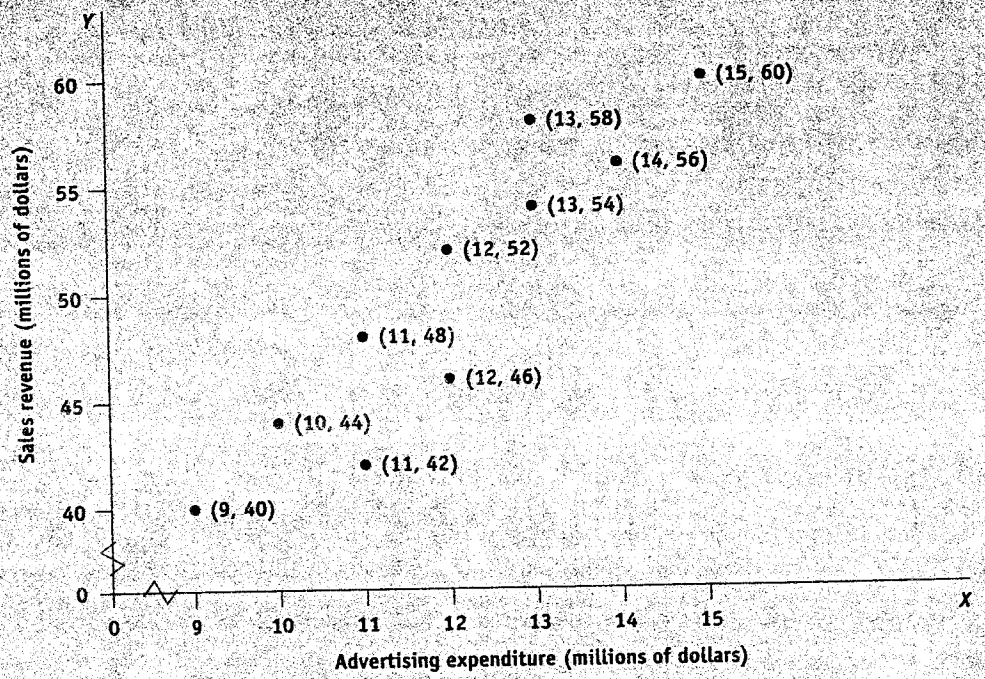
TABLE 4-2 Advertising Expenditures and Sales Revenues of the Firm (in millions of dollars)

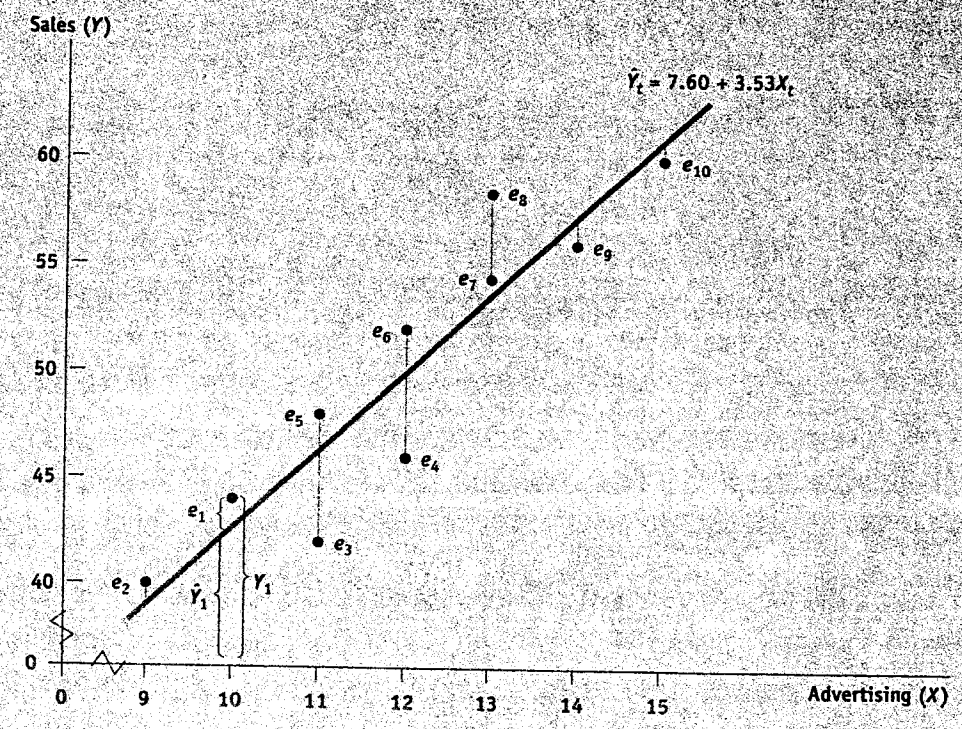
Year (t)	1	2	3	4	5	6	7	8	9	10
Advertising expenditures (X)	10	9	11	12	11	12	13	13	14	15
Sales revenues (Y)	44	40	42	46	48	52	54	58	56	60

FIGURE 4-2 Advertising Expenditures and Sales Revenues of the Firm in Each of 10 Years



Advertising expenditure (X), the independent variable, is measured along the horizontal axis, while sales revenue (Y), the dependent variable, is measured along the vertical axis. Each point (dot) in the figure represents one of the advertising-sales combinations shown in Table 4-2.

FIGURE 4-3 Fitting a Regression Line



The regression line shown in the figure is the line that best fits the data points in the sense that the sum of the squared vertical deviations of the points from the line is a minimum.

TABLE 4-3 Calculations to Estimate Regression Line for Sales-Advertising Problem

t Year	X_t Advertising	Y_t Sales	$X_t - \bar{X}$	$Y_t - \bar{Y}$	$(X_t - \bar{X})(Y_t - \bar{Y})$	$(X_t - \bar{X})^2$
1	10	44	−2	−6	12	4
2	9	40	−3	−10	30	9
3	11	42	−1	−8	8	1
4	12	46	0	−4	0	0
5	11	48	−1	−2	2	1
6	12	52	0	2	0	0
7	13	54	1	4	4	1
8	13	58	1	8	8	1
9	14	56	2	6	12	4
10	15	60	3	10	30	9
$n = 10$	$\Sigma X_t = 120$ $\bar{X} = 12$	$\Sigma Y_t = 500$ $\bar{Y} = 50$	$\Sigma (X_t - \bar{X}) = 0$	$\Sigma (Y_t - \bar{Y}) = 0$	$\Sigma (X_t - \bar{X})(Y_t - \bar{Y})$ $= 106$	$\Sigma (X_t - \bar{X})^2$ $= 30$

TABLE 4-4 Calculations to Estimate the Standard Error of $\hat{b}$

(1) Year	(2) X_t	(3) Y_t	(4) $\hat{Y}_t$	(5) $Y_t - \hat{Y}_t = e_t$	(6) $(Y_t - \hat{Y}_t)^2 = e_t^2$	(7) $(X_t - \bar{X})^2$
1	10	44	42.90	1.10	1.2100	4
2	9	40	39.37	0.63	0.3969	9
3	11	42	46.43	−4.43	19.6249	1
4	12	46	49.96	−3.96	15.6816	0
5	11	48	46.43	1.57	2.4649	1
6	12	52	49.96	2.04	4.1616	0
7	13	54	53.49	0.51	0.2601	1
8	13	58	53.49	4.51	20.3401	1
9	14	56	57.02	−1.02	1.0404	4
10	15	60	60.55	−0.55	0.3025	9
$n = 10$	$\Sigma X_t = 120$ $\bar{X} = 12$	$\Sigma Y_t = 500$ $\bar{Y} = 50$			$\Sigma e_t^2 = 65.4830$	$\Sigma (X_t - \bar{X})^2 = 30$

TABLE 4-5 Calculations to Estimate the Coefficient of Determination (R^2)

(1) Year	(2) Y_t	(3) $Y_t - \bar{Y}$	(4) $(Y_t - \bar{Y})^2$	(5) $\hat{Y}_t$	(6) $\hat{Y}_t - \bar{Y}$	(7) $(\hat{Y}_t - \bar{Y})^2$	(8) $(Y_t - \hat{Y}_t)^2$
1	44	−6	36	42.90	−7.10	50.4100	1.2100
2	40	−10	100	39.37	−10.63	112.9969	0.3969
3	42	−8	64	46.43	−3.57	12.7449	19.6249
4	46	−4	16	49.96	−0.04	0.0016	15.6816
5	48	−2	4	46.43	−3.57	12.7449	2.4649
6	52	2	4	49.96	−0.04	0.0016	4.1616
7	54	4	16	53.49	3.49	12.1801	0.2601
8	58	8	64	53.49	3.49	12.1801	20.3401
9	56	6	36	57.02	7.02	49.2804	1.0404
10	60	10	100	60.55	10.55	111.3025	0.3025
$n = 10$	$\sum Y_t = 500$ $\bar{Y} = 50$		$\sum (Y_t - \bar{Y})^2$ $= 440$			$\sum (\hat{Y}_t - \bar{Y})^2$ $= 373.8430$	$\sum (Y_t - \hat{Y}_t)^2$ $= 65.4830$

TABLE 4-6 Yearly Expenditures on Advertising and Quality Control, and Sales of the Firm (in millions of dollars)

Year (t)	1	2	3	4	5	6	7	8	9	10
Advertising (X_1)	10	9	11	12	11	12	13	13	14	15
Quality control (X_2)	3	4	3	3	4	5	6	7	7	8
Sales revenue (Y)	44	40	42	46	48	52	54	58	56	60

TABLE 4-7 Computer Results of Regression of Y on X_1 and X_2

```
SMPL 1 - 10
10 Observations
LS // Dependent variable is Y
```

	COEFFICIENT	STANDARD ERROR	T STATISTIC
C	17.9437	5.91914	3.03147
X1	1.87324	0.70334	2.66335
X2	1.91549	0.68101	2.81272

R squared	0.930154	Mean of dependent var	50.00000
Adjusted R squared	0.910198	SD of dependent var	6.992061
SE of regression	2.095311	Sum of squared resid	30.73242
Durbin-Watson stat	1.541100	F statistic	46.61000
Log likelihood	−19.80301		

TABLE 3-2 Retail Sales, Population, and Price Index in Memphis, 1970–1988

Year	Population (thousands) (1)	Price Level (1982 = 1.00) (2)	Retail Sales		Per Capita (dollars) (5)
			Current Dollars	Constant Dollars	
			(millions of dollars)		
			(3)	(4)	
1970	836	0.456	1,721	3,774	4,514
1971	845	0.474	2,077	4,382	5,186
1972	857	0.485	2,345	4,835	5,642
1973	859	0.517	2,619	5,066	5,898
1974	869	0.579	2,822	4,874	5,609
1975	872	0.623	2,977	4,778	5,479
1976	878	0.652	3,201	4,910	5,592
1977	884	0.687	3,489	5,079	5,745
1978	891	0.735	3,903	5,310	5,960
1979	904	0.807	4,272	5,294	5,856
1980	914	0.895	4,625	5,168	5,654
1981	921	0.967	4,881	5,048	5,481
1982	925	1.000	5,151	5,151	5,569
1983	929	1.021	5,838	5,718	6,155
1984	935	1.051	6,715	6,389	6,833
1985	945	1.070	7,108	6,643	7,030
1986	957	1.072	7,639	7,126	7,446
1987	971	1.076	7,878	7,322	7,541
1988	984	1.081	8,131	7,522	7,644

FIGURE 3-6 Retail Sales in Memphis