022	59	1
8	6	10182	63	2
9	7	8348	71	1
10	8	10702	85	2
11	9	12092	97	3
12				
13	Average	8293.000	53.556	1.778

Regression

Input

Input Y Range:

Input X Range:

Labels  Constant is Zero

Confidence Level:  %

Output options

Output Range:

New Worksheet Ply:

New Workbook

Residuals

Residuals  Residual Plots

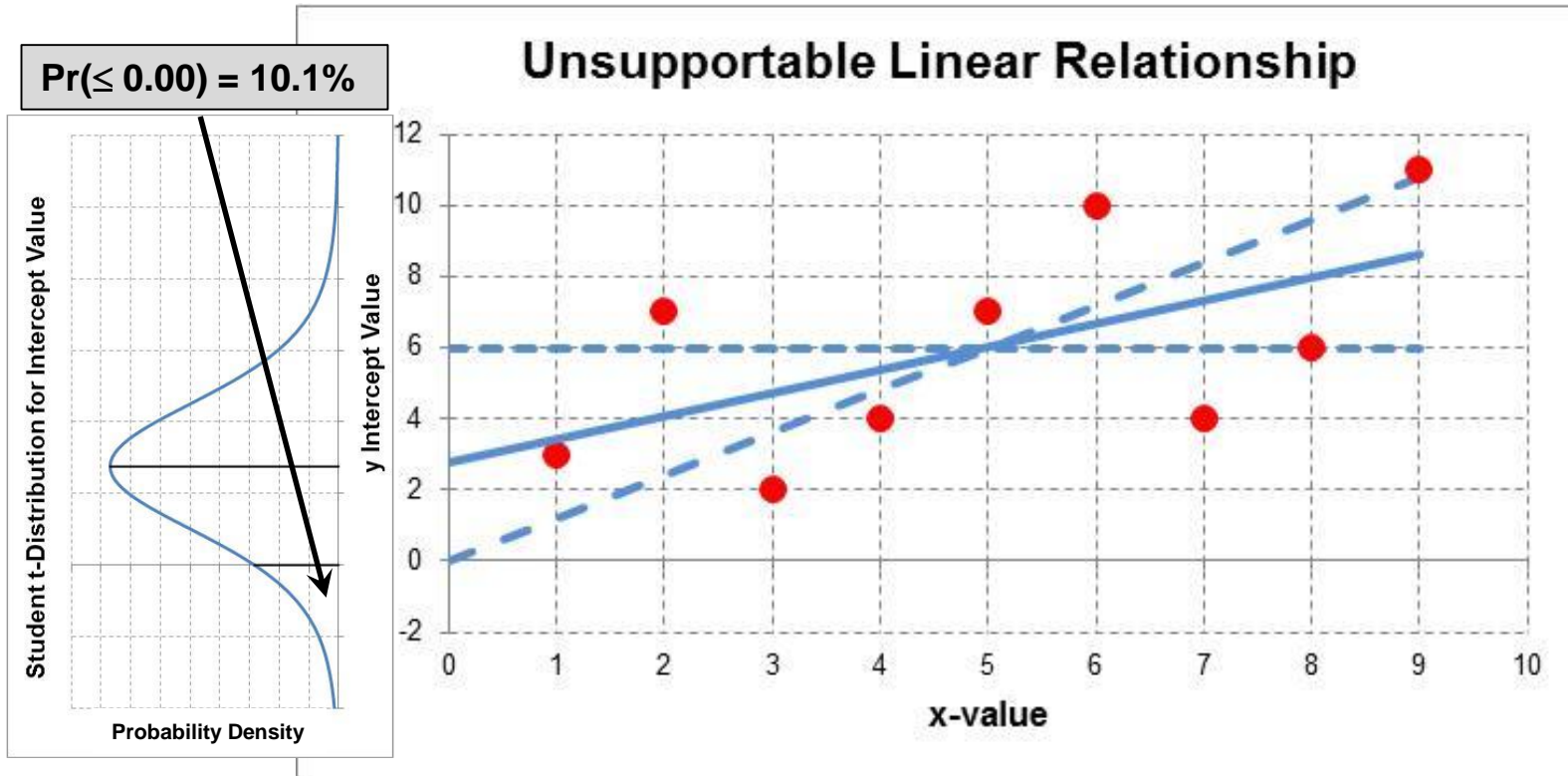
Standardized Residuals  Line Fit Plots

Normal Probability

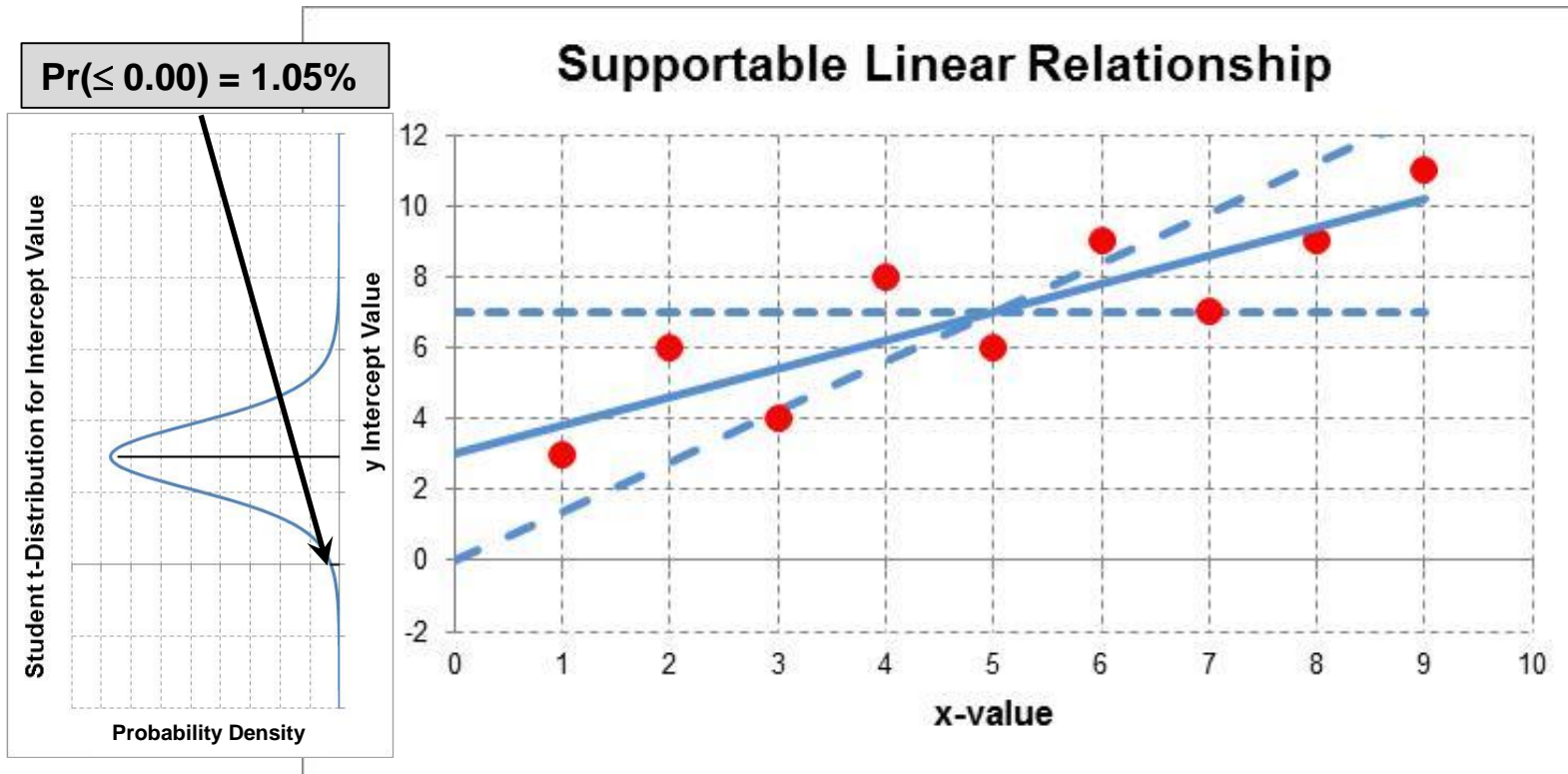
Normal Probability Plots

OK Cancel Help

Figure 4-7



**Figure 4-14**



**Figure 4-15**

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.862994614
R Square	0.744759704
Adjusted R Square	0.659679605
Standard Error	1446.444808
Observations	9

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	36628734.51	18314367.25	8.753629983	0.016628295
Residual	6	12553215.49	2092202.582		
Total	8	49181950			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	4253.803965	1079.511651	3.940489167	0.00762035	1612.334114	6895.273817
Weight Kg	55.89853767	26.79118351	2.086452719	0.081999597	-9.657126765	121.4542021
Circuits	627.3112769	779.4935141	0.804767795	0.45165584	-1280.040641	2534.663194

INPUT DATA >

	<b>y</b>	<b>x1</b>	<b>x2</b>
Obs	Cost £	Weight Kg	Circuits
1	5123	10	0
2	6927	21	2
3	4988	34	1
4	9253	42	1
5	7022	59	2
6	10182	63	2
7	8348	71	1
8	10702	85	3
9	12092	97	3
Average	8293.000	53.556	1.667

Figure 4-16

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.8593378
R Square	0.7384615
Adjusted R Square	0.7010989
Standard Error	1.3938641
Observations	9

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	38.4	38.4	19.764706	0.002986904
Residual	7	13.6	1.9428571		
Total	8	52			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	1	1.012618796	0.9875385	0.3562763	-1.39446296	3.394463
X Variable 1	0.8	0.179947082	4.4457514	0.0029869	0.374492766	1.2255072

INPUT DATA >

Obs	y	x
1	1	1
2	4	2
3	2	3
4	6	4
5	4	5
6	7	6
7	5	7
8	7	8
9	9	9
Average	5	5

**Figure 4-17**

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.9716287
R Square	0.9440623
Adjusted R Square	0.8190623
Standard Error	1.3917047
Observations	9

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	261.5052632	261.50526	135.0163	7.8903E-06
Residual	8	15.49473684	1.9368421		
Total	9	277			

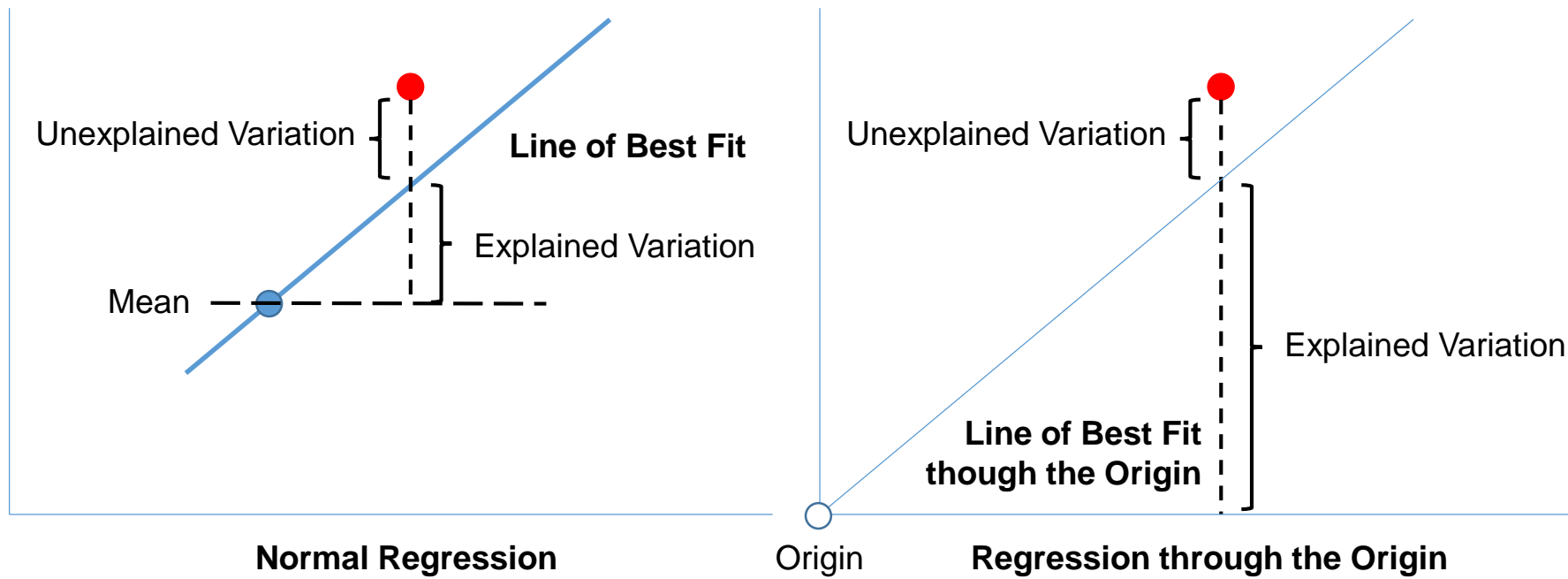
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
X Variable 1	0.9578947	0.082437475	11.619652	2.739E-06	0.76779358	1.1479959

INPUT DATA >

Obs	y	x
1	1	1
2	4	2
3	2	3
4	6	4
5	4	5
6	7	6
7	5	7
8	7	8
9	9	9
Average	5	5

**Figure 4-18**





**Figure 4-19**

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.7994563
R Square	0.6391304
Adjusted R Square	0.5875776
Standard Error	1.5399443
Observations	9

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	29.4	29.4	12.39759	0.009714308
Residual	7	16.6	2.3714286		
Total	8	46			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	0	0.51331478	0	1	-1.21379658	1.2137966
X Variable 1	0.7	0.198805959	3.5210212	0.0097143	0.229898607	1.1701014

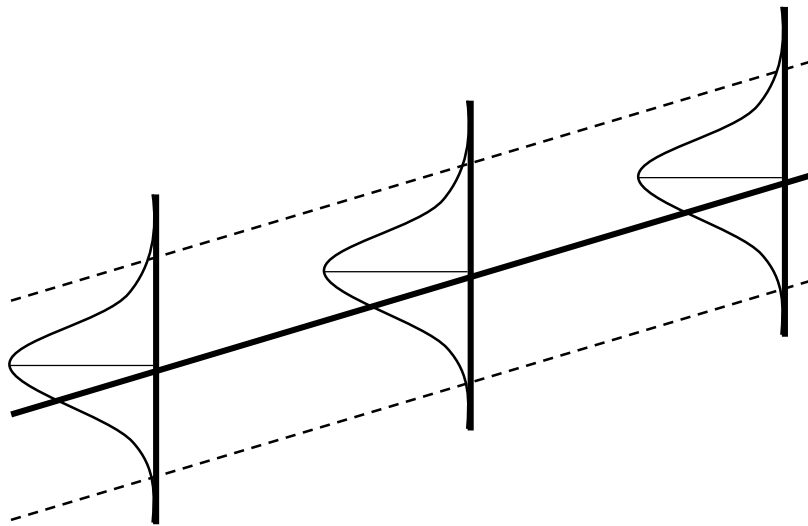
INPUT DATA >

Obs	y	x
1	-3	-4
2	-1	-3
3	-3	-2
4	1	-1
5	-1	0
6	2	1
7	-1	2
8	2	3
9	4	4
Sum	0	0
Average	0	0

**Figure 4-20**

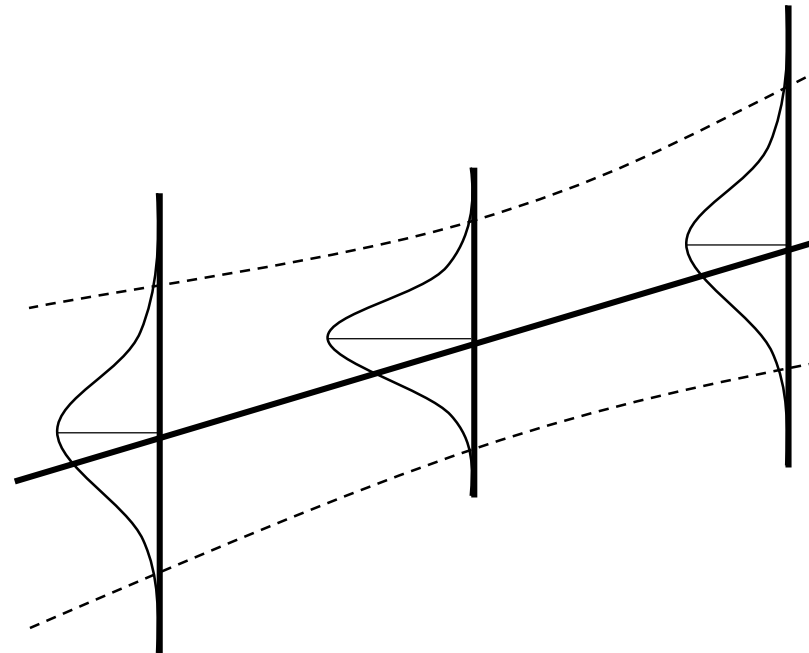
### **Homoscedastic**

Equal Variance Across Regression Range



### **Heteroscedastic**

Unequal Variance Across Regression Range



**Figure 4-22**

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.859337849
R Square	0.738461538
Adjusted R Square	0.701098901
Standard Error	1.393864105
Observations	9

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	38.4	38.4	19.76470588	0.002986904
Residual	7	13.6	1.942857143		
Total	8	52			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	3	1.012618796	2.962615362	0.021026869	0.605537038	5.394462962
X Variable 1	0.8	0.179947082	4.445751442	0.002986904	0.374492766	1.225507234

INPUT DATA >

Obs	Y	X
1	3	1
2	6	2
3	4	3
4	8	4
5	6	5
6	9	6
7	7	7
8	9	8
9	11	9

Figure 4-24

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.954261475
R Square	0.910614963
Adjusted R Square	0.88081995
Standard Error	0.827819597
Observations	9

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	41.88828829	20.94414414	30.56266433	0.000714158
Residual	6	4.111711712	0.685285285		
Total	8	46			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	3.171171171	1.135918982	2.79172302	0.031505848	0.391677552	5.95066479
X Variable 1	0.861261261	0.111119227	7.750785208	0.000242422	0.589362308	1.133160215
X Variable 2	1.135135135	0.365175043	3.108468544	0.020889591	0.241583994	2.028686276

INPUT DATA >

Obs	y	Unity	x <sub>1</sub>	x <sub>2</sub>
1	7	1	1	3
2	6	1	2	2
3	9	1	3	2
4	11	1	4	3
5	9	1	5	1
6	12	1	6	3
7	11	1	7	2
8	13	1	8	3
9	12	1	9	1

**Figure 4-25**