Chapter 9 - Economic Impacts

A wide variety of economic impacts can occur as a consequence of environmental policy. Analysis of who will experience gains and who will be burdened by a regulation, and analysis of the nature and magnitude of regulatory impacts, provides important information for decision makers, stakeholders and the broader public. An *economic impact analysis* (EIA)[1] identifies and quantifies a wide range of regulatory impacts including market-based impacts such as changes in employment, prices, profitability and plant closures; as well as impacts outside the marketplace (e.g., impacts on state and local governments). An EIA identifies specific groups that may benefit or be burdened by a policy and assesses the impacts they experience. Affected groups may include consumers, industries, small businesses, workers, communities, tribes and governments. Using this definition of an EIA, this chapter discusses issues relevant to estimating the economic impacts of EPA policies. An EIA can be tailored to improve understanding of specific regulatory impacts. However, in some instances, EPA has been directed to conduct an EIA, as explained in Section 9.2 of this chapter. Subsequent sections begin with a review of frameworks that provide a general understanding of economic impacts, followed by guidance for assessing each impact category.

This chapter primarily focuses on market impacts due to compliance costs. However, Section 9.5.6 is a discussion of the impacts of benefits (changes in environmental quality and public health) and several other sections, such as Section 9.5.1.5, briefly discuss specific beneficial impacts. Impacts on governments and non-profits are discussed in Section 9.5.4; and a consideration of economy-wide impacts from both costs and benefits is discussed in Section 9.5.5. Chapter 10, “Environmental Justice and Life Stage Considerations,” complements the current chapter by discussing how regulation might change the distribution of environmental quality and health risks across minority and low-income populations, and by life stage.

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1 At the EPA, an EIA differs from a Regulatory Impact Analysis (RIA). The latter Is frequently used interchangeably with "economic analysis" and may contain analyses of benefits, costs and economic impacts; in other words, an EIA is often contained within an RIA. For more information, see Chapter 1.

9.1 Background

Analyzing economic impacts sheds light on the distribution across groups of costs, transfers,[2] benefits and other economic outcomes induced by regulation. An EIA may include a broad range of measures including monetized metrics such as profit or price changes, as well as non-monetized metrics such as changes in employment or the likelihood of plant closures. The crux of an EIA is understanding these changes experienced by specific groups. In contrast, a BCA focuses on measuring aggregate social net benefits and is concerned with economic efficiency which requires that benefits outweigh costs, irrespective of to whom net benefits accrue. Thus, the two types of analyses use different measures. Unlike aggregate benefit and cost measures calculated for a BCA, the impact measures included in an EIA need not be mutually exclusive. For example, an impact that appears simultaneously in two related markets, such as costs in the regulated sector and revenues in the pollution control sector, can be included and appear as two impacts in an EIA. In BCA, where the focus is on aggregate efficiency, transfers which, by definition, shift money from one group to another will not impact estimates of net benefits. However, because transfers affect who experiences gains or burdens from a policy, they may be key within an EIA (OMB 2023).

Despite these important differences, analyses of economic impacts in an EIA and of social benefits and social costs in a BCA are complementary, as both shed light on the consequences of regulation. When conducted for the same policy, both types of analyses should use a consistent baseline and set of assumptions. Generally, both analyses have similar scopes; that is, if it is appropriate for the analysis of social costs to extend to markets beyond the regulated industry then it would likely be appropriate for the EIA as well. Both analyses should explain underlying assumptions, explore the sensitivity of results to assumptions and inputs, strive for transparency and include documentation and references (OMB 2023).

Whether regulatory consequences are measured in terms of economic impacts, changes in social welfare or both, ultimately the focus is on how *people* are affected. An EIA that analyzes profitability, for example, is studying potential impacts on the income of firm owners or shareholders. Analysis of employment impacts sheds light on impacts on workers. An EIA that estimates changes in prices is concerned about impacts on consumers. To complicate matters, many impacts estimated in an EIA give insight into changes that might affect multiple groups. For example, an increased likelihood of plant closure affects both firm owners and workers.

9.2 Statutes and Policies

Multiple statutes and policies contain directives for an EIA that are applicable across media.[3] The following statutes and executive orders (EOs), described more fully in Chapter 2, directly address economic impacts.

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2 Transfers are shifts of money or resources from one part of the economy to another such as tax payments. See Section 8.2.2.2 for a discussion of compliance costs and transfers. Circular A-4 defines a transfer as "… a shift in money (or other item of value) from one party to another. More generally, when a regulation generates a gain for one group and an equal-dollar-value loss for another group, the regulation is said to cause a transfer from the latter group to the former." (OMB 2023)

3 The EPA's Action Development Process (ADP) Library is a resource for analysts who wish to access relevant statutes, EOs or Agency policy and guidance documents. Besides the broadly applicable statutes and directives

- Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) (1996);
- Unfunded Mandates Reform Act (UMRA) (1995);
- EO 12866, Regulatory Planning and Review (1993) as amended by Executive Order 14094, Modernizing Regulatory Review (2023);
- EO 13132 (1999), "Federalism;"
- EO 13175 (2000), "Consultation and Coordination with Indian Tribal Governments;"
- EO 13211 (2001), "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution or Use."

Together with OMB's Circular A-4, these directives highlight features of affected entities that may be relevant for EIAs. Table 9.1 lists the features identified by these directives and offers examples of potentially affected groups.

Table 9.1 - Features of Potential Relevance to Economic Impact Analyses as Identified by Statutes, Executive Orders and Guidance

Feature	Statute, Order or Directive	Examples of Potentially Affected Economic Groups
Sector	UMRA; EO 12866; EO 13132; EO 13175; OMB Circular A-4	Producers; industries; state, county, local, territorial, or tribal governments.
Entity size	RFA/SBREFA; UMRA; EO 12866, OMB *Circular A-4*	Businesses, governmental jurisdictions, not-for-profit organizations. Analyze small entities separately.
Time; Dynamics	OMB Circular A-4	Groups (e.g., consumers, workers, producers, firms, industries) experiencing transitional or long-run impacts.
Geography	UMRA; EO 12866; OMB Circular A-4	Regions, states, counties, non-attainment areas, local or regional markets.
Energy	EO 13211	Energy sector (i.e., developers, distributors, generators, or users of energy resources).

9.3 Connections between Economic Impacts and Frameworks of Distributional Effects

Virtually any economic measure of the consequences of a regulation may be included in an EIA.[4] To accommodate this degree of flexibility, an EIA is not constrained or governed by an operating framework. However, there are several conceptual frameworks in the economics literature that

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discussed in this section, there are also environmental statutes with specific applicability that require consideration of impacts on certain populations (such as impacts on labor; see Section 9.5.1.4), or that may require analysis of impacts for facilities potentially eligible for regulatory variances.

4 For textbook discussions of the meaning and usefulness of impact analysis, see Field and Field (2005) and Tietenberg (2006).

provide insight into the meaning and interpretation of impact categories. Section 9.3.1 provides a summary.

While a worthwhile analytic objective for environmental policy is to estimate the net welfare changes experienced by each affected group in an economy, the EPA does not currently conduct such analyses. The information needed to distribute shares of regulatory costs, benefits and transfers among groups and estimate each group's net welfare change is not available. This is explained In Section 9.3.2.

9.3.1 Conceptual Frameworks

A deeper understanding of economic impacts can be achieved by drawing connections to conceptual frameworks of distributional effects. These frameworks, often presented in terms of welfare effects, are useful for understanding parts of an EIA because they illustrate the different pathways through which regulatory costs are distributed across population groups.[5] Expenditures are incurred by regulated entities to comply with environmental mandates, standards, permit requirements, taxes and so on. Compliance expenditures may be passed on partially or fully to other groups.[6] For example, costs may be experienced by firm owners or shareholders through lower profits, or passed on to consumers through higher prices. Or, costs may be passed on to workers through changes in labor compensation, and/or on to the owners of other factors of production through reduced rates of return to land and capital.[7] The portion of the cost experienced by these different groups depends on a variety of factors including the time-frame under consideration, the characteristics of the regulated market such as the elasticity of demand relative to the elasticity of supply and whether there are barriers that prevent new firms or imports from entering the market. Some costs may trickle through to related markets. While in practice economists cannot always measure the extent of cost pass-through, existing frameworks help shed light on the variety of ways that costs percolate through the economy.[8]

A framework developed by Harberger (1962) to better understand the distributional effects (incidence) of taxation provides insight into who bears the costs of environmental regulation. Effects are separated into two broad categories: those falling on the *sources* of income including owners of firms, labor, capital or land; and those falling on the *uses* of income, or consumption, due to changing prices. Harberger's simple two sector, two good model representing a perfectly competitive closed economy with perfectly mobile factors of production suggests that a tax on one input could lead to either, or both, source-side and use-side effects. Adapting the model to

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5 If the regulated entity is not a profit-maximizing firm, then the principles discussed in this section are likely not relevant. We address impacts on governments and non-profits in Section 9.5.4.

6 For a more detailed discussion, see Tietenberg (2002, 2006), which is the basis for the discussion in this paragraph. Useful textbook discussions are also provided by Kolstad (2000) and Field and Field (2005). For a review of the empirical literature, see Bento (2013). For a discussion specifically of the effects of command and control regulations, see Fullerton and Heutel (2010).

7 Throughout this chapter, all factors of production are represented by either land (natural resources), labor (human resources) or capital (man-made resources).

8 The following sources provide frameworks for understanding distributional impacts of environmental regulation: Christiansen and Tietenberg 1985; Baumol and Oates 1988; Field and Field 2005; Tietenberg 1992, 2002, 2006; Serret and Johnstone 2006; Kristrom 2006; Fullerton 2009, 2011; Robinson et al. 2016; Fullerton and Heutel 2010; Fullerton and Muehlegger 2019.

represent an environmental tax shows a use-side burden on purchasers of the commodity in the taxed sector; and a source-side impact on factors affected by the tax (Fullerton and Muehlegger 2019). Many other existing frameworks also categorize distributional effects according to the route through which the effect is transmitted (product prices, profits, shifts in factor compensation) which is then traced to the group on which the effect falls (consumers; owners of firms, land or capital; workers).

Figure 9.1 illustrates how Robinson et al. (2016) conceptualize one set of pathways through which regulatory compliance costs may eventually be distributed across population groups. These pathways help contextualize metrics that often appear in an EIA. The groups experiencing economic impacts as described in Section 9.5 (producers, workers, other factors of production, consumers, communities and the overall economy) are related to one or more of the three routes through which regulatory compliance costs flow.[9] The groups themselves, however, do not always align perfectly with the three groups identified in the figure (consumers, employees and owners). For example, the figure does not directly represent "producers," yet impacts on producers are commonly analyzed at the EPA, and directives to consider some producer impacts are given by statute or EO.[10] Impacts on producers will ultimately be felt by all the people who together make up affected firms (owners and shareholders, workers and other owners of productive factors).[11] Other impact categories discussed in Section 9.5, such as impacts on labor or employees, are more directly represented by Figure 9.1.[12] The right-hand box conceptualizes how costs might be experienced across different population groups; for example, among regions or among households with different demographic characteristics. This is a common endpoint for an EIA as explained in the sections below on specific impact categories — for example, Section 9.5.2 explains how price increases might be experienced differently by high- versus low-income consumer groups.

Fullerton (2016) offers a more nuanced framework for disaggregating regulatory consequences. He identifies the following *potential* cost-related effects on the regulated market:[13] (1) an increased cost of production results in an increase in the price of the regulated good affecting people who purchase the good; (2) decreased production reduces revenues and changes relative returns to

9 Government and non-profit organizations are also discussed In Section 9.5, but they are structured differently than private firms and are not well represented by Figure 9.1.

10 For example, RFA/SBREFA and EO 13211 (2001) direct agencies to consider impacts on small firms, and on energy producers, respectively.

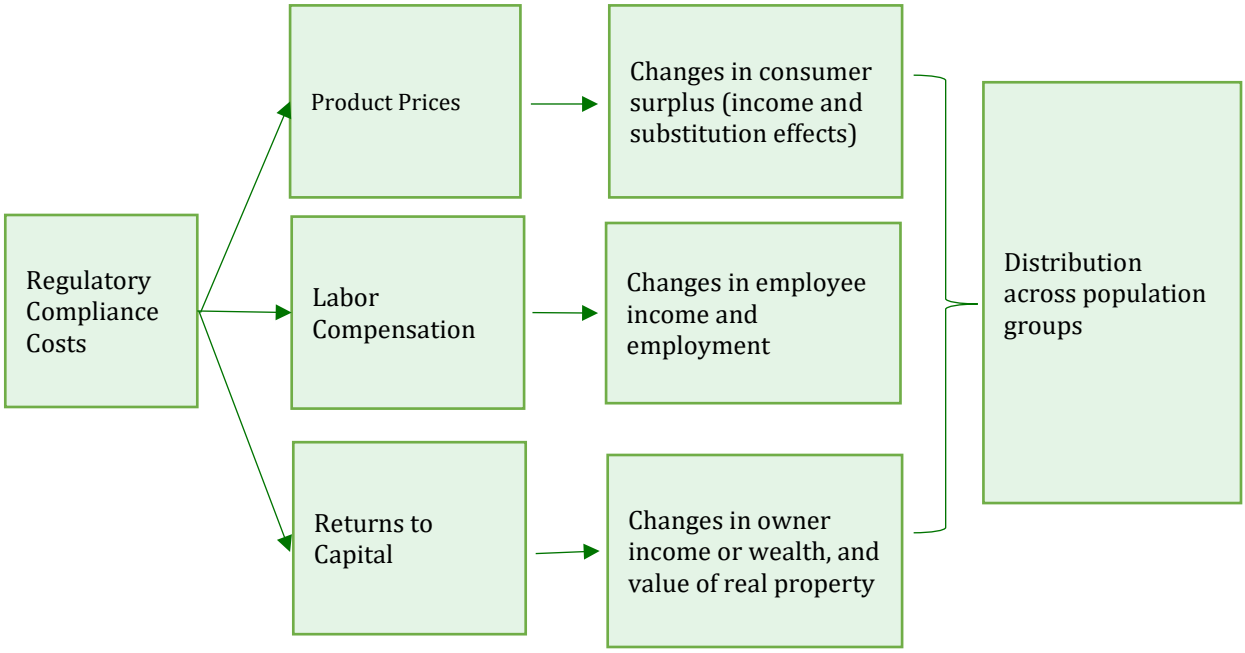
11 Through impacts on producers, regulatory costs could also affect upstream suppliers of inputs (e.g., coal) by leading them to lower their prices, thinking that if they do not, the regulated facilities (e.g., power plants) could shut down.

12 Some "changes" in Figure 9.1 may be measured as economic impacts, welfare changes or possibly both. For more context on Figure 9.1's "changes in employee income and employment," see Text Box 9.1 on labor impacts and benefit cost analysis.

13 Some of these effects may be negligible or may not occur at all. Fullerton (2016) also identifies channels through which distributional effects can occur on the benefits side. For example, asset prices can be affected by environmental quality improvements (e.g., improvements could be capitalized into land and housing prices (and some households could be dislocated due to higher rents). See Sections 9.5.1.5 and 9.5.3; and Chapter 10 for more discussion.

workers and firm owners and factors of production; (3) restrictions on pollution create scarcity rents[14] for owners of firms, capital, and/or land; (4) transitional impacts occur as the economy adjusts to a new equilibrium, for instance, if workers must search for new jobs; and (5) gains and losses are capitalized into asset prices such as corporate stock prices rising due to an expected future flow of scarcity rents.[15]

Figure 9.1 - Example Framework to Map Distribution of Compliance Costs (Robinson et al. 2016)[16]



A few key insights for EIA can be gleaned from these frameworks:

- **Differentiating between impacts that occur in the short- and long-run is important.** The short-run refers to the period in which only some factors of production are variable (e.g., labor) while others are fixed (e.g., capital equipment), and consumers are constrained by existing household assets, commitments, and information. In policy contexts, the short-run is sometimes referred to as a transition period. The long-run refers to the period in which all factors of production are variable, the aforementioned consumer constraints are relaxed, and the economy returns to equilibrium (i.e., all prices and quantities have fully

14 Scarcity rents represent a measure of welfare: "This producer's surplus which persists in long-run competitive equilibrium is called scarcity rent." (Tietenberg 2006). For a discussion of scarcity rents created by environmental regulations through pollution restrictions and captured by firms in the form of higher profits, see Fullerton and Metcalf (2001). See Buchanan and Tullock (1975) for a discussion of the potential for scarcity rents under a quota or a cap-and-trade policy where permits are distributed for free.

15 For an interesting example, see Fullerton (2011) where this framework is applied to a specific environmental policy (a carbon permit system) by linking measurable outcomes to welfare changes.

16 Reproduced with author permission.

adjusted to the new regulation). There are likely to be different implications for the economic impacts of a policy in the short-run compared to the long-run. For example, in the long-run, consumers are better equipped to switch to substitute goods, and firms are better equipped to switch to producing different outputs and to make entry and exit decisions. These time frames also have different implications for workers (see Section 9.5.1.4).

- **The distribution of impacts among market participants depends on the nature of the affected market(s).** Market characteristics including the extent of competition and the elasticity of demand relative to the elasticity of supply determine the allocation of impacts among consumers, labor and owners of firms, capital, and other resources. All things equal, competitive markets pass regulatory costs through to consumers to a greater extent than markets in which firms have monopoly power. Firms in very competitive markets do not earn excess profit and have no choice but to pass on costs if they want to stay in business. Of course, the reduced quantity demanded at higher prices may force them to close. Firms with market power have incentive to absorb a portion of regulatory costs since raising the price they charge reduces the quantity consumers demand of their products and reduces profits.[17] Relative elasticities are also important. In an imperfectly competitive market, the portion of the cost borne by producers increases with a greater elasticity of demand relative to elasticity of supply (and the portion borne by consumers increases with a greater elasticity of supply relative to elasticity of demand).[18]
- **Impacts may differ within market participant categories.** Substantial heterogeneity of a regulation's impacts is often experienced within groups. In practice, firms and their circumstances are not identical, so compliance may be more burdensome for some firms than for others.[19] For example, small firms may have fewer units of production over which to spread compliance costs, or some firms may have technologies that are more expensive to adapt to regulatory requirements. Similarly, consumers and their circumstances are not identical. People purchase varying bundles of goods and therefore will not be uniformly affected by price changes. Also, the same incremental change in consumption will affect individuals differently depending on their baseline levels of consumption; those with higher levels will value a small change in consumption less (referred to as the diminishing marginal utility of consumption). Industries, factors of production and other market participant categories can be affected differently as well. In Section 9.5, we discuss the conditions associated with divergent impacts for each impact category.

This section has discussed frameworks that shed light on the potential distribution of compliance costs. Several papers also consider the distribution of health benefits or environmental quality (e.g., Fullerton 2016; Robinson et al. 2016; Pearce 2006). For example, Robinson et al. trace the effects of hazard reduction on changes in human risks and the valuation of those changes. See Section 10.2.1 in Chapter 10 for a discussion of this literature.

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17 For a discussion of economic impacts on a representative firm and on the market, in a supply and demand model with perfect competition and under monopoly, see Tietenberg (2006), pp. 510-516.

18 See Fullerton and Metcalf (2002).

19 Heterogeneity in impacts may also be the result of regulatory design (e.g., differentiation of standards by facility vintage). This possibility is discussed in Section 9.5.1.

9.3.2 Disaggregated Welfare Effects

An analysis that disaggregates welfare effects (social costs and benefits) and transfers across relevant groups is a worthwhile goal. The analyst could estimate the net welfare changes experienced by each affected group in an economy, which in principle, if all regulatory consequences by group were fully described, might obviate the need for an EIA. In practice, however, many obstacles prevent a complete distributional analysis of welfare effects. For instance, at the EPA it is typical that the social costs and benefits of an environmental regulation are estimated for different groups. The former is usually estimated for firms that must comply with regulatory requirements, but the ultimate incidence of those compliance costs among owners, workers, and consumers (as costs are passed through to profits and prices, for example) is not typically estimated. Social benefits are estimated for individuals experiencing changes in environmental risks or conditions. Sparse information regarding the overlap between the groups bearing the costs and experiencing the benefits makes calculating disaggregated net welfare effects particularly challenging.

A different possibility to achieve disaggregated welfare effects would be converting the economic impacts included in an EIA experienced by different groups into welfare changes and summing across effects. Unfortunately, current models and data prevent such a detailed exercise. Consider business closures, for example. They might decrease profits to owners and upstream firms and cause workers to become unemployed. One would need to have information about effects on upstream firms (i.e., those that would be affected and by how much) as well as information on affected workers (e.g., the forgone wages of unemployed workers, the length of time they remain unemployed and their wages once they are successfully re-employed). Such detailed information is typically not available. Text Box 9.1 discusses the inherent difficulties of estimating social welfare effects associated with employment impacts.

Finally, to estimate group specific social benefits, analysts would need group-differentiated estimates of willingness to pay for the variety of environmental quality changes caused by EPA rules. While the existing literature contains evidence of variability in willingness to pay for public environmental goods among income (and other) groups, it does not contain a full suite of such estimates[20]; and the use of any specific estimate would be controversial without significant public review.

20 For discussion and examples, see Banzhaf et. al (2019) and Chapter 10 on willingness-to-pay in the environmental justice literature; Banzhaf and Walsh (2008) for empirical evidence of household sorting in response to toxic air emissions; and Ito and Zhang (2020) for evidence of variable WTP for clean air in China.

Text Box 9.1 - Labor Impacts and Benefit Cost Analysis

In a benefit-cost analysis, some portion of changes in employment may also affect social welfare, but there are many theoretical and practical challenges to accounting for them. One challenge is how to estimate transition costs to workers experiencing involuntary job loss and unemployment. Including all resulting earnings losses would overstate social costs if they are transfers of economic rents - for example, if displaced workers were highly paid relative to their productivity (Hall 2011).

In addition to earnings losses, workers may incur transition costs due to relocation across labor markets, health impacts or other impacts on well-being that are not well-measured (Smith 2015; Kuminoff, Schoellman, and Timmins 2015). Transition costs may be higher during a recessionary period, when overall labor demand is already reduced due to nationwide declines in production, which can lengthen the time needed to locate new employment (Bartik 2015). These costs may be higher for certain categories of workers such as those whose skills are specially adapted for the sector experiencing reduced labor demand. For example, effects may differ by workers' age. For involuntary job loss, older workers with more human capital may face larger earnings losses for fewer years of remaining labor force time in their careers than otherwise similar workers who are young. Older workers experiencing involuntary job loss may have access to more resources from lifetime earnings, private insurance or access to social programs. Otherwise, similar younger workers may face larger costs because capital market imperfections prevent borrowing against their future lifetime earnings.

Likewise, quantifying changes in health or welfare due to an environmental regulation that affects workers, for example by improving their productivity or their ability to work, is challenging. An emerging literature documents these benefits; for reviews see Aguilar-Gomez et al. (2022) and Graff Zivin and Neidell (2013, 2018). These are just some of the issues to consider regarding potential welfare effects of labor impacts. Economists do not yet have a unified theory that incorporates employment impacts measured as social welfare effects into benefit cost analysis. For discussions, see Hall (2011), Ferris and McGartland (2014), and Smith (2015) who conclude that more work is needed in this area.

With caution, we also mention an analytic construct for further considering net welfare by detailed groups. A Social Welfare Function (SWF) establishes criteria under which efficiency and equity outcomes are transformed into a single metric, making them directly comparable. To do this, SWFs make assumptions regarding how society places different values on incremental changes in measures of well-being across individuals or groups (see Adler 2012, 2019, for a discussion). OMB (2023) outlines an option to implement a SWF in which individual- or group-specific WTP estimates are weighted differently. The weights assign lower values to incremental increases in consumption accruing to individuals with higher baseline consumption relative to people with lower baseline consumption (to account for diminishing marginal utility of consumption).[21] Implementation of this approach requires estimates of costs and benefits for each individual or each income group conditional on their baseline income and cannot rely on estimates of the average WTP across the whole population. Such average estimates are common in analyses of environmental regulations - EPA's estimate of the value of statistical life is an example. OMB's optional approach reflects one possible SWF; however, given its subjective nature, there is no clear

21 Please see OMB (2023) Section 10.e. for a detailed explanation.

consensus in the literature regarding how to value different distributions of welfare improvements. For these reasons, SWFs are not currently recommended when conducting regulatory analysis at the EPA.

Despite an inability to estimate the net welfare effects experienced by different groups affected by regulation, estimates of economic impacts improve understanding of the pathways through which welfare changes can occur, e.g., through business closures, or by restructuring markets or by increasing housing values in a community. Impact measures may also be useful for identifying individuals who might be strongly affected — for example the firms likely to close; whereas net welfare changes among groups might average out such strong effects so that their severity is overlooked. In addition, certain impact categories are examined to respond to statutory and executive order directives. Instead of focusing directly on welfare effects, this chapter provides information for qualitatively and quantitatively assessing changes in a wide variety of economic impacts that are expected to have an effect on welfare.

9.4 Analytic Components of an Economic Impact Analysis

An EIA should develop a profile of baseline conditions among groups expected to experience important effects of the rule. These are the conditions occuring in the absence of the rule or policy over the period of analysis. For example, the profile could include the number of regulated firms, their average size, and their average profitability. These metrics would be estimated for the year the rule takes effect and for the remaining timeframe of analysis. An EIA may also include two additional components: a preliminary analysis to screen for the magnitude of incremental impacts and an in-depth examination of expected important impacts. For each component of an EIA, analysts should highlight key analytic limitations and uncertainties. This section discusses the baseline profile, the preliminary analysis, and the in-depth examination, and identifies potentially useful data sources.

9.4.1 Baseline Profile

An EIA should develop a baseline profile that describes the industries, consumers, workers, or other groups that are expected to experience important incremental effects of a regulation.[22] The profiles will overlap with baseline profiles developed for other components of a regulatory analyses, such as the cost analysis.

The effects of some regulations may extend beyond participants in directly regulated markets, affecting, for instance, upstream or downstream markets, or complementary or substitute product markets. Often the markets involved in pollution control activities are affected. We will refer to the latter as the environmental protection sector and note that it may overlap with upstream markets.

The following information can contribute to an industry profile:

22 For more about how to define and describe baselines, see Chapter 5. For more about developing a baseline for governments or non-profit organizations, see Section 9.5.

- The affected North American Industrial Classification System (NAICS) industry codes (NAICS is the standard used by federal statistical agencies in classifying business establishments);[23]
- Industry summary statistics, including total employment, revenue, costs, number of establishments, number of firms, size of firms, and race and gender profile of firm owners and workers;
- Baseline industry structure, including competitive structure, market concentration and degree of vertical integration within the industry;
- Characteristics of supply and demand (e.g., relative elasticities);
- Industry trends including growth rates, expected changes in technology and financial conditions;
- Openness to and reliance on international trade;
- Pre-existing environmental and other regulations and associated compliance behavior;
- Barriers to entry; and
- Diversity of production technologies among firms.

The baseline socioeconomic characteristics of groups expected to experience consequential economic gains or burdens due to a regulation are also important and may include consumers, workers, business owners, shareholders, renters, community members and others. Attributes to consider include:

- Income and poverty levels;
- Age distribution;
- Employment status;
- Community characteristics such as unemployment rate;
- Geographic location and mobility; and
- Pollution burdens.

The potential relevance of these market conditions and socioeconomic characteristics within the context of a specific impact category is discussed in Section 9.5.

9.4.2 Preliminary Analysis

During the early stages of regulatory analysis, a preliminary analysis to explore the potential for important impacts can be useful and may be as simple as systematically thinking through the expected impacts of a regulation and qualitatively describing them. When data are sparse, it may still be possible to roughly estimate some regulatory impacts. For example, to screen for significant impacts on small businesses, analysts can compare a rule's estimated annualized costs per regulated facility to estimated annual revenues of affected small facilities to determine whether the ratio of regulatory costs to facility revenues violates established thresholds.[24]

While the EPA has established thresholds that suggest when impacts on small entities are significant, in most cases the criteria for when an impact warrants additional analyses are not well defined and may depend on the condition of the economy. For example, during an economic

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23 For more information on classifying industries by NAICS codes, see https://www.census.gov/eos/www/naics/.

24 See Final Guidance for EPA Rulewriters: Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act (U.S. EPA 2006a).

recession, impacts on workers may be a concern. Or, the timing of regulatory impacts may be relevant, including the period of anticipation of an upcoming compliance date, and whether effects are expected to grow or diminish or affect different groups over time. The context or location within which economic impacts are experienced is important. For example, reduced demand for labor in a small town with declining job opportunities might have bigger labor market impacts than in a larger city with abundant work opportunities. Or, when a trade exposed industry is the subject of regulation, there may be concerns regarding potential loss of domestic market share. Finally, if analysts suspect important impacts beyond directly regulated industries, the scope of analysis can be broadened, even if data and tools permit only qualitative assessments.

9.4.3 In-Depth Examination

Analysts may conduct an in-depth examination of the impact categories identified as likely to be important by the preliminary analysis. Substantial adverse impacts deserve special attention. If possible, a partial equilibrium analysis of affected markets can yield greater insights into impacts relative to an engineering cost analysis alone.[25] For example, with information on demand and supply elasticities in affected markets, analysts can move to a more refined analysis that examines the pathways through which costs would travel (e.g., consumer prices versus producer profits and input prices including wages). With regional- and firm-specific demand and supply information, analysts might also be able to shed light on how impacts vary across regions and firms. It may also be possible to link together several sector-specific partial equilibrium models with a multi-market model to examine linked impacts on regulated and related markets. If appropriate, a general equilibrium model can offer insights into impacts on a broad spectrum of markets and groups across the economy (see Section 9.5.5).

9.4.4 Data

Analysts may have access to proprietary data or detailed plant-level data (which may be confidential business information) collected through the rulemaking process that can be leveraged in an economic impact analysis. However, often data must be sought elsewhere. Table 9.2 describes available data sources that might be useful for analyzing economic impacts. The right-hand column gives examples of groups or impact categories under analysis for which each data source might be useful. Note that quantitative estimates of some economic impacts may not be possible because of inadequate household-, firm- or community-specific data (including elasticity estimates). Data that are available are often aggregated to the sector, or jurisdiction, level.

25 For a discussion of partial equilibrium and other market and engineering models, see Chapter 8 on Analyzing Costs.

Table 9.2 - Examples of Available Data Sources for Analyzing Economic Impacts of EPA Regulations

Source	Examples of types of data	Examples of relevant groups/impact categories
U.S. Bureau of Labor Statistics Consumer Expenditure Survey: https://www.bls.gov/cex/	Expenditures, income and demographic characteristics of U.S. consumers.	Consumers, Communities.
U.S. Bureau of Labor Statistics - Current Employment Statistics: https://www.bls.gov/ces/	Establishment-level estimates of nonfarm employment, hours and earnings by industry.	Sectors or Industries, Producers, Labor, Communities.
U.S. Bureau of Labor Statistics – Current Population Survey: https://www.bls.gov/cps/	Household level data on employment, unemployment, persons not in the labor force, hours of work, earnings and other characteristics.	Labor Communities.
U.S. Bureau of Labor Statistics – Producer Price Index: https://www.bls.gov/ppi/	Index of producer output prices, by detailed industry.	Sectors or Industries, Producers.
U.S. Census Bureau – Longitudinal Employer-Household Dynamics: https://lehd.ces.census.gov/	Statistics on employment, earnings and job flows at detailed levels of geography and industry for different demographic groups.	Sectors or Industries, Labor, Producers, Government entities.
Published research specific to an industry or sector.	Demand and supply elasticities, regional supply and demand information, and other specific estimates of interest.	Sectors or Industries, Consumers, Producers.
University of Wisconsin – Wisconsin National Data Consortium: http://windc.wisc.edu/	Open-source datasets for economic analysis, for U.S. states and counties, with state, sector and region economic activity.	Sectors or Industries, Consumers, Producers, Government entities.
U.S. Census States & Local Areas: https://data.census.gov/all?g=010XX00US$0400000	Demographic and socioeconomic information.	Consumers, Government entities.
U.S. Census State and County Quickfacts: https://www.census.gov/quickfacts/fact/table/US/PST045221	Demographic and socioeconomic information.	Consumers, Government entities.
U.S. Census Bureau – American Housing Survey: https://www.census.gov/programs-surveys/ahs.html	Data on the housing and construction industry, homeownership, and characteristics of homes.	Housing and Construction Industry, Consumers, Government entities, Communities.
U.S. Department of Housing and Urban Development Aggregated USPS Administrative Data on Address Vacancies: https://www.huduser.gov/portal/datasets/usps.html	Occupancy status.	Communities, Government entities.

Source	Examples of types of data	Examples of relevant groups/impact categories
U.S. Census Bureau – American Community Survey: https://www.census.gov/programs-surveys/acs	Detailed population and housing information, by community	Sectors or Industries, Labor, Producers, Consumers, Government entities, Communities.
Trade Publications and Associations	Market and technological trends, sales, location and ownership changes.	Sectors or Industries.
U.S. Census Statistics of U.S. Businesses: https://www.census.gov/programs-surveys/susb.html	National and subnational economic activity by enterprise size and establishment industry.	Producers, Small businesses, Non-profits, Government entities.
U.S. Bureau of Economic Analysis: https://www.bea.gov/data	Economic statistics on U.S. production (e.g., GDP), consumption, investment, exports and imports, and income and saving. National, Regional, Industry and International economic accounts	Sectors or Industries, Producers, Labor, Consumers, Government entities, Communities, International competitiveness.
U.S. Census Bureau – Annual Survey of Manufacturers: https://www.census.gov/programs-surveys/asm.html	Statistics for manufacturing establishments Discontinued after 2021, transitioned to the Annual Integrated Economic Survey: https://www.census.gov/programs-surveys/aies.html	Manufacturing sector, Producers.
U.S. Census Bureau – Economic Census: https://www.census.gov/programs-surveys/economic-census.html	Sector-level sales, value of shipments, number of employees and establishments, value added, cost of materials, capital expenditures, household and community characteristics	Sectors or Industries, Producers, Consumers, Communities.
U.S. Department of Commerce Industry & Trade Outlook Periodically published book – most recently in 2000	Industry, trends, international competitiveness and regulatory events.	Sectors or Industries.
New York University. Margins by Sector: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html	Profit margins: gross income and net income based.	Sectors or Industries, Producers, Businesses.
Internal Revenue Service. Statistics of Income Bulletin https://www.irs.gov/pub/irs-soi/16winbul.pdf	Tax receipts, deductions and profits.	Sectors or Industries, Producers, Businesses.
Dun & Bradstreet Information Services: www.dnb.com	NAICS code, address, facility and parent firm revenues and employment.	Sectors or Industries, Producers, Businesses.

Source	Examples of types of data	Examples of relevant groups/impact categories
Standard & Poors: www.standardandpoors.com	Quarterly financial information for publicly held firms, line-of-business and geographic segment information and Standard and Poor's (S&P) ratings.	Sectors or Industries, Producers, Businesses.
Value Line Industry Reports: http://www.valueline.com/Stocks/Industries.aspx	Industry overviews, company descriptions and outlook, and performance measures.	Sectors or Industries, Producers, Businesses.
Securities and Exchange Commission Filings and Forms: https://www.sec.gov/edgar.shtml	Income statement and balance sheet, working capital, cost of capital, employment, regulatory history, foreign competition, lines of business, ownership and subsidiaries, and mergers and acquisitions.	Sectors or Industries, Producers, Businesses.
U.S. Energy Information Administration – Electricity Data: https://www.eia.gov/electricity/data.php	Statistics on electric power plants, capacity, generation, fuel consumption, sales, prices and customers.	Energy sector and subsectors (e.g., oil, natural gas, coal, nuclear energy sources), Customers.
United States Utility Rate Database (URDB)[26] https://openei.org/wiki/Utility_Rate_Database	Rate structure information for electric utilities in the United States. The URDB includes rates for utilities based on the authoritative list of U.S. utility companies maintained by the U.S. Department of Energy's Energy Information Administration.	Energy sector and subsectors (e.g., oil, natural gas, coal, nuclear energy sources), Customers.
U.S. Department of Commerce Pollution Abatement Costs and Expenditures Survey: https://www.census.gov/econ/overview/mu1100.html	Pollution abatement costs for manufacturing facilities by industry, state, and region. Data is limited to annually from 1973 to 1994, with the exclusion of 1987; and 1999 and 2005.	Sectors or Industries, Producers, Businesses.
S&P, Moody's and Fitch state and city bond ratings.	Financial strength indicator.	Government entities.
U.S. Department of Commerce Census of Governments: https://www.census.gov/econ/overview/go0100.html	Revenue, expenditures debt, employment, payroll, assets for counties, cities, townships and school districts.	Government entities.
United Nations, International Trade Statistics Yearbook.	Foreign trade volumes for selected commodities and major trading partners.	Sectors or Industries, Producers, Businesses.

26 Rates are posted annually by the National Renewable Energy Laboratory (NREL), under funding from the U.S. Department of Energy's Solar Energy Technologies Program, in partnership with Illinois State University's Institute for Regulatory Policy Studies.

Source	Examples of types of data	Examples of relevant groups/impact categories
U.S. International Trade Commission: https://www.usitc.gov/research_and_analysis.htm	Investigative Reports.	Sectors or Industries, Producers, International Trade
Global Trade Analysis Project: https://www.gtap.agecon.purdue.edu/databases/default.asp	Global data base describing bilateral trade patterns, production, consumption and intermediate use of commodities and services.	Sectors or Industries, Producers, International trade.

9.5 Impact Categories

This section provides guidance for assessing specific impact categories. Categories discussed are not mutually exclusive; rather, they have a high likelihood of overlap. For example, impacts on producers (employees and owners) likely overlap with impacts on the communities where they are located. Impact categories discussed in this section are:

- Producers and factors of production.
- Consumers.
- Communities.
- Governments and non-profits.
- Economy-wide.
- Benefits of improved environmental quality or health.

The discussion that follows usually considers the impacts of new compliance activities. However, it is also relevant to reductions in compliance activities which generally would produce impacts going in the opposite direction.

9.5.1 Impacts on Producers and Factors of Production

Compliance activities typically increase production costs to regulated industries. This may affect many different impact categories which are listed below and discussed in this section:

- Production.
- Profitability and plant closures.
- Small businesses.
- Labor.
- Land and capital.
- Related markets.
- Energy sector.
- Competitiveness.

Effects may vary by industry or firm characteristics, production technologies, pollution intensities, policy design and more. There may be different effects in the long-run versus the short-run, and according to whether one-time, ongoing, or transitional costs are being considered. Ongoing costs are to maintain the newly achieved state of environmental quality. Transitional costs stem from adjusting from one state of environmental quality to another (Baumol and Oates 1988).

Consideration of the effect on small businesses is mandated by statute; consideration of impacts on the energy sector is directed by executive order.[27]

If regulatory costs are small and/or distributed widely, there may be negligible impacts on producers. However, even if the average impact across firms is small, some producers, such as those facing the highest abatement costs, may be substantially affected. The following subsections discuss how to assess impacts on producers and factors of production.

9.5.1.1 Impacts on Production

In response to substantial regulatory costs, the supply curve in the directly regulated market may shift upward in the area near the market price which typically leads to higher prices and lower output.[28] Reductions in industry output are usually driven by a mix of increased and lowered operating rates at existing plants, closure of some plants and/or reduced future growth in production relative to the baseline. This section discusses circumstances that influence changes in output at the firm or facility (for firms that own more than one plant) level. Such changes can be combined with industry characteristics such as the number and size or regional distribution of firms to assess total changes in production.

At least two conditions can cause environmental regulation to have different impacts across firms, and lead to changes in both the number and size of the average firm (Tietenberg 2006). The first is significant heterogeneity in firm or facility cost structures; the second is regulatory requirements that differ depending on firm characteristics.

Variability in cost structures can cause variation in the magnitude of regulatory costs and, while not always the case, can lead to differences in the magnitude and direction of changes in output across producers. For example, total industry output may decline or shift from the highest cost plants to more efficient competitors. To better understand the extent of heterogeneity in how firms might adjust production in response to regulatory requirements, a profile of baseline conditions is useful. If available, detailed industry, firm or plant-level information may provide insights into how production processes and baseline costs might vary across facilities and how this variation might lead to different incremental costs of a regulation. For example, the ease with which facilities can accommodate pollution control equipment may vary, or there could be variability in the ability to substitute less hazardous chemicals for more toxic ones. Some firms may have to finance abatement equipment and activities. For such firms, the cost and availability of financing can affect production decisions.[29] Ultimately, what analysts will need are the differences across firms in post-regulatory costs. Firms may be able to maintain or even increase production levels if after absorbing compliance costs, their production costs fall below the highest cost firms. Or they may decrease

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27 See Chapter 2 and Section 9.2 which refers to the RFA as amended by the SBREFA, and to EO 13211.

28 In the post-policy equilibrium, if the production costs of the marginal firm are not notably affected by the regulation, then it is possible that the production and price effects can be de minimis even if inframarginal firms face notable compliance costs.

29 Analysts should carefully consider private market interest rates and other financing costs that firms might face. A detailed consideration is presented in chapter 10 of the documentation for EPA's Integrated Planning Model (IPM) for the power sector. Financing costs are represented as the weighted average cost of capital in which firms finance projects with a combination of debt and equity. Merchant power providers are assumed to face higher financing costs than utilities (U.S. EPA 2024a). See also Section 6.4 of these Guidelines on selecting private discount rates.

production if, after absorbing compliance costs, their production costs are among the highest in the market.

The second cause of variable impacts across firms are variable regulatory requirements. Vintage-based regulations that vary with the age of facilities may differentiate between existing and future pollution sources, with future sources regulated more stringently. In other cases, firms in regions with high baseline pollution may face stricter emission controls.[30] In general, regulatory requirements that vary by firm characteristics will shift economies of scale and can affect the distribution of output among firms as well as firms' average level of output. For example, firms may respond to policies that differ across plant locations by relocating production to a less-regulated area within the U.S. The greater the degree to which firms take advantage of this ability to shift production across space to reduce compliance costs, the more likely it is that overall domestic production does not change substantially. The outcome could be plant closure(s) and accompanying plant opening(s) due to relocations, with distributional effects on affected areas.[31] Shifts in production from domestic to foreign sources can also occur and are discussed in more detail in Section 9.5.1.8.

9.5.1.2 Impacts on Profitability and Plant Closures

Regulatory costs can reduce profits and increase the possibility of plant closures. The industry profile (see Section 9.4) describes baseline industry growth and financial conditions at regulated firms. To assess changes in profits due to a regulation, analysts should compare the expected change in market price to the change in production costs after accounting for compliance activities. This increment should be multiplied by expected changes in output to estimate how profits change.

Industries and firms that are relatively profitable in the baseline will be better able to absorb any new compliance costs that are not passed on to consumers. In cases where facilities have different baseline pollution controls or different production technologies, those with lower costs after meeting a new environmental standard will be better able to maintain profitability relative to other firms and may increase their market share. These firms may even be able to increase profitability if their costs of compliance increase by less than the increase in market price.

Discussing the likelihood of baseline closures improves understanding about the likelihood of closures attributable to the regulation.[32] Note that vertically or horizontally integrated facilities might not be viable as stand-alone operations but may continue to operate based on their contribution to the business line.

If pollution restrictions limit production of industry output, profitability may be affected. There may be different profitability impacts for new versus existing firms. This may be the case, for example, with vintage-differentiated regulation that imposes less rigorous pollution controls on

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30 The firms experiencing less-stringent regulation might be more likely to see expanding market shares relative to their counterparts, though some empirical evidence suggests this is not the case (Tietenberg 2006 citing Pashigian 1984 and Pittman 1981; Greenstone 2002).

31 Shadbegian and Wolverton (2010) survey the plant location literature which suggests that firms reallocate production (Gray and Shadbegian 2010), plant entry (List et al. 2003), or plant exit (Kahn 1997) in response to environmental regulations.

32 For example, the EPA's documentation for its power sector model, IPM, includes detailed information on power plants that have made public announcements of future closures, and this information can inform a baseline analysis (U.S. EPA 2024a).

existing relative to new firms.[33] If market demand is increasing, new firms can enter but face higher costs which negatively impact profitability. Existing firms can benefit through newly created scarcity rents, with positive impacts on profitability. Over the long run, the likelihood of plant closures may change if older plants with higher emissions are kept in operation for longer than was expected in the baseline scenario.

Analysis of impacts on regulated firms' financial conditions involves the use of available financial data. Impacts can be assessed by examining direct compliance costs as a percent of a firm's average revenues, profits, or sales. An upper-bound assumption is that compliance costs are borne entirely by the regulated industry (i.e., none are passed through to consumers). When data allow, assessing the ratio of regulatory costs to profits is useful.[34] Due to data limitations, analysts may only have access to industry average revenues or sales. Calculating the ratio of full compliance costs to average firm revenues gives some sense of the magnitude of compliance activities relative to production activities without directly addressing the effect on profitability. When data on firm profits are available, the ability of firms to pass costs through to prices should be considered.

Additional challenging issues affect ex-ante analysis of the effect of compliance spending on profitability. First, economic models are simplified representations of complex economic systems. They can be useful for estimating effects on groups but often are not reliable predictors of firm or facility-level decisions.[35] Second, common simplifying assumptions about firm decision-making include *perfect foresight*, where agents know precise values for all economic variables in all future years, and *perfect information*, where precise values drive decision-making so that a one-cent difference between costs and revenues can be the difference between continued operation versus closure.[36] Such assumptions may perform well when describing aggregate behavior, but they often run counter to the everyday complex and uncertain decision-making by managers, which is remarkably difficult to model.[37] There is typically little information regarding the economic decision maker's expectations about the future (e.g., the firm's profitability, costs, revenues and market conditions) and how those expectations respond to new conditions, such as a new regulation. Indeed, many decisions are multi-faceted.

For example, management decisions about plant closures often result from the cumulative effect of multiple factors, such as financial distress, unfavorable market conditions and aging equipment, rather than any single factor such as a new environmental regulation. Finally, facility-specific, rather than firm-specific, financial information is preferred for assessing profitability and particularly for assessing the likelihood of plant closures. However, it is often difficult to find. For instance, while financial data for publicly held companies is available, it is often too aggregated to shed light on specific business practices or management decisions. For these reasons it is important

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33 See Tietenberg (2006) Chapter 21 for more discussion and for references to literature finding evidence of a new-source bias in environmental regulations.

34 Several sources in Table 9.2 provide information on industry profitability. See the table entries labeled, "New York University, Margins by Sector," and "Internal Revenue Service, Statistics of Income."

35 Some models use "model plants" to represent specific plant or unit types and solve a linear programming problem by choosing compliance strategies to minimize costs across the model plants (see Section 8.4.3).

36 This is referred to in the literature as the "penny-switching effect." See Krey and Riahi (2009).

37 The financial literature points to managers' individual characteristics and biases that can affect corporate decision-making, e.g., risk aversion, confident or pessimistic approaches, misestimation of financial market data, or loss aversion. For a brief survey of the literature on behavioral corporate finance, see Malmendier and Tate (2015).

for analysts to describe the main limitations of the analysis when evaluating the incremental impact of a regulation on firm profitability or the likelihood of plant closures.

9.5.1.3 Impacts on Small Businesses

The RFA requires agencies to define small business according to the Small Business Administration's (SBA) small business size standard regulations.[38] As another option, the RFA authorizes any agency to adopt 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. If adopted, the agency must publish the alternative definition in the Federal Register. The analytical tasks associated with complying with the RFA include a screening analysis for "significant economic impacts on a substantial number of small entities" (SISNOSE). The small businesses to be included in the analysis are those that are directly regulated; that is, those that are subject to the rule's requirements. If a small business does not have an obligation imposed directly by the regulation, then EPA guidance is that it should be excluded from the analysis.

Care should be exercised when distributing regulatory costs experienced by small businesses over multiple years. The annualization of compliance costs should rely on an estimate of the private discount rate that reflects the cost of capital. In general, the private discount rate will reflect the risk associated with the regulated entity in question. The cost of capital will also be affected by the ability of affected firms to deduct debt from their tax liability.

Some small businesses may be liquidity constrained and find it challenging to spread costs over multiple periods as they may face difficulty in raising external capital, including external debt. This issue may differentially affect women-owned, minority-owned, rural small businesses and very small businesses (firms with revenues less than $100,000 annually) (Federal Reserve Banks 2023, 2024, Morazzoni and Sy 2022, Fairlie et al. 2020, Cole 2020). For example, the Federal Reserve Banks (2023) analysis finds that even though startups by people-of-color are just as likely to apply for financing through financial institutions/lenders as are startups by White individuals, they are less likely to receive the requested funds. Analysts should consider whether the costs faced by liquidity-constrained small businesses are best modeled as being fully incurred during the year in which they are borne.

In order to determine SISNOSE, the EPA conducts a screening analysis for both proposed and final rules based on a percentage of sales as an economic impact for small businesses (a "sales test") (U.S. EPA 2006a).[39] While the analytic objective includes better understanding the effect of regulatory costs on profitability, on the likelihood of plant closure or plant cutbacks, and so on, in practice sparse data on profitability often limits an analysis to examining compliance costs as a percent of average firm revenues or sales. As discussed in Section 9.5.1.2, ex-ante analysis of the effect of compliance spending on profitability presents a difficult challenge.

"Small Entities" are defined by the RFA but "substantial number" is not specified. The EPA has broad guidelines including example thresholds for determining SISNOSE certification, but generally recommends three factors in determining "significant impact" and "substantial number":

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38 See U.S. Small Business Administration (2022) for SBA's size standards.

39 See also Chapter 2. For a discussion of the screening analysis for small governments and small non-profits, see Section 9.5.4.

1. Magnitude of economic impact that may be experienced by regulated small entities;
2. Total number of regulated small entities that may experience the economic impact; and
3. Percentage of regulated small entities that may experience the economic impact.

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. Further analysis examining other types of impacts, as discussed elsewhere in this chapter, in relation to small businesses, may provide additional information for decision makers.[40]

9.5.1.4 Impacts on Labor

Evaluation of employment impacts is required by many of the major environmental statutes.41 Impacts can vary according to baseline labor market conditions; employer and worker characteristics such as industry, occupation, skill-level and region; and the type of workforce adjustment or job transition. Employment impacts may occur in the regulated and environmental protection sectors, in upstream or downstream sectors, or in sectors producing substitutes or complements. As economic activity shifts in response to a regulation, typically there will be a mix of declines and gains in employment in different parts of the economy over time. This section focuses on labor demand[42] and on employment impacts measured as changes in employment levels. An employment impact analysis will describe both positive and negative changes in employment to present a complete picture. For most situations, employment impacts are assessed as part of an EIA, and should not be included in the formal BCA.[43] See Text Box 9.1, above, for a discussion of social costs and employment effects within BCA.

When the economy is at full employment as in long-run equilibrium, a regulation may reallocate employment among economic activities rather than affect the general employment level, and in the short-run may lead to transitional employment effects, such as workers involuntarily separated from their jobs (Arrow et. al. 1996, Hafstead and Williams 2020).

Economic theory of labor demand indicates that employers affected by environmental regulation may increase their demand for some types of labor, decrease demand for other types, or for still other types, not change it at all. A variety of papers have provided frameworks for understanding the employment impacts of regulation. Morgenstern et al. (2002) decompose the labor consequences in a regulated industry facing increased abatement costs. They identify three separate components. First, there is a demand effect caused by higher production costs raising market prices. Higher prices reduce consumption (and production) reducing demand for labor within the regulated industry. Second, there is a 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 that require additional labor services to produce the same level of output.

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40 See EPA Final Guidance for EPA Rulewriters: Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act (U.S. EPA 2006a) for details on complying with the RFA.

41 Relevant statutes include the Clean Air Act, section 321(a); the Clean Water Act; section 507(e); the Toxic Substances Control Act, section 24; the Solid Waste Disposal Act, section 7001(e); and the Comprehensive Environmental Response, Compensation and Liability Act, (section 110(e).

42 See Section 9.5.6 and Chapter 7 Section 7.2. for examples of how environmental regulation may also affect labor supply through changes in worker health and productivity (e.g., Graff Zivin and Neidell 2012, 2013, 2018).

43 Except to the extent that labor costs are part of total costs in a BCA.

Third, there is a 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). A different paper, Deschênes (2014), describes environmental regulations as requiring additional capital equipment for pollution abatement that does not increase productivity. This can be included in a labor demand model as an increase in the rental rate of productive capital. These higher production costs induce regulated firms to lower output and decrease labor demand (an output effect) as well as shift away from the use of more expensive capital toward increased labor demand (a substitution effect).[44] Berman and Bui (2001) discuss how affected firms' overall labor demand could increase, decrease or remain unaffected, depending, in part, on the labor-intensity of environmental protection activities needed for regulatory compliance compared to the labor-intensity of producing output. To study labor demand impacts empirically, a growing literature has compared employment levels at facilities subject to an environmental regulation to employment levels at similar facilities not subject to that environmental regulation; some studies find no employment effects, and others find significant differences. For a review of recent empirical evidence, see Gray et al. (2023).

In practice, an EIA evaluates potential changes and shifts, positive and negative, in employment levels by industry or other affected groups, and describes transitional employment effects for affected groups of workers. While employment impacts are measured as changes in employment levels by industry or affected group, workers affected by changes in labor demand due to regulation may experience a variety of transitional effects including job gains or involuntary job loss and unemployment (Smith 2015; Schmalensee and Stavins 2011; Congressional Budget Office 2011; and OMB 2015). Transitional, or adjustment, costs may occur as workers shift out of current employment and into other, potentially less desirable jobs (for example, jobs that are lower paying or in a less desirable location); or into unemployment; or exit the labor force sooner than otherwise (Walker 2013). Workers involuntarily displaced from declining industries or occupations, with long job tenure, or living in areas where labor mobility is low or unemployment is high, may be especially likely to face challenges in finding comparable re-employment (Baumol and Oates 1988). If displaced workers' job search challenges are significant and keep them from employment, then from a resource perspective, their labor is underutilized, similar to a stranded asset.[45] Involuntary job loss can lead to significant earnings losses for displaced workers, and may involve periods of unemployment as well as other impacts, such as negative health effects (Jacobson, LaLonde and Sullivan 1993; Sullivan and von Wachter 2009a, 2009b).[46] Text Box 9.2 discusses involuntary job loss, unemployment impacts and health and wealth effects.

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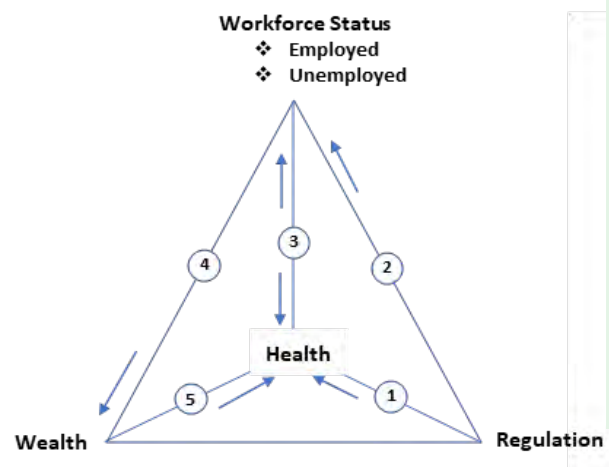
44 For an overview of the neoclassical theory of production and factor demand, see Chapter 9 of Layard and Walters (1978). For a discussion specific to labor demand, see chapter 4 of Borjas (1996). When using this theoretic framework, authors have conceptualized regulation as an increase in the price of pollution (Greenstone 2002; Holland 2012), an increase in the price of capital (Deschênes 2014), an increase in energy prices (Deschênes 2012), an increase in pollution abatement costs (Morgenstern et al. 2002), or with pollution abatement requirements modeled as quasi-fixed factors of production (Berman and Bui 2001).

45 Worker displacement can ultimately affect communities' provision of public services. See Morris et al. (2019) and Black et al. (2005) for examples of coal mining-reliant counties In Appalachia. See Section 9.5.3 for discussion of impacts on communities.

46 Involuntary job loss refers to job displacement that results from employer decisions and that is unrelated to worker performance, e.g. plant closings, mass layoff events and other firm-level employment reductions (Farber 2017; Sullivan and von Wachter 2009b; Chan and Stevens 2001).

Text Box 9.2 - Unemployment Impacts, Health, and Wealth

Empirical studies indicate unemployment is associated with increased mortality risk for those in their early and middle careers, but "whether unemployment is causally related to mortality remains an open question … and recent research has begun to focus on possible confounding, mediating and moderating factors" (Roelfs et al. 2011, p. 2). The figure below shows the complex relationships most related to *environmental* regulation between workforce status, regulation, wealth and health. As line (3) indicates, a bi-directional relationship exists between unemployment and health. Causality is difficult to identify for the unemployed population: increased mortality risk may be caused by unemployment itself, independent of pre-existing health status, or it may be caused by a decline in health resulting from a workforce status change (e.g., job loss, unemployment). The first causal pathway is potentially informative for regulatory analysis, but many studies lack detail to isolate it.



1. *Environmental regulation protects human health.*
2. *Employment impacts (e.g., workforce adjustment).*
3. *Workforce status affects health; health affects workforce status.*
4. *Workforce status affects wealth (e.g., unemployment reduces wealth).*
5. *Wealth affects health.*

A nascent economic literature uses detailed worker data to explore the effect of plant closures or mass layoff events on health. Sullivan and von Wachter (2009b) find increased mortality rates among displaced male workers with long job tenure in Pennsylvania and, in a study of displaced Austrian male workers, Kuhn et al. (2009) find that involuntary job loss negatively affected mental health. A study of plant downsizing in Norway found that displaced workers were more likely to utilize disability pensions than comparable workers in non-downsized plants (Rege et al. 2009). In a meta-analysis of studies on unemployment and health, Picchio and Ubaldi (2023) find on average a small negative effect of unemployment on health and, when the identification strategy relies on exogenous unemployment shocks like plant closure, the effect becomes smaller. Positive health impacts of moving from unemployment to a job may also exist (e.g., decreased depression) (van der Noordt et al. 2014).

The economics literature has found connections between wealth and health (indicated by line (5)). Sullivan and von Wachter (2009a) find that higher variability of earnings is associated with increased mortality. Dobkin et al. (2018) find that adverse health events measured by hospital admissions can lead to reduced earnings and increased risk of bankruptcy for those without health insurance.

The utility of these findings for regulatory analysis depends on whether involuntary job loss and unemployment are expected impacts. The prospect of such an impact is shown by line (2). If expected, the analysis may describe the likelihood of plant closures and employment impacts for affected workers. But analysts should use caution transferring published empirical estimates on adverse health impacts. Some studies use samples that may not correspond well to affected

workers in the policy scenario and some lack detailed data on key worker characteristics (e.g., "involuntariness" of job separation (Sullivan and von Wachter 2009b); if job loss was health-related (Burgard et al. 2007).

While regulatory analyses may estimate employment impacts of regulations, it is challenging to identify associated job displacement at the firm- or plant-level. Both Curtis (2018) and Hafstead and Williams (2018) find workforce adjustments occur through reduced hiring rates rather than increased job separations. Reduced hiring rates could still imply that workers spend more time unemployed, though this may have a smaller impact than increased job separations. In a survey of firms experiencing mass layoffs, government regulation is rarely a stated reason (U.S. BLS 2011). More research is needed.

Workforce adjustments can be costly to firms as well as workers, so employers may choose to adjust their workforce gradually over time through natural attrition (retirements, voluntary separations) or reduced hiring, rather than incur costs associated with job separations (layoffs or other firm-level employment reductions). Curtis (2018) estimates changes in industry employment levels over time due to an environmental regulation and finds that changes occurred slowly through reduced hiring rates, and not through increased job separations. Hafstead and Williams (2018) find a similar result for the regulated sector, of employment levels decreasing through slow hiring and natural attrition rather than increased separations, when modeling a carbon tax.

As a result of shifts in the demand for labor, environmental regulation might also induce wage effects. However, firms generally avoid adjusting existing employees' wages downward (Walker 2013; Curtis 2018). Nominal wage rigidity has been attributed to many causes, not least is the potential impact of lowering wages on employee morale (Howitt 2002). Another factor suggesting very limited wage impacts in the specific context of environmental regulation, is that regulated firms are often a fraction of employers in affected labor markets and thus are not influential enough to affect industry wage rates (Berman and Bui, 2001).

The remainder of this section describes practical approaches to employment impacts analysis.

Estimating Labor Impacts: An employment impact analysis provides a baseline profile of potentially affected employers and workers, labor market conditions and possibly potentially affected communities. The analysis discusses or estimates potential changes or shifts in employment due to a regulation. Both positive and negative employment changes should be examined, including for example, possible employment impacts in the regulated sector as well as the environmental protection sector. When feasible, analysts can describe direct changes expected in the use of labor by the regulated sector for compliance requirements.[47] In cases where impacts are anticipated, and if data and modeling allow, analysts can describe employment impacts due to changes in production, revenues or expenditures by the regulated sector and potentially also by related sectors.

A baseline employment profile may include the size of the affected labor force, the degree to which affected labor markets are concentrated among few employers, the amount of labor mobility, job turnover, job search rates and the affected workers' regional or occupational unemployment

47 These labor costs (in dollars) are already included in the cost analysis of an RIA as they are costs to regulated firms (see Chapter 8 for more information). They can also be described within an employment impact analysis, and may be converted from dollar value labor costs to numbers of employees, or annual full-time equivalent (FTE), etc.

rates.[48] Recent employment trends may be relevant. Characteristics of affected workers, such as sector, industry, occupation, earnings, experience and job skills, may be described. If employment impacts are expected to be concentrated in certain communities, those communities could be characterized. Table 9.2 lists examples of possible data sources that may be helpful in developing a baseline employment profile.

To examine the incremental impacts of a regulation on employment, analysts should keep in mind that labor demand may be affected differently in the short-run compared to the long-run. For example, the RIA for the 2024 New Source Performance Standards for Greenhouse Gas Emissions from Certain Units includes employment impact estimates for the power sector both for short-run effects (e.g., construction-related employment needs) as well as long-run or recurring non-construction employment due to shifts in the use of fuels in electricity generation (U.S. EPA 2024b).

For many regulations, assessing employment impacts will be limited to a qualitative discussion. It will include the baseline profile described above, and the likely direction of change of employment levels in affected sectors and occupations. A discussion of any concentrated employment impacts, regionally or otherwise, would be useful. Information on the ability or limitations of workers to respond to shifts in labor demand should be considered.

A quantitative analysis may project changes in employment in affected sectors by occupation or among other groups of workers (e.g., by region). The quantitative estimates can use information from the compliance cost analysis if the labor requirements for expected compliance activities are provided. Examples of compliance activities include installation, operation and maintenance of pollution control equipment; as well as monitoring, inspecting, reporting and recordkeeping. For example, the RIA for the EPA's Safer Communities by Chemical Accident Prevention Final Rule included estimates of changes in the number of labor hours required for compliance activities among different occupations and for different sized facilities.[49] Its analysis of labor impacts examined how many total labor hours on average per year would be required for certain provisions, and whether new workers would likely be hired. The analysis discussed which rule provisions would likely require additional labor hours, the occupations of workers needed, and whether the work was short- or longer-term.

In quantitative analyses, aggregated labor hours should be converted to estimates of annual average job-years or full-time equivalents (FTEs).[50] When these estimates are small relative to average employment at a representative facility or firm, a reasonable assumption may be that existing employees or contractors would take on the tasks for regulatory compliance rather than a facility or firm adjusting the size of its workforce.

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48 See, for example, Smith (2015) on local labor market conditions and unemployment, and Baumol and Oates (1988) Chapter 15, on reemployment prospects and consideration of workers in communities characterized by one or two large employers.

49 See U.S. EPA (2023a).

50 A job-year is not an individual job and is not necessarily a permanent or full-time job. Instead it is the work performed by one FTE employee in one year. For example, 20 job-years may represent 20 full-time jobs or 40 half-time jobs in a given year, or any combination of full- and part-time workers such that the total is equivalent to 20 FTE employees. In practice, for example, if the cost analysis for a regulation estimates a need for 1 million labor hours per year in the regulated sector to conduct compliance activities, this could be converted to approximately 480 job-years by dividing 1 million by the annual work hours for a full-time employee, which equals 2,080.

While transparent, the quantitative approach just outlined only addresses a subset of employment impacts as it does not address shifts in labor demand associated with potential changes in output in the regulated, or related, sectors. When a regulatory cost analysis project shifts in output due to compliance costs or shifts in the composition of production within the regulated sector (e.g., shifts in the electricity generation fuel-mix) a more detailed analysis may be possible. In these specific cases, analysts can estimate employment impacts by multiplying the change in output by the average amount of labor per unit of output (or per value of shipments) in the sector. This gives an approximation of the output effect, a potentially important type of employment impact.[51] The U.S. Census and U.S. Bureau of Labor Statistics (BLS) provide estimates of the units of labor associated with expenditures (or value of output/sales) at the industry-level. A limitation of this type of analysis is that in practice producer-level employment impacts will likely differ from aggregate, industry-level employment impacts. For example, relatively more efficient firms may expand output (and employment) to pick up the slack as less efficient producers contract (Jaffe et al. 1995; Tietenberg 2002; and Christiansen and Tietenberg 1985).

Detailed industry information is useful to develop disaggregated employment estimates for related sectors. For example, as part of estimating labor impacts in regulatory analyses of air pollution regulations affecting the electric power sector, the EPA examined coal mining by region.[52] The EPA combined estimates of changes in coal demand with detailed estimates of coal supply and regional coal mining productivity data available from the U.S. Energy Information Administration (U.S. EIA). Labor productivity differed significantly across geographic regions, e.g., in 2018 labor productivity in Virginia was 2.07 short tons of coal per labor hour, in Texas it was 6.73, and in Wyoming, it was 26.63 (U.S. EPA 2023b). This level of detail informed the analysis of employment impacts.

Approaches for estimating the employment impacts of environmental regulation are evolving. Analysts are encouraged to engage the EPA's National Center for Environmental Economics early in the process when developing a strategy for evaluating the employment impacts of a regulation. Analysts should describe the methods used in a quantitative employment impacts analysis – whether it analyzes changes in pollution abatement activities alone or combined with changes in production – and explain analytical limitations, which might include:

- Use of an estimation approach that produces *partial* employment impacts and does not fully measure all potential changes in regulated and related sectors.
- Application of average labor-to-cost or labor-to-output ratios instead of the change in labor expected in response to incremental increases or decreases in costs or production.
- Estimation of labor-to-cost, or labor to-output, ratios at the industry-level that reflect the labor component of pre-regulation costs or production rather than post-regulation costs or production. This is a limitation because such ratios can be influenced *by* the regulation.
- Use of available labor ratio data that may be for industrial sectors not well-aligned with the affected sectors.
- Heterogeneity of firm- or facility-level responses to regulation, especially those of marginal facilities operating at the tail end of productive efficiency, may be glossed over by labor ratio data typically available at the sector level only.

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51 Data on labor per unit of output would be a proxy for the overall effect on labor demand in the regulated sector. These data are based on past production processes and therefore are not directly useful for measuring a substitution effect between labor and other productive inputs when compliance activities are required in the regulated industry.

52 U.S. EPA (2023b), "U.S. EPA Methodology for Power Sector-Specific Employment Analysis."

Cautionary Notes: Analysts should proceed with caution regarding the following approaches sometimes used to estimate quantitative employment impacts of regulation.

Transferring Certain Empirical Estimates: Morgenstern et al. (2002) estimated the effect of pollution abatement expenditures on the quantity of labor in four highly polluting and regulated industries. However, a later attempt to replicate and extend this research failed. 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 the 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."[53] We highlight Morgenstern et al. (2002) because of its prominence in the prior edition of the EPA's *Guidelines for Preparing Economic Analysis* (2010). The theoretical model in Morgenstern et al. (2002) remains valid.

Input-Output Analysis: As described in Section 8.3.4.1, input-output analysis can provide employment impact estimates. This type of analysis is most suitable for analyzing detailed sectoral impacts of regional, state, or local policies in the short term. In general, input-output models should not be used for estimating impacts of national regulations because they do not allow prices, production processes or technologies to adjust over time. As a result, they represent a very short-term response to regulation and are better equipped to represent the response of a single region to a small regulatory change which is not expected to affect prices.[54] They are of limited use for analyzing large regulatory changes or regulations that are national in scope.[55]

Plant Closures and Employment*:* Section 9.5.1.2 discusses difficulties in assessing the likelihood of plant closures given a dearth of data and a limited ability to model key factors, such as expectations of future profitability. Even in cases when estimates of the likelihood of plant closures are available, estimating employment impacts from them can be difficult. Employment impacts associated with plant closures may differ from the projected decline in plant output. Firms face labor adjustment costs, and, for example, multi-plant firms may choose to transfer workers, potentially those more skilled and experienced, to other locations (Ferris, Shadbegian and Wolverton 2014). Or, as noted above, production and employment may shift between firms, away from higher cost plants towards more efficient competitors. Such heterogeneity implies that employment impacts at the firm or plant-level can differ in direction from industry-level employment impacts. Analysts should consider these possibilities.

9.5.1.5 Impacts on Other Productive Factors: Land and Capital

In addition to labor impacts, environmental regulation can lead to changes in the demand for, and value of, other factors of production employed by regulated firms. Economists label these other factors of production as land (any natural resource), and capital (any man-made resource). In general, environmental regulation is expected to have varying effects across factors, and tracing

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53 Quote is from Belova et al. (2015). Note that Belova et al. (2013a) inside the quote is identical with Belova et al. (2013), cited above.

54 Even for regional analyses, input-output models tend to overestimate impacts. "They typically include exogenous multipliers that magnify direct effects on output and employment based on the assumption that all new economic activity will recirculate within the regional economy. Input-output models tend to ignore displacement of workers or resources that might occur outside the region under analysis" (U.S. EPA 2011).

55 The underlying data can be useful for identifying related sectors, e.g., upstream and downstream.

impacts back to specific factors is difficult (Fullerton 2009). Estimating changes in the quantities demanded of broad categories of land and capital is more practical.[56] There are two separate and valid ways to represent the value of factors of production: earnings per period (also called rates of return) or asset values. The latter is the discounted present value of the future stream of earnings generated by the productive factor.

The relationship between changes in regulated firms' price and quantity of output, and changes in their factor demands or factor returns, can be complicated. In response to stricter environmental regulation, factors used intensively by the regulated industry might experience reduced demand and/or returns. If a unit of capital is not perfectly mobile, or a type of natural resource is taken out of production, it may lose value and impose a burden on the owners (Fullerton and Muehlegger 2019). For example, if a regulation induces firms to switch from high-carbon coal to lower emitting natural gas, then the value of coal will decline, and the stock value of coal-intensive businesses could decline as well. How fast an asset may return to production will affect the extent of burden. A coal mine that closes may become valueless as the land may be quite difficult to switch to a different use. It could even become a liability. Factors that are complements to pollution abatement might experience an increase in demand or returns; while those that are highly mobile with similarly valued alternative uses should hold their value. There are two general expectations for the long-run response to environmental regulation. One is for land and capital to shift away from high-emission activities toward lower emitting ones, including the environmental protection sector; another is for land and capital to shift towards less regulated uses. Regionally differentiated impacts on capital and land are possible when the stringency of pollution control varies by region.

To estimate how the costs of compliance are passed through to and distributed across productive factors, analysts need the cross-price elasticities between these factors. When this is not available, analysts can examine current production practices and the input biases of anticipated abatement activities to inform a qualitative discussion of likely impacts on productive factors.

In general, income earned from ownership of land and capital (or of firms) tends to make up a greater proportion of earnings for higher-income households. Thus, an increase in regulatory costs passed through to households via lower returns to capital tend to be progressive, placing a greater share of the burden on wealthier households.[57] The magnitude of the impact on owners and investors depends on the proportion of their portfolio affected by the change.

A different impact on factors of production stems from improved environmental quality which can be capitalized into the price of nearby land, and buildings (including housing). The increase in property or asset values accrues to the owners at the time of the improvement.[58] The degree to which the land and buildings are owner-occupied versus rented, and the degree to which the increased value is passed on in the form of higher rents, will influence who experiences positive versus negative impacts of the environmental improvement. If landlords increase rents to the point of forcing out renters, then the renters may experience transitional impacts from relocation activities. Identifying how owners and renters respond to improved environmental quality is a complicated exercise and quantitative analysis is challenging. A qualitative discussion can be useful. Related literature and modeling challenges are discussed in the final paragraphs of Section 10.2.1.

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56 Land and capital may also be rented or supplied under contract. When not owned by the regulated firm, the impacts are considered upstream, as discussed in Section 9.5.1.6.

57 For more details, see Rausch et al. (2011) or Fullerton and Metcalf (2002).

58 If land improvements are concentrated and substantial, there could be community-wide effects. See Section 9.5.3 for a discussion of impacts on communities.

9.5.1.6 Impacts on Related Markets

An environmental regulation may affect markets other than those that are directly regulated. Related markets may be positively affected, such as those in the environmental protection industry or those producing substitutes; or negatively affected, such as those producing complements, or those who are up- or downstream from the regulated industry (note that the environmental protection sector may overlap with upstream markets). 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 ones will be burdened. Consumers in the related markets may experience impacts as well (see Section 9.5.2). Downstream impacts may accrue to firms who purchase the regulated firms' outputs. In general, when analyzing related markets, analysts should consider the same potential impacts as for directly regulated markets.

If substantial impacts on related industries are expected, it will be useful to include firm sizes, profit margins, growth rates and more, in a baseline profile of the related industries. For instance, when the regulated sector sells an intermediate good or service (e.g., electricity), questions that might be relevant include: What proportion of the purchasing firms are small or face narrow profit margins? Are substitute inputs readily available? What proportion of the purchasing firms' spending goes to the regulated firms?

Partial equilibrium models that represent significantly affected, related markets may be useful, although sparse data and resources may limit their use. For regulations that are expected to substantially affect many related markets, an economy-wide model as described in Section 9.5.5 might be considered, though the additional conditions described there should also be satisfied.

9.5.1.7 Impacts on Energy Supply, Distribution or Use

EO 13211 (2001) directs agencies to prepare a Statement of Energy Effects 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."[59] OMB guidance suggests that adverse effects could include any of the following:

- 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 KWH per year or in excess of 500 MW 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%;
- Increases in the cost of energy distribution in excess of 1%; or
- Other similarly adverse outcomes.

A regulatory action also may have adverse effects if it is likely to:

- Adversely affect, in a material way, productivity, competition or prices in the energy sector;

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59 See Section 2.1.6 and especially see OMB (2001).

- Adversely affect, in a material way, energy productivity, competition or prices within a region;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency regarding energy; or
- Raise novel legal or policy issues adversely affecting the supply, distribution or use of energy arising out of legal mandates, the President's priorities or the principles set forth in EOs 12866 (1993) and 13211 (2001).

For actions that may be significant under EO 12866 (1993), particularly for those that impose requirements on the energy sector, analysts must be prepared to examine the energy effects listed above.

9.5.1.8 Impacts on Domestic and International Competitiveness

Competitiveness impacts are regulatory impacts that change the distribution of market power among firms or sectors, either domestically or internationally. Unfair advantage may accrue to producers that are free from regulatory constraints, or that face less expensive regulation. Or, high fixed costs that are incurred to comply with environmental regulation may cause production to become concentrated among fewer firms, enhancing their monopoly profits over the long run. Regulatory constraints may differ among specific subsets of sectors or firms: existing versus new, or small versus large.[60] If some firms find it less costly to comply with a regulation, they may benefit competitively at the expense of other regulated firms. Analysts may wish to consider the extent to which production is shifted toward plants with higher-than-average productivity (Jaffe et al. 1995).

As with other impact categories, the extent to which a regulation leads to effects on competitiveness depends on the interaction between the regulated firms' absorption of compliance costs and their market structure.[61] In general, greater compliance flexibility is expected to reduce competitiveness effects.[62]

A first step to gauge the potential for competitiveness effects is the baseline profile of affected industries. The profile should identify which domestic and international firms compete with regulated entities, and their basic market structures. Do competitors face expensive environmental regulation? Is the output produced by regulated firms differentiated from that of competitors, potentially reducing impacts on competition? The literature suggests an increased likelihood of competitiveness effects for industries in which compliance costs are high relative to total production costs.[63]

Consideration of the impact of new environmental regulation in three key areas is particularly germane to competitiveness effects. First, lack of access to debt or equity markets to finance market entry, including regulatory costs, can represent significant barriers to entry.[64] Over the long run, this can change market structures and reduce competitiveness. Second, a regulation may have an

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60 Section 9.5.1.2 discusses the impacts of differentiated regulation that occurs when existing firms are regulated with greater leniency than new firms.

61 The importance of this interaction is discussed by Iraldo et al. (2011).

62 Evidence for this is presented by Iraldo et al. (2011) and Jaffe et al. (1995).

63 See Iraldo et al. (2011).

64 See the discussion about small business access to credit In Section 9.5.1.3.

impact on market concentration. A potentially useful measure of concentration is the Herfindahl-Hirschman index (HHI), which is the sum of the squares of the market shares of each firm in a given market. The U.S. Department of Justice uses the HHI to estimate changes in market concentration due to mergers and acquisitions. Post-merger HHI values that are below 1,000 are considered "unconcentrated," between 1,000 and 1,800 are regarded as moderately concentrated and above 1,800 are considered highly concentrated.[65]

Finally, the impact of regulation on the market position of domestic firms relative to their foreign counterparts is important. Domestic environmental regulations may have global economic implications because the costs of domestic producers increases relative to foreign producers.[66] Analyses of impacts on international competitiveness have been concentrated on the most pollution- or energy-intensive and most trade-exposed industries because they are most likely to face regulatory requirements and least able to pass compliance costs to consumers.[67] For example, in the context of unilateral climate policy, proposed legislation has focused on potential competitiveness impacts on trade-exposed domestic energy firms.[68] Quantifying these effects can be complex and may require a multi-country computable general equilibrium model. There are three classes of indicators of impacts on international competitiveness: the degree to which net exports change, the degree to which production shifts overseas (i.e., pollution haven effect), and the relative change in investment from domestic (regulated) producers to producers in other countries (Jaffe et al. 1995).

9.5.2 Impacts on Consumers

Measuring impacts on consumers is straightforward when environmental policy regulates consumer behavior. Requirements for automobile emissions tests or product bans such as the Final Rule on Methylene Chloride in Paint and Coating Removal for Consumer Use (U.S. EPA 2019) have impacts on consumers through time costs and fees. More frequently, environmental regulatory requirements are imposed on producers. In these cases, there is a less obvious potential impact on consumers as a result of producers passing through or transferring regulatory costs to purchasers of their products through increased prices. To understand cost pass-through to consumers, analysts typically examine the expected impacts of a regulation on prices of final goods. Also relevant are the characteristics of consumers purchasing the goods. Of course, firms may also be consumers of regulated products and as such are covered in Section 9.5.1.6 "Impacts on Related Markets."

New environmental requirements typically raise the cost of production in directly regulated industries, causing an upward shift in the market supply curve (that is, an increase in the price

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65 For more information, see https://www.justice.gov/atr/herfindahl-hirschman-index.

66 A related literature examines how differences in environmental regulation across countries, states, or sectors may result in increased emissions in less regulated countries, also called emissions leakage. For instance, see Bohringer et al. (2012) and Fischer and Fox (2012).

67 Carbone and Rivers (2017) discuss the impacts of environmental regulation on international competitiveness. In general, the literature has found relatively small effects (Jaffe et al. 1995; Aldy and Pizer 2015; Carbone and Rivers 2017). Jaffe et al. (1995) point out that concerns about industry competitiveness may also ultimately affect consumers as net exports decline and in the long-run imported goods become more expensive as the economy returns to balanced trade.

68 For a survey of the literature on competitiveness impacts of unilateral climate change policy, see Carbone and Rivers (2017). For a policy relevant discussion, see U.S. EPA (2016).

producers require for each quantity supplied). In response, consumers will do without or with less of the product, and/or pay a higher price, thus bearing some of the burden of regulatory costs.

A good starting point to analyze potential impacts on consumers purchasing output from the regulated sector is to gather information on the determinants of the elasticity of demand relative to the elasticity of supply for the affected goods. To gauge elasticity of demand, a useful consideration is whether the product is considered necessary by the purchaser, has many substitutes or its purchase makes up a substantial portion of the consumer budget.[69] Consumer impacts may be smaller if there are good substitutes that are comparably priced causing a high demand elasticity and smaller price change. There also may be small changes in output prices if compliance expenditures are low relative to total production costs.

To gauge elasticity of supply, analysts should assess how easily firms can increase or decrease production quantities. Information on the flexibility of capital equipment and buildings for shifting into different types of production would be useful; for example, understanding whether excess capacity can be used to produce comparably valued output.

The characteristics of the regulated industry also influence the share of costs passed on to consumers.[70] Under noncompetitive conditions, when firms in the regulated industry have market power, less cost-pass-through via prices is likely.[71] All else equal, if the same compliance requirements are placed on two markets that differ in terms of the degree of competition among firms, the one with less competition (e.g., due to barriers to entry such as restricted access to a scarce natural resource) will generally bear a higher share of those costs than the more competitive market. For firms with market power, raising price will lower sales; therefore, these firms will generally absorb some portion of regulatory costs (Tietenberg 2006). A market consisting of producers that have different cost structures, perhaps because they use different technologies or are of different sizes or ages, will lead to heterogeneity in the degree of pass-through of compliance expenditures. Finally, the structure of related markets may affect cost pass-through. For example, Preonas (2023) finds that distortions in the rail industry (an upstream market to the regulated one) led railroads to reduce coal markups when downstream power plant demand for coal declined. This suggests that regulatory costs faced by an industry may sometimes be partially absorbed by related markets, shielding consumers from price increases.

A qualitative discussion of the factors that can affect impacts on consumers may be useful. However, analysts may be able to locate empirical estimates of demand and supply elasticities. If possible, analysts should select elasticity estimates that reflect the focus of analysis. For example, to understand potential differences in the pass-through of regulatory costs into prices over time, analysts should examine estimates of elasticity in the short-run compared to the long-run; to understand differences in cost-pass-through across communities, analysts should examine regional demand elasticity measures.

Combining an estimated price increase with information on the share of the consumer's budget spent on the product will improve understanding of the impacts on households. There is a possibility that budget shares may vary substantially across consumers. Even if price increases are small, specific groups of consumers may still be affected if the product is a necessity for which low

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69 For more information about the determinants of elasticities, see Appendix A: Economic Theory, Section A.4.1 Elasticities.

70 For cases when government or non-profit organizations are the producers, see Section 9.5.4.

71 For example, see Ganapti et. al. (2020) on incomplete pass-through of energy input costs and imperfect competition in the manufacturing sector.

income households spend a substantial portion of their budget. For example, the share of income spent on energy or water by low income households is larger than for others, so energy or water price increases may affect them more.[72] This effect may be strengthened by the flexibility among higher income households to purchase substitutes with substantial upfront costs such as efficient appliances. However, it is also important to consider whether existing government programs may help mitigate the impact of price increases on consumers.

If consumer impacts are expected to be nonnegligible, information on affected consumers such as their age distribution, income level or residential location should be gathered to contribute to a baseline profile. Nationwide averages of these variables may be appropriate if consumers are broadly distributed across the country.

In some cases, assessing the impact of a regulation on consumers can be complex.[73] Analyzing policies with limited use patterns such as pesticides or paint removers may be challenging due to inaccessible or sparse data. Other complicating factors are associated with goods for which price- or rate-setting is complex. For example, to explore the extent to which proposed air pollution control costs will be experienced by different electricity consumers, the analysis would need to include information on how the policy affects consumers served by cost-of-service utilities, compared to deregulated electricity providers. Any assistance available for low-income or other consumers to offset rate increases is also relevant; as is variability in consumption patterns among categories of customers. If regulatory costs are large, economy-wide models may lend additional insight into how impacts affect consumers across the economy (see Section 9.5.5). Such models may also examine the interaction with existing government transfer programs.[74]

9.5.3 Impacts on Communities

Environmental regulation may have significant impacts on some specific communities or neighborhoods. Facility closures or production curtailments provide an example of locally concentrated economic impacts that could be acute in areas with limited economic opportunities. Displaced workers who live in such communities may be especially challenged as they search for comparable re-employment. Out-migration by displaced workers and families may cause reductions in the demand for products in the local goods sector. Tax revenues may decline with negative impacts on the provision and quality of community public goods. As the local economy shrinks, property values may decline. For example, regulation on coal-fired power plants could have negative impacts on coal-dependent communities. Mine closures and employment cuts can affect others in the community as the economic base and local tax revenues decline (Baumol and

72 The share of income spent on energy falls as income increases. Some studies have found that policies that increase energy prices are regressive, placing a greater burden on lower income households (e.g., Burtraw et al. 2009; Hassett et al. 2009; Williams et al. 2015). Other studies account for the indexing of transfer payments to inflation and find that the burden of a carbon tax is roughly proportional to permanent income, and so is neither regressive, nor progressive (Cronin et al. 2019). See Deryugina et al. (2019) for a discussion of some of these energy policy studies.

73 Cory and Taylor (2017) conduct a detailed analysis of spending by low-income households and explore the potential impacts on health spending caused by price changes induced by safe drinking water standards.

74 Some government transfer payments like Social Security are indexed to inflation and may provide some protection of purchasing power for lower income households.

Oates 1988; Black et al. 2005; Morris et al. 2019).[75] Impacts of changing business conditions that spread across industries in the same community are often approximated by "local multipliers" (Moretti 2010; Osman and Kemeny 2022). Such multipliers measure the broader changes in employment and wage income across communities. When appropriate, analysis of baseline economic conditions at the community level can help identify where the regulated industry is a key driver of the local economy, signaling the potential for multiplier effects.

Community-level health impacts can be exacerbated by a combination of localized concentrations of emissions from one or more sources, and community-wide exposure to other stressors. Locations with such combinations of risks are often referred to as "hot spots." and may reflect baseline conditions or be caused or aggravated by environmental regulation. Relevant issues to consider may include proximity to multiple pollution sources, specific exposure pathways, and drivers of differential susceptibility. For a full discussion see EPA's Technical Guidance for Assessing Environmental Justice in Regulatory Analysis (2024d).

Localized improvements in environmental quality, such as hazardous site cleanup, can reduce health risks and improve local property values thereby increasing the local tax base, and potentially in the long run, increasing investments in local public and private goods. If low-income residents are largely renters, then they could be burdened by increases in land values and subsequent increases in rent due to improved environmental quality, while at the same time property owners could enjoy higher rent payments. Property owners who reside in their own homes may be burdened through property tax increases. The higher property taxes and rental payments may cause some residents to move. The turnover may cause cost-of-living increases that further burden remaining low-income residents even beyond increased rents and property taxes. Low-income residents who relocate face transactions costs and do not experience the benefits of improved environmental quality.[76]

When localized impacts of environmental policies are expected, a baseline profile of affected communities will be informative.[77] Data on the unemployment rate, average income level, the poverty rate, whether the community is rural or urban, and its growth rate can help inform policy makers as to the relative disadvantages faced by affected communities.[78]

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75 Historic funding levels are being directed to coal mining and power plant communities to help rebuild and diversify their economies. The Interagency Working Group on Coal & Power Plant Communities & Economic Revitalization presents information on funding eligibility and more at https://energycommunities.gov/priority-energy-communities/#.

76 When a community that has experienced improved environmental quality undergoes a widescale turnover to higher income households, this Is described as environmental gentrification. For further discussion of gentrification in housing markets, see Section 10.2.1 of this guidance document, Section 8.2.5.1 of EPA's Handbook on the Benefits, Costs, and Impacts of Land Cleanup and Reuse (U.S. EPA 2011), and/or Banzhaf and McCormick (2012).

77 For details regarding examining environmental justice communities, see Chapter 10.

78 For a discussion on contributors to higher susceptibility, see EPA's Technical Guidance for Assessing Environmental Justice in Regulatory Analysis (U.S. EPA 2024c), Section 4.2, which addresses susceptibility or vulnerability within groups such as communities.

9.5.4 Impacts on Governments and Non-Profits

State and local governments and their residents, and non-profit organizations may incur costs or bear the burden of costs from EPA regulations. The frameworks and impacts discussed above apply to private markets. Governments and non-profits are distinctive because they are not motivated by profits. Analysts should consider potential impacts to governments and non-profits, including short- and long-run impacts.[79] Useful measures for evaluating impacts on these types of entities include assessments of the difficulty of paying regulatory costs and of continuing to provide services.

Examples of important impacts on government include water treatment costs paid by municipally-owned water authorities to comply with water quality standards. Air pollution controls required of power plants may affect municipally-owned electric companies. Implementation and enforcement costs associated with a variety of environmental regulations may impose costs on state or local government. If regulation affects the local tax base, then there may be impacts on government revenues or expenditures that may affect the provision of local public or private goods and services. For example, some coal-mining counties in the United States derive a significant portion of their budgets from coal-related revenues. Policies to restrict carbon pollution that reduce coal production could significantly affect such communities causing the loss of local public goods and lowered property values.[80]

To understand economic impacts on state, local and tribal governments, analysts should develop a baseline profile potentially including the following relevant factors:

- Size of the population in the community;
- Property values;
- Household income levels (e.g., median and/or income range);
- Age distribution;
- Unemployment rate;
- Foreclosure rate; and
- Revenue amounts by source.

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 may be important. If a government entity serves multiple communities, such as a regional water or sewer authority, then information for all the communities in the service area may be relevant.

To gain insight into the ability of governments to finance new regulatory costs, U.S. EPA's *Clean Water Act Financial Capability Assessment Guidance* (U.S. EPA 2024d) suggests examining baseline financial capability by exploring indicators of debt, socioeconomic conditions and success regarding financial management.[81] Analysts can obtain the community's bond or credit rating, which is itself determined by an assessment of financial health. For governments that rely on property taxes for

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79 In some cases, EPA has been directed to consider impacts on government and non-profits. For example, UMRA requires assessment of impacts to state, local and tribal governments. The RFA as amended by SBREFA requires assessment of impacts to small entities including governments and non-profits (see Section 9.2 and Chapter 2).

80 Morris et al. (2019) study three counties with high labor shares engaged in coal mining and conclude that a third or more of their budgets may be funded with coal-related revenue.

81 The EPA uses U.S. EPA (2024d) to assess implementation of CWA requirements. The assessments affect negotiations for Clean Water Act compliance schedules.

income, analysts might consider the amount of debt that must be repaid through property taxes (known as net debt) per capita; or the net debt relative to the value of taxable properties. Property tax revenues relative to full market value of properties may be a useful indication of the property tax burden (U.S. EPA 2024d). Table 9.3 provides thresholds used by the Office of Enforcement and Compliance Assurance (OECA) and the Office of Water (OW) to indicate weak, mid-range or strong financial wellbeing of government entities.[82]

To screen for significant impacts on governments, analysts may wish to consider new regulatory costs per capita, the ratio of per capita costs to median household income and lowest quintile income, the latter especially in communities with households that have difficulty paying for their water services. Depending on these values, further analysis might be desirable.83 Further analysis should consider a government entity's options for funding new costs or how new process requirements could change operating procedures. For example, what is the availability of new loans or grants and user fees? Are there other viable routes for increasing funds available to finance new regulatory costs? Do new processes alter the quality or quantity of goods and services provided to residents? Other factors that are potentially relevant are the historic trend in government revenues; the capability of the revenue sources to shoulder additional financial burdens; and the magnitude of the benefits from the rule enjoyed by citizens.

Finally, indirect impacts on state, local and tribal government may be important if a policy changes local property values or employment rates or has other community-wide impacts. For example, brownfield grants to assess or clean up land may cause small increases in local property values which could raise property tax revenues (Sullivan 2017). On the other hand, a policy that exacerbates unemployment, for example, could cause more spending on assistance programs.

EPA regulations may also affect non-profit organizations. For example, non-profit hospitals face costs from hazardous waste disposal requirements. A baseline profile for non-profits should consider:

- 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 would be informative.

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82 For another source that explores approaches for assessing the health of a local government, see McDonald (2018).

83 For instance, when assessing regulatory costs, the EPA considers financial impact as low if costs per household are less than 1% of median household income, mid-range if it is 1-2% of median household income and high if it is greater than 2% (U.S. EPA 2024d). Also, see the discussion of financial and rate model analyses in Alternative 2 in U.S. EPA (2024d). Spreadsheet tools to help users evaluate the economic impacts of water quality decisions can be found at https://www.epa.gov/wqs-tech/economic-guidance-water-quality-standards#spreadsheet.

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

Indicator	Strong	Mid-Range	Weak
Bond Rating	AAA – A (S&P) or Aaa – A (Moody's) or AAA – A (Fitch Ratings)	BBB (S&P) or BAA (Moody's) or BBB (Fitch Ratings)	BB - D (S&P) or Ba – C (Moody's) or BB - D (Fitch Ratings)
Overall Net Debt as a Percent of Full Market Property Value	Below 2%	2% - 5%	Above 5%
Unemployment Rate	More than 1 Percentage Point Below the National Average	± 1 Percentage Point of National Average	More than 1 Percentage Point Above the National Average
Median Household Income	More than 25% Above Adjusted National MHI	± 25% of Adjusted National MHI	More than 25% Below Adjusted National MHI
Property Tax Revenues as a Percent of Full Market Property Value	Below 2%	2% - 4%	Above 4%
Property Tax Collection Rate	Above 98%	94% - 98%	Below 94%

Source: Table B-1 of U.S. EPA 2024d.

To screen for impacts on non-profits, analysts can compare regulatory costs to baseline revenues or operating expenses. Regulatory costs can also be compared to baseline asset values or, after accounting for debts, net asset values. If these ratios are large, insights would be gained from information on the relative importance, size and growth rate of the non-profit, the nature of the population being served and the vulnerability of revenues and donors.

Impacts on Small Governments and Small Non-Profits

Consideration of impacts on small governments and small non-profits is required by the RFA as amended by SBREFA.[84] 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. As with 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 activities 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 2006a). Under the RFA, economic impacts on small governments are included in the screening analysis for significant economic impacts on a substantial number of small entities (SISNOSE), and any required regulatory flexibility analysis. In order to determine

84 See Chapter 2 and Section 9.2 for more information.

SISNOSE for small governments, the EPA conducts a screening analysis for both proposed and final rules based on annualized compliance costs as a percentage of revenue (U.S. EPA 2006a).

The Unfunded Mandates Reform Act (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 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.[85]

The RFA requires separate consideration of regulatory impacts on small non-profits and defines one as a non-profit "enterprise which is independently owned and operated and is not dominant in its field." 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, direct economic impacts on small non-profit organizations are included in the SISNOSE screening analysis, and if required, the regulatory flexibility analysis for a rule. In order to determine SISNOSE for small non-profits, the EPA conducts a screening analysis for both proposed and final rules based on annualized compliance costs as a percentage of operating expenditures.[86]

9.5.5 Economy-Wide Impacts

The more interconnected a regulated sector is with the rest of the economy, the greater the likelihood that a regulation will affect related markets. If a regulation is expected to affect markets with (i) significant cross-price effects between markets, *and* (ii) significant pre-existing distortions, it may be appropriate to examine economy-wide impacts in a supplemental analysis (U.S. EPA 2017). Pre-existing market distortions that could be exacerbated by environmental regulations include taxes or subsidies on labor, energy or capital; monopoly or monopsony power; price controls; or other government regulations that change the way markets operate.

Computable general equilibrium (CGE) models are particularly effective at assessing long-run economy-wide impacts.[87] These include the allocation of employment or other factors of production across sectors, the distribution of output by sector and the distribution of income among households. For example, regulations in the power sector may cause electricity prices to increase. The price increase will affect all industries that use electricity as an input to production, as

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85 Guidance on complying with Section 203 of UMRA, "Interim Small Government Agency Plan," is available on the EPA's intranet site, ADP Library.

86 See Table 1, "Recommended Quantitative Metrics for Economic Impact Screening Analyses" of U.S. EPA 2006a.

87 CGE models assume that for some discrete time period an economy can be characterized by a set of conditions in which supply equals demand in all markets. When the imposition of a regulation alters conditions in one market, the model determines a new set of relative prices that return the economy to its long-run equilibrium. While highly aggregate in nature, CGE models capture substitution possibilities between production, consumption and trade; interactions between economic sectors; and interactions with pre-existing distortions. Thus, they provide information on changes outside the directly regulated sector. See Chapter 8 for more discussion.

well as households. A CGE model can assess the distribution of consequent changes in production and consumption. 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., effects on a certain type of facility or on an environmental endpoint such as drinking water) are difficult to capture in a CGE model due to model dimensionality and/or data constraints.

The simplest CGE models typically include a single representative consumer, a set of relevant production sectors, and a government sector within a single-country, static framework. Additional complexities can be specified. A CGE model can be solved dynamically over a longer time horizon, incorporating intertemporal decision-making on the part of consumers or producers. These decisions have implications for the treatment of savings, investment and the long-term profile of consumption and capital accumulation. Consumers can be divided into income quintiles or deciles, and producers disaggregated into a variety of regions and sectors, each producing a set of unique commodities. 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 intricate functional forms.

While CGE modeling is complex, the effort may be worthwhile when impacts are likely to be substantial and widespread and when appropriate data (e.g., input-output tables, elasticities) are available. Text Box 5.3 and Chapter 8 discuss detailed criteria for judging model quality. Feedback from the Science Advisory Board (SAB) identified several guiding principles as to when economy-wide modeling is appropriate for assessing economic impacts of regulation (U.S. EPA 2017). Aspects of a CGE model that could affect suitability include degree of temporal, sectoral and geographic disaggregation; time horizon; the way in which firm and household expectations about the future are modeled; the types of impacts that can be forecast; and the approach for representing the policy instrument. CGE models may be useful as a supplement to other analytic approaches to evaluate sectoral effects (including shifts in labor or capital between sectors), impacts on energy supply and energy prices and effects on consumers. In some instances, linking a CGE model to sector models may be a useful way to leverage the relative advantages of both approaches in a single comprehensive framework (U.S. EPA 2017).[88]

CGE models have limitations. Many are not designed to illuminate certain types of impacts, such as short-run or transitional impacts. For example, a standard forward-looking CGE model that assumes full employment and instantaneous market adjustments is ill-suited to evaluate overall employment impacts or the potential for short-run disequilibria in labor and capital markets. Analysts interested in evaluating the short-run impacts of a policy should select a different framework for analysis. Finally, relatively few CGE models incorporate feedback from changes in pollution; instead, they mainly focus on private markets.

A partial equilibrium model of multiple markets that considers the interactions between a regulated market and other closely related markets may be a practical alternative to a CGE model. Such models require estimates of demand and supply elasticities and cross-price elasticities for included markets. Partial equilibrium models may be appropriate for regionally-based or sector-specific regulations that are too narrowly defined to be adequately captured in more aggregate CGE models.

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88 See Text Box 8.1 for more discussion of model linking.

The SAB recommends that analysts apply the simplest model that is adequate to address the policy question at hand and consider a suite of models when possible (U.S. EPA 2017). A balance should be struck between capturing detail and complexity in the model versus transparency and tractability of the analysis.

As with all economic models, economy-wide and partial equilibrium models are simplified representations of complex economic systems built to assess relationships between economic factors. They are useful for estimating effects on groups but are not reliable predictors of firm or facility-level decisions. See Section 9.5.1.2 for further explanation of the common simplifying assumptions about firm decision-making.

9.5.6 Impacts of Benefits

Environmental benefits are generally nonmarket effects and as such pose special analytic challenges. As with costs, the benefits from improved environmental quality or health can accrue to, and may differ among, a wide variety of individuals. A key determinant of differential impacts is whether environmental improvements differ among affected groups (due to different exposure pathways, for example), or are uniform but have variable impacts due to differences in pre-existing factors such as baseline exposures or health (for more discussion, see U.S. EPA 2024c, especially Chapter 4).

The literature provides several potential frameworks for explicitly considering variability in the impacts of benefits across groups. Typically, these frameworks start with defining environmental damages as a function of exposure and individual susceptibility to environmental stressors, then they identify sources of susceptibility and finally they assess the impacts from environmental regulation (see, for instance, Hsiang et al. 2019; Gee and Payne-Sturges 2004; and Morello-Frosch and Jesdale 2006).

Useful information to improve understanding of the distribution of regulatory benefits includes:

- The types of health effects or other benefits;
- Population groups to whom the benefits are expected to accrue;
- How exposure varies across the affected groups; and
- How beneficial outcomes vary across population groups.

In addition to accruing to those who directly experience a reduced health risk, health and environmental quality benefits may also accrue to people who own homes near improved environmental quality, or to employers whose workers enjoy improved health and increased labor productivity, as well as to others.

Chapter 10 discusses how to analyze health effects and benefits for specific populations of concern (i.e., by income, race/ethnicity and age). The data and methods discussed there may be relevant for analyzing the distribution of benefits on other categories of people, on communities or on the general population. Sometimes analysts may wish to account not only for the ways in which changes in the regulated sector affect the distribution of benefits, but also how price and quantity responses across the economy affect the distribution of benefits, or how changes in environmental quality affect prices and quantities. Absent a partial-equilibrium or economy-wide model that explicitly incorporates benefits, relatively rare in the literature, these indirect impacts are difficult to evaluate.

Chapter 9 References

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