STATISTICAL METHODS FOR MANAGERS AND ADMINISTRATORS

ISABEL S. PATCHETT

Statistical Methods

For

Managers and Administrators

Isabel S. Patchett

Preface

The writing of this book was undertaken after a discussion with my former immediate supervisor, who travels around the United States and abroad presenting seminars on sales forecasting. In our discussion, he indicated that many of his seminar attendees expressed a need for some type of review text on basic business statistics. Thus, the idea of the book was born. Of course, it can be used for other purposes as well. It particularly lends itself to usage as a textbook for a beginning college course in statistics.

Within the covers of this book can be found many of the more common everyday statistical problems encountered by a busy managerial person. To help solve those problems, the following are included:

1. Excellent reference sources
2. Construction of Indexes
3. Detailed explanation of the Consumer Price Index. This is particularly important since so many of the people in the United States are directly affected by it in terms of Social Security payments and cost of living adjustments found in union contracts.
4. Time series analysis
5. Seasonal analysis
6. Elements of probability
7. Regression and correlation analysis
8. Statistical tests of significance
9. Analysis of variance
10. Bayes' theorem and decision making

I am grateful to the Literary Executor of the late Sir Ronald A. Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Longman Group Ltd. London, for permission to reprint tables from their book *Statistical Tables for Biological, Agricultural and Medical Research.* (6th edition, 1974).

I also wish to thank Pat Mansfield and Joel Stein of Van Nostrand Reinhold, who helped me in editing the manuscript.

ISABEL S. PATCHETT

Contents

1 Data Sources and Presentation

Finding a particular statistic can be very simple if you know where to look—and very hard if you do not. Often, business executives must obtain data quickly, but have little time to search them out. The purpose of this chapter therefore is to direct readers who need certain statistical and financial information to the proper sources. Data, once collected, must often be displayed in graphic form. This is discussed in the latter part of the chapter.

DATA SOURCES

Statistics are published by both government and private sources. The United States government probably publishes more statistics than any other government in the world. States and cities also prepare statistics. On the international level, there are several data sources. One of the leading suppliers is the Statistical Office of the United Nations, Department of Economic and Social Affairs.

United States Government Publications

Decennial Reports. Every 10 years the Bureau of the Census conducts a national survey of population and housing. A large number of reports are published as a result. *Current Population Reports* gives information categorized by such characteristics as age, income, and sex. It also gives projections of population trends by state, age, sex, and so on. Table 1.1 shows annual projections of the population of the United States.

In the projection of population trends, assumptions must be made about such factors as future mortality trends, fertility levels, and net immigration (i.e., imigration minus emigration). The Bureau of the Census uses three series, each predicting a different level of future population. For example, Series II predicts that the population of the United States will be 260 million by the year 2000, while Series III projects 246 million. See Figure 1.1.

Table 1.1. Annual Projections of the Population of the United States, by Single Years of Age and Sex: 1970 to 1985 with Quinquennial Extensions to 2020. (In Thousands, Figures relate to July 1 and include armed forces abroad.)

Series, Sex, and Age	1970	1971	1972	1973	1974	1975	1976	1977
Series B, both sexes								
All ages	204,800	207,036	209,484	212,155	215,053	218,177	221,519	225,065
Under 5 years	17,184	17,451	18,054	18,984	19,987	21,321	22,520	23,714
Under 1 year	3,412	3,789	4,021	4,261	4,507	4,753	4,992	5,220
1 year	3,495	3,407	3,782	4,013	4,253	4,498	4,742	4,981
2 years	3,326	3,498	3,410	3,785	4,016	4,255	4,500	4,744
3 years	3,419	3,331	3,503	3,415	3,790	4,021	4,259	4,504
4 years	3,531	3,425	3,337	3,509	3,421	3,796	4,026	4,265
5 to 9 years	19,876	19,278	18,665	18,022	17,629	17,327	17,592	18,193
5 years	3,730	3,537	3,432	3,344	3,516	3,428	3,802	4,033
6 years	3,916	3,737	3,544	3,439	3,351	3,523	3,435	3,809
7 years	4,001	3,923	3,744	3,551	3,446	3,358	3,530	3,442
8 years	4,066	4,008	3,930	3,751	3,558	3,453	3,365	3,537
9 years	4,162	4,073	4,016	3,937	3,758	3,566	3,460	3,373
10 to 14 years	20,805	20,932	20,809	20,651	20,411	20,042	19,446	18,835
10 years	4,134	4,169	4,080	4,022	3,944	3,765	3,572	3,467
11 years	4,190	4,140	4,175	4,086	4,029	3,951	3,772	3,579
12 years	4,194	4,197	4,147	4,182	4,093	4,035	3,957	3,778
13 years	4,222	4,200	4,203	4,153	4,188	4,099	4,041	3,963
14 years	4,065	4,227	4,205	4,208	4,158	4,193	4,104	4,047
15 to 19 years	19,285	19,660	20,167	20,526	20,786	20,930	21,057	20,935
15 years	4,020	4,071	4,232	4,210	4,213	4,164	4,198	4,109
16 years	3,958	4,024	4,075	4,236	4,214	4,218	4,168	4,203
17 years	3,859	3,961	4,028	4,079	4,240	4,218	4,221	4,172
18 years	3,737	3,863	3,965	4,032	4,083	4,244	4,222	4,225
19 years	3,712	3,741	3,867	3,969	4,035	4,086	4,247	4,226
20 to 24 years	17,176	18,097	18,110	18,461	18,886	19,384	19,758	20,263
20 years	3,540	3,716	3,745	3,871	3,973	4,039	4,090	4,251
21 years	3,552	3,544	3,720	3,749	3,875	3,977	4,043	4,094

Age	1	2	3	4	5	6	7	8
22 years	3,528	3,556	3,548	3,724	3,753	3,878	3,981	4,047
23 years	3,744	3,532	3,560	3,553	3,728	3,757	3,883	3,985
24 years	2,812	3,749	3,537	3,565	3,557	3,733	3,762	3,887
25 to 29 years	13,758	14,093	15,162	15,809	16,531	17,302	18,218	18,232
25 years	2,788	2,818	3,754	3,542	3,570	3,562	3,738	3,767
26 years	2,852	2,795	2,825	3,759	3,548	3,576	3,568	3,743
27 years	2,907	2,858	2,801	2,831	3,764	3,553	3,581	3,573
28 years	2,703	2,913	2,864	2,807	2,837	3,769	3,558	3,586
29 years	2,507	2,709	2,918	2,870	2,813	2,842	3,773	3,563
30 to 34 years	11,520	11,822	12,304	12,941	13,468	13,878	14,211	15,273
35 to 39 years	11,208	11,152	11,151	11,225	11,371	11,575	11,875	12,354
40 to 44 years	11,918	11,750	11,576	11,411	11,274	11,176	11,122	11,122
45 to 49 years	12,210	12,212	12,150	12,039	11,902	11,751	11,588	11,420
50 to 54 years	11,059	11,239	11,445	11,640	11,783	11,852	11,855	11,797
55 to 59 years	8,992	10,088	10,174	10,266	10,382	10,529	10,703	10,901
60 to 64 years	8,656	8,806	8,934	9,046	9,150	9,250	9,343	9,427
65 to 69 years	6,831	6,964	7,145	7,344	7,531	7,690	7,827	7,944
70 to 74 years	5,634	5,655	5,635	5,613	5,631	5,704	5,821	5,977
75 to 79 years	3,739	3,881	4,028	4,160	4,257	4,311	4,329	4,316
80 to 84 years	2,341	2,282	2,286	2,331	2,401	2,486	2,582	2,683
85 years and over	1,611	1,672	1,688	1,684	1,674	1,668	1,669	1,680
1 to 4 years	13,771	13,662	14,033	14,723	15,480	16,569	17,528	18,494
5 to 13 years	36,615	35,984	35,270	34,465	33,882	33,177	32,935	32,981
14 to 17 years	15,902	16,283	16,540	16,734	16,826	16,792	16,692	16,531
18 to 21 years	14,540	14,863	15,297	15,620	15,966	16,346	16,603	16,796
14 years and over	151,001	153,601	156,161	158,706	161,185	163,679	166,064	168,370
16 years and over	142,916	145,303	147,723	150,288	152,813	155,323	157,762	160,214
18 years and over	135,100	137,318	139,620	141,973	144,359	146,887	149,372	151,840
21 years and over	124,112	125,998	128,044	130,101	132,267	134,517	136,813	139,138
62 years and over	25,161	25,565	25,975	25,393	26,819	27,249	27,679	28,106
65 years and over	20,156	20,454	20,782	21,133	21,494	21,859	22,228	22,600
Median age (years)	27.9	27.9	27.9	28.0	28.0	27.9	27.9	27.9

4 STATISTICAL METHODS FOR MANAGERS AND ADMINISTRATORS

Year	Series I	Series II	Series III
ESTIMATES			
1930[1].......		123,188	
1935[1].......		127,362	
1940[2].......		132,594	
1945........		140,468	
1950........		152,271	
1955........		165,931	
1960........		180,671	
1965........		194,303	
1970........		204,878	
1975........		213,540	
1976........		215,118	
PROJECTIONS			
1980........	224,066	222,159	220,732
1985........	238,878	232,880	228,879
1990........	254,715	243,513	236,264
1995........	269,384	252,750	241,973
2000........	282,837	260,378	245,876
2005........	297,600	267,603	248,631
2010........	315,248	275,335	250,892
2015........	334,708	283,164	252,548
2020........	354,108	290,115	253,011
2025........	373,053	295,742	251,915

[1] Excludes Alaska and Hawaii.
[2] The figure excluding Alaska and Hawaii is 132,122.

Fig. 1.1 Projections of the population of the U.S. 1977-2050. (in thousands. as of July 1. Includes Armed Forces overseas)

SOURCE: *Current Population Reports—Population Estimates and Projections*, Series P-25, #704, p. 6, U.S. Dept. of Commerce, Bureau of the Census.

Annual Publications. The *Statistical Abstract of the United States* has been published annually since 1878 by the U.S. Department of Commerce. It is a summary of statistics on the social, political, and economic organization of the United States. The volume is designed to serve as a convenient statistical reference. Its data are selected from many publications, both government and private. It also assists readers in locating additional sources of information. Subjects listed in the index include among others agriculture, education, energy, foreign aid, foreign commerce, law enforcement, national defense, population, and veterans affairs.

The Bureau of Labor Statistics (BLS) publishes a *Handbook of Labor Statistics* that includes information on labor force, employment, unemployment, hours, productivity and unit labor costs, comprehensive price and living conditions, unions and industrial relations, occupational injuries and illnesses, foreign

labor statistics, and general economic data. It is published annually, with monthly updatings.

A good source reference for data on industries in the United States is the *U.S. Industrial Outlook* published annually by the Industrial Economic Bureau of the U.S. Department of Commerce. The 1981 edition lists 200 industries with projections to 1985. Industries, which are arranged by Standard Industrial Classifica-

agriculture

Subject	Tabular Detail	Areas to Which Data Apply	Frequency	Sources (See Bibliography, pp. 329-339.)
AGRICULTURE[1]				
Farms	All farms; farms with sales of $1,000 or more. 1969; 1974 Acreage: Land in farms; average size Farms with sales less than $2,500 Cropland: Farms; acreage Farm production expenses Value of agricultural products sold *Average per farm; crops, including nursery products and hay; forest products; livestock, poultry, and their products* Animals on place: Cattle and calves, hogs and pigs; chickens, 3 months or older	Counties	Every 5 years[2]	24. *Agriculture Census, 1974 Preliminary Reports*,[3,4] table 1. Census Bureau.
	Farms with sales of $2,500 or more; 1969; 1974: By sales, in 6 dollar ranges Organization: Individual or family; partner-ship; corporation, including family owned; other Farms; value: Farm-related income Related expenses Off-farm income Farms with grain storage facilities of 1,000 bushels or more Farms; animals on place: Heifers and heifer calves For beef and beef cow replacement For milk cow replacement Steers and bulls, including calves Lambs under 1 year old Ewes, 1 year or older Sheep and lambs shorn	Counties	Every 5 years	*Ibid.*, table 7.

[1] The Department of Agriculture, in cooperation with various State statistical or crop and livestock reporting services, assists in the release of numerous annual summaries covering specific crop production, livestock and poultry operations, and characteristics of farming enterprises within individual States. Since subjects vary widely according to State, these reports are not described in this directory.

[2] In years ending in 2 and 7 after the next census, to be taken for 1978.

[3] As this directory went to print, final reports from the 1974 Census of Agriculture were being released; they are essentially similar to the 1969 census final reports and the 1974 preliminary reports described in this directory, but some differences occur, and table numbers are not identical. For further information about final reports from the 1974 census, consult the Bureau of the Census Catalog (Bibliography No. 176) or write to the Chief, Agriculture Division, Bureau of the Census, Washington, D.C. 20233.

[4] Data vary in individual reports.

Fig. 1.2 Directory of Federal Statistics for Local Areas—Agriculture.

SOURCE: *The Directory of Federal Statistics for Local Areas,* Bureau of the Census.

tion (SIC) code, range from basic mining to services such as banks. Each industry description is authored by the Department of Commerce's industry expert in that field.

The *Directory of Federal Statistics for Local Areas,* published by the Bureau of the Census, presents information on areas ranging in size from Standard Metropolitan Statistical Areas (SMSAs) and counties to city blocks. The more than 100 areas include fishery districts, harbors, low-income neighborhoods, oil and gas districts, and rural areas. The reports, which include information published from 1966 through 1976, cover the entire United States broken down by area. The information is arranged by subject headings: Tabular Detail, Areas to Which Data Apply, Frequency, and Sources. See Figure 1.2.

Another helpful publication is the quarterly *Bureau of the Census Catalog.* Its contents are summarized in an annual volume that is updated monthly. It lists publications, data files, special tabulations, material on microfiche, summary tapes, and processing centers. Subjects covered include housing and construction, geography, agriculture, manufacturing, population, retail and wholesale trade, and transportation.

Monthly Publications. The *Survey of Current Business,* published monthly by the U.S. Department of Commerce, comes in two sections. The first gives current business statistics on some 2500 series such as gross national product, new plant and equipment expenditures, United States international transactions, personal income by source, commodity prices received by farmers, and producer prices. The second section discusses the current business situation, presents articles written by experts, and gives information on such timely topics as plant equipment expenditures, national income and product tables, and United States international transactions.

Historical data on the series shown in *The Survey of Current Business* are published every 2 years in *Business Statistics.* The 1977 issue (the latest as of fall 1981), the twenty-first biennial edition, presents data for most series on an annual basis for 1947–76 and monthly for 1973–76. The appendix provides monthly or quarterly data for earlier periods for over 400 of the more important series.

Publications of Private Organizations

There are many good statistical sources published by private organizations. Those mentioned here are but a few of those available.

The *Financial Market Place* (R.R. Bowker Co., 1972) is a directory of major corporations, institutions, services, and publications.

The seventh edition of the *Directory of Business and Financial Services* (Spe-

cial Libraries Association, 1976) deals exclusively with information services that provide continuous coverage of some facet of business activity.

Business Information Sources (University of California Press, 1976) includes such subjects as methods of locating facts; basic time-saving sources; locating information on companies, organizations, and individuals; basic United States statistical sources; industry statistics; foreign statistics and economic trends; investment sources; United States business and economic trends; and business in American society.

The *Dow Jones-Irwin Business Almanac, Nineteen Eighty-One* (Dow Jones-Irwin, 1980) contains information on major legislation enacted, regulatory agencies, finance and accounting, largest corporations, executive recruiting organizations, stock market, commodities market, money and financial institutions, banks and other financial institutions, and advertising and the media.

Information on international data bases may be obtained from the *Information Market Place, 1978-79* (R.R. Bowker Co., 1978). It provides quick reference to major products and services comprising the international information industry, as well as a trade directory of suppliers and services directed to the industry.

Encyclopedia of Business Information Sources (Gale Research Co., 1980) is a detailed list of primary subjects of interest to management personnel including record source books, periodicals, organizations, directories, handbooks, and bibliographies.

Sales & Marketing Management produces a two-volume *Annual Survey of Buying Power.* It is helpful to management personnel seeking information on retail sales and effective buying power for American and Canadian geographic markets. Part I, which is published each summer, gives information on annual changes in geographic markets such as American metropolitan areas, counties, cities, and states. It also gives a survey of Canadian buying power. Part II, published in the fall, presents an analysis of change in United States metropolitan markets and a 5-year projection of American and Canadian markets. An analysis of American newspaper and television markets is also presented.

Newsletters

Several major national banks issue newsletters on economic and business affairs. Chase Manhattan Bank, N.A. publishes *Business In Brief* bimonthly. *Morgan Guaranty Survey* is produced monthly by Morgan Guaranty Trust Co. of New York, and First National Bank of Chicago produces the bimonthly *First Chicago World Report.* Regional banks also publish similar information; for example, Hartford National Bank & Trust Co. publishes *Comments,* a quarterly newsletter about the Connecticut scene. The newsletters can be found in the business section of most large city libraries. In addition, in most cases they can be obtained by writing directly to the bank.

PRESENTATION OF DATA

Many functional areas of a business enterprise employ statistics in organizing and controlling various activities. Production is concerned with meeting requirements set by management, such as scheduling. Market research needs to know what consumers will buy in order to project sales for a product. Accounting is concerned with sales, income, taxes, profit, etc. All of the areas can reach meaningful conclusion from data if it is properly presented.

Data may be presented either graphically or in a table.

Table Format

In preparing data in tabular form, certain rules should be followed:

1. Number tables in sequence—Table 1, Table 2, etc. When a work is divided into chapters, number tables according to chapter number—Table 1.1 in Chapter 1, Table 2.1 in Chapter 2, etc.
2. Label heading of table clearly.
3. Label columns with proper descriptions (see Table 1.2).
4. If figures are in millions, instead of indicating "1,000,000," for example, it is often easier to drop the last six digits and use "1." Under the column heading or in a footnote, indicate how numbers are reported, i.e., "(Millions of Dollars)."
5. When information is taken from a source, be certain to give proper credit.

Graphic Format

Data may be presented graphically, using the arithmetic scale, in several ways including line graphs, bar charts (simple, component, and two-directional), and pie charts. The semilog scale is used mainly for line charts.

Arithmetic Scale

The arithmetic scale has the following characteristics:

1. Divisions on arithmetic scale are equidistant on both Y (vertical) and X (horizontal) axis.
2. Equal distances represent equal amounts.
3. Data plotted on the Y axis increase or decrease in magnitude from origin of zero.
4. Years progress from left to right on the X-axis.

One series of data (simple line chart) or several related series (multiple line chart) may be produced.

Table 1.2. Manufacturing and Trade Inventories, Book Value,
End of Selected Years 1948-76.

Selected Years	Inventories, Book Value, End of Period ($ Millions)
1948	$ 51,985
1956	86,183
1963	104,382
1971	187,087
1976	306,412

Source: *Business Statistics,* 1977 Edition, p. 27.

Line Graph. Arithmetic graph paper is used when it is desired to show an absolute amount of change (as opposed to percent change) from period to period (See Table 1.3). Figure 1.3, net exports of United States goods and services in actual dollars, illustrates the use of arithmetic graph paper and a simple line chart. This time series measures the exports less imports of goods and services. Exports of goods and services are included in the gross national product (GNP) because they are produced by the nation's economy. The GNP is the market value of goods and services produced by labor and property supplied by the residents of the United States before the deduction of depreciation charges and other allowances for business and institutional consumption of capital goods. Other business products used up by business are deducted. Since imports of foreign goods and services are included in the purchases of the various market groups (consumer, government, etc.) distinguished in the GNP breakdown, they must be deducted from the sum of these purchases to derive a measure of output attributable to the nations's economy.

Table 1.3. XYZ Co., Arithmetic Progression of Sales
(Thousands of Dollars)

Year	Sales	% Change
1968	$200	–
1969	220	10.0
1970	240	9.1
1971	260	8.3
1972	280	7.7
1973	300	7.1
1974	320	6.7
1975	340	6.3
1976	360	5.9
1977	380	5.6
1978	400	5.4

U.S. NET EXPORTS OF GOODS AND SERVICES
(Seasonally Adjusted Quarterly Totals At Annual Rate)
(Billions Actual Dollars)

+25-
+20-
+15-
+10-
+ 5-
0-
- 5-
-10-
-15-
-20-

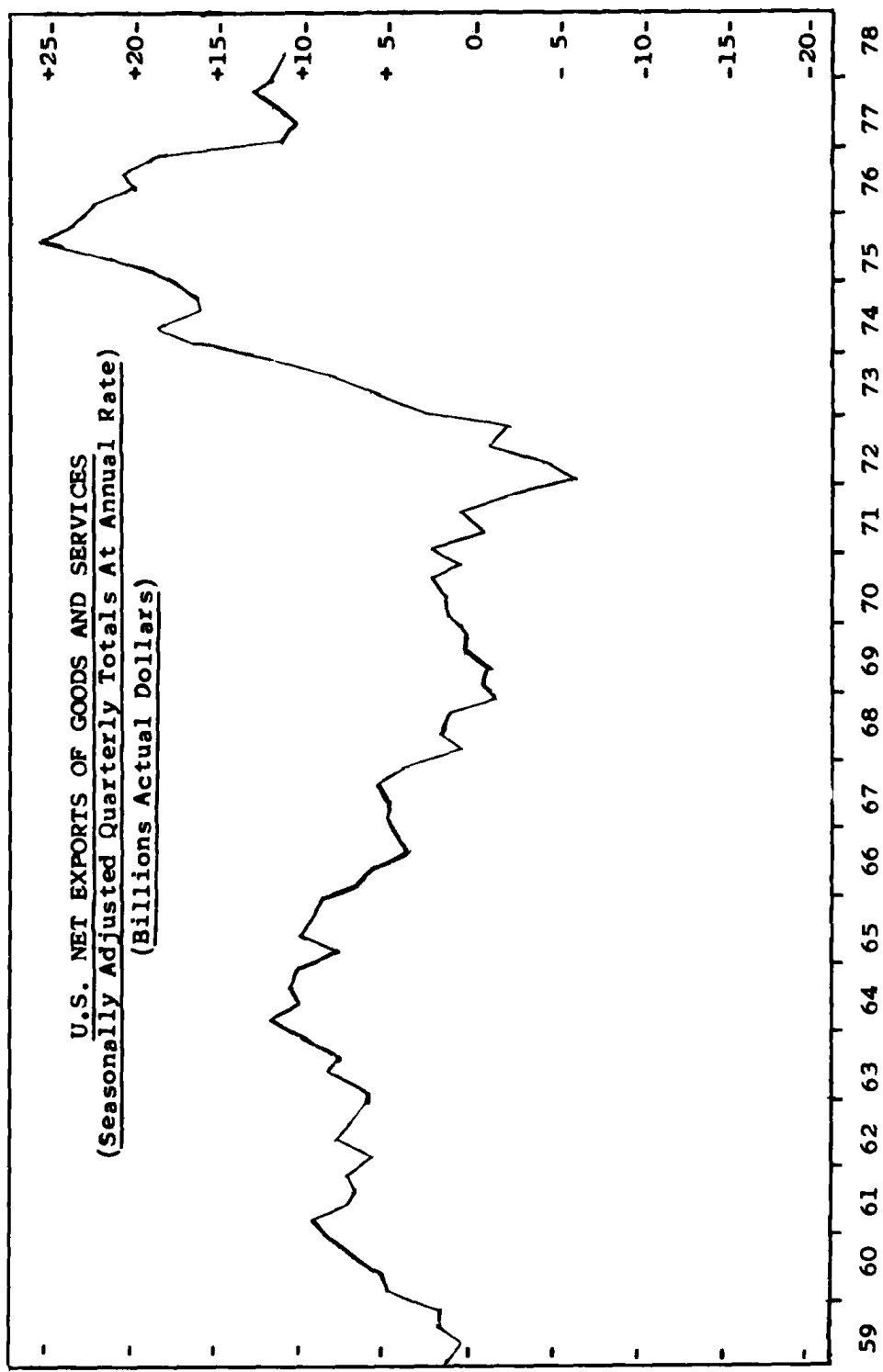59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78

Fig. 1.3 Line graph.

SOURCE: *Monthly Labor Review*, U.S. Dept. of Labor, Bureau of Labor Statistics, Jan. 1980, p. 41.
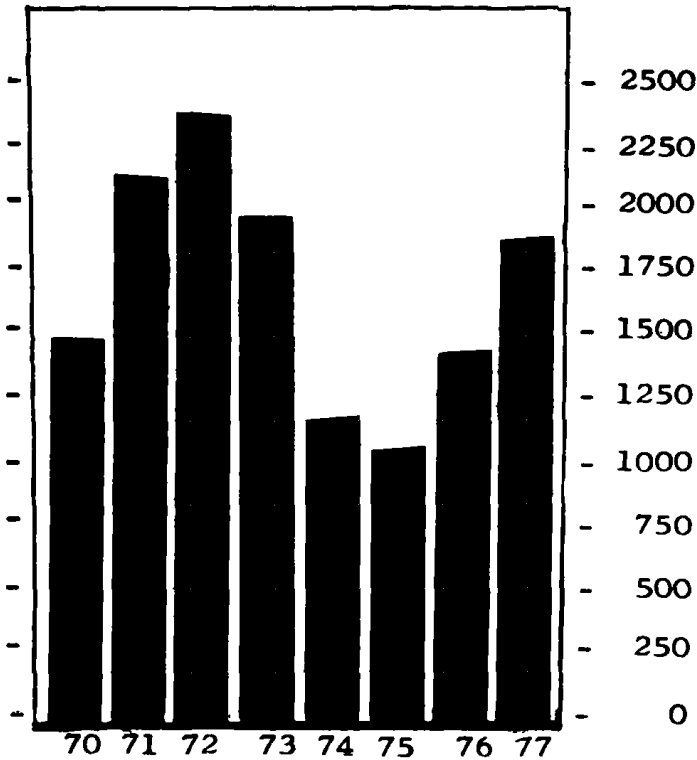
Fig. 1.4 Vertical bar chart.

Bar Chart. Bar charts may be simple (showing one series) or multiple (showing more than one series). They may be vertical or horizontal.

Vertical bar chart. The data to be presented are shown on the Y-axis and the identifying characteristic, such as years or percent change, are shown on the X-axis. Figure 1.4 is a vertical bar chart showing the number of building permits issued in the United States from 1970 through 1977. Building permits provide some indication of the activity in residential building in advance of actual construction.

Horizontal bar chart. A horizontal bar chart shows several classes of a particular group with a common characteristic (unit measure). See Figure 1.5.

Multiple bar chart. A multiple bar chart shows more than one series. See Figure 1.6.

Pie Chart. If relative sizes of components of a total are to be emphasized, a pie chart is useful. The total area of the pie equals 100%. The pie chart in Figure 1.7 shows the estimated United States government budget receipts by source for fis-