



The Economic Contributions of the Biotechnology Industry to the U.S. Economy

Prepared for the Biotechnology Industry Organization

by



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EXECUTIVE SUMMARY

The biotechnology industry has grown rapidly in recent years, doubling in size between 1993 and 1999. Much attention is given to the potential of the biotechnology industry, from drugs, agricultural and environmental products currently in the pipeline. These products have the potential to generate tremendous opportunities for society, by improving the quality of health care, increasing agricultural production and producing a cleaner environment. No less significant, however, is the fact that the industry clearly makes substantial *current* economic and fiscal contributions to the U.S. economy.

This report presents the estimates of the significant financial contributions of the biotechnology industry to the U.S. economy and to revenues collected by the federal, state and local governments. In 1999, the biotechnology industry generated:

- *437,400 U.S. jobs.* Of these, 150,800 jobs were generated directly by biotechnology companies, while the remaining 286,600 jobs were generated by companies supplying inputs to the industry, or by companies providing goods and services to biotechnology employees.
- *\$47 billion in additional revenues.* Even though the industry as a whole remains unprofitable, biotechnology companies produced revenues of \$20 billion. Companies supplying inputs or selling goods and services to biotech employees generated revenues of \$27 billion.
- *\$11 billion in research & development spending.* This includes research and development conducted by biotechnology firms, but does not include research and development conducted by firms supplying the biotechnology industry with inputs or workers with goods and services.
- *\$10 billion in tax revenues,* including federal, state and local taxes. The largest components of the tax revenues were individual income taxes, social security and property taxes, with a little over two-thirds of total taxes going to the federal government.

The analysis also estimated the contributions generated by publicly traded and private companies and by the agricultural biotechnology sector:

- Publicly traded companies generated 305,100 jobs and \$32 billion in revenues, while privately traded companies generated 132,300 jobs and \$14 billion in revenues, including the contributions of companies supplying inputs to the industry or goods and services to employees.
- Agricultural biotechnology generated 21,900 jobs and about \$2.3 billion in revenues, including the contributions of companies supplying inputs to the industry or goods and services to employees.

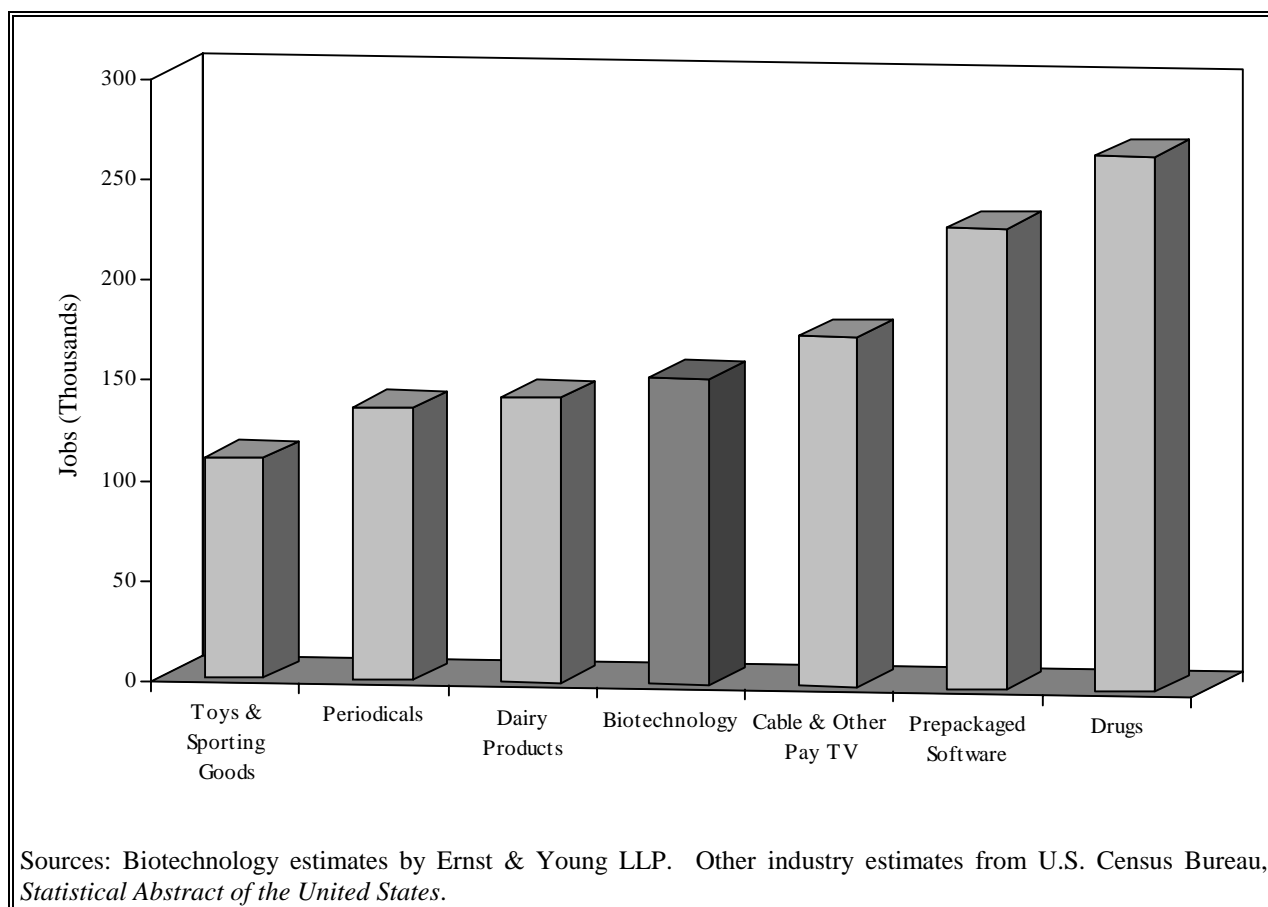
THE ECONOMIC CONTRIBUTIONS OF THE BIOTECHNOLOGY INDUSTRY TO THE U.S. ECONOMY

Introduction

This report estimates the contributions of the biotechnology industry to the U.S. economy and provides detail on the nature and magnitude of the various economic and tax revenue contributions. The analysis here is limited to the financial contributions (revenues, jobs, compensation and taxes generated). It does not include the significant nonfinancial contributions of the industry, from factors such as increased longevity and productivity from health improvements, increased quality of life and increased agricultural productivity. Data sources and methodological details about the analysis can be found in Appendix 1.

The biotechnology industry has grown rapidly, doubling in size from 1993 (\$8 billion in revenues) to 1999 (\$20 billion).¹ As shown in Chart 1, the direct employment of 150,800 American workers in the industry is considerably more than that of the toys and sporting goods industry, and slightly less than the cable television industry. The industry has approximately 100 biotech products on the market with many more in late stage clinical trials.

Chart 1. Employment in Biotechnology and Selected Industries



Given the rapid growth of the biotechnology industry, and its relative infancy, much existing analysis focuses on the future potential of the industry – the products in the pipeline, and potential benefits from improved health care, increased agricultural production and improvement

¹ Ernst & Young LLP, *Annual Biotechnology Industry Reports*, various years.

in the environment. Already, the industry is developing drugs for the fight against cancer, Alzheimer's and Parkinson's diseases, heart disease, diabetes, multiple sclerosis, AIDS, and other fatal or life threatening conditions. Gene therapy offers the potential to supply a patient's cells with healthy copies of missing or defective genes to prevent cancer and other diseases. Agricultural biotechnology promises to increase agricultural production by improving crops' resistance to natural enemies (e.g. insects, disease, weeds and harsh growing conditions) lessening the need for pesticides and other crop inputs. They allow farmers to reduce fuel costs and soil compaction and erosion. Environmental biotechnology products make it possible to clean hazardous waste or control agricultural pests and reduce the use of chemicals.

While these potential benefits will be enormously important, the industry makes significant *current* contributions to the U.S. economy despite its lack of overall profits. Even biotechnology companies that have yet to bring a product to market contribute to national income by engaging in research and development and purchasing inputs from companies such as contract research organizations and equipment manufacturers. Biotechnology firms employ workers, who purchase goods and services in the general economy. The industry also generates significant tax revenues for federal, state and local governments from property taxes, sales and use taxes, income taxes and other taxes.

Industry Definition

The Biotechnology Industry Organization (BIO, the industry's advocacy group) defines biotechnology as "the use of the cellular and molecular processes to solve problems or make products."² Included in this definition of the industry are firms that use cells and biological molecules for applications in medicine, agriculture and environmental management.

This study focuses on the impact of the biotechnology industry on the U.S. economy. It defines biotechnology to include only *U.S.* companies that are *primarily* engaged in biotechnology activities. This industry definition excludes foreign companies and their impact on the U.S. economy. In addition, it generally excludes companies whose primary business is not biotechnology (e.g., large pharmaceutical companies), unless distinct biotechnology divisions of these companies were identified. Chart 2 summarizes the biotechnology segments included and excluded under this definition of the industry.

Chart 2. Biotechnology Industry Segments Included and Excluded in This Report

Included	Excluded*
<ul style="list-style-type: none"> • Medical biotechnology (e.g., Amgen, Genentech) • Agricultural biotechnology (e.g., Mycogen) • Environmental & industrial biotechnology 	<ul style="list-style-type: none"> • Primarily pharmaceuticals (e.g., Merck) • Contract research organizations (e.g., Quintiles) • Equipment manufacturers (e.g., PE Biosystems)

* Excluded from the direct biotechnology industry, but included as applicable in the industry's indirect contributions.

² Biotechnology Industry Organization, "What Is Biotechnology?" <<http://www.bio.org/aboutbio/guide2000/whatis.html>>

Economic Contribution

The biotechnology industry's economic contributions consist of direct, indirect and induced impacts. These are discussed below.

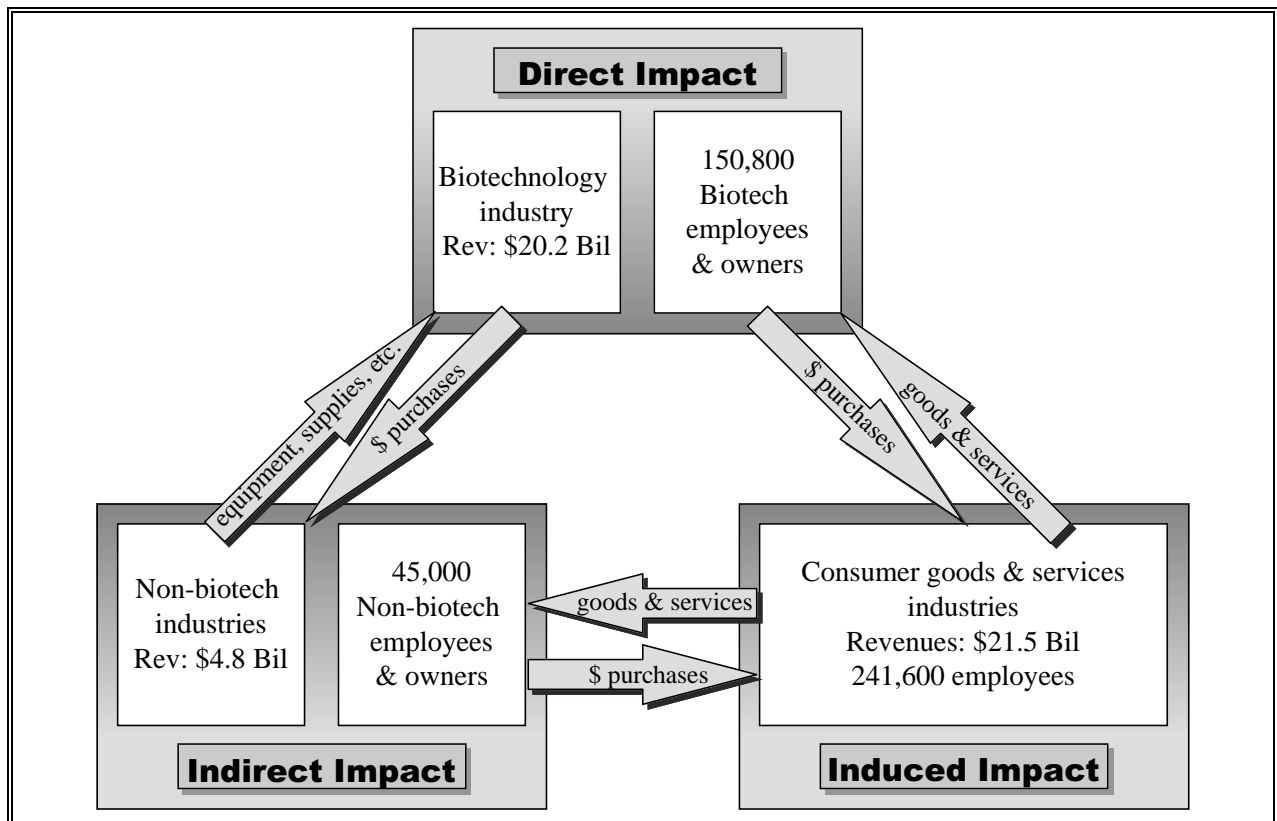
Direct Impact

The direct impact of the biotechnology industry is the economic impact directly attributable to biotechnology firms – their employees, revenues and wages. In 1999, biotechnology firms directly employed about 150,800 workers and produced revenues of \$20 billion (see Table 1). In addition, they paid their employees and owners \$15 billion in personal income.

Indirect and Induced Impacts

In addition to the direct impacts of the biotechnology listed above, the industry generated revenues, jobs, salaries and taxes through a number of indirect and induced impacts. Indirect impacts are the result of purchases made by the biotechnology industry from other industries. To operate, biotechnology companies create economic activity in non-biotechnology companies, such as computer and equipment manufacturers, and contract research organizations. The revenues of these industries that are generated by the activities of the biotechnology industry are called the *indirect impact*. The induced impact of the biotechnology industry is created by the purchases of workers and owners in the biotechnology and supporting industries. These employees and owners purchase goods and services in the general economy with the salaries and capital gains they earn. The revenues generated by these purchases are called the *induced impact*. The sum of the direct, indirect and induced impacts is the total economic impact of the biotechnology industry. These impacts are graphically illustrated in Chart 3.

Chart 3. Direct, Indirect and Induced Economic Impacts



As shown in Table 1, biotechnology companies directly employed 150,800 employees, but their purchases from other companies and the spending of their employees generated an additional 287,000 jobs, so that the total job generation attributable to the biotechnology industry is 437,000. In other words, there is an employment *multiplier* of 2.9, so that each job directly created in the biotechnology industry creates a total of 2.9 jobs, after factoring in the indirect and induced impacts. Similarly, while biotechnology companies directly produce \$20.2 billion in revenues and \$14.8 billion in personal income, their total impact on revenues and personal income in the U.S. economy are \$46.5 billion and \$28.8 billion, respectively.

Table 1. Economic Contribution of the Biotechnology Industry to the U.S. Economy, 1999

Employment	
Direct Impact on Employment	150,800 Jobs
Employment Multiplier	2.9
Total Impact on Employment	437,400 Jobs
Revenues	
Direct Impact on Revenues	\$20.2 Billion
Revenues Multiplier	2.3
Total Impact on Revenues	\$46.5 Billion
Personal Income	
Direct Impact on Personal Income	\$14.8 Billion
Personal Income Multiplier	2.0
Total Impact on Personal Income	\$28.8 Billion

Source: Estimates calculated by Ernst & Young LLP using the IMPLAN model. See corresponding text for definitions of key terms.

Public and Private Companies

As shown in Table 2, publicly traded companies generated most of these contributions. Public companies generated 105,200 jobs, \$14 billion in revenues and \$10 billion in personal income, while their total impact was 305,100 jobs, \$32 billion in revenues and \$20 billion in personal income. By contrast, private firms generated 45,600 jobs, \$6 billion in revenues and \$5 billion in personal income, and their total impact was 132,300 jobs, \$14 billion in revenues and \$9 billion in personal income.

Table 2. Economic Contributions of Public and Private Biotechnology Firms

		Public Firms	Private Firms
Employment:	Direct Impact	105,200 Jobs	45,600 Jobs
	Total Impact	305,100 Jobs	132,300 Jobs
Revenues:	Direct Impact	\$14.1 Billion	\$6.1 Billion
	Total Impact	\$32.4 Billion	\$14.1 Billion
Personal Income:	Direct Impact	\$10.3 Billion	\$4.5 Billion
	Total Impact	\$20.1 Billion	\$8.7 Billion

Agricultural Biotechnology

The contributions of the agricultural biotechnology industry are separately identified in Table 3. In 1999, agricultural biotechnology firms generated 21,900 jobs, \$2.3 billion in revenues and \$1.4 billion in personal income for employees and owners. These estimates include the contributions of biotechnology companies (direct contributions) and those of companies supplying inputs to biotech firms or supplying goods and services to their employees and owners (indirect and induced contributions).

Table 3. Total Contributions of the Agricultural Biotechnology Industry to the U.S. Economy, 1999

Employment	21,900 Jobs
Revenues	\$2.3 Billion
Personal Income	\$1.4 Billion

Source: Estimates calculated by Ernst & Young LLP using the IMPLAN model and data from Standard & Poors. Total contributions include direct, indirect and induced contributions. See Appendix 1 for methodological details.

Tax Revenue Contribution

As shown in Table 4, the biotechnology industry generated \$10 billion in tax revenues in 1999, including \$6.8 billion in federal taxes, \$1.9 billion in state taxes and \$1.2 billion in local taxes.

Table 4. Taxes Generated by the Biotechnology Industry, 1999

Type of Tax	Taxes Collected (\$ Millions)
Federal taxes	\$6,843
State taxes	\$1,900
Local taxes	\$1,215
Total taxes	\$9,958

Federal Taxes

The federal tax revenues generated by the biotechnology industry in 1999 are summarized in Table 5. As shown, the industry generated about \$6.8 billion in federal taxes; the main source of this revenue is individual income taxes paid by employees and owners. Although many biotechnology companies have current net operating losses, biotechnology firms paid about \$600 million in federal corporate income taxes, while companies in other industries paid an additional \$400 million, so that the industry generated almost \$1 billion in corporate income taxes.

Table 5. Federal Taxes Generated by the Biotechnology Industry, 1999

Type of Tax	Taxes Collected (\$ Millions)
Individual income tax	\$3,351
Corporate income tax	\$914
Social security taxes	\$2,331
Excise taxes	\$74
Other taxes	\$173
Total federal taxes	\$6,843

State and Local Taxes

The state and local tax revenues generated by the biotechnology industry in 1999 are summarized in Table 6. As shown, the industry generated about \$1.9 billion in state taxes and \$1.2 billion in local taxes, for a total of \$3.1 billion. The main sources of this revenue are property taxes, individual income taxes paid by employees, and sales and use taxes.

Table 6. State and Local Taxes Generated by the Biotechnology Industry, 1999

Type of Tax	Taxes Collected (\$ Millions)
State Taxes	
Individual income tax	\$649
Corporate income tax	\$112
Sales and use taxes	\$628
Excise taxes	\$288
Other taxes	\$222
Total state taxes	\$1,900
Local Taxes	
Individual income tax	\$61
Corporate income tax	\$10
Sales and use taxes	\$133
Excise taxes	\$61
Property taxes	\$896
Other taxes	\$55
Total local taxes	\$1,216
Total State and Local Taxes	\$3,116

Conclusion

The biotechnology industry has grown rapidly in recent years, essentially doubling in size between 1993 and 1999. The findings of this study document the already significant contribution of this relatively new industry to the overall U.S. economy. In 1999, the combined direct, indirect and induced activities of the biotechnology industry contributed a total of 437,400 jobs and \$47 billion in business revenues to the U.S. economy. The public sector is also benefiting significantly from the biotechnology industry through additional federal, state and local taxes, estimated to be \$10 billion in 1999. With continued advances in genomics research and the accelerating pace of new drug development and approval, the biotechnology industry's economic and fiscal contribution should increase in pace with the expected contributions of biotechnology to the human sciences, agricultural production and environmental quality.

APPENDIX 1: METHODOLOGY AND DATA SOURCES

Industry Definition

The biotechnology industry was defined for this study as U.S. companies that are primarily engaged in biotechnology activities. A list of U.S. public and private companies with a Standard Industrial Classification (SIC) code of 2833, 2834, 2835, 2836 or 8731 was generated. Table 7 lists these industries. This list of companies was then refined as described below. Firms whose primary business was pharmaceuticals were excluded. In many cases, these firms are known to have biotechnology divisions; however, if separate data for these divisions was not located, the entire company was excluded. In addition, equipment manufacturing and contract research organizations (CROs) were excluded. While these companies may be conducting activities in support of the biotechnology industry, their activities are included in the indirect impact estimates.

Table 7. Industries Used in Generating List of Biotechnology Companies

SIC Code	Industry
2833	Medicinal Chemicals and Botanical Products
2834	Pharmaceutical Preparations
2835	In Vitro and In Vivo Diagnostic Substances
2836	Biological Products, Except Diagnostic Substances
8731	Commercial Physical and Biological Research

The primary data sources for the list of biotechnology companies and their employment were the 1999 Ernst & Young report³ and the BIOScan⁴ database. This data was supplemented by industry information from OneSource, Dun & Bradstreet, BioCentury, *Signals* and Standard & Poor's industry reports.

Employment figures could not be located for some private biotechnology companies. Using the assumption that these companies were relatively small, the average number of employees was imputed from actual employment figures for the lowest quintile of biotechnology companies in the database. For companies where sales figures were not available, sales were imputed using the distribution of average sales per employee by SIC category and by employment level from OneSource data and actual or estimated firm employment.⁵

³ Ernst & Young LLP, *Biotech 99: Bridging the Gap, Ernst & Young's 13th Biotechnology Industry Annual Report*. The Ernst & Young Biotechnology Industry Annual Report series is widely regarded as a leading source of comprehensive estimates of the size of the biotechnology industry.

⁴ BIOScan® (February 2000) is a database produced by American Health Consultants. It is updated six times a year and provides current information on companies involved in biotechnology product research and development.

⁵ The employment figures obtained from these databases may include, in some cases, employment outside of the U.S. However, because most U.S. biotechnology companies do not have extensive overseas operations, this difference has a minimal effect on the estimates of the economic impact of the biotechnology industry.

Economic Contribution

The economic contribution of the biotechnology industry was estimated using the IMPLAN model.⁶ This input-output model captures all the relationships between various industries and sectors in the U.S. economy. The economic contribution of the biotechnology industry was estimated by identifying the biotechnology industry, and measuring the reduction in economic activity if there were no biotechnology industry. The contributions of the agricultural biotech, public and private segments were estimated by apportioning the contributions based on their share of employees.

Since biotechnology firms are different from the other (i.e., pharmaceutical and research) companies in these SIC codes, several adjustments were made. All of these adjustments were made based on empirically observed relationships from available data. Sales per worker was reduced to reflect the lower sales per worker ratio in the biotechnology industry (since many biotechnology companies have not yet brought products to market). Profitability was reduced to account for lower sales and higher investment in research and development. Finally, the industry's research and development expenditures were increased, and its advertising expenditures were decreased, since biotechnology companies spend differently on these items relative to pharmaceutical companies.

Tax Revenue Contribution

Federal, state and local governments receive significant additional tax revenue from the economic activity generated by the biotechnology industry. These tax impacts were estimated using the most recently available information on the relationship between U.S. personal income and tax collections by major tax source for each level of government. These ratios were applied to the estimated biotechnology industry's contribution to personal income to estimate tax collections.

Federal Taxes

The ratios of federal taxes to personal income were estimated by dividing 1999 U.S. tax revenues by Bureau of Economic Analysis (BEA) personal income figures. Total federal tax collections were obtained from the *Fiscal Year 2001 Budget of the United States Government, Analytical Perspectives*. Tax impacts were calculated for corporate and individual income taxes, social security taxes, excise taxes and other taxes.⁷

State and Local Taxes

The relationship of state and local taxes to personal income were calculated using state and local government tax collections from the most recent annual edition of the U.S. Bureau of the Census, *Intergovernmental Finances* and BEA personal income figures. The ratios were then applied to the estimated personal income attributable to the biotechnology industry.

⁶ For a more detailed description of IMPLAN and input-output modeling, refer to Appendix 2.

⁷ "Other taxes" includes estate and gift taxes and customs duties on federal funds.

APPENDIX 2: THE IMPLAN ECONOMIC MODEL

The IMPLAN United States Economic Model

The IMPLAN economic impact model was used to estimate the economic and tax contributions of the biotechnology industry to the U.S. economy. The model, which is licensed by the Minnesota IMPLAN Group, Inc., was developed over a period of eight years at the University of Minnesota. IMPLAN is used by more than 500 universities and government agencies to estimate the economic and fiscal impacts of investments and/or changes in industry employment. IMPLAN is an economic impact assessment modeling system that estimates the national, private-sector impacts of economic changes.

IMPLAN Economic Impact Analysis

An IMPLAN impact analysis involves specifying one or more economic changes, such as investments in buildings and equipment, and increases or decreases in employment. The model then uses the relationships between the various industries and sectors in the economy to calculate the additional indirect and induced economic impacts associated with the initial change. The key component is identifying the expenditures in terms of their sectoral impacts.

The notion of a multiplier rests upon the difference between the initial (direct) effect of a change and the total (direct, indirect and induced) effects of that change. Direct effects are production changes associated with the immediate effects or final demand changes. Indirect effects are production changes in backward-linked industries caused by the changing input needs of directly affected industries (e.g., additional purchases from equipment manufacturers by the biotechnology industry). Induced effects are the changes in regional household spending caused by changes in household income generated from the direct and indirect effects (e.g., purchases of goods and services by biotechnology workers).

IMPLAN is an input-output model. Input-output accounting describes commodity flows from producers to intermediate and final consumers. The total industry purchases of commodities, services, employment compensation, value added, and imports is equal to the value of the commodities produced. Purchases for final use (final demand) drive the model. Industries producing goods and services for final demand purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the jurisdiction (imports and taxes) stop the cycle.

The model summarizes these complex interactions as economic multipliers, which can be used to estimate the total economic impact of the employment, sales and taxes generated by the biotechnology industry.