

Chapter 9

Employment Impacts Update

EPA is currently revising its guidance for assessing the employment impacts of environmental regulation. Section 9.2.3.3 “Impacts on employment” will be replaced with a discussion based on more recent literature and feedback from the Economy Wide Modeling Science Advisory Board Panel.ⁱ The new section will summarize the theory and methods for assessing employment impacts. Please note that subsequent to publication of the current Section 9.2.3.3, researchers attempted to replicate and extend the empirical estimates in Morgenstern, et al. (2002).ⁱⁱ However, as Belova, et al. (2013) note, “the original datasets and data management code used by MPS [Morgenstern, et al. (2002)] in the Census Research Data Center were not available to us because of the failure of the backup drive at the Census on which they had been archived.” In light of this loss, replication attempts were not successful (Belova et al. 2013, 2015).ⁱⁱⁱ In preparing economic analyses, analysts should not rely on the empirical estimates from Morgenstern, et al. (2002). Likewise, analysts should not rely on the estimates from Belova et al. (2013, 2015) as the authors “recommend that EPA refrain from using these results until the underlying cause(s) for the implausibly large estimates in the employment effects found in Belova et al. (2013a) are uncovered and resolved.”^{iv}

While EPA is awaiting the Science Advisory Board Panel report and continuing to explore recent areas of the literature, analysts are encouraged to look at recent EPA Regulatory Impact Analyses (RIAs) for best available methods and approaches for conducting employment impact analyses. Recent RIAs include those for the final Clean Power Plan published in August 2015,^v the Residential Wood Heater New Source Performance Standard in February 2015,^{vi} and the final Tier 3 Vehicle Emission and Fuel Standards Program in March 2014.^{vii} These employment impact analyses contain an updated description of theoretic models and empirical methods that are more reflective of what will be incorporated into the employment impacts update to the *Guidelines*. Please contact EPA’s National Center for Environmental Economics with any questions.

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- ⁱ For more information please see
<http://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebProjectsCurrentBOARD/07E67CF77B54734285257BB0004F87ED?OpenDocument>
- ⁱⁱ Morgenstern, R.D., W.A. Pizer, and J. Shih. 2002. Jobs Versus the Environment: An Industry Level Perspective. *Journal of Environmental Economics and Management* 43: 412-436.
- ⁱⁱⁱ Belova, A., W.B. Gray, J. Linn, and R.D. Morgenstern. 2013. Environmental Regulation and Industry Employment: A Reassessment. Discussion Papers, U.S. Census Bureau, Center for Economic Studies 2K132B, 4600 Silver Hill Road, Washington, DC 20233.
- Belova, A., W.B. Gray, J. Linn, R.D. Morgenstern, and W. Pizer. 2015. Estimating the Job Impacts of Environmental Regulation. *Journal of Benefit-Cost Analysis*, 6(2), pp 325 – 340.
- ^{iv} Quote is from Belova et al. (2015). Note that Belova et al. (2013a) in the quote is identical with Belova et al. (2013) cited above.
- ^v See Chapter 6 of the RIA (EPA-HQ-OAR-2013-0602 at <https://www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis>).
- ^{vi} See Chapter 5, Section 5.7 of the RIA (EPA-452/R-15-001 at <https://www.epa.gov/sites/production/files/2015-02/documents/20150204-residential-wood-heaters-ria.pdf>).
- ^{vii} See Chapter 9 of the RIA (EPA-420-R-14-005 at <https://www3.epa.gov/otaq/documents/tier3/420r14005.pdf>).

Chapter 9

Economic Impact Analysis

The detailed study of regulatory consequences allows policy makers to fully understand a regulation's impacts, and to make an informed decision on its appropriateness. Economic information is necessary for the evaluation of at least two types of consequences of a regulatory policy: the regulation's efficiency, and its distributional effects. In principle, both could be estimated simultaneously using a general equilibrium model. In practice however, they are usually estimated separately.

The distributional effects of environmental regulations can be examined through an economic impact analysis (EIA). A related analysis, called an equity assessment, addresses the distribution of impacts across individuals and households, with particular attention to economically or historically disadvantaged or vulnerable groups (e.g., low-income households, racial or ethnic minorities, and young children). Equity assessments are sometimes referred to as environmental justice (EJ) analyses and are the subject of Chapter 10.

An EIA identifies the specific entities that benefit from or are harmed by a policy, and then estimates the magnitude of their gains and losses including changes in profitability, employment, prices, government revenues or expenditures, and trade balances. These estimates are derived from a study of the economic changes that occur across broadly-defined economic sectors of society, including industry, government, and not-for-profit organizations, but may also include more narrowly defined sectors within these broad categories, such as the solid waste industry or even an individual solid waste company. EIAs can measure a broad variety of impacts, such as direct impacts on individual plants, whole firms, and industrial sectors, as well as indirect impacts on consumers and suppliers.

9.1 Statutes and Policies

The following major statutes and EOs, all described in Chapter 2, directly address impact analyses:¹

- Regulatory Flexibility Act of 1980 (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA);
- Unfunded Mandates Reform Act of 1995 (UMRA);
- EO 13132, "Federalism";
- EO 13175, "Consultation and Coordination with Indian Tribal Governments;" and
- EO 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use."

Together with OMB's *Circular A-4*, they raise important dimensions relevant for economic impact analyses as summarized in Table 9.1.

¹ EPA's Regulatory Management Division's Action Development Process (ADP) Library (<http://intranet.epa.gov/adplibrary>) is a resource for those who wish to access relevant statutes, EOs, or Agency policy and guidance documents in their entirety.

Table 9.1 - Potentially Relevant Dimensions to Economic Impact Analyses²

Dimension	Statute, Order, or Directive	Entity	Subpopulation
Sector	UMRA; EO 13132; OMB <i>Circular A-4</i>	Industry or government	Industries or state, local, or tribal governments
Entity size	RFA; UMRA; OMB <i>Circular A-4</i>	Businesses, governments, or not-for-profit organizations	Small businesses, small governmental jurisdictions, or small not-for-profit organizations
Time	OMB <i>Circular A-4</i>	Individuals or households	Current or future generations
Geography	OMB <i>Circular A-4</i> ; UMRA	Region	Regions, states, counties, or non-attainment areas
Energy	EO 13211	Entities that use, distribute, or generate energy	Energy sector

The term “affected” is used throughout this chapter as a general term. Analysts should be aware that the authorizing statute for the rule, as well as other applicable statutes and administrative orders noted in this chapter, may make more specific use of this term. For example, the Regulatory Flexibility Act includes the clause “subject to the requirements of the rule” when quantifying economic impacts, meaning that the analysis considers only those entities that are directly regulated by the rule. On the other hand, provisions in the UMRA and EO 12866 address both direct and indirect impacts, and therefore define the affected population more broadly. Care should be taken to avoid double counting when estimating direct and indirect impacts.

9.2 Conducting an Economic Impact Analysis

There are three important distinctions between BCA and EIA to keep in mind when conducting an EIA.³ First, total social benefits and total social costs are not of primary importance in an EIA, as they are in a BCA. Rather, the main focus is on the components and distribution of the total social benefits and costs.

Second, transfers of economic welfare from one group to another are no longer assumed to cancel each other out, as they do in a BCA. Taxpayers, consumers, producers, governments, and the many sub-categories of these groups are all considered separately. While a BCA relies on estimates of the social benefits and costs of a regulation, an EIA focuses on the private benefits and costs associated with compliance responses. The EIA should use the same “starting point” as the BCA (i.e., same engineering or direct compliance costs, same benefit categories, etc.) for developing private benefit and cost estimates. In addition, some adjustments to these costs may be needed, as discussed below. For example, the tax status of a required piece of equipment is considered in private costs, but not in social costs.

Finally, there is a greater need for disaggregation in EIAs than in BCAs. Results may be presented for specific counties or other geographic units or types of entities, as appropriate, placing heavy demands on the modeling framework.

For any regulation, it is essential to ensure consistency between the EIA and the benefit-cost analysis (BCA). If a BCA is conducted, the corresponding EIA must be conducted within the same set of analytical assumptions. To the extent possible, adjustments to these assumptions or to the overall modeling framework used for the BCA should only be made when absolutely necessary, and then should be noted clearly in the text of the analysis.

² Some environmental statutes may also identify subpopulations that merit additional consideration. This document is limited to those statutes with broad coverage.

³ Traditionally, EIAs focus on the costs of a particular rule or regulation. However, it is also possible to focus on the distribution of benefits or to calculate the net benefits for particular entities.

9.2.1 Screening for Potentially Significant Impacts

A comprehensive analysis of all aspects of all economic impacts associated with a rule can require significant time and resources, and its accuracy and thoroughness depend on the quality and quantity of available data. Thus, screening analyses are often employed to determine data availability, the severity of a rule's anticipated impacts, and the potential consequences of further analysis if undertaking it would require a delay in the regulatory schedule. A screening analysis can be thought of as a "mini-EIA" consisting of a rough examination of the data to identify sectors that may warrant further analysis.⁴ Screening is effective for identifying the magnitude of the overall level of impacts on the regulated industry, but may fail to identify potentially large impacts on a single sector, region, or facility.

There are no established definitions for what constitutes a large or a small impact. However, a screening analysis is a tiered approach that initially captures most of the possible impacts (i.e., allows for many false positives) followed by a more detailed analysis that can help eliminate unfounded impacts. In this way, the screening analysis will eventually balance the risk of identifying "false positives" and "false negatives."

9.2.2 Profile of Affected Entities

Analysts should consider changes imposed by the rule in the regulated industry, as well as how related industries may be affected. Some industries may benefit from the regulation, while others may be subject to significant costs. If the regulation causes a firm to use different inputs or new technologies, then the producers of the new inputs will gain, while the producers of the old inputs will suffer. Developing a detailed industry profile will identify those industries that may be affected positively and negatively by the regulation.

⁴ The screening analysis discussed in this section is distinct from the screening analysis required to comply with the Regulatory Flexibility Act (as referred to in Section 9.3).

9.2.2.1 Compiling an Industry Profile and Projected Baseline

To determine the impacts of a particular regulation the analyst must understand the underlying structure of the affected industry and its various linkages throughout the economy.⁵ This includes an understanding of the condition of the industry in terms of its finances and structure in the absence of the rule—the baseline of the EIA. A rule may impose different requirements and costs on new versus existing entities. Such rules may affect industry competition, growth, and innovation by raising barriers to new entry or encouraging continued use of outdated technology. Thus, a substantial portion of an EIA involves characterizing the state of the affected firms and industries in the absence of the rule as a basis for evaluating economic impacts.

The following are important inputs to defining an industry profile:

- **North American Industrial Classification System (NAICS) industry codes.** NAICS has replaced the U.S. Standard Industrial Classification (SIC) system in the U.S. Department of Commerce (DOC) Economic Census and other official U.S. Government statistics. NAICS was developed to provide comparable statistics about business activity across North America. It identifies hundreds of new, emerging, and advanced technology industries and reorganizes existing industries into more meaningful sectors, particularly in the service sector.⁶
- **Industry summary statistics.** Summary statistics of total employment, revenue, number of establishments, number of firms, and size of firms are available from U.S. DOC Economic Census or the Small Business Administration.⁷

⁵ Generally, analysts should initially assume a perfectly competitive market structure. One of the primary purposes of developing an industry profile is to confirm this assumption or discover evidence to the contrary.

⁶ For more information see www.census.gov/epcd/www/naics.html, which includes a NAICS/SIC correspondence (accessed on January 21, 2011).

⁷ See www.sba.gov/advocacy/849 for more information (accessed on January 21, 2011).

- **Baseline industry structure.** Industry-level impacts depend on the competitive structure and organization of the industry and the industry's relationship to other economic entities. The number and size distribution of firms/facilities and the degree of vertical integration within the industry are important aspects of industry structure that affect the economic impact of regulations.
- **Baseline industry growth and financial condition.** Industries and firms that are relatively profitable in the baseline will be better able to absorb new compliance costs or take advantage of potential benefits without experiencing financial distress. Industries that are enjoying strong growth may be better able to recover increased costs through price increases than they would if there were no demand growth. Section 9.3.3.3 provides suggestions for using financial ratios to assess the significance of economic impacts on a firm's financial condition.
- **Characteristics of supply and demand.** Assessing the likelihood of changes in production and prices requires information on the characteristics of supply and demand in the affected industries. The relevant characteristics are reflected in price elasticities of supply and demand, which, if available, allow direct quantitative analysis of changes in prices and production. Often, reliable estimates of elasticities are not available and the analysis of industry-level adjustments must rely on simplifying assumptions and qualitative assessments. See Appendix A for a discussion of elasticities.

9.2.2.2 Profile of Government Entities and Not-for-Profit Organizations

Analysts should carefully consider whether a particular rule will directly affect government entities, not-for-profit organizations, or households.⁸ For example, air pollution regulations

that apply to power plants may affect government entities such as municipally-owned electric companies. Air regulations that apply to vehicles may affect municipal buses, police cars, and public works vehicles. Effluent guidelines for machinery repair activities may affect municipal garages. The profile of these affected entities should include a brief description of relevant factors or characteristics.

Relevant factors for *government entities* may include:

- Number of people living in the community;
- Property values;
- Household income levels (e.g, median, income range);
- Number of children;
- Number of elderly residents;
- Unemployment rate;
- Revenue amounts by source; and
- Credit or bond rating of the community.

If property taxes are the major revenue source, then the assessed value of property in the community and the percentage of this assessed value represented by residential versus commercial and industrial property should be determined. If a government entity serves multiple communities, such as a regional water or sewer authority, then relevant information should be collected for all the communities covered by the government entity. Socioeconomic factors influence demands on state or local government resources; for example a high proportion of children means more educational resources.

Data on community size, income, number of children and elderly, and unemployment levels are available from the U.S. Census Bureau. Data on property values, amount of revenue collected from each revenue source, and credit rating may be available from the community or state finance agencies. Most county websites provide information on property values. Private companies, such as Standard and Poor's (S&P), or Fitch's, provide community credit ratings.

⁸ Government entities that may be affected include states, cities, counties, townships, water authorities, villages, Indian Tribes, special districts, and military bases. Not-for-profit entities that may be affected include not-for-profit hospitals, colleges, universities, and research institutions.

Depending on the number of communities affected and the level of detail warranted, the analysis may rely on generally available aggregate data only. In other cases, a survey of affected communities may be necessary.⁹

Relevant characteristics of *not-for-profit* entities include:

- Entity size and size of community served;
- Goods or services provided;
- Operating costs; and
- Amount and sources of revenue.

If the entity is raising its revenues through user fees or charging a price for its goods or services (such as university tuition), then the income levels of its clientele are relevant. If the entity relies on contributions, then it would be helpful to know the financial and demographic characteristics of its contributors and beneficiaries. If it relies on government funding (such as Medicaid) then possible future changes in these programs should be identified.

9.2.2.3 Profile of Small Entities

Small entities include small businesses, small governments and small not-for-profit institutions. While these entities may require special considerations, as detailed below, the profiling of them should follow the same steps as discussed above.

9.2.2.4 Data Sources for Profiles

Profiles generally rely on information from the following sources: websites for affected communities, industry trade publications, and the U.S. Census Bureau.¹⁰ Relevant literature can be useful in characterizing industry activities and markets as well as regulations that already affect the industry. Relevant literature can usually be efficiently identified through a computerized

search using on-line services such as Dialog, BRS/Search Services, Dow Jones News/Retrieval, or EconLit. These on-line services contain more than 800 databases covering business, economic, and scientific topic areas. Table 9.2 describes some commonly used data sources for retrieving quantitative data.¹¹

The industry profile may also identify situations where insufficient data are available from standard sources. This situation could potentially arise when the affected industry has many product lines or activities affected by the rule. In addition, for some rules it may be difficult to identify the appropriate NAICS industry for all the firms or facilities affected by the rule if the industry can be categorized in multiple ways. In these cases, and particularly if facility-level data are required to estimate economic impacts, a survey of affected facilities may be required to provide sufficient data for analysis.

9.2.3 Detailing Impacts on Industry

This section explains how to determine the impact on individual plants or businesses so as to identify whether a particular plant or industry is likely to bear a disproportionate portion of the costs or benefits of a regulation.

9.2.3.1 Impacts on Prices

Predicted impacts on prices form the basis for determining how compliance costs are distributed between the directly-affected firms, their customers, and other related parties in a typical market. At one extreme, regulated firms may not be able to raise prices at all, and would consequently bear the entire burden of the added costs in the form of reduced profits. Reduced profits may result from reduced earnings on continuing production, lost profits on products or services that are no longer produced, or some combination of the two.

9 In cases where a survey is needed, care should be taken to comply with the requirements of the Paperwork Reduction Act (PRA) (44 U.S.C. 3501).

10 Academic literature may or may not contain quantitative data.

11 The Thomas Registry (www.thomasnet.com) is a source of qualitative information on manufacturing companies in the United States (accessed on January 21, 2011). In addition, Lavin (1992) provides sources of business information.

Table 9.2 - Commonly Used Profile Sources for Quantitative Data

Source	Data
Trade Publications and Associations	Market and technological trends, sales, location, regulatory events, ownership changes
U.S. Department of Commerce, Economic Census (www.census.gov)	Sales, receipts, value of shipments, payroll, number of employees, number of establishments, value added, cost of materials, capital expenditures by sector, household and community characteristics
U.S. Department of Commerce, <i>U.S. Industry & Trade Outlook</i> (http://www.ita.doc.gov/td/industry/OTEA/outlook/ or http://outlook.gov/)	Description of industry, trends, international competitiveness, regulatory events
U.S. Department of Commerce, <i>Pollution Abatement Costs and Expenditures Survey</i> (www.census.gov/mcd)	Pollution abatement costs for manufacturing facilities by industry, state, and region
U.S. Department of Commerce, <i>Census of Governments</i> (www.census.gov/govs/index.html)	Revenue, expenditures debt, employment, payroll, assets for counties, cities, townships, school districts
United Nations, International Trade Statistics Yearbook	Foreign trade volumes for selected commodities, major trading partners
Risk Management Association, <i>Annual Statement Studies</i> (www.rmahg.org/ann_studies/asstudies.html)	Income statement and balance sheet summaries, profitability, debt burden and other financial ratios, all expressed in quartiles and available for recent years (based on loan applicants only)
Dun & Bradstreet Information Services (www.dnb.com/us/)	Type of establishment, NAICS code, address, facility and parent firm revenues and employment
Standard & Poors (www.standardandpoors.com)	Publicly-held firms, prices, dividends, and earnings, line-of-business and geographic segment information, S&P ratings, quarterly history (10 years), income statement, ratio, cash flow and balance sheet analyses and trends
Securities and Exchange Commission Filings and Forms (EDGAR System Database) (www.sec.gov/edgar.shtml)	Income statement and balance sheet, working capital, cost of capital, employment, outlook, regulatory history, foreign competition, lines of business, ownership and subsidiaries, mergers and acquisitions
Value Line <i>Industry Reports</i>	Industry overviews, company descriptions and outlook, performance measures

Suppliers to the directly-affected firms might bear part of the burden in lost earnings if the regulation results in a decline in demand for particular products.¹² At the other extreme, firms may be able to raise prices enough to recover costs fully. In this case, there is no impact on the profitability of the directly-

affected firms but their customers bear the burden of increased prices. Assuming perfect competition, the amount of price pass-through depends on the relative elasticity of supply and demand. Another economic impact to consider is the potential backward shifting of regulatory costs (e.g., lowering wages of workers).

¹² For example, regulations limiting SO₂ emissions may result in reduced demand for high-sulfur coal, which results in a fall in the price of such coal and lost profits for its producers. While there is no clear rule for how far down the chain of effects one needs to consider, it is important to address effects that are likely to be substantial.

In general, the likelihood that price increases will occur can be evaluated by considering whether competitive conditions allow the affected facilities to pass their costs on to consumers.

The methods used to conduct the analysis of the directly-affected markets depend on the availability of appropriate estimates of supply and demand elasticities.¹³ As noted above, in cases where reliable estimates of elasticities are not available, the analyst must rely on a more basic investigation of the characteristics of supply and demand in the affected market to reach a conclusion about the likelihood of full or partial pass-through of costs via price increases. An examination of the number of firms, quantity of a product produced, and industry size will provide basic information about supply and demand. If an industry is highly concentrated with few producers then firms may be able to easily pass costs on to households and a 100 percent pass-through assumption may be justifiable. Of course, an industry with many producers would mean the opposite assumption.

9.2.3.2 Impacts on Production

Abatement costs tend to be only a small fraction of total manufacturing revenues. As such, even small changes in wage rates, materials costs, or capital costs are likely to have a much larger effect on manufacturing industries than any changes in environmental regulation. The U.S. Census Bureau collects data on pollution abatement capital expenditures and operating costs incurred to comply with local, state, and federal regulations and on voluntary or market-driven pollution abatement activities.¹⁴ According to the 2005 PACE Survey, the U.S. manufacturing sector spent approximately \$20.7 billion dollars on pollution abatement operating costs. This figure represents less than 1 percent of the sector's total revenue, which is similar to the historical average. Moreover, every manufacturing industry, including the most highly regulated ones, spend less than 1.2 percent of their revenues on pollution abatement. Figure 9.1 presents data for the five industries with the highest pollution abatement operating costs (PAOC) as a percent of total revenues.

Figure 9.1 - Pollution Abatement Costs as a Percentage of Total Revenues for Industries with Highest Pollution Abatement Costs in 2005

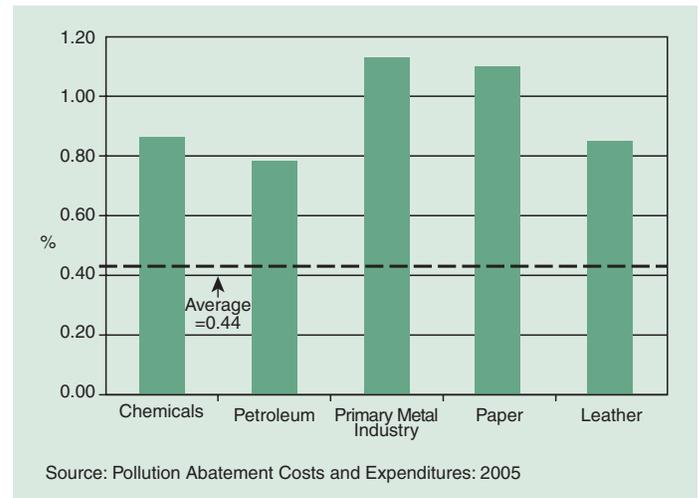
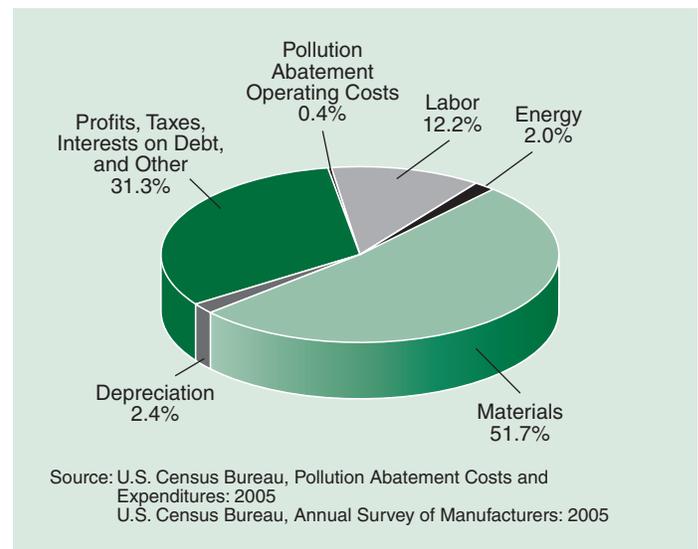


Figure 9.2 - Pollution Abatement Costs are a very Small Percentage of Total Manufacturing Costs



Considering the historical data, it is unlikely that the typical pollution control regulation will sufficiently increase the cost of doing business so as to make a meaningful part of production unprofitable, or will significantly reduce the quantity of output demanded as producers raise their prices to maintain profitability. Figure 9.2 shows the relative magnitude of each cost category for the manufacturing sector. Based on these relative magnitudes, reducing abatement costs by 10 percent will only reduce the total costs faced by industry by less than 1 tenth of 1 percent. Conversely, lowering material costs by 10 percent will reduce total costs by just over 5 percent as

¹³ See Appendix A for a more complete discussion of elasticity.

¹⁴ More detail on the PACE Survey is available at <http://yosemite.epa.gov/ee/epa/eed.nsf/pages/pace2005.html> (accessed March 13, 2011).

material costs were roughly 50 percent of revenues in 2005. Exceptions may be regulations banning the sale or manufacture of a specific product (e.g., a chemical ban) or when a production process is made obsolete. In these situations, the analyst should assess whether the existing plants have other profitable uses.

9.2.3.3 Impacts on employment

The chapters on benefits (Chapter 7) and costs (Chapter 8) point out that regulatory-induced employment impacts are not, in general, relevant for a BCA. For most situations, employment impacts should not be included in the formal BCA.¹⁵ However, if desired the analyst can assess the employment impacts of a regulation as part of an EIA. If this task is undertaken, the analyst needs to quantify all of the employment impacts, positive and negative, to present a complete picture of the effects. This section identifies pitfalls often encountered when performing an EIA and discusses the preferred approaches for conducting one.

Many analyses only present the employment effect on the regulated industry as a result of higher regulatory compliance costs. In doing so, these analyses make simplifying assumptions that employment in a given industry is proportional to output, i.e., if production goes down by 1 percent, employment goes down by 1 percent. These limited assessments on employment impacts from regulation examine how higher manufacturing costs lead to fewer sales and therefore lower employment in that sector. However, empirical and theoretical modeling suggests that these simplified relationships are faulty and should not be used.

In fact, it is not even clear that employment in the regulated industry goes down as a result of environmental regulation. Morgenstern et al. (2002) decompose the labor consequences in an industry facing increased abatement costs. They identify three separate components:

¹⁵ Appendix C discusses long-term, structural employment changes brought on by land clean up and reuse or other policies that may have a benefit component to them.

- **Demand effect:** Higher production costs raise market prices. Higher prices reduce consumption (and production) reducing demand for labor within the regulated industry;
- **Cost effect:** As production costs increase, plants use more of all inputs including labor to produce the same level of output. For example, pollution abatement activities require additional labor services to produce the same level of output; and
- **Factor-shift effect:** Post-regulation production technologies may be more or less labor intensive (i.e., more/less labor is required per dollar of output).

Morgenstern et al. empirically estimate this model for four highly polluting/regulated industries to examine the effect of higher abatement costs from regulation on employment. They conclude that increased abatement expenditures generally do not cause a significant change in employment. Specifically, their results show that, on average across the industries they consider, each additional \$1 million of spending on pollution abatement results in a (*statistically insignificant*) net increase of 1.5 jobs. However, they find that for two of their four industries (pulp and paper, and steel) additional abatement spending leads to a *statistically significant*, yet quite small, net increase in jobs due to the substitution of labor for other inputs and relatively inelastic estimated demand for their output.¹⁶

Finally, one effect that Morgenstern et al. do not consider is the effect regulation has on employment in industries that make substitute products, often cleaner products. Demand for these products increases as consumers respond to changes in costs. For example, more expensive virgin paper will cause a shift to more recycled paper. The recycled paper industry will employ more workers as sales increase. Similarly, employment in industries that are complements

¹⁶ These results are similar to Berman and Bui (2001) who find that while sharply increased air quality regulation in Los Angeles to reduce NOx emissions resulted in large abatement costs they did not result in substantially reduced employment.

may decrease. The analyst should also take these effects into consideration when analyzing the effect of regulations on employment.

In addition to the changes in the regulated industry as modeled by Morgenstern et al., the analyst should assess the increased employment in the environmental protection industry. The engineering analysis may provide some data on the labor required to design, build, install (and in some cases operate) the pollution control equipment. For example, a recent study by Industrial Economics Inc. shows that a \$19 million order for a new scrubber will immediately fund 77 to 91 new jobs for a year constructing and installing the new equipment. It will also create 16 permanent jobs to operate the new equipment (Price et al. 2010).

9.2.3.4 Impacts on Profitability and Plant Closures

In other cases, analysts may assess the impacts of rules on the profitability of specific firms or industry segments and identify potential plant closures based on a financial analysis. If partial or full plant closures are projected, then it is important to consider whether the production lost at the affected facilities will be shifted to other existing plants or to new sources, or simply vanish. If excess industry capacity exists in the baseline and facilities are able to operate profitably while complying with the rule, then these facilities may expand production to meet the demand created by the loss of plants that are no longer able to operate profitably. Some surviving plants could experience increases in production, capacity utilization, and profits even though they are subjected to regulatory requirements, if their competitors face even greater cost increases.

9.2.3.5 Impacts on Related Industries

The economic and financial impacts of regulatory actions spread to industries and communities that are linked to the regulated industries and to the pollution abatement industries, resulting in indirect business impacts. To build scrubbers, the environmental protection industry will order more

steel. If a plant produces less, it will order fewer raw materials. These indirect impacts may include employment and income gains and losses.

Although in principle every economic entity can be thought of as having a connection with every other entity, practical considerations usually require an analysis of indirect impacts for a manageable subset of economic entities that are most strongly linked to the regulated entity. In addition to considering major customers and specialized suppliers of the affected industry, it is important to consider less obvious but potentially significant links, such as basic suppliers like electricity generators.

For these reasons, the analysis of linkages should use a framework that thoroughly measures indirect as well as direct linkages. Whatever the approach, the goal of the analysis is to measure how employment, competitiveness, and income are likely to change for related entities and households given a certain amount of employment, competitiveness, and income in a regulated market.

9.2.3.6 Impacts on Economic Growth and Technical Inefficiency

While regulatory interventions can theoretically lead to macroeconomic impacts, such as growth and technical efficiency, such impacts may be impossible to observe or predict. In some cases, however, it may be feasible to use macroeconomic models to evaluate the regulatory impact on GDP, factor payments, inflation, and aggregate employment. For regulations that are expected to have significant impacts in a particular region, use of regional models, either general equilibrium or other regionally-based models, may be valuable.¹⁷

Typically in regulatory impact analyses some macroeconomic regulatory effects go unquantified due to analytic constraints. For example, price changes induced by a regulation can lead to technical inefficiency because firms are not choosing the production techniques that minimize

¹⁷ Chapter 8 discusses the use of regional modeling.

the use of labor and other resources in the long run. However, measuring these effects can be difficult due to data or other analytical limitations.

9.2.3.7 Impacts on Industry Competitiveness

Regulatory actions that substantially change the structure or conduct of firms can produce indirect impacts by changing the competitiveness of the regulated industry, as well as that of linked industries.¹⁸ An analysis of impacts on competitiveness begins by examining barriers to entry and market concentration, and by answering the following two key questions:

- **Does the regulation erect entry barriers that might reduce innovation by impeding new entrants into the market?** High sunk costs associated with capital costs of compliance or compliance determination and familiarization would be an entry barrier attributable to the regulation. Sunk costs are fixed costs that cannot be recovered in liquidation; they can be calculated by subtracting the liquidation value of assets from the acquisition cost of assets facing a new entrant, on an after-tax basis.¹⁹ Lack of access to debt or equity markets to finance fixed costs of entering the market can also present entry barriers, even if none of the fixed costs are sunk costs. However, if financing is available and fixed costs are recoverable in liquidation, the magnitude of fixed costs alone may not be sufficient to be a barrier to entry.
- **Does the regulation tend to create or enhance market power and reduce the economic efficiency of the market?** Important measures of competitiveness of an industry are degrees of horizontal and vertical integration (i.e., concentration) between both buyers and sellers in the baseline compared to post-compliance. If an industry becomes more concentrated as a result of the regulation then there are fewer firms within the industry. In this case, market power will be concentrated in the hands of a few entities,

which may result in a less efficient market than before the regulation. Closely related to concentration, product differentiation may occasionally either increase or decrease due to a regulatory action. A regulation may result in less product differentiation due to restrictions on production. This could mean that market power is more concentrated among the firms that manufacture the product.

9.2.3.8 Impacts on Energy Supply, Distribution, or Use

EO 13211 requires agencies to prepare a Statement of Energy for “significant energy actions,” which are defined as significant regulatory actions (under EO 12866) that also are “likely to have a significant adverse effect on the supply, distribution, or use of energy.”²⁰ These significant adverse effects are defined as:

- Reductions in crude oil supply in excess of 10,000 barrels per day;
- Reductions in fuel production in excess of 4,000 barrels per day;
- Reductions in coal production in excess of 5 million tons per year;
- Reductions in natural gas production in excess of 25 million mcf per year;
- Reductions in electricity production in excess of 1 billion kilowatt-hours per year or in excess of 500 megawatts of installed capacity;
- Increases in energy use required by the regulatory action that exceed any of the thresholds above;
- Increases in the cost of energy production in excess of 1 percent;
- Increases in the cost of energy distribution in excess of 1 percent; or
- Other similarly adverse outcomes.

For actions that may be significant under EO 12866, particularly for those that impose requirements on the energy sector, analysts must be prepared to examine the energy effects listed above.

¹⁸ See Jaffe et al. (1995) for an overview.

¹⁹ Sunk costs are sometimes referred to as exit barriers.

²⁰ See Section 2.1.6 for EPA and OMB’s guidance on EO 13211.

9.2.4 Detailing Impacts on Governments and Not-for-Profit Organizations

Section 9.3.5 discusses how to measure the impact of regulations and requirements on private entities, such as firms and manufacturing facilities. When dealing with private entities, an important focus is on measures that assess changes in profits (or proxy measures of profit). This section describes impact measures for situations where profits and profitability are not the focus of the analysis. Rather, the ultimate measure of impacts is the ability of the organization or its residents to pay for the requirements. Many of the same questions apply:

- Which entities are affected and what are their characteristics?
- To what extent does the regulation increase operating costs?
- To what extent does the regulation impact operating procedures?
- Does the regulation change the amount and/or quality of the goods and services provided?
- Can the entity raise the necessary capital to comply with the regulation?
- Does the regulation change the entity's ability to raise capital for other projects?

EPA regulations can affect governments and not-for-profit organizations in at least three significant ways. First, a regulation may directly impose requirements on the entity, such as imposing water pollution requirements for publicly-owned wastewater treatment works, or initiating air pollution restrictions that affect municipal bus systems or power plants. Second, a regulation may impose implementation and enforcement costs on government agencies. Finally, a regulation may impose indirect costs. For example increased unemployment due to reduced production (or even plant closure) could result in less tax revenues in a community.

9.2.4.1 Direct Impacts on Government and Not-for-Profit Entities

Direct impact measures can fall into two categories:

- Those that measure the impact itself in terms of the relative size of the costs and the burden it places on residents; and
- Those that measure the economic and financial conditions of the entity that affect its ability to pay for the requirements.

For each category, there are several types of measures that can be used either as alternatives or jointly to illuminate aspects of the direct impacts.

Measuring the relative cost and burden of the regulations

There are three commonly used approaches to measuring the direct burden of a rule; all involve calculating the annualized costs of complying with the regulation. For government entities the three approaches are:

- **Annualized compliance costs as a percentage of annual costs for the affected service.** This measure defines the impact as narrowly as possible and measures impacts according to the increase in costs to the entity. In practice, EPA has often defined compliance costs that are less than 1 percent of the current annual costs of the activity as placing a small burden on the entity.
- **Annualized compliance costs as a percentage of annual revenues of the governmental unit.** The second measure corresponds to the commonly used private-sector measure of annualized compliance costs as a percentage of sales. Referred to as the "Revenue Test," it is one of the measures suggested in the RFA Guidance (U.S. EPA 2006b).
- **Per household (or per capita) annualized compliance costs as a percentage of median household (or per capita) income.** The third measure compares the annualized costs to the ability of residents to pay for the cost increase. The ability of residents to pay for the costs affects government entities because fees and taxes on residents fund these entities. To the extent that residents can (or cannot) pay for the cost increases, government entities will

be impacted. Commonly referred to as the “Income Test,” this measure is described in the RFA Guidance (U.S. EPA 2006b) and the EPA Office of Water *Interim Economic Guidance for Water Quality Standards: Workbook* (U.S. EPA 1995a).²¹ Costs can be compared to either median household or median per capita income. In calculating the per household or per capita costs, the actual allocation of costs needs to be considered. If the costs are paid entirely through property taxes, and the community is predominately residential, then an average per household cost is probably appropriate. If some or all of the costs are allocated to users (e.g., fares paid by bus riders or fees paid by users for sewer, water, or electricity supplied by municipal utilities), then a more narrow measure may be appropriate. If some of the costs are borne by local firms, then that portion of the costs should be analyzed separately.

There are two commonly used impact measures for *not-for-profit entities*: (1) annualized compliance costs as a percentage of annual operating costs; and (2) annualized compliance costs as a percentage of total assets. The first is equivalent to the first of the impact measures described for government entities, measuring the percentage increase in costs that would result from the regulation being analyzed. The second is a more severe test, measuring the impacts if the annualized costs are paid out of the institution’s assets.

Measuring the economic and financial health of the community or government entity

The second category of direct impact measures examines the economic and financial health of the community involved, since this affects its ability to finance or pay for expenditures required by a program or rule. A given cost may place a much heavier burden on a poor community than on a

21 For example, in the water guidance and other EPA Office of Water analyses compliance costs are considered to have little impact if they are less than 1 percent of household income. Compliance costs greater than 2 percent are categorized as a large impact, and a range from 1 to 2 percent fall into a gray area and are considered to have an indeterminate impact.

wealthy one of the same size. As with the impact measures described above, there are three categories of economic and financial condition measures:

- **Indicators of the community’s debt situation.** Debt indicators are important because they measure both the ability of the community to absorb additional debt (to pay for any capital requirements of the rule) and the general financial condition of the community. While several debt indicators have been developed and used, this section describes two common indicators. One measure is the government entity’s bond rating. Awarded by companies such as Moody’s and Standard & Poor’s, bond ratings evaluate a community’s credit capacity and thus reflect the current financial conditions of the government body.²² A second frequently used measure is the ratio of overall net debt to the full market value of taxable property in the community, i.e., debt to be repaid by property taxes. Overall net debt should include the debt of overlapping districts. For example, a household may be part of a town, regional school district, and county sewer and water district, all of which have debt that the household is helping to pay.²³ See Table 9.3 for interpretations of the values for these measures. **Debt measures are not always appropriate.** Some communities, especially small ones, may not have a bond rating. This does not necessarily mean that they are not creditworthy; it may only mean that they have not had an occasion recently to borrow money in the bond market. If the government entity does not rely on property taxes, as may be the case for a state government or an enterprise district, then the ratio of

22 The indicators and benchmark values in Table 9.3 are drawn from *Combined Sewer Overflows — Guidance for Financial Capability Assessment and Schedule Development*, which discusses how to assess the feasibility of systems being able to comply with rules (U.S. EPA 1997b). These are general benchmarks that may prove useful in assessing financial stability in an EIA.

23 An alternative to the net debt as percent of full market value of taxable property is the net debt per capita. Commonly used benchmarks for this measure are: net debt per capita less than \$1,000 indicates a strong financial condition, between \$1,000 and \$3,000 indicates a mid-range or gray area, and greater than \$3,000 indicates a weak financial condition.

Table 9.3 - Indicators of Economic and Financial Well-Being of Government Entities

Indicator	Weak	Mid-Range	Strong
Bond rating	Below BBB (S&P) Below Baa (Moody's)	BBB (S&P) Baa (Moody's)	Above BBB (S&P) Above Baa (Moody's)
Overall net debt as percent of full market value of taxable property	Above 5%	2% - 5%	Below 2%
Unemployment rate	More than 1 percentage point above national average	Within 1 percentage point of national average	More than 1 percentage point below national average
Median household income	More than 10% below the state median	Within 10% of the state median	More than 10% above the state median
Property tax revenue as percent of full market value of taxable property	Above 4%	2% - 4%	Below 2%
Property tax collection rate	Less than 94%	94% - 98%	More than 98%

Source: U.S. EPA 1997b

debt to full market value of taxable property is not relevant. Information on debt and assessed property values are available from the financial statement of each community. The state auditor's office is likely to maintain this information for all communities within a state.

- **Indicators of the economic/financial condition of the households in the community.** There are a wide variety of household economic and financial indicators. Commonly used measures are the unemployment rate, median household income, and foreclosure rates. Unemployment rates are available from the Bureau of Labor Statistics. Median household income is available from the U.S. Census Bureau. Benchmark values for these and other measures are presented in Table 9.3.

- **Financial management indicators.** This category consists of indicators that gauge the general financial health of the community, as opposed to the general financial health of the residents. Because most local communities rely on property taxes as their major source of revenues, there are two ratios that provide an indicator of financial strength. First, property tax revenue as a percentage of the full market value of taxable property indicates the burden that property taxes

place on the community.²⁴ Second, the property tax collection rate gauges the efficiency with which the community's finances are managed, and indirectly whether the tax burden may already be excessive. As the property tax burden on taxpayers increases, they are more likely to avoid paying their taxes or to pay them late.

Measuring the financial strength of *not-for-profit* entities includes assessing:

- The size of the entity's reserves;
- How much debt the entity already has and how its annual debt service compares to its annual revenues; and
- How the entity's fees or user charges compare with the fees and user charges of similar institutions.

As with government entities, this analysis is meant to judge whether the entity is in a strong or weak financial position to absorb additional costs.

9.2.4.2 Administrative, Enforcement, and Monitoring Burdens on Governments

Many EPA programs require effort on the part of different levels of government for administration,

²⁴ If the state caps local property taxes (e.g., Proposition 13 in California or Proposition 2½ in Massachusetts) then it may be relevant to examine the ratio of property tax to the allowed level of the taxes.

enforcement, and monitoring. These costs must be included when estimating impacts of a regulation to comply with UMRA and to calculate the full social costs of a program or rule. See Chapter 8 for more information on government regulatory costs.

9.2.4.3 Induced Impacts on Government Entities

The induced impacts on government entities should also be considered. For example, a manufacturing facility may reduce or suspend production in response to a regulation, thus reducing the income levels of its employees. In turn, these reductions will spread through the economy by means of changes in household expenditures. These induced impacts include the multiplier effect, in which loss of income in one household results in less spending by that household and therefore less income in households and firms associated with goods previously purchased by the first household.

Decreased household and business income can affect the government sector by reducing tax revenues and increasing expenditures on income security programs (the automatic stabilizer effect), employment training, food and housing subsidies, and other fiscal line items. Due to wide variation in these programs and in tax structures, estimating public sector impacts for a large number of government jurisdictions can be prohibitively difficult.

On the other hand, compliance expenditures increase income for businesses and employees that provide compliance-related goods and services. These income gains also have a multiplier effect, offsetting some of the induced losses in tax revenue and increases in government expenditures identified above. As some linkages may be more localized than others, it is important to clearly identify where the gains and losses occur.

9.2.5 Detailing Impacts on Small Entities

The Regulatory Flexibility Act, as amended by the Small Business Regulatory Fairness Act of 1996 (RFA), and Section 203 of the Unfunded Mandates

Reform Act of 1995 (UMRA) require agencies to consider a proposed regulation's economic effects on small entities, specifically, small businesses, small governmental jurisdictions, or small not-for-profit organizations. The definition of "small" for each of these entities is described below. For guidance on when it is necessary to examine the economic effects of a regulation under the RFA or UMRA, analysts should consult EPA guidelines on these administrative laws (U.S. EPA 2006b and U.S. EPA 1995b, respectively). In general, the Agency must fulfill certain procedural and/or analytical obligations when a rule has a "significant impact on a substantial number of small entities" (abbreviated as SISNOSE) under the RFA or when a rule might "significantly" or "uniquely" affect small governments under Section 203 of UMRA.

9.2.5.1 Small Businesses

The RFA requires agencies to begin with the definition of small business that is contained in the Small Business Administration's (SBA) small business size standard regulations.²⁵ The RFA also authorizes any agency to adopt and apply an alternative definition of small business "where appropriate to the activities of the Agency" after consulting with the Chief Counsel for Advocacy of the SBA and after opportunity for public comment. The agency must also publish any alternative definition in the *Federal Register* (U.S. EPA 2006b).

The analytical tasks associated with complying with the RFA include a screening analysis for SISNOSE. If the screening analysis reveals that a rule *cannot* be certified as having no SISNOSE, then the RFA requires a regulatory flexibility analysis be conducted for the rule, which includes a description of the economic impacts on small entities. Impacts on small businesses are generally assessed by estimating the direct compliance costs and comparing them to sales or revenues. Because an estimate of direct compliance costs tends to be a conservatively low estimate of a regulation's impact, further analysis examining the impacts discussed in Section 9.3.3 (specifically in relation

²⁵ The current version of SBA's size standards can be found at <http://www.sba.gov/size> (accessed March 13, 2011).

to small businesses) may provide additional information for decision makers.²⁶

9.2.5.2 Small Governmental Jurisdictions

The RFA defines a small governmental jurisdiction as the government of a city, county, town, school district, or special district with a population of less than 50,000. Similar to the definition of small business, the RFA authorizes agencies to establish alternative definitions of small government after opportunity for public comment and publication in the *Federal Register*. Any alternative definition must be “appropriate to the activity of the Agency” and “based on such factors as location in rural or sparsely populated areas or limited revenues due to the population of such jurisdiction” (U.S. EPA 2006b). Under the RFA, economic impacts on small governments are included in the SISNOSE screening analysis, and any required regulatory flexibility analysis for a rule.

UMRA uses the same definition of small government as the RFA with the addition of tribal governments. Section 203 of UMRA requires the Agency to develop a “Small Government Agency Plan” for any regulatory requirement that might “significantly” or “uniquely” affect small governments. In general, “impacts that may significantly affect small governments include — but are not limited to — those that may result in the expenditure by them of \$100 million [adjusted annually for inflation] or more in any one year.” Other indicators that small governments are uniquely affected may include whether they would incur the higher per-capita costs due to economies of scale, a need to hire professional staff or consultants for implementation, or requirements to purchase and operate expensive or sophisticated equipment.²⁷ See Section 9.3.4 for information on measures of impacts to governments in general.

26 See Agency guidance (U.S. EPA 2006c) for details on complying with the RFA.

27 Guidance on complying with Section 203 of UMRA, “Interim Small Government Agency Plan,” is available on EPA’s intranet site, ADP Library at <http://intranet.epa.gov/adplibrary/statutes/umra.htm> (accessed March 21, 2011, internal EPA document)

9.2.5.3 Small Not-for-Profit Organizations

The RFA defines a small not-for-profit organization as an “enterprise which is independently owned and operated and is not dominant in its field.” Examples may include private hospitals or educational institutions. Here again, agencies are authorized to establish alternative definitions “appropriate to the activities of the Agency” after providing an opportunity for public comment and publication in the *Federal Register*. Under the RFA, economic impacts on small not-for-profit organizations are included in the SISNOSE screening analysis, and if required, the regulatory flexibility analysis for a rule. See Section 9.3.4 for more information on measuring impacts on not-for-profit organizations in general.

9.3 Approaches to Modeling in an Economic Impact Analysis

This section returns to the methods for estimating social costs covered in Chapter 8, adding more insight on their application to EIA. The reader should refer to Chapter 8 for a more in-depth discussion. As noted above, the analytic assumptions used for the EIA of a particular regulation should be consistent with those used for the corresponding BCA.

9.3.1 Direct Compliance Costs

The simplest approach to measuring the economic impacts is to estimate and verify the private costs of compliance. This is necessary regardless of whether the entities affected are for-profit, governmental, communities, or not-for-profit. Direct compliance costs are considered the most conservative estimate of private costs and include annual costs (e.g., operation and maintenance of pollution control equipment), as well as any capital costs. Direct compliance costs do not include implicit costs.

Verifying the compliance cost estimates entails two steps. First, the full range of responses to the rule needs to be identified, including pollution prevention alternatives and any differences in response across sub-sectors and/or geographic

regions. Second, the costs for each response need to be examined to determine if all elements are included and if the costs are consistent within a given base year. To ensure consistency across years, either a general inflation factor, such as the GDP implicit price deflator, or various cost indices specific to the type of project should be used.²⁸ The base year and indexing procedure should be stated clearly.

Implicit costs that do not represent direct outlays may be important. The cost estimates should include such elements as production lost during installation, training of operators, and education of users and citizens on programs involving recycling of household wastes. The cost of acquiring a permit includes the permit fee as well as the lost opportunities during the approval process. Likewise, the cost of having a car's emissions inspected is not so much the fee as it is the value of a registrant's time.

In addition, it is important to recognize that these expenditures may have other benefits and costs. For example, they may confer tax breaks (complying with regulations may be a tax deductible expense) and the new capital may be more productive than the old capital. These "offsets" should be considered, particularly when they may be substantial.

There are several issues analysts should consider when estimating the direct compliance costs of environmental polices for an EIA. These include:

- **Before- versus after-tax costs.** For businesses, the cost of complying with regulations is generally deductible as an expense for income tax purposes. Therefore, the effective burden is reduced for taxable entities because they can reduce their taxable income by the amount of the compliance costs. The effect of a regulation on profits is therefore measured by after-tax compliance costs. Operating costs

are generally fully deductible as expenses in the year incurred. Capital investments associated with compliance must generally be depreciated.²⁹ In most cases, communities, not-for-profits, and governments do not benefit from reduced income taxes that can offset compliance costs. Therefore, adjustments to cost estimates, annualization formulas, and cost of capital calculations required to calculate after-tax costs should not be used in analyses of impacts on governments, not-for-profits, and households.

- **Transfers.** Some types of compliance costs incurred by the regulated parties may represent transfers among parties. Transfers, such as payments for insurance or payments for marketable permits, do not reflect use of economic resources. However, individual private cost estimates used in the EIA include such transfers.³⁰
- **Discounting.** Compliance costs often vary over time, perhaps requiring initial capital investments and then continued operating costs. To estimate impacts, the stream of costs is generally discounted to provide a present value of costs that reflects the time value of money.³¹ In contrast to social costs and benefits, which are discounted using a social discount rate, private costs are discounted using a rate that reflects the regulated entity's cost of capital.³² The private discount rate used will generally exceed the social discount rate by an amount that reflects the risk associated with the regulated entity in question. For firms, the cost of capital may also be determined by their ability to deduct debt from their tax liability.

28 The GDP implicit price deflator is reported by the U.S. DOC, BEA in its *Survey of Current Business* (<http://www.bea.gov/scb/index.htm>). The annual *Economic Report of the President*, Executive Office of the President, is another convenient source for the GDP deflator, available at www.gpoaccess.gov/eop/ (accessed March 13, 2011).

29 Current federal and state income tax rates can be obtained from the Federation of Tax Administrators, *State Tax Rates & Structure*, available at <http://www.taxadmin.org/fta/rate/default.html> (accessed January 31, 2011).

30 These transfers cancel out in a BCA. In an EIA the distribution of results is important, therefore the transfers are included.

31 The present value of costs can then be annualized to provide an annual equivalent of the uneven compliance cost stream. Annualized costs are also discussed in Chapter 6.

32 While the discount rate differs, the formula used to discount private costs is the same as used for social costs. See Chapter 6 for details.

- **Annualized costs.** Annualizing costs involves calculating the annualized equivalent of the stream of cash flows associated with compliance over the period of analysis. This provides a single annual cost number that reflects the various components of compliance costs incurred over this period. The annual value is the amount that, if incurred each year over the selected time period, would have the same present value as the actual stream of compliance expenditures. Annualized costs are therefore a convenient compliance cost metric that can be compared with annual revenues and profits. It is important to remember that using annualized costs masks the timing of actual compliance outlays. For some purposes, using the underlying compliance costs may be more appropriate. For example, when assessing the availability of financing for capital investments, it is important to consider the actual timing of capital outlays.
- **Fixed versus variable costs.** Some types of compliance costs vary with the size of the regulated enterprise, such as quantity of production. Other components of cost may be fixed with respect to production or other size measures, such as the costs involved in reading and understanding regulatory requirements. Requirements that impose high fixed costs will impose a higher cost per unit of production on smaller firms than on larger firms. It is important that the effects of any economies of scale are reflected in the compliance costs used to analyze economic impacts.³³ Using the same average annualized cost per unit of production for all firms may mask the importance of such fixed costs and understate impacts on small entities.

9.3.2 Partial Equilibrium Models

A partial equilibrium framework is an alternative way to examine distributional effects when impacts are limited to a few directly and indirectly affected output markets only. For example, a regulation may increase the costs of producing a particular

chemical. Partial equilibrium models can be used to examine the distribution of these changes across directly affected industries, and a small number of indirectly affected entities (e.g., upstream and downstream). Partial equilibrium models can range in size from an analysis that estimates compliance costs for the affected industry only (i.e., direct compliance costs) to multi-market models encompassing several directly and indirectly affected sectors.

If a single-market partial equilibrium model is the only information source available for an analysis of impacts, then it may be possible to adopt further assumptions and acquire additional data to approximate impacts on other areas of concern. This may include deriving ratios to aggregate changes in order to assign these changes to specific regions or sectors. These new assumptions should be consistent with those used for the corresponding BCA.

Multi-market models consider the interactions between a regulated market and other important related markets (outputs and inputs), requiring estimates of elasticities of demand and supply for these markets as well as cross-price-elasticities (also found in CGE models). These models are best used when potential impacts on related markets might be considerable, but more complete modeling using a CGE framework may not be available or practical. Partial equilibrium models may also be more appropriate for regionally based or resource specific regulations that are too specific for more aggregated CGE models.³⁴ Care should be taken, however, to avoid double counting, particularly when both upstream and downstream entities are affected and included in the partial equilibrium analysis. If cost increases due to a regulation are passed on from the upstream to the downstream businesses then analysts should take care not to include impacts on both sets of entities to avoid double counting results.

³³ Economies of scale characterize costs that decline on a per unit basis as the scale of the operation increases.

³⁴ See the discussion of multi-market modeling in Chapter 8 and Just et al. (1982).

9.3.3 Computable General Equilibrium Models

CGE models are particularly effective in assessing resource allocation and welfare effects. These effects include the allocation of resources across sectors (e.g., employment by sector), the distribution of output by sector, the distribution of income among factors, and the distribution of welfare across different consumer groups, regions, and countries. As noted in Chapter 8, for example, regulations in the electric utility sector are likely to cause electricity prices to increase. The price increase will affect all industries that use electricity as an input to production (i.e., most industries), as well as households. A CGE model can assess the distribution of the changes in production and consumption that result. By design, the basic capacity to describe and evaluate these sorts of impacts exists to some extent within every CGE model. More detailed impacts (e.g., affects on a particular facility) or impacts of a particular kind (e.g., affects on drinking water) will require a more complex and/or tailored model formulation and the data to support it.

The simplest CGE models generally include a single representative consumer, a few production sectors, and a government sector, all within a single-country, static framework. Additional complexities can be specified for the model in a variety of ways. Consumers may be divided into different groups by income, occupation, or other socioeconomic criteria. Producers can be disaggregated into dozens or even hundreds of sectors, each producing a unique commodity. The government, in addition to implementing a variety of taxes and other policy instruments, may provide a public good or run a deficit. CGE models can be international in scope, consisting of many countries or regions linked by international flows of goods and capital. The behavioral equations that characterize economic decisions may take on simple or complex functional forms. The model can be solved dynamically over a long time horizon, incorporating intertemporal decision making on the part of consumers or firms. These choices have implications for the treatment of savings, investment, and the long-term profile of consumption and capital accumulation.

As effective as CGE models can be for looking at long-term resource allocation issues, they have limitations for the kinds of impact analyses described above. CGE models assume that markets clear in every period and often do not consider short-term adjustment costs, such as lingering unemployment. The analyst should be careful to select a model that does not assume away the underlying issue addressed by the distribution analysis. Moreover, a CGE model may not be feasible or practical to use when data and resources are limited or when the scope of expected significant market interactions is limited to a subset of economic sectors. In such instances a partial equilibrium model can be adopted as a more appropriate alternative to a CGE model.³⁵ Finally, it is worth noting that while CGE modeling is complex, the effort may be worthwhile when data are available and the distributional impacts are likely to be widespread.

³⁵ For a discussion of CGE analysis see Chapter 8 and Dixon et al. (1992).