IMPROVING ECONOMIC IMPACT ANALYSES OF GOVERNMENT REGULATIONS ON SMALL BUSINESS

JANUARY, 1981

PREPARED FOR U.S. SMALL BUSINESS ADMINISTRATION
BY JACA CORP., 550 PINETOWN ROAD, FORT WASHINGTON, PA 19034
### TABLE 2-3. Study Profiles

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<td>Textiles</td>
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*Note: Some data may be missing or not applicable due to the nature of the table format.*
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OF GOVERNMENT REGULATIONS
ON SMALL BUSINESS

Prepared for:
U.S. Small Business Administration

Prepared by:
JACA Corp.
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Fort Washington, Pennsylvania 19034

January 1981
This report has been reviewed by the Office of Economic Research of the Office of Advocacy, U.S. Small Business Administration, and approved for publication. Such approval, however, does not imply that the contents necessarily reflect the policies and views of the U.S. Small Business Administration.
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1.0 INTRODUCTION

Empirical evidence and economic theory both tend to support the contention that federal regulatory requirements imposed "neutrally" on all of the firms in an industry can engender disproportionately heavy burdens for small firms. Proponents of small business argue that this differential impact places small firms at a disadvantage in their efforts to compete with larger rivals. It has been argued that economic impact studies, completed in support of federal regulatory and standard-setting activities, may not adequately address differential impacts for a variety of reasons.

This study presents an examination of the broad methodologies and specific techniques of analysis that are employed in the economic impact studies of federal regulatory agencies. The specific aims of the research are to identify those methodologies and techniques of analysis that are most appropriate for assessing differential impact, and to also explore means by which existing methodologies can be improved or enhanced to achieve higher levels of accuracy in their predictions of small business impact.

This report is organized as follows. Chapter 2 deals with the procedures that were used in this research effort to identify and classify the methodologies used in economic impact studies. The specific subjects that are discussed include: 1) the selection of the federal regulatory agencies whose economic impact studies would serve as the basis for the analysis; 2) the procedure that was followed in collecting the studies; and, 3) the review of the studies and the classification of the broad methodologies presented in the studies.

Chapter 3 presents a detailed examination of three methods of analysis that are commonly used in economic impact studies. These methods are discounted cash flow analysis, return on investment analysis, and debt coverage analysis. The chapter is divided into three main segments: 1) the expression of each method in terms of a mathematical equation, and the performance
of sensitivity analysis on each in order to determine which of its variables are most likely to produce inaccurate conclusions if incorrectly specified by the analyst; 2) the identification of these "critical" variables by method, by size of firm, and by error elasticity; and, 3) the availability and quality of data needed to construct critical variables, particularly with respect to smaller firms.

Chapter 4 presents retrospective analyses of five economic impact studies. The studies were performed to develop empirical insights about the ability of particular methodologies to assess the differential effects of regulations. Three of the studies were performed by EPA. These deal with the areas of fruit and vegetable processing, soap and detergent manufacturing, and lime manufacturing. The fourth study was done by OSHA, and deals with coke ovens. The fifth study was done by the Consumer Product Safety Commission, and pertains to the manufacture of book matches.

Chapter 5 summarizes the general conclusions of the research effort, and discusses policy implications of the findings.

Summaries of the economic impact studies that were reviewed are presented in an Appendix.
2.0 IDENTIFICATION AND CLASSIFICATION OF METHODOLOGIES
USED IN ECONOMIC IMPACT STUDIES

2.1 INTRODUCTION

This chapter deals with three subjects: 1) the selection of the federal regulatory agencies whose economic impact studies served as the basis for the analysis; 2) the collection of the studies; and 3) the review of the studies and the classification of the broad methodologies represented in the studies. The first two subjects are dealt with in Section 2.2. The third subject is covered in Sections 2.3 and 2.4.

2.2 AGENCY SELECTION AND COLLECTION OF STUDIES

The first step in the project involved identifying the particular set of federal regulatory agencies whose economic impact studies would serve as the basis for the analysis. There were many possibilities from which to choose; however, due to limitations of time and resources, it was necessary to restrict the number to only those agencies whose regulatory activities are currently of the greatest interest to the SBA and the small business community. After several discussions between JACA and the SBA's Office of Economic Research, it was decided to focus attention on impact analyses done by the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the Consumer Product Safety Commission (CPSC), and the Food and Drug Administration (FDA). Of these, EPA and the CPSC are classified as independent regulatory agencies. Both OSHA and the FDA are subsumed under Executive Departments, the former under the Department of Labor, and the latter under the Department of Health and Human Services.

The next step in the research effort involved the collection of impact studies prepared by the abovementioned agencies. A twofold approach was employed in carrying out this task. On the one hand, officials of the agencies were contacted and requested to provide suggestions as to which of their studies might constitute good candidates for examination. At the same
time, candidate studies were also identified by JACA through a search of the literature. Initially, two basic guidelines were followed in the collection process. One was that the study should bear some relevance to small business and/or the subject of differential impact. The other was that only studies dealing with promulgated regulations should be considered, and that among these, the regulations involved should have been promulgated no more recently than two years ago. The two-year criterion was imposed in order to ensure that the impacts of the regulation would be manifested and susceptible to observation. Observability of impacts was necessitated by the requirement to perform retrospective analysis (covered in Chapter 4).

Shortly after the initiation of the collection process, a decision was made to relax the criteria for selection of candidate studies. This decision was made when it was realized that there were certain studies which would still be of great value to the research effort even though they did not conform to one or both of the basic guidelines. For example, studies involving current regulations (i.e., less than two years old or not even promulgated) are useful to look at since they provide an indication of the direction in which economic impact studies are evolving in terms of scope and methodology.

Listed in Table 2-1 are the 38 economic impact studies that were collected. Out of this total, four were prepared by the CPSC, 25 by EPA, five by OSHA, and three by the FDA. One other study dealing with the ban on chlorofluorocarbons in aerosols was done jointly by the CPSC, EPA, and the FDA (although it is listed under FDA). The large number of studies for EPA is accounted for by the fact that the studies were done by different offices dealing with separate areas of pollution control.

2.3 REVIEW OF THE STUDIES

Each of the 38 candidate economic impact studies was subjected to a preliminary screening, and characterized in terms of the types of economic impacts examined, the analytical methodology employed, the degree of attention paid to small business and the issue of differential impact, and the apparent feasibility of performing sensitivity and retrospective analyses.

Based on this screening, a recommendation was made for each study as to whether it should be retained for further examination in the project. Out of the initial list of 38 studies, a total of 22 were selected for further use. These are listed (by their short titles) in Table 2-2. Summaries of the studies are given in the Appendix of this report.
Table 2-1. LIST OF IMPACT ANALYSES COLLECTED AND REVIEWED

<table>
<thead>
<tr>
<th>Agency, Study Title, and Publication Date</th>
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<tbody>
<tr>
<td><strong>A. CONSUMER PRODUCT SAFETY COMMISSION</strong></td>
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<tr>
<td><strong>B. EPA, OFFICE OF AIR QUALITY PLANNING AND STANDARDS</strong></td>
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<tr>
<td>o Background Information for Proposed New Source Performance Standards: Asphalt Concrete Plants, Petroleum Refineries, Storage Vessels, Secondary Lead Smelters and Refineries, Brass or Bronz Ingot Production Plants, Iron and Steel Plants, Sewage Treatment Plants. June 1973. (Document was reviewed for two studies: asphalt concrete and secondary lead smelters.)</td>
</tr>
<tr>
<td>o Background Information on Proposed New Source Performance Standards: Steam Generators, Incinerators, Portland Cement Plants, Nitric Acid Plants, Sulfuric Acid Plants. August 1971. (Document was reviewed for three studies: portland cement, nitric acid, and sulfuric acid.)</td>
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<table>
<thead>
<tr>
<th>Agency, Study Title, and Publication Date</th>
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<tbody>
<tr>
<td><strong>o</strong> Lead-Acid Battery Manufacture: Background Information for Proposed Standards. November 1979.</td>
</tr>
</tbody>
</table>

C. EPA, OFFICE OF PLANNING AND EVALUATION/OFFICE OF WATER ECONOMICS


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<table>
<thead>
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<th>Agency, Study Title, and Publication Date</th>
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</thead>
<tbody>
<tr>
<td>D. EPA, OFFICE OF PLANNING AND MANAGEMENT</td>
</tr>
<tr>
<td>o Economic Analysis of Pretreatment Standards for Existing Sources of the Electroplating Point Source Category. August 1979.</td>
</tr>
<tr>
<td>E. EPA, OFFICE OF SOLID WASTE MANAGEMENT</td>
</tr>
<tr>
<td>F. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION</td>
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<tr>
<td>o Technology Assessment and Economic Impact Study of an OSHA Regulation for Benzene. May 1977.</td>
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G. FOOD AND DRUG ADMINISTRATION

- **The Economic Impact of Potential Regulation of Chlorofluorocarbon-Propelled Aerosols.** April 1977. Done in conjunction with EPA and CPSC.
<table>
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<th>Consumer Product Safety Commission</th>
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<tr>
<td>o Upholstered Furniture</td>
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<td>o Safety Standard for Matchbooks</td>
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<td>o Children's Garments Containing TBPP</td>
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<th>EPA - Office of Air Quality Planning and Standards</th>
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<tr>
<td>o Kraft Pulp Mills</td>
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<td>o Lead-Acid Batteries</td>
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<td>o Lime Manufacturing</td>
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<tr>
<th>EPA - Office of Planning and Evaluation/Office of Water Economics</th>
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<tbody>
<tr>
<td>o Leather Tanning and Finishing Industry</td>
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<tr>
<td>o Electroplating Industry (Copper, Nickel, Chromium, and Zinc)</td>
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<tr>
<td>o Fruit and Vegetable Industry</td>
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<td>o Soap and Detergent Industry</td>
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<tr>
<td>o Meat Packing Industry</td>
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<tr>
<td>o Pulp and Paper Industry</td>
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<tr>
<td>o Paint Manufacturing</td>
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<tr>
<td>o Textile Mills</td>
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<tr>
<td>o Existing Sources of Electroplating Point Source Categories</td>
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<th>EPA - Office of Planning and Management</th>
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<tr>
<td>o TSCA Proposed Premanufacturing Notification Requirements</td>
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<th>EPA - Office of Solid Waste</th>
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<td>o Leather Tanning and Finishing Industry</td>
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<td>o Cotton Dust</td>
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<td>o Benzene</td>
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<th>Food and Drug Administrationa</th>
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<td>o Fluorocarbons</td>
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aIn conjunction with EPA and Consumer Product Safety Commission.
2.4 IDENTIFICATION AND CLASSIFICATION OF METHODOLOGIES

The next major phase of the research effort involved the identification and classification of methodologies employed in economic impact studies. The purpose of this analysis was to define basic types of methodologies which could be evaluated in terms of their ability to assess the differential economic impact of regulations.

2.4.1 Study Profiles

The identification and classification of methodologies was based upon the 22 studies listed in Table 2-2. In order to analyze the methodologies represented in these studies, it was necessary to first of all develop an approach through which the studies could be systematically compared, contrasted, and grouped. The approach that was employed was based upon the construction of a matrix consisting of descriptive profiles for each of the 22 studies. This matrix is presented as Table 2-3. Each of the columns in the matrix profiles a study in terms of attributes listed down the left-hand tab. The attributes relate to six basic areas of interest:

- The nature of the regulatory approach -- i.e., whether the regulation in question is "specific" or "generic".
- The importance of small business in the industry or industries being analyzed.
- Whether the study devotes special attention to the problems and needs of small business.
- Whether the subject of differential impact is addressed in the study.
- The methodological characteristics of the study -- i.e., the approach used for estimating regulatory costs, and the techniques and approaches used in assessing economic impacts.
- The types of economic impacts addressed in the study.

The remainder of this section is devoted to a discussion of the information presented in Table 2-3.

As Table 2-3 shows, the majority of the studies deal with regulations whose approach is specific, as opposed to generic. Out of the 22 studies, 17 pertain to specific regulations, while only 5 pertain to generic regulations. The term "specific" is used in describing a regulation that deals with only one industry. The term "generic" refers to a regulation that simultaneously
affects several different industries. The industries are treated together owing to the similar or identical manner in which they may be regulated -- e.g., the same type of pollution control strategy might be employed for all. Of the studies that pertain to generic regulations, four utilize methodologies in which the regulatory costs are estimated as industry averages, and are not differentiated by sizes of firm or plant (see discussion below about alternate approaches for estimating regulatory costs).

For each of the studies, the importance of small business in the industry or industries being analyzed was assessed as being "major", "moderate", or "minor". The basic criterion used for evaluation was market share. In some cases, lack of data on the subject industry or industries made it necessary for the analyst to make a subjective assessment. In over half of the studies, the importance of small business was found to range from moderate to major. Interestingly, however, out of this subset of studies, less than half included special discussions pertaining to the problems and needs of small business.

Table 2-3 shows the studies as using three different approaches for estimating regulatory costs. The most commonly utilized is the "model plant" approach (14 studies). In this approach, regulatory costs are developed for conceptualizations of real plants. In most studies, models of small, medium, and large size are developed. Also, in some cases, additional models are developed to reflect differences in aspects such as production technology or product characteristics. From the standpoint of assessing differential impact, one decided advantage of the model plant approach is that it provides a means whereby economies of scale in regulatory compliance can be directly factored into the analysis. In the case of seven of the studies, the table shows that regulatory costs are estimated as industry averages. In this approach, only one conceptualization is developed (this is sometimes referred to as a "typical" plant). This conceptualization is taken to be representative of the entire population of plants in an industry. Since only one conceptualization is involved, economies of scale in regulatory compliance cannot be directly addressed in the analysis. A third approach to the estimation of regulatory costs is represented in three of the studies. In this approach, regulatory costs are estimated for real plants.

All of the 22 studies include industry profiles, and virtually all contain an analysis of baseline supply and demand trends. Only five of the industry profiles contain information about the small business sector. None of the
analyses of supply and demand trends focus upon differences between small and large firms.

Price elasticity of demand is an important issue in regulatory economic impact studies since it reflects the extent to which a firm may be able to pass through the costs of the regulation to consumers. In most studies, however, the subject is sidestepped completely, or else dealt with in a qualitative or indirect manner. As Table 2-3 shows, only five of the studies attempted to deal with the question in a quantitative manner.

Related to the subject of price elasticity is the question of how potential regulation-induced price increases are calculated. One popular approach is to key the increase to the maintenance of a pre-regulatory level of return on investment. Twelve of the studies calculate price increases in this manner. Another popular approach, especially when the regulatory costs are relatively small, is to assume that costs will be fully passed through to the consumer. This is sometimes referred to as a "worst case" approach. Four of the studies employ this procedure.

As Table 2-3 indicates, four of the studies attempt to assess the benefits of regulation. Three of these were done by OSHA, and one by the Consumer Product Safety Commission.

With respect to the types of economic impacts that are examined, virtually all of the studies examine price or inflationary effects. The preponderance of studies also examine impacts on profitability, employment, and supply and demand (at the macro level). Other impacts examined in many of the studies are capital availability, market structure changes, balance of trade, and community economic dislocation.

Most of the studies provide some assessment of differential impact. This can only be said in a qualified sense, however, since the subject of differential impact is not generally addressed directly, and where it is, the approach is qualitative. Where the model plant approach is employed, it is possible to make inferences about the nature of differential impact by comparing the various sizes of plants with respect to compliance costs per unit of output, and with respect to the various indices of economic impact.

Plant closures are estimated in 19 of the studies. In nearly all cases, however, the closure estimates are directional rather than specific. By this, it is meant that the study extends itself only to the point of stating something like "more plants are expected to shut down as a result of the
regulation". In some studies, conclusions are presented regarding the relative likelihood of small plants being forced to close; however, these are qualitative in nature.

Each of the studies was also characterized in terms of the specific analytical methods used in the impact analysis. The most commonly used methods are qualitative assessment, DCF analysis, ROI analysis, financial ratios (other than ROI), and simple algebraic calculations. Chapter 3 presents a detailed examination of DCF, ROI, and debt coverage analyses in an attempt to define why each method is more or less effective in the estimation of impact differentials between small and large businesses.

Each of the studies was also characterized in terms of whether the analysis dealt with the effect that SBA loans could have in mitigating the economic impacts of regulations on small businesses. Out of the 22 studies, three performed this examination. One was done by the Consumer Product Safety Commission; the other two by EPA.

In evaluating the economic impact of a regulation on an industry, consideration should be given to the question of whether the regulation gives rise to spin-off costs in other regulatory areas -- for example, compliance with an air pollution regulation could give rise to a solid waste problem that is covered by some other regulation. Such additional costs could be particularly critical to small firms that are already faced with capital availability problems connected with the regulation being analyzed. Among the 22 studies, five touched upon this question.

The final characteristic in the profile is whether or not the study provides an estimate of industrywide compliance costs. Sixteen of the studies provide such an estimate; however, none of these attempts to estimate the costs for the small business segment of the industry.

2.4.2 Classification of Methodologies

In the context of this study, the term "methodology" refers to the overall analytical approach that is used for evaluating the economic impacts of the regulation. The concept embraces everything from the estimation of the regulatory costs, to the calculation of the economic impacts resulting from the imposition of these costs. The term "method" is used when referring to a specific analytical tool or technique -- e.g., discounted cash flow analysis or return on investment analysis.
Given this understanding of what constitutes a methodology, and based upon the analysis of the study profiles presented in Table 2-3, the studies were classified in terms of three methodologies reflective of the three basic approaches for estimating regulatory costs. The three methodological groupings include:

- Studies based on the use of the model plant approach
- Studies based on the use of industry average regulatory costs
- Studies based on the use of regulatory costs developed directly from an analysis of real plants.

The decision to key the classification of methodologies to the approaches for estimating regulatory costs was based upon the conclusion that this particular attribute has the most fundamental bearing upon the ability of a study to assess differential impact.

The results of the classification procedure are presented in Tables 2-4, 2-5, and 2-6. Shown in Table 2-4 are the studies with methodologies based on the use of the model plant approach. Table 2-5 shows the studies with methodologies based on the use of industry average regulatory costs. Table 2-6 lists the studies with methodologies based on the use of regulatory costs developed directly from the analysis of actual plants. Indicated in each of these tables are the major analytical tools which each study employs in its impact analysis.

Fourteen of the studies employ methodologies based upon the use of the model plant approach. All but two of these studies were done by EPA. Seven studies involve methodologies based on the use of industry average regulatory costs. These studies are spread among all four of the federal regulatory agencies considered. Three studies involve methodologies based on the use of regulatory costs developed directly from the analysis of actual plants. The studies were done by CPSC, EPA, and OSHA.
Table 2-4. STUDIES WITH METHODOLOGIES BASED ON THE USE OF THE MODEL PLANT APPROACH

<table>
<thead>
<tr>
<th>Agency</th>
<th>Study</th>
<th>Major Methods/Tools Used in Impact Analysis</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Econometric Algebraic Qualitative</td>
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<tr>
<td></td>
<td></td>
<td>DCF ROI Techniques Calculations Assessment</td>
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<td>CPSC(^a)</td>
<td>Matchbooks</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Air)</td>
<td>Kraft Pulp Mills</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Air)</td>
<td>Lead-Acid Batteries</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Air)</td>
<td>Lime Plants</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Leather Tanning</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Electroplating (1973 study)</td>
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</tr>
<tr>
<td>EPA (Water)</td>
<td>Fruit and Vegetable Industry</td>
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</tr>
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<td>EPA (Water)</td>
<td>Soap and Detergent Industry</td>
<td>X</td>
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<tr>
<td>EPA (Water)</td>
<td>Meat Packing</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Integrated)</td>
<td>Pulp and Paper Industry</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Paint Manufacturing</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Textile Mills</td>
<td>X</td>
</tr>
<tr>
<td>EPA (Solid Waste)(^a)</td>
<td>Leather Tanning</td>
<td>X</td>
</tr>
<tr>
<td>OSHA</td>
<td>Benzene</td>
<td>X</td>
</tr>
</tbody>
</table>

\(^a\)The study involves more than one approach to compliance cost estimates.
<table>
<thead>
<tr>
<th>Agency</th>
<th>Study</th>
<th>Major Methods/Tools Used in Impact Analysis</th>
<th>Econometric</th>
<th>Algebraic</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DCF ROI Techniques Calculations Assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPSC</td>
<td>Upholstered Furniture</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>CPSC</td>
<td>Children's Garments</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>EPA (Toxics)</td>
<td>TSCA Premanufacturing</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>EPA (Solid Waste)</td>
<td>Inorganic Chemicals</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA (Solid Waste)</td>
<td>Leather Tanning</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>OSHA</td>
<td>Cotton Dust</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>FDA</td>
<td>Chlorofluorocarbons</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*aThe study involves more than one approach to compliance cost estimation.

*bStudy done jointly with EPA and CPSC.
Table 2-6. STUDIES WITH METHODOLOGIES BASED ON THE USE OF REGULATORY COSTS DEVELOPED DIRECTLY FROM THE ANALYSIS OF ACTUAL PLANTS

<table>
<thead>
<tr>
<th>Agency</th>
<th>Study</th>
<th>Major Methods/Tools Used in Impact Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Econometric Simple</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Algebraic Qualitative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DCF ROI Techniques Calculations Assessment</td>
</tr>
<tr>
<td>CPSCa</td>
<td>Matchbooks</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Electroplating</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>(1979 study)</td>
<td>(1979 study)</td>
</tr>
<tr>
<td>OSHA</td>
<td>Coke Ovens</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

aThe study involves more than one approach to compliance cost estimation.
3.0 DETAILED ANALYSIS OF METHODS OBSERVED

3.1 INTRODUCTION

As part of the discussion in Chapter 2, the various methods of analysis used in economic impact studies were identified. In this chapter, attention focuses upon the question of why particular methods may be more or less effective in assessing differentials in impact between small and large businesses. The question is of academic interest; however, more importantly, it is directly relevant to the formulation of policy recommendations concerning ways in which to improve the quality of economic impact studies.

The question is explored by performing a detailed examination of three different methods of analysis. The methods are return on investment analysis (ROI), discounted cash flow analysis (DCF), and debt coverage analysis (COVR). ROI and DCF analyses are two of the most widely used analytical tools in economic impact studies. COVR is employed to a much lesser extent; however, it is still considered to be an important technique.

The ROI method involves the development of a ratio that relates income to the amount of capital that was needed to generate it. The single number obtained from the ratio provides a general measure of a firm's performance. In capital budgeting analysis, the technique is used to determine the relative desirabilities of alternative uses of capital. Within the context of regulatory economic impact studies, ROI analysis is used to measure the change in a firm's performance that results from the imposition of regulatory costs.

In recent years, DCF has become one of the most popular methods of financial analysis. DCF is a technique for evaluating investments that is based on the notion that a dollar received today is preferable to a dollar received at some point in the future. The DCF approach recognizes that in
appraising investments that yield profits accruing over the future, it is not
correct to simply add up these amounts. Before the profits can be summed, a
correction must be made to account for the time value of money. This is done
through a procedure called discounting. Discounting involves division of the
future profits by a suitable factor to determine what their present values
really are. The result of this procedure is a discounted cash flow upon
which the true profitability of the investment can be assessed.

There are several variants of the DCF technique. The one discussed
in this chapter is the net present value method. This particular method
involves finding the present value of the expected net cash flows of an
investment (discounted at the cost of capital), and subtracting from it the
initial outlay associated with the investment. If the calculated net present
value (NPV) is positive, the investment is said to be acceptable -- the
reason being that a positive NPV indicates that over its economic life, the
investment will return the original capital outlay, earn the standard return,
and provide a cushion of excess value. A negative NPV indicates that the
investment should not be undertaken since it will not achieve the built-in
earnings standard and will lead to an opportunity loss. In economic impact
studies, the DCF technique is used by examining the changes in the value of
the NPV that result from the imposition of regulatory costs (i.e., the NPV
values before and after the regulation are compared). These results are used
in evaluating the affordability of regulatory requirements, and in assessing
the potential for regulation-induced plant closures and postponements of
investment.

COVR analysis entails the development and interpretation of a ratio that
expresses the coverage of current maturities by cash flow emanating from the
firm's operations. Since cash flow is the basic source of debt retirement,
the ratio provides a measure of the firm's ability to meet principal repay-
ment, and is an indicator of its additional capacity for assuming debt. With-
in the context of economic impact studies, COVR is used for examining the
ability of firms to assume the capital investments required by regulations.
The technique is generally used to supplement findings obtained from tech-
niques such as ROI and DCF.

Section 3.2 of this chapter expresses each method in terms of a mathe-
matical equation and performs a sensitivity analysis on each in order to
determine which variables are most likely to produce inaccurate conclusions if incorrectly specified by the analyst. Section 3.3 more precisely identifies these critical variables by method, by size of firm, and by error elasticity. Section 3.4 discusses the availability and quality of data needed to construct these critical variables, particularly with respect to smaller firms. Finally, Section 3.5 contains a summary and a list of the conclusions of this chapter. In going through the material in this chapter, the reader should keep in mind that the three methods are not being considered together in an effort to determine which one is the best to employ. Indeed, each method has its particular purpose, and its usefulness, as well as the feasibility of its deployment, will vary from one analytical context to another.

3.2 THE METHODS

3.2.1 Return on Investment Analysis

3.2.1.1 Mathematical Equation. Return on Investment (ROI) analysis in its simplest form may be expressed as:

\[
\text{ROI} = \frac{Y}{H}
\]

where ROI = percentage rate of return on total investment

\[Y = \text{net income after taxes}\]

\[H = \text{total investment}\]

Net income (after taxes) may be further defined as:

\[Y = S - (E + I + D) - T\]

where

\[S = \text{total sales revenue}\]

\[E = \text{total expenses (excluding interest and depreciation)}\]

\[I = \text{interest payments}\]

\[D = \text{depreciation and amortization}\]

\[T = \text{total income taxes}\]

Finally, total investment (H) can be decomposed into:

\[H = \text{NWC} + A\]

where \(\text{NWC}\) = net working capital (i.e., current assets minus current liabilities)

\[A = \text{plant, equipment, and other fixed assets}\]

Thus, ROI becomes:

\[
\text{ROI} = \frac{S - (E + I + D) - T}{\text{NWC} + A}
\]

where all variables are as previously defined.
3.2.1.2 Sensitivity Analysis. In order to determine how ROI analysis is affected by small changes in any of the variables above, a sensitivity analysis was performed on baseline data for a small and a large plant in two industries. Table 3-1 displays the results for a small frozen concentrated orange juice plant.

Each variable listed in the first column in Table 3-1 was increased by 10 percent over the baseline value (the changes are underlined within the body of the table) and ROI was re-computed. Next each new ROI was expressed as a percentage change over the base value. The percentage changes appear in the last column of Table 3-1. For example, when sales are increased by 10 percent (from 2707 to 2977.7), ROI becomes 35.55 percent. This ROI is 216.56 percent larger than the baseline ROI of 11.23 percent (or, if the reader prefers, it is 3.1656 times as large as the baseline ROI).

As Table 3-1 reveals, the ROI for this small orange juice plant is more sensitive to changes in sales (216.56% change) and total expenses (187.80%) than it is to changes in income taxes (8.20%), depreciation (7.75%), fixed assets (6.59%), interest (2.85%), and net working capital (2.77%).

Table 3-2 displays the results of a similar analysis of a large orange juice plant. Sales and total expenses again appear to produce greater fluctuations than the remaining variables. Interestingly enough, the large plant is more sensitive to taxes (9.16% vs. 8.20%), net working capital (4.74% vs. 2.76%), and interest (4.34% vs. 2.85%) than the small plant, while the small plant is more affected by sales (216.56% vs. 214.07%), total expenses (187.80% vs. 185.84%), depreciation (7.75% vs. 5.06%), and fixed assets (6.59% vs. 4.82%) than its larger counterpart.

Tables 3-3 and 3-4 show the results for a small and large plant in the meat packing industry. As can be seen, with the exception of taxes and net working capital, the small plant is more sensitive to changes in all variables than its larger counterpart.

3.2.2 Discounted Cash Flow Analysis (DCF)

3.2.2.1 Mathematical Equation. A formula for determining the net present value (i.e., net of the original investment) of a stream of future cash flows is:
Table 3-1. ROI SENSITIVITY ANALYSIS
A SMALL FROZEN CONCENTRATED ORANGE JUICE PLANTA

<table>
<thead>
<tr>
<th>Variables</th>
<th>S</th>
<th>E</th>
<th>I</th>
<th>D</th>
<th>T</th>
<th>NWC</th>
<th>A</th>
<th>ROI</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (S)</td>
<td>2977.7</td>
<td>2347</td>
<td>36</td>
<td>97</td>
<td>102</td>
<td>322</td>
<td>791</td>
<td>11.23%</td>
<td>35.55%</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>2581.7</td>
<td>36</td>
<td>97</td>
<td>102</td>
<td>322</td>
<td>791</td>
<td>-9.86%</td>
<td>187.80%</td>
<td></td>
</tr>
<tr>
<td>Interest (I)</td>
<td>39.6</td>
<td>97</td>
<td>102</td>
<td>322</td>
<td>791</td>
<td>10.91%</td>
<td>2.85%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>106.7</td>
<td>102</td>
<td>322</td>
<td>791</td>
<td>10.36%</td>
<td>7.75%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes (T)</td>
<td>112.2</td>
<td>322</td>
<td>791</td>
<td>10.31%</td>
<td>8.20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Working Capital (NWC)</td>
<td></td>
<td>354.2</td>
<td>791</td>
<td>10.92%</td>
<td>2.77%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed Assets (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>870.1 10.49%</td>
</tr>
</tbody>
</table>

a90% capacity utilization rate is assumed. Small is understood to mean 144 tons per day.

bAll figures are in thousands of dollars unless otherwise specified.

CAbsolute value of percentage change from baseline value of ROI.

Table 3-2. ROI SENSITIVITY ANALYSIS
A LARGE FROZEN CONCENTRATED ORANGE JUICE PLANTA

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base Valuesb</th>
<th>S</th>
<th>E</th>
<th>I</th>
<th>D</th>
<th>T</th>
<th>NWC</th>
<th>A</th>
<th>ROI%</th>
<th>% ChangeC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (S)</td>
<td>22334.4</td>
<td>17612</td>
<td>406</td>
<td>474</td>
<td>864</td>
<td>3776</td>
<td>3847</td>
<td>39.07%</td>
<td>214.07%</td>
<td></td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>19373.2</td>
<td>406</td>
<td>474</td>
<td>864</td>
<td>3776</td>
<td>3847</td>
<td>-10.67%</td>
<td>185.84%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest (I)</td>
<td>446.6</td>
<td>474</td>
<td>864</td>
<td>3776</td>
<td>3847</td>
<td>4.34%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>521.4</td>
<td>864</td>
<td>3776</td>
<td>3847</td>
<td>11.81%</td>
<td>5.06%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes (T)</td>
<td>950.4</td>
<td>3776</td>
<td>3847</td>
<td>11.30%</td>
<td>9.16%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Working Capital (NWC)</td>
<td>4153.6</td>
<td>3847</td>
<td>11.85%</td>
<td>4.74%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed Assets (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4231.7</td>
<td>11.84%</td>
<td>4.82%</td>
<td></td>
</tr>
</tbody>
</table>

A 90% capacity utilization rate is assumed. Large is understood to mean 1072 tons per day.

bAll figures are in thousands of dollars unless otherwise specified.

CAbsolute value of percentage change from baseline value of ROI.

Table 3-3. ROI SENSITIVITY ANALYSIS  
A SMALL MEAT PACKING PLANTA

<table>
<thead>
<tr>
<th>Variables</th>
<th>S</th>
<th>E</th>
<th>I</th>
<th>D</th>
<th>T</th>
<th>NWC</th>
<th>A</th>
<th>ROI</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (S)</td>
<td>9056.3</td>
<td>7961</td>
<td>49</td>
<td>98</td>
<td>60</td>
<td>251</td>
<td>897</td>
<td>5.66%</td>
<td></td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>8757.1</td>
<td>49</td>
<td>98</td>
<td>60</td>
<td>251</td>
<td>897</td>
<td>-63.68%</td>
<td>1225.09%</td>
<td></td>
</tr>
<tr>
<td>Interest (I)</td>
<td>53.9</td>
<td>98</td>
<td>60</td>
<td>251</td>
<td>897</td>
<td></td>
<td>5.24%</td>
<td>7.42%</td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>107.8</td>
<td>60</td>
<td>251</td>
<td>897</td>
<td>4.81%</td>
<td></td>
<td>15.02%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td>66</td>
<td>251</td>
<td>897</td>
<td>5.14%</td>
<td></td>
<td>9.19%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>276.1</td>
<td>897</td>
<td>5.54%</td>
<td>2.12%</td>
<td></td>
</tr>
<tr>
<td>Net Working Capital (NWC)</td>
<td></td>
<td>986.7</td>
<td>5.25%</td>
<td>7.24%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed Assets (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>276.1</td>
<td>897</td>
<td>5.54%</td>
<td>2.12%</td>
<td></td>
</tr>
</tbody>
</table>

aAn 85% capacity utilization rate is assumed. Small is understood to mean 4.2 millions of pounds per year.

bAll figures are in thousands of dollars unless otherwise specified.

bAbsolute value of percentage change from baseline value of ROI.

Table 3-4. ROI SENSITIVITY ANALYSIS
A LARGE MEAT PACKING PLANT\textsuperscript{a}

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base Values (b)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>% Change \textsuperscript{c}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>E</td>
<td>I</td>
<td>D</td>
<td>T</td>
<td>NWC</td>
<td>A</td>
</tr>
<tr>
<td>Sales (S)</td>
<td>103315.3</td>
<td>90575</td>
<td>564</td>
<td>786</td>
<td>959</td>
<td>2625</td>
<td>6570</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>99633.5</td>
<td>564</td>
<td>786</td>
<td>959</td>
<td>2625</td>
<td>6570</td>
<td>-87.21% 871.77%</td>
</tr>
<tr>
<td>Interest (I)</td>
<td>620.4</td>
<td>786</td>
<td>959</td>
<td>2625</td>
<td>6570</td>
<td>10.69% 5.40%</td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>864.6</td>
<td>959</td>
<td>2625</td>
<td>6570</td>
<td>10.44% 7.61%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1054.9 2625</td>
</tr>
<tr>
<td>Taxes (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6570</td>
</tr>
<tr>
<td>Net Working Capital (NWC)</td>
<td>2887.5</td>
<td>6570</td>
<td>10.99% 2.74%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed Assets (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7227</td>
</tr>
</tbody>
</table>

\textsuperscript{a}An 85% capacity utilization rate is assumed. Large is understood to mean 42.5 millions of pounds per year.

\textsuperscript{b}All figures are in thousands of dollars unless otherwise specified.

\textsuperscript{c}Absolute value of percentage change from baseline value of ROI.

NPV = \frac{CF_1}{(1 + i)^1} + \frac{CF_2}{(1 + i)^2} + \frac{CF_3}{(1 + i)^3} + \cdots + \frac{CF_N}{(1 + i)^N} \quad (5)

where

NPV = \text{net present value of a stream of future cash flows}

CF_1, \ldots, N = \text{after-tax cash flow in years } 1, 2, \ldots, N

i = \text{interest rate (or cost of capital)}

N = \text{project duration}

Alternatively, this formula may be written as:

\[ NPV = \sum_{k=1}^{N} \frac{CF_k}{(1 + i)^k} \quad (6) \]

Cash flow in year \( k \) may be further refined:

\[ CF_k = Y_k + D_k - R_k \quad (7) \]

where \( CF_k = \text{after tax cash flow in year } k \)

\( Y_k = \text{after tax net income in year } k \)

\( D_k = \text{depreciation in year } k \)

\( R_k = \text{replacement investment in year } k \)

Since

\[ Y_k = S_k - (E_k + I_k + D_k) - T_k \quad (8) \]

where \( Y_k = \text{after tax net income in year } k \)

\( S_k = \text{sales revenue in year } k \)

\( E_k = \text{total expenses in year } k \)

\( I_k = \text{interest expense in year } k \)

\( D_k = \text{depreciation in year } k \)

\( T_k = \text{total income taxes in year } k \)

Then DCF may be expressed as:

\[ NPV = \sum_{k=1}^{N} \frac{S_k - (E_k + I_k + D_k) - T_k + D_k - R_k}{(1 + i)^k} \quad (9) \]

where all variables are as previously defined.

3.2.2.2 Sensitivity Analysis. A sensitivity analysis was performed to determine the extent to which NPV is affected by changes in the values of the variables identified above. As in the examination of the ROI method, the analysis focuses on small and large plants for the orange juice and meat packing industries. The results of the analysis are presented in Tables 3-5 to 3-8.
Table 3-5. DCF SENSITIVITY ANALYSIS
A SMALL FROZEN CONCENTRATED ORANGE JUICE PLANTA

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base Valuesb</th>
<th>Sales (S)</th>
<th>2707</th>
<th>2347</th>
<th>36</th>
<th>97</th>
<th>102</th>
<th>6%</th>
<th>20</th>
<th>97</th>
<th>1397</th>
<th>% Changed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Expenses (E)</td>
<td>2581.7</td>
<td>36</td>
<td>97</td>
<td>102</td>
<td>6%</td>
<td>20</td>
<td>97</td>
<td>-1226</td>
<td>187.76%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest (I)</td>
<td>39.6</td>
<td>97</td>
<td>102</td>
<td>6%</td>
<td>20</td>
<td>97</td>
<td>1356</td>
<td>2.93%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>106.7</td>
<td>102</td>
<td>6%</td>
<td>20</td>
<td>97</td>
<td>1397</td>
<td>0.00%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes (T)</td>
<td>112.2</td>
<td>6%</td>
<td>20</td>
<td>97</td>
<td></td>
<td></td>
<td>1283</td>
<td>8.16%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Capital (K)c</td>
<td>8%</td>
<td>20</td>
<td>97</td>
<td>1157</td>
<td>17.18%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Horizon (N)</td>
<td>22</td>
<td>97</td>
<td>1447</td>
<td>3.58%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement Investment (R)</td>
<td>106.7</td>
<td>1288</td>
<td>7.80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aA 90% capacity utilization rate is assumed. Small is understood to mean 144 tons per day.
bAll figures are in thousands of dollars unless otherwise specified.
cThis calculation is based on a 33% increase in the cost of capital (i.e., from 6 to 8%) in order to ease the computations.
dAbsolute value of percentage change from baseline NPV.

### Table 3-6. DCF SENSITIVITY ANALYSIS
A LARGE FROZEN CONCENTRATED ORANGE JUICE PLANTA

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base Valuesb</th>
<th>% Changed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>E</td>
</tr>
<tr>
<td>Sales (S)</td>
<td>20304</td>
<td>17612</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>19373.2</td>
<td>406</td>
</tr>
<tr>
<td>Interest (I)</td>
<td>446.6</td>
<td>474</td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>521.4</td>
<td>864</td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes (T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Capital (K)c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Horizon (N)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement Investment (R)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A 90% capacity utilization rate is assumed. Large is understood to mean 1072 tons per day.

All figures are in thousands of dollars unless otherwise specified.

This calculation is based on a 33% increase in the cost of capital (i.e., from 6 to 8%) in order to ease the computations.

Absolute value of percentage change from baseline NPV.


3-11
Table 3-7. DCF SENSITIVITY ANALYSIS
A SMALL MEAT PACKING PLANT\textsuperscript{a}

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base Values\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Sales (S)</td>
<td>8233</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>9056.3</td>
</tr>
<tr>
<td>Interest (I)</td>
<td>53.9</td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>107.8</td>
</tr>
<tr>
<td>Total Income</td>
<td>8751.1</td>
</tr>
<tr>
<td>Taxes (T)</td>
<td>66</td>
</tr>
<tr>
<td>Cost of Capital (K)\textsuperscript{c}</td>
<td>8%</td>
</tr>
<tr>
<td>Time Horizon (N)</td>
<td>33</td>
</tr>
<tr>
<td>Replacement Investment (R)</td>
<td>107.8</td>
</tr>
</tbody>
</table>

\textsuperscript{a}An 85% capacity utilization rate is assumed. Small is understood to mean 4.2 millions of pounds per year.

\textsuperscript{b}All figures are in thousands of dollars unless otherwise specified.

\textsuperscript{c}This calculation is based on a 33% increase in the cost of capital (i.e., from 6 to 8%) in order to ease the computations.

\textsuperscript{d}Absolute value of percentage change from baseline NPV.

Table 3-8. DCF SENSITIVITY ANALYSIS
A LARGE MEAT PACKING PLANT

<table>
<thead>
<tr>
<th>Variables</th>
<th>S</th>
<th>E</th>
<th>I</th>
<th>D</th>
<th>T</th>
<th>K</th>
<th>N</th>
<th>R</th>
<th>NPV</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (S)</td>
<td>1033</td>
<td>905</td>
<td>564</td>
<td>786</td>
<td>959</td>
<td>6%</td>
<td>30</td>
<td>786</td>
<td>1303</td>
<td>903.91%</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>996</td>
<td>564</td>
<td>786</td>
<td>959</td>
<td>6%</td>
<td>30</td>
<td>786</td>
<td>-1002</td>
<td>871.77%</td>
<td></td>
</tr>
<tr>
<td>Interest (I)</td>
<td>620.4</td>
<td>786</td>
<td>959</td>
<td>6%</td>
<td>30</td>
<td>786</td>
<td>1228</td>
<td>5.43%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>864.6</td>
<td>959</td>
<td>6%</td>
<td>30</td>
<td>786</td>
<td>1298</td>
<td>0.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income Taxes (T)</td>
<td>1054.9</td>
<td>6%</td>
<td>30</td>
<td>786</td>
<td>1178</td>
<td>9.23%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Capital (K) C</td>
<td>8%</td>
<td>30</td>
<td>786</td>
<td>9833</td>
<td>24.29%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Horizon (N)</td>
<td>33</td>
<td>786</td>
<td>13087</td>
<td>0.76%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement Investment (R)</td>
<td>864.6</td>
<td>12005</td>
<td>7.57%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aAn 85% capacity utilization rate is assumed. Large is understood to mean 42.5 millions of pounds per year.

bAll figures are in thousands of dollars unless otherwise specified.

cThis calculation is based on a 33% increase in the cost of capital (i.e., from 6 to 8%) in order to ease the computations.

dAbsolute value of percentage change from baseline NPV.

In order to ease the computational burden, the NPVs in Tables 3-5 to 3-8 were calculated using a simplification of equation (9) shown above. The calculation takes the form of:

\[
NPV = \frac{CF \times N}{(1 + i)^{N/2}}
\]  \hspace{1cm} (10)

where CF = annual after-tax cash flow

N = project duration

i = interest rate (or cost of capital)

In order to employ (10), it is necessary that the annual cash flows be the same from one year to another. This is the case in the examples covered in Tables 3-5 to 3-8. The results obtained through the use of (10) are reasonably good approximations of those that would be obtained using (9). For example, in Table 3-5, the baseline NPV obtained through the use of (10) is $1,397. The corresponding value obtained from (9) is $1,433.

Tables 3-5 and 3-6 present the results of the sensitivity analysis for a small and a large orange juice plant, respectively. The small plant's NPV appears to be more sensitive to changes in sales, expenses, cost of capital, and replacement investment than the large plant, while the large plant's NPV is more sensitive to changes in interest expense, taxes, and the time horizon. Depreciation registers no impact since it cancels out (i.e., it is subtracted from sales revenue to arrive at net income for tax purposes, then it is added back in to obtain cash flow).

The results of a sensitivity analysis for a small and a large plant in the meat packing industry are shown in Tables 3-7 and 3-8. The small plant's NPV is more sensitive to changes in sales, total expenses, interest, cost of capital, and replacement investment. On the other hand, the large plant's NPV is more sensitive to change in the time horizon. The sensitivities are equal for income taxes; and, as pointed out above, depreciation has no impact since it cancels out in the calculation. For the small plant, the greatest sensitivities are associated with sales, total expenses, and the cost of capital.
3.2.3 Coverage Ratio Analysis (COVR)

3.2.3.1 Mathematical Equation. In its simplest form, COVR analysis may be expressed as:

\[
COVR_t = \frac{CF_t}{CPD_t} \tag{11}
\]

where \(COVR_t\) = debt coverage ratio in time period \(t\)

\(CF_t\) = cash flow in time period \(t\)

where \(CPD_t\) = current portion of long-term debt in time period \(t\)

Since

\[
CF_t = Y_t + D_t \tag{12}
\]

where \(Y_t\) = after-tax net income in time period \(t\)

\(D_t\) = depreciation in time period \(t\)

and since

\[
Y_t = S_t - (E_t + I_t + D_t) - T_t \tag{13}
\]

where \(S_t\) = sales revenue in time period \(t\)

\(E_t\) = total expenses (excluding interest and depreciation charges) in time period \(t\)

\(I_t\) = interest expense in time period \(t\)

\(D_t\) = depreciation in time period \(t\)

\(T_t\) = total income taxes in time period \(t\)

then COVR may be considered:

\[
COVR_t = \frac{S_t - (E_t + I_t + D_t) - T_t + D_t}{CPD_t} \tag{14}
\]

where all variables are as previously defined.
3.2.3.2 Sensitivity Analysis. The results of the COVR sensitivity analysis performed on a small and large orange juice plant appear in Tables 3-9 and 3-10. It should be noted that the COVR for the large plant is considerably more responsive to changes in all variables (with the exception of CPD) than the small plant. The small plant's COVR tends to be only slightly more sensitive with respect to CPD.

Tables 3-11 and 3-12 display the outcome of a similar analysis undertaken for a small and large meat packing plant. Again, the COVR for the small plant is less sensitive to change in the variables than the COVR for the large plant.

3.3 THE CRITICAL VARIABLES

The percentage changes listed in the last column of Tables 3-1 through 3-12 may be interpreted as elasticities since they register the responsiveness of a particular measure (i.e., ROI, DCF, COVR) to a 10 percent change in a variable. In order to ease interpretation and to aid in defining a critical variable, it is necessary to convert these elasticities so that they reflect a 1 percent (rather than a 10%) change in a variable. This is accomplished simply by dividing the percentage change column in each Table by 10 (with the exception of the cost of capital which should be divided by 33 since it was increased 33% rather than 10% - see Table 3-5, footnote c). These new elasticities may then be considered measures of error since they would show the percentage error that may occur in a particular technique (ROI, DCF, or COVR) as a result of a 1 percent error in one of the variables. Thus, a critical variable will be defined as one for which the error elasticity is greater than unity (i.e., a 1% error in a variable produces more than a 1% error in a particular measure). These error elasticities were averaged and collected by variable, technique, and size of firm. The results appear in Table 3-13.

As the table reveals, the critical variables (i.e., those most likely to be responsible for errors) for small firms are sales (EE_1 = 66.68), total expenses (EE_2 = 63.30), replacement investment (EE_10 = 1.15), and depreciation (EE_4 = 1.14). The remaining variables possess inelastic (i.e., less than unity) error responses, and thus may be considered non-critical. Table 3-14 more succinctly divides the variables into critical and non-critical by size of firm.

According to Table 3-14, small firms are more sensitive than large firms to changes in sales (66.68 vs. 50.67), expenses (63.30 vs. 49.92), replacement
Table 3-9. COVERAGE RATIO SENSITIVITY ANALYSIS
A SMALL FROZEN CONCENTRATED ORANGE JUICE PLANTA

<table>
<thead>
<tr>
<th>Variables</th>
<th>S</th>
<th>E</th>
<th>I</th>
<th>D</th>
<th>T</th>
<th>CPD</th>
<th>COVR</th>
<th>% Change d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (S)</td>
<td>2977.7</td>
<td>2347</td>
<td>36</td>
<td>97</td>
<td>102</td>
<td>88.8</td>
<td>2.50</td>
<td>122.00%</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>2581.7</td>
<td>36</td>
<td>97</td>
<td>102</td>
<td>88.8</td>
<td>-0.14</td>
<td>105.60%</td>
<td></td>
</tr>
<tr>
<td>Interest (I)</td>
<td>39.6</td>
<td>97</td>
<td>102</td>
<td>88.8</td>
<td>2.46</td>
<td>1.60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>106.7</td>
<td>102</td>
<td>88.8</td>
<td>2.50</td>
<td>0.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes (T)</td>
<td>112.2</td>
<td>88.8</td>
<td>2.39</td>
<td>4.40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current PortionC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of Long Term Debt (CPD)</td>
<td>97.68</td>
<td>2.27</td>
<td>9.20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aA 90% capacity utilization rate is assumed. Small is understood to mean 144 tons per day.

bAll figures are in thousands of dollars unless otherwise specified.

cCoverage ratio analysis was not actually employed in the original study. Nonetheless, in order to provide consistency and comparability of methods, the COVR baseline was constructed by assuming that the average COVR for small firms in this industry (as reported in Robert Morris Associates Annual Statement Studies) was applicable.

dAbsolute value of percentage change from baseline COVR.

Table 3-10. COVERAGE RATIO SENSITIVITY ANALYSIS
A LARGE FROZEN CONCENTRATED ORANGE JUICE PLANT

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base Values</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>CPD</th>
<th>COVR</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (S)</td>
<td>22334.4</td>
<td>17612</td>
<td>406</td>
<td>474</td>
<td>864</td>
<td>316</td>
<td>4.50</td>
<td>10.93</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>19373.2</td>
<td>406</td>
<td>474</td>
<td>864</td>
<td>316</td>
<td>-1.07</td>
<td>123.78%</td>
<td></td>
</tr>
<tr>
<td>Interest (I)</td>
<td>446.6</td>
<td>474</td>
<td>864</td>
<td>316</td>
<td>4.37</td>
<td>2.89%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>521.4</td>
<td>864</td>
<td>316</td>
<td>4.50</td>
<td>0.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>950.4</td>
<td>4.23</td>
<td>6.00%</td>
</tr>
<tr>
<td>Taxes (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>316</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Portion of Long Term</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debt (CPD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>347.6</td>
<td>4.09</td>
<td>9.11%</td>
</tr>
</tbody>
</table>

a A 90% capacity utilization rate is assumed. Large is understood to mean 1,072 tons per day.

b All figures are in thousands of dollars unless otherwise specified.

Coverage ratio analysis was not actually employed in the original study. Nonetheless, in order to provide consistency and comparability of methods, the COVR baseline was constructed by assuming that the average COVR for large firms in this industry (as reported in Robert Morris Associates Annual Statement Studies) was applicable.

d Absolute value of percentage change from baseline COVR.

Table 3-11. COVERAGE RATIO SENSITIVITY ANALYSIS
A SMALL MEAT PACKING PLANTa

<table>
<thead>
<tr>
<th>Variables</th>
<th>S</th>
<th>E</th>
<th>I</th>
<th>D</th>
<th>T</th>
<th>CPD</th>
<th>COVR</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (S)</td>
<td>9056.3</td>
<td>7961</td>
<td>49</td>
<td>98</td>
<td>60</td>
<td>95.88</td>
<td>1.70</td>
<td>505.29%</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>8757.1</td>
<td>49</td>
<td>98</td>
<td>60</td>
<td>95.88</td>
<td>-6.60</td>
<td></td>
<td>488.24%</td>
</tr>
<tr>
<td>Interest (I)</td>
<td></td>
<td>53.9</td>
<td>98</td>
<td>60</td>
<td>95.88</td>
<td>1.65</td>
<td></td>
<td>2.94%</td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td></td>
<td></td>
<td>107.8</td>
<td>60</td>
<td>95.88</td>
<td>1.70</td>
<td></td>
<td>0.00%</td>
</tr>
<tr>
<td>Total Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>66</td>
<td>95.88</td>
<td>1.64</td>
</tr>
<tr>
<td>Current PortionC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of Long Term Debt (CPD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>105.47</td>
<td>1.55</td>
<td>8.82%</td>
</tr>
</tbody>
</table>

aAn 85% capacity utilization rate is assumed. Small is understood to mean 4.2 millions of pounds per year.

bAll figures are in thousands of dollars unless otherwise specified.

cCoverage ratio analysis was not actually employed in the original study. Nonetheless, in order to provide consistency and comparability of methods, the COVR baseline was constructed by assuming that the average COVR for small firms in the meat packing industry (as reported in Robert Morris Associates Annual Statement Studies) was applicable.

dAbsolute value of percentage change from baseline COVR.

Table 3-12. COVERAGE RATIO SENSITIVITY ANALYSIS
A LARGE MEAT PACKING PLANT\textsuperscript{a}

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sales (S)</th>
<th>Total Expenses (E)</th>
<th>Interest (I)</th>
<th>Depreciation (D)</th>
<th>Total Income Taxes (T)</th>
<th>Current Portion of Long Term Debt (CPD)</th>
<th>COVR</th>
<th>% Change \textsuperscript{d}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Values</td>
<td>93923</td>
<td>90575</td>
<td>564</td>
<td>786</td>
<td>959</td>
<td>467.95</td>
<td>3.90</td>
<td>23.97 514.62%</td>
</tr>
<tr>
<td>Sales (S)</td>
<td>103315.3</td>
<td>90575</td>
<td>564</td>
<td>786</td>
<td>959</td>
<td>467.95</td>
<td>3.90</td>
<td>-15.46 496.41%</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>99632.5</td>
<td>564</td>
<td>786</td>
<td>959</td>
<td>467.95</td>
<td>3.78</td>
<td>0.00%</td>
<td>3.08%</td>
</tr>
<tr>
<td>Interest (I)</td>
<td>620.4</td>
<td>786</td>
<td>959</td>
<td>467.95</td>
<td>3.90</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>864.6</td>
<td>959</td>
<td>467.95</td>
<td>3.90</td>
<td></td>
<td></td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Total Income</td>
<td>1054.9</td>
<td>467.95</td>
<td>3.70</td>
<td>5.13</td>
<td></td>
<td></td>
<td>514.75</td>
<td>3.55 8.97%</td>
</tr>
</tbody>
</table>

\textsuperscript{a}An 85% capacity utilization rate is assumed. Large is understood to mean 42.5 millions of pounds per year.

\textsuperscript{b}All figures are in thousands of dollars unless otherwise specified.

\textsuperscript{c}Coverage ratio analysis was not actually employed in the original study. Nonetheless, in order to provide consistency and comparability of methods, the COVR baseline was constructed by assuming that the average COVR for large firms in the meat packing industry (as reported in Robert Morris Associates Annual Statement Studies) was applicable.

\textsuperscript{d}Absolute value of percentage change from baseline COVR.


3-20
Table 3-13. VARIABLES BY TECHNIQUE, SIZE OF FIRM, AND BY ERROR ELASTICITY

<table>
<thead>
<tr>
<th>Variable</th>
<th>Method</th>
<th>Weighted Averagea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>ROI</td>
<td>DCF</td>
</tr>
<tr>
<td>Sales (S)</td>
<td>74.19</td>
<td>74.11</td>
</tr>
<tr>
<td>Total Expenses (E)</td>
<td>70.65</td>
<td>70.13</td>
</tr>
<tr>
<td>Interest (I)</td>
<td>0.51</td>
<td>0.53</td>
</tr>
<tr>
<td>Depreciation (D)</td>
<td>1.14</td>
<td>0.00</td>
</tr>
<tr>
<td>Total Income Taxes (T)</td>
<td>0.87</td>
<td>0.87</td>
</tr>
<tr>
<td>Net Working Capital (NWC)</td>
<td>0.24</td>
<td>0.37</td>
</tr>
<tr>
<td>Fixed Assets (A)</td>
<td>0.69</td>
<td>0.57</td>
</tr>
<tr>
<td>Cost of Capital (K)</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>Time Horizon (N)</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td>Replacement Investment (R)</td>
<td>1.15</td>
<td>0.63</td>
</tr>
<tr>
<td>Current Portion of Long-Term Debt (CPD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted Average</td>
<td>70.80</td>
<td>53.00</td>
</tr>
</tbody>
</table>

aThe error elasticity, EEij, is defined as the percentage change in the ith measure (i.e., ROI or DCF or COVR) in response to a 1% change in variable j (i.e., sales, interest, depreciation, etc.).

bThe weighted averages were calculated as follows. For each variable (i.e., for each row), the error elasticities for each of the three methods were summed for the small firm and the large firm. Within each of the firm-size categories, the percentage which each error elasticity comprised of the total was calculated. These percentages were used as weights by multiplying them times the error elasticities. The products were then summed to obtain the weighted averages for the small firm and the large firm. The weighted averages at the bottom of the table were calculated using the same procedure. These averages, however, apply to a given method (e.g., ROI), and reflect the error elasticities for all of the relevant variables.

Source of data: Tables 3-1 through 3-12.
Table 3-14. VARIABLES RANKED BY SIZE OF FIRM AND BY ERROR ELASTICITY

<table>
<thead>
<tr>
<th>Small Firms</th>
<th>Error Elasticity</th>
<th>Large Firms</th>
<th>Error Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales (S)</td>
<td>66.68</td>
<td>Sales (S)</td>
<td>50.67</td>
</tr>
<tr>
<td>Expenses (E)</td>
<td>63.30</td>
<td>Expenses (E)</td>
<td>49.92</td>
</tr>
<tr>
<td>Replacement Investment (R)</td>
<td>1.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>1.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Critical Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Por. Debt (CPD)</td>
<td>0.90</td>
<td>Current Por. Debt (CPD)</td>
<td>0.90</td>
</tr>
<tr>
<td>Income Taxes (T)</td>
<td>0.78</td>
<td>Income Taxes (T)</td>
<td>0.84</td>
</tr>
<tr>
<td>Fixed Assets (A)</td>
<td>0.69</td>
<td>Cost of Capital (K)</td>
<td>0.63</td>
</tr>
<tr>
<td>Cost of Capital (K)</td>
<td>0.63</td>
<td>Replacement Investment (R)</td>
<td>0.63</td>
</tr>
<tr>
<td>Interest (I)</td>
<td>0.47</td>
<td>Depreciation (D)</td>
<td>0.63</td>
</tr>
<tr>
<td>Net Working Capital (NWC)</td>
<td>0.24</td>
<td>Fixed Assets (A)</td>
<td>0.57</td>
</tr>
<tr>
<td>Time Horizon (N)</td>
<td>0.22</td>
<td>Interest (I)</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Net Working Capital (NWC)</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time Horizon</td>
<td>0.22</td>
</tr>
</tbody>
</table>

*A critical variable is defined as one which has an error elasticity greater than unity.

Source of data: Table 3-13.
investment (1.15 vs. 0.63), depreciation (1.14 vs. 0.63), interest (0.47 vs. 0.45), and fixed assets (0.69 vs. 0.57), while large firms are (slightly) more influenced by changes in income taxes (0.84 vs. 0.78), and net working capital (0.37 vs. 0.24) than their smaller counterpart. The error elasticities for CPD (0.90), the cost of capital (0.63), and the time horizon (0.22) do not appear to vary with firm size.

Another interesting feature of Table 3-13, which is summarized in Table 3-15 for convenience, is a ranking of methods by error elasticity and size of firm. As can be seen from Table 3-15, with regard to small firms, the ROI method is subject to the most sensitivity (slightly more than DCF) and COVR to the least sensitivity. In the case of large firms, the DCF method is the most sensitive (but almost the same as ROI), with COVR being the least sensitive. If firm size is not taken into account, the ROI method ranks as the most sensitive, but only slightly more than the DCF method (70.80 for ROI vs. 70.53 for DCF). Both the DCF and ROI methods are more sensitive with respect to small-firm analyses than is the case for large-firm analyses. For COVR, however, the sensitivity is slightly greater for large-firm analyses.

3.4 AVAILABILITY AND QUALITY OF THE NECESSARY DATA

3.4.1 Sales

A sales figure can be obtained either directly via a plant survey and/or an engineering study or indirectly via secondary and tertiary sources. Table 3-16 depicts these sources along with a general assessment of the availability and quality of the data they contain. A brief statement concerning the limitations with respect to small business applications is also included.

As the table makes clear, a sales figure is usually generated by multiplying an average price times output, both of which are obtained separately. It is usually easier to obtain output data than it is price information, and tertiary and secondary sources are more readily available than primary sources. Unfortunately, information on privately-held corporations (which tend to be the smaller enterprises in an industry) is generally nonexistent in secondary sources and data for the smaller publicly-held corporations is often extremely scarce. Hence, verification of primary data and/or the use of secondary data in small-firm analyses is often not possible.

With respect to the quality of the sources, primary sources are the most reliable (particularly since the data can often be verified by secondary and
## Table 3-15. METHODS RANKED BY ERROR ELASTICITY AND SIZE OF FIRM

<table>
<thead>
<tr>
<th>Method</th>
<th>Error Elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small Firms</td>
</tr>
<tr>
<td>DCF</td>
<td>70.53</td>
</tr>
<tr>
<td>ROI</td>
<td>70.80</td>
</tr>
<tr>
<td>COVR</td>
<td>29.82</td>
</tr>
</tbody>
</table>

Source of data: Table 3-13.
Table 3-16. AVAILABILITY AND QUALITY OF THE DATA: SALES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Availability</th>
<th>Quality</th>
<th>Small Business Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>Existing Plant: moderately easy to obtain historical data</td>
<td>Good: added advantage is that primary data can often be verified with secondary data</td>
<td>Model plant may not be representative of the size classes in a particular industry</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td>New Plant: difficult to obtain since data must be generated</td>
<td>Poor: not able to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>Existing Plant: readily available in published form in most public libraries</td>
<td>Decent: in most cases but depends on source</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Plant: not available and must be forecast</td>
<td>Poor: not able to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>Easiest to obtain</td>
<td>Poor: not easily verifiable and subject to considerable error</td>
<td>Error likely to be greatest for smaller concerns</td>
</tr>
<tr>
<td>Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>Existing Plant: moderately easy to obtain historical data</td>
<td>Decent: problems arise when geographical/locational differences exist</td>
<td>Problems arise when there is considerable product differentiation and specialization by size of firm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Plant: difficult to obtain since data must be generated</td>
<td>Poor: not able to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>Existing Plant: available in published form</td>
<td>Decent: problems arise when geographical/locational differences exist</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Plant: not available and must be forecast</td>
<td>Poor: not able to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>Readily available</td>
<td>Poor: not easily verifiable and subject to considerable error</td>
<td>Given competition, error not likely to differ by size of firm</td>
</tr>
</tbody>
</table>
tertiary sources), followed by secondary, and then by tertiary source information. Data quality is influenced by the sources (of course) and by the nature of geographical/locational differences, and by the extent of product differentiation and specialization in the industry. Since a single model plant is usually constructed via primary and secondary data sources to represent a particular sized firm (small, medium, and large), its ability to properly depict that size class may be severely compromised when there is a considerable amount of product differentiation and specialization in an industry, and/or when there are geographical differences in product prices and costs due to varying degrees of locational advantage.

3.4.2 Expenses

Table 3-17 displays the various sources of information for procuring expense estimates, the availability and quality of this information, and some small business considerations.

Generally, raw material costs are based on an engineering study of the input-output relationship involved in a particular production process, and then verified by primary and secondary sources. Such data is usually readily available, both from cooperating firms and from published documents. However, in addition to the difficulty of obtaining information for privately-held and small publicly-held firms from secondary sources, a bias is often present in primary data since the questionnaire response rate for smaller firms tends to be lower than that for larger firms. Furthermore, expense data is often generated by size class by assuming that the cost of raw materials as a percentage of sales accounted for by the entire sample or the average firm applies without regard to scale. This assumption may be most inappropriate regarding smaller enterprises.

Finally, the quality and applicability of the data to small firms may suffer further when there are myriad multi-product establishments (so that it is difficult to separate out some of the costs attributable to a single product) and when there are geographical differences in costs due to differences in locational advantages.

3.4.3 Depreciation and Replacement Investment

The availability and quality of data used to construct the final two critical variables appear in Table 3-18. Since most impact studies take replacement investment to be equal to depreciation charges, these variables will be treated together.
### Table 3-17. AVAILABILITY AND QUALITY OF THE DATA: EXPENSES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Availability</th>
<th>Quality</th>
<th>Small Business Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation</td>
<td>Primary</td>
<td>Existing Plant: generally readily available from cooperating firms</td>
<td>Good: added advantage is that primary data can often be verified with secondary data</td>
<td>Model plant may not be representative of the size classes in a particular industry</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>New Plant: not available and must be forecast</td>
<td>Poor: not possible to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>Existing Plant: available in published form</td>
<td>Decent: in most cases but depends on source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>New Plant: not available and must be forecast</td>
<td>Poor: not possible to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>Readily available</td>
<td>Poor: not easily verifiable and subject to considerable error</td>
<td></td>
</tr>
<tr>
<td>Replacement</td>
<td>Primary</td>
<td>Existing Plant: moderately easy to obtain historical data</td>
<td>Good: verifiable via secondary sources</td>
<td>Problems arise when there is considerable specialization of equipment by size of firm</td>
</tr>
<tr>
<td>Investment</td>
<td>Primary</td>
<td>New Plant: not available and must be forecast</td>
<td>Poor: not possible to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>Existing Plant: easily accessible in published form</td>
<td>Decent: in most cases but depends on source</td>
<td>Replacement investment is usually taken to be equal to depreciation. This is likely to result in a distortion, particularly when there is a considerable amount of diversity in process equipment.</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>New Plant: not available</td>
<td>Poor: not possible to verify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>Readily available</td>
<td>Poor: not easily verifiable and subject to considerable error</td>
<td></td>
</tr>
</tbody>
</table>

- Variable: Depreciation, Replacement Investment
- Source: Primary, Secondary, Tertiary
- Availability: Existing Plant, New Plant, Readily available
- Quality: Good, Decent, Poor
- Small Business Considerations: Model plant may not be representative of the size classes in a particular industry, Problems arise when there is considerable specialization of equipment by size of firm, Often taken as a certain percentage of sales regardless of scale; thus, may not be truly reflective of small business situation, Replacement investment is usually taken to be equal to depreciation. This is likely to result in a distortion, particularly when there is a considerable amount of diversity in process equipment.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Availability</th>
<th>Quality</th>
<th>Small Business Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenses &amp; Raw Material Costs</td>
<td>Primary Engineering Studies, Plant Surveys, Annual Reports</td>
<td>Existing Plant: generally readily available from cooperating firms New Plant: not available and must be forecast</td>
<td>Good: verifiable via secondary sources Poor: unable to be verified</td>
<td>Response rate for smaller firms generally lower than for larger firms; thus, a bias may be present</td>
</tr>
<tr>
<td></td>
<td>Secondary Annual Reports, Other Studies Dun &amp; Bradstreet Moody's Standard &amp; Poor's Census of Mfg. Robert Morris Assoc. Troy Almanac Trade Associations Federal Trade Commission Periodicals</td>
<td>Existing Plant: available in published form New Plant: not available and must be forecast</td>
<td>Decent: in most cases but depends on source Poor: unable to be verified</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tertiary Industry Experts, Professional Judgment</td>
<td>Readily available</td>
<td>Poor: not easily verifiable and subject to considerable error</td>
<td></td>
</tr>
<tr>
<td>Direct and Indirect Operating Costs</td>
<td>Primary Engineering Studies, Plant Surveys</td>
<td>Existing Plant: moderately easy to obtain historical data New Plant: not available and must be forecast</td>
<td>Good: verifiable via secondary sources Poor: unable to be verified</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary Annual Reports, Other Studies Dun &amp; Bradstreet Moody's Standard &amp; Poor's Census of Mfg. Robert Morris Assoc. Troy Almanac Trade Associations Federal Trade Commission Periodicals</td>
<td>Existing Plant: easily accessible in published form New Plant: not available</td>
<td>Decent: in most cases but depends on source Poor: unable to be verified</td>
<td>Often taken as a certain percentage of sales regardless of scale; thus, may not be truly reflective of small business situations</td>
</tr>
<tr>
<td></td>
<td>Tertiary Industry Experts, Professional Judgment</td>
<td>Readily available</td>
<td>Poor: not easily verifiable and subject to considerable error</td>
<td></td>
</tr>
</tbody>
</table>
Most of the earlier comments regarding availability and quality of the data for sales and expenses also apply here. There is, however, one consideration unique to these two variables. When a single model plant is used for a particular size class, there may be distortions concerning the true replacement investment/depreciation charge, particularly when there is a considerable amount of diversity in process equipment and technology in use in the industry.

3.5 SUMMARY AND CONCLUSIONS

3.5.1 Summary

This chapter undertook a detailed analysis of three methods (ROI, DCF, and COVR). Each method was expressed in terms of a mathematical equation and a sensitivity analysis was performed on each in order to determine which variables were most likely to result in inaccurate conclusions if improperly specified. This analysis was undertaken for a small and a large plant in two industries: frozen orange juice and meat packing. The critical variables were identified by method, size of firm, and by error elasticity. The availability and quality of data needed to construct these critical variables, particularly with regard to smaller firms, were also discussed.

As pointed out in the beginning of this chapter it is important that the reader keep in mind that the three methods were not considered together in an effort to determine which one is the best to employ in an economic impact analysis. Indeed, each of the methods has its particular purpose, and its usefulness, as well as the feasibility of its deployment, will vary from one analytical context to another.

3.5.2 Conclusions

The major conclusions of this chapter are:

1) The critical variables (i.e., those most likely to be responsible for errors) for small firms are sales, total expenses (excluding interest and depreciation), depreciation, and replacement investment. The remaining variables possess inelastic (i.e., less than unity) error responses, and thus may be considered noncritical.

2) The critical variables for large firms are sales and total expenses.

3) Small firms are more sensitive than large firms to changes in sales, total expenses, replacement investment, depreciation, interest, and fixed assets.
4) Large firms are more sensitive than small firms to changes in income taxes and net working capital.

5) The error elasticities for the current portion of long-term debt, the cost of capital, and the time horizon do not appear to vary with firm size.

6) The ROI and DCF methods appear to be the most sensitive without regard to firm size.

7) The COVR method appears to be the least sensitive without regard to firm size and when size is taken into account.

8) The ROI and DCF methods are more sensitive with respect to small-firm analyses than is the case for large-firm analyses. For COVR, however, the sensitivity is slightly greater for large-firm analyses.

9) It is usually easier to obtain output data than it is price information, and tertiary and secondary sources are more readily available (and less expensive) than primary sources.

10) In terms of quality, primary data is the most reliable, followed by secondary and tertiary data.

11) Information on privately-held corporations (which tend to be the smaller firms in an industry) is generally nonexistent in secondary sources and data for smaller publicly-held corporations is often extremely scarce. Thus, verification of primary data and/or the use of secondary data is often precluded in small-firm analyses.

12) Data quality is a function of the source, the nature of geographical/localational differences in prices and costs, the extent of product differentiation and specialization in an industry, the questionnaire response rate, the extent of multi-product establishments, the diversity in process equipment and technology in use -- all of which may compromise the results of a small business analysis.

13) Finally, three reasons that COVR analysis may be the least sensitive of the three methods (both overall and if the focus is small business) are:

   i) It employs fewer variables (critical and otherwise) than the other methods (see Table 3-13);

   ii) It involves a simpler mathematical expression (at least when compared with DCF); and finally
iii) When compared to ROI given the same data (as was the case in this chapter), the numerator of COVR is larger than the numerator of ROI (i.e., cash flow = net income plus depreciation is larger than net income) and the denominator of COVR is smaller than the denominator of ROI, making COVR numerically larger than ROI. Thus, 10 percent changes relative to larger bases will yield smaller numbers than 10 percent changes relative to smaller bases.
4.0 RETROSPECTIVE ANALYSIS

4.1 INTRODUCTION

In this chapter, five economic impact studies are subjected to retrospective analysis in order to gain additional insight about the ability of existing analytical methodologies to assess differential impact. Retrospective analysis involves the identification and evaluation of economic impacts predicted by a study, and the comparison of these predicted impacts with the impacts that are actually observed.

The five studies that are analyzed include:


These studies were selected from the list of 22 studies discussed in Chapter 2. Each of the 22 studies was screened to determine its basic possibilities for retrospective analysis. A particular study was ruled out if any of the following conditions obtained:

- The regulation has not been promulgated yet.
- Since the date of promulgation, not enough time has passed to allow for the occurrence of measurable impacts. Two years was used as a cutoff.
The predicted impacts were not sufficiently quantified to permit evaluation of their accuracy.

The results of the screening procedure are summarized in Table 4-1. The "X" marks indicate which criterion is the basis for disqualification of a particular study. A total of 10 studies were identified as possible candidates for analysis.

Given the list of 10 possibilities, the number was then narrowed down to the final five by applying several considerations. To begin with, it was determined that studies employing methodologies based upon the use of industry average regulatory costs should be ruled out since they do not possess the capability of directly assessing differential impact. In this type of methodology, a single conceptualization (sometimes called a "typical plant") is used to represent an entire industry, and variation in plant size is not accounted for. A second consideration was that to the extent possible, all of the major techniques of analysis (such as ROI and DCF analyses) should be represented in the final set of studies to be analyzed retrospectively. A third criterion, was that the selected studies should cover as many different agencies as possible. A final consideration was that the selected studies should be representative of the general depth and quality of the agencies' regulatory impact analyses.

The retrospective analyses are presented in Sections 4.2 to 4.6. Each section is divided into five parts. The first part describes the regulation involved, and points out any changes that have occurred since the regulation was proposed. The second part provides a brief description of the industry that is subject to the regulation. The third part of the discussion provides an examination of the methodology employed in the study. The fourth part examines the accuracy of the forecasts of impacts. The final part provides a general critique of the analysis, and points out ways in which the analysis could be improved, particularly with respect to the evaluation of differential impact.

Section 4.7 summarizes the results of the retrospective analyses, and presents comments on the ability of existing methodologies to assess differential impact.
Table 4-1. DETERMINATION OF CANDIDATES FOR RETROSPECTIVE ANALYSIS

<table>
<thead>
<tr>
<th>Agency</th>
<th>Study Title</th>
<th>Basic Screening Criteria</th>
<th>Candidate for Retrospective Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSC</td>
<td>Upholstered Furniture</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>CPSC</td>
<td>Children's Garments</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>CPSC</td>
<td>Matchbooks</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>EPA (Air)</td>
<td>Kraft Pulp Mills</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>EPA (Air)</td>
<td>Lime Plants</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>EPA (Air)</td>
<td>Lead-Acid Batteries</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Leather Tanning</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Electroplating (1973 Study)</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Fruit and Vegetable Industry</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Soap and Detergent Industry</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Meat Packing</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>EPA (Integrated)</td>
<td>Pulp and Paper</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Paint</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Textile Mills</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Water)</td>
<td>Electroplating (1979 Study)</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Toxics)</td>
<td>TSCA Premanufacturing Notification</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Solid Waste)</td>
<td>Inorganic Chemicals</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>EPA (Solid Waste)</td>
<td>Leather Tanning</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>OSHA</td>
<td>Coke Ovens</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>OSHA</td>
<td>Cotton Dust</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>OSHA</td>
<td>Benzene</td>
<td>Small businesses (i.e., gas stations) were exempted. Also, regulation is currently subject of court case.</td>
<td>No</td>
</tr>
<tr>
<td>FDAa</td>
<td>Chlorofluorocarbons</td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

aStudy sponsored jointly with EPA and CPSC.
4.2 FRUIT AND VEGETABLE PROCESSING

4.2.1 The Regulation

The overall framework for the control of water pollution was established by the 1972 amendments to the Clean Water Act. Among other things, this legislation established standards of pollution control that were to be met by 1977 by all existing and new industrial point sources discharging into public waterways. The legislation also established more stringent standards of control to be met by 1983. These standards required every discharger to install by 1977 the "best practicable control technology" (BPT) and to install additional equipment by 1983 representing the "best available technology economically achievable " (BAT).

Following upon this legislation, EPA undertook an extensive program of developing effluent guidelines defining for various industrial categories pollution loads allowable under BPT and BAT. In this connection, on November 3, 1973, EPA proposed in the Federal Register a set of effluent guidelines for the fruit and vegetable processing industry. The analysis of the potential economic impact of these proposed guidelines was released in October, 1973. The guidelines were promulgated in the Federal Register on March 21, 1974.

Subsequent to the date of promulgation, legislation was passed that had an important bearing upon the guidelines. In 1977, amendments to the Clean Water Act altered the abovementioned requirements for 1983. The deadline for compliance with the more stringent standards of control was changed to 1984, and the single BAT limitation was replaced with a more complicated formula that applied a "best conventional technology" (BCT) limitation to certain conventional pollutants, a best available technology standard to toxic pollutants, and a best available technology limitation, subject to possible extension of the deadline to 1987, to certain other pollutants.¹ Both large and small firms benefited from the postponement of the deadline to 1984 and the change to BCT. In addition to these general changes, later deliberations concerning the fruit and vegetable guidelines, in particular, led to an exemption for small apple processing plants of less than 10 tons per day of production.²
4.2.2 The Fruit and Vegetable Processing Industry

The fruit and vegetable processing industry can be characterized as dominated by a small number of large plants which account for a major portion of sales, but with a significant number of small plants that account for a small portion of the total industry's sales. At the time the economic impact study was completed (October, 1973), the industry consisted of approximately 1,700 plants. Approximately one percent of the plants in the industry account for roughly 50 percent of the sales in the industry, while approximately 51 percent of the plants account for less than 3 percent of the sales (the total number of plants varies according to data source).3

Therefore, this characterization suggests that there are a large number of small marginal processors which may be sensitive to an increase in their production costs in the form of pollution control. In the economic impact study, two sectors of the industry are emphasized: citrus processing, and apple processing (other subcategories in the industry such as tomatoes and beans are treated separately).

4.2.3 Study Methodology

A model plant approach is used in the economic analysis, with three model plant sizes developed for each industry segment in order to represent small, medium, and large plant sizes. The choice of three model plant sizes is favorable because it permits examination of the impact on the small plant alone as well as permitting examination of the differential impacts among the three plant sizes.

Three principal data sources are used in the economic analysis. Two of these, the Census of Manufactures and The Directory of the Canning, Freezing, Preserving Industries, published by Edward E. Judge and Sons, Inc., provide mainly production information. The third source, Almanac of Business and Industrial Financial Ratios, published by Leo Troy, provides mainly financial information. Although there is not perfect consistency among these three sources, each of them does categorize its information according to various plant sizes. The fact that each of the data sources provides information based on size leads to a more accurate representation of model plant financial characteristics.
The impact analysis is structured around the use of the discounted cash flow (DCF) technique. The technique is used to evaluate the affordability of the pollution controls required by the regulation. DCF is the most comprehensive financial analytical technique because it considers the time value of money, while most other techniques do not, plus it considers special situations that affect cash flow such as salvage value, where other techniques do not. A second technique, return on investment (ROI), is used to bring an added perspective to the analysis and supplement the DCF analysis. An added element which strengthens the methodology is that sensitivity analysis is performed both on the pollution control costs and on the utilization rate of plant capacity. Overall, the methodology used in the economic analysis is thorough.

4.2.4 Forecast Accuracy

At the outset, it should be pointed out that the study contains an error in the calculation of the discount rate used in the DCF analysis. The weighted average cost of capital is calculated as six percent in the study, although the correct calculation yields a figure of nine percent. The total of six percent is the result of reducing the before-tax cost of equity to what would be an after-tax cost. Dividends, however, are not deductible for tax purposes -- thus, the before-tax cost of equity and the after-tax cost of equity should be the same. The use of six percent rather than nine percent results in net present values (NPV) that are overstated by approximately 20 percent. In the absence of a time consuming recalculation of NPV's, it generally appears that the fundamental conclusions of the economic analysis concerning affordability would remain the same although the actual numbers change.

One of the principal outputs of the study is a projection of the number of plant closures likely to result from the imposition of the regulation. The projected closings, however, are not cited by the name of the firm involved (neither baseline closures nor regulation-induced closures). It is therefore not possible to make an exact comparison on a company-by-company basis of actual plant closures versus projected plant closures. Additionally, changes such as mergers and acquisitions obscure the trail of closures. Also, over a period of approximately seven years from the date of the economic analysis to the present, the addition or subtraction of product lines...
at existing plants could cause a plant to be grouped in a different product category other than its original classification. In spite of these limitations, however, there are some conclusions that can be drawn. These are discussed below.

In recent years, there has been a decline in the number of plants in the fruit and vegetable processing industry. The decline is not related to pollution control. The study estimated the historical rate of baseline (not related to pollution control) net plant closures at between 2.8 and 1.3 percent per year for both fruit and vegetable canners and freezers. A historical rate of approximately 2 percent per year was used to project baseline plant closures. According to the Census of Manufactures, the actual rate that occurred for canners from 1967 to 1977 was approximately 3 percent, and approximately 2.5 percent from 1972 to 1977 (the SIC classification for freezers was changed starting in 1972 and is not comparable to earlier years). Therefore, the decision in the study to continue the historical trend of two percent in order to project future net plant closures appears reasonably accurate.

Although the baseline long-term trend of fewer total plants in the industry is continuing, the percentage of small plants versus large plants has not changed. Information from the 1977 Census of Manufactures shows that approximately 59 percent of the canning firms have 20 or more employees, which is the traditional proportion for this industry.4

As mentioned earlier, the study focused attention on the citrus processing and apple processing segments of the fruit and vegetable industry. Shown below are the study's forecasts for both baseline closures and pollution-control-related closures for these two segments.

<table>
<thead>
<tr>
<th></th>
<th>Total Existing Plants (1970)</th>
<th>'73-'83 Baseline Plant Closures</th>
<th>Pollution Control Plant Closures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Citrus</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrus only</td>
<td>41</td>
<td>105</td>
<td>18</td>
</tr>
<tr>
<td>Citrus plus other products</td>
<td>64</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Apples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apples only</td>
<td>29</td>
<td>144</td>
<td>25</td>
</tr>
<tr>
<td>Apples plus other products</td>
<td>115</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

4-7
The small single strength (SS) citrus juice processors and the small apple processors were relatively low-profit operations even in the absence of pollution controls and as such are projected to be the most heavily-impacted by the pollution controls. Although a precise comparison is not possible, a review of The Directory for 1978-1979 shows that there are plants which still can only apples (15 plants), including several small plants, and there are also plants that still can only SS citrus juice.

EPA maintains an Economic Dislocation Early Warning System (EWS) which provides a listing of plants that are threatened with closure or have actually closed due substantially to pollution-control regulations. The EWS covers a variety of industries, one of which is Food and Kindred Products. The EWS Food and Kindred Products category includes a broader range of products than merely fruits and vegetables, such as dairy products and soda bottling plants. Also, the EWS covers a longer period of time, from 1971 to the present, than is directly relevant for this study. The EWS cites a total of 23 plant closures for Food and Kindred Products Category from 1971 to the present. Closures in the earlier years are not related to the 1977 BPT guideline. For the period from 1976 to the end of 1979, the EWS cites five plant closures. The EWS is a voluntary system and does not attempt to include plants with less than 25 employees; however, even with these limitations, the EWS does seem to support in a general manner the conclusion of the study that numerous closures would not occur due to the regulation. Also, the five plant closures cited by the EWS are not apparently citrus or apple plants, plus factors other than solely pollution control may have played a significant role in the closure decision, such as obsolete plant and equipment and poor market conditions.

Total projected plant closures due to pollution control (two citrus plants and four apple plants) were not forecast to disrupt total industry production because adequate excess capacity exists in the industry. Baseline plant closures were forecast to cause an unspecified level of short-term disruption in production but with production recoverable in the long-term.

There has been no discernible disruption in total industry production due to the 1977 BPT regulation either in the citrus and apple segments or in the overall fruit and vegetable industry. The value of shipments for the fruit and vegetable industry has exhibited healthy increases of about eight
percent per year since 1976 with an additional eight percent increase projected for 1980 including a modest increase in total production projected for 1980.\(^5\),\(^6\) Therefore, as is projected in the study, no significant industry-wide disruption has occurred in production.

The price increase projected as a result of the pollution controls is approximately one to two percent. For this industry, it is not possible to make a meaningful analysis of the actual results of a projected price increase as small as one to two percent, due to a variety of factors such as:

- High inflation
- Increased energy costs
- Changes in the regulation
- Changes in the tax laws
- Technological advances in the industry
- Variable harvests.

Some additional qualitative insight into the significance of the regulation is provided by a literature search on the subject of the impact of the 1977 BPT regulation. There is a noticeable lack of literature on the subject. Also, during 1977 in testimony before a House Committee reviewing the issue, a spokesman for the then National Canners Association (now the National Food Processors Association) stated that the industry supported the BPT regulation but felt that the BAT regulation was too costly (BAT was later revised)\(^7\) All of this suggests that the industry has not experienced significant economic impact and in this sense supports the conclusions reached in the economic analysis.

4.2.5 General Critique of the Analysis

As pointed out earlier, the methodology used in the economic analysis is thorough, and the results are generally reasonable. However, in addition to the many factors that are considered in the study, there are some important ways in which the analysis could have been augmented. These are discussed below.*

First, the study could have included specific estimates of the cost of reporting and recordkeeping requirements associated with the regulations for

* The following recommendations focus on types of analyses that were not commonly included in economic impact studies that were done around 1973. Many of the analyses, however, have come into widespread use in the past two to three years.
both the industry and for the government. Also, the cost of compliance testing could have been included. Though the cost of reporting, record-keeping, and testing may be a small part of the budget at a large firm, these costs may be significant at a small firm. If these costs are significant at a small firm, some relief may be possible such as shortened reporting forms, less frequent testing or both.

Second, the study could have included some discussion of special pollution-control financing available for all business or only small business. Examples of special financing for control equipment would include Small Business Administration loans, Industrial Development Bonds (IDB's), and low-interest commercial bank loans. Where special financing is available, this may have a bearing on the issue of capital availability for control equipment.

Third, consideration could have been given to compliance costs due to other regulations that were either in the process of being developed or which had been in effect for such a short period of time that the financial impact was not manifested in the then current financial information. The cumulative impact of two or more regulations may be significant although each regulation individually is not significant. Examples would include situations where an industry is subject to both air and water pollution controls, or two agencies such as OSHA and EPA may be developing regulations for different aspects of the same industry.

Fourth, some qualitative consideration could have been given to engineering contingency factors that could vary from a large plant to a small plant due to differences to R&D, technical support capabilities, and experience. For example, a multi-plant firm or a large plant may be able to rely on employees from another plant or division to provide expertise and experience in special situations, whereas a one-plant firm or a small firm faced with a similar special situation might have to purchase outside services or learn through a trial-and-error process.

Fifth, cost effectiveness could have been considered in the decision-making process in order to choose among alternative levels of control. A cost-effectiveness evaluation will not change the basic conclusion concerning affordability versus nonaffordability, but it will highlight which control alternative among several choices removes the most pollution for a given amount of expenditure.
4.3 SOAP AND DETERGENT MANUFACTURING

4.3.1 The Regulation

As pointed out in the preceding discussion dealing with the fruit and vegetable processing industry, following upon the enactment of the 1972 amendments to the Clean Water Act, EPA embarked upon the development of effluent guidelines and standards of performance for various industrial categories. Another industrial category for which guidelines and standards were developed is the soap and detergent industry. The guidelines and standards for this industry were initially proposed in the Federal Register on December 26, 1973. The economic impact analysis of the proposed regulation was published in August, 1973. The final form of the guidelines and standards was published in the Federal Register on April 12, 1974.

The guidelines and standards were set according to three levels of technology:

- **Level I** - Best Practicable Control Technology (BPT); to be met by July 1, 1977.
- **Level II** - Best Available Technology Economically Achievable (BAT); to be met by 1983.
- **Level III** - Best Available Demonstrated Control Technology (BADCT); applicable to new sources.

Subsequent to their promulgation, the guidelines and standards were altered in several ways. Following is a summary of the changes that occurred:

1. **All levels of technology**
   - Modified to allow for fast turnaround operation of automated fill lines. This modification was intended to accommodate the small liquid detergent manufacturer.
   - Modified by increasing the daily maximum limitation to account for normal variability in measurement.

2. **BPT only**
   - Modified to provide for flexibility in dealing with special circumstances that may not have been adequately accounted for when the regulations were developed.

3. **BADCT only**
   - Modified to reflect the degree of waste control equivalent to identifiable technology appropriate for new sources manufacturing by batch kettle boiling.
Although small plants were not explicitly exempted from the guidelines and standards, the first modification listed under "all levels" and the modification listed under "BPT only" were intended primarily to alleviate the disproportionately heavy impact on small plants.

4.3.2 The Soap and Detergent Industry

The soap and detergent industry comprises establishments primarily engaged in manufacturing soap, synthetic organic detergents, inorganic alkaline detergents or any combination thereof, and also establishments producing crude and refined glycerine from vegetable and animal fats and oils. According to the Census of Manufactures, the industry in 1977 consisted of 635 plants, of which 225 had 20 or more workers. The estimated value of shipments was $5.8 billion.9 The industry may be characterized as oligopolistic, with the bulk of the market power being concentrated in the hands of a few large sellers. In 1972, according to the Census Bureau, out of an industry total of 577 firms, the top four firms accounted for 62 percent of the industry's total value of shipments ($3.4 billion).10 As this ratio suggests, the industry has a large number of very small firms with relatively little market power. There is no apparent price competition in the industry, except in the area of light-duty liquid detergents. The high degree of concentration gives rise to a situation in which the so-called "big three" (Proctor and Gamble, Lever Brothers, and Colgate-Palmolive) extend a price umbrella over the industry.

4.3.3 Study Methodology

The economic impact study was concerned with evaluating the impact of the proposed standards and guidelines on the economic viability of three categories of firms making up the soap and detergent industry. Segment I comprises the four largest firms in the industry. Segment II comprises the next four largest, and Segment III comprises the balance of the industry. In order to evaluate the impact of the guidelines and standards on these groups, three model plants were developed. Each model corresponds to one of the three groups, and represents a single-plant firm. Of the three models employed, the first represents a small marginal producer of soap, the second represents a small successful producer of liquid detergent, and the third represents a large, integrated soap and detergent plant operated by one of the four largest firms in the industry. The model plants were assigned
complete sets of financial characteristics based on Dun and Bradstreet key financial and profitability ratios. The financial characteristics of the model plants were selected with the objective of having the plants serve as "average" firms. Each of the model plants is subjected to the costs associated with the different levels of effluent control technology (i.e., Levels I, II, and III), and the impacts on profitability and risk are observed. The results from the model plant analysis are summarized and generalized for the industry as a whole.

By employing three different model plants, the study is able to illustrate the differential impact of the guidelines and standards. At the same time, however, the significance that can be attached to the results of the analysis is limited somewhat by the assumptions that had to be employed in developing the model plants. The study even makes a special point of noting that in order to evaluate the effects of the guidelines and standards, each model plant had to be considered as a separate profit center, and, as mentioned above, a company in itself.

The assumption that a plant is tantamount to a firm would appear to be reasonable in the case of this industry. In the study, support for this assumption is developed by comparing 1963 summary data on the numbers of establishments and firms comprising the industry. The data show a fairly good correspondence between the two distributions (i.e., multiplant firms are in the minority).

There would appear to be some question, however, about the validity of assuming that single plants are also separate profit centers. The study recognizes this fact, and points out that within the soap and detergent industry, single plants are not generally considered as profit centers. Rather, the general practice is to treat a product as a profit center, and to assign costs to the various plants that manufacture the product.

The use of these two assumptions can be defended on the grounds that they facilitate the impact analysis; however, it must be recognized that they introduce a certain degree of error into the analytical framework. For example, the relationship between multiplant operations and potential economies of scale in pollution control cannot be addressed.

As a form of "worst-case" analysis, the study estimates the economic impact of the guidelines and standards for a hypothetical situation in which
all of the plants in the industry utilize on-site treatment of effluent (and are thereby subject to the guidelines and standards). In actuality, the majority of plants in the industry discharge their wastes into publicly-owned treatment facilities. The study even goes so far as to estimate that less than five percent of the plants in the industry would be impacted directly by the guidelines and standards. According to the study, in 1973 about 98 percent of the industry's plants were not "point sources"* of effluent.

Leaving these facts aside, the rationale for utilizing a worst-case analysis is to establish the upper bounds for the impacts associated with a regulation. If the impacts in the worst case are relatively minor, it can be assumed that at least they would be no greater in more likely cases. The real value of the approach is that it can considerably reduce the amount of analytical work that is needed to derive basic conclusions about the magnitude of the regulatory impact.

The study makes a qualitative observation that the demand for soap and detergents for the entire industry is price inelastic. This observation is probably correct; however, it should have been based upon a quantitative analysis. There would appear to be adequate data to perform such an analysis.

4.3.4 Forecast Accuracy

The study develops quantitative forecasts of the effects of the guidelines and standards on profit margins and prices. These are shown in Tables 4-2 and 4-3, respectively. In both tables, the impacts are presented in terms of quartiles. This arrangement is due to the particular characteristics of the data used in the analysis. In the study, the economic impact analysis was based upon the construction of hypothetical balance sheets for the three model plants. The balance sheets were constructed using financial ratios obtained from the Dun and Bradstreet publication, *1971 Key Business Ratios*. The balance sheet items were derived by applying the ratios to estimated sales revenues for the plants.

The Dun and Bradstreet ratios were developed from data for 64 representative firms (in SIC's 2841, 2842, 2843, and 2844), and arranged in terms of upper, median, and lower quartiles. For each of the model plants, a balance sheet was first prepared using the median quartile data. The study

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*Plants that utilize on-site treatment of effluent.*
Table 4-2. PROFIT MARGIN DECREASE IF NO PRICE CHANGE\textsuperscript{a,b}

<table>
<thead>
<tr>
<th></th>
<th>Level I</th>
<th>Level I &amp; Level II</th>
<th>Level III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Soap</td>
<td>50 Percentile</td>
<td>80%</td>
<td>93%</td>
</tr>
<tr>
<td>Plant</td>
<td>Lower Quartile</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Small Detergent</td>
<td>Upper Quartile</td>
<td>13.5%</td>
<td>63.8%</td>
</tr>
<tr>
<td>Plant\textsuperscript{C}</td>
<td>50 Percentile</td>
<td>14.2%</td>
<td>66.8%</td>
</tr>
<tr>
<td>Large Soap and</td>
<td>Upper Quartile</td>
<td>2.1%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Detergent Plant</td>
<td>50 percentile</td>
<td>2.2%</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Results obtained from original study.
\textsuperscript{b}The presentation of the profit margin decreases in terms of quartiles is explained in the discussion in Section 4.3.4.
\textsuperscript{C}This plant is assumed to meet Level I and Level II technology simultaneously.
Table 4-3. IMPACT ON PRICE PER POUND OF PRODUCT
IF PROFIT MARGINS REMAIN CONSTANT

<table>
<thead>
<tr>
<th>Rank of Firm</th>
<th>Price $/lb.</th>
<th>Level I Price Change</th>
<th>Level II Price Change</th>
<th>Level III Price Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Soap Plant 50 Percentile</td>
<td>24.00</td>
<td>25.46 6.08%</td>
<td>25.70 7.08%</td>
<td>27.38 14.08%</td>
</tr>
<tr>
<td>Small Soap Plant Lower Quartile</td>
<td>24.00</td>
<td>25.43 5.90%</td>
<td>25.66 6.90%</td>
<td>27.24 13.50%</td>
</tr>
<tr>
<td>Small Detergent Plant Upper Quartile</td>
<td>28.93</td>
<td>29.13 .68%</td>
<td>29.13 .68%</td>
<td>30.64 5.91%</td>
</tr>
<tr>
<td>Small Detergent Plant 50 Percentile</td>
<td>28.93</td>
<td>29.13 .68%</td>
<td>29.13 .68%</td>
<td>30.60 5.77%</td>
</tr>
<tr>
<td>Large Soap and Detergent Plant Upper Quartile</td>
<td>28.94</td>
<td>29.00 .21%</td>
<td>29.02 .31%</td>
<td>29.35 1.41%</td>
</tr>
<tr>
<td>Large Soap and Detergent Plant 50 Percentile</td>
<td>28.94</td>
<td>29.00 .21%</td>
<td>29.02 .31%</td>
<td>29.40 1.59%</td>
</tr>
</tbody>
</table>

*a*All information was obtained from the original study for this conversion.

*b*The presentation of the impacts in terms of quartiles is explained in the discussion in Section 4.3.4.

*c*Calculated from model plant parameters presented in the study.
argued that these balance sheets would be representative of the financial profiles of "average" firms. Once the balance sheets were constructed, the model plants were impacted with the incremental costs associated with the various levels of effluent control technology. To broaden the scope of the analysis, the study constructed additional balance sheets for the model plants, based upon ratios corresponding to other quartiles. In the case of the small detergent plant and the large, integrated soap and detergent plant, balance sheets were also developed from upper quartile data. For the small soap plant, an additional balance sheet was developed from lower quartile data. The study notes that the reason why the use of lower quartile data was restricted to the small soap manufacturing plant is that this model constitutes a form of "acid test". The model is intended to represent a marginal operation. Use of lower quartile data for the other two model plants was rejected on the grounds that it would be unrealistic.

Table 4-2 shows how the various levels of pollution control would impact plant profit margins if product prices were held constant (i.e., if the firms were unable to pass through any of the regulatory burden to consumers). The percentage decreases shown in the table are with respect to the baseline profit margins (i.e., net income) that would prevail in the absence of regulation. The impacts for the small soap plant are considerably greater than those for the other two plants. In four cases (indicated with dash lines), the imposition of pollution control costs even results in a net loss for this plant.

Table 4-3 shows the price increases that are necessary in order for a given model plant to maintain the profit margin that it enjoyed previous to the imposition of the regulation. In the case of Level I technology, the necessary price increases range from .21 percent for the large, integrated soap and detergent plant, to 6.08 percent for the small soap plant. A similar pattern obtains for Level I plus Level II, and for Level III. The study suggests that in the soap and detergent industry, the leading firms attempt to avoid antitrust action by pricing in such a way to keep the small firms in a profitable environment. If this is the case, the expected industry average price increase under this regulatory scenario would be around 6 percent.

Actual price changes for the period relevant to the implementation of Level I control technology (6/74 - 7/77) appear to lie within the bounds
suggested. The Producer Price Index for soaps and detergents had an absolute increase of 29.7 percent for this period.\textsuperscript{11} Most of this increase is due to inflation. Using the Producer Price Index (PPI) as a proxy for inflation, an estimate of the real price change can be obtained. For the period of June, 1974 to July 1977, the PPI increased 24.9 percent. The resulting real price increase for soaps and detergents is 5 percent, well within the bounds described above.

The study also presents qualitative forecasts of the impacts of the guidelines and standards with respect to production, employment, industry profitability, the number of point-source firms, plant closures, community economic dislocation, and international trade. In none of these areas are the impacts expected to be discernible.

The considerable influence of the business cycle on data for production, employment, and profitability makes it impossible to identify any significant impact from the guidelines and standards. The number of point-source firms was expected to remain at less than 5 percent of the industry. Currently, 34 plants are considered by the EPA as point sources, which is approximately 5 percent of the industry. No plant closures were expected, and, according to EPA, no regulation-caused plant closures have occurred.\textsuperscript{12}

4.3.5 General Critique of the Analysis

In analyzing the impact of the guidelines and standards on the profit margins for the model plants, the study examines only the situation in which prices remain constant. The analysis could have also focused on the situation in which the control costs are totally passed through to the consumer while profit margins remain constant. Further, since data was available, a more rigorous analysis of price elasticity should have been conducted in order that a "most likely" case could have been defined and analyzed for impacts.

Certain assumptions were necessary so that data on plants could be used in the analysis as a proxy for data on firms. Consideration of potential cost savings from economies of scale associated with large multi-plant firms was neglected by using the proxy data. The differential impact between small and large firms was perhaps underestimated because these cost savings were not explicitly considered.
4.4 COKE OVENS

4.4.1 The Regulation

The coke oven standard was developed by OSHA in response to concern about the high incidence of cancer among workers exposed to emissions from coking operations. The standard seeks to reduce employee exposure to such emissions through the implementation of engineering, work practice, and personal protective controls.

The standard was originally proposed in the Federal Register on July 31, 1975. The inflation impact analysis of the proposed standard was completed in February, 1976. On October 22, 1976, the final standard was presented in the Federal Register. The effective date of the standard was January 20, 1977. On February 17, 1977, however, the standard was revised to also include both new and rehabilitated coke ovens, in addition to existing ovens. The deadline for industry to meet the standard was January 20, 1980.

4.4.2 Coke Producing Facilities

Approximately 90 percent of the coke output is consumed by integrated steel producers. There are 34 firms that have coke producing facilities (these are included in SIC 3312). Twelve of these are publicly-held, integrated steel producers, and, of the remaining 22, several are manufacturing firms with steel producing capabilities, several are subsidiaries of larger non-steel firms, and several are privately held.

4.4.3 Study Methodology

The study used the 12 publicly-held, integrated producers as a representative sample to estimate the potential economic impact of the coke oven standard. These 12 firms produce 75 percent of the domestic coke and also account for approximately 75 percent of domestic finished steel shipments. The study argued that the impact of the standard would fall less heavily upon the remaining 22 coke-producing firms, since steel assumed a less significant role in their total corporate operations.

Of the 12 steel producers, 7 were considered as major producers and 5 as minor producers. There are between 20 and 30 publicly-held minor steel producers; hence, this sample represents about 15-25 percent of the minor producers.

The development of these 12 plants as models for the industry was based on a variety of data. The sources of this data included trade associations,
labor unions, OSHA, EPA, published materials, the 12 coke-producing firms, various suppliers, manufacturers, contractors, and other heavy industries.

For each company and for every cost item, the capital costs were based upon the estimated cost of compliance and the percentage of compliance already achieved or committed for other programs. For example, it was estimated that compliance with the requirements for filtered HVAC on pusher machines would cost $35,000 per pusher machine. U.S. Steel had about 52 pusher machines and was in compliance on 4 percent of those machines. Thus, the total estimated cost to U.S. Steel for compliance with this item was calculated as:

\[
52 \times \$35,000 \times .96 = \$1,747,200
\]

Calculations such as these were done for each cost item for each of the 12 firms. The capital costs were added to determine the total costs. These costs were expressed in terms of total amounts, cost per ton of coke produced, and cost per ton of finished steel. Finally, the costs for the 12 companies were extrapolated to calculate the compliance cost for the industry as a whole.

Table 4-4 presents the estimated compliance costs per ton of coke produced, for each of the 12 firms. As can be seen, the compliance costs per unit of output tend to vary inversely with the scale of output, with the costs being much higher for the firms producing 1.2 million tons and less. Although none of these firms could be construed as small business, the data graphically illustrate how regulations can impose a disproportionately heavier burden upon smaller firms.

In addition to the independent estimates made in the study, data was also obtained from nine companies on capital costs, annual costs, increased manpower requirements, and production losses. The estimates of capital costs provided by the companies range from 10 percent to 390 percent of the study's estimates. The study attributed the great variability to differences in the interpretations of the scope and requirements of the proposed standard.
Table 4-4. COMPLIANCE COSTS PER TON OF COKE PRODUCEDa

<table>
<thead>
<tr>
<th>Company</th>
<th>1974 Coke Production (1,000 Tons)</th>
<th>Compliance Costs ($/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>195</td>
<td>5.5</td>
</tr>
<tr>
<td>2</td>
<td>365</td>
<td>4.4</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
<td>4.1</td>
</tr>
<tr>
<td>4</td>
<td>1,180</td>
<td>4.1</td>
</tr>
<tr>
<td>5</td>
<td>1,400</td>
<td>2.9</td>
</tr>
<tr>
<td>6</td>
<td>1,830</td>
<td>2.8</td>
</tr>
<tr>
<td>7</td>
<td>2,460</td>
<td>1.9</td>
</tr>
<tr>
<td>8</td>
<td>2,470</td>
<td>1.9</td>
</tr>
<tr>
<td>9</td>
<td>4,280</td>
<td>2.8</td>
</tr>
<tr>
<td>10</td>
<td>4,800</td>
<td>2.5</td>
</tr>
<tr>
<td>11</td>
<td>11,000</td>
<td>1.8</td>
</tr>
<tr>
<td>12</td>
<td>15,900</td>
<td>2.1</td>
</tr>
</tbody>
</table>

aCalculated from data presented in the impact study.
The economic impacts estimated in the study are as follows:

1) Compliance costs:
   - Capital - $451 million
   - Annual - $173 million
   - Total annual - $240.65 (includes annual capital, operating, and maintenance costs)

2) Employment in coke-producing firms to increase by an average of 17 percent, with a range from 9 to 35 percent. No appreciable impact on wages paid by coke producers.

3) Labor productivity to decrease from 1.73 to 1.41 short tons of coke per manhour, under the most conservative assumptions about changes in output.

4) Labor costs of coke producers to increase by $102.5 million — represents an increase in the cost of coke of about $1.65 per ton, or 1 to 3 percent.

5) Financing of OSHA-related capital requirements with equity would dilute the earnings of major producers by a substantially smaller amount than that of minor producers.

6) Price of steel to increase by about $2.50 per ton.

7) Increase in Consumer Price Index of 0.01 percent.

8) Competitive position of major coke producers relative to minor producers expected to improve.

4.4.4 Forecast Accuracy

As part of this retrospective analysis, an effort was made to obtain data on the actual compliance costs resulting from the regulation. Both OSHA and firms in the steel industry were contacted. OSHA, however, does not keep track of compliance costs, and the industry is reluctant to provide such information because of pending litigation with OSHA on the standard. The lack of extensive data on compliance costs presents a major obstacle in attempting to determine the actual economic impact of the standard; however, some estimates can be made.

One firm -- Republic Steel -- was willing to provide estimates of its costs of complying with the standard. The estimates are $28.3 million for capital costs and $11.8 million for annual costs.
The Cost of Government Regulation Study done for the Business Round Table provides another estimate of compliance costs. According to the study, in 1977, the cost for the primary metals industry of complying with OSHA regulations was $11 million. Most of this $11 million was for steel producers. About 80 percent of the costs for the firms was associated with the control of coke oven emissions. Unfortunately, these results cannot be compared to the total capital costs estimated in the impact study under consideration, since 1977 was the initial year of the coke oven regulation and not all of the control equipment was in place.

Another source of information on compliance costs is McGraw-Hill's annual survey of investment in employee safety and health. According to this survey, total annual capital expenditures in the iron and steel industry for health and safety equipment amounted to $41 million in 1977 and 1978, and $55 million in 1979. The survey also lists planned expenditures of $60 million for 1980, and $42 million for 1983. Unfortunately, the costs for the coke oven standards are not broken out; however, it is interesting to note that the sum of the estimates for 1977, 1978, and 1979 amounts to only $137 million, which is far below the $451 million of capital costs estimated in the economic impact study. (Only these three years should be considered since the deadline for meeting the standard was January, 1980.)

A report by the Congressional Research Service entitled, Cost-Benefit Studies for OSHA Standards Use and Misuse, argues that cost estimates prepared by consulting firms under contract with the Department of Labor are reasonably accurate, but they tend to be slightly high. There are several possible reasons for this. First, cost estimates are generally made for innovations based on existing technology rather than on the cost-saving technology that is inevitably developed as a result of standard promulgation. According to Bernard Bloom, a steel expert with EPA, the compliance costs for the coke oven standard are overstated because cost-saving techniques were not considered in the impact study. For example, the study calculated the cost for purchasing a new larry car and did not consider the less expensive solution of simply modifying the larry car. The latter method is the one industry would most likely use. A second reason is that the Department of Labor tries to make certain that cost estimates are high enough so that standards are not remanded by the courts on the basis that the costs of compliance have been underestimated. Another reason is that since cost
estimates are based partially on information supplied by industry, there is a need to make certain that the full costs of compliance are not underestimated.\textsuperscript{17}

The impact study estimated that the standard would lead to an 18 percent decline in productivity in coking operations. In a study done for the Commerce Department by W. T. Hogan and F. T. Koelble, however, the loss in production from both EPA and OSHA regulations was estimated at only eight percent.\textsuperscript{19} R. O. Wenger of Bethlehem agrees with this but says that in the short term it is probably a lot higher because of retrofitting.\textsuperscript{19} In contrast, Warren Ferguson of Allied Chemical argues that productivity in their coke oven has declined even more as a result of OSHA and EPA regulations. He estimates there has been a 15-30 percent decline in productivity. Ferguson also says that there has been no substantial increase in employment as a result of the standard.\textsuperscript{20} Likewise, Robert Engles of Republic Steel's Safety and Health Division says that there was only a negligible increase in employment due to the regulation.\textsuperscript{14}

The price increases of steel and coke resulting from the OSHA regulations were projected at one to two percent, and one to three percent, respectively. According to \textit{Iron Age} magazine, the price of steel increased from 14.213 cents per pound in 1976 to 19.984 cents per pound in 1979. Coke has also risen from the range of $116 to $122 per pound in December, 1976, to $142.40 to $148.50 per pound in July, 1980.\textsuperscript{21}

The task of evaluating the extent to which the standard was responsible for increases in the prices of coke is complicated by factors such as general inflation and rising energy costs. However, in examining coke prices for the last two years, it can be seen that there has not been an increase in the price of coke beyond the general inflation rate. This suggests that the coke producers have not been able to pass on OSHA and EPA regulatory costs, and have had to absorb them. It has not been possible to pass on these costs because the market for coke has been poor. According to Lucian Ferguson of the American Coke and Coal Institute, these increased costs and the difficulty of passing them on has had a greater impact on the smaller producers.\textsuperscript{21} Moreover, the larger firms have been selling their coke works to smaller companies because they can obtain higher profits elsewhere.
In addition to the direct price impact on the iron and steel industry, the standard was also expected to have secondary effects on other industrial sectors since iron and steel products are basic inputs in many industries. An increase in the price of steel can even have an impact on those industries that do not consume iron and steel products directly, since they do so indirectly through the purchase of materials and other inputs from industries that consume iron and steel products. Moreover, the iron and steel industry, itself, purchases inputs from other industries that either consume iron and steel directly or indirectly. Hence, a circular chain of effects results from an increase in iron and steel prices.

The study employed an input-output analysis to trace this intricate chain of effects throughout the entire economy. This produced estimates of the inflationary impact on the steel industry and subsequent indirect effects throughout the economy. In addition, the feedback affect on the iron and steel industry itself was examined.

Input-output analysis is a very useful tool for exploring the total economic impact of a regulation. There are, however, some problems associated with the technique. First of all, if the input-output model must be developed from scratch, a considerable amount of time and money may be required. The impact study minimized the cost by using a model that was developed by the U.S. Bureau of Economic Analysis. This model, however, was based upon 1967 data, and it was necessary to update it by using the Wholesale Price Index. Another problem with the input-output technique is that the results are in terms of industry-level impacts, and do not provide insights as to the nature of differentials in impacts between firms of different sizes. A third drawback of the approach is that it assumes linear production functions -- i.e., economies of scale are not considered. Unfortunately, the results of the input-output analysis that was done in the study cannot be verified. It is felt, however, that more regulatory impact analyses should utilize this technique.

4.3.5 General Critique of the Analysis

Much to its credit, the study made a good effort to assess the differential effects of the standard on the earnings per share for various sizes of steel producers. There are, however, several ways in which the
quality of the analysis could have been improved. To begin with estimates could have been made of the costs of complying with the record-keeping and reporting requirements associated with the regulation -- for both industry and government. In addition, the cost of compliance testing could have been calculated. These informational costs are important to consider since they often impose a disproportionately heavy burden upon smaller firms. In the large firm, most of the paper work will be handled by the legal and accounting staffs. In the small firm, however, this responsibility often falls directly upon the shoulders of management since legal and accounting staffs may be minimal or even nonexistent. This can significantly reduce the amount of attention that management can devote to running the operations of the firm; and, over the long-term, it might be argued that this additional burden can have a negative impact upon the competitive position of the firm.

There are some costs that the study neglected to consider, which a firm may incur indirectly as a result of OSHA regulation, and are such that one might never think of associating them with OSHA. One example of such a hidden cost is the decline of productivity because of worker discontent with being required to wear personal protection equipment. At one aerospace plant, for instance, two mechanics, whom the firm had just spent four months training, quit their jobs rather than wear earplugs. In addition, other employees at the firm have expressed dissatisfaction over being required to wear safety shoes. Similarly, workers at a coke oven are required to wear personal protection equipment and worker discontent is most likely. This cost, although difficult to measure, might have been considered.

In addition, the study could have performed a plant closure analysis. The study mentioned that the standard would tend to improve the competitive position of the major producers vis-a-vis the minor ones; however, a quantitative assessment of the number of potential plant closures resulting from the standard would have been more useful.

The control costs associated with other regulations could have been examined. For example, the EPA regulation on coke ovens also affects the financial position of the steel industry. The cumulative impact of two or more regulations may be significant although each regulation individually is not significant.
Another observation is that the study could have performed a more thorough analysis of the financing potential of each of the firms affected by the standard. Although the study examined the impact on earnings for both large and small firms, a debt-coverage ratio analysis for each firm would have been useful. This would have been particularly valuable in assessing the extent of differential impact.

Lastly, it should also be pointed out that discounted cash flow analysis might have been used in evaluating the impacts. Discounted cash flow analysis is the most comprehensive financial analytical technique because it considers the time value of money. The technique is now widely used in economic impact studies.

4.5 MATCHBOOKS

4.5.1 The Regulation

The regulation dealt with in this section is a consumer product safety standard that prescribes safety requirements, including labeling requirements, for all matchbooks manufactured in, or imported into the United States. Responsibility for administering the standard lies with the U.S. Consumer Product Safety Commission (CPSC).

The regulation was originally proposed in the Federal Register on April 1, 1976. Under the regulation, matchbooks would have to conform to various requirements, including:

- Better quality control, and improved performance standards and testing procedures for fragmentation of match heads, split match heads, and delayed ignition.
- Relocation of the friction, or striking surface, on the outside of the back cover near the bottom (referred to as "reverse friction").
- A flame that would self-extinguish after burning no more than one-half inch down from the top of the match splint and within a period of 15 seconds (limited burn time/distance).
- A latching device for the cover that would thwart the efforts of children to open the cover.

After considerable debate, the final regulation was published in the Federal Register on May 4, 1977, and became effective on May 4, 1978.
Deleted from the final regulation were the requirement for a child-resistant latching device and the requirement for limited burn time/distance. (Note: other provisions were also deleted, but these were by far the most costly.) The provisions relating to quality control, performance standards, and testing procedures were retained.

Subsequent to its promulgation, the regulation was challenged by industry in a case brought before the U.S. Court of Appeals for the First Circuit (D.D. Bean & Sons, Co. v. CPSC, 574 Frd. 643). The decision of the court was announced on May 31, 1978. In a unanimous decision, the court struck down the matchbook performance requirements and all of the testing procedures. The major component that survived was the provision for reverse friction, an improvement that the larger producers had already implemented. A basic element in the court's decision was its opinion that the CPSC had failed to demonstrate a causal connection between matchbook-related injuries and the safety standards. In the opinion of the court, the benefits of the regulation were both small and tenuous, and not worth the costs incurred.23

4.5.2 The Matchbook Manufacturing Industry

Matchbooks are currently manufactured by nine firms at 12 plants. The names of these firms, the number of plants operated by each, and, where applicable, the parent firms, are given in Table 4-5. Among the nine firms, D.D. Bean and Universal Match are the only ones with multi-plant operations. Bean operates three plants, and Universal operates two. Three of the industry's nine firms are privately held, one is owned partially by foreign interests, and the remaining five are subsidiaries or divisions of larger firms.

In 1977, according to the Census of Manufactures, the current-dollar value for shipments of all types of matches was $111 million. Of this total, shipments of paper-stem matches accounted for $93 million, or 84 percent.24 Nearly all of the balance was accounted for by wooden-stem matches. It should be noted that paper-stem matches are used almost entirely as components of matchbooks.

There are two basic types of matchbooks produced in this country: the "resale" matchbook and the "special reproduction" matchbook. Within the resale category, a further distinction may be made between "advertising" and "nonadvertising" matchbooks. Resale matches of the advertising variety
Table 4-5. FIRMS COMPRISING THE MATCHBOOK MANUFACTURING INDUSTRY, 1980

<table>
<thead>
<tr>
<th>Firm</th>
<th>Number of Plants Operated</th>
<th>Parent Firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlas Match Corp.</td>
<td>1</td>
<td>A.H. Belo Corp.</td>
</tr>
<tr>
<td>D.O. Bean &amp; Sons, Co.</td>
<td>3</td>
<td>(privately held)</td>
</tr>
<tr>
<td>Bradley Industries</td>
<td>1</td>
<td>(privately held)</td>
</tr>
<tr>
<td>Columbia Match Corp.</td>
<td>1</td>
<td>(owned partly by foreign interests)</td>
</tr>
<tr>
<td>Diamond Match Divisiona</td>
<td>1</td>
<td>Diamond International Corp.</td>
</tr>
<tr>
<td>Lion Match Corp. of America</td>
<td>1</td>
<td>(privately held)</td>
</tr>
<tr>
<td>Ohio Match Co.</td>
<td>1</td>
<td>Bradley Industries</td>
</tr>
<tr>
<td>Superior Match Co.</td>
<td>1</td>
<td>Gulf &amp; Western Industries, Inc.</td>
</tr>
<tr>
<td>Universal Match</td>
<td>2</td>
<td>UMC Industries, Inc.</td>
</tr>
</tbody>
</table>

12

*aHas one other plant producing wooden matches.
have commercial messages imprinted upon them, and are purchased by businesses such as tobacco shops, drug stores, and vending companies. These may or may not be given to users free of charge. Nonadvertising resale matches carry no message, and are generally sold by large chain stores. These account for only a small share of the total resale match volume. Special reproduction matchbooks are characterized by their distinctive designs. These are purchased by advertisers for promotional use, and are given to users free of charge.

Resale matchbooks account for about 75 percent of the total volume of matchbooks produced; however, their share of sales revenue has only been about 35 percent. On the other hand, while special reproduction matchbooks comprise only 25 percent of the industry's total output, they account for nearly two-thirds of the sales revenue. The bulk of the profits in matchbook manufacturing are obtained from the sales of special reproduction matchbooks.

The match industry is highly concentrated. The impact analysis estimates that in 1976, the top four firms accounted for 77 percent of the industry's sales. This estimate cannot be verified, however, it appears to be reasonable in the light of concentration data for earlier years. For example, the Census of Manufactures shows that in 1963, the top four firms accounted for 71 percent of the industry's value of shipments.

Most of the plants and firms in the match industry are small. In 1976, for example, the impact analysis estimates that except in the cases of the top few firms, annual sales were less than $10 million, and, in several cases, were between only $1 million and $5 million. The small scale of match manufacturing is also illustrated by Census data on the employment-size distribution of establishments. The most recent year for which such data is available is 1963. During that year, out of the 26 establishments in the industry, 19 had less than 250 workers, five had from 250 to 499 workers, two had from 500 to 999 workers, and none had 1,000 or more workers. This data is now 17 years old, but it is probably still representative of the employment-size distribution of plants in the industry.

The match industry is old and technologically mature and now finds itself in the midst of a long-term decline. The contraction of the industry is well illustrated by historical data on employment. Census data show that the peak employment level for the industry was 7,350 in 1947. Since then, the figure
has steadily declined. By 1972, the level had dropped to 3,700. More current Census data are not presently available, however, the impact analysis estimates that the level of employment in 1976 was roughly 3,400.

The contraction of the industry is also revealed by time-series data on the value of shipments. These data are published by the Census Bureau in terms of current dollars and the values show a steady increase over the years. If the figures are translated into constant dollars, however, a downward trend is revealed.* In 1967, the value of the industry's shipments was $66.1 million. The value for 1970 in terms of 1967 dollars was 65.5 million. By 1977, the value had declined to $50.3 million.

In 1974, when development of the safety standard was initiated, the matchbook manufacturing industry consisted of 13 firms operating a total of 18 plants. With the onset of the recession in 1975, however, the composition of the industry changed greatly. One firm was liquidated, two firms were acquired by private interests, and three or four plants were closed. According to the impact analysis, by 1976 the number of firms in the industry was down to 10, and the number of plants had decreased to about 14 or 15. As noted earlier, the industry now has nine firms operating 12 plants.

4.5.3 Study Methodology

The economic impact of the proposed standard for matchbooks was analyzed for the CPSC by Battelle Columbus Laboratories. Battelle's analysis was carried out in two phases. The results of the first phase were published in March, 1975, in a report entitled, Analysis of the Book Match Industry and the Potential Impact of a Proposed Standard on Book Matches. Phase I -- Industry Information and Analysis. The results of the second phase of the analysis were published in October, 1976, in a report entitled; Economic Impact of Proposed Matchbook Safety Standard: Phase II.

It is important to note that shortly before the second Battelle report was published, the CPSC announced its decision to delete some of the provisions that had been included in the proposed regulation. These deletions are taken into account in a February, 1977 CPSC report entitled, Economic Impact Statement: Safety Standard for Matchbooks. The analysis and findings presented in this report build upon Battelle's analysis; however, not surprisingly, the estimated impacts are much smaller.

*In this analysis, the Census of Manufactures current-dollar data on value of shipments was deflated using BLS Producer Price Indexes for matches.
One of the basic problems that the Battelle analysis encountered was the almost total lack of publicly-available economic data on the matchbook industry. Since 1966, the total match industry (i.e., both wooden and paper-stem matches) has not even been assigned a separate four-digit SIC classification, but has been subsumed under SIC 3999, "Manufacturing Industries, Not Elsewhere Classified." A limited amount of data on the match industry is presented in the Census of Manufactures at the five- and seven-digit SIC product classification levels. Matches, in general, are assigned SIC 39993. This category is broken down into wooden stem matches (3999336); paper-stem matches, packed in books or otherwise (3999361); and matches, not specified by kind (3999300). The Census data pertains to the number of companies with annual shipments of $100,000 or more, and the value of product shipments. The data is not broken down by the size of the firm. The most recent Census of Manufactures data is for the year 1977. The data on paper-stem matches provides a good approximation for matchbooks. The Census Bureau also publishes annual data on the value of imported matches. Another source of data is the Bureau of Labor Statistics, which publishes monthly and annual average Producer Price Indexes for the broad category of matches (i.e., all types of matches). Aside from this data, there are no other governmental or private sources of information that are available to the public. The match industry does not even have a trade association that can be consulted.

The scarcity of data for the match industry is largely a reflection of the fact that the match industry has been operating for more than 30 years under a consent decree issued by the U.S. Department of Justice. The decree prohibits match manufacturers from dividing markets, restricting the production and distribution of products, excluding persons or firms from the marketplace, and fixing or maintaining prices and selling terms. Importantly, the decree also specifically forbids match manufacturers from exchanging information on prices, sales, inventory, or production, and from engaging in industry association activities. Given the scarcity of publicly-available data, it was necessary for Battelle to contact the firms in the industry in an effort to secure information.

The Battelle analysis begins by assessing the effect of price increases on the demand for matchbooks. On the basis of survey responses, separate "derived-demand" curves for special reproduction matches and the advertising and non-advertising categories of resale matches are constructed. Each curve shows the volume of matchbooks (in terms of number of cases) that would be
demanded assuming a given percentage increase in price. The curves play a fundamental role in the assessment of impacts.

In order to develop a general context for the impact analysis, the supply and demand for "lights" (i.e., fire) is examined. The analysis estimates that U.S. consumers require about 645 billion lights per year, and that 98 percent of this is for tobacco products. This estimate conforms roughly with annual data on cigarette consumption, published by the U.S. Department of Agriculture in Tobacco Situation. The annual growth rate in the U.S. demand for lights is estimated at three percent.

With respect to the supply of lights, the Battelle analysis estimates that paper stem matches account for nearly two-thirds of the lights consumed annually. The share for lighters is roughly 25 percent. Butane lighters, alone, are estimated to account for 17 percent. The analysis assumed that even if a given supply source of lights were greatly reduced, the total consumption of lights in the U.S. would not decline, since the shortfall would be made up by another source of fire.

The analysis notes that most of the paper-stem matches and imported wooden matches used in the U.S. are given away free. Thus, U.S. consumers receive, without direct payment, about two-thirds of the lights that are required in a year. If this "free" supply of lights were reduced, consumers would have to obtain their lights from some other source or sources. Since these lights would have to be purchased, a reduction in the supply of bookmatches would result in an economic cost to the consumer. Battelle develops an estimate of this cost.

In order to evaluate the impact of the proposed standard on the manufacturers of matchbooks, compliance cost estimates were made by Battelle for each of the firms in the industry. The estimates relied upon cost information provided by the firms, themselves. Since the information obtained from the firms varied greatly in quality, the responses were reviewed to minimize variability. In most cases, capital costs for the various aspects of the standard were obtained directly from the industry comments. In cases where the estimate of capital costs obtained from a particular firm was very high or very low, the costs were adjusted using information obtained from other firms. Once the compliance costs for the individual firms were developed, these were summed to obtain a total for the industry. To facilitate later analysis, the compliance costs were divided into subtotals for manufacturers of special reproduction matches and manufacturers of resale matches.
Given the estimated compliance costs, the Battelle analysis uses the derived-demand curves to estimate the impact of the proposed safety standard on sales of paper-stem matches. Separate estimates of the loss in sales are made for special reproduction matchbooks, and the advertising and nonadvertising segments of the resale market. Based on the calculated decrease in the supply of paper-stem matches (stated in terms of cases of matches), calculations are then made of the reduction in paper-stem lights available to consumers and the cost to them of replacing these lights. The cost of replacement is calculated based on the assumption that butane lighters would be purchased.

In order to obtain a better understanding of the impact of the standard on manufacturers of matchbooks, a supplementary financial analysis of a model plant is performed. The model plant used in the analysis is a facility producing only special reproduction matches. The plant which is specified is a small plant (or firm) with an annual revenue of $2,442,000. It will be recalled that most of the firms in the match industry have annual sales revenues of less than $10 million, but that $1 million to $5 million is on the low end of the scale. The costs, output, operating rates, and other parameters for the plant were obtained from interviews with match manufacturers. The annual output of the plant is specified at 66,000 cases. The price per case is taken as $37.

The economic impact on the model plant is calculated by first determining the incremental costs associated with each of the provisions contained in the proposed standard. The testing provisions were assumed to require three additional employees, while the provision for a child-resistant cover would require three additional employees. Indirect labor costs are assumed to increase in a proportional fashion. The labor requirements for maintenance and repair are estimated to increase by one worker, and the total costs by 30 percent. The incremental capital investment requirements are estimated to be more than $260,000.

Given the imposition of the incremental costs associated with the standard, the analysis proceeds by calculating the net profit of the model plant. This is found to be a loss of over $322,000. Given this result, the analysis focuses upon the problem of determining the amount by which the revenues of the model plant would have to increase in order to maintain the
pre-regulatory level of ROI (3.4 percent). Given the amount by which revenue would have to increase, a calculation is then made of the amount by which the price of a case of matchbooks would have to increase. The calculated increase is from $37 to $43.25, or 17 percent. Next, realizing that a price increase could result in sales loss, it is determined that a 17 percent price increase would result in a sales loss of 2,370 cases, or roughly $88,000 of revenue at the original price of $37 a case. This revenue loss would necessitate a further price increase. This, in turn would reduce revenues. The analysis argues that this process of adjustment would continue until an equilibrium is reached at about $44 a case. This price represents a 20 percent increase over the original price.

The results from the model plant analysis are used to shed further light upon the potential impact of the standard on industry profits and cash flow. In a study preceding the Battelle Phase II effort, the CPSC examined the industry's ability to generate the cash flow needed for making the capital investments required by the proposed standards. It was assumed that the proposed standard would cause five firms to leave the industry. The capital investment required of the remaining firms was estimated to be about $14 million. The calculated increase in variable costs for these firms was $12 million. The before-tax profits of the industry were estimated at $4.2 million. Given this data, the Battelle analysis calculates the payback period for the capital investment. Assuming that the $12 million of variable costs could be recovered through increased prices, the payback period for the $14 million capital investment is calculated to be about 3-1/2 years. But, the analysis notes, if matchbook manufacturers were to experience a profit decline similar to that estimated for the model plant, the before-tax profits of the industry (for 1976) would drop to about $1.4 million. The payback period would then increase to about eleven years. The Battelle analysis reasons that this could lead to more closures and exits of firms.

4.5.4 Forecast Accuracy

The economic impacts estimated in the Battelle analysis are as follows:

(1) Compliance costs for matchbook manufacturers would include one-time capital investments of nearly $14 million, and increased ongoing variable costs of nearly $12 million. About 58 percent
of the total cost would be associated with the child-resistant cover.

(2) Prices of resale and special reproduction matches would increase 20 percent and 5 percent, respectively.

(3) Five firms would leave the industry.

(4) There would be a net loss of 717 jobs in the industry. The lost wages of these workers would equal more than $12 million.

(5) In order to replace lost lights from the decline in paper match sales to advertisers, users would be subject to an increased cost of $56 million.

(6) Model plant impacts:

- Required capital investment of more than $260,000 on sales of slightly more than $2.4 million.
- Reduction of profits to a net loss of slightly more than $322,000.
- Increase of 17 percent in selling prices in order to maintain pre-regulation ROI of 3.4 percent.

The Battelle analysis concludes with the comment that if the provision for a child-resistant cover were to be deleted from the standard, the compliance costs and resulting impacts would be substantially smaller. It is noted that under these circumstances, no firms would be expected to exit in the short run, and only those firms that were already in serious financial trouble would exit in the long run.

On September 14, 1976, the CPSC announced that it had decided to delete several of the provisions included in the proposed standard. Most notable among these were the requirement for a child-resistant latching cover, and the provisions for limited burn time/distance. Pursuant to this announcement, the CPSC performed another economic impact analysis, the results of which were published in February, 1977. In this report, the compliance costs for the industry were scaled down to $808,000 for capital investment, and a little over $4 million for additional annual variable costs. The report noted that the compliance costs would tend to be concentrated in the costs to complete the change-over to reverse friction, to mark shipping
containers, and to establish and implement testing programs and certification procedures. Most of the direct costs to manufacturers would stem from the implementation of testing programs.

The price effects of the modified standard were estimated to be an increase of 5.5 percent in the price of resale matchbooks, and 2.9 percent in the price of special reproduction matchbooks. It was estimated that these increases would lead to reductions in the volume sold of resale matchbooks of 370,000 cases and 15,000 cases of special reproduction matchbooks. This would translate into a loss of 19 million free lights for the consumer. The CPSC estimated that the cost to the consumer of replacing these lights would be $15 million annually.

The report notes that the long-term contraction and increased consolidation of the industry will probably continue due to the marginal profitability of matchbook manufacturing and increased competition from substitute products such as disposable butane lighters. Recognition is given to the fact that the cost impacts resulting from the standard, no matter how modest they might be in relative terms, would contribute to this trend. It is argued, however, that the standard would not cause a significant deterioration in the economic conditions in the industry, or accelerate or change industry trends substantially. Much to the credit of this analysis, recognition is given to the fact that the provisions for testing programs and certification procedures could bear more heavily upon the smaller firms, due to their lack of relatively sophisticated laboratories and testing techniques. As mentioned earlier, still more of the standard's provisions were deleted following a court ruling in March, 1978. It was not possible, however, to obtain the study dealing with the economic impacts of the standard in this form.

Because of the considerable changes which the standard underwent subsequent to its proposal, it was not possible to assess the accuracy of the impact estimates made in the Battelle analysis. An effort was made, however, to determine to the greatest extent possible, what economic effects the standard has had up to the present time. This particular case well illustrates the problems that can be encountered in attempting to perform a retrospective analysis.
As part of the present study, matchbook manufacturers were contacted in the hopes of obtaining information on the current status of the industry and the actual impact of the safety standard. Considering the limitations imposed by the consent decree affecting the industry, the responses of the firms turned out to be quite substantial.

From the industry responses, it was learned that matchbooks are currently produced by nine firms at 12 plants. These firms have already been identified earlier in this discussion. Since the promulgation of the safety standard in May, 1977, there have been two plant closures. One of these is the Monarch Match Company. The Monarch plant was a subsidiary of Gulf and Western Industries, which is still involved in the manufacture of matchbooks through its ownership of the Superior Match Company. The Maryland Match Company, a subsidiary of the Maryland Cup Corporation, no longer manufactures matchbooks, but is still engaged in the marketing of matchbooks. There is no definite information on the reasons why the plants were closed; however, it would appear that the closures were not materially precipitated by the safety standard.

The firms that were contacted were asked to provide estimates of the costs of complying with the standard. Only a few of the firms, however, elected to respond to this particular item. The estimates of one-time capital expenditures necessitated by the standard ranged from $10,000 to $150,000. The estimates of annual variable costs ranged from $30,000 to $200,000. For all manufacturers, the cost of compliance is somewhat less than what it might have been under the original proposed standard, which included provisions for a child-resistant cover, controlled burning time/distance, and stringent performance and testing requirements.

The prices of matches have increased steadily since 1977. For May, 1980, the producer price index for matches of all types was 200.0. This represents an increase of approximately 23 percent from the 1967 annual average level of 162.8. According to industry responses, the price of resale matches has increased by 35 percent since 1977. There is no data on special reproduction matches due to the fact that their prices vary widely; however, price increases for this category are known to have been proportionately greater than those for resale matches. But, in both cases, the increases have been less than what would have been expected relative to overall material,
labor, and overhead cost increases for the past three to four years. Un-
doubtedly, the standard has contributed to the rise in matchbook prices;
however, the contribution has been quite small -- for resale matches, per-
haps on the order of only a few cents for a case (composed of 50 caddies).

There is no published data on the sales of matchbooks for years more
recent than 1977. According to the industry responses, however, the decline
since 1977 may have been as much as 40 to 50 percent. The drop in sales
has been greater in the market for resale matchbooks. The major reason
for declining sales is the steadily increasing competition from cheap dis-
posable butane lighters. According to data from the 1977 Census of Manu-
factures, shipments of lighters increased from 3.2 million units in 1972
to 191 million units in 1977. This tremendous increase was due mainly to
the soaring popularity of disposable butane lighters.

The general contraction of the matchbook industry is also reflected
in employment levels. According to the industry responses, employment in
the industry has dropped by about 50 percent since 1977.

Although extensive current data on the matchbook industry is not avail-
able, it would appear that the safety standard has not had a significant
economic impact on the industry. The problems of the industry seem to be
due mainly to factors such as the intense competition among the producers
of matchbooks, the marginal profitability of match manufacturing, and the
rapidly growing popularity of disposable lighters.

4.5.5 General Critique of the Analysis.

It would perhaps be best to begin by considering the procedure that
Battelle used to estimate the compliance costs for the industry. The pro-
cedure used was straightforward. Each of the firms comprising the match
industry was contacted and requested to provide an estimate of what it felt
its cost of compliance would be. The estimates were broken down into incre-
mental capital costs and incremental annual variable costs. Where estimates
appeared to be considerably out of line, adjustments were made. Unfortunately,
the estimated compliance costs for the individual firms are not presented in
the study. There is also no discussion about how the magnitude of the com-
pliance costs varies on a per-unit-of-output basis among different sizes
of firms. On the positive side, however, it is felt that if the provisions
of the standard had remained unchanged, Battelle's estimate of the industry-wide compliance cost would have been reasonably accurate. Needless to say, estimates of compliance costs that are obtained from firms in the regulated industry are subject to bias. This is a problem, however, that can be addressed.

The analysis of the demand for lights could have been explained in more detail. The estimate of demand, however, appears reasonable. There is a fairly close correspondence between the estimated demand for lights and the estimated annual consumption of cigarettes (this data is published by the U. S. Department of Agriculture). According to the Battelle analysis, use of tobacco products accounts for about 98 percent of the lights required annually.

The analysis of the supply of lights is also vague. Estimates are presented of the numbers of lights accounted for by different sources (i.e., paper stem matches, wooden stem matches, imported matches, and butane and pocket lighters); however, there is no discussion on how the estimates were obtained.

The study did a good job of analyzing the effect of price increases on demand for matchbooks. As will be recalled, separate derived-demand curves were developed for special reproduction matches, and for the advertising and nonadvertising categories of resale matches. The effect of price increases on demand is rarely addressed in a direct fashion such as this. The curves were developed from information obtained from matchbook advertisers and manufacturers of matchbooks.

In order to more closely examine the potential financial impact of the proposed standard on firms, the study also included a model plant analysis. This was an excellent idea that should have been carried further. The model plant used in the analysis is a representation of a small, marginal operation. The idea in selecting such a model was to demonstrate what degree of financial impact could be expected in the worst possible case. The analysis would have been more useful, however, if additional model plants were examined. The model plant in the analysis produced only special reproduction matches. Perhaps model plants producing resale matches should have also been examined. Moreover, for both the special reproduction and resale categories, model plants of different sizes should have been examined. Such an increase in the number of models would have made it possible to more directly examine the
nature of differential impact. Much to the credit of the Battelle analysis, however, considerable attention is paid to the impact of the standard on smaller firms. The analysis notes that the industry is highly concentrated with respect to sales, and even more concentrated with respect to profits. Very low profits, especially among the smaller firms, have encouraged consolidation of firms and a decline in the number of plants.\textsuperscript{25} The analysis observes that the standard could accelerate this trend.

Battelle predicted that five firms could be expected to exit the industry as a result of the standard. This estimate was based on the responses of firms regarding the costs of compliance. If additional model plants had been developed, it might have been possible to check this estimate through the use of DCF analysis.

With the CPSC's announcement that the requirement for a child-resistant cover would not be included in the final standard, it became apparent that the safety standard would have only a modest economic impact on the industry. The Battelle analysis had estimated that the requirement for the child-resistant cover would account for 59 percent of the compliance costs directly imposed upon the match industry. In February, 1977 when the CPSC issued its Economic Impact Statement for the standard, the bulk of the remaining compliance costs were associated with the establishment and implementation of testing programs. In 1978, however, the testing requirements were also deleted from the standard because of a court ruling. Thus, the compliance costs now associated with the standard are only a fraction of what they might have been. According to industry sources, the economic impact of the standard has not been great. The major concern of matchbook producers at this moment is the rapidly growing popularity of disposable butane lighters.

4.6 LIME MANUFACTURING

4.6.1 The Regulation

The regulation under consideration was issued by EPA under Section 111 of the Clean Air Act, and involved the establishment of new source performance standards (NSPS) for lime manufacturing plants. The regulation was originally proposed in the Federal Register on May 3, 1977. The final version of the regulation was published in the Federal Register on March 7, 1978. In May, 1980, the standards were remanded to EPA by the U.S. Court of Appeals.
The calcination process that transforms limestone into lime creates measurable amounts of four pollutants: particulate matter, SO₂, CO, and NOₓ. Both NOₓ and CO emissions are relatively small and their control is not feasible. In the proposed regulation, emissions of both particulate matter and SO₂ were to be controlled. In the final regulation, however, standards were set for only particulate matter. It was shown that dry control systems for particulate matter such as a baghouse or an electrostatic precipitator would reduce SO₂ levels by 88 percent. Any additional control to remove the remaining 12 percent was not considered reasonable.

The promulgated regulation is such that the particulate matter from a lime plant is reduced by 99 percent (90 percent more than a typical state standard). This is equivalent to a standard of .15 kg/Mg for lime kilns and .076 kg/Mg for lime hydrators and an opacity standard of 10 percent. The NSPS applies to any stationary source, the construction or modification of which is commenced after the regulations are proposed.

The National Lime Association (NLA) played a significant role in the development of the NSPS. On June 16, 1977, the NLA Air Quality Committee testified before EPA opposing the original proposed standards and counter proposed the more achievable standards of .30 kg/Mg for lime kilns, .175 for hydrators and 20 percent opacity standard without continuous monitoring. The lime industry (and, in particular, the NLA) was not satisfied with the final form of the regulation that was published in the Federal Register on March 7, 1978. The NLA therefore took steps to challenge the standards in court. This effort culminated on May 19, 1980 with the decision by the U.S. Court of Appeals to remand the standards to EPA for a more adequate explanation of the representativeness of the emissions sources whose testing served as the basis for the formulation of the standards. In addition to being concerned about the representativeness of the sources that were tested, the decision also focused on the achievability of the promulgated standards. As of this writing, the fate of the regulation has yet to be determined.

Two final points concerning the remandment are necessary. First, the NLA, representing the lime industry, did not in any way disagree directly with either the methodology of the economic analysis or its conclusions. However, the economic analysis is affected since the output of the engineering analysis forms part of its basis. Any problems creating errors in the
engineering studies finally surface as errors in the economic analysis. Second, size of kiln (or plants) as a variable affecting the achievability of the standard was not a major concern since it was explicitly considered in the analysis.

4.6.2 The Lime Industry

In terms of physical volume of production, the lime industry ranks as one of the nation's largest. The production of limestone (the raw material for lime) ranks second only to sand and gravel in commodity tonnage, and surpasses petroleum, coal, and iron ore. Limestone occurs in every state, and deposits lie beneath an estimated 15 to 20 percent of the surface area of the country. Lime manufacturing plants are located in over 40 states. 28

Lime has a variety of applications. The most important of these is steel production, which accounts for roughly 35 percent of the total demand for the material. 29 Other major uses are in water purification, and in the production of cement, alkalies, and paper and pulp.

Lime production is capital intensive, and is currently carried out at 154 plants. Over the past decade, the industry's labor force has averaged about 5,000 workers. 29 On a national level, production in the lime industry would appear to be relatively concentrated. In 1979, the top 10 firms in the industry accounted for nearly 50 percent of the total tonnage produced. 30 It should be noted, however, that this potential domination of smaller firms is mitigated somewhat at the regional level since lime has a relatively low value to weight ratio with transportation costs accounting for a considerable percentage of the delivered price. The larger firms are also multiplant operations, with the plants scattered throughout many different regions, thus limiting competition to a plant versus plant basis.

4.6.3 Study Methodology

The economic impact analysis that was done in support of the development of the NSPS was completed in April, 1977, and focused upon the version of the regulation that was proposed the following month. The analysis is based upon the model plant approach. Using the return on investment (ROI) criterion as a basis for comparison, the economic impact of the proposed NSPS is examined for three different sizes of plants: 125 tpd (tons per day); 250 tpd; and, 500 tpd. The model plant approach provides an avenue for examining the differential impact of regulations on small firms; however, in the case of this study, data limitations hindered such an effort.

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The selection of the representative sizes for the model plants was made in a separate engineering study. The economic analysis assumed that these sizes were appropriate. Data on the distribution of plant sizes, however, suggests that this assumption is questionable. Very large plants are not represented in the model plant schema. The analysis states that "the most representative model plant for new plants being built is 500 tpd." But, according to a sampling of new plants under construction for the years 1976-1979, the size distribution reveals that a 500 tpd plant is relatively small. These data are shown below:

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Plant size (tpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 Percentile</td>
<td>350 tpd</td>
</tr>
<tr>
<td>50 Percentile</td>
<td>500 tpd</td>
</tr>
<tr>
<td>75 Percentile</td>
<td>1000 tpd</td>
</tr>
<tr>
<td>Mean</td>
<td>650 tpd</td>
</tr>
<tr>
<td>Mode</td>
<td>1000 tpd</td>
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</tbody>
</table>

This evidence suggests that the model plant comparisons of 125 tpd, 250 tpd and 500 tpd plants neglect the large plant case of 1,000 tpd. Moreover, according to a representative of Kennedy Vanlaun Corp., a manufacturer of kilns, plants with capacities of 2,000 to 2,500 tpd may be built in the not too distant future. When large plants are not represented in the model plant schema, there is a good possibility that the measurement of differentials in impacts will be understated.

In the study, diseconomies of scale are implicitly assumed in the estimated incremental control costs for new sources. Table 4-6 is a summary of the results from the study. For the new sources, the diseconomies of scale are quite noticeable in the range from 125 tpd to 250 tpd, with the incremental cost per unit of output increasing from $.16 to $.53. This cost reduction for the 125 tpd kiln is attributed to the availability of modular construction and factory assembly of control equipment. Further diseconomies are evident in the 250 tpd to 500 tpd range; however, no similar explanation is given in the study for the accompanying increase in per unit control costs from $.53 to $.57. This situation is most unusual, and should have been thoroughly explained.
Table 4-6. SUMMARY OF IMPACTS FOR THE A-1 CASE\textsuperscript{a}

<table>
<thead>
<tr>
<th>Kiln Size (tpd)</th>
<th>Cost/unit Increase</th>
<th>Decrease in ROI with No Price Change</th>
<th>Increase in Price with No ROI Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>New 125</td>
<td>0.16</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>Sources 250</td>
<td>0.53</td>
<td>1.9%</td>
<td>NG</td>
</tr>
<tr>
<td>(Baghouse) 500</td>
<td>0.57</td>
<td>2.1%</td>
<td>20%</td>
</tr>
<tr>
<td>New 125</td>
<td>2.79</td>
<td>10.2%</td>
<td>NG</td>
</tr>
<tr>
<td>Modified 250</td>
<td>NG</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>500\textsuperscript{b}</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>500\textsuperscript{c}</td>
<td>0.81</td>
<td>3.0%</td>
<td>33%</td>
</tr>
</tbody>
</table>

\textsuperscript{a}The A-1 case was the most likely situation with standards of .15 kg/mg. feed, 10% opacity and no SO\textsubscript{2} standards. The baghouse was the most likely type of control device chosen.
\textsuperscript{b}Particulate controlled by a baghouse.
\textsuperscript{c}Particulate controlled by a wet scrubber.

NG - not given
The economic analysis makes two other assumptions which merit further examination. Past output growth rates are assumed to be good proxies for future growth rates in new capacity and lime demand. Since output increased by 5.0 percent per year over the period 1930-1975, it is assumed that future lime demand (to 1982) will also increase at the same annual rate. This assumption is questionable since the factors affecting lime demand in the 1930's and 40's are quite different from the factors affecting lime demand in the 1970's. A better approach would have been to assign the shorter term growth rates more importance (through differential weighting) in estimating the future growth of lime demand. This would be the case unless some extraordinary nonrecurring factor can be identified as having a major impact on short run growth rates. Since no such factor was identified for the period 1960-1975, this period's average annual growth rate of 3.6 percent seems to be a more appropriate projection.

Future capital expenditures are estimated from a time series regression on past capital expenditures. From an estimated growth rate for new and replacement capacity of 5.6 percent, the rate breaks down into 3.6 percent for net new capacity (the lime production growth rate for the 1960-1975 period) with the remaining 2.0 percent allocated for replacement. It would seem to be more appropriate to estimate future capital expenditures on a disaggregated basis with net new capacity requirements based on estimated demand and replacement capacity based on historical replacement ratios. This procedure will probably yield results with similar accuracy, but will have the advantage of being more consistent with the procedures a firm would use in estimating its own future capital expenditures.

The assumptions underlying the development of the pollution control costs seem to be reasonable. Turnkey bids from a representative sample of kiln manufacturers are assumed to be the best estimates available for future incremental capital and annualized control costs. The ROI analysis is performed using these control costs in conjunction with industry financial statistics obtained from various sources. Data limitations, however, make the analysis focus narrowly on the 500 tpd model plant. The fact that the 125 tpd and 250 tpd model plants are neglected result in a less than adequate analysis of differential impact. The study notes the lack of data on small firms. This is attributed to such firms either being privately held and
unwilling to divulge information, or captively owned by a large firm with no separate revenue and cost accounts kept on their lime operations.

4.6.4 *Forecast Accuracy*

The ability of the study to make quantitative forecasts of economic impacts was limited by the availability of data. Data on the actual impacts that were realized over the period May, 1977 to March, 1980 are also limited. The comparison of the forecasts to the actual results will therefore be limited to areas of sufficient data.

Under an NSPS, the impact on an industry does not occur immediately, but rather in a cumulative manner as new plants are built to meet requirements for additional capacity, and existing plants are reconstructed or modified. The economic impact study estimates that 8 to 10 new kilns (i.e., plants) would be built each year to accommodate the estimated 5 percent annual growth rate of the demand for lime. Thus, for a three year period, it would be expected that 24 to 30 new plants would be constructed.

Data on the actual extent of industry compliance with the NSPS was obtained from the EPA's Compliance Data System (CDS). Of the 164 lime manufacturing plants that are identified in the CDS, EPA believes that only two were actually subject to the NSPS.

The CDS data clearly shows that the number of new lime plants that were actually constructed over the period 1977-1979 was less than what would have been expected on the basis of the projection made in the economic impact study. There are several explanations for this divergence. First, the actual annual rate of growth in lime demand over the period 1977-1979 was 2.48 percent -- less than half the projected rate. Second, it is possible that many of the firms that intended to build new plants did so prior to May 3, 1977 -- anticipating the eventual promulgation of the NSPS, and wishing to avoid it by starting construction before the effective date of the regulation. A third reason is that many of the new kilns under construction are twice as large as the largest model plant specified in the study (recall that this is 500 tpd). This being the case, the estimated construction of 8 to 10 new kilns per year could be an overestimation by a factor of approximately two. Possibly the most important reason, however, was that many of the member firms of the NLA were convinced the NSPS was unfair and that it would be remanded -- hence, construction of new kilns would be postponed until such time that the NSPS was modified to be more achievable.
Table 4-6 shows for the case of the 500 tpd model plant, the projected impacts of the NSPS on the price of lime and on ROI. The impact on the ROI (when price is held constant) is expected to be negative with a range of 20 percent for new sources to 33 percent for a modified source. The price impact (when ROI is held constant) is expected to be positive with a range of 2.6 percent for new sources to 4.5 percent for a modified source.

A small sampling of publicly-held firms with a substantial share of the lime market suggests average ROI's actually increased by 9.7 percent for the three-year period. For the period May, 1977 to March, 1980, actual prices increased by 31.4 percent. Most of this increase is due mainly to inflation. Using the Producer Price Index (PPI) as a proxy for producer price inflation, an estimate of the real price change can be obtained. For the period of May, 1977 to March, 1980, the PPI increased by 35.4 percent. The resulting real price change for lime is -4.0 percent.

The study examines the potential impacts of the NSPS on capital requirements for several different scenarios. In the case of the "most likely" scenario, the study projects that capital requirements would be minimal. Additional capital requirements would be in the range of 0-2.1 percent higher for new sources, and 0-12 percent higher for modified sources. A minimal impact is forecast since very few modifications were expected to occur. In reality, the actual impact on the industry turned out to be less than the projected impact--since, as pointed out above, the number of plants that actually ended up being subject to the NSPS was much smaller than anticipated.

The study assumes that the concentration ratios (as a measure of the market power of large firms) for the lime industry would follow past trends, with no noticeable impact likely from the NSPS. The past trend observed in the study suggests a trend peak in 1954-58 and a falling trend to 1975. The analysis indicates a trend toward plants larger than 300 tpd, but provides no analysis of how this trend might impact concentration ratios. Estimated industry concentration ratios for the years from 1971 through 1979 are given in Table 4-7. Also shown for each of these years is the percentage of the industry accounted for by captive (both backward and forward) operations.

The data help to illustrate the plight of the small firm in recent years. The trend in concentration ratios shows that the industry is becoming
Table 4.7. CONCENTRATION RATIOS AND % CAPTIVES FOR THE LIME INDUSTRY

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Concentration a</td>
<td>45%</td>
<td>42%</td>
<td>40%</td>
<td>43%</td>
<td>43%</td>
<td>49%</td>
<td>47%</td>
</tr>
<tr>
<td>% Captive b</td>
<td>37</td>
<td>32</td>
<td>33</td>
<td>31</td>
<td>29</td>
<td>26</td>
<td>26</td>
</tr>
</tbody>
</table>

a% of market controlled by top 10 firms.
b% of industry held captive (either backward or forward integrated).
more and more concentrated. Over the same period, the percentage of the industry accounted for by small captive operations has been declining.

4.6.5 General Critique of the Analysis

One of the basic problems with this study lies in the regulatory cost data that provides the basis for the impact analysis. These regulatory costs (i.e., pollution control costs engendered by the NSPS) were not developed as an integral part of the study, but were obtained as inputs from a separately-performed engineering study. As was later brought out in the court case leading to the remandment of the standards, there was apparently a failure in the engineering study to thoroughly consider the wide range of variables affecting control costs. Although this deficiency was not directly related to the economic analysis, it undoubtedly had a major bearing upon the accuracy of the predicted economic impacts.

To the credit of the study, consideration is given to the impact of the regulation on small business, insofar as the effects of the standards on smaller model plants are examined. However, as alluded to earlier, it would appear that smaller plants are perhaps given too much weight in the selection of the three model plant sizes (recall that 500 tpd is the largest size specified). Consideration should have been given to the larger size plants (e.g., 1000 tpd) that were planned for construction during the timeframe covered by the impact analysis. The distribution of model plant sizes would have then been more representative of the actual population of plants in the industry.

Another observation regarding the study is that it fails to devote much attention to the issue of differential impact. Treatment of the subject is confined to a comparison of pollution control costs for the model plants. The study, however, cannot be severely criticized on this point since data limitations made it impossible to make comparisons using other measures of economic impact. Due to confidentiality restrictions, financial data on small private lime manufacturing firms could not be obtained.

One final criticism of the study is that it should have more thoroughly discussed the assumptions underlying the analysis. Very little, for example, is said about the particular assumptions that were made in selecting the three representative model plant sizes. Another example is the failure to adequately discuss the reasonableness of the assumption that pollution control
costs per unit of output would vary directly with the level of output--this does not follow the expected pattern (i.e., control costs varying inversely with plant size); hence, a detailed explanation was clearly in order. More should have also been said about the assumptions underlying the methods used in estimating future lime demand and production capacity.

4.7 SUMMARY AND CONCLUSIONS

Five economic impact studies were subjected to retrospective analysis for the purpose of learning more about the ability of particular methodologies to assess the differential impact of regulations. Three of the studies were performed by EPA. These deal with the areas of fruit and vegetable processing, soap and detergent manufacturing, and lime manufacturing. The fourth study was done by OSHA, and deals with coke ovens in the steel industry. The fifth study was done by the CPSC, and pertains to the manufacture of book matches.

The EPA study on the fruit and vegetable processing industry deals with the impact of effluent guidelines. The methodology employed by the study is based upon the use of the model plant approach. Model plants of small, medium, and large sizes are employed for each of the segments of the industry. (The models were developed from another set of model plants that were specified in a separately-performed engineering study.) Economic impacts on the model plants are assessed through the use of ROI and DCF analyses. The results from the DCF analysis suggest that small apple processing plants and single-strength orange juice plants of all sizes would be highly subject to closure due to the guidelines. The study estimates the number of regulation-induced plant closures for each segment of the industry, but does not break these down by the size of plant.

The retrospective assessment of the fruit and vegetable study found the estimates of plant closures to be reasonably accurate. As mentioned, however, the study's estimates are not broken down by plant size. At the model-plant level of analysis, the study's treatment of differential impact is excellent. Unfortunately, however, the results of this analysis are not rigorously tied to the conclusions that are presented about economic impacts at the industry level. This is a shortcoming that is apparent in all impact studies employing methodologies based on the model plant approach. More will be said about this later in this report.
The EPA study on the soap and detergent industry also deals with the impact of effluent guidelines. As in the fruit and vegetable study, this study also employs analytical methodology structured around the model plant approach. The specification of model plants in this study, however, is not as detailed as in the fruit and vegetable study. Only three model plants are specified: a small soap plant, a small liquid detergent plant, and a large integrated soap and detergent plant. The small soap plant is modeled to represent a financially marginal operation. Quantitative estimates are made of the effects of the effluent guidelines on the profit margins and product prices for the three model plants. No plant closures due to the guidelines are predicted. All other impacts are estimated in a qualitative fashion.

In the retrospective analysis of the soap and detergent study, the accuracy of the predicted impacts on plant profit margins could not be determined. The predicted price increases, however, were found to be reasonably accurate. Yet, it cannot be stated to what extent the observed price increases were due to the EPA regulation. Too many extraneous factors are involved to permit this type of assessment. The study's prediction of no regulation-induced plant closures proved to be accurate.

At the model-plant level of analysis, the soap and detergent study did a reasonably good job of examining differential impact. Again, however, as in the case of the fruit and vegetable study, the results of this analysis are not rigorously incorporated into the conclusions about industry-level impact.

The EPA study on lime manufacturing deals with the impact of New Source Performance Standards (these pertain to control of air pollution) on plants in the industry. As in the other two EPA studies, the methodology employed is based upon the model plant approach. Model plants of small, medium, and large sizes are utilized. The impacts of the standards on product prices and ROI's for the three plants are examined quantitatively. Capital requirements are examined, and found to be minimal in what the study believes to be the most likely regulatory scenario.

In the case of the lime study, the ability to perform a retrospective analysis was limited by the scarcity of data pertaining to current conditions in the industry. The available data, however, tend to suggest that the
actual impacts of the regulation differ significantly from those that were predicted in the study. There are two explanations for this apparent divergence. One is that a much smaller number of firms became subject to the regulation than was anticipated in the study. The other is that not enough model plants were specified, and in the case of the three plants that were utilized, there is some question about the validity of the regulatory cost estimates that were developed for each. With respect to the number of model plants, it would appear that one more model plant of very large size should have been specified. The regulatory cost estimates for the model plants were developed in a separate engineering study.

The lime study does not devote a great deal of attention to the issue of differential impact. Treatment is confined to a comparison of pollution control costs for the model plants. The study, however, cannot be severely criticized on this point since data limitations made it impossible to make comparisons using other measures of economic impact. Due to confidentiality restrictions, for example, financial data on small, privately-held lime manufacturing firms could not be obtained.

The OSHA study on coke ovens deals with the impact of an occupational health and safety standard. None of the producers of coke can be considered as small businesses; however, the study is relevant to this research effort because of the methodological insights it provides concerning the assessment of differential impact. The methodology employed in this study is based on the use of regulatory costs developed directly from an analysis of actual plants. A total of 12 plants are analyzed for impacts resulting from the standard. All of the plants are operations of publicly-held, integrated steel companies. The results obtained from the analysis of the 12 plants are extrapolated to obtain conclusions about impacts at the industry level. In addition to estimating industry compliance costs, the study also examines impacts in areas such as coke and steel prices, labor costs, earnings per share, employment, productivity, and market structure. The study does a good job of examining the differential impact of the standard on producers of different size.

The effort to retrospectively analyze the coke oven study was handicapped by the lack of published data on coke producers. Solid figures on the industry's cost of compliance could not be obtained. OSHA does not keep

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track of compliance costs on a routine basis, and industry sources were reluctant to provide estimates of these costs because of pending litigation with OSHA over the standard. Some studies have been done, however, which touch upon this subject in a general fashion. These seem to suggest that the OSHA study's estimates of the industry compliance costs are high.

The type of methodology that is used in the coke oven study would appear to offer definite advantages with respect to the assessment of differential impact. Like the model plant approach, it permits the analysis to focus upon the effect which size has upon regulatory costs and the impacts that arise from the imposition of these costs. However, unlike the model plant approach, this methodology does not involve the unrealistic assumption that a plant and a firm are always one in the same thing. Of course, in many situations, it may not be feasible to base the impact assessment on an analysis of actual plants. This would be the case, for example, where the regulated industry is composed of a large number of firms whose financial and technological characteristics vary widely.

The CPSC study on matchbook manufacturing deals with the impact of a consumer product safety standard. The methodology used in this study is a combination of two approaches. On the one hand, in order to estimate the cost of industry compliance, an individual estimate of regulatory costs was developed for each of the firms in the industry (there are currently nine). Each estimate was based largely upon information provided by the firm involved. The individual estimates developed in this manner are combined to produce a total cost for the entire industry. In addition to this procedure, the study also develops a single small model plant that is subjected to financial impact analysis. The model is said to represent a marginal operation. By examining the impacts of the standard on this model, the study argues, it is possible to determine what the magnitude of the impacts of the standard would be in the worst possible case. The principal analytical technique used in this assessment is ROI analysis.

The effort to perform a retrospective analysis of the matchbook study was severely constrained by two problems. First, there is an almost total lack of published economic data concerning the industry. This is due largely to the fact that the industry has been operating for more than 30 years under a consent decree issued by the U.S. Department of Justice. Importantly,
the decree forbids matchbook manufacturers from exchanging information on prices, sales, inventory, or production, and from engaging in industry association activities. The second problem is that the number of provisions included in the standard was reduced significantly after its proposal. Despite these problems, however, it was still possible to draw some conclusions. Based on information obtained from matchbook manufacturers, it was determined that the standard has had, at most, only a negligible impact on the industry. There have been no regulation-induced plant closures. As far as the study's forecasts are concerned, it was felt that they might have been reasonably accurate had the requirements of the standard not changed so drastically.

The matchbook study could have devoted more attention to the subject of differential impact. Within the existing methodological framework, it would have been possible to determine how compliance costs (on a per unit of output basis) varied by size of firm. Also, by specifying additional model plants of different sizes, it would have been possible to directly demonstrate the extent to which the small plant was more seriously impacted by the standard.

4.8 REFERENCES FOR CHAPTER 4
7. Semling, Harold V., Jr., "Congress, Agencies Wrestle with Key Concerns to Food Processors." Food Processing, November 1977, p. 16.


12. Information obtained from files of EPA Economic Dislocation Early Warning System.


23. See Reference 22, p. 86.

25. See Reference 22, p. 83.
28. National Lime Association v. EPA.
5.0 CONCLUSIONS AND POLICY IMPLICATIONS

5.1 OBSERVATIONS REGARDING THE ABILITY OF METHODOLOGIES TO FORECAST DIFFERENTIAL EFFECTS

A total of 38 different economic impact studies were reviewed as part of this research effort. Out of this group, 22 studies were selected for detailed examination. In addition, five of these studies were subjected to retrospective analysis. Based upon this research, some general comments can be made about the ability of methodologies to assess the differential effects of regulations. To begin with, it should be noted that economic impact studies have come a long way in terms of the amount of attention devoted to the subject of differential impact and the special problems of small business. Nonetheless, one of the basic observations that can be made is that the analysis of differential effects can still be greatly improved.

In Chapter 2, impact assessment methodologies were classified into three basic types. The analysis of real plants permits an examination of differential regulatory burden; however, the approach is not feasible to employ in most situations because of practical considerations (e.g., too many firms in the industry). Analyses based upon the use of a single conceptualization to represent an entire industry (i.e., the "typical plant" approach) do not permit the direct examination of differential effects since variations in regulatory costs by scale of operation are not considered (regulatory costs are compared on a per-unit-of-output basis). The model plant approach, on the other hand, allows the analyst to focus directly upon the manner in which regulatory burden varies with the scale of operation. The model plant approach would therefore appear to be the methodology of choice in situations where there is interest in exploring the differential effects of the regulation as between small and large businesses. In using this approach, however,
a great deal of skill is required in specifying the model plants. Major error can be introduced into the impact assessment by utilizing models which are not good representations of the actual plants comprising the industry.

Chapter 3 discussed three of the more popular methods or tools of analysis that are currently employed to evaluate the economic impacts of regulations. DCF analysis, ROI analysis, and debt-coverage analysis can be very useful means for revealing the extent to which regulatory burdens vary among firms of different sizes. When these tools are used to assess the impacts of regulations on small businesses, however, their utility can be significantly diminished by the limited availability of financial data on small firms. To get around this problem, the analyst frequently resorts to the use of data which are averages for the industry. Where this is done, the likelihood of obtaining inaccurate conclusions is greatly increased.

5.2 SUMMARY OF REGULATORY COST DIFFERENTIALS BETWEEN SMALL AND LARGE BUSINESSES

Tables 5-1 to 5-8 present regulatory cost data drawn from economic impact studies that were reviewed as part of this research effort. The data illustrates the manner in which regulatory requirements tend to impose a disproportionately heavy burden on small businesses. In each of the tables, the regulatory costs for the different sizes of plants are expressed in per-unit-of-output terms. In all cases the per unit cost of compliance for the small plant is higher than those of its larger competitors.

5.3 CAUSES OF INACCURACIES IN ASSESSMENTS OF SMALL BUSINESS IMPACT

The analysis in this study has called attention to several different ways in which error may be introduced into the assessment of small business impact. As discussed in Chapter 3, one potential cause of inaccurate assessment of impact is the incorrect specification of values for "critical" variables. It will be recalled that relative to a particular method or technique of analysis, the critical variables are those which, when incorrectly specified, exhibit the greatest potential to introduce error into the dependent measure. In Chapter 3, three different methods of analysis (DCF, ROI, and debt coverage) were examined in order to identify critical variables. One major finding was that in the case of these analytical methods, the critical variables in the analysis of small businesses are sales, total expenses (excluding interest and depreciation), depreciation, and replacement investment.
Table 5-1. COMPLIANCE COSTS: SOAP AND DETERGENT MANUFACTURING PLANTS

(cents per pound of production)

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>Small Soap Plant (4M lbs/yr)</th>
<th>Small Detergent Plant (25M lbs/yr)</th>
<th>Large Integrated Plant (740M lbs/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I Technology&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.37</td>
<td>0.074</td>
<td>0.08035</td>
</tr>
<tr>
<td>Levels I and II Technology&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.59</td>
<td>0.074</td>
<td>0.08035</td>
</tr>
<tr>
<td>Level III Technology&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.65-3.14</td>
<td>0.634</td>
<td>0.4199</td>
</tr>
</tbody>
</table>

<sup>a</sup>All costs were calculated for the median data case. Refer to discussion in Section 4.3.4 for explanation of data base.

Table 5-2. COMPLIANCE COSTS: ELECTROPLATING PLANTS

(expressed as a % of annual sales)

<table>
<thead>
<tr>
<th>Plant Sizes (# of Employees)</th>
<th>1-4</th>
<th>5-9</th>
<th>10-19</th>
<th>20-49</th>
<th>50-99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level I Rural</td>
<td>36.7</td>
<td>15.5</td>
<td>16.0</td>
<td>15.2</td>
<td>15.0</td>
</tr>
<tr>
<td>Level I Urban</td>
<td>18.3</td>
<td>7.7</td>
<td>8.0</td>
<td>7.6</td>
<td>7.5</td>
</tr>
<tr>
<td>Level II Rural</td>
<td>15.2</td>
<td>6.1</td>
<td>9.5</td>
<td>8.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Alternate B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level I Urban</td>
<td>36.7</td>
<td>15.5</td>
<td>16.0</td>
<td>15.2</td>
<td>15.0</td>
</tr>
<tr>
<td>Level II Rural</td>
<td>15.2</td>
<td>6.1</td>
<td>9.5</td>
<td>8.0</td>
<td>7.7</td>
</tr>
</tbody>
</table>

Note: The terms, "Level I" and "Level II", refer to levels of effluent treatment. Level I corresponds to best practicable technology (BPT) and Level II corresponds to best available technology (BAT). In the study, two alternatives -- A and B -- were established for levels of treatment for rural and urban electroplating plants.

Table 5-3. COMPLIANCE COSTS: TEXTILE MILLS\textsuperscript{a}

<table>
<thead>
<tr>
<th>Plant Size</th>
<th>Daily Capacity (000 lbs)</th>
<th>Annual Production\textsuperscript{b} (000 lbs)</th>
<th>Annual Control Costs ($000)</th>
<th>Control Cost Per Pound ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>12</td>
<td>2,681</td>
<td>100</td>
<td>.037</td>
</tr>
<tr>
<td>Medium</td>
<td>44</td>
<td>10,185</td>
<td>163</td>
<td>.016</td>
</tr>
<tr>
<td>Large</td>
<td>110</td>
<td>26,455</td>
<td>243</td>
<td>.009</td>
</tr>
<tr>
<td>X-Large</td>
<td>485</td>
<td>101,853</td>
<td>525</td>
<td>.005</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Costs are for existing woven fabric finishing plants (that are direct dischargers of effluent) to comply with water pollution control requirements -- in this case, Best Available Technology Economically Achievable (BATEA). The costs presented are for only one of several control alternatives considered in the study.

\textsuperscript{b}The number of operating days per year and the utilization rate varies from one model plant to another.

Table 5-4. COMPLIANCE COSTS: PAINT MANUFACTURING PLANTS

(cents per gallon of output)

<table>
<thead>
<tr>
<th>Regulatory Option</th>
<th>Very Small</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>Very Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.4</td>
<td>4.7</td>
<td>1.6</td>
<td>2.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Option 2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.8</td>
<td>4.7</td>
<td>4.0</td>
<td>2.7</td>
<td>1.4</td>
</tr>
</tbody>
</table>

<sup>a</sup>Physical chemical pretreatment.
<sup>b</sup>Zero discharge with a least cost method.

Table 5-5. COMPLIANCE COSTS: ORANGE JUICE MANUFACTURING PLANTS

(dollars per ton of output)

<table>
<thead>
<tr>
<th>Regulatory Alternative</th>
<th>Plant Sizes</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>114 TPD</td>
<td>528 TPD</td>
<td>1,072 TPD</td>
<td></td>
</tr>
<tr>
<td>Alt. B (BPT)</td>
<td>1.62</td>
<td>.56</td>
<td>.35</td>
<td></td>
</tr>
<tr>
<td>Alt. C (BAT)</td>
<td>3.36</td>
<td>1.16</td>
<td>.59</td>
<td></td>
</tr>
<tr>
<td>Alt. D (BPT and BAT)</td>
<td>1.85</td>
<td>.88</td>
<td>.70</td>
<td></td>
</tr>
<tr>
<td>Alt. E (BPT)</td>
<td>1.43</td>
<td>.56</td>
<td>.39</td>
<td></td>
</tr>
<tr>
<td>Alt. F (BAT)</td>
<td>1.93</td>
<td>.73</td>
<td>.50</td>
<td></td>
</tr>
</tbody>
</table>

Note: BPT stands for best practicable technology, and BAT for best available technology. TPD stands for tons per day of frozen orange juice concentrate produced.

Table 5-6. COMPLIANCE COSTS: COKE MANUFACTURING PLANTS

(dollars per ton of output)

<table>
<thead>
<tr>
<th>Company</th>
<th>1974 Production (1,000 Tons)</th>
<th>Control Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>195</td>
<td>5.5</td>
</tr>
<tr>
<td>2</td>
<td>365</td>
<td>4.4</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
<td>4.1</td>
</tr>
<tr>
<td>4</td>
<td>1,180</td>
<td>4.1</td>
</tr>
<tr>
<td>5</td>
<td>1,400</td>
<td>2.9</td>
</tr>
<tr>
<td>6</td>
<td>1,830</td>
<td>2.8</td>
</tr>
<tr>
<td>7</td>
<td>2,460</td>
<td>1.9</td>
</tr>
<tr>
<td>8</td>
<td>2,470</td>
<td>1.9</td>
</tr>
<tr>
<td>9</td>
<td>4,280</td>
<td>2.8</td>
</tr>
<tr>
<td>10</td>
<td>4,800</td>
<td>2.5</td>
</tr>
<tr>
<td>11</td>
<td>11,000</td>
<td>1.8</td>
</tr>
<tr>
<td>12</td>
<td>15,900</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 5-7. COMPLIANCE COSTS: KRAFT PULP MILLS

(dollars per ton of output)

<table>
<thead>
<tr>
<th>Regulatory Alternatives</th>
<th>Plant Size</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500 TPD</td>
<td>1,000 TPD</td>
<td>1,500 TPD</td>
</tr>
<tr>
<td>2</td>
<td>1.57</td>
<td>1.42</td>
<td>1.47</td>
</tr>
<tr>
<td>3</td>
<td>1.55</td>
<td>1.41</td>
<td>1.45</td>
</tr>
<tr>
<td>4</td>
<td>2.23</td>
<td>1.99</td>
<td>1.99</td>
</tr>
<tr>
<td>5</td>
<td>2.56</td>
<td>2.29</td>
<td>2.29</td>
</tr>
</tbody>
</table>

Note: TPD stands for ton per day of output.

Table 5-8. COMPLIANCE COSTS: NEW LEAD-ACID BATTERY MANUFACTURING PLANTS

<table>
<thead>
<tr>
<th>Plant Size b</th>
<th>Total Annualized Control Cost ($)</th>
<th>Control Cost per Battery c ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 BPD</td>
<td>36,600</td>
<td>1.46</td>
</tr>
<tr>
<td>250 BPD</td>
<td>43,700</td>
<td>0.70</td>
</tr>
<tr>
<td>500 BPD</td>
<td>67,500</td>
<td>0.54</td>
</tr>
<tr>
<td>2000 BPD</td>
<td>158,000</td>
<td>0.32</td>
</tr>
<tr>
<td>6500 BPD</td>
<td>379,000</td>
<td>0.23</td>
</tr>
</tbody>
</table>

a Costs are for air pollution controls to comply with a new source performance standard.

b BPD: batteries produced per day.

c Annual output calculated by multiplying daily production capacity times 250 days.

Source of Data: EPA, Office of Air Quality Planning and Standards, Lead-Acid Battery Manufacture -- Background Information for Proposed Standards, November 1979, Table 8-50.
Error may also be caused by the inability to collect adequate data regarding the critical variables of the analytical methods being used. Information on privately-held firms (which tend to be the smaller firms in an industry) is generally nonexistent in secondary sources, and data for smaller publicly-held firms is often extremely scarce. In many economic impact studies, budget and/or time constraints rule out the development of original data. The collection of primary data is also complicated by the fact that firms are generally hesitant to provide information to a researcher who is doing work connected with the development of a regulation. When data specific to small firms cannot be obtained or developed, the researcher may find it necessary to resort to the use of data which is representative of the entire size distribution of firms comprising the industry, or, worse yet, data which relates to larger firms.

As will be recalled from the discussion in Chapter 2, economic impact studies may be broadly classified in terms of the approach that is used for the estimation of regulatory costs. Three categories of broad methodologies were defined; and, in this connection, it was pointed out that studies employing methodologies in which all of the plants in an industry are represented by a single conceptualization (the "typical plant" approach) cannot directly assess the nature of differential impact. Since the conceptualization is a form of average, conclusions cannot be directly drawn regarding the variation of regulatory burden by size of plant or firm. Where this type of methodology is employed, therefore, assessments of small business impact (if they are presented at all) may not be very accurate.

In studies using methodologies based upon the model plant approach, results obtained from the analysis of the models bear direct relevance to the issue of intraindustry variation in regulatory burden. There are, however, several ways in which errors in the assessment of small business impact can arise when the model plant approach is employed. The most fundamental causes of error are connected with the specification of the model plants and the approach used in calculating the regulatory costs for the plants. Model plants are developed through the use of an engineering survey of real plants. (Depending upon the regulatory agency that is involved, the engineering study may or may not be performed separately from the economic impact study.) Because of constraints on time and resources, the survey of plants is rarely
exhaustive. In many instances, firms are reluctant to participate in such surveys. There is a chance, therefore, that the surveyed plants may not provide a good representation of the diversity (in terms of size, technology, product characteristics, financial health, etc.) found in the total population of plants in the industry. It is the feeling of JACA that the smaller marginal plants often tend to be under-represented in surveys. Where this is the case, the small model plant which is developed from the survey data may not be a good representation of the actual small plants in the industry. As a consequence, the regulatory costs which are developed from this basis may be distorted, and therefore lead to error in the assessment of small business impact. It should also be noted that in some instances, because of a lack of adequate survey data on small plants, use is made of theoretical engineering cost curves to estimate regulatory costs for the small model plant. Since this procedure is basically a form of extrapolation (from known points derived from the observed real plants), there is the possibility that the estimated costs for the small model plant may not be good representations of the costs that might be associated with actual small plants.

Another possible source of error in the model plant approach stems from the necessity of having to assume that the model plant represents a single-plant firm. This assumption can lead to overestimates of regulatory impact in the case of large multiplant firms. Because of the economies of scale that they enjoy with respect to both production and regulatory compliance, large multiplant firms may be less affected by a regulation than are single-plant firms. Thus, it is possible that the impact analysis could understate the differential in regulatory burden between small and large firms.

When the model plant approach is utilized, errors in the assessment of small business impact may also arise when the results from the plant-level analysis are generalized to derive conclusions about the nature of impacts at the industry level. The error arises from the fact that judgment must be applied when determining the extent to which actual plants will be impacted in the manner suggested by the model plant analysis.

5.4 POLICY IMPLICATIONS

Among the 22 economic impact studies that were reviewed in detail, there is considerable variation in the extent to which the matter of differential impact is addressed. In some of the studies the treatment is minimal, and
the reader is left to draw his or her own conclusions. In other studies -- particularly the newer ones -- special attention is focused upon the potential hardships that the regulation could impose upon small business. Some examples of the latter are the EPA studies dealing with lead-acid batteries, existing sources of electroplating point source categories, and TSCA proposed premanufacturing notification requirements (these are summarized in the Appendix).

Of currently-available methodologies, the model plant approach does the best job of identifying small business needs and potential problem areas. Clearly, as pointed out in Section 5.3 and in other parts of this report, the model plant approach has shortcomings; however, it offers a feasible approach for attempting to characterize the relationships between firm size and the magnitude of regulatory burden. The fruit and vegetable study that was retrospectively analyzed in Chapter 4 serves as a good example of the type of detailed analysis that is possible with the model plant approach. On the negative side, however, the study dealing with the lime industry points up some of the major problems that can be encountered in the use of the approach.

Impact assessment methodologies based on the use of the "typical plant" approach generally cannot do a good job of examining small business impact since differentials in regulatory burden as between small and large firms are not directly accounted for. The approach is popular, however, since it requires less analytical effort than does the model plant approach. For examples of this approach, the reader is referred to the studies on inorganic chemicals (EPA), cotton dust (OSHA), and upholstered furniture (CPSC).

During the course of this research effort, JACA has identified several ways in which existing methodologies can be improved or enhanced to achieve higher levels of accuracy in the assessment of small business impact. One of these would be to include the costs of required reporting, recordkeeping, and testing in the estimation of regulatory costs. These informational costs are important to consider since they often impose a disproportionately heavy burden upon smaller firms. In the large firms, there are likely to be personnel who are assigned specifically to deal with matters pertaining to regulatory compliance. In the small firm, however, the responsibility for handling compliance matters often falls directly upon the shoulders of management. This can significantly reduce the amount of attention that
management can devote to running the operations of the firm. Over the long term, this additional burden may serve to erode the competitive position of the firm.

A second way in which existing methodologies can be enhanced would be by focusing attention on special financing mechanisms that may be available to small firms for meeting the costs of regulatory compliance. Examples of these are SBA loans, industrial development bonds, and low-interest commercial bank loans. From an analytical standpoint, such forms of assistance are important to consider since they can mitigate the degree of small business impact. In one of the more recent EPA studies that was reviewed (1979 study on electroplating), a sensitivity analysis is performed to determine the effects of SBA loans in reducing the rate of regulation-induced closures among small job shops. The same type of procedure could readily be employed in other studies.

A third improvement would be to consider the differences that exist between small and large firms with respect to the way in which operations are financed. Generally, the small firm must rely on relatively short-term debt to finance its operations. In contrast, the large firm has access to bond markets and/or equity markets. Thus, there can be a considerable difference between small and large firms with respect to borrowing costs. These differences should be accounted for in all calculations of impact in which borrowing costs are an input (e.g., the discount rate used in DCF).

A fourth improvement relates to the fact that the small firm often does not have the same ability as the large firm to pass along costs of regulation to the consumer. The large firm is generally able to pass along these costs with a smaller increase in unit price. This factor should be taken into account when regulation-induced increases in product prices are calculated.

A fifth improvement pertains to the definition of the small business sector. Where small business impact is to be examined, care should be taken in the analysis to precisely define what constitutes the small business sector. Unless such a definition is provided, it is difficult to draw conclusions about the magnitude of small business impact at the industry level (as opposed to conclusions that can be drawn at the micro, or plant level of analysis).

Finally, and most importantly, great improvements in the assessment of small business impact could be achieved through the availability of more and
better data on small business. It is true that currently-available methodologies and techniques of analysis could stand improvement. Nonetheless, it is felt that if more and better data on small businesses were available, these same methodologies and techniques would be generally capable of providing reasonably accurate assessments of small business impact. Moreover, the availability of more and better data on small businesses would also have the positive effect of encouraging regulatory agencies to devote more attention to the issue of differential impact and the special problems of small business.

The recent passage of the Regulatory Flexibility Act underscores the need for more and better data on small businesses. The provisions of the Act require that federal regulatory agencies be able to assess the small business implications of the rules and standards that they propose. They will be able to fully comply with this legislation only if the data situation is improved.

The SBA can play a vital role in helping to improve both the availability and quality of data on small businesses. As part of their loan application processing, SBA regional offices collect financial data on small firms. Some of this data could perhaps be utilized by regulatory agencies in their economic impact studies. It is recommended, therefore, that SBA examine the feasibility of consolidating this information into a single data base that could be accessed by regulatory agencies and other organizations having an interest in small business.
## SUMMARY OF STUDIES REVIEWED FOR METHODOLOGY CLASSIFICATION

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*In conjunction with EPA and Consumer Product Safety Commission.
A. Industry Coverage

The analysis covers the upholstered furniture industry, plus suppliers of fabrics and cushioning and padding materials for the upholstered furniture industry. The production of upholstered household furniture is concentrated mainly in SIC 2512 (upholstered wood household furniture). Other industry groups accounting for important shares of the production include SIC 2514 (metal household furniture), SIC 2515 (mattresses and bed springs), and SIC 2519 (household furniture, not elsewhere classified). Suppliers of fabrics comprise the following groups: fabric mills, fabric finishers, producers of plastic, leather, and other types of upholstery materials, and suppliers of decorative trimmings. The suppliers of cushioning and padding materials are divided between suppliers of natural material materials and suppliers of synthetic materials.

The wood upholstered household furniture industry is largely composed of small firms. About 40 percent of the firms in this industry employ fewer than 20 workers. Perhaps 1,500 firms produce wood upholstered household furniture and dual-purpose sleep furniture. The four largest firms account for approximately 14 percent of the total value of wood upholstered furniture shipments; the 50 largest firms account for about 50 percent. The relative contribution to the total value of the industry's shipments by smaller firms, as well as the number of establishments producing upholstered furniture, has been decreasing in recent years.

The size characteristics of suppliers of fabrics and cushioning and padding materials are as follows:

- **Fabric Suppliers**
  - Fabric mills - estimated that 40 percent of cotton weaving mills and man-made fiber mills have less than 100 employees;
  - Fabric finishers - over 40 percent of establishments have less than 100 employees;
- Coated fabrics (plastics) - 83 percent of establishments have less than 100 employees;
- Leather fabrics -- currently 9 major suppliers with employment ranging from less than 100 to 350.

**Cushioning and Padding Suppliers**
- No estimates of size were given in the study.

### B. Nature of Regulation

The regulation, which has yet to be proposed, involves a product safety standard pertaining to cigarette ignition of upholstered furniture. The regulatory approach is specific, and would not involve any special provisions for small business.

### C. Estimation of Regulatory Costs

The total additional manufacturing costs resulting from the cigarette ignition standard are estimated by the study to range from about $57 million to $87 million annually. These figures were obtained by adding up costs in the following areas: 1) fabric classification testing costs; 2) mock-up testing costs; 3) construction material cost increases; and 4) recordkeeping costs.

Fabric classification testing costs were estimated on the basis of an expectation that each test would cost from $16 to $17. There are about 110 firms that produce most of the fabric for upholstered furniture. Based on industry information, an estimate was made of the average number of upholstery fabric types produced by textile firms. The number was given in terms of a range. These numbers were then multiplied by the expected costs for each test. This total was then adjusted by adding testing costs in fabrics not originally intended for upholstery use.

Mock-up testing costs were estimated by summing the following: labor, materials, and miscellaneous costs directly associated with each test; fixed costs associated with the construction of testing, storage, and recordkeeping facilities; amortization of equipment; and, in cases where in-house testing is not performed, costs associated with testing done by independent laboratories. The study notes that mock-up testing costs will represent a greater percentage of sales for smaller firms in the industry. It is assumed that these firms are likely to use independent laboratories. While it is true that many smaller firms specialize in higher priced furniture that enables higher percentage mark-ups, the study recognizes that, other things being equal, mock-up testing and other costs of the standard may have a disproportionate impact on the smaller firms in the industry. The study concludes
that the standard may therefore contribute to the recent trend of the diminishing importance of output of smaller firms to total industry shipments, and the exodus of smaller firms from the industry.

Construction material cost increases due to the standard were estimated in three parts: 1) costs of improving smolder resistance of substrates; 2) costs of backcoating 50 percent of class D fabrics; and 3) costs of using foil barriers on 10 percent of class D fabric constructions. The costs were estimated using the results of previous research conducted by the industry and by agencies of Federal and State government. Potential differentials in costs by size of firm are not addressed. The cost estimates are for the industry as a whole.

The study notes that recordkeeping costs cannot be estimated with certainty at this time. It is estimated that total recordkeeping costs may range from less than $1,000 for small firms to $10,000 for large firms. The point is made that perhaps 25 percent of the firms in the industry presently have electronic data processing equipment, and that these firms should enjoy significantly reduced recordkeeping costs compared to other firms of similar size.

As pointed out above, the total additional manufacturing costs resulting from the standard were estimated to range from about $57 million to $87 million annually. Each of these costs was divided by an estimate of the industry's value of shipments, with the quotients being multiplied by 100. The percentages obtained represented the percentages by which producer prices (on average) could increase if the regulatory costs were to be fully passed on. Given these increases, potential average increases in the prices of upholstered chairs and sofas were calculated.

D. Analysis of Baseline Economics

Baseline economics are covered in two separate attachments to the study: 1) Profile of the Upholstered Furniture Industry, and 2) Profile of Selected Groups Supplying Fabrics and Cushioning Materials to the Upholstered Furniture Industry.

The profile of the upholstered furniture industry deals with subjects including: historical and projected trends in the demand for upholstered furniture; general structure of the industry; types of products manufactured; concentration; size and geographical distribution of establishments; employment and earnings; financial characteristics of firms; distribution and marketing of upholstered furniture; price trends; and imports and exports. Similar subjects are dealt with in the profile of suppliers of fabrics and cushioning materials.
E. **Evaluation of Economic Impacts**

The types of economic impacts examined in the study include: additional manufacturing costs resulting from the standard; likely retail price increases, by furniture type; reduction in annual economic losses associated with upholstered furniture fires; likely sales shifts; changes in industry concentration; exits from the industry; and balance of trade effects.

The methods used in estimating additional manufacturing costs and price increases have already been discussed above.

The benefits of the standard (i.e., reductions in annual economic loss) were evaluated using a discounting procedure. In the years following the promulgation of the standard, the reduction in annual economic losses would increase as complying furniture accounts for an increasing share of the total furniture population. The study estimates that when almost all furniture is replaced by complying furniture, the benefits of reduced economic losses would approach about $470 million per year. The study argues that the costs of the standard to society occur mainly at the time that the furniture is purchased. The benefits of the standard, however, accrue over the life of the furniture. Since benefits in later years are valued less than those which are realized sooner, the annual benefits are discounted to reflect society's time preference. They are then summed to yield total benefits over the lifetime of the furniture. This total is then compared to costs at time of purchase to obtain a measure of net benefits.

A qualitative approach was used in analyzing sales shifts, changes in industry concentration, exits from the industry, and balance of trade effects.

F. **Additional Comments**

The study is essentially concerned with macro-level impacts. As such, it does not deal in a quantitative manner with differentials in impacts as between smaller and larger firms. In the section dealing with the estimation of additional manufacturing costs, however, the study does attempt to qualitatively explore the subject of differential impact and its ramifications with respect to the structure of the upholstered furniture industry.

Given the considerable importance of small business in the industry, perhaps more attention could have been focused on the problem which small firms are likely to encounter in attempting to comply with the standard.
A. Industry Coverage

The analysis covers the match industry, and the manufacturing of wooden stem or paper stem matches for resale or special reproduction markets. Most of the firms and plants in industry are small. In 1975, there were 13 firms and 18 plants (Phase I), and, in 1976, 10 firms and 15 plants (Phase II).

B. Nature of Regulation

The regulation was proposed in the Federal Register, April 1, 1976, as 16 CFR 1202, dated March 29, 1976. The proposed regulation is contained as Appendix in Phase II study. The regulation was submitted to the Consumer Product Safety Commission by American Society for Testing Materials in February 1975. As proposed, it contains 3 components:

1. Better quality control, testing provisions to upgrade overall match quality;

2. Time-burn feature - flame must go out with 1/2" from top of splint in 15 seconds;

3. Latching cover safety requirement.

The proposed regulation is specific, with no special provisions for small business.
C. **Estimation of Regulatory Costs**

Compliance costs were estimated on an industrywide basis and, partially to support the industry findings, applied to a model plant.

**Industry-wide estimates (Phase II)** consisted of:

1. Manufacturer capital and variable costs, estimated for each of the 3 components of the proposed standard on an individual company basis and aggregated;

2. Total cost impacts estimated for 2 industry markets segments (resale and special reproduction) on unit cost basis;

3. Derived demand curves applied to estimate resulting industry volume.

A model plant was developed in Phase I, with cost parameters based on information obtained through interviews (also used for industry estimates) and production assumptions on:

1. Type of match produced;

2. Cost estimates based on interview findings;

3. Some contracting out of functions and centralized distribution area;

4. Operating parameters - 1 shift, 5 days/week, 52 weeks/year;

5. Annual output, price.

An income statement was the basic model. The model plant was updated by applying cost increases for Phase II use. The impact of the standard on the model plant was assessed in Phase II by making assumptions on:

1. Additional direct (new employee), indirect labor costs;

2. Maintenance and repair costs;

3. Capital investment requirement;

4. Inventory levels

to yield, through the income statement analysis,
1. Revenue increases necessary to cover costs, including net profit shift;
2. Average product cost and related price increase;
3. Support to previous exit predictions.

Only 1 model plant was developed and reflected a representative, i.e., relatively small, size. The plant parameters, reflecting the marginal profitability and capital intensity of the industry, were primarily used to support the exit findings of the industrywide analysis and, in this sense, were small business oriented.

D. Analysis of Baseline Economics

In the industry profile, there was no special attention per se paid to the small business segment. Data sources were published sources (primarily census, including annual reports) and interviews.

1. Demand Analysis. Lights demand was evaluated to assess relative demand for matches and determined to be price inelastic. A derived demand curve for matches was estimated in terms of volume of output relative to increased purchase costs, in order to estimate purchase volume shifts with cost increases. While the approach was quantitative, basically descriptive statistical techniques were applied.

2. Price Elasticity of Demand. Match market has 2 components (resale, special reproduction) and matches are frequently free to customers. Demand was analyzed as it would impact advertisers, with price elasticity not examined on a unit basis.

3. Supply Analysis. Supply was analyzed relative to total light supply and the likely impact of the regulation on industry competition. Study's focus was on supply assessment through cost evaluation.

E. Evaluation of Economic Impact

Industrywide analysis yielded:

1. Industry capital investment, variable compliance costs;
2. Price impact, increased costs to consumers;
3. Number of firms which would exit, employment and wage decrease;
4. Most costly component of standard.

Because imports are not significant, balance of trade was only briefly examined. Based on exit predictions, the impact of the standard on industry competition was examined.

The study did not assess the potential impact of the regulation on regulatory costs in other areas. While no cost pass-through assumption was specifically stated, full pass-through appears to have been assumed. With the demand relationship between purchase costs and output estimated, compliance costs increased purchase costs, decreasing sales and output. Consumer costs were estimated as indirect costs due to the standard.

Simple algebraic calculations were used, with differential impacts on the two match markets resulting from the analysis.

Five manufacturers were predicted to exit from the industry, a highly significant finding.

F. Comments

The algebraic methodology used was adequate given the size of the industry, the relative simple production methods, and, except for the somewhat unique role of advertising in product consumption, the clearly delineated markets. The methodology was unique in that model plant findings were basically used to support industrywide conclusions by indicating the fragility of most industry firms.
STUDY #3


Date of Regulation Proposal:

Date of Regulation Promulgation: April 8, 1977, but since then the ban has been voided.

A. Industry Coverage

The industries covered are: chemical manufacturing, textile manufacturing, and garment manufacturing and retailing. A cost examination is made of the garment industry. The SIC groups in this industry which are dealt with include:

SIC 23215 12 - Boys' nightwear
23413 11 - Girls' children's nightgowns
23413 13 - Girls', children's pajamas
23413 15 - Infants', toddlers' nightgowns
23413 16 - Heavy-weight sleeping gams made with feet
23413 17 - Infants', toddlers' pajamas

Small business is very important in the garment industry. Small businesses are engaged in almost every segment of the production of children's sleepwear containing TBPP.

B. Nature of Regulation

The study focuses on the Consumer Product Safety Commission's ban on the sale of all children's wearing apparel containing tris (2,3-dibromopropyl) phosphate (TBPP) and fabric intended for use in children's clothing containing TBPP. This was done after the National Cancer Institute discovered that TBPP is a carcinogen. The CPSC declared children's wearing apparel containing TBPP a hazardous substance under Section 2(q)(1)(A) of the Federal Hazardous Substances Act (FHSA). The ban was effective April 8, 1977.

Following a series of court actions, the ban has been voided. But the study points out that regardless of further legal action, it is "extremely unlikely" that TBPP will ever again be used in children's sleepwear.
C. Estimation of Regulatory Costs

The estimated regulatory costs were based upon industry interviews, 1972 Census of Manufacturers, U.S. Department of Commerce, and the Bureau of Census. The types of costs considered include production costs (value added basis), transportation and handling charges, disposal costs, and other costs which may be comprised of legal fees, administration and clinical time charges, and storage costs. Total industry costs were calculated for each segment. (Chemical manufacturers, textile manufacturers, garment manufacturers and retailers). In addition, costs were calculated for the "average" firm involved in the production of children's sleepwear.

Estimates were made of the financial loss incurred by each industry segment for each of the following CPSC actions:

Case A - A ban on sales of TBPP-treated sleepwear coupled with a recall of unwashed garments in the possession of consumers.

Case B - A ban on TBPP-treated fabrics, yarns, fibers and TBPP used or intended for use by children's sleepwear, with a recall of unwashed garments in the possession of consumers.

Case C - A ban on future sales of TBPP-treated garments.

Case D - A recall of all TBPP-treated sleepwear, repurchase responsibilities extending to garment manufacturers.

D. Analysis of Baseline Economics

A profile is given for each industry involved in the manufacture and distribution of TBPP-treated sleepwear. These industries include: chemical manufacturing, yarn spinning, fiber and fabric manufacture, textile converting, fabric finishing, garment manufacturing, garment distribution and retail trade. The resources used to develop information on the industry profile are as follows: trade publications, CPSC documents, testimonies before various governmental bodies, Association contacts and industry contacts. Each industry description contains information about companies and establishments, output, employment, cost composition, industry prices, concentration, and financial structure. Also, supply and demand conditions operating in the children's sleepwear market resulting from the ban are presented.

E. Evaluation of Economic Impacts

The types of impacts evaluated include demand influences, financial effects, production employment, regional, community effects, differential impacts among industry firms, secondary impacts, closure, and balance of
payments. Also a special summary of the effects of the CPSC action on small business is provided. Algebra computation of economic loss was done to determine the impacts of alternative CPSC actions. Evaluation of other impacts was based on the financial profile, prices, and qualitative assessments.

Financial reports were compiled of 53 firms engaged in the production of children's sleepwear. In reviewing these reports it was discovered that few indexes were consistently similar with respect to size of firm, specialization, or any other method of segmentation. So, a picture of the "average" firms was developed to show how that firm might be impacted by CPSC actions.

In order to show the different impacts between firms in the industry the estimated extent of repurchase responsibility as a percentage of net worth was calculated for 40 firms. Financial coverage for losses was looked at in terms of the companies net income.

Estimates were made as to the number of firms that would have closed if the owners personal money had not been used to maintain operations. Also the number of firms that had obtained SBA loans to finance the losses resulting from the ban were presented.

The secondary impacts on suppliers and the balance of payments effects were examined qualitatively. Also the overall increases in the retail price for children's sleepwear due to the ban were calculated. Besides the economic impact analysis an environmental analysis was completed.

F. Comments

A more quantitative evaluation of the impacts on small producers could have been performed.
STUDY #4


Date of Regulation Proposal: September 24, 1976

A. Industry Coverage

Analysis deals with the Kraft Pulping Industry. This industry is horizontally and vertically integrated. Less than one third of the 56 firms are producers of pulp, paper, and/or paperboard exclusively. The others are engaged in a wide variety of activities. About 90 percent of the Kraft Pulp is not marketed; but it is used captively. The industry is also highly concentrated. (Six firms account for 40 percent of U.S. Kraft Pulp capacity and the 10 larges account for 56 percent of U.S. Kraft Pulp capacity.)

Thus, the small business segment appears to be small.

B. Nature of Regulation

This study focuses on standards of performance for new and modified kraft pulp mills under the authority of Section 111 of the Clean Air Act. Particulate matter and total reduced sulfur (TRS) are the emissions that will be controlled. These regulations are specific.

C. Estimation of Regulatory Costs

Model plant approach was employed. Air pollution control costs were based on information from studies done by research and engineering companies under contract with EPA, state, and local air pollution control agencies, manufacturers of emission control equipment, industry representatives, and EPA engineer visits to 26 kraft pulp mills.

The control costs are estimated for four alternative control systems and for three sizes of kraft mill models (500, 1000, 1500 tons per day of air dried pulp). Both the aggregate costs and incremental costs for alternative controls over state requirements were estimated.
D. Analysis of Baseline Economics

Most of the information for this analysis comes from industry experts, trade associations, and published literature. Industry profile gives information on geographic distribution integration and concentration, international influence demand determinants, supply determinants, and projected industry growth. Price elasticity of demand, was also dealt with. This was based on qualitative assessments and industry expert estimations. In addition to the expenditures the industry are presented. Baseline demand and supply projection are also given. It was assumed that the control costs would be passed on.

E. Evaluation of Economic Impact

The types of impacts examined include profitability, energy, prices, industry growth, output, and employment. A return on investment analysis was done on new and modified plants for each of the three sizes. This was used in determining whether a plant owner would still modify a plant in the face of NSPS. Also, ROI was employed to estimate the impact on earnings for new plants with NSPS. Industrywide compliance costs were also calculated.

Two other types of analysis were also made. These were environmental impact assessment and cost-effectiveness analysis. In addition, the impacts of other regulations, such as OSHA, were assessed qualitatively.

F. Comments

Capital availability should have been examined. Also the impacts on the small producer could have been examined more extensively.
A. Industry Coverage

This analysis deals with the lead-acid battery industry. There are two main types of lead-acid storage batteries produced in the United States:

1. Starting-lighting-ignition (SLI) batteries, used in automobiles, golf carts, and aircraft (SIC 36911); and

2. Industrial storage batteries for low voltage power systems, industrial fork-lift trucks, etc. (SIC 36912). Over 80 percent of the market is for SLI units.

Six companies dominate the lead-acid battery industry. These six manufacturers hold over 70 percent of the market; the top four account for 60 percent of industry sales.

In the United States there are about 190 lead-acid battery plants, of which 91 have been classified as small plants (less than 500 batteries per day). The study deals with the impact on the manufacturer and assemblers of the batteries of all sizes.

B. Nature of Regulation

The proposed standards would limit atmospheric lead emissions from new, modified, or reconstructed facilities at any lead-acid battery manufacturing plant which has a production capacity equal to or greater than 500 batteries per day (bpd). Thus, the small producers are exempted.

C. Estimation of Regulatory Costs

The regulatory costs were determined by three steps:
1. Selecting five representative model plants;
2. Applying the selected five control alternatives for lead and sulfuric acid mist control systems;
3. Determining the total control costs based upon each strategy and typical exhaust volume.

Of the 190 battery manufacturing plants in the United States, nearly 50 percent produce less than 500 units per day and 30 percent manufacture between 500 and 6,500 units per day. Based on these statistics, the following models were developed: small - 100, 250, and 500 bpd; medium - 2,000 bpd; and large - 6,500 bpd. The sizes and costs of the model plants were developed from industry and government contacts.

D. Analysis of Baseline Economics

The analysis is based on publicly available information, interviews with selected industry representatives, and information obtained from earlier EPA studies. No formal economic survey of lead-acid battery plants was performed; therefore many of the observations about industry conditions and trends are based on qualitative information. Industry profile gives information on the size and number of plants, regional distribution, markets, growth, imports, sales, and characteristics of the small producer. Also, the different markets for the small and large firms were examined closely. Price elasticity of demand and supply response were assessed qualitatively. In addition, demand projections were made. It was also determined that there will not be any growth in the small business segment.

E. Evaluation of Economic Impacts

The types of impacts evaluated include profitability, capital availability, prices, employment industry structure/competition, growth, balance of trade, community effects, and energy use. Ratios, return on investment analysis, and simple algebraic calculations were used to assess these impacts. Also, debt coverage analysis was done to determine the capital availability.

Considerable attention was given to the economic impact on small firms. First, the total assets and characteristics of the small model plants were determined, based on field investigations, and interviews with industry representatives. Secondly, estimates were made of the current earnings and profit rate for both manufacturers and assemblers before the imposition of the control costs. Next, the total assets from Step 1, earnings level from Step 2, and the control costs developed by the engineers were used to calculate the ROI before and after incremental costs are required. The ROI analysis was conducted for three different scenarios. Attention was given to portion
of the increase in cost of production due to controls that could be recovered through price increases (cost pass-through) and the amount that would have to be absorbed. Finally, the study evaluated the capability of the firms to finance the control equipment that is required to meet the standard. The financing capability was based on determining the debt coverage for each firm after the incremental cost increase.

Industrywide compliance costs were calculated. Also, postponement of investment and regulatory costs in other areas were predicted in general terms.

In addition, cost-effectiveness analysis and environmental impact analysis were done.

Comments

The study examined the impact on small business carefully.
A. Industry Coverage

The study deals with the lime manufacturing industry (SIC 3274). Specifically, the standards were proposed for the new and modified rotary kilns, and hydrators at lime manufacturing plants. So the processes covered on these regulations are just the calcination and hydration of the lime product. The quarrying, crushing, and sizing of limestone were considered in another document.

In 1974 the total production capacity of all lime plants was 22 million tons. Of this total, commercial plants account for about 78 percent and captive plants for 22 percent. The extent of the small plants is not clear, but it is estimated that plant sizes will continue to increase.

B. Nature of Regulation

Standards of performance for control of particulate matter emissions from affected facilities of Sections 111, 114, and 301(a), of the Clean Air Act, as amended. The regulation is specific.

C. Estimation of Regulatory Costs

The model plant approach was employed. Three models were used, 125 tons per day, 250 tons per day, and 500 tons per day of quicklime. The 500 TPD plant is the most representative model for new plants being built. However, in a few cases small rotary kilns may be built either to satisfy a very small regional market or regeneration requirements for a sugar refiner.

The development of the control costs were based upon contacts with the industry, EPA, and other studies. The cost estimates were made not only for
new facilities, but for modified/reconstructed plants as well. This was done because many plants might convert their gas or oil-fired kilns to coal between 1978 and 1987.

D. Analysis of Baseline Economics

The data used in the economic analysis was obtained from published sources, trade associations, the industry and government agency contacts. The industry profile provides information on the number of plants and sizes, geographic distribution of firms, the markets, capital expenditures, employment, wages, and other expenses. Also, demand and supply projections were made. The price elasticity of demand was not dealt with. However, a time series regression of historical capital expenditures, discounted for inflation, was used to predict the annual rate of investment in new capacity. It was mentioned that there might be some growth of the small business segment in regional areas, but most of the projected industry expansion will be toward larger plants.

E. Evaluation of Economic Impacts

The control costs were addressed for two situations -- one in the absence of a price increase, the other in the absence of a change in profitability. In addition, the degree to which a vertically integrated firm can pass on the cost versus the commercial producer was examined. The types of impacts analyzed include: profitability, capital availability, prices, industry structure, competition, balance of trade, growth trends, and energy. Return on investment analysis, ratios, and simple algebraic calculations (e.g., of profit reduction and increase in capital requirements) were used to evaluate the impacts. Also, the industrywide investment costs were calculated, and so was the number of new and modified facilities that would be affected. The postponements of investment were looked at in general terms.

It is mentioned that the lime industry must comply with EPA's water effluent guidelines in addition to the air pollution standards discussed in this report. An attempt was made to estimate these costs. This study also looked at the environmental impacts of implementing the regulations.

Comments

The study could have dealt with the price elasticity of demand. It also could have looked at the impact on the smaller producers more closely.
STUDY #7


Date of Regulation Proposal: July 2, 1979

Date of Regulation Promulgation: Not promulgated yet.

A. Industry Coverage

Leather tanning and finishing (SIC 3111), with three types of establishments: "regular tanneries", converters, contract tanneries. In 1967, approximately 52 percent of the tanneries had less than 10 employees. More than 70 percent of industry plants are 50 years of age or older. There is neither significant forward nor backward integration in the industry.

B. Nature of Regulation

Application of Sections 304(6) and 306 of Federal Water Pollution Control Act, as amended. Regulation was specific rather than generic, with no special treatment of small business.

C. Estimation of Regulatory Costs

Regulatory cost estimates were obtained from engineering contractor to representative model plants in seven categories. Four effluent control levels (BPT, BAT, NSPS, and Pre-treatment) were considered as alternative practices for the seven plant categories. In the impact analysis, four model plants for one (the major) industry segment were used, as there was insufficient financial data for smaller segments to develop model plants. Corresponding investment and O&M cost data were derived on a graphical basis from the engineering data. One small plant, processing 100 hides/day, was developed.

D. Analysis of Baseline Economics

The industry profile includes information on the characteristics of the firm, industry segments, and ability to finance new investments. Data sources were primarily Census of Manufacturers and information compiled and
tabulated by the Tanners' Council of America, Inc. Financial information was also obtained in Troy's Almanac, an RMA Urban Systems Report, and special studies.

Industry demand, which is derived demand from finished product demand, is qualitatively assessed with regard to industry prices. Supply, which depends on domestic and foreign cattle supply, is similarly, qualitatively assessed. In estimating the supply response, judgment was applied. International trade is a significant factor in the determination of industry prices. Price elasticity is not addressed.

E. Evaluation of Economic Impacts

- Price effects
- Financial effects
- Production effects
- Employment effects
- Community effects
- Balance of trade effects.

Emphasis was placed on financial and plant closure analysis. Basic hypotheses of analysis predicting closure was:

Closure predicted if:

a. Variable costs greater than revenues; or
b. Variable costs less than revenues but revenues less than variable costs plus overhead expenses; or

c. Net present values less than or equal to 0.

For all model plants, the first two were examined through book value analysis, where net profit as percentage of sales impact was examined. An NPV was also calculated for all plants, with a weighted cost of capital computed and applied such that the discount rate was set at this target ROI level. Computation of annual earnings differed under the two methods. The former was applied to estimate after tax income streams, the latter to estimate after tax cash proceeds, the differences being:
- Deduction of after-tax interest and depreciation in the book value analysis
- No interest deduction and inclusion of depreciation, except for tax effect, in the DCF analysis.

Both methods predicted small plant closures. For the NPV methodology, closure was analyzed with and without pollution controls (i.e., a baseline) and with a sensitivity analysis of 30 percent plus of the control costs.

The required price increase to maintain net income was computed, with the caveat that probably only large plants could pass costs through. The NPV analysis was performed with and without a price increase, but with both cases predicting small plant shutdown.

Analysis of production effects included attention to capital availability assessed to be difficult. This assessment included a qualitative comparison of BPT versus replacement investment cost. Production losses from 7 to 21 predicted shutdowns (depending on whether or not the plants were tied into a municipal treatment systems) were assessed, including a qualitative evaluation of whether the loss would be absorbed domestically or internationally.

Direct employment losses (i.e., in the tanning industry) were estimated based on production losses. Indirect losses (i.e., in leather consuming industries) were estimated based on a multiplier. Community and balance of trade effects were qualitatively assessed.
STUDY #8


Date of Regulation Proposal: December 7, 1973

Date of Regulation Promulgation: March 28, 1974

A. Industry Coverage

Copper, Nickel, Chromium, Zinc electroplating (SIC 3471).

B. Nature of Regulation

Application of alternative effluent limitations, standards of performance under Sections 304(b) and 306 of Federal Water Pollution Control Act, as amended.

C. Estimation of Regulatory Costs

Model plant methodology was used, with 5 model plant sizes (each differentiated into urban and rural) developed based on sales, number of employees, and profitability. Effluent limitation alternates were established for rural and urban plants (1977) and rural plants (1983). Engineering cost data, based on: 1) number of square feet/hour painted per employee and number of gallons of water used/hour for investment; and 2) square feet/hour and manhours worked per employee per year, were obtained from the engineering contractor. Two small plant sizes (less than 10 employed), each differentiated by rural vs. urban, were developed.

Total investment costs for the industry and operating cost increases were estimated for each effluent alternative.

D. Analysis of Baseline Economics

Industry profile was presented, with data collected from published sources, trade associations, and industry interviews and surveys. The latter included National Association of Metal Finishers, Chicago Electroplaters Institute, 30 telephone interviews of job and captive electroplaters, and industry consultants. The former included Robert Morris Associates', Moody's, Predicast, Census, Dun and Bradstreet, as well as special industry studies.
Demand was briefly discussed in terms of industry segments' use of electroplating and predicted growth rates. Supply response was basically assessed qualitatively, through judgment and interview findings. No attention was given to price elasticity, although substitutes were noted.

E. Evaluation of Economic Impacts

The following impacts were covered:

- Profitability impact, based on industry before taxes to sales ratio;
- Price impact, based on profitability maintenance;
- Capital availability, by type of financing (including SBA);
- Production and plant closures, based on interviews and judgmental assessment of expected financial impact.

Price increases were estimated for each model plant. Plant closures, employment effects, community and production effects were assessed on an industry-wide basis under each effluent alternative. The no pass-through (price maintenance) case was assessed in terms of the impact on each model plant's profitability. Simple algebraic calculations provided the methodology. A significant percentage of plant closures were predicted.

F. Comments

Study did not include captive shops. Methodology, while not sufficiently rigorous, is useful because of qualitative attention given to price and capital availability factors. Attention to small business is integrated into the analysis through the selected model plant sizes.
A. Industry Coverage

The analysis covers selected portions of fruit and vegetable processing industry (parts of SICs 2033, 2034, and 2037). Within the three SIC groups, concern is with citrus, apples, potatoes, spinach, and asparagus. Fruit and vegetable canning, freezing, and dehydrating firms vary greatly in terms of size, organizational structure, product mix, and degree of diversification and integration. Canning and freezing industries are characterized by having large numbers of firms. In both industries, small firms have small shares of markets; also, there has been an exodus of small firms and growth in number and dominance of larger, multiplant firms. The dehydrating industry is much smaller in size (as measured by number of firms and volume of sales) and is characterized by greater degree of firm domination. Of 598 canning firms analyzed in this study, over one-third are classified as "small" (annual pack of less than 250,000 cases). At the opposite end of the range, nearly 29 percent of firms are classified as large (annual pack of over 1 million cases). Of the 271 freezing firms analyzed, 30 percent were in the "small" category, with an annual volume of less than 5 million pounds, and nearly 47 percent were in the "large" category, with annual volume in excess of 20 million pounds.

B. Nature of Regulation

This study focuses on the application of alternative effluent limitation guidelines and standards of performance which were to be established under Sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended. Regulatory approach is specific.

C. Estimation of Regulatory Costs

A model plant approach was employed. The basic pollution control cost estimates were developed by the engineering contractor. Costs were specified for selected plants (small and large) in each of the principal
processing categories: i.e., apple juice, apple products except juice, and citrus products. Control investment and operating cost data were presented for alternative treatment practices corresponding to BPT and BAT effluent reduction guidelines.

Based upon the above model plant data, the economics contractor generated additional investment and operating cost data in the form desired for the economic impact analysis. The need, in particular, was to have data corresponding to different sizes of plants within each category of processing plant. The method used to develop this cost data involved linear interpolation and extrapolation of the investment and annual operating cost data provided by the engineering contractor. The cost data obtained from the engineering contractor were for small and large plants of specified size (in terms of TPD processed). The model plants developed by the engineering contractor were of small, medium, and large sizes. The sizes of these plants ranged from smaller to larger than those estimated by the engineering contractor. Insufficient information was available to establish nonlinear relationships of investment and annual operating costs by size. The linear cost estimating functions developed for each treatment alternative were derived given the two data points (for small and large plants) provided for investment and annual costs. A total of 24 model plants were developed through this procedure; the basic processing categories included citrus, apple, and spinach.

D. Analysis of Baseline Economics

An industry profile is presented in the study. Among other things, the discussion touches upon subjects such as size and number of firms, degree of integration, concentration, plant characteristics, and characteristics of specific product segments. Price determination within the industry is examined. As part of this, the study presents analyses of demand, supply, and market competition. Data on demand are presented, but the analysis is essentially qualitative. Price elasticity of demand is only briefly touched upon. Supply characteristics of the industry are examined in a qualitative fashion.

E. Evaluation of Economic Impacts

The main objective of the analysis is to estimate potential plant closures resulting from the imposition of the regulation. The specific types of impacts examined include price, financial, production, employment, community, and balance of trade effects. Price effects are analyzed by estimating the percentage price increase that would be required in order to recover the estimated cost of pollution control. This is done for 15 model plants for BPT and BAT controls. In the analysis, the decision was made to limit the price increases to the levels determined by the largest producers. A sensitivity analysis was performed to assess the sensitivity of price changes to
pollution control costs. Given a 50 percent increase in the estimated control costs, calculations were then made of the incremental price increases needed to maintain net incomes.

Financial effects are assessed through an examination of two types of impacts: 1) impacts on profitability; and 2) impacts on the present value of future net income streams. The former are examined by measuring the reductions in net profits and ROI resulting the additional costs associated with pollution control. The latter impacts are assessed through the use of a DCF analysis, in which the NPV's for the model plants before and after pollution control are compared.

In the analysis of production effects, qualitative assessments are made of reductions in capacity utilization and the extent to which plant closures may be offset by increases in capacity utilization on the part of plants remaining in operation. On the basis of the DCF analysis discussed above, an identification is made of which model plants should be closed, the marginal operations, and the sound operations.

Qualitative approaches are used for assessing employment, community, and balance of trade effects.

Differential impacts by size of plant are identified. The problems of small plants are acknowledged. There is no special treatment given to the small business section, however.

F. Additional Comments

The economic analysis was based mainly on published information obtained from governmental and industry sources. Due to the nonavailability of the Development Document for this regulation, nothing can be said at this time about the methodology used by the engineering contractor in developing the basic set of model plants.
STUDY #10


Date of Regulation Proposal: December 26, 1973
Date of Regulation Promulgation: April 12, 1974

A. Industry Coverage

This study deals with the soap and detergent industry (SIC 2841), which is comprised of firms engaged in manufacturing soap, synthetic organic detergents, inorganic alkaline detergents, or any combination thereof. It includes establishments producing crude and refined glycerine from vegetable and animal fats and oils. Companies primarily engaged in manufacturing shampoos or shaving products, whether from soap or synthetic detergents, and also producers of synthetic glycerine are classified elsewhere.

In 1967 the value-of-shipments and other receipts of the soap and detergent industry totaled 2.3 billion dollars. For 1973 the volume was estimated to be 2.8 billion dollars.

This industry has a highly concentrated oligopolistic market in which, according to 1970 census data, the first four companies accounted for 70 percent of the value-of-shipments and the first eight companies accounted for 79 percent. In the small segment of the industry, there are over 350 firms whose sales range from $20,000 to $50,000,000 per year.

B. Nature of Regulation

The study focuses on application of alternative effluent limitation guidelines and standards of performance which are to be established under Sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended. Regulatory approach is specific rather than generic.

C. Estimation of Regulatory Costs

A model plant approach is employed. The water pollution control costs are based upon costs developed by the engineering contractor. The models are impacted with Level I, Level II, and Level III guidelines.
Level I - BPCTCA - Best Practicable Control Technology Currently Available

Level II - BATEA - Best Available Technology Economically Achievable

Level III - BADCT - Best Available Demonstrated Control Technology

The models hypothesized are:

1. A small soap company;
2. A small liquid detergent company;
3. A very large integrated soap and detergent company.

In the engineering analysis detailed flowsheets of all eighteen processes involved in the manufacture of soap and detergent products were developed. The accuracy and completeness of the models were verified by visits to soap and detergent installations and by discussions with industry experts.

In the financial analysis, unit sales volume, average selling price, and operating costs were developed for time zero and for Levels I, II, III technologies for effluent control from the engineering estimates. Then a financial profile is derived for each of the three models.

Included in the financial profile is a statement of income and expense, a balance sheet for each of the models, for each of the conditions specified. These conditions refer to the assumptions with regard to profitability with specific reference to the after tax rate of return on tangible net worth. Then the Dun and Bradstreet key business ratios for the soap and detergent industry were used to construct a balance sheet for each model company.

There are various ratios for different quartiles, such as upper, median, and lower quartiles. The lower quartile data was used for the small firm as the "acid test". Medium and upper quartile ratios were also used for the small firm. But for the larger models, it would be unrealistic to use lower quartile data, so just median and upper quartile ratios were tested. Finally, the results of impacting these model companies with effluent control costs are summarized and generalized for the industry as a whole.

D. Analysis of Baseline Economics

The data used in the economic analysis was obtained from published sources, trade associations, and government contacts. The industry profile gives information on the number and sizes of plants, geographic distribution,
and industry concentration, productivity, employment, wages, and characteristics of the small versus the large firms. The study also examines the differences in productivity, cost of materials, and payroll in terms of shipments for small, medium, and large companies. In addition, pricing processes in the soap and detergent industry are presented. The report also includes qualitative assessment of price elasticity of demand and supply response to price changes. It was assumed the costs would be fully passed through. Demand projections were given, but nothing was said about the growth of the small business segment.

E. Evaluation of Economic Impacts

The types of impacts examined include profitability, capital availability, prices, employment, industry structure/competition, balance of trade, community effects, production effects (curtailment of production and plant closures) and industry growth. The differential impact was assessed qualitatively. The qualitative approach was also used in analyzing production, employment, community and balance of payment effects. The study does not attempt to estimate the potential impact of the regulation or regulatory costs in other areas, such as OSHA, nor were industrywide compliance costs calculated.

F. Comments on the Study

More attention should have been given to the small producer.
A. **Industry Coverage**

The analysis deals with meat packing plants and slaughter houses (SIC 2011). Specific types of plants analyzed include: 1) meat packinghouses, slaughtering livestock and processing meat and meat products; and slaughterhouses, slaughtering livestock but not doing processing. The analysis is limited to beef and pork operations. The small business segment of the industry is important; about 96 percent of firms represented by Federally-inspected plants are single-plant firms, while virtually all State-inspected firms are single-plant firms. In 1971, 53 percent of Federally-inspected plants were "small" (300 thousand to 25 million pounds annual liveweight killed). The figure for nonfederally-inspected plants was 100 percent.

B. **Nature of Regulation**

The study focuses on application of alternative effluent limitation guidelines and standards of performance which were to be established under Sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended. The regulatory approach is specific rather than generic.

C. **Estimation of Regulatory Costs**

A model plant approach was employed. Water pollution control costs in economic impact analysis were based upon costs developed by an engineering contractor. BPT, BAT, and NSPS effluent guidelines were considered in the development of these costs. Four model plants were specified by engineering contractor: 1) "simple" slaughterhouse; 2) "complex" slaughterhouse; 3) "low-processing" slaughterhouse; and 4) "high-processing" packinghouse. The control costs developed for these plants were "single point" estimates, applying specifically to a given type of plant with a given annual liveweight kill volume. It was necessary to adapt these costs for use in the economic analysis. This was done as follows. The assumption was made that for a given treatment level, both investment and operating costs were a function
of the quantity of wasteflow. Given this assumption, each of the four model plants was plotted on a graph, and a smooth curve was drawn to fit the points. On the basis of this procedure, investment and annual treatment cost data were estimated for alternative plant sizes (small, medium, and large). A total of 18 model plants were defined -- of these, 11 were used in the economic analysis. The size of the model "small" plant was 23 million pounds annual kill. (Actual "small" plants were defined as ranging in size from 300 thousand to 25 million pounds annual liveweight killed.) Very small plants (under 2 million pounds annual kill) were excluded from the formal analysis since adequate pollution control costs were not available; however, the study does discuss probable economic impact on these plants. The study gives estimated data error ranges for model plant data.

D. Analysis of Baseline Economics

Most of the data used in economic analysis has been obtained from published sources. An industry profile gives information on distribution of multiple versus single-plant firms, size of firms, concentration of ownership, level of integration, size of plants, geographic distribution of plants, number of multiple versus single species plants, number and characteristics of very small meat packing and slaughter plants, and employment and wages. Also provided is financial data on earnings, earnings ratios, distribution of sales dollar in terms of expenses and earnings, and annual cash flow. Pricing processes in the meat packing industry are examined, analyses including qualitative assessment of demand and supply response to price changes. Figures obtained from other studies on price elasticity, cross elasticity, and income elasticity are given. None of these are directly used in cost pass-through analysis, however, and no baseline demand and supply projections are given.

E. Evaluation of Economic Impacts

The main objective of the analysis is to estimate potential plant closures. Types of impacts examined include price increases, financial effects (income, return on investment, return on sales, cash flow), production effects (curtailment of production and plant closures), unemployment, community effects, and balance of payments effects. Attention is paid to differential impacts on small plants; effects upon profitability are assessed using ROI and DCF analyses. A qualitative approach is used in analyzing production, employment, community, and balance of payments effects. Impacts are assessed for both BPT and BAT controls.
A. Industry Coverage

The analysis deals with the pulp, paper, and paperboard sectors that are the primary product production components of the paper and allied products industry. This includes timber sales and paper/paperboard conversion to end products. In particular, the areas studied are paper mills (SIC 2621), paperboard mills (SIC 2661), and market pulp mills (SIC 2611).

In 1974, about 410 companies operated 718 pulp, paper, paperboard, and building paper mills or mill complexes. The extent of small business is not clearly described.

B. Nature of Regulation

The study is aimed at measuring the potential economic impacts that would result from the industry's total cost to comply with the following existing or proposed regulations:

- Water Regulations -- those issued by EPA for existing and new capacity. Two levels of control for existing industry are assessed (BPT and BAT). Also NSPS currently in effect are evaluated.

- Air Regulations -- those issued by States (SIP) for existing industry and EPA's NSPS regulations.

- Noise Regulations -- issued by OSHA for existing and new capacity.

C. Estimation of Regulatory Costs

One problem that the authors found was that the economic impact of compliance was measured in terms of the associated cost for an individual
product, but the development studies computed the cost of compliance on a manufacture process basis. Thus, the cost of compliance from a specified process basis had to be converted to an individual product basis. A further complication is that a given product can often be made by more than one process or combination of processes, and the cost of compliance for the various methods may differ significantly. The process-to-product conversion required considerable judgment, which was done on the basis of contacts with industry experts.

The cost to comply with air regulations is presented for three sizes of kraft mills, 500, 1,000, and 1,500 tons of dried pulp per day. To estimate the costs of compliance with NSPS for mills of 800 tpd and 1,000 tpd, the costs were extrapolated from the base costs.

For the water regulatory compliance costs, the study used cost models from the Development Documents, which were based on average in-place treatment facilities. In most of the process subcategories used by the authors, cost models were developed for small, medium, and large size categories. To arrive at an aggregate cost for a given subcategory, the average cost per ton for the category was multiplied by the corresponding tonnage in that size range. Thus, these total aggregate costs are based on tonnage.

The study relied upon the American Paper Institute's cost estimates for compliance with OSHA noise regulations. These costs were based on a 500 tpd plant, and were extrapolated to estimate the cost of compliance with a new 800 tpd plant.

After developing the costs for these models they were compiled and summarized for the whole industry, after which the error margin was calculated. The accuracy of the aggregate compliance costs summed for each product sector is:

Air and Water Regulations + 25%, - 10% OSHA Regulations + 25%, - 50%.

D. Analysis of Baseline Economics

A product sector analysis presented in the industry. These products include containerboard, packaging papers, recycled paperboard, construction paper, market pulp, printing, writing and related papers, bleached board, tissue, newsprint and uncoated groundwood paper, and specialty paper. This analysis describes the product, supply and demand conditions, prices, concentration of ownership, number of manufacture, and the international market. Chase Econometric's May 17, 1976, "Economic Growth Forecasts for the Council on Environmental Quality" were used as the bases for the demand and capacity forecasts. Econometric techniques were also employed to estimate the elasticity of demand for each product.
E. Evaluation of Economic Impacts

The types of impacts evaluated include prices and demand effects, short-term capacity constraints, secondary impacts on suppliers, closure and employment effects, external financing requirements, and balance of trade effects. To examine the long-run equilibrium price effects, a discounted cash flow analysis was employed. Then average price increases needed to meet costs were calculated through a flow-of-funds analysis. Next, an econometric model of industry supply and demand was used to project capacity utilization for analysis of capital availability. A sensitivity analysis was also included. To determine the plant closure and employment effects the authors used interviewing screening, and (selected) financial analysis. In addition, a flow-of-funds analysis was employed to look at the external financing. Finally, a comparative analysis was used to examine the balance of trade effects.

F. Comments

The impact on small business was not examined.
A. **Industry Coverage**

The analysis covers the paint manufacturing industry which is dominated -- 65 percent -- by very small companies.

B. **Nature of Regulation**

BAT, PSES, PSNS, AND NSPS regulations are used.

C. **Estimation of Regulatory Costs**

Financial model plants were constructed for industry segments based on sales/production. Five model plant sizes were developed.


D. **Evaluation of Economic Impact**

A two stage analysis was undertaken:

1. If before-tax ROI was less than or equal to 10 percent after controls or if investment cost more than 25 percent of plant fixed assets, the model plant was considered to be significantly impacted.
2. For significantly impacted segments (very small and small), detailed impact analysis for 2 control options (physical/chemical pretreatment and zero discharge) were undertaken. A control cost sensitivity test was also performed.

The following impacts were assessed: price effects, plant closures, production effects, employment effects, total industry investment and annual operating costs.

The annual price increase was computed as average cost per gallon to maintain before-tax ROI before treatment for each segment. Average industry price increase was computed as costs divided by gallons were produced.

The ROI criteria was considered closure criterion. For closure analysis, cases with and without a price increase (2¢/gallon) were examined. No baseline closure was predicted because of general industry stability. For the worst case, 232 closures were predicted.

Capital availability for small plants was analyzed for 5-year payback with 12 percent interest. Payback period analysis was applied to generally assess capital availability. While NPV analysis was done for the two impacted plants to assess closure (for both cases, NPV was greater than 0 so closure was not predicted), it was not integral to the analysis because it is not used by the industry.

No production effect was predicted, assuming that industry could compensate for the lost production. Employment effects were quantitatively assessed based on closure predictions.
A. Industry Coverage

The study covers the textile mill products group -- SIC 22 (the textile industry). It does not deal with the apparel and other textile products -- SIC 23 (the apparel industry) -- because they do not have a wastewater problem and thus would not be subject to effluent guidelines.

The textile industry is comprised of a wide variety of companies which produce textile-related materials for further processing into apparel home furnishing, or industrial goods. There are 30 separate SIC industries which manufacture approximately 90 classes of products. These establishments are primarily involved in receiving and preparing fibers, transforming these materials into yarn, thread, or webbing, converting the yarn into fabric or related products, and dyeing and finishing these materials at various stages of production. Many of these companies produce final consumer products such as thread, yarn bolt fabric, hosiery, towels, sheets, carpets, etc., while the rest produce transitional products for use by other establishments in the textile industry and by establishments in the apparel industry as well as others.

A majority of the textile mills are relatively small with 70 percent of the mills employing less than 100 employees (in 1972). In the aggregate industry, 37 percent of the mills were classified as small, less than 20 employees; 30 percent were defined as medium, 20 to 99 employees; 29 percent fit into the large category, 100 to 999 employees; with the rest, 2 percent, employing more than 1,000 workers.

B. Nature of Regulation

The study covers several regulations. One effluent guideline studied is the application of the best available technology economically achievable for existing direct dischargers. Also, new industrial dischargers are required to comply with new source performance standards (NSPS) and Section
306 of the Clean Water Act. In addition, new and existing industrial dischargers to publicly-owned treatment water (POTWs) are subject to pretreatment standard (PSES for existing sources and PSNS for new sources) under Sections 307(b) and 307(c) of the Act.

C. Estimation of Regulatory Costs

Two surveys of the industry were made to obtain data for developing model plants. The first survey was technical and was conducted for this Development Document. This survey collected the following descriptive information:

1. Number and location of facilities;
2. Production levels;
3. Wastewater discharge quantities;
4. Methods of discharge;
5. General treatment status.

In developing model plants, production as well as flow was considered. Survey responses were initially grouped by subcategory and discharge type, i.e., direct and indirect. Then the initial groups were further divided into three groups on the basis of production size. Average percent utilization values (obtained from the survey) were applied to the average production values for each group to determine capacity production for typical plants. These capacities were multiplied by the median water usage rates for each subcategory to calculate a flow rate for each production group. Finally, the model plants were compared to actual plants, and were found to accurately represent the mills in each subcategory. These subcategories include: wool scouring, wool finishing, woven fabric finishing, knit fabric finishing, carpet finishing, stock felted fabric finishing, nonwoven manufacturing, and fabric processing.

But, in a second survey, it was revealed that additional segmentation within the industry was required in order to reflect the economic characteristics of different type mills in terms of product ownership and degree of integration. Consequently, in addition to categorization by type processing, mills were further categorized by type of mills to include: 1) integrated, 2) commission, and 3) own fabric finishers. The "Commission" models represent those plants which are engaged in job finishing on a commission fee basis, and thus do not purchase the textiles processed. Own fabric finishers either purchase the textile inputs or are plants within multiplant firms which are vertically integrated. The "integrated" models are those mills involved in both greige milling and finishing operations.
D. Analysis of Baseline Economics

This study provides an in-depth profile of the textile industry. The report contains information about the number and sizes of plants, location, industry structure, employment, production, capacity and utilization domestic market description, international textile market, sales operating costs, financial profile, prices, and price determination. Supply and demand relationships are analyzed qualitatively. Past studies are used to examine price elasticity of demand and gross price elasticity. The data in the profile is based on industry surveys, published sources, Standard and Poors, other studies, Census Bureau, and other government contacts.

E. Evaluation of Economic Impacts

The types of impacts examined are:

1. Price effects -- including effects upon industry's suppliers and consumers;
2. Profitability -- growth and capital availability;
3. Number, size, location of plants that can be expected to close or curtail employment;
4. Change in employment;
5. Community impacts;
6. Dislocation effects;

A discounted cash flow analysis and return on investment analysis were used to examine these impacts. The amount of the cost that could be passed through was considered in light of the price elasticities of the commodity involved and the competitive structure of the industry. The amount of plant closures and employment losses were expressed quantitatively. Community impacts and balance of trade effects were assessed qualitatively. In addition, capital availability was examined on an industrywide basis. Industrywide compliance costs were not calculated.
## Range of Error

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<th>Percent</th>
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<td>1</td>
<td>Information regarding the organization and structure of industry, number, location and size of plants, and other information descriptive of industry segments;</td>
<td>± 10</td>
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<tr>
<td>2</td>
<td>Price information for products and raw materials;</td>
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</tr>
<tr>
<td>3</td>
<td>Cost information for plant investments and operating costs;</td>
<td>± 20</td>
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<tr>
<td>4</td>
<td>Financial information concerning the industry.</td>
<td>± 15</td>
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### Comments

The treatment of small business was limited.
A. Industry Coverage

The analysis is restricted to those segments of the metal finishing industry which involve the following processes enumerated under the Electroplating Point Source Category: 1) electroplating of common metals; 2) electroplating of precious metals; 3) coatings, i.e., phosphating, chromating, or immersion plating; 4) chemical etching, milling, and engraving; 5) electroless plating; 6) anodizing; and 7) printed board manufacturing. In addition to being limited to industry segments performing these seven specific processes, the study is also limited to those firms within these segments that are Indirect Dischargers -- i.e., firms that discharge their spent liquid wastes to a municipal sewer or Publicly Owned Treatment Works (POTW's).

The study divides the metal finishing industry into three broad groups: 1) independent metal finishing job shops, 2) independent manufacturers of printed circuit boards, and 3) captive metal finishing.

Job shops are often small operations having fewer than 10 production employees, and annual sales revenues of less than $600,000. It is estimated that there are about 2,900 of these firms. The firms are classified under SIC's 3471 and 3479. Of the 2,900 firms, about 2,700 are covered in the analysis.

Independent manufacturers of printed circuit boards also tend to be small businesses. These firms generally have around 30 production employees and tend to be concentrated in areas noted for electronic goods manufacturing. There are approximately 400 firms in this segment. Some 327 of these are covered in the analysis. The firms are included in SIC 3679.

Captive metal finishing operations are in-house operations found in many durable goods manufacturing establishments. Although these operations are found in firms with employment ranging from several hundred to several thousand workers, the captive operation itself is comparable in size to a job shop with 20 workers. It is estimated that there are around 6,000 of these operations which are covered under the Electroplating Point Source Category. Of these, 4,700 are Indirect Dischargers.
B. Nature of Regulation

Section 307(b) of the Clean Water Act, as amended [33 U.S.C. 1317(b)] requires EPA to establish pretreatment standards for existing and new sources for incompatible pollutants introduced into POTW's. In the situation covered by the study, the concern is with existing sources.

C. Estimation of Regulatory Costs

In order to better understand the methodology used in estimating the regulatory costs (i.e., the pollution control costs), it would be useful at this point to outline the five basic steps involved in carrying out the study. These are as follows:

1. Survey the relevant segments of the industry to gather descriptive information;
2. Designate a group of survey respondents as model plants against which costs can be arrayed and impacts assessed;
3. Develop pretreatment pollution control costs through modeling and verify the applicability of those estimates for specific cases;
4. Design a tool capable of incorporating relevant fiscal and cost data such that accurate predictions of financially impacted firms can be made;
5. Establish a means for sealing sample based observations to the universe of affected firms.

Virtually all of the descriptive and analytical data utilized in the study was obtained from primary sources. The industry was consulted for information pertinent to finances, production processes, and market conditions. Pollution control equipment suppliers were contacted for information on treatment components and their costs.

Three separate data gathering surveys were employed. The groups surveyed were: 1) independent suppliers of metal-finishing services, i.e., job shops; 2) independent producers of printed circuit boards or metal clad wiring; and 3) individual manufacturing establishments with in-house metal-finishing capabilities, i.e., captive operations. The questions asked in the surveys covered subject areas including production activities, market conditions, technical operations, financial conditions, treatment requirements, and investment options.

A total of 2,221 job shops were sent questionnaires. Out of 900 responses, 205 were found to be qualified as model plants.
Manufacturers of printed circuit boards were surveyed by telephone. Out of 100 interviewed, 40 were determined to be suitable as model plants.

Captive operations were surveyed by means of mail questionnaires. A total of 8,800 firms were sent questionnaires. Returns came back from some 3,400 cases, of which 1,600 were used for analysis. Out of the group analyzed, more than 600 were selected to serve as model plants.

The pollution abatement costs were developed by a separate technical contractor. The data used in developing the costs was obtained from the mail survey of job shops. Out of a group of 300 responses, 82 were chosen which provided sufficient plant data for costing, and which were representative of at least 3 or 4 other returns. The 82 plants were felt to represent a full distribution of job shops along the following dimensions: 1) processes, 2) water use, 3) employment, 4) level of production output, 5) location, 6) number of finishing lines, and 7) sales volume. Due to inconsistencies and/or omissions on 8 records, pollution control costs were developed for only 74 plants. Cost estimation was carried out through the use of an automated cost program developed specifically for the industry.

The estimates developed by the technical contractor illustrated changes in costs under assumptions of different water use and compliance requirements. Given the costs developed by the technical contractor, regression equations were developed to assign control costs to the plant models through which the economic impacts would be assessed. A plant model was identified as any survey respondent providing sufficient technical and financial data so that the plant could be costed and tested for closure. The identified plant models consisted of 205 job shops, 40 printed board manufacturers, and more than 600 captives.

D. Analysis of Baseline Economics

The study presents a detailed profile of the industry. All of the descriptive and analytical information presented was obtained through the surveys discussed above. The job shop, printed circuit board, and captive segments are characterized in terms of employment, revenues, number and size distribution (by employment) of firms, metal-finishing processes used, and water requirements. For each of the three segments, the subset of firms that are Indirect Dischargers is estimated, with data given on their distribution by employment size class. The financial characteristics of firms are analyzed, as are market demand and price behavior for the industry. The potential for pass-through of regulatory costs is assessed by analyzing the nature of price competition within the industry and customer response to price changes.
E. Evaluation of Economic Impacts

The primary objective of the analysis was to estimate potential plant closures. The possibilities of plant closures for job shops and manufacturers of printed circuit boards were evaluated through the use of an automated financial model. Before closures due to pollution control were determined, potential baseline (i.e., pre-investment) closures among the 205 job shop plant models and 40 printed circuit board plant models were estimated. Potential closures were screened out by imposing a nominal capital burden on the plants and applying a coverage ratio tests. Out of the 205 job shops, 28 were identified as baseline closures, leaving 177 plant models on which economic impacts due to pollution control were computed. Out of the 40 printed circuit board plant models, 5 were singled out as baseline closures. Economic impacts were computed on the remaining 35. The automated financial model uses reported income and balance sheet data to compute a present cash flow situation and a projected cash flow situation after the investment in pollution control. Special features of the model are as follows:

- Any combination of interest rates, payback periods, and pollution control systems and their associated costs can be specified.
- The model screens candidates for closure both by capital availability through commercial sources, and then by equity infusion by private (owner) sources.
- By altering assumptions on pay-back period, sales, and coverage ratio, a cash-flow approach to the investment can be simulated.

As part of the closure methodology, the effects of control costs on profitability and capital accessibility are examined. It should be noted that in the case of job shops, the closure analysis was performed on the basis of two sources of capital - commercial bank loans and a special loan program such as that offered by the SBA. One conclusion of the study is that were a special loan program readily accessible to the metalfinishing industry, job shop closure rates could be one-fourth that predicted by regular financing.

Closures for captive operations were estimated through a qualitative approach. In the case of a large firm with a captive metalfinishing operation, the potential for closure of the captive operation in the face of required pollution control is a function of the extent to which the firm is "free" to divest itself of that operation.

Other economic impacts which the study addresses include increases in prices for metalfinishing goods and services, employment and community effects, effects upon industry structure and competition, and balance of trade effects. Industrywide compliance costs were calculated.
F. **Additional Comments**

The analysis presented in the study is sophisticated. A great deal of attention is focused on firm size.
STUDY #16


Date of Regulation Promulgation: Not yet promulgated.

A. Industry Coverage

The analysis deals with the chemicals and allied products industry (SIC 28), which is comprised of establishments producing basic chemicals and establishments manufacturing products by predominately chemical processes. The industry manufactures 50,000 to 70,000 chemicals which fall into three basic product categories: 1) basic chemicals; 2) synthetic materials such as plastics, synthetic rubber, and man-made fibers, which are used in the manufacture of end products; and 3) finished chemical products, such as drugs, soaps, cosmetics, paints, and agricultural products. In terms of physical volume, basic chemicals account for more than 60 percent of the industry's annual production. In terms of value of shipments, finished chemical products account for nearly 50 percent of the industry output, basic chemicals for 35 percent, and synthetic materials for 15 percent. Not counting drug companies, there are about 7,000 firms in the industry. These firms operate nearly 10,000 establishments and employ over 700,000 workers. Over 50 percent of the firms in the industry only process and formulate chemicals, and are not involved in the actual manufacture of chemicals. These firms are not directly affected by the subject premanufacturing notification requirements. Of the three basic product areas mentioned above, the role of small business is most important in the area of finished chemicals, where a large number of small firms manufacture a wide variety of chemical specialties.

B. Nature of Regulation

Section 5 of the Toxic Substances Control Act (TSCA) requires that firms intending to manufacture or import a new chemical substance must notify EPA at least 90 days before commencing production. The proposed regulation requires manufacturers to complete the Premanufacture Notification Form, the purpose of which is to provide EPA with the data that it considers essential to the premanufacture review. The regulatory approach is generic.
C. Estimation of Regulatory Costs

The costs of completing the Premanufacture Notification Form were computed based on the judgment and expertise of the study contractor rather than an attempt to develop actual costs for sample chemicals. In developing the costs, it was recognized that the costs of completing the form would vary according to a variety of factors including: 1) the amount of existing test data for the new chemical substance, 2) the amount of data "known or reasonably ascertainable" to the firm, and 3) the level of expertise employed by the firm in completing the form. With regard to the last factor, it was assumed that the firms completing the forms would have at least a modest level of knowledge, expertise, and sophistication. In the case of small-volume manufacturers, however, it was assumed that such firms might not possess the level of expertise to enable them to develop "reasonably ascertainable" information, making the costs for these firms correspondingly low. The expectation expressed by the study was that EPA would consider small-volume manufacturers separately and perhaps require only an abbreviated form with lower associated costs. This being the case, the anticipated responses of such manufacturers were not accounted for in the cost estimates.

The costs of completing the form were estimated in ranges, i.e., high and low extremes for completing the various sections of the form. The total cost to complete the Minimal Mandatory portions of the form were estimated to range from $2,500 to $14,000.

D. Analysis of Baseline Economics

The study includes a general industry profile. Areas dealt with include industry structure, characteristics of markets for chemical products, supply and demand trends, the role of foreign trade, employment in the industry, and input-output relationships for the chemical industry. Most of the data were obtained from published sources.

For purposes of the economic impact analysis, the chemical industry is disaggregated into 41 segments. Most of the segments are 4-digit SIC categories; a few 5- and 6-digit categories are also included. Presented for each of the segments are data on value of shipments, value added, capital expenditures, employment, number of establishments, and number of establishments in different employment-size classes.

The financial characteristics of the chemical industry are also discussed. Industry-level financial statements are presented for SICs 28, 281, 282, and 286. Particular note is made of the fact that within segments, financial characteristics can vary with firm size. In this connection, the study presents financial statements for smaller firms (less than $50 MM in assets) within the following segments: soap and detergents, perfumes and toilet preparations, plastic materials and resins, industrial chemicals, and paint and allied products. The study notes that in comparing the smaller with the larger firms, the smaller are generally less profitable and are financially weaker.
E. **Evaluation of Economic Impacts**

The evaluation of economic impacts was carried out in a qualitative fashion. The following impacts were examined: 1) changes in the chemical R&D process, 2) reduction in the number of new chemicals introduced, 3) reduced industry growth resulting from a slowdown in the development and commercialization of new chemicals, 4) effects on chemical consuming industries resulting from a slowdown in the development and commercialization of new chemicals, 5) effects on the national economy, including rate of GNP growth and balance of payments.

F. **Additional Comments**

It should be noted that the costs which were estimated in this study were subsequently revised as a result of comments received following the initial proposal of the regulation on January 10, 1979. The regulation was re-proposed on October 16, 1979. A revised economic impact assessment based upon the new cost estimates was not available.

Although the approach of the study was basically qualitative, the study was of interest because of its attempt to deal with the impact of administrative and clerical costs. Moreover, the attention given to small business and differential impact was fairly substantial.
A. Industry Coverage

The Assessment Report developed costs of waste management for 13 chemicals and chemical processes included in the Inorganic Chemicals Industry (SIC 281). The economic impact analysis has been focused on five primary chemicals likely to have the greatest impact. Eight secondary chemicals and chemical processes likely to experience a lower level of impact have been treated in less detail.

The chemicals were segmented on the basis of hazardous waste management costs as a percent of selling price and by market size. The five primary chemicals examined were chlorine made by the mercury cell process, titanium dioxide made by the chloride process, elemental phosphorus, sodium dichromate, and hydrofluoric acid.

The inorganic chemicals industry is merely a sub-category of the chemical industry. The markets for chemical products are oligopolistic. A small number of very large diversified firms account for a majority of the output. Thus the small business segment appears to be minor.

B. Nature of Regulation

Study focuses on application of hazardous waste management guidelines pursuant to Section 209 of the Solid Waste Disposal Act, as amended. The regulation is generic.

C. Estimation of Regulatory Costs

The estimation of the regulatory costs was based on information from industry, waste, treatment and disposal contractors, engineering firms, equipment suppliers, government sources, and published literature. Costs were based, when possible, on actual facilities as supplied by contributing
companies, or from waste treatment and disposal contractors prices. When this information was not available, cost estimates have been developed insofar as possible from plant-supplied costs for similar waste treatments and disposal for other plants or industries. In addition, the treatment/disposal technology levels and costs developed were submitted for comment to the chemical industry. Then adjustments were made to incorporate these inputs.

All of the plant costs are estimated for "typical plants". The study defines typical plants as:

The arithmetic average of production size and age for all plants, or the size and age agreed upon by a substantial fraction of the manufacturer in the subcategory producing the given chemical.

Thus, models of small plants were not made, just average plants were analyzed. Herein lies the inaccuracy of this report. The authors admit that the costs to treat and dispose of hazardous wastes at any given plant may be considerably higher than the typical plant because of individual circumstances. Thus, the error margin is large (20-50%).

D. Analysis of Baseline Economics

A general profile of the industry was made and also a more detailed profile is given for each of the chemicals. The information was based on published material and interviews with knowledgeable persons in the industry. In the profile, data is given on profitability, wages, employment, new investment, sales, markets, capital structure, cost structure, demand and supply characteristics, industry structure, and competition.

E. Evaluation of Economic Impacts

In the engineering study, three levels of control technology were identified, namely:

I Current practices;
II Best currently used practices;
III Environmental acceptable practices.

For the calculations of price and demand impacts, the incremental cost to the average plant moving from Level I to Level III was used. For the
worst case plant closure analysis, the total Level III costs were used. Also, higher cost developed through industry interviews were used in the sensitivity analysis.

The types of impacts analyzed include plant closures, cost increases, demand reduction, and associated effects on industry size, growth, employment, wages, local economies, and foreign trade. The report did not examine the secondary effects on consumers, long-range changes in demand, or capital limitations.

As mentioned, the study methodology involved a segmentation of the chemicals into two categories: primary affected chemicals, and secondary affected chemicals. The segmentation allowed a greater concentration of effort on the 5 chemicals likely to experience the greatest impact.

For the primary chemicals, the demand functions were econometrically estimated using historical sales. The supply function was not estimated because of data limitations, and thus, equilibrium prices could not be derived. However, engineering estimates were made of production costs at the plant level for use in the plant closure analysis.

Using data from published sources and industry interviews the competitive environment was characterized. These factors were taken into account when determining how the producers would respond to the regulations. Once establishing the price strategies, changes in total demand were estimated using the demand elasticity values.

A discounted cash flow analysis was performed on each of the models for primary chemical producers. This was done to test whether manufacturers were likely to close plants rather than install the required capital facilities and continue to operate with higher waste management costs to test the range of potential plant closures. In addition, different levels of pass-through of treatment costs were examined, ranging from 0 to 100 percent.

The study also attempted to assess the impact of regulatory costs in other areas. For example, air and water pollution regulation costs were examined.

F. Comments

The economic analysis is limited by the inaccuracy of the compliance cost estimates made by the engineering contractor (error margin 20-50%). The impact on the small producer was not analyzed. The issue of capital availability was not examined.
STUDY #18


Date of Regulation Proposal: Not yet proposed.

A. Industry Coverage

The analysis deals with the leather tanning and finishing industry (SIC 3111), which is comprised of establishments primarily engaged in tanning, currying, and finishing hides and shins into leather. There are three types of establishments: 1) regular tanneries, 2) converters, and 3) contract tanneries. There is wide variation in the characteristics of the firms in the industry. Ownership ranges from family-owned companies and closely-held corporations to divisions of relatively large conglomerates. There is considerable variation in the size of tanneries as well as in tanning techniques and types of leathers produced. The small business segment of the industry is important. In 1972, 57 percent of the total plants in the industry had less than 19 employees.

B. Nature of Regulation

The regulation deals with the transportation and disposal of hazardous solid wastes generated by the leather tanning and finishing industry. The basis for the regulation is the Resource Conservation and Recovery Act of 1976 (P.L. 94-580). The regulation has not yet been proposed.

C. Estimation of Regulatory Costs

The regulatory costs were developed in a separate technical study performed by another contractor (Battelle Columbus Laboratories, Cost of Complying with Hazardous Waste Management Regulations, October 12, 1977). The assumed control technology to meet regulations is disposal in secured landfills (Pathways Leid III Technology). Only one industrywide average control cost (stated as cost per metric ton of waste handled per year) was estimated. Included in this cost ($55 per metric ton per year) were costs for contract hauling and disposal. No allowances were made for cost variations due to plant location, plant size, or type of leather processing involved.
D. Analysis of Baseline Economics

A detailed industry profile is presented in the study. The discussion of industry structure deals with subjects such as types, numbers, and sizes of tanneries; types of products, degree of vertical integration, employment and wages, firm ownership characteristics, and industry segments. Also presented is a financial characterization of the industry. Covered in this discussion are areas such as cost structure of the industry; industry profitability; industry assets, liabilities, and net worth; cost of capital; and ability to finance new investment.

The analysis includes a discussion of leather prices and other factors bearing upon supply and demand trends within the industry. The approach is qualitative and descriptive, with a considerable amount of data being presented. Particular attention is focused on imports of finished leather products into the United States, and on the raw hide market. Supply and demand forecasts are not presented.

E. Evaluation of Economic Impacts

The economic impact analysis was based upon a model plant approach. The models were developed by first defining eight general categories of tanneries. For each of these categories, at least one model plant was developed. Where appropriate, different sizes of model plants were specified. Small plants were not developed for three of the categories. The model plants were developed using data obtained from plant surveys, industry contracts, and government and private publications. A total of 17 model plants were developed. Financial profiles were worked up for each of the models.

Economic impacts on the model plants were calculated using the average per unit control cost developed in the technical study. The impacts were calculated relative to a baseline involving no compliance.

The principal economic variables of interest in the impact analysis are: 1) price and production effects -- short- and long-run effects on suppliers and consumers, possible curtailments of production and plant closures, with special attention to small business; 2) financial effects -- pre-tax income, other profit parameters, and capital availability; 3) employment and wage effects; 4) community impacts; and 5) foreign trade consequences.

The assessments of price and production effects were carried out simultaneously. In order to evaluate these effects, two levels of analysis were employed: one was at the micro level, using the model plant as the basis for determining the price increases needed to maintain profitability levels and the other was at the industry level using supply and demand analysis. In the first level of analysis, required price increases were determined through the use of the DCF technique. In the second level of
analysis, the calculated price increases were evaluated in the light of the
price elasticities of the commodities involved, and competitive factors in
the industry. The supply and demand analysis provided insights into likely
demand and supply responses to different prices. This provided a basis for
making preliminary estimates of the production and price impact of the
control costs. Next, further analysis was carried out at the micro level to
obtain more detailed insight into plant response to expected prices, and into
the possibilities for plant closures. The estimated plant closures were then
aggregated to determine whether the last production could be absorbed by the
remaining capacity and whether these closures would increase prices.

The financial impact analysis involved the preparation of income and
cash flow statements for the model plants following the assessment of
likely price changes. This made it possible to determine the impact of
control costs on plant profitability. DCF and ROI procedures were employed
in the analysis.

F. Additional Comments

The subject of differential impact is not discussed directly; however,
variation in impact from one size of plant to another can be determined from
the data presented. The treatment of small business is good.
A. Industry Coverage

The analysis deals with the steel industry. Approximately 90 percent of the coke output is consumed by integrated steel producers. There are 34 companies that have coke producing facilities (SIC 3312). Twelve of these are publicly-held integrated steel producers and of the remaining 22, several are manufacturing firms with steel producing capacities, several are subsidiaries of larger nonsteel firms, and several are privately-held.

The authors of the study used the 12 publicly-held integrated producers as a representative sample to determine the impact of the OSHA coke oven regulation. They say this was done because of time and data limitations. These 12 firms produce 75 percent of the domestic coke and account for approximately 75 percent of domestic finished steel shipments. It is argued that the impact of the proposed standards will fall less heavily upon the remaining 22 coke-producing firms, since steel has a less significant role in their total corporate operations.

Of the 12 steel producers, 7 are considered as major producers and 5 may be regarded as minor ones. There are between 20 and 30 publicly-held minor steel producers, and thus this sample represents about 15 to 25 percent of the minor producers.

B. Nature of Regulation

The standards were specific, and were proposed to protect the 32,520 workers employed annually in coking operations, and to a lesser extent persons living adjacent to such facilities.

C. Estimation of Regulatory Costs

As mentioned, the twelve plants analyzed were used as models for the industry. The sources of information that were used include: trade
associations, labor unions, OSHA, EPA, published materials, the 12 coke producing firms, various suppliers, manufacturers, contractors, and other heavy industry.

For each company and for every cost item the capital costs are based upon the estimated cost of compliance and the percent of compliance already achieved or committed for other programs. For instance, it is estimated that compliance with the requirements for filtered HVAC on pusher machines will cost $35,000 per pusher machine. U.S. Steel has about 52 pusher machines and is "in compliance" on 4 percent of those machines. Thus, the total estimated cost to U.S. Steel for compliance with this item is:

\[ 52 \times \$35,000 \times .96 = \$1,747,000. \]

Calculations such as these were done for each of the twelve firms, and for each item. Then the capital costs were added to determine the total costs. These costs were expressed in the following terms: total amounts, cost per ton of coke produced, and cost per ton of finished steel. Finally, the costs for each company were extrapolated to calculate the compliance cost for the industry.

Besides the authors' independent estimates, nine companies supplied them with summary data concerning estimated capital costs, annual costs, increased manpower, production losses, etc. These firms used a worksheet form developed by representatives from the steel industry. The capital cost estimates provided by the companies range from -10 percent to 132 percent of the authors' estimates. The annual costs range from -76 percent to 390 percent of the authors' estimates. The study attributed the great variability to differences in the interpretations of the scope and requirements of the proposed standard.

D. Analysis of Baseline Economics

The economic analysis was based on data obtained from: government contacts, published sources, OSHA, trade associations, other studies, and industry surveys. The industry profile gives information on the number and sizes of plants, geographic distribution of firms, productivity, industry structure and competition, sales, markets, and employment. Baseline demand projections are given. Price elasticity of demand is dealt with quantitatively. Past and recent economic studies using econometric techniques were employed to estimate both the short- and long-run elasticity of demand.

E. Evaluation of Economic Impacts

The study examines the impacts on employment, demand for labor, wages, labor productivity, capital requirements, financing potential, energy, market structure, competition, profitability, price of steel, consumers, related
industry, production effects, government, and balance of payments. Ratios, return on investment analysis, and simple algebraic calculations (e.g., profit reduction and increase in capital requirements) were used to assess these impacts. Also, an input-output analysis was employed to determine the inflationary impact of regulation. The total number of additional employees required to meet the regulations were calculated. The impact on wages and the balance of trade was assessed qualitatively. A quantitative approach was used to determine the impact on productivity. The dilution of the earnings per share of major producers versus the "minor" producers is examined. Also analyzed is the degree to which the larger producers can pass on the cost versus the small firms.

In addition to the engineering and economic analyses, a benefit assessment is also included.

F. Comments

The impact on the small coke produced should have been explored further, possibly using a discounted cash flow analysis. However, this might have been difficult, given data limitations.
A. Industry Coverage

The analysis deals with yarn manufacturing (all or part of SICs 2211, 2221, 2257, 2281, 2284, and 2296); weaving (all or part of SICs 2211, 2221, 2241, and 2296); cotton waste processing (SICs 2293, 2294, and 2515); cotton ginning (SIC 0724); and cottonseed oil mills (SIC 2074). Other industrial categories in which cotton dust exposures occur were omitted for lack of adequate data.

Six yarn spinning textile mill sectors (SICs 2211, 2221, 2257, 2281, 2284, and 2296) consume raw cotton. Of these six sectors, SICs 2211 (weaving mills, cotton); 2221 (weaving mills, manmade fiber and silk); and 2281 (yarn mills, except wool) account for more than 96 percent of the annual raw cotton consumption in the United States. Because of this, the main focus of the study was on these sectors.

Production in these six sectors is labor intensive, and is only moderately concentrated in large plants. However, historical data on concentration ratios indicate a trend toward higher ratios within the three major sectors (SICs 2211, 2221, and 2281). In conjunction with this trend, the structures of these industry groups have also become more oligopolistic.

B. Nature of Regulation

At the time the study was carried out, the OSHA workroom standard for occupational exposure to raw cotton dust, as specified in 29 CFR 1910.93, was 1.0 mg/m³ as an 8-hour, time weighted average (TWA). The study was performed to assess the technological feasibility and determine the inflationary impact of implementing NIOSH recommendations for a new cotton dust standard and regulations limiting worker exposure. In the study, four alternatives were analyzed: 1) retention of the exposure level of 1.0 mg/m³ on an 8-hour TWA; 2) reduction of the permissible level to a 0.5 mg/m³ 8-hour TWA; 3) reduction of the permissible level to a 0.2 mg/m³ 8-hour TWA; and 4) reduction of the permissible level to a 0.1 mg/m³ 8-hour TWA.
C. **Estimation of Regulatory Costs**

The regulatory costs were estimated as averages for the SIC groups covered by the analysis. (In essence, the approach is a "model plant" approach, with one "plant" representing the entire SIC group.) Costs associated with the implementation of controls to attain the proposed cotton dust standards fall into two general categories: 1) costs associated with the installation/operation of engineering controls; and 2) costs associated with ancillary programs, e.g., medical surveillance, environmental monitoring, respirators, recordkeeping, and training. All of the cost estimates were calculated in incremental form, at alternative dust exposure levels.

The cost estimation procedure began by defining the most probable control systems that plants would implement in order to meet the new dust standards. The engineering costs were calculated on the basis of cost per cubic foot per minute of air required to control dust generation from production and processing equipment. These costs were then converted to a per machine basis, and subsequently to a cost per pound of raw cotton processed through the equipment. The data used in estimating these costs were obtained from control system vendors, textile plants in which control systems were in operation, and from data provided by a consultant pertaining to construction costs. Equipment inventory data were obtained from Census Bureau publications. Data on equipment capacities and throughputs were obtained from the literature. Estimates of the costs of engineering controls needed to achieve 0.1 mg/m³ limits were obtained by extrapolating from the costs for less stringent controls (i.e., from the 1.0, 0.5, and 0.2 mg/m³ levels).

The costs of ancillary programs were estimated on the basis of data obtained from equipment suppliers, various in-house (OSHA) sources, published government and academic research, Census Bureau publications, and industry contacts.

D. **Analysis of Baseline Economics**

The study presents a fairly comprehensive analysis of the subject industry sectors. Areas dealt with include:

- Industry structure, including discussions on distribution of establishments by employment size class, and on trends in concentration ratios;
- Employment and productivity;
- Demand;
- Production capacity and capacity utilization;
- Plant and equipment expenditures;
- Profitability;
- Energy consumption;
- Fiber consumption;
- Interfiber competition (cross-elasticities dealt with);
- Foreign trade.

E. Evaluation of Economic Impacts

The economic impacts of the regulatory costs on the industry and the economy were assessed in terms of: 1) additional employment requirements, 2) increases in production costs and resulting price increases by the industries, 3) capital requirements and capital financing problems, 4) effects on competition and market structure, 5) inflationary effects, 6) employment losses due to contraction of demand for output, and 7) effects on energy consumption.

The major procedures used in the impact analysis are as follows. First of all, in order to determine the levels of average price increases likely to result from the imposition of the exposure limits, it was necessary to estimate the average rate of return on investment at the industry level, both before and after imposition of the required controls. In calculating the average price increases, it was assumed that average output price levels in the affected industries would be increased after compliance to the level required to maintain the pre-compliance rate of return on investment.

Secondly, the impacts on market structure were assessed on the basis of differentials in the capabilities of firms of different sizes to finance the required capital investments. The ratio of compliance capital costs to profits after taxes was used as an indicator of the ability to finance capital. The ratios were calculated for different size classes of firms. The greater the ratio, the greater the probability of a firm in a given size class experiencing capital availability problems, and being forced to rely on external debt financing.

Third, the inflationary impacts of the regulation on the Consumer Price Index were calculated through the use of an input-output model. The model was also used to estimate employment losses due to regulation-induced reductions in consumer demand.

In analyzing the effects of the regulation on plant profitability, potential closures are estimated.

One major finding of the study was that there was no significant variation in the compliance capital costs and annualized cost per unit of output among different size classes of textile mills.
F. Additional Comments

The study is relatively sophisticated and does focus on the issues of differential impact by size of firm. The analysis would have been better, however, if the compliance cost estimates were more detailed -- i.e., if cost variation within SIC groups were accounted for, rather than using single average costs to represent entire SIC groups.

The benefits of the regulation are estimated.
A. **Industry Coverage**

Since the standard is one which affects the use of benzene, all industries capable of exposing employees to greater than 1 ppm benzene are included. Specific industries include: benzene production, benzene transportation, chemical processing, petroleum refining and related activities, rubber industry, and laboratories.

B. **Nature of Regulation**

The study was completed in support of the reduction of the OSHA standard for benzene in the workplace. The original standard specified an 8 ppm allowable ceiling while the new standard would lower the ceiling to 1 ppm. The economic study was completed as part of the requirements of E.O. 11949, which called for the analysis of inflationary impacts of government regulations. The study did, to some extent, attend to small business since service stations and bulk gasoline plants were exempted from the standard due to profitability impacts. In general, the other industries affected do not have significant small business sectors.

C. **Estimation of Regulatory Costs**

Since the standard is basically a "workplace" standard, there are essentially a number of methods by which an employer can comply with the 1 ppm level, that is, either by eliminating benzene emissions at the source (engineering controls) or reducing worker exposure (protective devices, training, measurements, etc.).

Model plants, with two exceptions, are not used in the analysis. Costs are presented in terms of summaries for segments of the six "industries" noted above. Costs are distinguished by three broad categories: first year operating costs, recurring operating costs, and capital investment. The cost summaries, for the most part, were estimated by the consulting
firm that prepared the impact study, and it is assumed that while alternative methods of compliance are available to employers, they will choose the least-cost method of compliance. From this point the three categories are presented (summed for each industry). Little in the way of background as to how the costs were developed is given, for example it seems "our recent work with chlorinated solvents" is the only source of cost data. Capital costs are based upon rough estimates, for example -- "Communication with large refineries and chemical producers indicates there is general agreement that rigid controls through engineering applications could reflect capital outlay of up to 3 to 5 percent of facility replacement costs."

Model plants are employed in the cases of gasoline service stations and gasoline bulk plants. It should be noted, however, that all model plants assembled are in fact "small businesses". For service stations three plant sizes were examined; however, it is not clear how these sizes were selected. Individual cost estimates are made for each size plant; however, it is not clear from the report how costs were derived. Profit margins and cash flows are estimated for each size service station and in each cash annualized costs exceed annual cash flow, the basic justification for "nonaffordability".

For bulk gasoline plants it is simply shown that the capital costs of vapor controls are exceptionally high. Bulk gasoline plants were exempted for this reason.

D. Analysis of Baseline Economics

An industry profile is presented and estimates the number of service stations and bulk plants. Sources of this data are, however, not noted. The future demand picture, for any of the industries included, is not specifically addressed.

The elasticity of demand is estimated in a qualitative fashion. The discussion concludes that demand is price-inelastic due essentially to the inavailability of benzene substitution. No distinction between price elasticity by firm size is included.

E. Evaluation of Economic Analysis

For all industries with the exception of service stations and bulk plants, all economic impacts are discussed in terms of price increases (as directed by E.O. 11949 Inflation Impacts). For these industries some discussion of capital requirements is included, but the impacts of these requirements are not addressed.

For service stations and bulk plants, however, economic impacts are discussed in terms of profitability impairment through ROI and DCF. Other regulatory costs, and differential impacts are not covered.
F. Comments on Study

The major problem with this study is that the development of the regulatory control costs are not made clear. This is probably because all control cost estimates were made through rough approximations.
A. Industry Coverage

The analysis dealt with those segments of the aerosol industry which it was felt would be most affected by a restriction on the use of chlorofluorocarbons as aerosol propellants. These segments include: 1) marketers, 2) fillers, 3) suppliers (containers, valves, caps, ingredients, etc.), 4) fluorocarbon propellant manufacturers, and 5) producers of precursor chemicals.

Five product groups are covered in the analysis: 1) hairsprays, 2) deodorants and antiperspirants, 3) other toiletries, 4) household products, and 5) other aerosol products.

Six companies account for nearly all of the domestic production of fluorocarbons. The largest producer is DuPont, followed by Allied Chemical Corporation, Union Carbide, Kaiser Aluminum and Chemical Corporation, Penwalt Corporation, and Racon, Inc.

The two most important precursor chemicals used in the production of chlorofluorocarbons are carbon tetrachloride and hydrogen fluoride. Carbon tetrachloride is produced by five companies, while hydrogen fluoride is manufactured by nine companies.

The marketers are involved with delivering the aerosol package to the consumer. An example of a marketer is the Gillette Company.

The filling segment of the industry involves the assembly of the major components of the aerosol package into a complete unit, ready for customer use. Some marketers have captive filling operations, while others rely on contract fillers to produce aerosol products to their specifications. Many of the contract fillers are small operations with annual capacities of less than 10 million units. These smaller firms tend to be regionally oriented, and rely on a few accounts for the bulk of their business.

The supplier industries provide components such as containers, valves, and caps (and ingredients, to some extent).
B. **Nature of Regulation**

The study was carried out in anticipation of restrictions being placed on the use of chlorofluorocarbons in aerosols. The economic impacts examined in the study are the aggregate impacts associated with joint EPA, FDA, and CPSC regulation.

The study assumed that a regulatory announcement would be made on January 1, 1977, and that the effective date of the ban (i.e., 30, 18, or 6 months after the announcement) would apply to the production of specified fluorocarbon propellant systems, but not to their retail sale. In other words, it was assumed that the regulation would not prevent the industry from running through existing inventories.

A total of nine different regulatory scenarios were considered. The scenarios were constructed by varying two key parameters: 1) the timing assumed for the phase-out of aerosol propellants; and 2) assumptions regarding the viability of substitute aerosol propellants. All of the scenarios assumed that the chlorofluoroalkanes F-11, F-12, and F-114 would be banned from use in aerosols. The phase-out schedules considered were 30 months, 18 months, and 6 months. Three substitution levels were postulated for each phase-out schedule: 1) a combination of mechanical alternatives, hydrocarbon propellants, and other fluorocarbon propellants; 2) a combination of mechanical alternatives and hydrocarbon propellants; and 3) mechanical alternatives only.

C. **Estimation of Regulatory Costs**

The study examined the feasibility, availability, and cost implications of alternatives to aerosol products relying on F-11, F-12, F-114, or some combination of these propellants. The alternatives were divided into five major categories:

1. **Fluorocarbon alternatives** -- these alternatives would use F-22 and/or F-1426 as substitutes for F-11 and F-12, with the exact quantities and degree of substitution varying depending on the product involved;

2. **Hydrocarbon alternatives**;

3. **Compressed gas alternatives**;

4. **"Mixed gas" alternatives**;

5. **Mechanical alternatives**.
For each of the product categories covered by the study, estimates are made of the unit manufacturing costs associated with each of the alternative product delivery systems which might be utilized. For purposes of comparison, unit costs are also given for systems using F-11, F-12, or F-114. For each product category/delivery system combination, however, only one unit manufacturing cost is estimated. In other words, the possibility of differentials in costs between production operations of different sizes is not addressed. There is no documentation presented on how the cost estimates were generated.

D. Analysis of Baseline Economics

An industry profile is presented. Areas discussed include:

- Production and sales for the aerosol industry;
- Extent to which fluorocarbon propellants were used in aerosol units;
- Characteristics of selected aerosol product groups -- e.g., sales, use of fluorocarbon propellants, unit manufacturing costs;
- Production of fluorocarbons and precursor chemicals;
- Feasibility and production costs of alternatives to fluorocarbon-propelled aerosols.

Baseline demand projections were made for each year from 1976 to 1980. Separate projections were developed for each of the following areas:

- Aerosol products
  - Hairsprays
  - Antiperspirants
  - Other toiletry products
  - Other aerosol products;
- Chemical products
  - Chlorofluorides
  - Precursor chemicals.

The baseline projections for the aerosol products were developed using an ad-hoc approach based partially upon results obtained from a multiple regression analysis and a consideration of factors relating to structural
changes resulting from alternations in preferences and styles, population growth rates, laws, consumer incomes, product prices, and prices of substitutes. Based on the estimated participation of the various fluorocarbons in the production of the subject aerosol products, the baseline demand estimates for the aerosol products were translated into baseline demand projections for fluorocarbons. Using chemical input-output relationships, baseline demand projections for precursor chemicals were developed from the projections for fluorocarbons.

E. Evaluation of Economic Impacts

Nine different regulatory scenarios were considered. The economic impacts associated with the regulatory scenarios were calculated in terms of changes in value added for different segments of the aerosol industry (e.g., marketers, fillers, container and valve manufacturers) and manufacturers of chlorofluorocarbon propellants; and in terms of effects on employment, consumers, and small businesses. The impacts were calculated over the years from 1977 to 1980, with 1976 used as the base year.

The analysis assumed that a regulatory announcement would be issued on January 1, 1977, and that the effective date of the ban (i.e., 30, 18, or 6 months after the announcement) would apply to the production of specified fluorocarbon propellant systems, but not to their retail sale.

For each product category, sales patterns were evaluated with a view toward identifying secular trends in total product demand, the distribution of market shares to substitutes, market penetration or saturation, and elasticities of demand. It was assumed that each product category as a whole faces a fairly inelastic demand within a relevant price range. Retail prices were projected by applying the markup structure for each product group to the estimated manufacturing costs of each alternative within that group. The assessment of economic impacts was carried out as follows. First of all, baseline demand was forecast in constant dollars for each product category (i.e., hairspray, antiperspirants, other toiletry products, and other aerosol products). Second, value added and marketer contribution were estimated by industry segment per unit of product sold. Next, for each industry segment, the value of labor employed in the manufacture of each unit of product was used to determine the total wage bill for the segment. Given this data, the number of jobs was then estimated on the basis of the value of a labor year. Changes in demand were forecast by product and type of delivery system (e.g., fluorocarbon aerosol, hydrocarbon aerosol, mechanical). Differences in average costs/prices were then determined for different delivery systems and levels of output. Lastly, the economic impacts were estimated on the basis of changes in the number of aerosol units demanded and the price per unit.

The impacts upon the producers of fluorocarbons and precursor chemicals were derived from changes in demand for aerosols and substitute products. Increased costs of manufacturing fluorocarbons and precursors associated with underutilization of plant capacity were determined on the basis...
of engineering estimates. A computerized process model was used to evaluate changes in demand and production cost for each of the regulatory scenarios. In this analysis, it was assumed that costs would be fully passed through, and that the after-tax return on capital investment was 15 percent.

A sensitivity analysis was carried out in order to determine the extent to which the results of the economic impact analysis would be affected by changes in the underlying assumptions.

The nature of differential economic impacts upon firms of different sizes was not evaluated quantitatively. The study notes, however, that the impacts upon small businesses under the various scenarios are likely to be more adverse than for larger firms because of the former's limited access to the financing needed for plant conversion and research and development, and also because of the fact that larger firms tend to have more influence on suppliers, and may be able to obtain necessary new equipment faster than small businesses, even when the latter possess the financial resources to pay.

F. Additional Comments

The study is very complex in its organization. More documentation on sources of data and methodology could have been presented.

Small business appears to be quite important in the "filler" segment of the industry. However, due to the aggregative nature of the analysis (i.e., focus upon economic impacts at the level of the industry segment or higher), differential impacts on these smaller operations could not be addressed in detail.