

Chapter 13

Alternative Paths for the U.S. Economy

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Alternative Paths for the U.S. Economy

Given the enormous range of choices Americans face about what to buy, what to produce, how to produce it, and whom to employ, confident forecasts about the future are absurd. To an extent never before possible, the future hinges on conscious choice. It is possible, however, to construct self-consistent descriptions of the future that may provide a useful guide for policy makers.

This chapter examines the impact on the economy of a number of different scenarios, which include different assumptions about change in five main areas:

- consumer and government purchases,
- international trade,
- production recipes,
- labor productivity, and
- staffing patterns.

Chapters 2 through 12 provide quantitative and qualitative support for likely changes in these broad areas. The effects of these assumptions are summarized by two indicators of change: shifts in the sectoral composition of the Gross National Product (GNP) (as discussed in ch. 5) and changes in the numbers of jobs in each production sector and occupation (as discussed in ch. 10).

Four scenarios are constructed from the various assumptions made about each of the broad areas:

1. "Trend" is an attempt to extend trends established during the past two decades into the future.
2. "Manufacturing" attempts to maintain the traditional lines of manufacturing.
3. "Stagnation" assumes that growth slows due to slack demand, reduced productivity, and a trade situation in which the United States slips behind its trading partners in the production of sophisticated equipment and services.
4. "Transformation" reflects a series of hypotheses about the ways consumers may elect to purchase amenity and the manner in which producers may choose to organize production. The underlying theme is one of high flexibility in

the tailoring of goods and services to targeted tastes and markets. This scenario assumes that trade falls sharply as a fraction of economic activity because most products can be made more efficiently in locations close to the consumer, due to both reduced material and energy inputs and the fast pace of technology transfer.

Two of these scenarios, the Trend and Transformation scenarios, outlined in earlier chapters, include both a low- and a high-growth variant, making an actual total of six scenarios. The low-growth case (in which real GNP grows at 1.5 percent per year) assumes the comparatively slow growth rates of the late 1970s and early 1980s. The high-growth case (real GNP grows at 3 percent a year) assumes that the economy is able to restore the high rates of growth of the late 1960s. These cases were chosen to illustrate the boundaries of reasonable GNP growth rates, and are in general concordance with the U.S. Department of Labor's low-and high-growth projections for the year 2000.¹

These different scenarios will obviously result in different levels and arrangements of GNP and jobs in the year 2005. Each GNP level can, however, be produced by very different kinds of economies.

The analysis is not a closed dynamic model, in which demand for output generates a set of prices and a pattern of income which, in turn, generate purchasing patterns and a demand for output.² Instead, the scenarios are intended to illustrate rough parameters for the future direction of the economy, providing an awareness to possible changes rather than an exact prediction.

¹See Norman C. Saunders, "Economic Projections to the Year 2000," *Monthly Labor Review*, vol. 110, No. 9, September 1987, pp. 10-18.

²For a description of an operational dynamic model, see W. Leontief and F. Duchin, "The Impacts of Automation on Employment, 1963-2000," Institute for Economic Analysis, New York University, New York, NY, April 1984. A description of a forecasting model used by the Bureau of Labor Statistics appears in N.C. Saunders, "The U.S. Economy Through 1990—An Update," *Monthly Labor Review*, vol. 104, No. 8, August 1981, pp. 18-27; and U.S. General Accounting Office, "Bureau of Labor Statistics Employment Projections: Detailed Analysis of Selected Occupations and Industries," GAO/OCE-85-1, Washington, DC, Apr. 25, 1985.

Changes in each of the five main areas that collectively define these scenarios are called the component assumptions. These assumptions, and their individual effects on sectoral contribution to GNP and

jobs, are described below, providing a sensitivity to the relative impact of each component assumption. Following this discussion, they will be combined into the six scenarios.

COMPONENT ASSUMPTIONS

The influence of assumptions about demand, trade, production recipes, productivity, and staffing patterns is examined by assuming an economy where other factors are held constant. The impact of the changes is then shown cumulatively. This means beginning with baseline patterns for demand, trade, production recipes, productivity, and staffing. First, only demand is changed and values for the other factors are left at baseline levels. Second, demand is set at a fixed future level (for instance, at the 3 percent trend level) and alternative trade patterns are explored. Third, demand and trade are set at fixed future levels and the effects of different production recipes are explored. The series is continued until all factors are considered.

This analysis is undertaken only to illustrate the direction of change resulting from altering assumptions—none of the cases can be considered realistic descriptions of the future. The calculations are based on straightforward input-output techniques described in chapters 4, 7, and 10. While most of the component estimates were prepared for 85 business sectors, uncertainties are so large that the results are displayed only for nine summary sectors to avoid giving a false sense of precision.

Consumer and Government Purchases

The analysis in Part I resulted in two types of estimates about the future of personal and government spending: a trend case, and an alternative pattern of demand built on speculation about how technology, changes in government regulation, and changes in how consumers acquire information could lead to a higher level of amenities than the trend. Estimates were made for both high- and low-growth rates (see table 2-9 of ch. 2 for a summary of the alternative demand estimates).

At the level of aggregation shown in table 13-1, these assumptions have a surprisingly modest effect on economic structure. The alternative cases result

in significantly lower use of Natural Resources (primarily because of an assumed increase in the energy efficiency of houses and automobiles), higher spending on Transactional Activities, and lower consumption of High Wage Manufacturing products—all of which translates into shifting patterns of value-added for these sectors. Because productivity and staffing patterns have been kept constant, the impact on jobs mirrors the changes in value-added.

International Trade

Four trade cases were outlined at the end of chapter 8 under the assumption that the United States would achieve something approaching balanced trade in the year 2005. The cases differ in assumptions about the total volume of trade and about the comparative advantage of U.S. products. Briefly recapitulating:

1. The *Caesar case* assumes that the United States recovers a dominant position in the export of sophisticated manufactured products while trade continues to grow as a fraction of the U.S. GNP. In this case, the gross level of trade increases from the 1984 level of 22 percent to 30 percent of GNP in 2005. Exports of manufactured goods and services exceed imports while the United States becomes a slight net importer of natural resources, largely because of oil imports.
2. The *Banana case*, like the Caesar case, assumes that trade rises to become 30 percent of GNP in 2005. The Banana case, however, assumes that the U.S. trade balance is restored primarily by increasing exports of raw materials and resource-intensive manufactured products (following trends of the past decade). Exports of high technology products continue to fall. Imports and exports of services are identical to the Caesar case.
3. The *Drucker case* supposes that technological advances will lead to a decline in merchandise

Table 13-1.—Sensitivity Matrix of Jobs and Value-Added Under Different Assumptions of Final Demand

Production sector	1984		3% Trend		1.5% Trend		3% Alternative		1.5% Alternative	
	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added
Natural Resources	4.5	9.2	4.3	9.1	4.6	9.5	4.1	8.5	4.2	8.7
Construction	4.5	6.2	4.1	5.8	4.3	6.0	4.2	5.9	4.4	6.1
Low Wage Manufacturing	4.5	3.2	4.5	3.3	4.3	3.1	4.8	3.6	4.5	3.3
Medium Wage Manufacturing	9.3	9.7	8.8	9.3	9.3	9.8	8.8	9.3	8.9	9.4
High Wage Manufacturing	5.7	9.2	5.0	8.2	5.2	8.4	4.9	7.9	4.9	8.1
Transportation and Trade	26.3	19.4	25.5	19.1	25.6	19.0	26.3	19.7	25.5	19.1
Transactional Activities	12.8	24.2	12.6	24.2	12.9	24.5	13.0	24.9	12.9	24.7
Personal Services	5.6	3.6	6.4	4.2	5.8	3.8	7.0	4.6	6.4	4.2
Social Services	26.8	15.3	28.7	16.7	28.1	16.1	26.9	15.6	28.4	16.4
Total (percent)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total jobs in millions, GNP in trillions (1980\$)	107.0	3.0	200.0	5.4	143.0	4.0	199.0	5.4	144.0	3.9

NOTE: Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

trade, leaving the exchange of ideas and designs (services) as the prominent focus of trade. The level of gross trade is assumed to fall to 10 percent of GNP—approximately the level of trade in 1970. A deficit of natural resource and manufactured goods is balanced by exports of services.

4. The *Trend* case assumes 1984 levels of trade, but increases exports to restore the trade balance.

Table 13-2 indicates that the effects of these different cases tend to be isolated to a few sectors. The Caesar case succeeds in boosting manufacturing's share of jobs and GNP relative to the other trade assumptions, especially in the Medium and High Wage sectors. The main impact of the Drucker case is to boost the share of jobs and GNP appearing in the Low Wage Manufacturing sector—not surprising since a lower level of trade coupled with no change in domestic demand would effectively force businesses in this sector, such as textile and apparel firms, back “on-shore.” As expected, the Banana case increases the Natural Resource sector's share of jobs and GNP while reducing the role of manufacturing.

Since balanced trade is a net generator of jobs, both cases with high levels of trade (Caesar and Banana) generate 4 to 5 million more jobs than the low-trade volume Drucker and 84-Base cases. Interestingly, the low-trade Drucker case generated as many jobs as the Trend, presumably because of the labor-intensive service industries created by Drucker. As was the case with domestic demand, however, the impact of the radically different trade cases on the structure of the economy is relatively small.

Production Recipes

Changes in the production recipe are considered in two parts: first, changes in the use of non-durable intermediate inputs for production; and, secondly, changes in the kinds of capital equipment purchased.

Intermediate Inputs

The complex changes in production recipes reviewed in chapters 4, 5, and 6 defy easy generalization. Three hypotheses are developed to explore ranges of reasonable possibilities:

1. The *trend* case is developed by extrapolating the changes in recipe occurring between 1972

to 1980 for an additional ten years. The general patterns of the trend were discussed in chapter 4. Inputs from natural resource and manufacturing sectors decline, and inputs from the service sectors, particularly Transactional Activities, increase. The trend case also results in a higher level of inter-industry transactions, indicating a more tightly linked economy that is a reflection of increased specialization.

2. The *stagnation case* assumes that production recipes remain fixed at 1980 levels.
3. The *alternative* recipe is based on the sectoral analyses of chapter 6. It resembles the trend case except that it is carried out 15 years further to 2005, and Natural Resource inputs to each sector are cut to 70 percent of their 1980 level—a reflection of the economy's reduced use of natural raw materials. Through the adoption of modern production techniques and a changing product mix, it is also assumed that the production recipe of the Construction, Low Wage Manufacturing, and High Wage Manufacturing sectors would increasingly begin to resemble the production recipes now used by Medium Wage Manufacturing.

One-third of Medium Wage Manufacturing's production recipe change from 1980 to 2005 has been added to the 1980 recipe of each of these sectors, resulting in an overall increase of inputs, especially those originating in the Medium Wage Manufacturing, Transactional Activities, and Transportation & Trade sectors. A similar technique is applied to make education and the “paper pushing” parts of government behave more like Transactional Activities in the way they purchase inputs from the rest of the economy.

The results shown in table 13-3 indicate that the alternative recipe case postulates a much higher use of advanced technology, reflected in an increased role for Medium Wage Manufacturing, the need for more distributive and transactional services provided by the Transportation & Trade and Transactional Activities sectors, and a sharply reduced role for the Natural Resource sector. The trend recipe case proves to be roughly intermediate between the stagnation case and the alternative.

The alternative case creates 11 percent more jobs than the trend case, which in turn creates 6 percent more jobs than the stagnation case. This is because

Table 13=2.—Sensitivity Matrix of Jobs and Value-Added Under Different Scenarios of International Trade

Production sector	1984		Caesar		Banana		Drucker		Trend	
	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added
Natural Resources	4.5	9.2	4.4	9.1	4.8	9.8	4.3	8.9	4.3	9.1
Construction	4.5	6.2	4.1	5.7	4.1	5.7	4.1	5.8	4.1	5.8
Low Wage Manufacturing	4.5	3.2	4.8	3.5	4.6	3.3	5.2	3.9	4.5	3.3
Medium Wage Manufacturing	9.3	9.7	9.0	9.6	9.1	9.6	8.8	9.4	8.8	9.3
High Wage Manufacturing	5.7	9.2	5.4	8.8	5.3	8.6	5.3	8.8	5.0	8.2
Transportation and Trade	26.3	19.4	25.5	19.1	25.1	18.7	24.8	18.6	25.5	19.2
Transactional Activities	12.8	24.2	12.4	23.8	12.6	24.0	12.4	23.8	12.6	24.2
Personal Services	5.6	3.6	6.3	4.1	6.3	4.1	6.4	4.2	6.4	4.2
Social Services	26.8	15.3	28.1	16.3	28.1	16.2	28.6	16.6	28.7	16.7
Total (percent)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total jobs millions, GNP in trillions (1980\$)	107.0	3.0	205.0	5.6	204.0	5.6	200.0	5.4	200.0	5.4

NOTE: Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

Table 13-3.-Sensitivity Matrix of Jobs and Value-Added Under Different Production Recipe Scenarios

Production sector	1984		Stagnation		Trend		Alternative	
	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added
Natural Resources	4.5	9.2	4.3	9.1	4.3	7.4	2.5	3.5
Construction	4.5	6.2	4.1	5.8	4.0	5.2	4.1	5.2
Low Wage Manufacturing	4.5	3.2	1.5	3.3	4.1	3.8	3.4	2.8
Medium Wage Manufacturing	9.3	9.7	8.8	9.3	8.9	9.6	10.4	12.0
High Wage Manufacturing	5.7	9.2	5.0	8.2	4.8	6.0	3.7	7.3
Transportation and Trade	26.3	19.4	25.5	19.1	27.3	20.0	30.8	21.0
Transactional Activities	12.8	24.2	12.6	24.2	13.3	28.4	13.5	31.8
Personal Services	5.6	3.6	6.4	4.2	6.1	4.3	5.6	4.1
Social Services	26.8	15.3	28.7	16.7	27.2	15.2	26.1	12.2
Total (percent)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total jobs millions, GNP in trillions (1980\$)	107.0	3.0	200.0	5.4	212.0	5.4	235.0	5.4

NOTE: Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

the alternative and trend cases lead to increased inter-industry linkage and result in significantly greater demand for intermediate inputs from the comparatively labor-intensive service sectors.

Producers' Durable Equipment

Three producers' durable equipment composition cases have been constructed: a trend case, which extends the 1950 to 1985 trends out to 2005; a *manufacturing* case, which uses the 1972 pattern of investment to depict a surge in expenditures on industrial machinery; and an *information* case, which extends the 2005 share of computers, communication equipment, instruments, and photocopiers to 50 percent of all durable equipment expenditures.

Table 13-4 shows that the relative change attributable to these cases is small, with almost no difference between the information and trend cases. The major difference occurs in the manufacturing case, which increases the share of both jobs and GNP for the High Wage Manufacturing sector while lowering Medium Wage Manufacturing's share. This result is expected, given the emphasis on industrial machinery (a High Wage product) that reduces the share of equipment expenditures for information equipment (a Medium Wage product).

Labor Productivity

Not unexpectedly, a plausible range of assumptions about productivity translates into quite signif-

Table 13-4.—Sensitivity Matrix of Jobs and Value-Added Under Different Scenarios of Producers' Durable Equipment

Production sector	1984		Information		Manufacturing		Trend	
	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added
Natural Resources	4.5	9.2	4.3	9.1	4.4	9.1	4.3	9.0
Construction	4.5	6.2	4.1	5.8	4.1	5.8	4.1	5.8
Low Wage Manufacturing	4.5	3.2	4.4	3.3	4.5	3.3	4.5	3.3
Medium Wage Manufacturing	9.3	9.7	9.1	9.6	8.5	9.0	9.0	9.5
High Wage Manufacturing	5.7	9.2	4.9	8.0	5.1	8.4	4.9	8.1
Transportation and Trade	26.3	19.4	25.4	19.0	25.6	19.2	25.5	19.1
Transactional Activities	12.8	24.2	12.7	24.4	12.7	24.3	12.7	24.3
Personal Services	5.6	3.6	6.4	4.2	6.4	4.2	6.4	4.2
Social Services	26.8	15.3	28.7	16.7	28.8	16.7	28.7	16.6
Total (percent)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total jobs millions, GNP in trillions (1980\$)	107.0	3.0	200.0	5.4	199.0	5.4	200.0	5.4

NOTE: Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

icant differences in the distribution and numbers of jobs.

- The trend *productivity* case assumes that the productivity growth rates established between 1958 and 1984 continue to 2005.
- The *high productivity* case assumes that trends prevailing between 1958 and 1972 are restored and continue between 1984 and 2005.
- The low *productivity* case assumes that the growth rates that occurred from 1973 to 1984 continue until 2005.
- There are two *alternative* cases, Both assume that productivity in the Construction sector follows the long-term (1958 to 1984) trend in productivity experienced in the Medium Wage Manufacturing industry; in other words, it is assumed that Construction will increasingly resemble manufacturing. The productivity of the Transportation sector is assumed to follow the low productivity path because of the increase in less-than-truckload hauling. The high productivity trend is used for the retail and wholesale trade (assuming the use of new technologies, such as scanners, and new processes, such as self service).

Greater use of capital equipment (particularly computer and communication technology) is assumed to increase productivity in Transactional Activities and the government portion of the Social Service sector at a rate of 2 percent per year from 1984 to 2005. The productivity of the rest of the Social Service sector, consisting mainly of private health and education, is assumed to grow as it did from 1973 to 1984. The use of new technology is not assumed to change student-

teacher ratios, but instead will change the *quality* of education in ways that are not normally measured (it will, for example, increase the productivity of a student's time). The high-alternative case assumes that the productivity of the Natural Resource, manufacturing, and Personal Service sectors grows at the high productivity rates through 2005; the low-alternative case assumes the low productivity rate for these sectors.

All of the cases shown in table 13-5 have higher shares of employment in the service sectors than in 1984, with the largest increases coming from the high productivity and high-alternative cases. This is undoubtedly the result of the much higher rates of productivity in the Medium and High Wage Manufacturing, Construction, and Natural Resource sectors as opposed to the service sectors. The modifications made in the alternative cases lower the share of employment in the Construction sector due to improvements in productivity, but indirectly increase the share held by manufacturing, largely because of gains in service sector productivity. In the low-alternative case, this assumption results in the highest share of High Wage Manufacturing jobs of any of the cases examined. (Since changes in labor productivity would not affect the amount of value-added generated, these calculations are not presented.)

Staffing Patterns

The remaining component examined is the occupational mix within each sector. Three cases were constructed:

Table 13-5.—Sensitivity Matrix of Jobs Under Different Scenarios of Productivity

Production sector	1984	Trend	High	Low	High-alternative	Low-alternative
Natural Resources	4.5	3.0	2.1	4.3	2.3	5.2
Construction	4.5	6.4	5.3	6.1	4.9	4.1
Low Wage Manufacturing	4.5	3.7	4.0	3.2	4.3	3.9
Medium Wage Manufacturing	9.3	7.8	8.6	6.8	9.3	8.3
High Wage Manufacturing	5.7	4.3	4.0	4.8	4.3	5.9
Transportation and Trade	26.3	23.7	21.6	25.5	25.3	21.4
Transactional Activities.	12.8	13.5	14.3	12.6	13.6	11.5
Personal Services.	5.6	5.8	5.4	6.8	5.9	8.4
Social Services	26.8	31.7	34.6	29.9	30.1	31.2
Total jobs (percent)	100.0	100.0	100.0	100.0	100.0	100.0
Total jobs (millions)	107.0	150.5	132.4	178.2	123.0	145.4

NOTE: Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988

- a stagnation case, which assumes staffing patterns as they existed in 1984;
- a *trend case*, which extends changes that have occurred in staffing since the recession of the early 1980s to 2005; and
- an *alternative case*, based on the trend case, which makes modifications following the sectoral analyses of chapter 12.

As in the alternative recipe and productivity cases, the alternative staffing pattern case attempts to make Construction emulate a manufacturing concern by imposing the 2005 staffing pattern of High Wage Manufacturing onto Construction. Similarly, the staffing patterns of Low Wage and High Wage Manufacturing are made to resemble that of the Medium Wage sector by adding two-thirds of Medium Wage Manufacturing's 1984-2005 change to their 1984 staffing pattern. Medium Wage Manufacturing itself has been modified to reflect increased use of advanced manufacturing technologies by increasing the numbers of technical professionals and technicians, and by lowering the numbers of machine operators and precision production workers. The staffing patterns of the service sectors are changed to reflect a decrease in information distribution and processing occupations, based on the developments outlined in chapter 12. The number of people employed as

"managers" are reduced by one-third and reclassified as "other professionals" in each service sector. This is based on an assumption that occupations growing out of new information technology will be both managerial and clerical in nature (akin to the para-professionals included in the "other professional" classification).

Because changes in staffing patterns do not alter the sectoral composition of jobs and GNP, it is necessary to look at the changes on the basis of occupations. Table 13-6 shows that the alternative and trend assumptions are somewhat similar and contrast sharply with the stagnation case. Under the alternative and trend assumptions, the share of managers, technical professionals, and sales workers rises while the share of education and health professionals, information distributors, precision production workers, machine operators, and farmers fall.

The differences between the trend and the alternative cases are in the size and not the direction of change. The alternative case produces more technical workers, "other" professionals, and transport workers, and fewer data entry & manipulation and precision production workers, than the trend case. Jobs for managers and sales workers also grow more slowly in the alternative case.

Table 13-6.-Sensitivity Matrix of Jobs Under Different Scenarios of Staffing

Occupation	Stagnation	Alternative	Trend
Managers and management support	10.6	13.5	17.3
Technical professionals	2.0	4.9	3.0
Education and health professionals	6.7	4.9	5.6
Other professionals	3.3	8.9	4.4
Technicians	3.0	6.7	3.9
Sales workers	10.5	13.4	13.7
Other customer contact	1.2	1.3	1.2
Information distribution	3.6	2.6	3.2
Data entry, manipulation, and processing . . .	12.7	8.8	11.3
Food and beverage preparers	6.2	4.3	4.0
Other service workers	9.3	8.2	7.6
Precision production, craft, and repair	11.7	5.8	8.5
Machine operators, assemblers, and inspectors	7.6	5.6	5.2
Transportation and material moving	4.4	5.3	4.5
Handlers, equipment cleaners, helpers, and laborers	3.9	4.0	4.9
Farming, forestry, and fishing	3.3	1.7	1.7
Total jobs (percent)	100.0	100.0	100.0
Total jobs (millions)	200.0	200.0	200.0

NOTE: Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

Comparing the Influence of Different Factors

Table 13-7 shows the relative effects of all the factors just described when combined into the high-growth Trend scenario. While the magnitude of different factors varies widely between sectors, changes in productivity have the greatest influence on the change in a sector's share of jobs between 1984 and 2005. Lagging productivity is the primary reason for a gain in Construction's job share, while

declining demand is nearly as powerful a factor behind High Wage Manufacturing's decline in job share. Although the Transportation & Trade sector would lose job share if the positive trend in productivity continued, the trend in the recipe of production substantially reduces the loss.

When staffing patterns are considered, however, even the productivity effects are overwhelmed by changes in staffing patterns within individual sectors (see table 13-8).

Table 13-7.—Change in Percentage of Job Share From 1984 to 2005 According to the High-Growth Trend Scenario

	1	2	3	4	5
Production sectors	Job share shift	Productivity	Demand	Production Recipe	interactive
Natural Resources	-2.4%	-2.2	-0.2	0.0	0.0
Construction	0.7	1.2	-0.4	-0.1	0.0
Low Wage Manufacturing	-0.8	-0.5	0.0	-0.4	0.1
Medium Wage Manufacturing	-0.6	-0.2	-0.5	0.1	0.0
High Wage Manufacturing	-1.9	-1.0	-0.7	-0.2	0.0
Transportation and Trade	-3.2	-3.9	-0.8	1.8	-0.3
Transactional Activities	2.3	1.6	-0.2	0.7	0.2
Personal Services	-0.4	-1.0	0.8	-0.3	0.1
Social Services	6.1	5.9	1.9	-1.5	-0.2

NOTE: 1-2 +3+4+5. Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1966.

Table 13-8.—Change in Percentage of Job Share From 1984 to 2005 According to the High-Growth Trend Scenario

	1	2	3	4	5	6
Occupations	Job share shift	Demand	Production Recipe	Productivity	Staffing	Interactive
1. Managers and management support	7.3%	0.0%	0.1%	0.3%	6.7%	0.2 %
2. Technical professionals	0.9	-0.1	0.0	0.0	1.1	-0.1
3. Education and health professionals	-0.2	0.5	-0.3	1.3	-1.4	-0.3
4. Other professionals	1.3	0.1	-0.1	0.4	0.9	0.0
5. Technicians	1.2	0.1	-0.1	0.3	0.9	-0.0
6. Sales workers	1.9	-0.3	0.6	-1.2	3.6	-0.8
7. Other customer contact	0.1	0.0	0.0	0.1	-0.1	0.1
8. information distribution	-0.4	0.0	0.0	0.0	-0.4	0.0
9. Data-entry, manipulation, and processing.	-0.8	0.1	0.1	0.9	-1.6	-0.3
10. Food and beverage workers	-2.4	0.0	0.2	-0.5	-2.2	0.1
11. Other service workers	-0.8	0.6	-0.3	0.8	-2.2	0.3
12. Precision production, craft, and repair	-3.1	-0.4	-0.1	-0.1	-2.8	0.3
13. Machine operators, assemblers, and operators	-3.0	-0.3	-0.2	-0.6	-2.2	0.3
14. Transportation and material moving	-0.3	-0.1	0.1	-0.3	0.2	-0.2
15. Handlers, equipment cleaners, helpers & laborers	0.6	-0.1	0.0	-0.1	1.2	-0.4
16. Farming, forestry, and fishing	-2.2	0.0	-0.1	-1.2	-1.6	0.7

NOTE: 1 =2+3+4+5+6. Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

COMBINING COMPONENT ASSUMPTIONS INTO SCENARIOS

Constructing the Scenarios

The six scenarios described at the beginning of this chapter were constructed by combining assumptions from the set just described:

- The two *Trend* scenarios cluster assumptions extrapolating trends in domestic demand, international trade, the recipe of production, producers' durable equipment, labor productivity, and staffing patterns. These scenarios represent an effort to provide a reasonable extrapolation of trends established in the recent past.
- The *Manufacturing* case represents an attempt to describe a U.S. economy in which parts of traditional manufacturing enjoy a renaissance. This is done by coupling the Caesar trade scenario with capital equipment investments dominated by industrial machinery purchases. The trend projection for production recipes is used to reflect the shifting mixture of inputs as raw materials decline and services increase. The resultant output is converted to jobs via the high productivity scenario, and finally translated into occupations using the 1984 staffing patterns.
- The *Stagnation* case is designed to illustrate the effect of sluggish economic growth. It is constructed using the low-growth domestic demand trend, the low productivity trend, and the Banana trade scenario. The stagnation case keeps the recipe of production as it was in 1980, and maintains 1984 staffing patterns. The scenario assumes few changes except that trade is brought into balance as a result of large exports of natural resource materials such as foodstuffs, lumber, and coal.

- The two *Transformation* cases are designed to show what might happen if the economy undergoes a major transformation in consumption and production recipes of the type described in chapters 3 and 6. High- and low-growth rate cases are examined separately. The alternative scenarios are used for domestic demand, production recipe, productivity, and staffing patterns. The Drucker scenario is used for international trade, which assumes a low level of merchandise trade because of the world-wide diffusion of technology. In terms of capital equipment expenditures, the information scenario is used.

These assumptions are summarized in table 13-9.

Impact *on Business Sectors*

The structure of the U.S. economy resulting from these assumptions is displayed in table 13-10. As expected, the *Trend* scenarios continue the pattern of structural change discussed in chapters 5 and 10, while the *Transformation* scenarios result in a change in direction. With the exception of the *Stagnation* scenario (which postulates large foreign sales of resources), all of the scenarios result in a decline in the share of national output and employment generated by Natural Resource enterprises.

Taken together, the Nation's manufacturing enterprises hold a roughly constant share of GNP in all scenarios, although the sectoral mix depends heavily on the scenario.³ The comparatively high

³ This finding is similar to that reported for the year 2000 by the U.S. Department of Labor. See Valerie A. Personick, "Industry Output and Employment through the End of the Century," *Monthly Labor Review*, September 1987, vol. 110, No. 9, pp. 30-41.

Table 13-9.—The Assumptions Used in the Scenarios

Assumption	Scenarios					
	Trend 3%	Trend 1.5%	Manufacturing	Stagnation	Transformation 3%	Transformation 1.5%
Domestic demand . . .	Trend-3%	Trend-1.5%	Trend-3%	Trend-1.5%	Alternative-3%	Alternative-1.5%
Trade	Trend	Trend	Caesar	Banana	Drucker	Drucker
Production recipe . . .	Trend	Trend	Trend	Stagnation	Alternative	Alternative
Producers' durable equipment	Trend	Trend	Manufacturing	Base-84	Information	Information
Productivity	High	Low	High	Low	High alternative	Low alternative
Staffing patterns	Trend	Trend	Stagnation	Stagnation	Alternative	Alternative

NOTE: See this chapter's text for definitions.

Table 13-10.—Sensitivity Matrix of Jobs Under Different Scenarios That Combine Various Assumptions

Production sector	130%		110% 1.3%		110% 3%		Stagnation		Transformation 1.5%		Transformation 3%	
	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added	Jobs	Value-added
Natural resources	4.2	4.2	4.4	7.7	2.1	7.4	4.9	10.2	2.8	3.2	1.1	3.1
Construction	4.5	6.2	6.2	5.4	5.2	5.2	6.3	5.8	4.3	5.5	4.5	5.3
Low Wage Manufacturing	4.5	3.2	2.8	3.6	3.7	3.8	3.1	3.2	3.4	3.2	3.7	3.4
Medium Wage Manufacturing	9.3	9.7	7.2	10.2	8.8	9.8	7.3	10.0	10.1	12.5	10.2	12.3
High Wage Manufacturing	5.7	9.2	4.8	6.0	3.8	5.8	5.3	8.7	4.5	7.4	2.9	7.1
Transportation and Trade	26.3	19.4	27.4	19.8	23.1	20.0	25.3	18.5	26.7	20.3	29.6	20.8
Transactional Activities	12.8	24.2	13.5	28.7	15.2	28.5	12.8	24.2	12.3	31.8	13.4	32.0
Personal Services	5.6	3.6	5.9	3.9	5.2	4.3	6.2	3.7	7.4	4.1	5.1	4.5
Social Services	26.8	15.3	27.7	14.7	32.9	15.2	28.7	15.7	28.6	12.1	29.5	11.5
Total (percent)	00.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	00.0	00.0	100.0
Total jobs (millions)												
GNP in trillions (1980\$)	107.0	3.0	135.5	4.0	139.7	5.4	30.3	4.1	122.6	3.9	156.4	5.4
Projected unemployment (percent)	8.6											
low labor force estimate (percent)			7.0		4.1		10.5		15.8		-7.4	
high labor force estimate (percent)					.9		17.8		22.6		1.2	

..... Figures may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

technology Medium Wage Manufacturing enterprises hold a constant or growing share of GNP while High Wage Manufacturing loses share. Manufacturing as a whole actually increases its share of GNP under the Transformation scenarios.

While all the scenarios examined show manufacturing enterprises providing a shrinking fraction of jobs during the next two decades, the rate of decline remains well below that of the previous 20 years.⁴ Manufacturing seems likely to provide 16 to 18 percent of all jobs by the year 2005. The next section suggests, however, that the nature of these jobs may change rapidly.

Although every scenario indicates that the share of value-added and jobs contributed to the economy by the service sectors is likely to increase, the size and composition of the contribution varies widely depending on the scenario chosen. The comparatively low rates of productivity growth in the Social Service sector, and increasing demand for health and other services contained in the Trend and Manufacturing scenarios, result in a significant increase in Social Services employment. Transactional Activities employment also grows sharply in the Trend cases because of relatively slow rates of productivity growth and the continuation of strong demand for their products. The sharp increases in service sector productivity evident in the Transformation scenarios reduce the share of jobs held by the Transactional Activities sector.

Impact on Occupations

Since all earlier analysis suggests that shifts of jobs within sectors has the greatest effect on the kinds of jobs provided by the U.S. economy, it is not surprising that the differences between the scenarios are most pronounced when measured by their impact on different occupations (see table 13-11). Unemployment rates, provided in table 13-10, are computed assuming high and low estimates of the labor force in 2005 of 146 and 158 million (see ch. 11 for details). The scenarios result in unemployment rates

varying from 23 percent to minus 7 percent (implying a labor shortage).⁵

Composition

The scenarios lead to startling contrasts in the composition of the 2005 work force. For example, both the Trend and the Transformation scenarios lead to a situation where one out of every six or seven jobs is classified as managerial or management support, while the two cases that do not include an assumption about changing staffing patterns (Manufacturing and Stagnation) leave this category comparatively unchanged from 1984. In both the Trend and the Transformation cases, the number of people employed in occupations with comparatively low skills (food & beverage preparers and farm workers) decline. Many of these declining occupations are also some of the most dangerous occupations in the economy.

The difference between the Manufacturing and Stagnation cases and the other two cases is clearly visible in estimates of the future job opportunities for precision production & craft workers versus technicians and technical professionals. Both the Trend and Transformation scenarios indicate a decline in the production and craft workers and an increase in technicians. These findings are in rough agreement with forecasts made by the U.S. Department of Labor.⁶

The Transformation cases lead to a significant decline in employment for people who enter and perform routine manipulation on data (because of the assumed high rates of productivity growth in these occupations), and a doubling of the share of jobs held by technical professionals in 1984. The share of jobs called "other professionals" increases dramatically, due to the assumption that some managerial functions are reclassified and appear in this category. The

⁵ The upper range of OTA estimates of the labor force are higher than those projected by the Department of Labor because of OTA's larger projected population and higher assumed participation rates. This coupled with more extreme assumptions about productivity and production recipes result in a much wider future range of unemployment of -7 to 23 percent while the Department of Labor predicts a smaller range of 4.5 to 7.7 percent. See Howard Fullerton, Jr., "Labor Force Projections: 1986 to 2000," *Monthly Labor Review*, September 1987, vol. 10, No. 9, pp. 19-29.

⁶ George T. Silvestri and John M. Lukaszewicz, "A Look at Occupational Employment Trends to the Year 2000," *Monthly Labor Review*, vol. 110, No. 9, September 1987, pp. 46-63.

⁴ Again, the Department of Labor reached a similar conclusion in their projections. See *Ibid.*

Table 13-11.—Sensitivity Matrix of Jobs Under Different Scenarios That Combine Various Assumptions

	Base Case	Transformation 1.5%	Transformation 3%
Managers and management support	10.6	10.8	13.3
Technical professionals	2.0	2.0	4.8
Education and health professionals	6.7	8.0	4.9
Other professionals	3.3	3.7	9.1
Technicians	3.0	3.3	6.6
Sales workers	10.5	10.1	13.8
Other customer contact	1.2	1.2	1.3
Information distribution	3.6	3.6	2.6
Data-entry, manipulation, and processing	12.7	13.7	8.8
Food and beverage preparers	6.2	5.9	6.2
Other service workers	9.3	10.2	8.5
Precision production, craft, and repair	11.7	11.2	5.8
Machine operators, assemblers, and inspectors	7.6	6.8	5.5
Transportation and material moving	4.4	4.1	5.2
Handlers, equipment cleaners, helpers & laborers	3.9	3.7	4.0
Farming, forestry, and fishing	3.3	2.1	1.3
Total (percent)	100.0	100.0	100.0
Total jobs (millions)	107.0	122.6	156.4

SOURCE: Office of Technology Assessment, 1988.

Transformation cases do not lead to an increase in jobs for teachers or health professionals, because of the assumed growth in non-traditional aspects of health care and education (e.g. software development).

Turnover

The change in the skills needed by the U.S. economy in both the Trend and Transformation scenarios is dramatic. Only the Stagnation and Manufacturing cases result in a set of jobs matched to the skills in the work force today. The Trend and Transformation cases result in a 14 to 20 percent shift of employment between occupations—meaning that at a minimum, 14 to 20 percent of all jobs would be redefined during the next 20 years. Obviously, the high level of aggregation in the tables masks large changes in job definitions within categories such as “precision production worker” or “data entry worker.” Some categories will be redefined by attrition as new workers enter with new skills and people with less needed skills retire. Others will be redefined by layoffs and new hires.

Earnings

If some of the scenarios suggest that a significant fraction of all jobs will be redefined in the next two decades, they also suggest that there will be a net decline in jobs traditionally paid low wages and an increase in the number of jobs that now pay high wages (see figure 13-1). While the Stagnation and

Manufacturing scenarios leave income distribution comparatively unchanged, the Trend and Transformation scenarios lead to a decline in the percentage of people in occupations paying less than 66 percent of 1986 median weekly earnings, and a sharp increase in the percentage of people in occupations paying more than 133 percent of 1986 median weekly earnings.

Educational Attainment

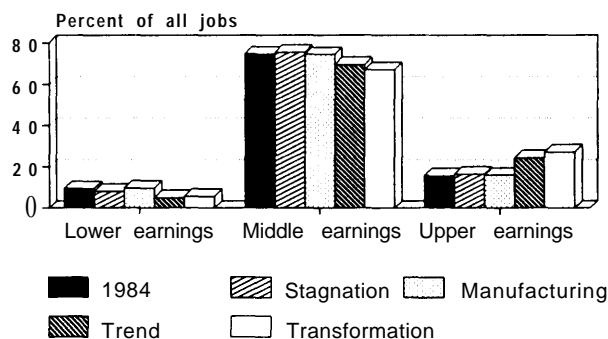
Given the correlation between income and education, it is not surprising that occupations dominated by people with no more than high school degrees decline in all the scenarios except Manufacturing and Stagnation (see figure 13-2). In both the Trend and Transformation scenarios, the share of all jobs in positions now held by people with four or more years of college increases while the share of jobs offered people with lower educational levels declines. The share of jobs available for people with four years of high school or less declines most sharply.⁷

Minorities and Women

The Department of Labor reports that blacks and Hispanics respectively account for about 11 and 7 percent of the labor force in 1986, but will makeup 17 percent and 29 percent of the total labor force growth between 1986 and 2005 (see table 11-2 of ch. 11).⁸ Extrapolating from current statistics, the Labor Department estimates that minorities will be disproportionately employed in occupations that are projected to decline, such as machine setters and assemblers, and underrepresented in occupations estimated to increase, such as technicians and managers.⁹

With few exceptions, the occupations projected to grow now employ significant numbers of women while male-dominated jobs are in declining occupations. The major exceptions are the rapidly growing natural scientist, computer specialist, and engineering, architectural, & surveyor occupations, all now largely male. The share of jobs held by machine setters (42 percent female) is projected to decline.¹⁰

Figure 13-1.-Earnings Distributions of Scenarios Based on 1986 Median Weekly Earnings by Occupation



NOTE: Lower group is 2/3s of the average, upper is 4/3s of the average, middle is remainder.

SOURCE: Office of Technology Assessment, 1987.

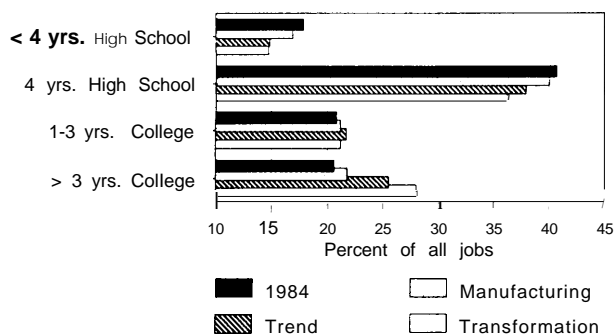
⁷ A similar finding was reported by the Department of Labor in Ibid.

⁸ H. Fullerton, op. Cit., footnote 5.

⁹ G. Silvestri and J. Lukasiewicz, op. cit., footnote 6.

¹⁰ Ibid.

Figure 13-2.-Educational Requirements of Scenarios Based on 1986 Educational Attainment



SOURCE: Office of Technology Assessment, 1987.

At a Crossroads

These scenarios present stark contrasts for the future of the economy. Given continued productivity growth and freedom to transform production processes, the economy clearly has the opportunity to provide both real increases in amenity and a much improved mix of jobs. Changes in consumption and production recipes could even result in a net improvement when measured levels of economic growth are comparatively low. The analysis presented in chapter 3 reveals that the low-growth Transformation case can lead to improved levels of amenity—in respect to employment, the low-growth Transformation scenario could lead to a 16 to 23 percent unemployment rate given current working habits, but this could be reduced to 4 percent unemployment if the yearly number of hours worked declines 15 to 20 percent (e.g., a 35-hour work week).

Table 13-12 shows how the need for the basic amenities would be satisfied with respect to jobs by the various occupation classifications if the economy followed the path outlined by the high-growth Transformation scenario. Although many of the component assumptions that compose this scenario are rather drastic and tend to be exacerbated by the high rate of economic growth, they provide a rough indicator of the nature and magnitude of change that could occur.

The occupational composition of the amenities echoes the assumptions underlying the transformation scenario: technicians, technical professionals,

sales workers, and managers play a larger role in almost every amenity group. Data entry and information distribution workers, precision production workers, and machine operators tend to decline in importance in all amenity groups. Compared to the patterns that prevailed in 1984 (see table 10-6 of ch. 10), the fraction of jobs in the education & health professional occupation drops significantly in the Health, Education, and Government amenity groups, and the share of work conducted by farmers is reduced in the Food and Export amenities.

Overall, the share of the employed workers dedicated to the production of the Food, Housing, and Export amenities declines while the fraction of all jobs that are needed to supply the amenities of Recreation and Leisure, Clothing and Personal Care, and Government increases.

Though not shown in table 13-12, every amenity requires less value-added from the Natural Resource sector and more from the Medium Wage Manufacturing and Transactional Activities sectors in 2005 than in 1984 (see table 4-6 of ch. 4). The magnitude of some of these potential shifts is sometimes startling: the fraction of value-added contributed from the Natural Resource sector to the Food amenity drops from 15 to 3 percent; the share of Construction value-added used to provide the amenity of Housing could fall by half; and the relative role of the Social Services sector in providing value-added to the Health, Education, and Government amenities could significantly decrease.

A Caveat

The probability of an economic future like that depicted in the high-growth Transformation scenario is low, but the probability of no change is even more unlikely. The preceding 12 chapters have outlined many changes that have been evolving steadily over time, like the shift from manufacturing to services, and some that are surprises, like the rapid diffusion of information technologies. In comparison to the last 15 years, many of the changes assumed in the scenarios for the year **2005** are conservative, but the analyses presented here must not be read as *Confident* forecasts. They are *not* intended to be a comprehensive model of the U.S. economy. They are designed instead to illustrate how choices that affect different parts of the economy may affect the

Table 13-12.—Jobs Needed to Produce Amenity under the Transformation 3% Scenario, by Occupation

	Total	Food	Housing	Transportation	Health	Clothing and Personal Care	Education	Personal business and Communication	Recreation and Leisure	Government n.e.c.	Federal Defense	Exports
Managers and management support	13.1	11.4	13.7	11.9	13.9	11.7	14.1	14.9	12.5	14.0	14.0	13.1
Technical professionals	4.7	4.7	6.5	4.7	3.6	4.6	4.0	7.3	4.0	4.5	4.8	6.1
Education and health professionals	4.9	1.3	1.7	2.0	10.3	1.4	9.8	2.7	5.1	8.0	7.3	1.3
Other professionals	9.1	6.3	10.0	7.6	10.6	6.8	10.3	13.5	9.5	9.7	9.2	6.7
Technicians	6.7	4.0	5.0	4.3	10.3	3.9	10.0	6.1	6.4	8.9	8.5	4.6
Sales workers	14.8	24.7	17.2	20.4	6.9	21.7	6.9	12.6	14.6	9.1	10.1	19.4
Other customer contact	1.3	0.9	1.6	1.2	1.3	1.1	1.3	2.3	1.5	1.3	1.2	0.9
Information distribution	2.7	2.6	2.6	2.5	2.9	2.5	2.9	2.7	2.5	2.8	2.8	2.6
Data-entry, manipulation, and processing	8.9	6.7	9.4	6.8	11.0	6.5	10.8	11.7	8.1	10.2	9.8	7.3
Food and beverage preparers	4.8	6.7	3.9	5.9	4.0	6.1	3.8	2.4	5.3	3.9	4.0	4.9
Other service workers	8.1	3.5	5.8	6.4	11.9	5.2	11.4	8.4	10.3	10.0	9.2	3.9
Precision production, craft, and repair	5.6	6.9	6.0	7.2	3.7	7.4	4.2	4.2	5.4	5.1	5.3	7.7
Machine operators, assemblers, and inspectors	5.3	6.5	5.8	6.5	2.8	8.1	3.6	3.5	4.9	4.5	5.3	8.5
Transportation and material moving	5.2	7.3	5.7	6.3	3.6	6.6	3.6	4.6	5.1	4.0	4.3	6.4
Handlers, equipment cleaners, helpers & laborers	4.0	6.0	4.3	5.5	2.1	6.0	2.3	2.6	4.0	3.0	3.2	5.6
Farming, forestry, and fishing	0.8	0.7	0.7	0.7	1.0	0.6	1.0	0.6	0.8	0.9	0.9	1.0
Total (percent)	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 jobs (millions)	156	19	18	12	19	14	16	7	21	12	13	5

NOTE: Numbers may not add due to rounding.

SOURCE: Office of Technology Assessment, 1988.

structure of the economy as a whole. The choices reflect decisions made by individual households, by producers, by people looking for work, and by gov-

ernment. The way government choice can influence the directions taken by the economy, for better or for worse, is the subject of the next chapter.