Part 11

The Networks of Production

Understanding how changing patterns of consumer and government purchases translate into demand for output from specific businesses is a heroic challenge in a modern economy. Products once brought to consumers through direct and obvious channels are now provided through networks of extraordinary complexity. In the 19th century many Americans lived on the farm. They produced most of their own food and, with the exception of an occasional purchase from a blacksmith, were essentially self-sufficient. Today, not only have farms become specialized, highly capitalized, and technologically sophisticated, they have become comparatively minor elements in a sophisticated network of businesses delivering the "Food" amenity to consumers. This section describes the operation and performance of these production systems in a modern economy, and speculates about how they may change in the future.

The growth of linkages connecting diverse parts of the economy helps explain the explosive growth of sectors other than traditional manufacturing. A packaged frozen pizza may combine produce picked and processed in California, sophisticated packaging materials made in Michigan, and a paper label manufactured in Washington and printed in Illinois, as well as financing from Chicago, advertising and legal services from New York, trucking from independent truckers throughout the Nation, inventory control and billing software from Palo Alto, and communication systems from New Jersey. The "service" businesses play a growing role in getting pizzas to American plates. Among other things, such businesses facilitate the billions of transactions that connect elements of production networks, make it possible for firms to redesign their operations quickly in response to new market opportunities and changes, and allow production networks to make and deliver products and services more precisely targeted for the increasingly diverse markets described in Part I.

Increasingly, networks of production also involve foreign producers and consumers (the topic of Part 111). Tightly integrated networks create a situation where the effects of international trade are felt far beyond the sectors actually engaged in trade. Imports that displace U.S. manufacturing output, for example, also reduce output in a constellation of nonmanufacturing enterprises linked to manufacturing —such as banking, insurance, and business services.

The complex networks that connect producers to consumers in the American economy have become so elaborate that it is difficult even to determine how and where value is added in the process of delivering useful products and services to final consumers. Yet most of the important changes taking place in the American economy can only be understood by observing the integrated performance of these networks operating as a whole. In such a situation it is easy to be misled by asking the wrong questions. It is entirely possible, for example, that firms appearing to enjoy productivity gains may perform poorly within a dynamic and flexible network. A firm that depends on mass production and great certainty about future markets to ensure low costs may have difficulty in a world where products and production strategies are in constant flux. Certainly, any attempt to improve network performance through public policy now requires a system-wide perspective to ensure that changes actually help, rather than frustrate, the emergence of efficient networks.

Driven by new technologies, the pressures of foreign trade, new patterns of demand, and a changed regulatory environment, profound changes are sweeping through virtually every major business network. Even those that have resisted change, such as residential construction and education, may be on the brink of major change. The next three chapters provide a description of trends in the performance of the eight major networks that deliver amenities to final consumers and suggest possibilities for future patterns of change. Chapter 4 provides some basic tools for describing the integrated performance of these networks. Chapter 5 uses these tools to examine recent patterns of change. Three kinds of change are examined:

1. Changes in the "production recipe," or the mix of goods and services a business uses to make its product. Virtually every such recipe involves proportionately less natural resources and more "transactional" serv-

ices like banking and legal help. And nearly all production recipes are growing in complexity, increasing the links connecting one part of the economy with another.

2. Changes in the internal management of busine~, and in the way businesses connect to form production networks. Generalizations are difficult. It appears that highly fragmented structures (elements like small farms, homebuilders, or family physicians) are increasingly becoming parts of larger enterprises, while firms that had concentrated production in a few establishments are turning to smaller facilities and purchasing more inputs from other businesses. In an increasing number of cases, a few dominant firms set de-facto standards and serve, indirectly, to organize activity.
3. Changes in the **geography of production.** The growth of activity outside of traditional manufacturing and the vast increase in communications technology offers the potential to decentralize production in ways never before considered possible. In general, however, this potential has not been realized, and economic activity increasingly accumulates in and around major urban centers—particularly those on the east and west coasts.

Finally, chapter 6 pursues these themes through the eight major amenity networks discussed in chapter 3. Each, of course, has a unique story to tell. Taken together, they can provide a perspective on structural change in production that cannot be obtained from an examination of economy-wide statistics.

Chapter 4
Defining the Production Recipe

CONTENTS

Chapter 4

Defining the Production Recipe

The first chapter of this volume proposed a strategy for understanding how complex networks of activity in a modern economy connect work with amenity. The first step in this process (undertaken in Part 1) was to convert demand for amenity into demand for output from specific industries. The second step (the task of the present chapter) is to describe the "production recipe" that U.S. businesses use to create these goods and services. The accounting method employed to perform this calculation is commonly called "input/output" analysis. Part IV will examine how these outputs translate into jobs.

A concrete example can help to introduce the basic concept and the somewhat baroque vocabulary used in the accounts. One way to begin is by asking where a customer's money goes when he buys a frozen pizza. The pizza was made in a factory that ships products to a grocery outlet through a series of intermediaries. The sales price can be divided into two categories: one that generates business for the pizza factory; and another that goes to pay for the insurance, transportation, wholesale, and retail businesses involved in getting the pizza from the factory to the grocery store shelf. These latter costs are called "margin s."

The question then becomes one of determining the business recipes used by the pizza factory and by the enterprises that provide the "margins." These recipes consist of two parts: intermediate inputs and value-added. The "intermediate inputs" are purchased by a firm from other businesses. For the pizza company this might include ingredients like flour and tomatoes, as well as the advertising, accounting, and legal services needed to conduct business. The difference between the revenue received by selling pizzas and the cost of the intermediate inputs is the "value-added" generated by the pizza firm. This value-added consists of salaries paid to employees, "indirect business taxes" (like sales taxes), and profits.[1] A business recipe of this sort can be constructed for the grocery store where the pizza was purchased, the wholesale operations that supplied the store, and the insurance company and trucking firms that provided other needed services.

This is, however, not the end of the story. The "intermediate inputs" purchased by the pizza firm in turn generate demand for other products. Purchased flour, for example, generates demand for farm production. Farming generates demand for fertilizer. The purchase of a pizza therefore generates "indirect" demand for the products of the chemical firms that produce fertilizer. Since both the farms and the chemical fertilizer firms have "intermediate input" expenses as well, they retain only a portion of the consumer's dollar as value-added. The challenge, then, is to trace the consumer's dollar through this elaborate network of activities in a way that avoids double-counting. A $5 frozen pizza can only generate 5 dollars' worth of value-added in the economy. A complete set of production recipes (one that covers all parts of the economy) can be used to estimate the output in each business created by different patterns of consumer and government purchasing using "input/output" analysis (see box 4-A).

The remainder of this chapter uses this method to show how consumer purchases result in activity throughout the U.S. economy. It proceeds in the following steps. First, it assigns each business operation to one of 10 "production sectors. " This is done so that broad shifts in production recipes can be illustrated. Second, it shows how consumer purchases in different amenity categories translate into demand for different types of business activity (including an estimate of the margins). It then turns to a discussion of the production recipe for each major business type and explores recent trends in the "intermediate inputs" required. Finally, it uses input/output methods to calculate the direct and indirect consequences of different types of purchasing. The techniques can be used to show how spending for each amenity category generates value-added directly and indirectly in all areas of the economy, and how the economy is becoming increasingly interconnected.

[1] More precisely, "value-added" shown on the input/output tables includes the following categories: employee compensation (a category that includes wages, salaries, and employer contributions for such purposes as pensions and health plans), property type income, and indirect business taxes (a category that does not include corporate income tax). For more detail on employee compensation, see ch. 11.

Box 4=A.–Input-Output Analysis

The logic of input-output accounts has been recognized since 1758, when they were published as a "Tableau Economique" by Francois Quesnay, the French economist. Refined and applied to the U.S. economy by Wassily Leontief in the late 1930s, input-output accounts (1-O) form the foundation of most modern econometric models. Leontief was later awarded the Nobel prize in economics. Input-output accounts are used by approximately 70 countries. They incorporate data from all Federal industry censuses and nearly 100 other data sources.1

I-0 accounts are not economic models in the common sense of the term. Rather, they provide a mechanism for displaying and manipulating a large amount of data that has been forced into a consistent format. The central feature of the accounts is a table in which each column represents the production recipe for an industry. In effect, this table represents a series of linear equations that can be solved simultaneously to convert a pattern of final demand to industry output.

While I-O accounts have the invaluable feature of making the technology of production an explicit part of an analysis, they do suffer from a number of limitations. Because the model is based on observed data, there tends to be a long lag time between the collection of data and the availability of I-O tables. A "benchmark" table for 537 business categories is published following publication of the industrial censuses, which are conducted every 5 years. The benchmark table for the 19771-0 tables became available only in 1985. A 1980 summary and "revision" of this benchmark, published for 85 business categories and available from the U.S. Department of Commerce, is **used throughout this** analysis.[2]

Fortunately, later discussions will indicate that with very few exceptions, the interindustry relationships change extremely slowly. Factors that change more rapidly, such as patterns of consumer and government demand, imports, exports, and investments, are updated each year, and are incorporated in the analysis presented here.

I-O data are much more detailed for manufacturing than for service industries, which tend to be lumped into highly aggregated categories. At the detail published in the 1980 I-O accounts there is a separate category for the manufacture of metal boxes, while health, education, and social services are lumped into a single category.

The most important assumption made in I-O analysis is that of "linear," or constant, economies of scale. Unlike the myriad of assumptions implicit in elaborate econometric analyses, this assumption has the virtue of being simple and clear. Since 1-0 essentially represents an accounting technique, the I-O accounts force the user to construct "dynamic" characteristics of the economy-assumptions about how production recipes will respond to price changes, to new technologies, and to changes in the scale and scope of industrial organization. The burden of making changes, such as those that will appear chapter 13, thus falls squarely on the user. The links between I-O accounts and the primary data are transparent.

[1]See W. Leontief, *Input-Output Economics (New* **York: Oxford University Press, 1966); and R.E. Miller and P.D. Blair,** *Input-Output Analysis: Foundations and Extensions* **(Englewood Cliffs, NJ: Prentice-Hall, Inc., 1985). For a description of data sources, see "Definitions and Conventions of the 1972 Input-output Study," Bureau of Economic Analysis, U.S. Department of Commerce, pp. B3-B7.**

[2]**U.S. Department of Commerce, Bureau of Economic Analysis, Input-output Tables, 1980, unpublished. A 1981 matrix was released in the** *Survey of Current Business* **of January 1987, See Appendix for the algebra of input-output analysis.**

DEFINING A TEN-SECTOR ECONOMY

The analysis used throughout Part 11 can be earried out by grouping industries into as many or few sectors as needed. The original data that forms the basis of this report actually used 85 sectors (see the appendix), but only 9 or 10 will be displayed in the examples that follow. Summary categories are useful for keeping broad patterns of change in view. These 10 sectors have been selected as ones likely to be affected in similar ways by changes in technology, trade patterns, and regulation. The 10 sectors, and their relative shares of the U.S. gross national product (GNP), are shown in box 4-B.

Box 4-B.—The 10 Production Sectors

Description	% share of GNP[1]
1. *Natural Resources* includes the production of raw materials and energy of all kinds, including the generation of electricity. These industries were singled out to measure the impact of different kinds of economic activity on depletable natural resources, many of which are imported, and at the same time to trace the impact of substitutes for strategic raw materials.	9%
2. *Construction* is given its own category because of the unique nature and large size of construction activities, and in view of the critical role construction plays in renewing infrastructure and improving productivity throughout the economy. The highly cyclical nature of construction activities also sets this category aside from other business activities.	6%
3-5 *Manufacturing* activities have been selected because of growing concern about the future role of these industries in the U.S. economy. Significant direct and indirect linkages exist between manufacturing and the other parts of the economy. Manufacturing has traditionally been the major source of U.S. productivity growth, increasing at twice the rate of the economy as a whole between 1960 and 1983. It is also likely that wage increases in other industries can be traced to productivity growth in manufacturing. Activities within manufacturing have been subdivided into low, medium, and high wage sectors, based on the average level of annual compensation per full-time equivalent employee in 1984. This was done due to concern for the quality of jobs offered by growing and shrinking enterprises; more trade, for example, is attractive if the transactions result in the net substitution of high wage employment for low wage employment. The division by wage levels also provides groupings roughly commensurate with other areas of policy interest.	22%
3. *Low Wage Manufacturing* is clustered in the traditional apparel, footwear, and furniture industries.	3%
4. *Medium Wage Manufacturing* contains most enterprises recently tagged as "high technology," because these firms conduct significant amounts of research and employ relatively larger numbers of engineers and scientists. It includes industries such as electrical equipment, communications equipment, scientific instruments, and computers, and less technology-intensive industries such as food & kindred products.	10%
5. *High Wage Manufacturing* is dominated by traditional "smokestack" industries, such as those that produce motor vehicles, iron and steel, construction machinery, and glass. However, the high wage category also includes such technologically sophisticated industries as chemical production and aircraft manufacturing.	9%
6. *Transportation & Trade* are clustered because together they form much of the overhead associated with the physical movement of products. These activities are increasingly tied to manufacturing through sophisticated inventory control and dispatching networks. New technologies in transportation will be essential to system-wide improvements in efficiency—not so much from innovations in specific kinds of transportation or retailing equipment, but through advances in information flows that connect production with the marketplace more closely. While many of these technologies are difficult to trace, it appears that dramatic changes may occur in the near future.	19%
7. *Transactional Activities* deliver financial and information services to businesses. In 1984, the sector generated more value-added than the whole of manufacturing. The activities are clustered because, taken together, they are the most rapidly growing sector in the U.S. economy in terms of output and employment, and are associated with activities in which productivity improvements due to new information technologies could be enormous.	23%
8. *Persona/ Services* are selected because, with the exception of retailing, they contain most activities traditionally associated with the "service sector" of the economy: hotels, beauty parlors, and dry cleaning, for example. They also contain most activities associated with recreation and leisure—a sector that has grown rapidly in response to rising affluence among many consumers.	4%
9. Social Services follow a unique logic because of the involvement of government. With the exception of government "overhead" functions—the sector includes the salaries of both the President of the United States and the authors of this document-most of the activities in this sector, such as public and private health care and education, are delivered directly to consumers. In effect, social services support a human infrastructure.	14%
10. *National Defense was* separated from the "social services" of government because it is plainly affected by a unique set of factors.	2%

NOTES: The divisions of service functions are modifications of the categories used in J. Singlemann, "The Sectoral Transformation of the Labor Force in Seven Industrialized Countries, 1920-1970," *American Journal 01 Sociology, vol. 83, No. 3, 1978,* pp. 1224-1234. See also the discussion of alternative taxonomies in J I. Gershuny and I.D Miles, *The* New Service Economy (New York: Praeger, 1983). The appendix shows the industrial composition of each of these sectors in greater detail.

[1]The percentages represent the fraction of all value-added in the economy generated by the sector in 1984. They are calculated in 1980 dollars.

Finding a taxonomy that reveals rather than obscures deep structural change proves to be a significant challenge. Perceptions of change are often guided by what one chooses to measure. Take the distinction between "services" and "manufacturing." The printing & publishing industry is conventionally counted as a manufacturing enterprise, while television & radio broadcasting is not (presumably because this industry does not produce anything tangible). An individual writing news is considered a manufacturing employee if employed by a newspaper, but is not a manufacturing employee if employed by a television station.

Technology has begun to blur many traditional distinctions. Ten years ago, four-fifths of the value of a computer was embodied in its hardware, the remainder being associated with the software. Today, these ratios are reversed.2 Complex patterns of merger and acquisition have further confused the situation. General Motors earned more than one-quarter of its profits in 1985 from its finance division, GMAC, the Nation's single largest holder of consumer debt. Does that make GM a service industry?3 Chapter 6 will provide many other examples.

[2]Office of the U.S. Trade Representative, "U.S. National Study on Trade in Services," Washington, DC, December 1983.

[3]James B. Quinn and Christopher E. Gagnon, "Will Services Follow Manufacturing into Decline?" *Harvard Business Review,* November/December 1986, p. 101.

MARGINS

The cost of wholesale and retail trade, transportation, and insurance can add a significant amount to prices paid by consumers. In some areas, such as clothing, such margins can reach more than 50 percent of the total consumer priced Moreover, technology may rapidly change the role played by margins. Later discussions will show how new technologies and management systems are reshaping the connections between producers and retail outlets. Not only will changing patterns of consumer purchasing reshape the nature of demand for services provided by retail trade, wholesale trade, and transportation, but the net productivity of these systems may change radically. Meeting demand for a series of niche markets expected to change quickly, for example, clearly requires a different retail and delivery network than a system designed to meet demand for a comparatively undifferentiated product competing entirely on the basis of prices

Table 4-1 indicates the changes in margins that occurred between 1972 and 1984 for the amenity "Food." In 1972, for example, groceries (food purchased for off-premise consumption) required a commodity mix with more transportation & warehousing and food & kindred products, but less wholesale & retail trade than it did in 1984.6

The conversion from goods and services needed to satisfy an amenity to commodities results in a rearrangement of the consumption recipe into a consistent set of consumer demands to which industries can respond. Commonly referred to as final demand, this demand stimulates a second round of interindustry intermediate demand for various commodities needed as inputs in the production process. The inputs, which consist of physical materials, services, and the capital and labor required to produce output, are referred to here as the production recipe.

[4]Based on the 1977 margins published in U.S. Department of Commerce, Bureau of Economic Analysis, *Survey o/Current Business, vol. 64, No. 5,* May 1984, p. 46.

[5]For the purposes of the analysis presented throughout this document, consumer purchases expressed in the categories of the "National income and Product Accounts" of the U.S. Department of Commerce, Bureau of Economic Analysis (historic diskettes), are converted to demand expressed in input-output categories through use of a "bridge" provided by the U.S. Bureau of Economic Analysis ("The 1977 Input-Output Structure of the United States," *Survey of Current Business, vol. 64, No. 5,* May 1984, pp. 46-49). A similar bridge between government purchases and input-output categories was also made available by the Bureau of Economic Analysis.

[6]The 1984 commodity mix is based on the "1977 Input-Output Commodity Composition of Personal Consumer Expenditure," published in the *Survey of Current Business, vol.* 64, No. 5, May 1984.

Table 4-1.—The Commodity Mix for Food in 1972 and 1984' (current dollars, in percent)

Industry	Food purchased for off-premise consumption		Purchased meals & beverages		Other consumer food purchases		Total	
	1972	1984	1972	1984	1972	1984	1972	1984
Transportation & warehousing	3.60/o	2.40/o	0.0%	0.1 %0	0.90/0	0.7%	2.60/o	1.7%
Wholesale & retail trade	29.5	32.7	0.0	0.0	41.3	40.6	23.9	25.1
Finance & insurance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Livestock and livestock products	0.9	1.1	0.0	0.0	1.3	1.2	0.8	0.8
Other agricultural products	3.1	3.3	0.0	0.0	2.0	1.4	2.3	2.3
Food & kindred products	62.1	60.1	0.0	0.0	13.9	17.4	43.8	41.6
Tobacco manufacturers	0.0	0.0	0.0	0.0	40.6	38.7	3.6	3.1
Eating & drinking places	0.0	0.0	100.0	98.4	0.0	0.0	22.4	24.7
Amusements	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.4
Other	0.8	0.4	0.0	0.0	0.0	0.0	0.5	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total (billions of dollars)	**115**	**183**	**37**	**69**	**15**	**22**	**167**	**273**

HOW To Read This Table: On average, $100 in groceries purchased in 1984 ("food purchased for off-Premise consumption") was allocated as follows: $2.40 went to transportation and warehousing businesses, $32.70 went to grocery stores and other wholesale and retail businesses, and $60.10 went to firms that supply food to the system. A significant fraction of the $60.10 received by these firms, of course, went to pay their suppliers. For an estimate of these "intermediate inputs, " see table 4-2.

NOTES: Totals may not equal 100 percent due to rounding.

aThe 1984 Commodity Mix is estimated usingthe1977 composition updated with 1984 demand fOr these products.

SOURCE" U.S. Department of Commerce, Bureau of Economic Analysis, "The Input-Output Structure of the U.S. Economy," *Survey of Current Business,* April 1979 for 1972 data, and May 1984 for 1977 data; "National Income and Product Accounts," Survey of *Current Business,* **table 2.4, July 1987.**

THE PRODUCTION RECIPE

The production recipes for 9 of the 10 sectors listed earlier are summarized in table 4-2 for the years 1972 and 1980. The table indicates that the 1980 recipe for making $100 of output in the Construction sector involved:

- total intermediate input purchases of $56.80: $1.20 in products from the Natural Resource industries, $0.10 from other Construction businesses, $7.30 from manufacturing enterprises paying low wages, $20.40 from Medium Wage Manufacturing businesses, etc.; and
- $43.20 in the form of wages paid and returns to capital in the Construction sector.

Table 4-2 exposes expected differences in the production recipes of different business categories. The value-added generated by manufacturing firms in 1980 accounted for between 29.6 and 36.5 percent of total manufacturing output, while intermediate purchases-those goods and services purchased from other businesses that become part of a final manufactured product—account for the rest. On the other hand, in the relatively labor-intensive fields of Transportation & Trade, Transactional Activities, and Personal Services, value-added accounts for 59.0 to 72.8 percent of total sectoral output.

Table 4-2 includes only direct intermediate purchases with expected lifetimes of less than a year. It does not include purchases of buildings or capital equipment needed to expand operations or replace old machinery.[7] But capital equipment is clearly an essential ingredient in any production recipe. The National Accounts refer to items that last more than a year as Gross Private Fixed Investment (GPFI). This category includes purchases of residential and nonresidential structures, and of capital equipment such as machine tools, computers, and tractors. Components of GPFI include accounts for items bought as both replacements for older equipment and equipment purchased for expansion.

Purchases of producers' durable equipment (PDE) are nearly half of the 1984 GPFI total.[8] The remainder consists primarily of non-residential and residential structures, which each represent about

[7] A more detailed examination of the role of capital flows in a dynamic model of the economy has been developed. See W. Leontief and F. Duchin, "The Impacts of Automation on Employment, 1963-2000," Contract #PRA-801 2844 to the National Science Foundation, Washington, DC, April 1984, p. 2.1.

[8] Unless otherwise noted, data about PDE comes from table 5.7, "Private Purchases of Producer's Durable Equipment by Type in Constant **Dollars,"** in "National Income and Product Accounts," op. cit., footnote 5.

Table 4-2.—Recipes for the Production Sectors

Production sector	Natural Resources	Construction	Low Wage Manufacturing	Medium Wage Manufacturing	High Wage Manufacturing	Transport & Trade	Transactional Activities	Personal Services	Social Services
The 1980 Direct Requirements Table									
Natural Resources	**27.2%**	**1 .2%**	**4.4%**	**12.6%**	**20.4%**	**2.4%**	**1 .2%**	**3.4%**	**2.6%**
Construction	**2.5**	**0.1**	**0.5**	**0.6**	**0.7**	**1.2**	**3.6**	**1.4**	**2.2**
Low Wage Manufacturing	**0.4**	**7.3**	**27,3**	**2.0**	**2.3**	**0.7**	**0.2**	**1.9**	**0.7**
Medium Wage Manufacturing	**3.9**	**20.4**	**2.8**	**18.6**	**5.9**	**5.1**	**1.6**	**5.0**	**2.6**
High Wage Manufacturing	**8.8**	**6.8**	**15.4**	**15.0**	**29.0**	**5.5**	**1.1**	**6.7**	**3.2**
Transportation & Trade	**4,1**	**10.5**	**7.5**	**8.6**	**7.7**	**8.8**	**2.0**	**7.1**	**2.5**
Transactional Activities	**5.7**	**9.9**	**4,6**	**5.2**	**3.7**	**12.6**	**15.6**	**10.1**	5.9
Personal Services	0.5	0.5	0.6	0.7	0.5	2.2	1.1	4.8	0.8
Social Services	0.3	0.1	0.4	0.4	0.2	0.5	0.9	0.6	1.2
Total intermediate inputs	53.3	56.8	63.5	63.7	70.4	39.2	27.2	41.0	21.7
+									
Value-added	46.7	43.2	36.5	36.3	29.6	60.8	72.8	59.0	78.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
The 1972 Direct Requirements Table (1972 I-0 in 1980 dollar in percent)									
Natural Resources	26.l%	1.1%	6.0%	14.2%	18.2%	2.9%	1.4%	2.9%	2.5%
Construction	1.7	0.0	0.3	0.3	0.5	1,2	4.2	1.1	1.8
Low Wage Manufacturing	0.4	6.8	30.4	1.9	2.4	0.5	0.4	2.9	0.5
Medium Wage Manufacturing	3.0	19.3	3.7	16.7	6.2	5.5	1.6	4.7	1.5
High Wage Manufacturing	6.4	10.8	15.2	17.0	26.8	5.4	2.1	11.2	2.1
Transportation&Trade	2.4	8.9	6.9	6.5	5.4	6.9	2.2	4.5	1.7
Transactional Activities	4.8	5.2	4.4	4.9	3.5	10.2	16.1	10.1	4.4
Personal Services	0.3	0.4	0.7	0.8	0.5	2,1	1.6	4.6	0.6
Social Services	0.2	0.1	0.4	0.4	0.2	0.6	1.1	0.3	0.8
Total intermediate input	45.3	52.5	68.1	62.6	63.6	35.4	30.6	42.2	16.0
+									
Value-added	54.7	47.5	31.9	37.4	36.4	64.6	69.4	57.8	84.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

How To Read This Table:On average, each $100 in sales made by a Natural Resource business in 1980 resulted in $46.70 paid as compensation to employees in Natural Resource businesses or payments to the owners of these businesses, or indirect business taxes paid by these businesses, collectively called "value-added." The remainder of the $100 in sales went to pay firms that directly supplied Natural Resource industries. $2.50 went to purchase goods and services from construction firms, $0.40 went for purchases from Low Wage Manufacturing firms, $3.90 from Medium Wage Manufacturing, etc. These estimates reflect only the direct inputs, not the secondary or indirect contributions which are estimated in table 4-4.

NOTE: Totals may not equal 100 percent due to rounding.

SOURCE: Office of Technology Assessment, from data provided by the U.S. Department of Commerce, Bureau of Economic Analysis, "The Input-Output Structure of the U.S. Economy," 1972, Survey of Current *Business,* April 1979 and Input-Output Tables, 1980, unpublished; U.S. Department of Labor, Bureau of Labor Statistics, "Time Series Data Base for Input-Output Industries," unpublished.

one-quarter of GPFI. Residential structures are not considered to be part of the production recipe and expenditures on non-residential structures have remained relatively constant, leaving PDE as the component of capital investment that has experienced the most change. Most of this change has been in the form of purchases of information processing equipment, which increased from 6 percent of PDE in 1950 to over 40 percent of all such investment in 1986, with most of the growth occurring since 1973 (see figure 4-l). Two-thirds of the increase was attributable to two categories of equipment: office, computing, & accounting machines; and communications equipment. Of the growth in office, computing, & accounting machines, 93 percent occurred during the last 10 years. Recent estimates attribute 77 percent of all of the office, computing, & accounting machines and 95 percent of the communication equipment expenditures to purchases made by the service sector.[g]

The other components of PDE—industriaI, transportation, and other equipment—are of roughly equal size and all have lost about the same share of total expenditures, falling from about one-third in 1950 to about 22 percent in 1985.

In standard accounts, GPFI is treated in the same manner as consumer purchases. Unless otherwise stated, however, the calculations presented in this analysis will treat *both* durable and non-durable elements of production as being part of the production recipe, Purchases of residential structures were examined in chapter 2 and are not included in the production recipe because they are not considered an input to production.

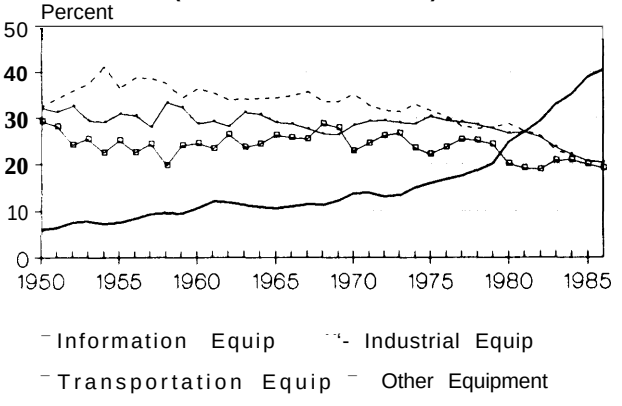
There are, of course, powerful links that cannot be exhibited in a table such as 4-2. The health of U.S. research and development efforts, for example, may be badly hurt if manufacturing capacity in an industry moves offshore, since there is evidence that commercially useful research thrives when it is integrally connected with practical manufacturing prob lems.l" Likewise, every business relies on educated workers as an "input," but schools are not formally linked as an input in the production process. Such connections must be recognized using tools other than the ones presented here.

The table also reports all value-added as a single statistic, lumping labor costs of managers, production workers, and scientists together with the cost of capital. In fact, some of the most interesting changes in production recipes are occurring within these value-added categories. Chapter 10 will explore the value-added recipe in much greater detail.

As prices, technologies, regulations, and other factors change, so will the recipe used for production. Generally, the process of changing this recipe is slow and gradual; even a large shock such as the quadrupling of oil prices between 1972 and 1980 had a long lag period before an adjustment was incorporated into the production process.l[l] Nevertheless, comparing the 1972 production recipes with those of 1980 reveals that in almost every sector, the level

[g] **Stephen S. Roach,** "The Information Economy Comes of Age," *Information Management Review, vol. 1, No.* **1, summer 1985.**

Figure 4-1.-Share of Producers' Durable Equipment (constant 1982 dollars)



How To Read This Figurs: Information equipment (computers, photocopiers, communication equipment, instruments, and related equipment) were only 6°/0 of all business investment in producers' durable equipment in 1950, but were 40°/0 in 1986. The percentages are computed after converting all spending to constant dollars. Producer durables were almost exactly half of all private investment in 1986, with the remaini ng investment going to buildings and other structures.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, "National Income and Product Accounts, " historical diskettes, table 5,7.

10 For a discussion of this link, see Stephen S. Cohen and John Zysman, "The Myth of a Post-Industrial Economy, " Technology *Review,* February/March 1987; or Charles F. Sabel, et al., "How To Keep Mature Industries Innovative," *Technology* Review, April 1987.

[l] See Anne Carter, "Changes in Input-Output **Structure Since** 1972," *Interindustry Review,* Data Resources Inc., summer 1980, p. 1.16; and Stanley J. Feldman and Karen Palmer, "Structural Change in the United States: Changing Input-Output Coefficients," *Business Economics,* January 1985, p. 39.

of inputs—particularly service sector products—increased between 1972 and 1980.

Chapter 6 provides a detailed discussion of the ways production recipes are changing. Major changes can be found in virtually every business network. For example:

- Heating oil dealers have been able to cut down on the number of trucks and drivers, and on their inventories, by maintaining data on the capacity of customers' tanks, consumption rates, and the weather. The recipe has been changed, substituting information for vehicles, people, and storage facilities.
- Levi Strauss & Co. uses 3-D computer imaging equipment to simulate how different fabrics and styles will look and wear, instead of producing samples. Software and computers have replaced sewing machines and material.
- Advances in polymer technology and a desire to boost fuel efficiency have altered the recipe for producing a car, as high strength plastics and aluminum are substituted for iron and steel. Computer-Aided-Design and robotics have optimized designs so that less steel is used.
- Banks have used automated tellers and communication networks to substitute for many hand operations.

In all of these cases, changes in the recipe of production, whether as a result of price changes or technological innovation, have altered the respective positions of industries in the U.S. economy.[12]

Intermediate Inputs and Direct Linkages

As table 4-2 indicates, the manufacturing sectors make comparatively heavy use of intermediate inputs purchased from other businesses. Roughly two-thirds of the value of manufacturing sales must go to pay for intermediate inputs supplied by other sectors, while the three sectors retain significantly less than half of the sales price of their goods. In comparative terms, the Social Services sector is only weakly linked to other parts of the economy. Of the price of Social Services sold, 78.3 percent results in direct value-added (returns to capital and labor) to the Social Service industries themselves; not much "leaks out" to the other sectors of the economy. Indeed, this insular quality holds true for all the sectors that are characterized as services.

Taken as a whole, the economy became more interconnected between 1972 and 1980, as the share of goods and services produced for use as intermediate inputs rose by 1.2 percent. This translates into more than $60 billion (1980 dollars) if applied to the 1980 economy, or more than all the value-added generated by the eating& drinking industry in that year.[13]

Some sectors became much more highly linked during the 1972-1980 period. The Natural Resource and High Wage Manufacturing sectors made much heavier use of intermediate inputs, increasing their intermediate inputs by 8 and 7 percentage points, respectively. The bulk of the increase for both of these sectors occurred between 1972 and 1977, and was in the form of energy-related commodities: crude & refined petroleum, chemicals, and electric, gas, and water services (utilities). Nevertheless, the single biggest increase in an input for the High Wage Manufacturing sector was the service provided by the wholesale & retail trade industry.

The change in use of intermediate inputs is not uniform. For example, the Natural Resource sector greatly reduced inputs of livestock and agricultural products inputs while High Wage Manufacturing reduced its purchases of iron ore, steel products, and metal containers.

Transactional Activities and Low Wage Manufacturing actually reduced their intermediate inputs between 1972 and 1980, becoming less tightly linked to the rest of the economy. In the case of Low Wage Manufacturing, the bulk of the decrease was attributable to a decline in textile and apparel inputs; for Transactional Activities, the decrease was more evenly spread between paper products, real estate, and maintenance & repair construction.

In many cases, relatively small total changes mask significant offsetting changes in production recipes.

[12]Since many of the sectors reflect the combination of many industrial processes, changes in demand, which necessarily change the share of a particular product or industry within the broader sector, may appear to be a change in recipe at this higher level of aggregation.

[13]This is 0.012 times $5,210 billion (total gross output in 1980 in 1980 dollars).

For example, intermediate inputs for Construction grew only 4 percentage points. Construction, however, greatly increased its purchases of business service inputs while reducing demand for refined petroleum. The Transportation & Trade sector also increased its use of business services, as well as communication services. Overall, Medium Wage Manufacturing increased its use of inputs only slightly, but its inputs of wholesale& retail trade, electronic components, and office & computer equipment increased dramatically, while its use of primary iron & steel, livestock products, and food& kindred products decreased.

When these sectors are combined and their relative size is taken into account, it becomes clear that the Nation's production recipe has undergone a significant realignment, using more service inputs and fewer raw or semi-finished materials.[14] Table 4-3 lists the 10 industries which contributed most to an increase in intermediate inputs and the 10 that contributed most to declines between 1972 and 1980.

[14]See **Andrew G.** Clem **and William P. Thomas,** "New Weight Structure **Being** Used in Producer Price Index," *Monthly Labor Review,* August 1987, pp. 12-21 for a similar analysis.

Table 4-3.—Changes in Production Recipe Inputs From 1972 to 1980 (ranked by greatest gain and loss)

Industries gaining share	Industries losing share
1, Wholesale & retail trade	Primary iron & steel manufacturing
2. Business services	Livestock & livestock products
3. Communications	Other agricultural products
4. Electronic components & accessories	Primary nonferrous metals manufacturing
5. Maintenance & repair construction	Motor vehicles & equipment
6. Electric, gas, water, & sanitary services	Stone & clay products
7. Transportation & warehousing	**Forestry & fishery products**
8. Plastic & synthetic materials	**Paper & allied products**
9. Office, computing, & accounting machines	**Lumber & wood products**
10. Finance & insurance	Broad & narrow fabrics

How To Read This Table: Intermediate inputs from wholesale and retail trade were responsible for the largest share of the total increase in intermediate inputs occurring between 1972 and 1980. Changes in intermediate inputs of primary iron & steel manufacturing contributed most to counteract this increase.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, "The Input-Output Structure of the U S. Economy, " 1972, *Survey of Current Business,* **April 1979 and Input-Output Tab[es, 1980, unpublished; converted to a constant dollar basis using Bureau of Labor Statistics Output Deflators, unpublished; U.S. Department of Labor, Bureau of Labor Statistics, "Time Series Data Base for Input-Output Industries," unpublished**

The overall increase in the use of intermediate inputs and the pronounced rise of service sector inputs suggests that the economy has become more specialized. '5 This specialization is apparent in the fact that more interindustry transactions are taking place, requiring significant increases in wholesale & retail trade inputs as well as inputs that tend to facilitate transactions: communications and business services.

Much of this specialization is fueled by technological developments and competitive pressures that make it nearly impossible, both technically and financially, for any one firm to conduct all facets of production. Specialized contractors fill this void, providing the contracting firm with additional flexibility because costs are shared, but also making the firm more dependent because of the strategic position of the contractor in the production process. Chrysler cites a 50-percent decrease in engineering costs to its increased use of suppliers.]G

Much of the increase in interindustry connections is also due to new technologies, particularly information processing technologies, that allow coordination of complex production processes which increasingly span the globe. As a result of this growth in subcontracting, and the wider geographical dispersion it entails, service sector businesses have thrived because of the increased need for legal contracts, consulting services, transportation, communication, and wholesale & retail trade.[17]

Indirect Linkages

Although the analysis of direct input requirements shows how recipes have changed, it does not include the indirect economic activity generated by an industry's output. As in the frozen pizza example, grain is needed to make flour, fertilizer is used to produce grain, chemicals are needed to make fertilizers, and so on. Numerous "upstream" and "downstream" linkages are associated with almost every commodity, although some are more tightly linked than

[15]See Anne Carter, *Structural Change in the American Economy* (Cambridge, MA: **Harvard University** Press, 1970), for a more detailed analysis of specialization.

[16]Elizabeth A. Haas, "Breakthrough Manufacturing, " *Harvard Business Review,* **March/April 1987, p. 79.**

[17]Charles **F.** Sabel, **et al., op. cit., footnote 10, p.** 32; and Richard McKenzie, "The Emergence of a Service Economy: Fact *or* **Artifact?"** Policy Analysis No. 93, Cato Institute, Washington, DC, October 1987.

others. By tracking these connections, the impact of buying a new domestically produced car on the auto industry's suppliers (like the steel industry) becomes apparent, as does the secondary impact of those increased steel purchases on the steel industry's suppliers (like coal). The indirect connections between different parts of the economy, implicit in table 4-2, can be illustrated using mathematical techniques described in the appendix to estimate how $1 of output in one industry sector generates value-added in other sectors, incorporating both direct and indirect effects.

Table 4-4 reconfirms that the Social Services sector is the most "insular," even when indirect effects are taken into consideration. Of the total value-added generated throughout the U.S. economy by demand for Social Services, 77 percent is retained within the Social Service sector-only 23 percent spills over into the rest of the economy (e.g., for purchase of hospital or school supplies).

As was the case when only direct effects were examined, this insular quality holds true for all the sectors characterized as services when indirect effects are included. On average, almost two-thirds of the value-added generated from demand for services stays in the service sectors. Their linkage to other sectors is relatively weak; of every $1 of value-added generated by demand for services, only around 15 cents ends up in manufacturing. The biggest spillover to manufacturing, more than 16 cents on each dollar, comes from demand for Personal Services; the smallest, 8 cents, comes from demand for Social Services.

A very different situation prevails in manufacturing, where the three sectors—as before—reap under half of the value-added generated from the sale of their goods, passing the other half on to other sectors of the economy. Low Wage Manufacturing is the most insular of the three, but even in this case, nearly one-quarter of every dollar spent on goods produced by the Low Wage sector, such as apparel, ends up in the coffers of a service industry-especially Transportation & Trade (12 cents per dollar) and Transactional Activities (9 cents).

This strong link to services is also evident in the Medium Wage sector; about one-quarter of the value added generated by demand for the products of Medium Wage Manufacturing is captured by services. But in contrast to the Low Wage sector, the demand for $1 of Medium Wage products, such as electronics or processed food, also translates into 12 cents of value-added for the Natural Resource sector. The other major link to Natural Resource industries—other than the Natural Resource sector itself—is High Wage Manufacturing. Only about 43 cents of every dollar of value-added resulting from demand for High Wage manufactured goods is retained by the High Wage sector. The bulk of the remaining 57 cents is divided between Natural Resources, reaping 17 cents, and Medium Wage Manufacturing, Transportation & Trade, and Transactional Activities, each gaining more than 8 cents worth of value-added.

The Natural Resource and Construction sectors are the least insular of all. Only 36 cents of $1 in value--added generated by demand for Construction goes to construction firms, while five of the eight other sectors gain at least a nickel in value-added from such purchases. About one-quarter of the value--added that is not retained by Construction from demand for its own products is split between Transportation & Trade and Transactional Activities—1 4 and 12 cents, respectively. The Natural Resource sector is the least insular sector, reaping only 25 cents of the dollar of value-added that results from purchases of Natural Resources. Major beneficiaries from demand for this sector's products are Transportation & Trade (16 cents) and Transactional Activities(11 cents).

Table 4-5 provides a summary view of the way that each of the sectors is linked to the rest of the economy. The table estimates the total industry output resulting from $1 of demand in each of the 10 sectors. This statistic is conventionally called the "output multiplier."[18]

[18]One dollar of sales can, by definition, **generate only $1 of value--added. If an industry purchases no items from other industries, there** would be no direct or indirect links to the rest of the economy, and $1 of its output **would generate only $1 of total output** (namely its own). All **value-added** would be captured by the producing enterprise. If a large portion of the value in an industry's sales represents the cost of goods **and services purchased from other enterprises, only a fraction of the total value-added in** the economy generated by the value of its sales will remain in the industry itself. The total output generated by $1 of the industry's output will be larger than 1.0 because the intermediate outputs are counted at least twice (once as a part of the output of the industry itself, and once as the output of the supplying industries). A chain of connections thus leads to multiple counting when an industry is not completely insular. The extent of this multiple counting provides a good measure of the degree to which the industry is linked

Table 4-4.—Sectoral Linkages: Value-Added Derived by Production Sector From the Purchase of $100 of a Sector's Product[a] (1980 dollars, in percent)

Production sector	Natural Resources	Construction	Low Wage Manufacturing	Medium Wage Manufacturing	High Wage Manufacturing	Transport &Trade	Transactional Activities	Personal Services	Social Services
Natural Resources	25.3%	6.1%	6.8%	11.8%	16.9%	5.6%	3.6%	4.9%	2.5%
Construction	10.5	35.9	3.3	3.9	4.3	3.8	12.7	3.9	2.7
Low Wage Manufacturing	2.3	4.7	47.6	2.4	2.7	1.6	2.1	2.5	1.0
Medium Wage Manufacturing	13.2	14.8	7.7	44.5	12.2	6.9	8.9	7.4	4.2
High Wage Manufacturing	12.9	10.5	11.8	12.4	43.4	5.7	5.3	6.5	3.0
Transportation&Trade	15.9	13.8	11.6	13.2	10.3	62.1	7.4	8.8	3.8
Transactional Activities	11.4	12.2	8.8	9.4	8.2	11.0	57.5	9,7	5.3
Personal Services	1.3	1.1	1.1	1.3	1.0	1.7	1.0	55.0	**0.7**
Social Services	**7.1**	**0.9**	**1.2**	**1.2**	**0.9**	**1.6**	**1.4**	**1.3**	**76.9**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

How To Read This Table: Following all the direct and indirect effects, $lOO of products purchased from Natural Resource businesses in 1980 created $25.30 invalue-added in the Natural Resource businesses themselves, $10.50 in Value-added for the Construction industry,etc. The $loo purchase can only generate $l00 in value-added throughout the econorny. it can, however create much more than $100 in output. Table 4-2 looked at direct effects of $100 in output produced by the Natural Resource industries. Table 4-4 looks at the chain of events created by $100 in final demand *for commodities* **produced by Natural Resource industries.**

aBased on the distribution of demand as it existed in 19S4, includes 1977 capital flows table updated to 1984 levels.

NOTE: Totals may not equal 100 percent due to rounding.

SOURCE: Office of Technology Assessment, from data provided by the U.S. Department of Commerce, Input-Output Tables, 1980, unpublished, Bureau of Labor Statistics, "Time Series Data Base for Input-Output Industries," unpublished, and 1977 Capital Flows Table.

Table 4-5.—Changing Sectoral Linkage: Output Multipliers for 1972 and 1980 (includes capital equipment)

Production sector	1972	1980
High Wage Manufacturing	2.6	3.0
Natural Resources	2.3	2.8
Low Wage Manufacturing	2.9	2.8
Medium Wage Manufacturing	2.6	2.8
Construction	2.5	2.6
Transportation&Trade	2.0	2.1
Personal Services	2.3	2.1
Transactional Activities	1.8	1.7
social Services	1.5	1.6
Total	2.3	2.4

How To **Read** This Table: **In** 1972, **$100** in ***final demand for commodities*** *produced* **by Natural Resource industries created $260 in total output throughout the economy. This had risen to $300 in 1980 because the sector had become more highly linked with the rest of the economy. A completely insular business purchasing nothing from the outside would create $100 in output and $100 in value-added for** $100 in sales. A highly linked business might buy a $90 product from suppliers and sell it for $100. This creates at least $190 in total output for the **economy. Adding output inherently involves double-counting because each output contains the value of intermediate inputs.**

SOURCE: Office of Technology Assessment, from data provided by the U.S. Department of Commerce, Bureau of Economic Analysis, "The Input-Output Structure of the U.S. Economy," 1972, *Survey of Current Business,* **April 1979 and Input-Output Tables, 1980, unpublished; U.S. Department of Labor, Bureau of Labor Statistics, "Time Series Data Base for Input-Output Industries)" unpublished, 1972 and 1977 Capital Flows Table.**

It is again evident that service enterprises are comparatively independent of the rest of the economy, while the Natural Resource and manufacturing sectors are highly linked. The changes in output multipliers between 1972 and 1980 tend to parallel the changes in production recipe: Natural Resources and High Wage Manufacturing had the largest increases, while Low Wage Manufacturing, Transactional Activities, and Personal Services experienced a decrease. In other words, Transactional Activities has altered its operations so that this sector had less interaction with other sectors in 1980 than in 1972.

Presumably, industries becoming more tightly linked with the rest of the economy require more connections to other business or more expensive inputs. They may also be contracting for work or buying inputs that were previously generated "in-house,"[19] The analysis of High Wage Manufacturing's production recipe indicates that the bulk of these additional links are with trade- and energy-intensive sectors, suggesting that the increase in connectivity is due to the higher cost of energy and the increased number of transactions needed for production—possibly due to the use of imported inputs.[20]

Table 4-5 also shows that the output multiplier for the whole economy increased between 1972 and 1980, The U.S. economy has become more interconnected in spite of the fact that sharp growth has been experienced in service sectors, which exhibit comparatively weak links to the rest of the economy. These seemingly contradictory findings are explained by the fact that businesses are increasingly using services as an input into their production recipes, both directly and indirectly—thus increasing services' role in the economy and creating a higher level of interindustry linkage.

Increased linkages have both attractive and unattractive effects. A more tightly linked economy allows a greater degree of specialization, flexibility, and efficiency. Nevertheless, interdependent sectors also mean that an economic downturn in one sector will quickly spread to other sectors of the economy. Unlike the situation in manufacturing, where growth in demand for its products has also meant growth in the Natural Resource and service sectors, the growth of services-especially that of Transactional Activities—results in little growth outside transactional businesses. On the other hand, the health of transactional service businesses may depend heavily on a healthy manufacturing sector.[21]

The concept of linkage takes on greater importance when viewed in terms of international trade, an issue that will be addressed in chapter 8. Trade has a major effect on manufacturing, which is highly linked to the rest of the economy. Therefore, trade problems in manufacturing ripple throughout the U.S. economy.

continued from previous page

directly and indirectly to other enterprises. See J.M. Szyrmer, "Measuring Connectedness of Input-Output Models: Survey of Measures, " *Environment and P/arming, vol. 17, 1985,* pp. 1591-1612, for a discussion of the use of this measure.

[19] See **John Tschetter,** "Producer Services **Industries:** Why Are They Growing So Rapidly?" U.S. Bureau of Labor Statistics, *Monthly Labor Review*, December 1987, pp. 31-41.

[20] For example, the "big three" U.S. auto companies now draw a significant amount of their parts from foreign producers. See Kevin Flaherty, "Foreign Sourcing by the U.S. Automobile Industry," U.S. Congressional Research Service, Nov. 8, 1985.

[21] **Stephen S. Cohen and John Zysman,** "The Myth of a Post-Industrial Economy," op. cit., footnote 10.

NETWORKS THAT PROVIDE AMENITIES

The methods just described can be used to show how the set of consumer and government purchases needed to satisfy specific amenities described in Part I connect to direct and indirect demand for industry output. The chain of analysis proceeds as follows:

1. consumers purchase a variety of goods and services to achieve an amenity,
2. these purchases translate into direct demand for output from a variety of different industries (including businesses providing "margins" such as transportation, insurance, and trade), and
3. the value of the products and services sold to consumers is distributed across a complex network of businesses because of direct and indirect connections.

It is possible, therefore, to connect purchases for an amenity such as Food with economic activity distributed throughout the U.S. economy. The distribution of value-added generated in each industry by purchases needed to serve 11 major amenity groups are summarized in table 4-6 for 1984 and 1972. This table shows how all value-added flowed through the economy from producing sectors to amenity categories in each of the 2 years. The sum of all value--added in each year is the entire U.S. gross national product.

Table 4-6 indicates, for example, that including all direct and indirect effects, approximately 15 percent of the U.S. Food bill goes to purchase value--added from farms and other Natural Resource operations—down from 17.6 percent in 1972. Similar decreases in share came from the Medium Wage and High Wage Manufacturing sectors. The bulk of the value-added required for the Food amenity, increasingly true since 1972, comes from the Transportation & Trade sector.

Although Natural Resource inputs were above average for the Housing, Transportation, and Export amenities both in 1972 and 1984, the share of value-added contributed by the Natural Resource sector has declined in 9 of the 11 amenities since 1972.

Interestingly, the largest share of value-added required for Housing, both in 1972 and 1984, does not go to the Construction sector. Rather, Transactional Activities accounts for nearly 45 percent, due to the enormous impact of the real estate industry on homebuying.[22] This is up dramatically from 1972. Exports also require a larger share of inputs from the Transactional sector as does Personal Business and and Communication. Between 1972 and 1984, the increased spending for Personal Business and Communication translated directly into value-added for Transactional Activities, while every other production sector lost share—particularly Construction and High Wage Manufacturing. Indeed, the importance of Transactional Activities has increased sharply since 1972 for every amenity except Defense, which is sensitive to the choice of 1972 as an endpoint due to the influence of the Viet Nam War.

Not surprisingly, value~added from the Social Service sector plays a large role in creating the Health, Education, Government, and Defense amenities, and this role has increased in size compared to 1972. All amenity groups except Defense and Personal Business and Communication registered increased demand for inputs from Transportation & Trade.

The Food, Transportation, Clothing and Personal Care, Recreation and Leisure, Federal Defense, and Export amenities make the heaviest use of manufactured inputs. With the exception of Defense, however, the share of value-added contributed by manufacturing declined significantly between 1972 and 1984. Purchases from High Wage Manufacturing fell sharply, especially for Transportation, Clothing and Personal Care, and Exports.

[22] The National Income and Product Accounts also impute a rental-equivalence value for homeowners, which is allocated to the real estate industry.

Table 4-6–Networks That Provide Amenity: Contributions From Sectors Needed To Satisfy Amenity categories, 1964 and 1972 (1960 dollars, in percent)

	Amenity categories											
Production sectors	Food	Housing	Transportation	Health	Clothing and Personal Care	Education	Personal Business and Communication	Recreation & Leisure	Government n .e.c.	Federal Defense	Exports	Total
1984~												
Natural Resources	15.0%	9.7%	14.5%	4.3%	4,9%	4.0%	2.6%	6.0%	5.2%	4.4%	16.4%	9.1 %
Construction	3.3	12.9	6.1	3.7	2.4	5.2	2.8	3.7	11.0	3.8	3.4	6.2
Low Wage Manufacturing	1.5	3.2	2.7	1.5	17.0	1.2	1.1	3.5	1.9	1.4	3.8	3.2
Medium Wage Manufacturing	16.8	6.8	7.8	6.6	5.2	4.8	6.7	12.1	6.1	10.9	19.4	9.7
High Wage Manufacturing	8.1	5.7	16.1	5.9	7.6	3.3	2.9	7.1	5.0	17.6	19.5	8.7
Transportation & Trade	39.1	12.8	30.1	10.3	39.1	4.1	6.0	21.7	8.0	8.1	18.8	19.3
Transactional Activities	12.7	44.7	12.3	15.6	12.8	7.0	70.9	15.4	12.4	9.0	16.1	23.5
Personal Services	1.6	2.3	8.0	1.4	10.0	0.6	3.2	14.4	1.4	1.2	1,5	3.7
Social Services	1.8	2.0	2.3	50.8	1.1	69.9	3.7	16.2	49.1	43.4	1.1	16.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total (billions of 1980$)	428	672	264	285	171	180	161	200	120	173	238	2,892
1972[b]												
Natural Resources	17.6%	13.8%	13.1 %	5.2%	5.7%	6.1 %	3.7%	6.7%	7,4%	20.1 %	15.9%	12.5%
Construction	3.7	12.2	7.1	5.6	4.1	6.1	5.1	5.5	12.8	9.8	3.9	7.6
Low Wage Manufacturing	1.5	3.8	2.9	1.7	18.3	1,3	1.6	4.1	2.0	3.5	4.1	3.8
Medium Wage Manufacturing	19.8	7.0	8.0	6.3	5.5	4.8	8.1	12.3	6.6	10.2	17.2	10.0
High Wage Manufacturing	10,7	8.4	22.7	8.0	11.3	5.1	5.4	9.6	8.0	14.6	27.9	12.0
Transportation & Trade	34.4	12.1	27.0	10.1	33.9	3.8	6.7	21.2	7.3	14.4	17.0	18.3
Transactional Activities	9.6	37.8	10.2	13.9	10.3	5.7	61.6	11.7	11.0	11.7	11.6	18.1
Personal Services	1.2	2.9	6.3	1.2	9.8	0.5	4.0	12.4	1.3	2.0	1.3	3.5
Social Services,	1.5	2.1	2.6	48.1	1.1	66.5	3.8	16.3	43.6	13.8	1.1	14.3
Total	100.0	100.0	100,0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total (billions of 1980$)	374	509	263	191	161	168	104	160	126	377	131	2,564

[a]Using 1984 demand and 1980 production recipe witi
[b]Using 1972 demand and production recipe with adju

NOTE: Totals may not equal 100 percent due to rounding.

SOURCES: Derived from U.S. Department of Commerce, Bureau of Economic Analysis, "National Income and Product Accounts," *Survey of Current Business*, for 1984 personal consumption expenditur made to the 1972 Input-Output Tables, *Survey of Current Business*, April 1979, 1980 Input-Output Table, unpublished, 1972 and 1977 Capital Flows Table; and U.S. Department of La rebased into 1980 dollars, unpublished and Time Series Data Base for Input-Output Industries.

A CONCLUDING NOTE

This chapter provides a set of tools for viewing the economy as a series of interconnected networks, where the product of one sector works in conjunction with the products of another sector to satis~ the needs of a consumer—whether that consumer is a person, a business, or a government agency.

These tools can be used to explore many of the structural changes that have occurred in the past few years, and are the basis for speculating about future changes. This will be the task of chapter 5. The tools also provide a way of describing the operation of complex networks of business activities that must combine operations to deliver goods and services that consumers require for different amenities. This will be the task of chapter 6.