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ECONOMIC IMPACTS OF PULP AND PAPER INDUSTRY COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

VOLUME I

Summary and Aggregate Industry Impact Analyses

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ECONOMIC IMPACTS OF PULP AND PAPER INDUSTRY COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

VOLUME I

SUMMARY AND AGGREGATE INDUSTRY IMPACT ANALYSES

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PREFACE

This report is the result of a major program of study sponsored by the Environmental Protection Agency as part of its continuing effort to assess the economic impacts of its regulatory programs. Unlike many of EPA's other industry economic studies, where the focus is on the impact of a particular regulation, this study examined the combined effect of water, air, and noise regulations on the pulp and paper industry.

It was not possible, of course, to take every environmental regulation into account. In some cases, cost data was lacking, as were some final regulations. It was possible, however, to focus quantitatively on the most significant programs now in effect.

In addition to providing an assessment of the combined impact of major environmental programs, a key objective of this study was to improve the methods used in previous studies and thereby provide more accurate conclusions as well as a better foundation for future studies. In many cases, this objective was realized through the use of more recent or previously unused data in areas such as industry production cost and pollution control cost. However, the basic analytical methods also were improved.

In sponsoring this study, the EPA wanted an independent assessment of the pulp and paper industry. Although the overall conclusions are endorsed by the Agency, there may be instances in which technical judgments of the contractor differ from those of the EPA. Similarly, assumptions that concern policy should not be construed as an indication of EPA policy intentions.

This report was prepared for EPA by Arthur D. Little, Inc., Cambridge, Massachusetts, under contract number 68-01-2841. Additional copies are available through the National Technical Information Service, Springfield, Virginia 22151. Further information concerning this and other economic studies conducted by EPA can be obtained through the Office of Planning and Evaluation, U.S. Environmental Protection Agency.

EPA and Arthur D. Little gratefully acknowledge the important data inputs to this study provided by: The American Paper Institute (production, capacity, OSHA noise cost data), National Council of the Paper Industry for Air and Stream Improvement (water and air effluent control costs), U.S. Department of Commerce (OSHA noise and state air regulation costs) and a cross section of pulp and paper companies (historical selling prices, and mill closure factors and probabilities).

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CHAPTER I
EXECUTIVE SUMMARY

I. EXECUTIVE SUMMARY

A. PURPOSE AND SCOPE

To assist various government agencies in making decisions about environmental regulations for the U.S. paper industry, the EPA retained Arthur D. Little, Inc., to undertake a comprehensive study 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 the existing industry are assessed—that for compliance with BPT ("best practicable control technology currently available") which is required for 1977, and that for BAT ("best available technology economically achievable") which is required for 1983. New-capacity control costs are based on the New Source Performance Standards (NSPS) currently in effect. These regulations do not affect existing pretreatment standards or other costs associated with use of municipal treatment facilities.

- Air Regulations—those issued by states (State Air Quality Implementation Plans—SIP) for the existing industry, and those issued by EPA as they apply to new capacity.

- Noise Regulations—those issued by the Occupational Safety and Health Administration (OSHA) for compliance with a 90-dBA noise level using engineering and/or administrative controls to achieve compliance. Noise regulations apply equally to both existing and new capacity.

Four types of existing or proposed environmental regulations were excluded from these economic impact analyses:

- All regulations that affect woodland management (e.g., use of herbicides and pesticides), harvesting practices, and alternative timberland uses.

- Regulations that mandate fuel switching or require SO_2 removal. (This study assumes the use of low-sulfur fuel.)

- "Nonsignificant deterioration" regulations under consideration by Congress that would tighten current air emission limitations for new or expanded pulp and paper mills.

- Priority pollutants regulations that are being studied by the EPA for possible inclusion in the 1983 water effluent guidelines.

The study analyzes cost-recovery impacts of the above water, air, and noise regulations on the pulp, paper, and paperboard product sectors of the total paper and allied products industry. Thus, the analysis does not include costs or impacts associated with timberlands, or paper/paperboard converting operations (except where converting is done at the paper mill). The study also excludes specialty paper products, for which Federal water effluent guidelines have not yet been proposed. Table I-1 shows that the studied product sectors accounted for about 99% of 1974 U.S. primary pulp, paper and paperboard capacity.

In 1975, the studied product sectors accounted for about 45% of the sales of the paper and allied products industry, 55% of its assets and 42% of its employment.

The report assesses the industry's incremental costs to meet the environmental regulations defined above. Then it estimates the following economic impacts of these costs on the product segments they affect directly and on the industry and economy as a whole:

Price and Demand Effects
Short-Term Capacity Constraints
Secondary Impacts on Suppliers
Closure and Employment Effects
External Financing Requirements
Balance of Trade Effects

B. KEY BASES OF ANALYSIS

The results of this analysis should be interpreted in the light of the following key assumptions and study parameters:

1. The base case assumed that: *regulatory timetables and national effluent standards will be achieved.* It is evident that this assumption does not hold for EPA's BPT water guidelines, which required effective treatment systems to be operating by July 1977. A number of mills reported in 1976 that they would be unable to meet this deadline. Moreover, some mills received five-year permits prior to the promulgated national standards. Consequently, the effluent limitations in many permits may differ from the national standards. A sensitivity analysis was preformed to test the capital effects of extending the BPT expenditures beyond 1977 to January 1980.

2. *Starting dates for the Arthur D. Little forecasts* were: January 1976 — for the industry's capital and financing requirements; January 1975 — for environmental control and operating costs (including capital recovery). The earlier date was used for operating costs because the 1975 recession prevented most paper companies from raising prices in 1975 and 1976; thus the incremental costs incurred since January 1975 generally are not reflected in 1976 prices.

3. *Product quality will not change significantly through 1983.* There has been much industry discussion about employing lower-brightness, higher-yield pulp in its products, and thereby reducing pollution loadings as well as costs. As yet, however, there is no evidence that this trend has begun; therefore, it would be very speculative to predict its timing and effects.

4. *Competitive pricing* is assumed in all price, demand, and capacity forecasts. To the extent that Federal price controls or guidelines are imposed and sustained, the capacity and capital requirement forecasts in this report would be altered.

TABLE I-1

STUDIED PRODUCT SECTOR SHARES OF U.S. PRIMARY PULP, PAPER, AND PAPERBOARD CAPACITY, 1974

Sector	% of 1974 U.S. Capacity
Unbleached Kraft Paper	7.1
Unbleached Kraft Paperboard	22.6
NSSC Corrugating Medium	7.2
Recycled Paperboard	14.0
Construction Paper	3.5
Bleached Market Pulp	7.8[1]
Dissolving Pulp	3.8[1]
Printing/Writing Paper	18.8
Bleached Board and Bristols	8.3
Tissue	7.0
Newsprint and Uncoated Groundwood	8.1
Bleached Packaging Paper	2.1
Total (Excludes Specialty Papers)	98.7

1. Based on total pulp.

Source: American Paper Institute.

5. Cost models and dollar projections employ constant 1975 dollars, unless otherwise noted. This assumes no "real" inflation relative to the general GNP deflator. If the paper industry experiences real cost inflation, its price, capital, and financing requirements will be higher than projected here. However, the studied regulations would not change the relative increase in its cost-recovery price.

6. 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. The industrial production index and GNP series in the Chase forecasts reflect a mild recession in 1978-1979, followed by four years of sustained growth to 1983. Chase Econometrics predicted average annual growth rates of 4.3% for GNP and 6.5% for industrial production, 1976-1983. The forecast of real GNP was very close to the 1976 actual and is also close to the Administration's prediction for 1977 made in early 1977.

C. CONCLUSIONS

1. The analysis indicates that on balance, the economic impacts of the studied regulations on the paper industry and on the economy as a whole are relatively small.

   - By 1983 the average paper price at the mill level will be about 6% higher than the 1975 price ($292 per ton) as a result of the regulations. Relative price increases at the consumer level will be less than the base paper price increases except for tissue which will equal the paper price increase of about 4.1%. As a result of the regulations, consumers will pay about $10.50 more per capita annually for paper products by 1983.

- In the long run as a result of the studied requirements for new capacity, average prices will be 8% higher than if the regulations were not in effect. This corresponds to about $15 per capita at the consumer level.

- A few products are likely to experience supply shortages through 1980, as is now the case with coated printing papers. However, beyond 1980, if the current slow rate of growth in capacity continues, and if the economy grows at the high end of the predicted likely range, supply shortages may become more prevalent. Neither current nor long-range shortages, however, can be directly attributable to the studied regulations.

- The demand for certain raw materials will continue to decline because of pulping chemical changes to reduce air pollution loadings and costs; the impact on suppliers of those materials will be mitigated, however, because most suppliers are aware of this trend and are likely to cultivate other markets to offset declining sales to the paper industry.

- If all paper companies were to achieve BPT by 1977, the industry's external financing requirements would reach a peak somewhat exceeding the industry's previous share of total U.S. corporate financing. However, an effective stretch-out of BPT expenditures to about 1980 (evidenced by the industry's reported and planned expenditures) indicates that this peak will not occur. Moreover, assuming the industry will space its capital expenditures evenly from 1978 to meet 1983 guidelines, its external financing requirements should not be difficult to obtain since it will be well below the industry's historic share of total corporate financing. However, the comparative difficulty particularly for small- to medium-sized firms in raising expansion capital on top of meeting pollution control regulations will contribute to the increasing concentration of larger firms in this industry.

- Projected mill closures during the forecast period are about one-third of the industry's normal attrition rate. In the near term, about 10 mills could close because of 1977 water regulations. (Many closure situations are under judicial or EPA review so the firms have not made a final decision to close.) The primary employment associated with these mills is about 2,600 people or 1% of the current employment of all studied sectors. The mills have a total capacity of 1,400 tons per day or 0.7% of 1974 U.S. capacity.

- After the 1977 deadline, an additional 17 mills could be financially unable to meet 1983 water standards. This impact is much less certain. First, the time horizon is longer. Second, the analysis did not attempt to predict the effect of Section 301(c) of the 1972 Federal Water Pollution Control Act, which provides that if plants can demonstrate serious financial hardship, they may be granted a variance from the 1983 water regulations. Primary unemployment could amount to 3,500 jobs or about 1.6% of current employment for all studied product sectors. These 17 mills have a total capacity of about 1,700 tons per day or 0.9% of 1974 U.S. capacity.

- The U.S. balance of trade is not likely to be affected significantly. U.S. mills engaging in international trade generally have a large total cost advantage over their foreign competitors and their relative costs for environmental controls will increase only modestly through 1983. Thus, their total cost advantage will not be reduced significantly.

2. The studied compliance costs and their impacts vary widely by process/product sector, size of mill (economies of scale) and age (retrofitting problems). Table I-2 indicates the product/process sectors that as a result of higher costs or financing problems are likely to experience and/or cause economic impacts greater than the industry average in one or more categories:

TABLE I-2

PRODUCT SECTORS WITH ECONOMIC IMPACT(S) ABOVE THE PAPER INDUSTRY AVERAGE

Product/Sector	Long-Run Environmental Price Effect[1] (%)	Environmental Closures (% of 1974 Capacity)	Unusual Financing Problems
NSSC Corrugating Medium	16	2	
Kraft Bag Paper	10	—	
Kraft Linerboard	10	—	
Bleached Board	8	—	
Printing/Writing Paper	6	5	Poor profit prospects — nonintegrated
Tissue	5	4	Poor profit prospects — nonintegrated
Construction Paper	NE	3	
Bleached Paper Pulp	NE	3	Age/obsolescence of sulfite process mills
Recycled Paperboard	6	2	Low profit and growth prospects

1. Prices are expected to be higher by these amounts (derived from new mill costs) than they would have been without the studied regulations. They do *not* represent the incremental effect of going from the 1975 control levels to New Source Performance Standards.

NE — Not estimated.

Source: Arthur D. Little, Inc., estimates.

D. KEY COST AND ECONOMIC IMPACT FINDINGS

In reaching the above conclusions,Arthur D. Little, Inc., considered the following facts and analytical findings to be most relevant:

1. Costs of Compliance

By 1975, the paper industry had made substantial progress toward complying with existing environmental regulations, but it still faces large capital expenditures to meet the studied regulations from 1975 through 1983 (Table I-3). Water effluent control will account for about 76% of total direct capital costs for the studied regulations and thus will impose the heaviest financial burden. Taken individually, average incremental costs to comply with air and OSHA regulations are relatively small. Incremental capital costs to meet 1977 timetables are about 55% of total direct costs.

The industry's recent and planned direct water and air emission control investments reported by the National Council of the Paper Industry for Air and Stream Improvement (NCASI) are lower than the annual rates implied by the Arthur D. Little, Inc, cost estimates. This variance is caused by several factors:

- Some effluent permits were based on interim guidance that was different from the promulgated standards; affected firms are not required to "catch up" until after their permit expires.

- Certain mills may have found less costly ways to achieve 1977 standards than the technology assumed for the compliance cost estimates.

- Some mills plan to meet EPA requirements by tying into new municipal treatment systems whose construction has been delayed beyond the July 1977 deadline.

- A number of mills have not yet initiated treatment plant construction, which makes it impossible for them to meet the 1977 deadline.

Water effluent expenditures for the industry represent about 80% of the total incremental operating costs for the studied regulations. The incremental costs projected to 1977 will represent 65% of the total increment, as demonstrated in Table I-4.

For new mills, the capital component of compliance costs varies between $7 million and $27 million depending upon the mill's pulping process and its size (Table I-5). On the basis of projected industry capacity represented by each of the product sector cost models, the weighted average cost of compliance is about 15% of the total capital cost for new industry capacity. New-mill operating costs also vary widely, from $12 to $28 per ton.

New-mill costs of compliance (both capital and operating) are higher than existing mill costs primarily because the latter reflect partial compliance by January 1975, the starting point for this study. The new-mill regulations also generally are more stringent than those for existing mill 1977 standards, but less demanding than proposed 1983 guidelines (primarily because color removal is excluded).

TABLE I- 3

ESTIMATED CAPITAL COSTS FOR COMPLIANCE
($Million)

	1975-1977	1977-1983	Total 1975-1983
Direct Cost (Internal and External Treatment)			
Existing Capacity			
Air	690	170	860
Water	2250	1410	3660
OSHA	320	80	400
Total Existing	3260	1660	4920
New Capacity (2)			
Air	30	120	150
Water	240	960	1200
OSHA	30	120	150
Total New	300	1200	1500
Existing and New Capacity			
Air	720	290	1010
Water	2490	2370	4860
OSHA	350	200	550
Total Direct Cost	3560	2860	6420 (1)
Indirect Cost			
Replacement of capacity retirements induced by effluent control (3)			623
Capitalized maintenance for equipment used in environmental control			2014
Total Indirect			2637
TOTAL			9057 (1)

Notes: (1) To relate to the capital impact analysis ADL estimates that 1975 expenditures were $1,640 million; therefore, the direct and total capital cost from 1976 to 1983 is $4,780 million and $7,417 million respectively.

(2) Estimated on the basis of: a) mid-range capacity growth rate (Ref Vol III, Table H-6B) which results in about 20 million tons of capacity growth 1975-1983; and b)a 1975 average cost for environmental control at 15% of the average capital requirement for replacement capacity ($500/annual ton).

(3) ADL estimates about 1.25 million tons of capacity retirements primarily caused by the water regulations.

TABLE I-4

INCREMENTAL OPERATING COSTS FOR
EXISTING INDUSTRY COMPLIANCE[1]
(1975 Dollars per Ton)

	Total	EPA Water	SIP Air	OSHA Noise
1975-1977	11.10	8.40	1.80	.30
1978-1983	6.10	5.40	.40	1.20
Total	17.20	13.80	2.20	1.50

(1975 Average base price: $292 per ton.)

1. Includes capital recovery.

Source: Arthur D. Little, Inc., estimates.

Compliance costs vary widely among alternative pulping processes and different sizes of existing and new mills. In tissue production, for example, compliance costs for a small mill integrated to sulfite pulp are about three times those of a large mill integrated to kraft pulp (Table I-6).

Similar cost differences among other pulp and paper industry sectors account for most of the variability in economic impacts, particularly price increases, mill closures and the ability to obtain financing.

2. Price and Secondary Impacts

The long-term effect on the average paper price, 8%, is based on the impact of the studied regulations on new mills. The studied water guidelines will account for 6% and the air and OSHA noise regulations for the remaining 2%. The product sector averages vary from 4% to 16% with a clustering in the 6-10% range. Note that the price effects cited above represent the total long-term impact of the studied environmental regulations and not the incremental effect of going from the 1975 effluent level to NSPS.

The existing industry will require a smaller price increase (6%) to recover the incremental cost of the studied regulations, because it is already in substantial compliance with the environmental requirements for 1977. Long-term paper prices will increase about 12% without additional environmental costs (assuming the industry maintains a 13% return on equity) because of the higher costs of current new mills compared with those of typical existing mills.

Demand for paper products is relatively price inelastic; thus, the projected 8% long-run environmental price increment will reduce potential consumption by 5%. This loss is equivalent to one or two years of normal growth potential spread over at least the next six years.

Tight capacity is possible in 1977-1978 for printing/writing paper and could develop in 1982-1983 for bleached board, printing/writing paper, NSSC medium, and kraft linerboard, if the industry maintains its current rate of capacity expansion, and if the Chase growth forecast and

TABLE I-5

COSTS FOR TYPICAL NEW MILLS TO COMPLY WITH STUDIED REGULATIONS

(1975 Dollars)

Product Sector	Typical Mill Capacity (tons/day)	Total Compliance Costs: Capital $MM	Capital %of Mill	Operating[1] $/Ton	Operating[1] % of Mfg
Kraft Linerboard	1000	24.9	17	14.60	9
Kraft Bag Paper	230	7.6	12	18.90	7
NSSC Corrugating Medium	450	17.7	26	25.90	13
Recycled Boxboard	400	8.1	14	12.50	5
Bleached Board	500	20.2	14	24.00	7
Bond Paper	300	11.7	12	22.50	6
Tissue (from Kraft)	163	7.4	10	23.40	4
Newsprint (Kraft/GW)	550	12.0	10	17.90	5
Newsprint (Deinked)	330	14.1	25	27.50	12
Bleached Market Pulp	800	26.4	14	19.60	8

[1] Includes capital recovery.

SOURCE: Arthur D. Little, Inc., estimates

TABLE I- 6

EFFECT OF MILL SIZE AND PULPING PROCESS

ON BAT WATER EFFLUENT CONTROL COSTS[1]

(1975 Dollars)

	Bleached Sulfite	Bleached Kraft		
Mill Size (tons/day)	100	100	250	500
Capital Costs				
$ (Million)	15.8	10.5	18.0	28.5
$/Annual Ton	158	105	72	57
Operating Costs ($/Ton)[2]				
Operational	17.60	9.80	7.50	6.20
Capital-Related	19.10	12.70	8.20	6.90
Total	36.70	22.50	15.70	12.10

[1] The cost increments are the additional costs beyond the industry's average control costs at the end of 1974.

[2] Includes capital recovery.

SOURCE: Arthur D. Little, Inc., estimates.

the upper boundary of demand both materialize. If these shortages occur, they will not be caused by plant closures since environmentally related closures represent only 1.2% of the industry's 1982 capacity. Nor will they be caused by the capital requirements of the studied regulations per se because the industry's ability to expand capacity does not appear to be constrained by its external financing requirements to comply with the studied regulations. During their formulation, the regulations probably heightened management uncertainties, but historically there has been no correlation between pollution control expenditures and increases in capacity.

With the exception of tissue, prices for consumer paper products and packaging will increase by a lower percentage than will intermediate paper products. By 1983, however, the average consumer will pay about $10.50 more per year for paper because of price increases resulting from the studied regulations. Beyond 1983, when new mill costs will strongly influence price, the per capita cost increment will rise to about $15 per year.

Saltcake suppliers to the paper industry are likely to experience the greatest secondary impacts as their product continues to be replaced by caustic soda and sulfur in the interest of reducing kraft mill sulfur emissions. The saltcake producers are certainly aware of this trend and have successfully increased sales to other markets to offset losses in the paper industry market; the impact hinges on their continued success in finding offsetting growth opportunities.

3. Mill Closures and Employment Impacts

Of 556 U.S. pulp and paper mills studied, 27 may close because of difficulties in meeting pollution control requirements.[1]

Ten mills could close because of 1977 pollution control requirements. The resulting loss of capacity, about 1,400 tons per day, would reduce the capacity for bleached paper grade market pulp by 3%, printing/writing paper by 2.4%, tissue by less than 1%, construction paper by 1.5%, and recycled paperboard by 1.1%. About 2,600 jobs, or slightly more than 1% of total current employment of all studied product sectors would be lost. Total unemployment (primary plus secondary) is estimated at 3,700 jobs.

If proposed 1983 water effluent guidelines are adopted, an additional 17 mills, representing 1,700 tons per day of capacity, may also close. This impact would reduce the nonintegrated printing/writing paper capacity by 2.6%, nonintegrated tissue by 3.3%, corrugating medium by 1.8%, construction paper by 1.5%, recycled paperboard by 1.1%, and newsprint by less than 1%. About 3,500 additional jobs would be lost, or about 1.6% of total current employment of all studied sectors. Primary plus secondary unemployment from these closures is estimated to be 7,100 jobs.

1. Air pollution control requirements were considered in the mill screening phase and discussed in the industry interviews, but water effluent regulations proved to be the most serious problem for the mills judged to be in jeopardy of closure. No closures related to emission control are projected for kraft process mills, which face the largest air pollution control expenditures. Also no mills were judged likely to close primarily as a result of the OSHA noise regulations.

4. External Financing Requirements

The flow of funds analysis indicates that over the eight-year period 1975-1982, the pulp, paper, and paperboard sectors (exclusive of woodlands and converting operations) of the industry will invest about $21.3 billion in 1975 dollars) in total capital equipment. Of this, about $7.4 billion represents direct compliance costs (by existing and new mills) plus replacement of pollution-related closures; almost $6 billion is attributable to water effluent controls while the balance is split between air and noise regulations.

To finance its investment requirements, the paper industry will need to raise about $4.5 billion in the capital markets, of which about $3.5 billion is attributable to the studied regulations. About 77% of the external financing would have been required during 1976 and 1977 if the EPA's original July 1977 water effluent deadline were to have been met using the compliance costs employed in this study. The stretch-out of BPT expenditures to about 1980, which appears to be taking place, will reduce the industry's high financing requirements in 1976 and 1977.

This level of external financing, compared to aggregate financing in the economy, does not differ significantly from the share of total corporate financing successfully obtained by the pulp and paper industry in the past. Therefore, there is no reason to expect that the industry's demand for capital funds to comply with the studied regulations will divert capital away from capacity expansion or place an insurmountable barrier in the way of compliance. While reasonable variations in the major assumptions of the analysis would have a substantial impact on the total amount of external financing over the period, they would not alter the qualitative conclusion that compliance is financially feasible.

Although the projected financing requirements appear to be manageable for the industry as a whole, certain firms undoubtedly will experience difficulties. In particular, small and medium companies (especially the marginally profitable ones) are finding it difficult to meet the large capital requirements for plant and woodlands that are necessary for even minimum expansion increments on top of smaller, but continuing, pollution control expenditures. Thus, in combination with plant and woodland cost inflation, capital requirements for pollution control are diminishing the smaller firms' opportunities to expand, and hence, are helping to increase the concentration of the large paper companies.

5. Balance of Trade Impacts

Increases in current U.S. environmental cost disadvantages versus Canada and Sweden (the two largest world trade competitors) are projected through 1982; however, they are relatively small and are offset by much larger U.S. cost advantages in wood, transportation, and tariff protection. Thus, the studied regulations are not likely to cause significant changes in the current relative cost advantage of the average U.S. mill that exports unbleached kraft linerboard, bleached kraft market pulp, and dissolving pulp — the three largest-volume pulp and paper products exported by the United States. Nor are U.S. imports of newsprint and bleached kraft paper pulp (which account for nearly 80% of U.S. pulp and paper imports) likely to increase as a result of environmental cost differences.

The analysis, therefore, indicates that there will be no significant impacts on the U.S. trade balance as a result of the pulp and paper industry's compliance with the studied regulations.

E. ANALYTICAL APPROACH AND LIMITATIONS

1. Industry Segmentation and Procedural Framework

The first major task was to disaggregate the paper industry into relevant process and product sectors. Arthur D. Little then applied the compliance costs developed for 12 process-related sectors to each of the industry's 13 major product groups. Of these, the 10 most important sectors were selected for analyses of price and output effects, whereas all sectors were included in the closure and capital sufficiency analyses.

Figure I-1 shows the procedural framework used for estimating the various economic impacts. It indicates the sources and uses of data drawn from outside the study, and the interrelationships of the various inputs and analyses designed to assure consistency of results throughout the study.

2. Process Economics Analysis

A process economics cost analysis was the foundation for all of the subsequent economic impact analyses. Here, Arthur D. Little drew upon many sources of compliance costs data, e.g., the National Council of the Paper Industry for Air and Stream Improvement (NCASI), the American Paper Insitute (API), the U.S. Department of Commerce (USDC), the EPA and their consultants. Arthur D. Little modified the basic cost data to put it in a comparable timeframe and to include consistent cost elements, and then applied the costs to the various product sectors for use throughout the analysis. It also employed its data files and industry experience to develop models of new and existing mills and used these to estimate price effects and capital requirements for capacity expansion, and to ascertain the closure potential of selected groups of marginal mills.

The likelihood that new technology may reduce the compliance cost estimates was not quantified. To this extent, therefore, the costs may be overstated. The accuracy of the aggregate compliance costs, summed for each product sector, is: Air and Water Regulations +25%, −10%; OSHA Noise Regulations +25%, −50%. The foregoing cost variability is within the accuracy of other key inputs (e.g., projections of GNP, capacity, and cost of capital) used in the economic impact analysis.

3. Price and Output Effects

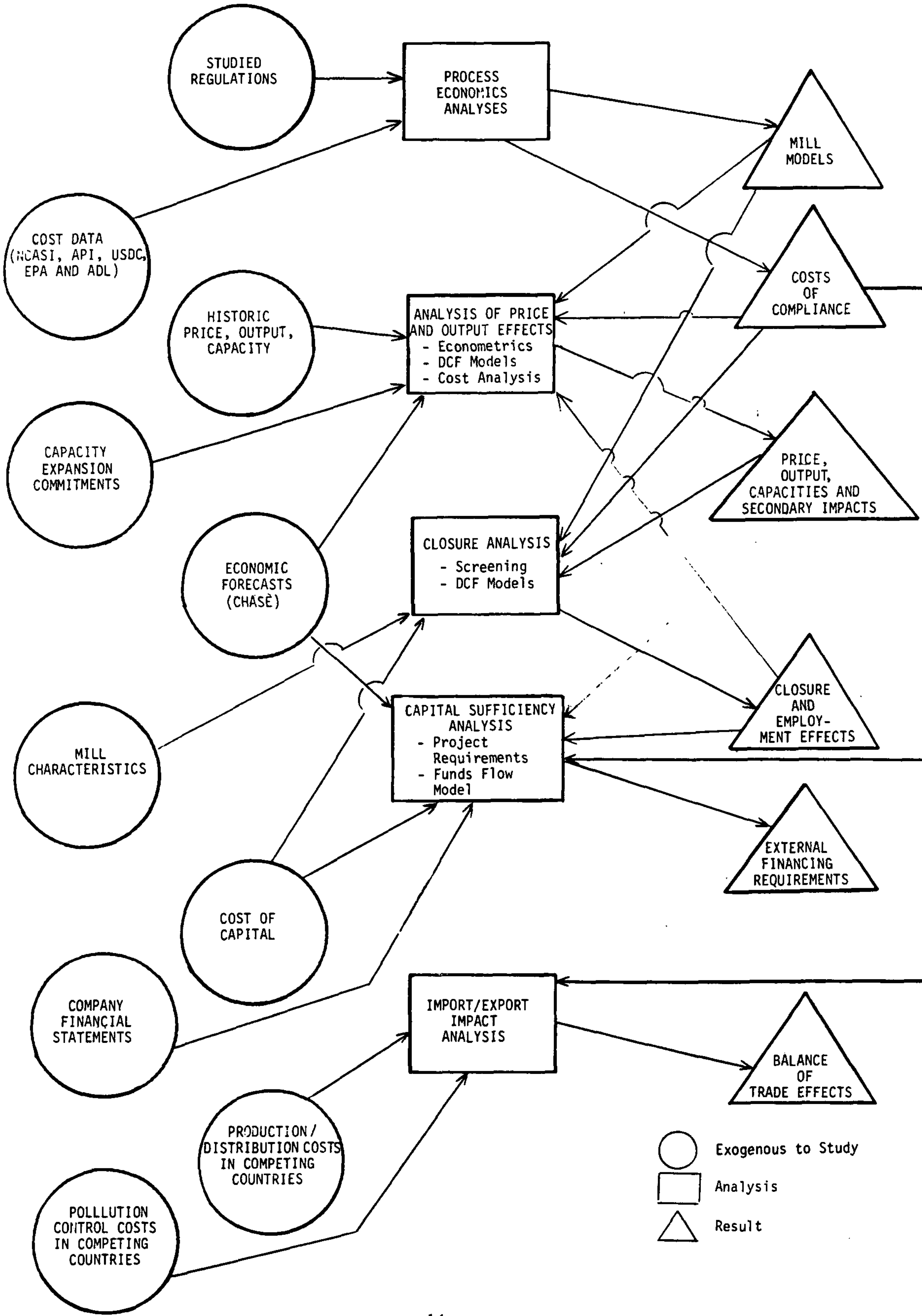
An economic analysis provided price, output, and capacity projections for the aggregate industry and each of its major product sectors. Process economics cost models for new mills were employed to analyze compliance cost impacts using a discounted cash flow technique to arrive at estimates of the long-run equilibrium price effects. These price effects were traced through distribution channels for selected products to obtain representative consumer price impacts.

In addition to estimating long-run price effects, Arthur D. Little calculated for each product sector and in aggregate the price increase necessary for existing mills to recover their increase in average total cost resulting from compliance with the studied regulations. The flow of funds analysis generated an estimate of the average price impact likely between 1976 and 1983 for the projected mix of new and existing industry capacity.

Econometric models (i.e., demand and supply equations) for the industry and its key product sectors were generated from historic price, production, and capacity data. The resulting demand equations were used with Chase Econometric's May 1976, macro-economic forecasts to

FIGURE I- 1

PROCEDURAL FRAMEWORK FOR ESTIMATING ECONOMIC IMPACTS



project demand to 1983. The paper industry's announced commitments for new capacity through 1979, and Arthur D. Little's estimates of capacity expansion from 1979 to 1983 (both adjusted by the results of the mill closure analysis) were linked with the demand projections to arrive at capacity utilization forecasts. The forecasts from the aggregate industry model were then used in the capital financing analysis.

The long-run equilibrium price effects of the studied regulations were based upon a 10% cost of total capital to the pulp and paper industry. Sensitivity analysis on this variable indicates that the *relative* impact of the studied regulations is not sensitive over the cost of capital range of 7.5-12.5%. The relationship between the long-run baseline price (assuming none of the studied regulations existed) and the 1975 market price is more sensitive. The baseline price ranged from 2% to 22% over the range of 7.5 to 12.5% in cost of total capital.

The demand forecasts are subject to several uncertainties: historic relationships between paper consumption and price could change; product substitution technology may change; Chase Econometric's economic forecasts may not materialize; and the demand equations themselves have an uncertainty range. Since only the last two sources of uncertainty can be quantified, only they were included in the sensitivity analysis.

4. Mill Closures and Employment Effects

In the mill closure analysis, a number of estimating problems had to be addressed: distinguishing environmental causes from other factors that could lead to future closures; different decision criteria for various types of owners; and wide variations among the mills themselves. To address these complexities, Arthur D. Little developed a method that involved: (1) screening each mill in the studied product/process sectors to identify mills that may have difficulty in complying with environmental regulations; (2) interviewing the management of 143 questionable mills to gain perspective on their closure potential; and (3) financial analysis of selected categories of mills identified as having closure potential. This approach led to estimates of the number of mills, the amount of capacity and the employment that are likely to be impacted by the studied regulations.

Since closure methodology was designed to estimate overall paper industry closure impacts, each mill within the studied product/process sectors was not specifically analyzed in sufficient depth to predict whether it in particular is likely to close. However, the results provide an estimate of overall impact for each sector. Also, the majority of mills that were found most likely to be severely impacted by environmental regulations already are marginally profitable; thus, it was difficult to clearly distinguish environmentally related closures from closures that would have occurred in any event.

5. External Financing Requirements

The external financing analysis was based on a flow-of-funds model of the pulp, paper, and paperboard sectors of the industry developed by Arthur D. Little. The model does not independently forecast sales margins; instead it assumes that over the period 1976-1983, the industry will continue to pursue its traditional financial policies and to price its products consistent with the demand schedule it faces to achieve its required rate of return (i.e., cost of equity capital). Major inputs were the projected costs of equity capital, composite financial statements for 32 major companies whose business activities are highly concentrated in primary pulp and paper production, announced industry commitments for future capacity expansion through 1979, Chase

Econometric macro-economic forecasts, demand forecasts from the econometric models, estimates of the level of capital investment for capacity expansions and projections of the capital costs for compliance with the studied regulations. The model balanced the industry's capital requirements against its cash flow and estimated the timing and magnitude of the residual external financing requirements. To lend perspective, the analysis compared the paper industry's projected share of all corporate external financing with the historic trends.

The fact that the model does not reflect the financing requirements of the entire paper and allied products industry in no way invalidates the results, since comparisons of projected requirements with historical experience also excluded converting and woodlands investment.

Industry operating rates projected in the analysis were somewhat lower (80-90%) than those which obtained (85-95%) until recently. To the extent that the industry expects to run at higher operating rates than those projected, its rate of capacity expansion will decline and its demands for investment funds will be lower than those projected here.

The analysis employs the usual equilibrium assumption in both product and capital markets, which in a dynamic economy is an objective sought but never exactly achieved. Therefore, it is to be expected that over the years the paper industry's actual performance will fluctuate about the forecast values.

6. Balance Of Trade

The import/export impact analysis compared projected environmental costs in the United States with those of major countries competing in pulp and paper trade. Then it evaluated what changes the cost differences are likely to cause in current intercountry production/distribution cost structures. At present, U.S. mills have cost advantages in marketing the major import/export products. Thus, if environmental costs were to change this cost advantage significantly, the U.S. balance of trade also would be affected.

The study analyzed major products which in 1974 accounted for 79% of U.S. imports and 45% of U.S. exports of pulp and paper products. Small-volume products were excluded since they typically face relatively high tariff barriers and therefore are less sensitive to environmental cost differentials. Moreover, if some of these products were to be affected, the tonnage involved would have little effect on the U.S. trade balance.

Intercountry production/distribution cost differentials included only items whose cost differences most significantly affect total delivered costs: wood, transportation, and duties. To the extent that aggregate costs for other factors of production also vary, estimates of U.S. competitive advantages could change; rapidly rising labor costs in other countries currently are increasing the competitive advantage of U.S. mills.

The analysis assumes that U.S. mills will maintain their approximate current six-year lead time (in implementing water, air, and noise controls) over their counterparts in key competing countries; the projected environmental cost differentials would change to the extent that this lead time changes or the proposed 1983 water effluent guidelines change.

7. Other Studies Examined

Arthur D. Little reviewed the following studies related to future costs and economic impacts of the paper industry's compliance with various environmental regulations to familiarize its project members with the analytical techniques employed and conclusions reached:

- "Economic Impacts on the American Paper Industry of Pollution Control Costs," by URS Research Company to the American Paper Institute, September 1975.
- "Capabilities and Cost of Technology Associated with the Achievement of the Requirements and Goals of the Federal Water Pollution Act Amendments of 1972 for the Pulp and Paper Industry," by Hazen and Sayer, Inc., to National Commission on Water Quality, March 1975.
- "A Pilot Study on Measuring the Economic Impact of Water Pollution Abatement, Pulp, Paper, and Paperboard Mills, SIC 2611, 2621, 2631" by National Bureau of Economics Research to the National Commission on Water Quality, June 1975.
- "Capacity Creation in the Basic Materials Industry, Preliminary Draft by Barry Bosworth, Brookings Institution, August 1976.
- "Price Increases and Capacity Expansion in the Paper Industry," Council on Wage and Price Stability, December 1976.
- "The Environmental Regulation Impact Study on the Pulp and Paper Industry," draft report by U.S. Department of Commerce, December 1976.

CHAPTER II
INDUSTRY DESCRIPTION

II. INDUSTRY DESCRIPTION

This chapter describes the economic and financial characteristics of the pulp and paper industry that were considered relevant in the economic impact analyses which follow.

A. CHARACTERISTICS OF THE PAPER AND ALLIED PRODUCTS INDUSTRY

The pulp, paper and paperboard product sectors that are the subjects of this analysis are the primary product production components of the paper and allied products industry, which also encompasses timber sales and paper/paperboard conversion to end products.

With sales of about $32 billion in 1975, the total industry ranked tenth among the 15 major U.S. manufacturing industries and accounted for about 4% of the total shipment value of U.S. manufacturing output. This industry includes the manufacture of pulp (from wood and other fibrous raw materials), and paper and paperboard (from pulp and wastepaper), and conversion of the latter into end products such as boxes, stationery, and sanitary tissue. In 1975, the industry employed 643,000 people or 0.8% of the total U.S. working force (3.7% of manufacturing industry employment) and had total assets at book value of $28 billion.

The industry generates about 45% of its own heat and power requirements. Nevertheless, it is the third largest purchaser of electricity and fuels among all U.S. industries and in 1974 accounted for about 10% of total industrial energy purchases.

The industry was the fourth largest user of water according to the latest available data (1972 Census), accounting for roughly 17% of the water consumed by manufacturing establishments that year. Most of the paper industry's water use is for processing of wood pulp and as the medium for carrying the pulp to produce paper and paperboard. In contrast, most water use in other manufacturing industries is for cooling and boiler feed where the water is not intermingled with the product and the pollution problems are therefore mitigated.

The paper industry employs a relatively high ratio of capital per dollar of sales. With its sales-to-assets (book) ratio of 1.14 in 1975, the paper industry is the fifth most capital intensive among the 15 U.S. industries (Table II-1). This measurement, however, understates the true asset size of the paper industry. Many companies carry substantial timberland properties on their books at original purchase prices, which are well below present market value.

Vertical integration is the prevalent corporate structure in this industry. About 72% of current U.S. pulp, paper, and paperboard production comes from mills that are integrated in three tiers: 1) control of a portion of the woodlands required for their wood supply, 2) pulping, and 3) paper and paperboard production operations. Paper and paperboard mills which are not integrated to pulp or woodlands operations supply the remaining 28% of industry production. However, many of these, as well as most of the integrated mills are forward integrated to paper or paperboard converting operations such as stationery, tissue and boxes. Thus the typical paper company is integrated to three or four levels.

Considering its capital intensiveness and the apparent advantages of vertical integration, this industry is relatively fragmented in terms of the number of companies and number of plants that operate within it. In 1974, approximately 410 companies operated 718 pulp, paper, paperboard and building paper mills or mill complexes. The converting sectors of the industry are even more fragmented. The degree of concentration varies considerably among the industry's primary product sectors, as described in Volume II. There has been no pronounced historic trend toward increasing concentration for the aggregate production of pulp, paper, and paperboard.

TABLE II-1

SALES TO ASSETS RATIOS FOR PAPER AND OTHER MANUFACTURING INDUSTRIES, 1975

	Sales/Assets*
Petroleum and Coal Products	1.00
Primary Metals	1.02
Instruments and Related	1.07
Chemicals and Allied Products	1.10
Paper and Allied Products	1.14
Machinery Except Electrical	1.16
Stone, Clay and Glass Products	1.24
Printing and Publishing	1.26
Rubber and Miscellaneous Plastics Products	1.31
Electrical and Electric Equipment	1.32
Transportation Equipment	1.40
Textile Mill Products	1.50
Fabricated Metal Products	1.56
Food and Kindred Products	2.12
Tobacco	2.54

*Ratios are based on data for the fourth quarter of 1975, assets are at book value.

SOURCE: Federal Trade Commission, Quarterly Financial Report for Corporations.

In 1975, the United States accounted for about 35% of the world's production and 37% of total world consumption of paper and paperboard products. Thus, while the country is a large exporter (mainly pulp and kraft linerboard), on balance it is a net importer, primarily because of the large amounts of newsprint and pulp it imports from Canada.

B. DEFINITION OF INDUSTRY SECTORS TO BE ANALYZED

1. Aggregate Industry Subdivisions

This analysis focuses on certain sectors of the paper industry that involve the production of pulp and primary paper and paperboard products. The processes employed generate substantial amounts of water and air pollutants; to meet the requirements of Federal and state environmental regulations the companies already have invested large amounts of capital for control facilities.

Converting operations are included in the price and closure analyses only to the extent that some converting (predominantly tissue) is usually done at the paper mill site; in these cases, the employment and value added for converting are integral to the mill's paper production. All other converting operations that are generally separated from the paper mills (such as containers, boxes, and bags) were excluded. Converting operations generally have relatively minimal pollution problems and will be subject to a different set of effluent guidelines and regulations than the paper and paperboard sectors.

Table II-2 provides an overview of all primary sectors of the pulp and paper industry in terms of the latest available U.S. Department of Commerce data (1972). A total of 787 establishments with gross fixed assets of about $14 billion employed about 220,000 people to produce products worth about $12 billion in 1972.[1] Thus, the value of shipments for the primary processing sectors amounted to about half of the industry's total and the sectors accounted for about 30% of the industry's employment.

The largest primary SIC subdivisions are paper mills and paperboard mills. Most of the production in both these sectors comes from mills integrated to on-site pulp production. However, many mills, particularly in the paper sector, are included that rely on purchased "market" pulp and wastepaper for their fiber raw material.

The so-called "market" pulp mills specialize in either paper grade pulp, dissolving pulp, or a combination of both. Paper grade pulp, an intermediate product, is sold primarily to non-integrated or partially integrated paper mills. A substantial amount of market pulp also is sold by pulp producers that are integrated to paper or paperboard.

In 1972, the total value of pulp shipped by all market pulp producers was $1.1 billion. Of this, $658 million, or 58%, was shipped by plants in the pulp mills sector (SIC 2611) while the remaining $442 million (42%) was shipped by mills classified as paper mills (SIC 2621) or paperboard mills (SIC 2631).

1. These figures include 25 building board mills which are not considered as part of the paper industry in this study. The USDC mill count is also higher than that used by Arthur D. Little, Inc., because of finer separation of establishments in multimill complexes.

TABLE II-2

MAGNITUDE OF ALL PULP, PAPER AND PAPERBOARD SECTORS - 1972

SIC Code	Sector	Number of Establishments	Number of Employees	Value of Shipments ($ million)	Gross Value[a] Fixed Assets ($ million)	Shipments/ Assets/Ratio
2621	Paper Mills	358	130,000	6,400	7,600	0.84
2631	Paperboard Mills	276	68,000	4,100	4,400	0.93
2661	Building Paper and Board Mills	95	12,000	470	400	1.18
2611	"Market" Pulp Mills	58	11,000	690	1,600	0.43
	TOTAL	787	221,000	11,600	14,000	0.83

[a]1971 data; 1972 data not yet available.

SOURCE: 1972 Preliminary Census of Manufactures U.S. Department of Commerce.

2. Process/Product Sectors Studied

For this impact analysis the primary pulp, paper and paperboard segments were subdivided into the 12 process and product sectors shown in Table II-3. These process-oriented subcategories were employed in EPA's water effluent guidelines study of this industry; they were chosen on the basis of similar production and pollution loading characteristics. The 12 sectors include about 162 fewer mills than the total industry because the Guidelines and Impact studies exclude building board and specialty paper mills. Following are summaries of the studied process/product sectors which are amplified in Appendix A (Volume III):

The *unbleached kraft* process is employed almost exclusively to produce unbleached kraft paperboard (primarily linerboard, the facing material for corrugated containers) and unbleached bag, sack, and coarse papers. It produces high strength, relatively low cost packaging products.

NSSC corrugating medium is the inner fluting material used for corrugated containers. It employs a high-yield, low-cost but weak pulp suitable for its role as a partition between two layers of linerboard. This product is often made adjacent to a linerboard mill to minimize water effluent costs by using a joint chemical recovery system.

Recycled paperboard is a product group consisting of paperboard made predominantly from coarse recycled paper (e.g., newsprint, corrugated containers, cartons) that is not deinked or bleached. Major products include folding boxboard, corrugating medium, linerboard, gypsum wallboard facing, cardboard and specialty boards.

TABLE II-3

PAPER INDUSTRY PROCESS SECTOR SUBDIVISIONS FOR EFFLUENT GUIDELINES ANALYSIS

Process Sectors	Number of Mills End of 1975	Total Product Capacity-1974[1] (1000 tons)	Average[4] Mill Size (tons/day)
Unbleached Kraft	29	9,100	900
NSSC[2]	18	2,900	460
Unbleached Kraft and NSSC	10	5,400	1,540
Recycled Paperboard	160	9,100	165
Construction Paper	70	2,300	95
Bleached Kraft	80	26,000[2]	925
Sulfite	28	4,300	440
Soda	3	300	285
Mechanical[3]	22	2,500	325
Deinked	35	2,300	190
Nonintegrated Tissue	59	1,700	80
Nonintegrated Printing /Writing	42	2,400	160
TOTAL	556	68,300	

[1]Includes all products produced at mills.

[2]Includes one mill producing printing/writing paper; rest produce corrugating medium.

[3]Includes chemi-mechanical mills.

[4]Based on total mill products.

SOURCES:
- Lockwood's Directory of the Paper and Allied Trades-1976.
- Arthur D. Little, Inc., estimates.

Construction paper is produced mainly from coarse wastepaper although significant amounts are also made from groundwood pulp. Its primary applications are roofing felt, underlayment paper, and asphalt shingles.

The *bleached kraft* process is used to produce both dissolving pulp and paper grade pulp. The latter is employed primarily in bleached paperboard, bleached packaging papers, newsprint and groundwood specialty papers, tissue and printing/writing papers.

The *sulfite* process competes directly with kraft in the dissolving and paper pulp markets and also in producing newsprint, groundwood specialty papers, tissue and printing/writing papers. Sulfite is being displaced gradually by kraft.

A third chemical pulping process, *soda,* has been displaced almost completely by kraft. Only three U.S. printing/writing paper mills now employ this process.

Several *groundwood* or mechanical pulping processes are used primarily to produce newsprint and both coated and uncoated groundwood papers. A minor application, molded pulp, has been excluded from the analysis because water effluent guidelines have not been issued for this sector.

Deinking of printed wastepaper is finding increasing use in producing recycled newsprint, tissue and printing/writing papers. It is often the only feasible means for nonintegrated mills to become at least partially integrated to pulping and thus reduce their fiber costs.

Nonintegrated paper consists of two product sectors: tissue and printing/writing papers that are made primarily from purchased pulps. Nonintegrated mills which make coarse papers such as bag and special industrial papers were excluded because water effluent guidelines have not as yet been finalized for this sector.

Sixteen *cotton linter* mills that produce pulp from cotton were also excluded from the analysis because applicable water effluent guidelines have not been issued. Cotton linter or rag pulp finds it major use in printing/writing and special industrial papers.

In sum, the analyzed process sectors include 78% of the industry's mills, and 93% of its primary product production and employ about 267,000 people including workers associated with converting tissue and printing/writing paper at the mill site.

3. Studied Product Sectors and Relationship to Process Sectors

While pollution control technology and costs vary with each pulping and papermaking process, the impacts of the costs are primarily a function of the market characteristics of the industry's products. The paper industry is made up of a number of subindustries built around major product categories. For this analysis, the numerous product categories were aggregated into 10 paper/paperboard and two market pulp sectors. These were selected on the basis of: (1) having common applications or markets, or (2) combining products customarily produced within a single mill. Many of the product sectors use a variety of pulping processes. Table II-4 indicates the relationships of the 10 paper/paperboard product groups to the pulping processes employed by showing pulp consumption by type.

TABLE II - 4

PROCESS/PRODUCT RELATIONSHIPS - WOODPULP CONSUMED BY TYPE, 1973

(Type of Pulp Consumed Divided by U.S. Product Production)

Pulp Type	Newsprint & Un-Coated Groundwood	Printing & Writing Paper	Tissue Paper	Bleached Board And Bristols	Packaging Papers Unbleached	Packaging Papers Bleached	Unbl.Kraft Paperboard	NSSC Paperboard	Recycled Paperboard	Const. Paper**	Specialty Papers
Bleached Kraft	17.5%	54.6%	40.0%	100.5%	7.8%	86.2%	5.2%	-%	3.9%	-%	51.2%
Unbleached Kraft	Small	2.7	5.5	2.3	94.6	7.7	94.0	7.0	1.7	-	19.9
Bleached Sulfite	Small	8.9	20.8	1.4	-	7.4	Small	-	Small	-	12.1
Unbleached Sulfite	5.1	Small	1.5	Small	-	1.8	Small	-	Small	-	Small
Groundwood	66.3	6.3	3.9	Small	Small	-	-	Small	1.1	3.0	1.6
Semi-Chemical	Small	3.2	2.3	Small	Small	Small	-	69.1	Small	Small	Small
Dissolving	-	Small	Small	-	-	Small	-	-	Small	-	2.7
Soda and Other Woodpulp	Small	6.2	1.6	Small	Small	Small	1.1	-	Small	33.0	1.8
Wastepaper	11.3	8.2	29.2	-	2.3	Small	2.9	23.5	107.3	72.0	28.2
Other Fibers	Small	Small	1.0	Small	-	Small	-	-	Small	2.0	22.3
TOTAL*	103.8%	92.0%	105.8%	106.9%	105.6%	105.6%	103.4%	100.4%	115.8%	110.0%	141.4%

*Excess over 100% primarily reflects fiber losses, while figure below 100% is due to coatings and other additives.

**Arthur D. Little, Inc., estimates.

SOURCE: American Paper Institute restructured data.

The processes used to make the various pulp and paper products are directly related to the types of pulp that best fit the desired product properties. Certain products are synonymous with a particular process: e.g., unbleached kraft paper and paperboard, NSSC (neutral sulfite semi-chemical paperboard and bleached kraft) board and bristols. The remaining product groups are made by a variety of processes, and usually with a blend of different pulps.

Since process characteristics and costs vary considerably, this factor causes differences in the cost competitiveness of various producers as well as in their costs for pollution abatement.

Table II-5 shows the 1974 U.S. capacity for the 12 product groups included in the analysis and points up the leading positions of the unbleached kraft paperboard and printing/writing paper sectors. Each sector is discussed separately in Volume II to illustrate its demand/supply/price characteristics, export/import trends, price impacts, output effects and likelihood that supply shortages will occur as a result of the studied environmental regulations.

C. HISTORICAL REGIONAL DEVELOPMENT

The U.S. pulp and paper industry began in New England in the 1880's with the development of groundwood pulping, sulfite pulping, and papermaking to supply the growing paper needs of the Northeast. The proximity of the expanding population centers to water and high-quality softwood pulpwood resources in northern New England and New York State were key contributors to this early development.

Gradually, however, the need for substantial wood supplies for pulping (as well as for lumber and plywood) outstripped the resources of the Northeast. Many of the mills, particularly those nearest the population centers, closed their pulping facilities and turned to purchased pulp, or, in some cases, deinked wastepaper for their fiber requirements. The pulp and paper industry moved its production base to the North Central States, then to the Pacific Northwest and finally to the South as the population spread from the eastern seaboard.

The movement to the South in the late 1930's was prompted by the commercialization of the kraft process, which enabled mills to use the resinous wood that grows there. The industry flourished in that region because of the availability of low-cost wood, favorable timberland acquisitions from defunct lumber companies during the depression, plentiful fossil fuel, and a lower cost area for new industrial construction than in the Northeast. About 64% of the industry's pulping capacity and 49% of its papermaking capacity are now located in the South (Figure II-1).

Because of this pattern of development, the older, smaller, nonintegrated and generally less productive mills tend to be located in the Northeastern and North Central States, while the newer, larger, and integrated mills are located in the South and Pacific Northwest. Table II-6 shows this regional distribution.

D. TECHNOLOGY AND PRODUCTIVITY TRENDS

Pulp and papermaking technology has been refined over many years of development. Recent technology advances in this industry have been almost exclusively evolutionary refinements (rather than breakthroughs), or adaptations of outside technology (e.g., computerized process control) to the paper industry. Nevertheless, the refinements have significantly improved pulp and papermaking technology and productivity. For example, theremo-mechanical pulp provides quality advantages and cost savings over the conventional stone or refiner groundwood

TABLE II-5

PULP AND PAPER INDUSTRY PRODUCT SECTORS

Sector	Number of U.S. Suppliers	1974 Capacity 000 Tons	1974 Capacity % Total
Unbleached Kraft Paper	∿20	4,389	7.1
Unbleached Kraft Paperboard	30	13,965	22.6
NSSC Medium	30	4,430	7.2
Recyled Paperboard	∿90	8,680	14.0
Construction Paper	19	2,165	3.5
Bleached Market Pulp	∿25	3,711	7.8[1]
Dissolving Pulp	8	1,824	3.8[1]
Printing and Writing	74	11,613	18.8
Bleached Board and Bristols	21	5,155	8.3
Tissue	51	4,322	7.0
Newsprint and Uncoated Groundwood[2]	∿20	5,002	8.1
Bleached Packaging Paper[2]	∿19	1,291	2.1
TOTAL (excluding pulp)		61,012	98.7
Total Paper and Paperboard[3]	∿400	61,881	100.0
TOTAL PULP[4]		47,540	100.0

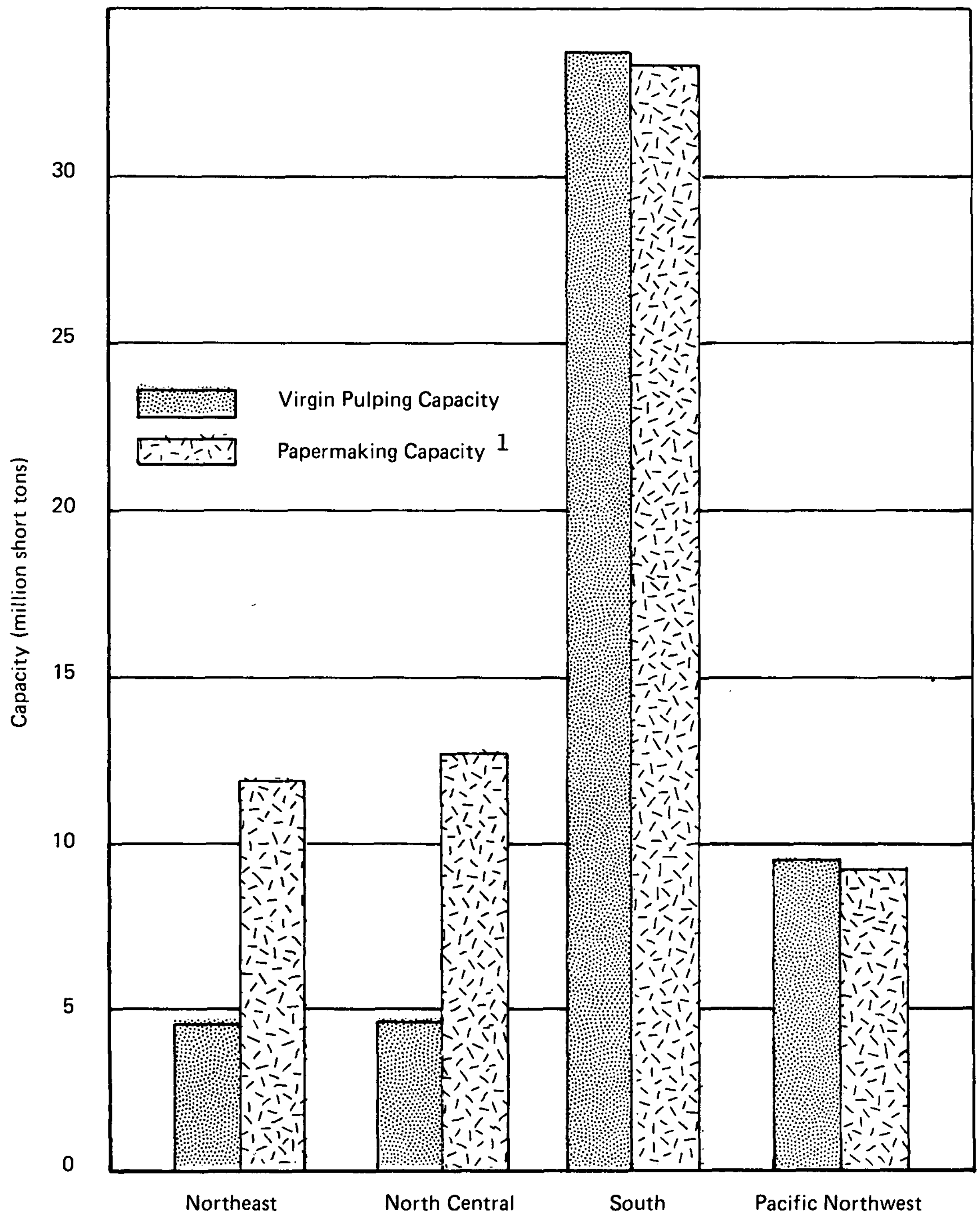
[1]Based on total pulp.

[2]Uncoated groundwood and bleached packaging papers were not included in the econometric analysis.

[3]Excludes insulating and hard-pressed board.

[4]Excludes defibrated/exploded and screenings since products not applicable for this.

SOURCES: American Paper Institute
Arthur D. Little, Inc., estimates.



Source: "Paper/Paperboard/Wood Pulp Capacity," API — 1975–1978

[1] All grades of paper and paperboard.

FIGURE II–1 YEAR-END CAPACITIES FOR VIRGIN PULP AND PAPERMAKING, BY REGION – 1975

TABLE II-6

REGIONAL DISTRIBUTION OF U.S. PULP AND PAPER MILLS - 1975
(numbers of mills)

Sector	Northeast	North Central	South	West	Total
Unbleached Kraft	0	1	25	3	29
NSSC	2	10	5	1	18
Unbleached Kraft and NSSC	0	0	7	3	10
Recycled Paperboard	60	53	28	19	160
Construction Paper	16	16	29	9	70
Bleached Kraft	11	7	47	15	80
Sulfite	4	11	1	12	28
Soda	1	0	2	0	3
Groundwood[1]	10	7	1	4	22
Deinked	14	15	1	5	35
Nonintegrated Printing, etc.[2]	19	19	2	2	42
Nonintegrated Tissue	33	11	12	3	59
TOTAL	170	150	160	76	556

[1]Includes Chemi-Mechanical mills.

[2]Excludes cotton fiber mills.

SOURCES: Lockwood's Directory of Paper and Allied Trades -1975. Industry Sources.

processes. Almost every major paper machine component (particularly the headbox, and wire) has been improved recently. In addition, a number of chemical pulping processes are also under development which offer potentially higher pulp yields or lower pollution loadings than the conventional kraft and semi-chemical processes.

Most mills reinvest or periodically "rebuild" components of their pulping and papermaking equipment. In these rebuilds, the bottlenecks to higher production rates are replaced with more productive equipment. Thus a typical mill usually continues to improve productivity until the mill is too obsolete to warrant further investment.

Technical developments, coupled with rebuild programs and increasing scale of operations for new and expanded mills and closures of less efficient facilities, have improved paper industry productivity at a relatively steady rate. According to Bureau of Labor Statistics, the industry average productivity increased about 4.5% per year between 1960 and 1969 and 3.9% per year between 1969 and 1974 (reflecting growth between years with comparable capacity utilization rates).[2] The industry's rate of productivity improvement will probably continue to decline because of slower demand and capacity growth and a peaking of new mill sizes. However, continued technology refinements and perhaps some future breakthroughs should improve productivity at least at a modest rate.

The paper industry on average spends about 0.8% of its sales revenues on research and development, split about equally between product research and process development. In addition, paper companies obtain important R&D support from suppliers of process equipment and chemicals.

The industry's process research is heavily oriented toward projects that are directed primarily at reducing air and water effluents (and hence control costs) from pulping and papermaking processes. Often these research projects also reduce production costs. For example, 14 of the 17 recent significant process developments reviewed in Appendix C (Volume III) are aimed primarily at reducing air or water effluents.

E. ECONOMIC CHARACTERISTICS

This section addresses the salient characteristics of demand, supply, prices, and general competitive characteristics of the pulp and paper industry that were considered in the economic impact analysis.

Demand

As a whole, pulp and paper is a mature industry. Total demand for its products has grown at only about the same rate as the GNP in real terms. In fact, only a few product sectors are growing faster than GNP. The industry's growth appears to be gradually declining below the GNP rate because prices have increased rapidly of late, the full per-capita consumption potential has almost been attained and some competing products have substituted. At the same time, entry to the industry and expansion of capacity are becoming more difficult. Thus its capacity expansion rate is more likely to also be slower and paper prices more likely to rise at least as fast as the general inflation rate.

2. Labor costs, however, represent only about 15% of the total costs of the pulp, paper and paperboard industry segments.

U.S. per capita consumption of paper and paperboard products is significantly higher than that of any other country. In 1975, for example, U.S. annual per capita consumption was 524 pounds: the next closest country was Sweden at 490 pounds and Canada was third at 350 pounds. Per capita consumption in the underdeveloped regions is well under 100 pounds.

Few substitute materials compete directly with paper and paperboard products. The exceptional products primarily affected are tissue, bleached paperboard and both unbleached and bleached packaging papers. Tissue products have displaced reusable cloth towels, napkins and handkerchiefs, in achieving their relatively high rate of growth in the 1950's and 1960's. The growth rate of bleached paperboard has diminished primarily because of substitution by plastic packages for milk and other dairy products and in disposable plates, cups, and trays. Unbleached and bleached packaging papers have been growing very slowly, primarily because of substitution by polyethylene and other plastic films.

On the raw materials side, bleached market pulp competes with the cleaner "pulp substitute" grades of wastepaper, primarily in the production of printing and writing papers and tissue. It also competes to a limited degree with cotton fibers in certain high-quality writing papers. There are no direct substitutes for dissolving pulp, but 70% of its output is consumed in cellulosic fibers and cellophane, which compete strongly with fibers and films derived from petroleum products.

Historically, paper prices actually declined relative to the wholesale price and GNP deflator indices during 1960-72. This decline probably stimulated demand and the consumption correlation with GNP might not have held had real paper prices risen. However, this stable price pattern changed dramatically in 1973. The 18-month period from mid-1973 through year end 1974 saw an average increase (in current dollars) of 37% for pulp and paper products compared with 27% for the wholesale price index. Prices of a number of individual pulp and paper products increased by well over 100%.

It is generally believed that demand for most of the industry's products is relatively insensitive to price changes. Key supporting factors are that few substitute products compete directly with paper and that direct or indirect expenditures on paper products represent a small portion of the consumer's total disposable income.

The econometric analysis in this study confirmed that the demand for paper is price inelastic. The average percent reduction in demand due to a price increase is about two-thirds of the percent price increase relative to the GNP deflator. This estimate is based upon price, demand, and U.S. economic trends from 1968 through 1975. It is possible that the effects of the unprecedented rapid price increases that occurred in 1973-74 have not yet been reflected fully in the subsequent consumption data and that the long-term price elasticity of demand will be higher than the present estimate.

Supply

Short-term supply potential in this industry can be measured by annual published capacity data for each major product group and for nearly every pulp and paper mill. The product group data are derived by the American Paper Institute (API) through annual surveys of current capacity and planned expansions of all pulp and paper manufacturers. These surveys provide reasonably accurate capacity projections for the next three years. Thus, the data can be compared with the industry's current and projected production data to indicate average mill operating rates in each sector.

The API defines "practical maximum capacity" as the tonnage of paper, paperboard, or pulp of normal commercial quality that could be produced with full use of equipment and adequate supplies of raw materials and labor, assuming full demand. No allowance is made for losses due to unscheduled shutdowns, strikes, temporary lack of power, etc., which decrease actual production, but not production capacity. The capacity of paper machines which produce more than one grade is apportioned in accordance with actual production patterns and plans for future operation.

As a result of the unscheduled production losses noted above, few product sectors can operate at full capacity over a full year. For most sectors, full annual operation means a 95-96% operating rate. Chief exceptions are dissolving pulp and bleached board, where the producers report capacity more conservatively and thus have attained 100% annual operating rates.

The short-term supply curves in this industry are nearly horizontal and then rise very steeply as production costs increase when the mills are run continually at higher operating rates. To increase production some mills can simplify their product line and emphasize heavier weight products, but there are few other opportunities. Pulp and paper mills are run on a three-shift basis because of the time and costs associated with mill shut-downs and start-ups. For the same reason, most mills run on a seven-day-per-week basis, although some of the smaller mills (typically those that are not integrated to pulp) run on a five-day-per-week schedule.

Paper machines and pulp mills require a certain amount of maintenance down-time. This time is scheduled throughout the year and factored into the capacity rating for each mill. When the industry is straining to meet demand, a certain amount of maintenance down-time can be foregone, temporarily, but this leads to machine breakdowns that cause production losses and require the use of overtime maintenance labor.

There are essentially three methods for increasing capacity over the longer term: incremental expansion of existing mills, installation of new paper machines, or construction of new mills. An incremental expansion is usually less than 50% of the original plant capacity and takes one to two years to complete once plans have been laid. This expansion route typically costs about half of a new mill's investment per ton of capacity because most support facilities are already in place. Construction of new mills typically takes three to four years once financing has been arranged and the necessary environmental clearances obtained. New-mill lead times, after preliminary planning, are typically 3-6 years. In the 1960's, the lead time was 2-4 years. The longer time has increased the uncertainty in planning for and investing in new mills and thus had an inhibiting effect on capacity expansions. New-mill costs recently have been rising at 10-20% per year and in 1975 typically were $150,000-200,000 per daily ton of capacity.

Table II-7 compares pulp, paper and paperboard mill capital expenditures with their net annual capacity expansions since 1965. The comparison indicates that since 1965 the industry has been able to increase capacity an average of 3.3% per year while its net plant expenditures (excluding pollution control equipment) have declined by about 2% per year (in current dollars) despite a high capital goods inflation rate. This apparent anomaly was caused by a dramatic shift to capacity expansions via additions to existing mills. In 1968, for example, new mills contributed 49% of the net capacity increment compared with only 7% of the expansions committed for 1976-1978.

TABLE II-7

CAPITAL EXPENDITURES AND CAPACITY EXPANSIONS FOR

ALL PULP, PAPER AND PAPERBOARD MILLS, 1965-1976

(Current Dollars)

	Total Capital Expenditures[1]	Pollution Control Component[2]		Net Plant Expenditures	Net Paper & Paperboard Capacity Increase Over Preceding Year[3]	
	$ MM	$ MM	% of Total	$ MM	M Tons	% of Total
1965	827	50	6.0	777	1,823	3.9
1966	961	65	6.8	896	3,337	6.9
1967	1122	76	6.8	1046	2,569	5.0
1968	766	93	12.1	673	2,262	4.2
1969	878	128	14.6	750	2,131	3.8
1970	882	187	21.2	695	580*	1.0
1971	755	203	26.9	552	1,750*	3.0
1972	841	339	40.3	502	2,861	4.7
1973	998	351	35.5	637	1,785	2.8
1974	NR	523	--	--	1,305	2.0
1975	NR	645	--	--	1,006	1.5
1976		621	--	--	1,371	2.0
Avg. Annual Growth (%)	2.2	25.7		-2.1		3.3

*Unusually large number of mill closings significantly reduced net expansions in 1970 and 1971.

NR - Not yet released.

SOURCES: [1]U.S. Department of Commerce, Annual Survey of Manufacturers.

[2]National Council of the Paper Industry for Air and Stream Improvement, Inc., Special Report No. 76-05.

[3]American Paper Institute - Paper, Paperboard, Wood Pulp Capacity.

The table also shows the very rapid increase in expenditures for pollution control facilities that occurred as the industry made substantial efforts to comply with existing state and Federal requirements. Some capacity was expanded and chemical and energy saved by these expenditures, but such economic benefits were generally small and incidental to their primary purpose of reducing air and water effluents. While the industry's net plant expenditures declined as pollution expenditures rose, this does not necessarily imply a direct trade-off. Many other factors exerted an influence in reducing plant investment over this period.

Other factors that have contributed to the slowdown in net plant expenditures, particularly since 1967, include a growing scarcity of new or expandable mill sites that have an economic supply of wood, price controls, and management uncertainty over future economic cycles, governmental regulations, energy supply and cost inflation. As a result of these factors, fewer and fewer firms have available mill sites and the financial and woodland resources needed to make major capacity expansions.

The rising capital requirements for new mills coupled with the practical difficulties of finding enough suitable supporting woodlands to acquire or lease has limited the number of firms that are now able to finance major capacity expansions. Most major expansions are now being made by the large, well-capitalized firms that have already obtained substantial woodland ownership or control at prices considerably below today's market values.

Tables II-8 and II-9 show how capital requirements changed between 1965 and 1974, using as examples linerboard and bleached kraft pulp mills, the most capital intensive of the industry's product sectors. Over this period, the minimum economic mill size has nearly doubled and the investment per annual ton of capacity has more than doubled. Selling prices also have more than doubled so the mill investment-to-sales ratio increased only modestly. However, when the investment required to provide what is considered a minimum level of woodlands ownership coverage is added, one finds that both the total capital requirements and the investment per dollar of sales have escalated significantly.

Capacity expansion via mills that are not integrated to pulp is now virtually nonexistent, primarily because of low profitability. The present producers are caught in a squeeze between paper prices established by integrated producers and the costs for bleached market pulp, the price of which has escalated more rapidly than that of all other paper industry products.

The above trends also reduced the entry of new firms into the pulp and paper industry. The primary entry route for companies outside this industry is by acquisition of existing pulp and paper companies rather than by grassroots investment.

All of the above factors point to a slower rate of capacity expansion in the paper industry and increasing market concentration among the largest firms that have the resources to make major expansions. Pollution control regulations probably contribute to the increasing concentration trend because the larger firms generally will have greater financial ability, both to retrofit their existing mills to meet pollution regulations and to make large capacity expansions.

Prices

Comparison of the wholesale price indices (current dollars) for paper/paperboard and for all commodities since 1963 reveals that, until 1973, the paper price indices demonstrated a general

TABLE II-8

KRAFT LINERBOARD MILL CAPITAL REQUIREMENTS

IN 1964 AND 1974

(Current Dollars)

	1964	1974
Sales		
Size of Mill	700 TPD/238,000 TPY	1,000 TPD/340,000 TPY
Price (End of Year)	$110/Ton	$195/Ton
Annual Sales	$26 MM	$66 MM
Mill Investment	$40 MM	$135 MM
Investment per Annual Ton	$168	$397
$ Investment per $ Sale	1.5	2.1
Land Investment		
Acres Required for 100% Coverage[1]	420,000	510,000
Acres Required for 20% Ownership	84,000	102,000
Cost of Land per Acre	$200	$1,000
Total Land Investment	$17 M	$102 M
Total Investment for Mill & Land	$57 MM	$237 MM
$ Investment per $ Sales	2.2	3.6

[1] 1-1/2 Cord per Annual Ton; 1.2 acres per cord in 1964.
1-1/2 Cord per Annual Ton; 1 acre per cord in 1974.

Source: Arthur D. Little, Inc. estimates

TABLE II-9

BLEACHED KRAFT PULP MILL

INVESTMENT DECISION MADE IN 1964 AND 1974
(Current Dollars)

	1964	1974
Sales		
Size of Mill	450 TPD/150,000 TPY	800 TPD/270,000 TPY
Price (End of Year)	$145/Ton	$335/Ton
Annual Sales	$22 MM	$90 MM
Mill Investment	$40 MM	$170 MM
Investment per Annual Ton	$267	$630
$ Investment per $ Sale	1.8	1.9
Land Investment		
Acres Required for 100% Coverage[1]	375,000	540,000
Acres Required for 20% Ownership	76,000	108,000
Cost of Land per Acre	$200	$1,000
Total Land Investment	$15 MM	$ 108 MM
Total Investment for Mill & Land	$55 MM	$278 MM
$ Investment per $ Sales	2.5	3.1

[1] 2 Cords per Annual Ton; 0.8 cords per acre in 1964.
2 Cords per Annual Ton; 1 cord per acre in 1974.

Source: Arthur D. Little, Inc., estimates.

pattern of stability and rose more slowly than the all-commodity index (Figure II-2). In deflated dollars, paper/paperboard prices declined by 19% and all commodities by 14% between 1960 and 1972. Between 1973 and 1975, however, both indices, but especially the paper/paperboard index, rose faster than the general inflation rate.

The relative stability and modest increases in nominal pulp and paper prices in the 1960's and early 1970's can be explained by a combination of factors. The slow rate of increase can be attributed to the fact that capacity was rapidly expanded, causing several cycles of oversupply, and prices were held down as producers tried to expand their market share, increase volume and more fully utilize their woodlands, large acreages of which had been acquired recently. Also, primarily as a result of economies of scale, the addition of new capacity and the improvement or replacement of old facilities, the industry was able to improve productivity by about 4.5% per year, which helped to stabilize costs. Finally, the industry experienced only a modest rate of cost inflation for raw materials and energy because both were in ample supply in the 1960's.

Just the opposite set of conditions led to the very rapid price increases in 1973 and 1974. First, the industry's rate of productivity increase dropped to 3.9% per year in the early 1970's as its rate of capacity expansion decreased sharply and as new-mill economies of scale reached practical limits. Second, raw material, energy and labor costs began to inflate at a much faster rate than in the past, but could not be passed on through price increases in the weak markets and low mill operating rates of 1970-1972. When most pulp and paper markets rebounded strongly in 1973, prices started to climb, but the increases were held in check by Federal price controls. Then as demand continued to grow and approached the industry's practical maximum capacity in 1974, price controls were lifted partially in March and fully in July. This, coupled with capacity constraints, caused the industry's prices to surge, not only absorbing the cost inflation the industry had been unable to pass on since 1969, but also bringing profit margins to a post-World War II high.

Figure II-3 shows that the relationship between average paper industry prices and capacity utilization rates (a surrogate for supply/demand equilibrium) is imperfect. This imprecision is caused partially by the fact that the paper/paperboard price index employs list prices for a number of large commodities which do not reflect the full amplitude of true market price swings. The econometric analysis in this study utilizes actual market prices for the major product sectors. However, even these prices do not track closely with capacity utilization. This indicates that the industry is not perfectly competitive and/or that the other causal factors discussed earlier mask the price/capacity utilization relationship.

Price leadership has been noticeable in several of the more concentrated product sectors. The North American newsprint industry exhibited the most clear pattern of price leadership. The dominance and concentration of the Canadian industry has had an important influence since Canada supplies about two-thirds of U.S. demand. John Guthrie[3] has documented the newsprint price changes that have occurred between 1950 and 1970. His data indicates that price changes in this period were initiated by six Canadian and U.S. companies.

3. John A. Guthrie, *An Economic Analysis of the Pulp and Paper Industry*, Washington State University Press, 1972.

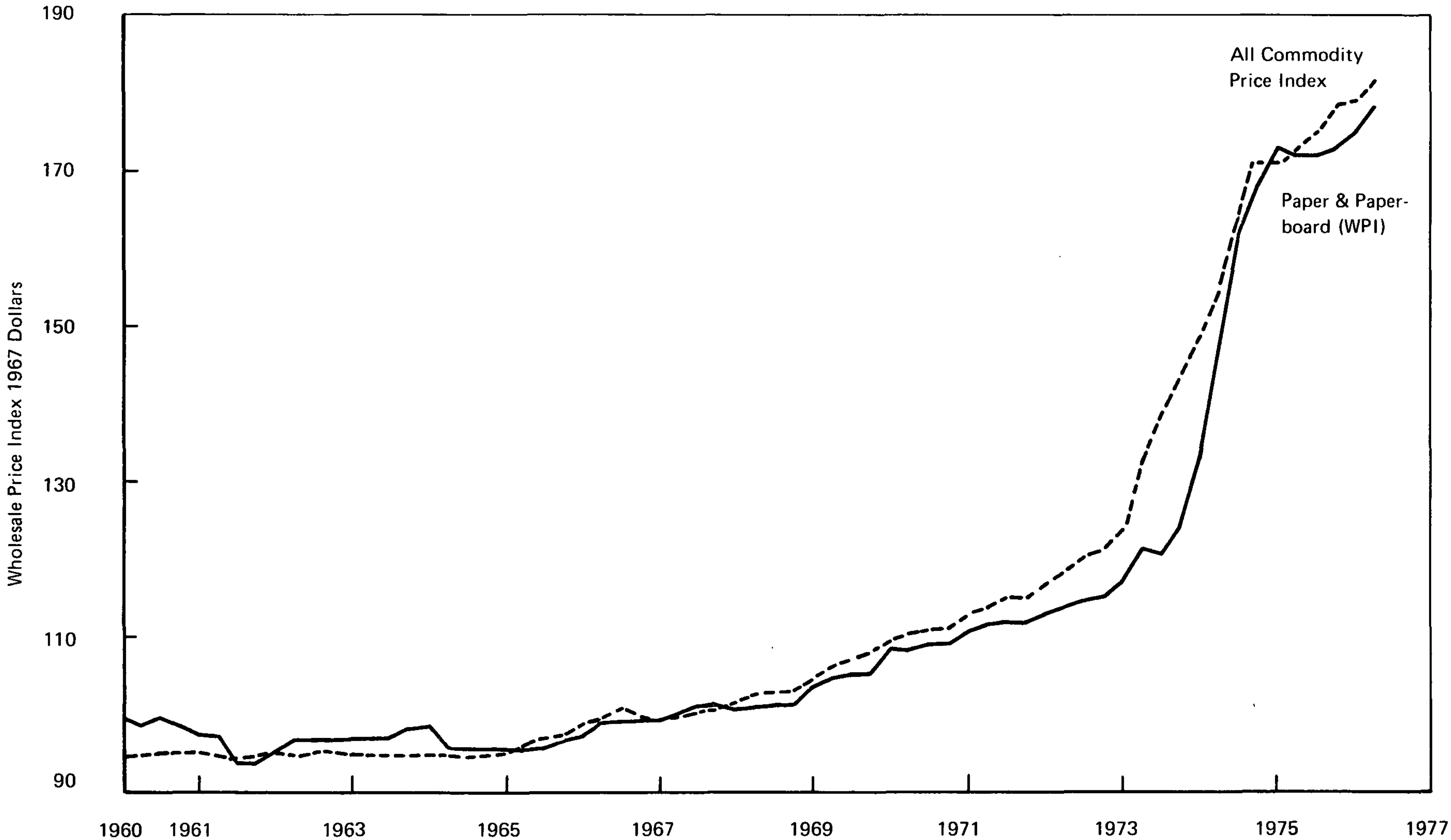
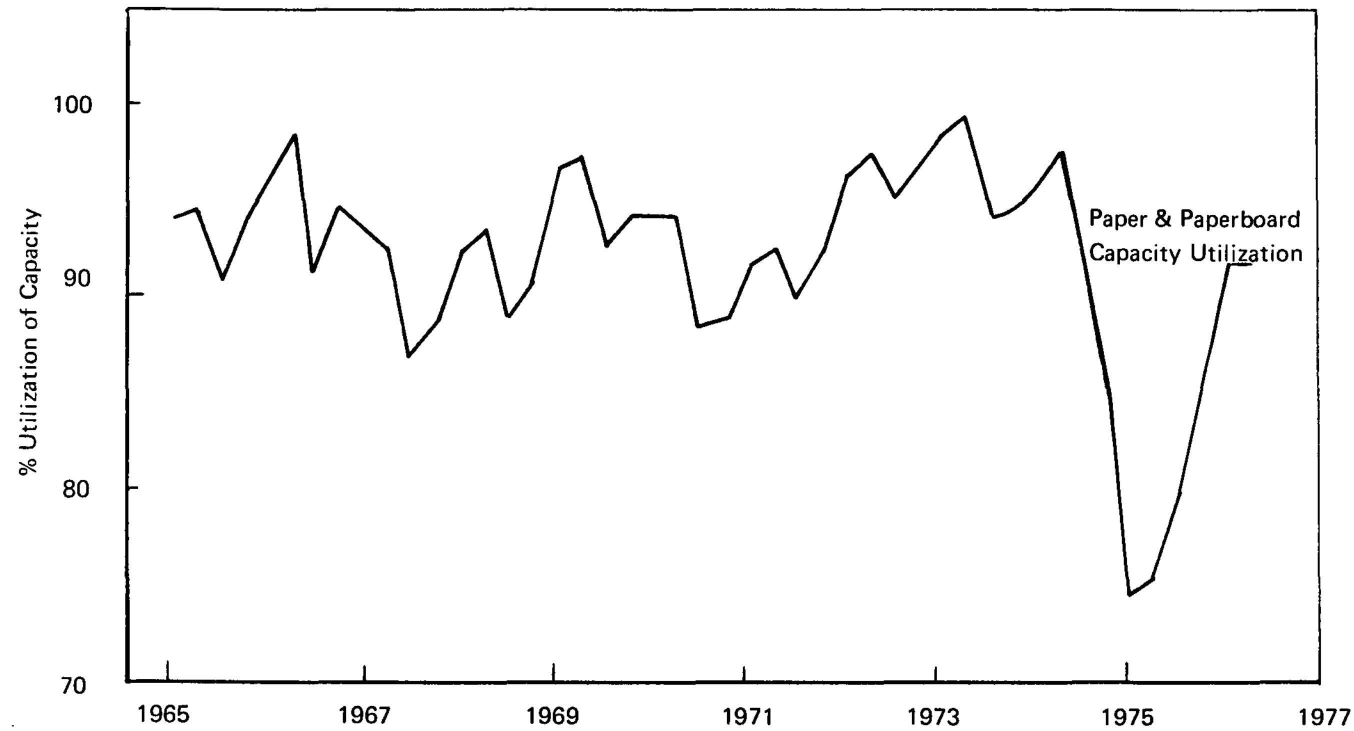


FIGURE II-2 PAPER & PAPERBOARD WHOLESALE PRICE INDEX (WPI) AND ALL COMMODITY PRICE INDEX



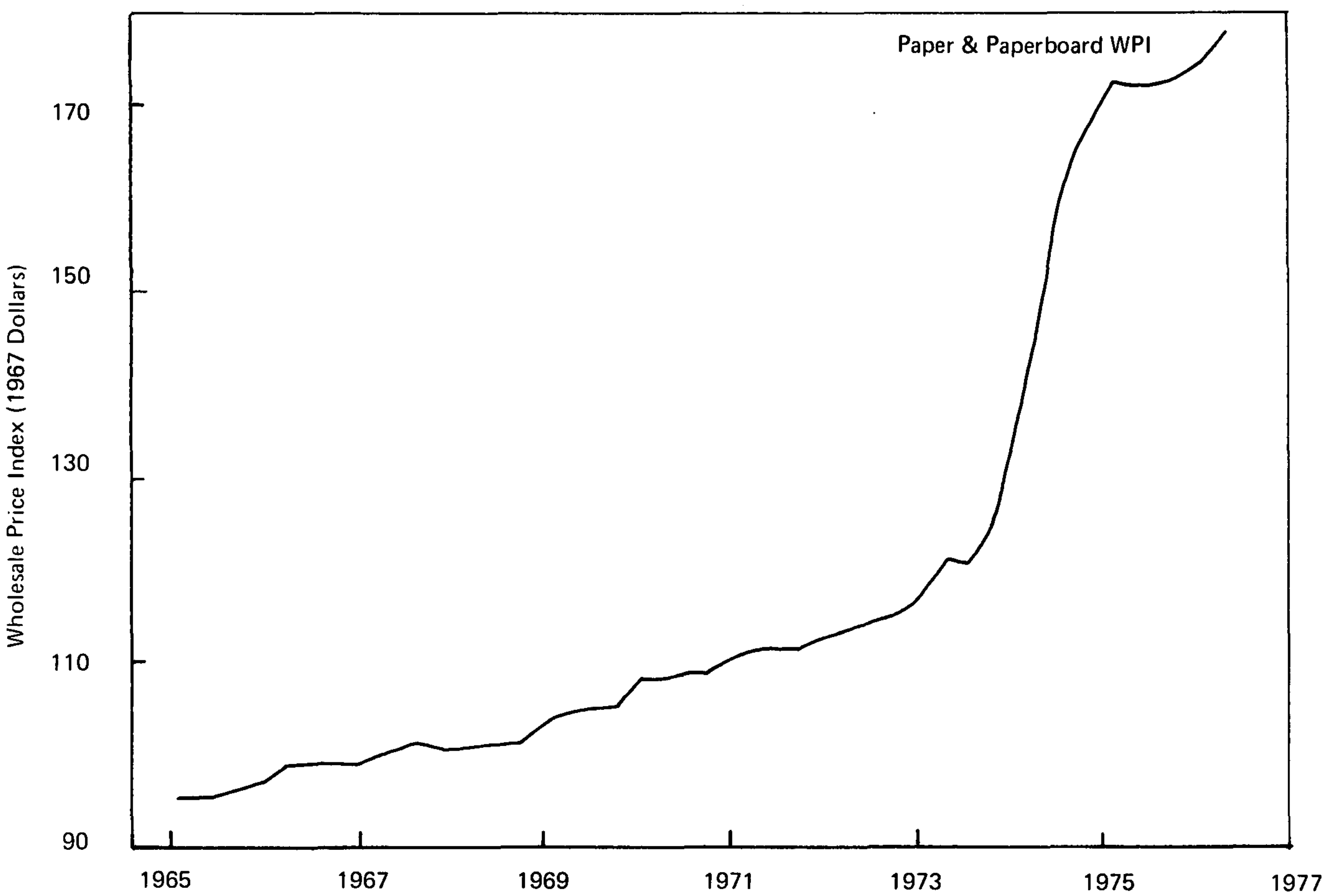


FIGURE II–3 PAPER & PAPERBOARD WHOLESALE PRICE INDEX AND UTILIZATION OF CAPACITY

Like newsprint, paper grade pulp supply is relatively concentrated, and Canadian producers currently supply about 60% of U.S. requirements. The dissolving pulp market has the characteristics of a bilateral oligopoly (few suppliers sell to a small group of buyers) and transactions are made through long-term contracts which tend to stabilize prices. List prices for paper grade pulp also appear stable, but actual prices are more volatile than dissolving pulp's since there usually is considerable discounting under list prices during weak markets and a greater incidence of premium spot prices during tight markets. During the U.S. price controls of 1973-1974 and continuing through the weak markets of 1975-1976, Canadian producers were able to price considerably above most U.S. mill prices because of their generally better pulp quality and their large share of the market.

With the possible exception of bleached paperboard and kraft linerboard, price leadership patterns are not evident in the other product sectors. Most other sectors have many competitors and are less capital intensive. Their prices have changed more frequently, and generally prices have increased at faster rates than prices of newsprint, bleached paperboard or linerboard, but more slowly than prices of dissolving and paper grade pulps.

Trend Toward Increasing Market Concentration

Volume II discusses the current competitive structure of each major product sector. In general, they fall within the spectrum from oligopolistic (e.g., dissolving pulp with eight competitors), to something approaching perfect competition (e.g., recycled paperboard with about 90 competitors). International competition is important in only a few sectors: newsprint where the United States is a substantial importer, linerboard where it is an important exporter, and pulp where it is both a significant importer and exporter. Thus, with these exceptions, the United States is essentially a self-contained market for other paper and paperboard products.

Although market share concentration in the paper industry's product sectors changed very little through 1972 (according to the latest U.S. Department of Commerce statistics) recent developments indicate concentration will increase. The primary causes are the mounting barriers to entry discussed previously. Relatively slow growth in demand for the industry's products, coupled with increasing capital intensiveness as mill sizes, woodlands requirements, and plant costs rise in this industry have discouraged most smaller firms from making major expansions. Few, if any, firms from other industries have entered over the past ten years other than by acquisition of existing facilities.

At present, most capacity expansion is being undertaken by the larger, more profitable firms that have the necessary capital resources to make major expansions as well as the substantial control over the woodlands needed to assure a continuing supply of wood raw materials. Thus small to medium companies are likely to lose market share.

An accelerated rate of closures of marginal mills by both large and small paper companies in the early 1970's has also contributed to increasing concentration.[4] Closure rates have been primarily a function of the paper industry's economic cycles — the most rapid closure rates since World War II occurred in the 1970-71 recession. Closure rates will probably also increase around the water effluent control implementation deadlines in 1977 and 1983 as some mills are unable to take on the required new capital burden. Ironically, pollution control regulations could also have

4. Appendix A-12, Mill Closure Trends, discusses historical mill closures by product sector.

the effect of extending the life of certain mills. To justify making a major investment in pollution-control equipment, some mills will be modernized to assure that they will remain sufficiently competitive to recoup the new investment. The pollution regulations will also increase the cost for new mills through 1983 and thus will temporarily reduce their cost competitiveness with the older mills that now are close to compliance with 1977 standards.

One factor which tends to stabilize market concentration in the paper industry is that no major technological change appears to be in the offing which would obsolete the existing pulping and papermaking process. All the technological changes that have occurred in the recent past or are now on the drawing boards involve incremental improvements to the existing technology, and when their merits are proven, they can be readily adopted by most existing mills. Appendix C (Volume III) describes the most significant current technology changes taking place or under pilot evaluation in the pulp, paper, and paperboard sectors.

F. FINANCIAL STRUCTURE AND PERFORMANCE

Very few publicly-held companies in the paper industry produce a single product line or employ a single process. Thus, no composite data are publicly available on the profitability of individual product or process sectors. Financial models of typical new mills (discussed later in this section) indicate that, in general, product sector profitability clusters fairly closely around the industry average. The industry's aggregate profitability, on the other hand, is well documented and illustrates the financial consequences of the supply, demand, and price trends just discussed.

Both the Federal Trade Commission (FTC) and the Internal Revenue Service (IRS) publish composite data which provide the primary profitability indicators for the total paper and allied products industry. The IRS also accumulates a composite for firms that produce primarily pulp, paper, or paperboard (as opposed to converted products); however, this data is not as useful for current analyses since it is not published until several years after the fact.

1. Total Industry Averages

Figures II-4 and II-5 compare trends in the paper industry's after-tax return on sales and net worth with those of all manufacturing industries. The FTC data indicates higher profitability than the IRS data. This difference can be explained by the fact that the FTC uses a sampling of paper companies which is heavily weighted toward large companies. The IRS, on the other hand, employs a composite of all companies submitting income tax returns that also include a balance sheet, and its data is more representative of the entire industry. The chief implication from the differences in these two data series is that the smaller or less capital intensive (e.g., paper converting) companies generally are less profitable than the larger firms and tend to bring down the industry's profitability.

Throughout most of the 1960's, the paper industry's return on sales and net worth was below the all-industry average as it increased capacity rapidly and suffered through several cycles of excess capacity as a result. As discussed earlier, a number of reasons contributed to the over-supply cycles — the competition for the dwindling number of mill sites and backup woodlands, the vying for market share in markets that were beginning to mature, and the extremely low prices for market pulp mainly because of capacity overexpansion in Canada. However, coincident with the profitability plunge in 1970 and 1971, the industry's historical rate of capacity expansion fell and stayed well below historic trends despite the up-turn in profitability in 1973 and 1974.

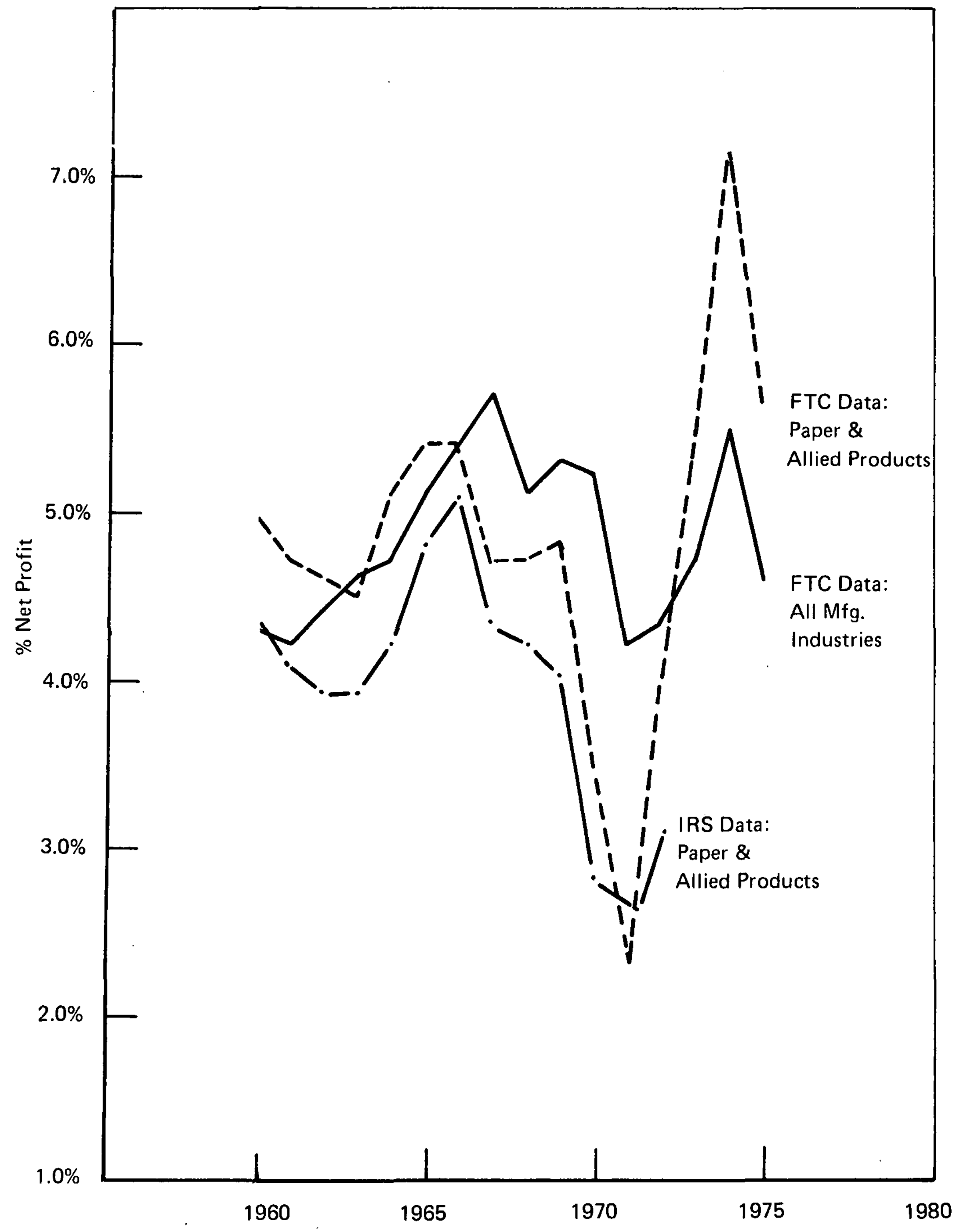


FIGURE II–4 PERCENT NET PROFIT AFTER TAX TO NET SALES

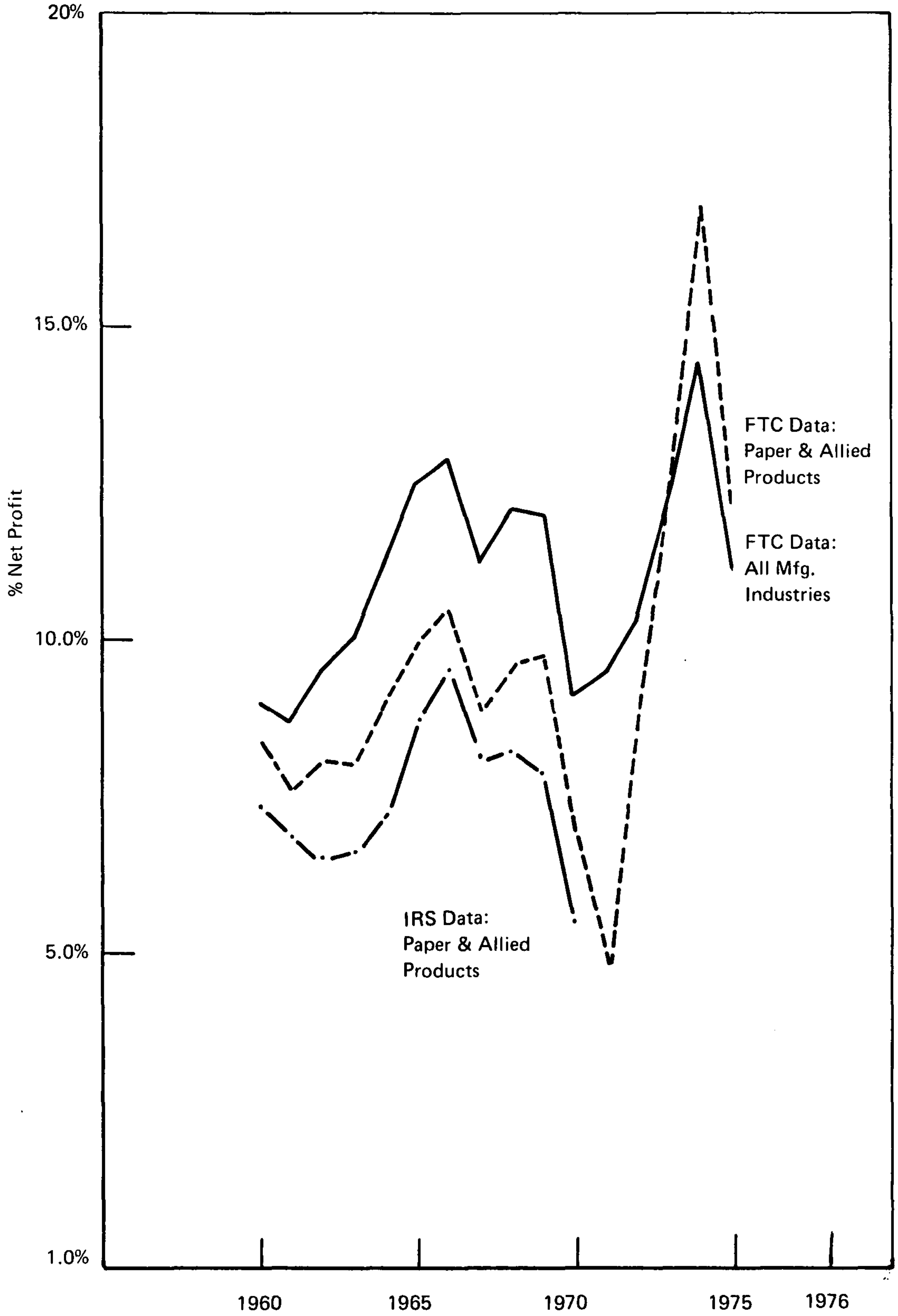


FIGURE II–5 PERCENT NET PROFIT AFTER TAX TO NET WORTH

In 1970 and 1971, the paper industry's after-tax return (both on sales and capital) fell to its lowest point since World War II. The period of overcapacity and weak prices in the 1960's laid the foundation. Demand for paper declined slightly as a result of the 1970 recession and the industry's capacity expansions brought its capacity utilization to around 90%.[5]

Demand recovery in 1972 led to improved mill operating rates and higher prices throughout the paper industry which in turn caused a dramatic up-turn in profitability. Profits continued to rise through 1973 and particularly in the first and second quarters of 1974 after price controls were partially lifted for this industry in March of that year and fully lifted in June. The up-turn in the industry's earnings also caused shareholder's equity to regain a larger proportion of the total capital structure.

In 1974, the industry's return on sales and net worth reached its highest point since World War II and climbed well above the all-manufacturing-industry average after holding well below this average in the 1960's. This rapid up-turn in profitability and ranking was caused by high mill operating rates and particularly by the very large price increases that the industry obtained after price controls were lifted. The industry's operating rates approached, and in some cases exceeded, maximum sustainable levels for such items as bleached market pulp, newsprint, linerboard, printing papers, and tissue. This tight supply condition enabled the producers to simplify their product lines and thus achieve longer runs and more production from their mills. However, the fundamental reason for the tight supply itself was that the industry began to slow its rate of capacity expansion starting in 1970. This slowdown in turn caused the industry's capacity to be stretched by the up-turn in demand which took place from 1972 through mid-1974.

The recession which began in the second half of 1974 again caused a decline in paper industry profitability starting in the fourth quarter and continuing through the third quarter of 1975. The principal factor behind the profitability decline was low mill operating rates as paper demand declined faster than GNP. Average capacity utilization dropped to around 85%; however, there was very little price deterioration. Therefore, while profitability declined, it held up surprisingly well compared with previous serious recessions. With their newly won price increases in 1973 and 1974, producers chose to curtail production rather than risk price reductions which might be difficult to recoup when the economy recovers. The industry's higher profitability reduced its breakeven capacity utilization rate (historically around 85%), making it easier to decide in favor of production cutbacks rather than price discounts. And, of course, there was widespread concern that price controls would be re-established and industry managers were reluctant to get caught with their prices and profits down as they did in 1972.

Figure II-6 shows that between 1963 and 1971, the capital structure of the paper and the all-manufacturing industry composites saw the rapid displacement of net worth by long-term debt. However, the paper industry's debt proportion increased faster than that of the all-industry composite. With an average debt-to-total-capital ratio of 33% and a low profitability in 1970-1971, many firms exhausted their borrowing power. The combination of low profits and debt limitations contributed importantly to the subsequent slower rate of capacity expansion. Even as profitability rose in 1972-1974, relatively high debt levels along with capital goods inflation prevented many companies from using debt to finance major expansions.

5. Although 90% is not a particularly low operating rate, the market was sufficiently weak to preclude any opportunities for the companies to increase prices to cover the accumulating cost inflation they experienced during 1967-1971. Conversely, prices were held low to keep demand and capacity utilization as high as possible.

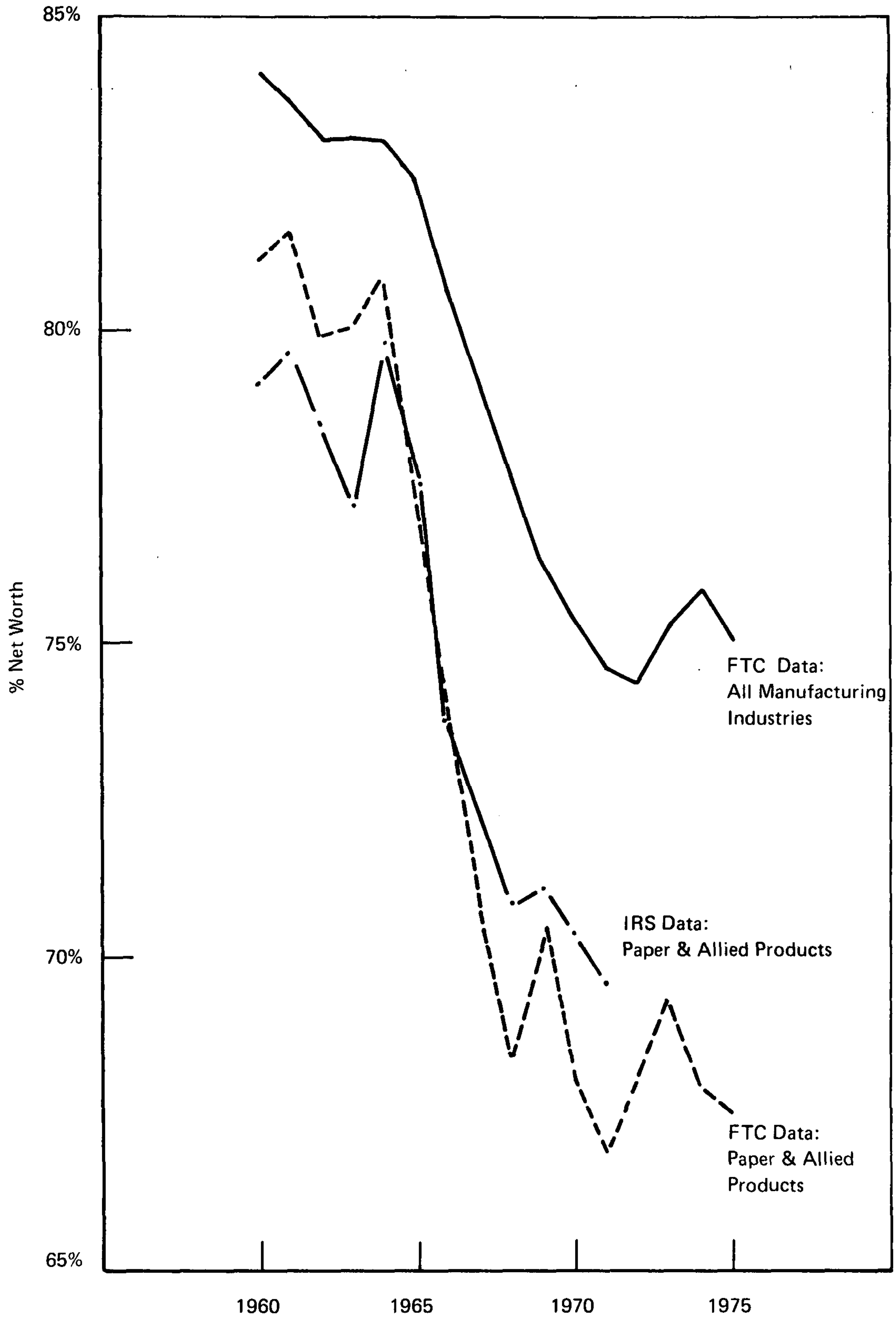


FIGURE II–6 PERCENT NET WORTH TO TOTAL CAPITAL FOR PAPER VERSUS ALL INDUSTRIES

Table II-10 shows annual changes in the paper industry's sources of capital since 1960. It indicates that equity financing has not been an attractive alternative to debt. The only significant net revenues from stock sales took place in 1961, 1969, and 1971. More frequently, large amounts of stock were repurchased, reflecting prevailing low stock prices. As a result, all of the industry's increases in net worth have come from retained earnings. This is not to imply that retained earnings and long-term debt will continue to be the primary financing modes for the paper industry. In 1975 and 1976, equity financing became attractive for a number of paper companies that successfully sold new issues by taking advantage of their recent profit improvement trend and a period of stock market recovery.

2. Profitability Variations by Product Sector

Table II-9 indicates that in 1975, bleached paper pulp was the most profitable and NSSC corrugating medium the least profitable of the industry's major product sectors. Note that the purpose of the analysis is to show relative and not absolute differences between product sectors. It employs mid-1975 prices and estimated costs for minimum economic-sized mills assuming that they were brought fully on-stream in 1975 and had a capacity utilization of 90%. The analysis does not attempt to reflect the actual costs of existing mills and it is of course a snapshot of one point in time under prescribed conditions. Appendix F (Volume III) provides the supporting data used in this comparison.

Bleached paper grade pulp is clearly the most profitable product sector at present. It achieved this position primarily because of very large price increases in 1973 and 1974 when the world supply/demand balance reached shortage proportions. Bleached pulp is the most capital and wood intensive of the paper industry's products and this has limited recent capacity expansions.

Printing/writing paper's profitability index is deceptively high in that the sector's mid-1975 capacity utilization rate was around 75% rather than the 90% rate employed for the comparative analysis. With its operating rate about 10 points below the industry average of about 85% in 1975, this sector's profitability was close to the paper industry's average.

The comparisons do not reflect the profitability of the nonintegrated printing/writing and tissue paper companies, whose average profitability is probably below that of the least profitable sector in Table II-11. These firms are currently caught in a profit squeeze between high market pulp prices and relatively low paper prices that are held down by integrated producers seeking better capacity utilization. New mill models were not developed for the nonintegrated sectors because it is unlikely that new mills will be built until the margin between market pulp and paper prices widens appreciably. There is no evidence that this will happen in the foreseeable future.

Volume II describes the major product sectors and analyzes the economic and competitive characteristics which affect their profitability and growth.

TABLE II-10

CHANGES IN PAPER AND ALLIED PRODUCTS INDUSTRY CAPITAL STRUCTURE, 1970-1975

(millions of dollars)

	Net Change in Equity			Net Change
	Retained Earnings[1]	Net Stock Sales	Total	In Long-Term Debt
1960	275	39	314	110
1961	255	401	656	97
1962	288	(134)	154	234
1963	286	(171)	115	9
1964	378	40	418	3
1965	461	(93)	368	472
1966	539	6	545	657
1967	405	(104)	301	632
1968	493	(201)	292	463
1969	569	340	909	68
1970	289	(196)	93	555
1971	94	253	347	417
1972	564	(275)	289	(164)
1973	1,025	(104)	921	100
1974	1,668	124	1,792	411
1975	1,158	118	1,276	736
TOTALS	8,747	43	8,790	4,800
% of Total Capital			65%	35%

[1]Net profit retained in business.

SOURCE: FTC Quarterly Financial Report for Manufacturing Corporations.

TABLE II-11

RELATIVE PROFITABILITY OF SELECTED PRODUCT SECTORS
(Basis: New Mills On-Stream in 1975)

Product Category	Capacity (tpd)	Production[1)] (1000 tpy)	Costs Including Effluent Control: Capital[2)] ($millions)	Costs Including Effluent Control: Operating[3)] ($/ton)	Selling Price ($/ton)	Profitability Index[4)] (%)
Kraft Linerboard	1,000	313	159	119	195	9.2
Kraft Bag Paper	230	72	68	155	250	4.3
NSSC Corrugating Medium	450	141	74	143	193	3.7
Recycled Paperboard[5)]	380	119	55	169	215	4.2
Bleached Paper Pulp	800	250	196	181	335	13.8
Dissolving Pulp (Sulfite)	550	172	173	230	385	9.6
Bleached Paperboard	500	157	154	220	350	7.5
Printing & Writing (Bond & Book)	300	94	103	281	480	12.4
Newsprint	550	172	128	169	260	6.4
Newsprint (De-inked)	330	103	61	176	260	8.4
Tissue	163	51	78	528	736	7.8
Tissue (De-inked)	76	24	32	611	736	3.6

1) Annual production at 90% operating rate;
2) Capital costs include air control, effluent control, OSHA requirements, and working capital;
3) Operating costs indicated exclude depreciation; they include air, effluent, and OSHA requirements;
4) Profitability index is pre-tax profit (margin minus depreciation) divided by total capital; depreciation calculated at 5.8% of total capital, equal to 6.25% of fixed capital.
5) Reflects weighted average for clay coated boxboard, recycled liner and medium and gypsum linerboard.

SOURCE: Arthur D. Little, Inc., estimates.

CHAPTER III
COST OF COMPLIANCE

III. COST OF COMPLIANCE

A. SUMMARY

1. Introduction

The principal aim of this chapter is to portray for each major sector of the paper industry the total costs of complying with existing and proposed air, water, and noise regulations.

The costs are not meant to apply to any one mill. The estimates, and the methodology through which they were derived, are meant to provide a basis for measuring the economic impact of the studied regulations on the industry as a whole. A different method was used to assess the potential impact of pollution controls on possible closure candidates. (See Chapter V.)

The estimated costs of compliance are based primarily upon published data. These data were primarily the EPA Development Documents for air emissions control and water effluent control. See Volume III, Appendices E-1 and E-2 for the specific references. Arthur D. Little was not retained to develop cost estimates for any of the three types of regulations; Arthur D. Little did, however, update and supplement the basic data for the sake of consistency and comparability.

Separate cost estimates were prepared for the existing industry and for new capacity. Since the capacity of the existing industry is clearly defined, total costs for compliance are reported as well as cost per unit of capacity. However, the capacity of mills not yet built will be influenced by the potential impact of control costs. In this chapter, therefore, only the unit cost of compliance of these future mills are derived. Total costs are estimated in Chapter VI, which deals with capital impacts.[1]

2. Findings Related to the Existing Industry

The capital costs for the existing paper industry to comply with regulations on air, water, and noise from 1974 to 1977 total $3.2 billion (Table III-1):

- $690 million to achieve compliance with SIP air regulations.
- $2.2 billion for compliance with BPT water regulations.
- $320 million for the proposed 90-dBA noise control level.

The weighted average operating cost, including charges for capital recovery (@ 12.1%),[2] is $11.1/ton for the situations analyzed. Note that the capacity decline shown in Table III-1 is based on economic as well as environmental reasons.

The estimates also indicate that between 1977 and 1983 the existing industry will be required to spend $1.7 billion for compliance with the studied regulations (Table III-2): $170 million to comply with SIP air regulations, $1.4 billion for compliance with BPT water regulations and $80 million for the proposed 90-dBA noise control level. Again, the decline in capacity is based on economic as well as environmental regulations. Note that control costs for new replacement or expansion capacity constructed during this period are not included here.

1. Note that all investment and operating costs are reported in mid 1975 dollars, and thus do not reflect future cost inflations.

2. See Chapter IV for derivation of this value.

TABLE III-1

SUMMARY OF INCREMENTAL COSTS OF COMPLIANCE FOR EXISTING INDUSTRY THROUGH 1977
(1975 Dollars)

Product Sector	Year-End Capacity Base (000 tons/yr) 1974	Year-End Capacity Base (000 tons/yr) 1977	SIP Air Emission Control[a] Capital ($MM)	SIP Air Emission Control[a] Total Oper.[d] ($/ton)	Federal Water Effluent Control[b] Capital ($MM)	Federal Water Effluent Control[b] Total Oper.[d] ($/ton)	Federal OSHA Requirements Capital ($MM)	Federal OSHA Requirements Total Oper.[d] ($/ton)	TOTAL[c] Capital ($MM)	TOTAL[c] Total Oper.[d] ($/ton)
Unbleached Kraft Paperboard	13,970	13,970	186	1.9	373	5.8	40	0.5	599	8.3
Unbleached Kraft Paper	4,390	4,390	61	2.0	122	6.3	12	0.5	195	8.8
NSSC Corrugating Medium	4,430	4,240	22	1.0	112	5.0	24	1.0	158	7.0
Recycled Paperboard	8,680	8,440	27	0.7	187	5.1	44	1.0	258	6.8
Construction Paper	2,160	2,160	7	0.7	34	3.5	19	1.8	60	6.0
Bleached Board & Bristols	5,160	5,160	82	2.2	174	8.1	15	0.5	271	10.8
Printing & Writing Paper	11,600	11,270	154	2.2	595	12.8	81	1.3	830	16.2
Tissue	4.320	4,210	54	2.1	268	15.3	38	1.7	360	19.0
Newsprint	3,720	3,650	43	1.8	162	10.7	23	1.1	228	13.6
Bleached Pkg. & Ind. Conv.	1,290	1,290	17	2.0	54	10.2	5	0.7	76	12.8
Uncoated Groundwood Paper	1,280	1,190	16	2.0	62	11.9	12	1.8	90	15.7
Dissolving Pulp	1,820	1,820	18	1.5	102	13.9	7	0.7	127	16.1
TOTAL[a]	62,820	61,790	690	1.8	2,250	8.4	320	0.9	3,260	11.1

a. Incremental costs to 1977 are estimated at 80% of total SIP regulations after deducting estimates expenditures through 1974. Incremental costs to 1983 are the remaining 20% of costs to reach SIP standards.
b. Incremental costs to 1977 are costs for BPT less estimated expenditures through 1974. Incremental costs to 1983 are the total increment from 1977 to 1983.
c. Totals may not add because of rounding.
d. Operating costs include capital recovery at 12.1%.

SOURCE: Arthur D. Little, Inc., estimates.

TABLE III-2

SUMMARY OF INCREMENTAL COSTS OF COMPLIANCE FOR EXISTING INDUSTRY 1977-1983

(1975 Dollars)

Product Sector	Year-end Capacity Base (000 tons/pr.) 1983	SIP Air Emission Control[a] Capital ($MM)	SIP Air Emission Control[a] Total Oper.[d] ($/ton)	Federal Water Effluent Control[b] Capital ($MM)	Federal Water Effluent Control[b] Total Oper.[d] ($/ton)	Federal OSHA Requirements Capital ($MM)	Federal OSHA Requirements Total Oper[d] ($/ton)	TOTAL[c] Capital ($MM)	TOTAL[c] Total Oper.[d] ($/ton)
Unbleached Kraft Paperboard	13,970	46	0.5	258	4.7	10	0.1	314	5.3
Unbleached Kraft Paper	4,390	15	0.5	90	5.0	3	0.1	108	5.6
NSSC Corrugating Medium	4,090	6	0.2	108	4.3	6	0.3	120	4.8
Recycled Paperboard	8,070	7	0.2	54	1.6	11	0.3	72	2.1
Construction Paper	2,060	2	0.2	24	2.5	4	0.5	30	3.0
Bleached Board & Bristols	5,160	20	0.6	141	6.1	4	0.1	165	6.8
Printing & Writing Paper	10,950	39	0.5	363	7.5	20	0.3	422	8.3
Tissue	4,050	14	0.5	155	8.8	10	0.4	179	9.7
Newsprint	3,440	11	0.5	91	6.0	6	0.3	108	6.7
Bleached Pkg. & Ind. Conv.	1,290	4	0.5	36	6.3	1	0.2	41	6.9
Uncoated Groundwood Paper	800	4	0.5	41	10.8	2	0.4	41	11.7
Dissolving Pulp	1,710	4	0.4	52	9.7	2	0.2	58	10.3
TOTAL	59,980	170	0.4	1,410	5.4	80	0.3	1,660	6.1

a. Incremental costs to 1977 are estimated at 80% of total for SIP regulations after deducting estimated expenditures through 1974. Incremental costs to 1983 are the remaining 20% of costs to reach SIP standards.
b. Incremental costs to 1977 are costs for BPT less estimated expenditures through 1974. Incremental costs to 1983 are the total increment from 1977 to 1983.
c. Totals may not add because of rounding.
d. Operating costs include capital recovery at 12.1%.

SOURCE: Arthur D. Little, Inc., estimates.

All states will not have the same SIP regulation level through 1977; hence, the incremental cost of $170 million in 1977-1983 represents the cost to the industry if all states impose regulations as stringent as the current Oregon standards used in the cost calculations. If states impose more stringent regulations than those used here, the estimates would have to be revised.

An estimated capital cost of $1.4 billion will be needed to bring the existing industry from the water effluent level required by 1977 to the more stringent 1983 level.

The 1977-1983 capital cost for OSHA noise control, like the estimate for compliance with SIP regulations, reflects broader compliance with the present regulations rather than imposition of more stringent regulations.

3. Findings Related to New Capacity

Compliance costs for a new-mill may vary from $4.4 million to $31.6 million (Table III-3), depending on the type of facility as well as its size.

In this section, cost of compliance estimates are given on a unit basis. These unit costs are subsequently used to develop capital requirements for the postulated capacity increases through 1983. (See Chapter VI.)

Note that the cost of compliance with air and water effluent regulations is computed on a process basis; thus the estimated costs of compliance for the same product made by different processes can be significantly dissimilar. Since economic impacts were measured on a product basis, it was necessary to estimate product/process combinations for future mills. The relationship between manufacturing processes and products is described in Section III-B.

Note also that in some instances pulp mill size is disproportionately larger than paper mill size. The difference, however, simply reflects the different economic unit sizes of the respective operations. For example, it would be economical to build a 1,000-tpd unbleached pulp mill and support it with a 1,000-tpd liner board mill. However, it would not be economical to build a 300-tpd printing and writing paper mill and support it with a 300-tpd bleached kraft pulp mill; about an 800-tpd pulp mill would be necessary to achieve economic operation. Therefore, the balance of the pulp mill capacity not utilized in the studied *product sector* (printing and writing paper) is assumed to be utilized on site for other grades. Accordingly, the investment for the pulp mill is apportioned to the study products on the basis of its corresponding capacities. Compliance with NSPS water effluent regulations is by far the single most important cost. Generally, these regulations are about equivalent to the BAT levels that apply to existing mills. The only significant difference between the two applies to the bleached kraft process category: color removal is not required under NSPS but is specified in the BAT regulations. The addition of color removal to the NSPS regulation would add $3 to $5 million capital cost to the bleached kraft process examples (bleached board, printing and writing papeps, tissue, newsprint, and market pulp).

The investment and operating costs for air emission control are measured from an "economic level" of control and clearly do not reflect total industry expenditures for air emission control equipment. The "economic level" is site specific and changes with the value of the by-product. Thus, the derived cost of compliance would change if a different percentage of recovery were considered "economic." For purposes of this analysis, Arthur D. Little used the 97.5% economic recovery level employed in EPA's control cost estimate.

TABLE III-3

UNIT COST OF COMPLIANCE WITH FEDERAL STANDARDS FOR NEW MILL SOURCES

(1975 Dollars)

Product Sector and Specific Products	Process Category	Mill Cap. (tpd) Pulp	Mill Cap. (tpd) Paper	NSPS Water Effluent Stds. Capital ($MM)	NSPS Water Effluent Stds. Total Oper.[a] ($/ton)	Air Emission New Source Standards Capital ($MM)	Air Emission New Source Standards Total Oper.[a] ($/ton)	OSHA Requirements Capital ($MM)	OSHA Requirements Total Oper.[a] ($/ton)	Total Unit Cost of Compliance Capital ($MM)	Total Unit Cost of Compliance Total Oper.[a] ($/ton)
Unbleached Kraft Paperboard:											
Kraft Linerboard	Unbleached Kraft	1000	1000	19.0	11.7	2.9	1.6	3.0	1.3	24.9	14.6
Unbleached Kraft Paper:											
Kraft Bag Paper	Unbleached Kraft	800	230	4.8	13.3	0.8	2.0	2.0	3.6	7.6	18.9
NSSC Corrugating Medium:											
Corrugating Medium	NSSC Pulping	450	450	13.6	21.3	1.1	1.6	3.0	3.0	17.7	25.9
Recycled Paperboard:											
Recycled Boxboard	Recycled Paperboard	400	400	6.8	10.3	0.3	0.8	1.0	1.4	8.1	12.5
Jute Linerboard	" "	330	330	6.1	11.2	0.8	0.8	1.0	1.7	7.4	13.5
Bogus Medium	" "	330	330	6.1	11.2	0.2	0.6	1.0	1.7	7.3	13.3
Gypsum Linerboard	" "	400	400	6.8	10.3	0.3	0.8	1.0	1.4	8.1	12.5
Construction Paper:											
None	Construction Paper	-	-	-	-	-	-	-	-	-	-
Bleached Board & Bristols:											
Bleached Paperboard (SBS)	BCT Kraft	800	500	16.1	19.7	2.1	2.4	2.0	1.9	20.2	24.0
Printing & Writing Paper:											
Bond Paper	Fine Kraft	800	300	8.5	17.3	1.2	2.4	2.0	2.8	11.7	22.5
Book Paper	Fine Kraft	800	300	8.5	17.3	1.3	2.5	2.0	2.8	11.8	22.6
Tissue:											
Tissue Paper	BCT Kraft	800	163	4.8	18.0	0.6	2.5	2.0	4.9	7.4	25.4
Tissue Paper	Nonint. from Waste Paper	-	76	3.4	28.0	0.1	0.9	1.0	7.7	4.5	36.6
Newsprint:											
Newsprint	Fine Kraft/GW	1240	550	9.2	10.2	0.8	0.9	2.0	1.8	12.0	12.9
Newsprint	Deinking	-	330	12.9	25.2	0.2	0.6	1.0	1.7	14.1	27.5
Pkg. & Ind. Converting:											
None	-	-	-	-		-	-	-	-	-	-
Uncoated Groundwood Papers:											
None	-	-	-	-		-	-	-	-	-	-
Dissolving Pulp:											
Dissolving Pulp	Dissolving Sulfite	550	550	27.5	33.6	1.1	1.3	3.0	2.4	31.6	37.3
Bleached Market Pulp:											
Kraft Market Pulp	Kraft Mkt. Pulp	800	800	20.3	15.8	3.1	2.1	3.0	1.7	26.4	19.6

a. Operating costs includes capital recovery at 12.1%.

SOURCE: Arthur D. Little, Inc., estimates.

The capital investment for noise control for new mills is significantly greater than that reported for existing mills. The apparent discrepancy reflects the fact that, presented with the option of using either administrative controls or building sufficient "engineering control," into a new mill to comply with noise regulations, most producers will elect to take the latter route. Although administrative control reduces capital costs, it is subject to subsequent modification by OSHA in the event the mill is found to be in violation. Rather than risk being faced with the high costs of mill modification, most producers would choose to design in "engineering controls" for new capacity. The variation in operating costs from about $12 to $37 per ton of production for the studied product sectors is caused by a number of factors, for example, *size, type of manufacturing process,* etc. For a new mill the capital cost for the studied regulations varies from 10% to 26% of the total capital requirement and operating costs vary from 4% to 14% of the total manufacturing cost of the selected products (Table III-4).

B. GENERAL METHODOLOGY

This section describes in general terms the methodology used in developing the cost of complying with the studied regulations. A more detailed explanation is contained in the analysis of the three types of regulations (Appendix E) and in the supporting data for the mill cost models (Appendix F).

1. Process-to-Product Transformation

Although the economic impact of compliance is measured by the associated cost for an individual product or product sector, the studied regulations apply to the manufacturing processes, not the products. Moreover, a given product often can be made by more than one process or combination of processes, and the cost of compliance for these alternative methods may vary significantly.

Unfortunately, data are not available to transform current industry capacity, typically reported on a product basis, to a process basis. Hence, the percentages of the process costs allocated to the individual product sectors are based on the considered opinions of a number of individuals knowledgeable about the industry.

On the basis of this knowledge of industry practice, Arthur D. Little constructed a matrix (Table III-5) showing the process categories to which the EPA water effluent control regulations apply and the related product sectors used in the economic impact analysis. The matrix indicates how costs of compliance should be apportioned. Table III-5 shows for example, that regulations (and their associated costs) for the unbleached kraft *process category* would apply to the unbleached kraft paperboard and the unbleached kraft paper *product sectors.* Accordingly, cost of compliance derived for the existing industry related to the unbleached kraft process category must be apportioned to these two product sectors. The costs derived from the remaining process categories identified in this table were similarly apportioned to their corresponding products.

In the cost calculations, all mills that make a combination of products are included in those process categories with the higher costs for compliance.

A similar problem occurs in estimating costs for new increments of industry capacity. Therefore, in projecting costs for compliance out to 1983, Arthur D. Little assumed one or more currently favored processes would be employed for each of the studied product sectors.

TABLE III-4

COST OF COMPLIANCE RELATIVE TO TOTAL FIXED CAPITAL AND OPERATING COSTS FOR NEW MILLS

(1975 Dollars)

Product Sector and Specific Products	Process Category	Mill Capacity (tpd) Pulp	Mill Capacity (tpd) Paper	Total Delivered Manufacturing Cost Capital ($MM)	Total Delivered Manufacturing Cost Total Operating ($/ton)	Total Cost of Compliance Capital ($MM)	Total Cost of Compliance Total Operating ($/ton)	Cost of Compliance (Percent of Total Mfg.) Capital	Cost of Compliance (Percent of Total Mfg.) Total Operating
Unbleached Kraft Paperboard:									
Kraft Linerboard	Unbleached Kraft	1000	1000	148.7	170.9	24.9	14.6	17	9
Unbleached Kraft Paper:									
Kraft Bag Paper	Unbleached Kraft	800	230	65.3	258.7	7.6	18.9	12	7
NSSC Corrugating Medium:									
Corrugating Medium	NSSC Pulping	450	450	67.7	196.1	17.7	25.9	26	13
Recycled Paperboard:									
Recycled Boxboard	Recyc. Paperbd.	400	400	57.8	238.4	8.1	12.5	14	5
Jute Linerboard		330	330	39.1	198.9	7.4	13.5	19	7
Bogus Medium		330	330	32.1	178.9	7.3	13.3	23	7
Gypsum Linerboard		400	400	49.8	203.0	8.1	12.5	16	6
Bleached Board & Bristols:									
Bleached Paperboard (SBS)	BCT Kraft	800	500	144.8	326.0	20.2	24.0	14	7
Printing & Writing Paper									
Bond Paper	Fine Kraft	800	300	96.7	389.1	11.7	22.5	12	6
Book Paper	Fine Kraft	800	300	94.8	403.6	11.8	22.6	12	6
Tissue:									
Tissue Paper	BCT Kraft	800	163	70.9	687.9	7.4	25.4	10	4
Tissue Paper	Nonint. from Waste Paper	-	76	28.4	748.2	4.5	36.6	16	5
Newsprint:									
Newsprint	Fine Kraft/GW	1,240	550	120.5	246.7	12.0	12.9	10	5
Newsprint	Deinking	-	330	55.9	237.1	14.1	27.5	25	12
Dissolving Pulp:									
Dissolving Pulp	Diss. Sulfite	550	550	161.6	332.5	31.6	37.3	20	11
Bleached Paper Pulp:									
Bleached Market Pulp	Kraft Mkt. Pulp	800	800	184.0	261.3	26.4	19.6	14	8

SOURCE: Arthur D. Little, Inc., estimates.

TABLE III-5

PRODUCT SECTORS INCLUDED IN STUDIED PROCESS CATEGORIES*

Process \ Product	Unbl. Kraft Paper-board	Unbl. Kraft Paper	NSSC Corr. Med.	Recyc. Paper-board	Const. Paper	Bleached Board & Bristols	Print. & Writ.	Tissue	News print	Bl. Pkg & Ind. Conv. Paper	Unc. GW Paper	Bl. Kraft Mkt. Pulp	Dis. Pulp
Unbleached Kraft	●	●	–	–	–	–	–	–	–	–	–	–	–
NSSC	–	–	●	–	–	–	–	–	–	–	–	–	–
Unbl. Kraft/NSSC	●	●	●	–	–	–	–	–	–	–	–	–	–
Recycled Paperbd.	–	–	–	●	–	–	–	–	–	–	–	–	–
Const. Paper	–	–	–	–	●	–	–	–	–	–	–	–	–
Bleached Kraft **	●	●	–	–	–	●	●	●	●	●	●	●	●
Sulfite	–	–	–	–	–	–	●	●	●	●	–	–	–
Dissolv. Sulfite	–	–	–	–	–	–	–	–	–	–	–	–	●
Soda	–	–	–	–	–	–	●	–	–	–	–	–	–
De-inked	–	–	–	–	–	–	●	●	●	–	–	–	–
Groundwood	–	–	–	–	–	–	●	–	●	–	●	–	–
N/I Tissue	–	–	–	–	–	–	–	●	–	–	–	–	–
N/I Fine	–	–	–	–	–	–	●	–	–	–	–	–	–

* See Table E-1, Appendix E for specific value.
** Note that the bleached Kraft process is used to make unbleached Kraft products. This apparent anomaly is not an error; several mills produce both bleached and unbleached products.

When industry capacity is reported by process category, 1974 bleached kraft market pulp capacity is included at some 6.1 million tons, but when industry capacity is reported on a product basis, that tonnage and its associated control cost appears to be excluded. In fact, however, its associated investment and operating cost of compliance is apportioned to those product sectors — principally printing and writing, tissue and uncoated groundwood papers — that use it as a raw material.

The cost of compliance for market pulp was handled in this manner because of the methodology used for the economic impact analysis. In that analysis, market pulp was considered an intermediate product; hence, its cost of compliance is passed on to the user — the non-integrated paper mill. Accordingly, the investment and operating cost estimates for those product sectors which use market pulp include both costs of compliance actually experienced on-site, and those associated with market pulp.

2. Engineering Cost Estimates

The original engineering cost estimates used to derive costs of compliance come from sources other than Arthur D. Little. Arthur D. Little's role was to modify the basic cost data to put it in a comparable time framework with consistent cost elements for us throughout the economic impact analysis.

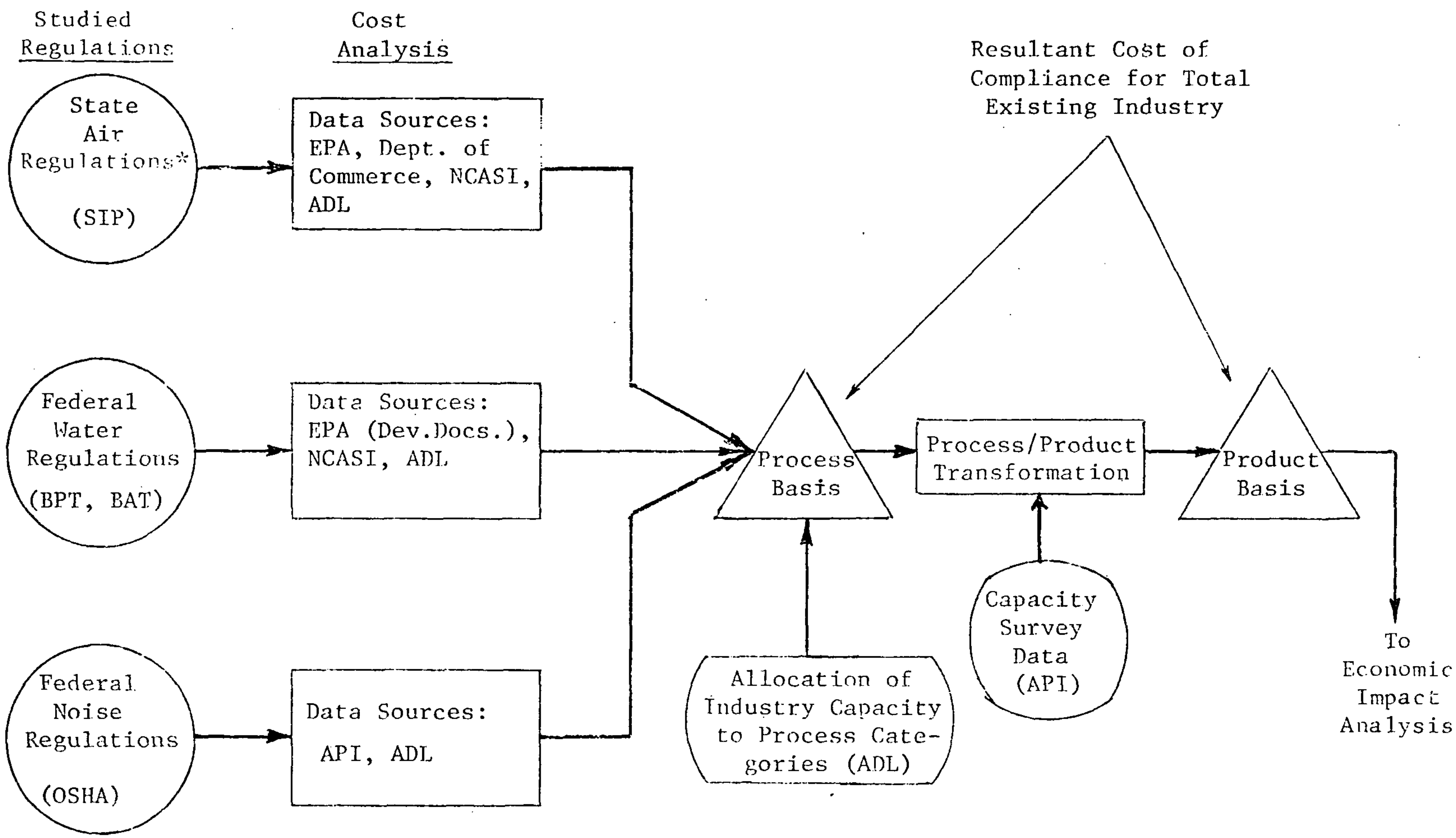
C. COSTS FOR EXISTING INDUSTRY

1. Approach

Figure III-1 illustrates the applicable regulations and the principal sources used to estimate compliance costs for the existing industry. The costs of compliance are estimated separately for the existing and new segments of industry capacity, because: (a) most regulations differ for the two segments, (b) existing industry costs are incremental from year-end 1974, whereas NSPS costs reflect total costs for new mills, and (c) the capacity of the new segment is unknown; hence its cost for compliance cannot be aggregated on a total industry basis.

The separate consideration of existing and new capacity is a logical approach for analytical cost analysis, but it is not the usual way in which industry exports expenditures for pollution abatement; more typically, published capital expenditures combine costs for modifications to existing facilities with those associated with new capacity. Accordingly, in those instances where Arthur D. Little used industry cost data, appropriate adjustments were made to exclude that portion (or estimated portion) associated with new or incremental capacity. Conversely, to estimate the total industry expenditure — say for 1977 — Arthur D. Little combined the estimate derived in this section to that associated with new capacity added in that year (Section D).

To project the capacity of the existing industry through 1983, Arthur D. Little employed the industry's year-end 1974 capacity and assumed normal retirement rates through the ten-year studied period. The retirements, estimated at some 3 million tons out of a total of some 68 million tons of capacity, are for all purposes and *not* as the result of pollution considerations alone. Closures attributed to environmental regulations are estimated and discussed separately. Therefore, cost of compliance for the retired tonnage is reflected not in the estimates derived in this section but in the discussion of the capital required to replace the retired tonnage.



* SIP regulation for Oregon used as the basis for calculating cost of compliance

FIGURE III-1. METHODOLOGY FOR CALCULATING COST OF COMPLIANCE - EXISTING MILLS

All costs of compliance are first shown on a process basis (as they are derived) and are subsequently apportioned to the appropriate product sectors. Note that when presented on a process basis, the annualized operating cost does not include capital recovery charges.

2. Air Emissions Control

Existing mills are not directly subject to Federal air regulations, but they must comply with State Air Quality Implementation Plans (SIPs); accordingly, the latter were used as the basis for calculating cost of compliance. Appendix E-1 (Volume III) lists the SIP standards for several states, illustrating that the requirements differ somewhat from state to state.

In this analysis, Arthur D. Little selected the most stringent current state standards, typified by Oregon's 99.0% particulate removal in kraft recovery boilers.

Implicit in the use of a single set of standards for SIP are two key assumptions:

- All states will ultimately impose regulations consistent with the most stringent current state regulations.
- Progressively more stringent state regulations will not apply over the period covered by this study.

The total cost to the existing industry to meet SIP standards was estimated in three broad areas: controls for kraft pulp mills, controls for power boilers, and early retirement of existing kraft recovery boilers. From the total derived cost of $1,284 million, $428 million was deducted as the reported cost incurred through 1974. The net — some $860 million — is the additional capital requirement for the existing industry to meet SIP standards (Table III-6), the details of which are explained as follows:

(1) Kraft process controls (including power boilers): This is a straightforward application of unit cost estimates for the kraft process subcategory. Power boiler standards and costs are not well defined for SIP standards. To determine the cost for SIP standards, Arthur D. Little employed EPA's well-defined power boiler cost for proposed federal standards and used the same cost ratio as for recovery boiler particulate removal.

(2) Power boiler controls for other categories: This item was not estimated on an engineering basis, which would require a mill-by-mill survey to determine applicable standards and approximate costs. The total industry cost estimates include only a reasonable allowance based on applying kraft category unit costs for power boiler particulate controls to the production generated in other process categories.

(3) Retirement of recovery boilers in kraft categories: Historically, kraft recovery boilers were operated above their rated capacity, but stringent SIP standards for removal of particulates and TRS usually cannot be met under these conditions. Thus, the imposition of SIP standards generally requires the addition of incremental recovery boiler capacity, or the replacement of existing capacity with a larger unit, so that boilers may be operated near their nominal capacity without loss of pulping capacity in the mill. Arthur D. Little did not attempt mill-by-mill engineering estimates for this item. Its total industry cost estimates include a capital allotment for premature recovery boiler replacement based on total capacity, to acknowledge that this is a legitimate and significant factor in the total cost of compliance with SIP regulations.

TABLE III-6

SUMMARY OF AIR EMISSION CONTROL COSTS FOR EXISTING INDUSTRY
(1975 Dollars)

	Capital Costs ($millions)	Operating Costs [a] ($millions/yr)
1. Kraft categories process controls		
Economic Recovery Level	298	(115.0)
Additional costs to SIP level	319	28.8
Sub-total	617	(86.2)
2. Power boiler controls for other categories	107	10.7
3. Retirement of recovery boilers in kraft categories	560	-
Total Industry Costs for SIP Standards	1,284	(75.5)
4. Less Expenditures through 1974, one-third of total	(428)	(103.3)
Net Industry Costs for SIP Standards from 1974	860[b]	28[b]

[a] Excludes capital recovery.

[b] Rounded

SOURCE: Arthur D. Little, Inc., estimates.

(4) Expenditures through 1974: This item was estimated on the basis of industry reports that about one-third of the industry was in compliance. This was interpreted as meaning that one-third of the total capital investment for compliance with SIP standards (including the economic recovery level) had been made by 1974. Arthur D. Little distributed capital and operating costs by assuming that all mills had achieved the economic recovery level, and that

additional expenditures were proportional to capacity throughout the kraft categories. This approximation is adequate for estimating total industry costs, costs by major process and product sectors, and costs for the total industry to achieve compliance with SIP standards.

The detailed development of unit cost estimates and their application to appropriate process subcategories and size ranges are explained in Appendix E-1, (Volume III).

Arthur D. Little further assumed that 80% of the incremental cost of compliance will be met in the period from 1975 to 1977 and 20% beyond 1977. It is apparent that uniform compliance with SIP standards will not be achieved by 1977. However, the compliance distribution over the studied period is not precise.

Cost of compliance with SIP standards are aggregated by major process category in Table III-7. The operating costs indicated are for operation and maintenance only (excluding capital recovery), as required for the impact analysis methodology. The process-to-product transformation discussed previously was applied to establish the cost of compliance by product sector (Table III-8). The variation among product sectors simply reflects the fact that the costs for kraft pulping controls, power boiler controls, and replacement of recovery boilers would not apply equally to all sectors. Product sectors that do not employ the kraft process — such as NSSC corrugating medium, recycled paperboard, and construction paper — incur only the cost associated with air emissions controls for the power boiler.

3. Water Effluent Control

Federal water effluent regulations for existing pulp and paper mills call for compliance with the BPT level by 1977 and the BAT level by 1983. The specific requirements and the derivation of the costs for compliance are described in Appendix E-2. The general methodology is similar to that used for deriving the costs for air emission control — namely, to develop models for various size mills in each of the process categories and multiply the unit cost for each model by the corresponding number of plants in the industry. From the resultant derived total cost, the expenditures reported by the industry through 1974 are deducted; the net is apportioned to the studied product sectors via the product transformation process.

Unit costs from the process models in the EPA Development Documents were used to derive the industry's cost of compliance.[3] Arthur D. Little estimated the number of mills corresponding to the models and adjusted the unit costs and incremental cost calculations contained in the Development Documents by:

3. The "Development Documents" referred to include the following:

"Development Document for Advanced Notice of Proposed or Promulgated Rule Making for Effluent Limitations Guidelines and New Source Performance Standards for the Bleached Kraft, Groundwood, Sulfite, Soda, Deink, and Nonintegrated Paper Mills Segment of the Pulp, Paper, and Paperboard Point Source Category," EPA 440/1-75/047, August 1975.

Development Document for Interim Final and Proposed Effluent Guidelines and Proposed New Source Performance Standards for the Bleached Kraft, Groundwood, Sulfite, Soda, Deink, and Nonintegrated Paper Mills Segment of the Pulp, Paper, and Paperboard Point Source Category," Vol. 1, EPA 440/1-76/047-a, January 1976.

"Development Document for Effluent Limitations Guidelines and Standards of Performance: Pulp, Paper, and Paperboard Industry," draft report to EPA by Wapora, Inc., June 1973.

"Development Document for Effluent Limitations Guidelines and Standards of Performance: Builders' Paper and Board Industry," draft report to EPA by Wapora, Inc., June 1973.

Arthur D. Little meetings and correspondence with E.C. Jordan, Company, EPA contractor for compliance cost estimates in August 1975, and January 1976, Development Documents.

TABLE III-7

SUMMARY OF INCREMENTAL AIR CONTROL COST TO EXISTING INDUSTRY (SIP STANDARDS) BY MAJOR PROCESS CATEGORY

Major Process Category	Total Category Year-end Capacity[a] (000 tons/yr) 1974	1977	1983	Capital Costs ($ 1975)	Operating Costs[b] ($ 1975)
Unbleached Kraft	8,760	8,760	8,760	143	3.5
NSSC Medium	3,270	3,080	2,930	12	1.2
Bleached Kraft/NSSC	4,960	4,960	4,960	80	1.9
Recycled Paperboard	8,670	8,430	8,060	34	3.4
Construction Paper	2,160	2,160	2,060	9	0.9
Bleached Kraft	26,460	26,420	26,290	526	11.7
Sulfite	3,200	2,990	2,830	12	1.2
Dissolving Sulfite	910	910	800	4	0.4
Soda	290	190	190	1	0.1
De-inked	2,420	2,390	2,220	10	1.0
Groundwood	2,850	2,740	2,300	11	1.1
N/I Tissue	1,670	1,650	1,580	7	0.7
N/I Fine	2,380	2,290	2,180	9	0.9
TOTAL	68,000	66,970	65,160	860[c]	28.0

[a] Declines reflect total closures in process category.

[b] Excludes capital recovery.

[c] Rounded.

SOURCE: Arthur D. Little, Inc., estimates.

TABLE III-8

SUMMARY OF INCREMENTAL AIR CONTROL COST TO EXISTING INDUSTRY (SIP STANDARDS) BY PRODUCT SECTOR

Product Sector	Sector Year-End Capacity Base [a] (000 tons/yr) 1974	1977	1983	Capital Costs ($/millions)	Operating Costs [b] Oper. & Maint. ($/ton)	Capital Recovery ($/ton)	TOTAL ($/ton)
Unbleached Kraft Paperboard	13,970	13,970	13,970	232	0.4	2.0	2.4
Unbleached Kraft Paper	4,390	4,390	4,390	76	0.4	2.1	2.5
NSSC Corrugating Medium	4,430	4,240	4,090	28	0.4	0.8	1.2
Recycled Paperboard	8,680	8,440	8,070	34	0.4	0.5	0.9
Construction Paper	2,160	2,160	2,060	9	0.4	0.5	0.9
Bleached Board & Bristols	5,160	5,160	5,160	102	0.4	2.4	2.8
Printing & Writing Paper	11,600	11,270	10,950	193	0.6	2.1	2.7
Tissue	4,320	4,210	4,050	68	0.6	2.0	2.6
Newsprint	3,720	3,650	3,440	54	0.5	1.8	2.3
Bleached Packaging & Ind. Conv. Paper	1,290	1,290	1,290	21	0.5	2.0	2.5
Uncoated Groundwood Paper	1,280	1,190	800	20	0.6	1.9	2.5
Dissolving Pulp	1,820	1,820	1,710	22	0.4	1.5	1.9
TOTAL	62,820	61,790	59,980	860 [c]	0.5	1.7	2.2

[a] Declines reflect total closures in product sector.

[b] Unit costs based on 1977 capacities.

[c] Rounded.

SOURCE: Arthur D. Little, Inc., estimates.

- Updating from 1974 to mid-1975 dollars;
- Adding about 5% to the reported operating cost for operating and maintenance supplies; and
- Revising the assumptions about "in-place" treatment facilities for certain process categories.

The Development Documents presented a rough estimate of the amount of land required for effluent treatment but not its cost. Arthur D. Little believes the cost would be only about $25 million, or less than 1% of the total capital requirements for water effluent treatment. Land availability, therefore, was considered significant only for estimating closure probabilities for specific mills and land was excluded from the cost estimates.

To use EPA's unit cost estimates, Arthur D. Little categorized industry capacity to agree as closely as possible with the rationale for industry categorization in the Development Documents. The capacities were assigned by subcategory and mill size, and corrected for mills known to use municipal treatment. Arthur D. Little assumed there will be no capacity retirement in mills that use municipal treatment.

Table III-9 summarizes the investment and operating cost for the existing industry to meet 1977 and 1983 Federal water effluent regulations. Note that these costs are incremental to expenditures made prior to 1975 and that the operating costs exclude capital recovery. The estimated $2.2 billion through 1977 for BPT and the additional $1.4 billion through 1983 for BAT excludes any capital investment for replacement capacity or net new additional capacity that may be built during the studied period.

Tables III-10 and III-11 present the cost of compliance on a product basis — the former for the 1974 to 1977 period and the latter for the 1978 to 1983 period.

The indicated operating costs are weighted averages over the total capacity of each product sector. The range of these costs has been calculated on the basis of the highest- and lowest-cost subcategory and mill size range for each product. Note that the weighted averages for recycled paperboard and construction papers are lower than the indicated minimums. This reflects the fact that many mills use municipal treatment in these product sectors, causing the effective range for the weighted average to have a minimum cost of zero. However, the reported range applies only to mills that have on-site effluent treatment and therefore must invest in their own treatment systems.

As described previously, the treatment costs associated with market pulp are handled in a special way in the process-to-product transformation. Market pulp capacity is included in the process summaries as a part of bleached kraft capacity. When costs are transformed to the product sectors, those associated with market pulp production are added to the costs incurred at the point where it is consumed — i.e., in nonintegrated or partially integrated mills. For example, the cost component associated with nonintegrated printing and writing paper production includes not only the direct cost of treating mill effluent but also the treatment cost associated with the market pulp used as raw material by the mill.

TABLE III-9

SUMMARY OF WATER EFFLUENT CONTROL COST FOR THE EXISTING INDUSTRY BY PROCESS CATEGORY

(1975 Dollars)

	Total Category Year-End Capacity (000 tons/yr)			Effluent Control Costs					
				Capital Cost ($millions)		Operating Cost[a] ($millions/yr)		Operating Cost[a] (avg. $/ton cap'y)	
Major Process Category	1974	1977	1983	BPT	BAT	BPT	BAT	BPT	BAT
Unbleached Kraft	8,760	8,760	8,760	237	153	20.3	23.2	2.3	2.6
NSSC Medium	3,270	3,080	2,930	91	95	5.6	2.4	1.8	0.8
Unbleached Kraft/NSSC	4,960	4,960	4,960	106	67	9.5	10.8	1.9	2.2
Recycled Paperboard	8,670	8,430	8,060	187	54	19.9	6.1	2.4	0.8
Construction Paper	2,160	2,160	2,060	34	24	3.4	2.3	1.6	1.1
Bleached Kraft	26,460	26,420	26,290	904	733	106.8	75.0	4.0	2.9
Sulfite	3,200	2,990	2,830	216	92	27.8	9.3	9.3	3.3
Dissolving Sulfite	910	910	800	71	27	9.3	3.4	10.2	4.2
Soda	290	190	190	10	8	1.2	0.7	6.5	3.7
Deinked	2,420	2,390	2,220	144	26	20.5	4.1	8.6	1.8
Groundwood	2,850	2,740	2,300	110	44	10.8	4.5	3.9	2.0
N/I Tissue	1,670	1,650	1,580	78	44	8.3	5.7	5.0	3.6
N/I Fine	2,380	2,290	2,180	66	47	6.8	5.5	3.0	2.5
TOTAL	68,000	66,970	65,160	2,250[b]	1,410[b]	250	153	3.7	2.3

[a]Excludes depreciation and cost of capital

[b]Rounded

SOURCE: Arthur D. Little, Inc., estimates.

TABLE III-10

SUMMARY OF WATER EFFLUENT CONTROL COST FOR THE EXISTING INDUSTRY BY PRODUCT SECTOR
(1975 Dollars to Meet BPT Regulations)

Product Sector	Year-End Capacity Base (000 tons/yr)		Capital Costs ($ millions)	Operating Costs[a,b] ($/ton)			
	1974	1977		O&M	Capital Recovery	Total Avg.	Total Range
Unbleached Kraft Paperboard	13,970	13,970	373	2.6	3.2	5.8	5.3 - 6.9
Unbleached Kraft Paper	4,390	4,390	122	2.9	3.4	6.3	5.6 - 7.4
NSSC Corrugating Medium	4,430	4,240	112	1.8	3.2	5.0	4.5 - 6.0
Recycled Paperboard	8,680	8,440	187	2.4	2.7	5.1	4.6 - 6.0
Construction Paper	2,160	2,160	34	1.6	1.9	3.5	3.1 - 4.1
Bleached Board & Bristols	5,160	5,160	174	4.0	4.1	8.1	7.3 - 9.5
Printing & Writing Paper	11,600	11,270	595	6.4	6.4	12.8	11.5 - 11.7
Tissue	4,320	4,210	268	7.6	7.7	15.3	13.8 - 18.0
Newsprint	3,720	3,650	162	5.3	5.4	10.7	9.6 - 12.5
Bleached Packaging & Industrial Converting Paper	1,290	1,290	54	5.1	5.1	10.2	9.1 - 11.9
Uncoated Groundwood Paper	1,280	1,190	62	5.6	6.3	11.9	10.7 - 14.0
Dissolving Pulp	1,820	1,820	102	7.1	6.8	13.9	12.5 - 16.3
	62,820	61,790	2,250[c]	4.0	4.4	8.4	7.6 - 9.9

a. Operating costs include capital recovery at 12.1%
b. Based on 1977 capacities
c. Rounded

SOURCE: Arthur D. Little, Inc., estimates.

TABLE III-11

SUMMARY OF WATER EFFLUENT CONTROL COST FOR THE EXISTING INDUSTRY BY PRODUCT SECTOR

(1975 Dollar Increment from BPT to BAT Regulations)

Product Sector	Year-end Capacity Base (000 tons/yr) 1983	Capital Costs ($millions)	Operating Costs ($/ton)[a,b] O&M	Capital Recovery	Total Avg.	Total Range
Unbleached Kraft Paperboard	13,970	258	2.5	2.2	4.7	4.3 - 5.5
Unbleached Kraft Paper	4,390	90	2.5	2.5	5.0	4.5 - 5.8
NSSC Corrugating Medium	4,090	108	1.1	3.2	4.3	3.9 - 5.2
Recycled Paperboard	8,070	54	0.8	0.8	1.6	1.4 - 1.9
Construction Paper	2,060	24	1.1	1.4	2.5	2.3 - 3.0
Bleached Board & Bristols	5,160	141	2.8	3.3	6.1	5.5 - 7.2
Printing & Writing Paper	10,950	363	3.5	4.0	7.5	6.8 - 8.9
Tissue	4,050	155	4.2	4.6	8.8	7.9 - 10.4
Newsprint	3,440	91	2.8	3.2	6.0	5.4 - 7.1
Bleached Pkg. & Ind. Converting Paper	1,290	36	2.9	3.4	6.3	5.6 - 6.6
Uncoated Groundwood Paper	800	41	4.6	6.2	10.8	9.7 - 12.8
Dissolving Pulp	1,710	52	3.5	6.2	9.7	8.7 - 11.6
TOTAL	59,980	1,410[c]	2.6	2.8	5.4	4.9 - 6.4

a. Operating costs include capital recovery at 12.1%
b. Based on 1983 capacities
c. Rounded

SOURCE: Arthur D. Little, Inc., estimates.

4. Noise Control

Noise regulations proposed by the Occupational Safety and Health Administration (OSHA) for compliance with a 90-dBA noise level apply to both existing and new industry capacity. A more detailed description of the regulation is given in Appendix E-3 (Volume III). Because of the scarcity of published information on this subject, Arthur D. Little drew almost entirely upon estimates of noise control costs developed by the American Paper Institute, the best current data source.

API recently conducted a company survey and estimated that the existing industry would have to invest some $516 million to comply with the proposed 90-dBA regulation. This figure, which does not include the cost of facilities already in place, applies to all sectors within the 2600 SIC code — pulp, paper and board manufacturing and converting.

Since the Arthur D. Little study did not include converting or the manufacture of certain types of building products (e.g., hardboard and particleboard) the full $516 million did not apply. The excluded sectors have fewer than the average number of workers and process steps per mill, so it was assumed that they would incur only 25% of the total investment. The remainder, about $400 million, was applicable to the studied sectors.

Arthur D. Little allocated this incremental $400 million into various process categories, taking the position that the capital costs for compliance are more closely related to type and number of installations than to the number of production workers. The costs were then transformed into the product sectors used in the economic impact analysis. A more detailed description on the cost allocation is contained in Appendix E-3.

API has estimated operating costs at $25-68 and $20-40 per worker for monitoring and audiometric testing, respectively. Arthur D. Little used the low end of the range — $25 per production worker for monitoring and $20 per production worker for audiometric testing. In addition to these charges, Arthur D. Little assumed 5% of capital investment for maintenance labor and supplies and 12.1% for capital recovery.

Tables III-12 and III-13 summarize the cost by process category and product sector, respectively. Again, capital recovery was not included in the operating costs for OSHA noise control by process category but was included in the tabulation by product sector.

Arthur D. Little assumed that 80% of these expenditures would be required through 1977 and the remainder between 1977 and 1983. As with the studied air and water regulations, costs associated with new mills were handled separately.

D. COSTS FOR NEW MILL SOURCES

1. Approach

Figure III-2 illustrates the regulations and methodology used for estimating the cost of compliance for new industry capacity. Costs of compliance for new mill sources are based entirely on federally promulgated or proposed regulations. In general, the regulations are somewhat more stringent than those that apply to existing mills.

TABLE III- 12

SUMMARY OF INCREMENTAL OSHA NOISE CONTROL COST TO EXISTING INDUSTRY BY MAJOR PROCESS CATEGORY

(1975 Dollars)

Major Process Category	Total Category Year-end Capacity (000 tons/yr)			Capital Costs ($MM)	Operating Costs[a] ($MM/yr)
	1974	1977	1983		
Unbleached Kraft	8,760	8,760	8,760	36	1.9
NSSC Medium	3,270	3,080	2,930	27	1.5
Bleached Kraft/NSSC	4,960	4,960	4,960	12	0.7
Recycled Paperboard	8,670	8,430	8,060	55	3.9
Construction Paper	2,160	2,160	2,060	23	2.0
Bleached Kraft	26,460	26,460	26,290	99	5.4
Sulfite	3,200	2,990	2,830	27	1.5
Dissolving Sulfite	910	910	800	6	0.3
Soda	290	190	190	4	0.2
De-inked	2,420	2,390	2,220	40	2.5
Groundwood	2,850	2,740	2,300	31	1.7
N/I Tissue	1,670	1,650	1,580	20	1.4
N/I Fine	2,380	2,290	2,180	14	1.0
TOTAL	68,000	66,970	65,160	400	24.0

[a]Excludes capital recovery

SOURCE: Arthur D. Little, Inc., estimates.

TABLE III-13

SUMMARY OF INCREMENTAL OSHA NOISE CONTROL COST TO EXISTING INDUSTRY BY PRODUCT SECTOR

(1975 Dollars)

Product Sector	Sector Year-End Capacity Base (000 tons/yr)			Capital Costs ($/millions)	Operating Costs[a]		
	1974	1977	1983		Oper. & Maint. ($/ton)	Capital Recovery ($/ton)	Total ($/ton)
Unbleached Kraft Paperboard	13,970	13,970	13,970	50	0.2	0.4	0.6
Unbleached Kraft Paper	4,390	4,390	4,390	15	0.2	0.4	0.6
NSSC Corrugating Medium	4,430	4,240	4,090	30	0.4	0.9	1.3
Recycled Paperboard	8,680	8,440	8,070	55	0.5	0.8	1.3
Construction Paper	2,160	2,160	2,060	23	1.0	1.3	2.3
Bleached Board and Bristols	5,160	5,160	5,160	19	0.2	0.4	0.6
Printing & Writing Paper	11,600	11,270	10,950	101	0.5	1.1	1.6
Tissue	4,320	4,210	4,050	48	0.7	1.4	2.1
Newsprint	3,720	3,650	3,440	29	0.4	1.0	1.4
Bleached Pkg. & Ind. Conv. Paper	1,290	1,290	1,290	6	0.3	0.6	0.9
Uncoated Groundwood Paper	1,280	1,190	800	15	0.7	1.5	2.2
Dissolving Pulp	1,820	1,820	1,710	9	0.3	0.6	0.9
TOTAL	62,820	61,790	59,980	400	0.4	0.8	1.2

[a] Unit costs based on 1977 capacities

SOURCE: Arthur D. Little, Inc., estimates.

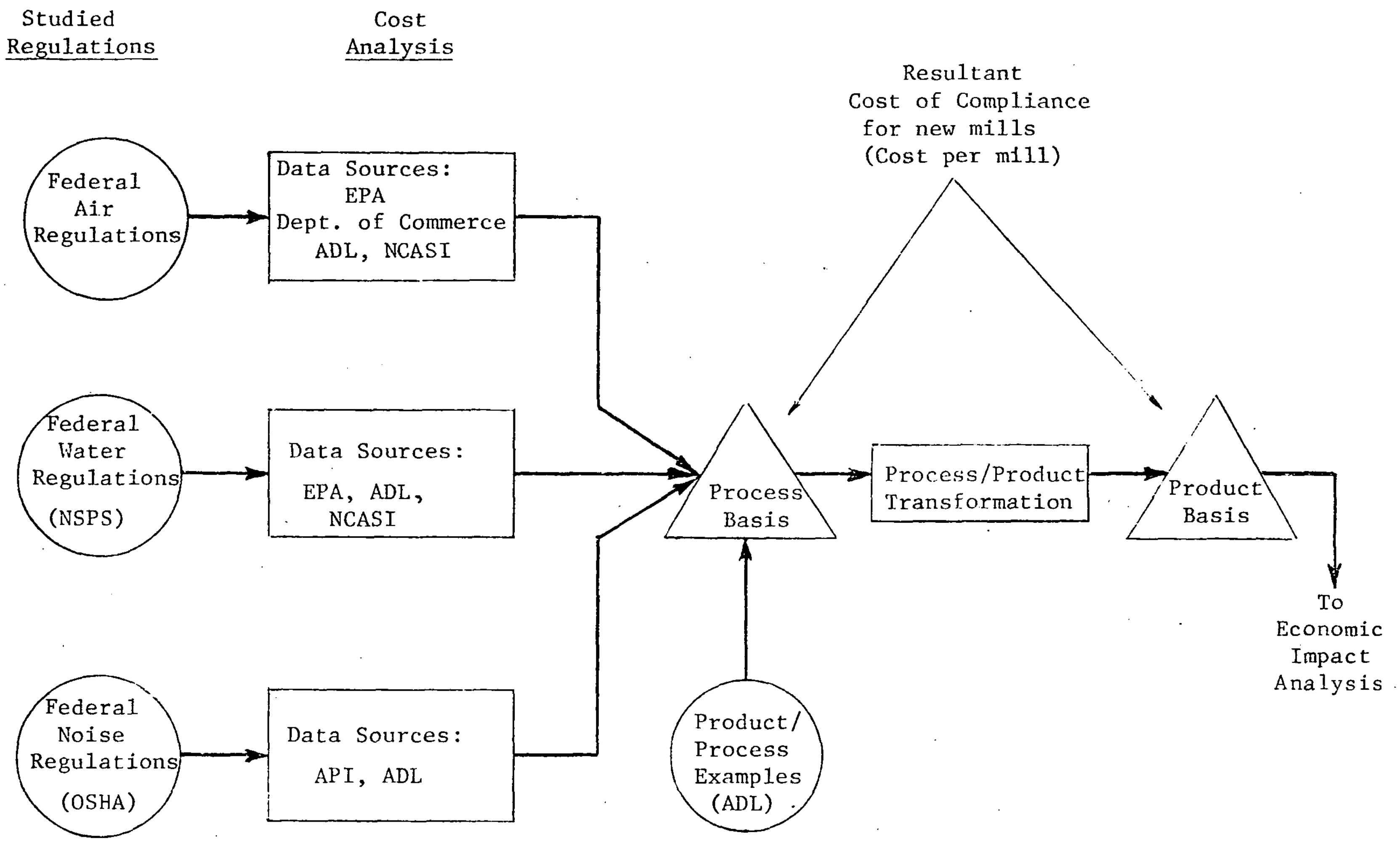


FIGURE III-2. METHODOLOGY FOR CALCULATING COST OF COMPLIANCE - NEW MILLS

As noted earlier, environmental regulations are based upon type of manufacturing process, while their economic impact is measured on a product basis. An analysis of the cost of compliance for new sources therefore tends to be speculative: since more than one type of process may be used in the manufacture of a single product, one must decide which process is most likely to be used in the construction of new capacity to meet future demands. This decision will affect the cost of compliance because of the differences between the various manufacturing processes. Fortunately, clear process preferences have developed for most paper products. Arthur D. Little discussed this issue with numerous industry representatives and then exercised its judgment as to what this future "process mix" will be.

Costs for new mill sources are presented on a unit basis, using cost models of specific processes and *corresponding products*. Accordingly, a process/product transformation is not necessary, because it is implicit in the cost models.

Each cost model indicates the mill capacity used in developing the cost estimates. As shown in the supporting data contained in Appendix E (Volume III), costs of compliance are not linearly related to size; the comparatively large mills used in the models have lower unit costs than do existing facilities, which in general tend to be smaller than new econonic-size mills.

2. Air Emission Controls

The proposed Federal air control regulation calling for 99.7% particulate recovery from the kraft recovery and combination boilers was used as the basis for deriving the cost of compliance with air emission controls. The specific requirements of the proposed regulation are contained in Table E-3, Appendix E-1. The investment and operating cost estimates for compliance are those incremental from an "economic recovery level," assumed in this analysis to be 97.5% removal of particulate matter. Obviously, the incremental cost for compliance would change if the "economic level" were altered.

Table III-14 illustrates the investment and operating cost for the increment from 97.5% to 99.7% particulate recovery for selected products. The mill sizes chosen in these examples typify new economic-size manufacturing facilities, which are generally larger than the average existing facility. The relationship between size and cost is discussed in Appendix E-1.

3. Water Effluent Control

The proposed Federal New Source Performance Standards were used as the basis for deriving costs of compliance. These regulations are essentially the same as the BAT regulations proposed for existing mills, except that color removal for the bleached kraft sectors is not specified in the NSPS.

Arthur D. Little used the NSPS cost estimates for an aerated stabilization basin in all new-mill models. New mills are not required to meet more stringent effluent control standards for 10 years after their initial permits are issued; therefore, costs for new mills to reach BAT have not been included. The specific requirements for each of the studied process (and corresponding product) categories are contained in Tables E-17 to E-19, of Appendix E-2 (Volume III).

The effluent control capital and operating costs were obtained from the Development Document base (detailed in Appendix E-2) in two steps. First, the applicable process subcategory costs for typical sizes were adjusted to pulp mill capacity where applicable, or to paper machine

TABLE III-14

UNIT COST OF COMPLIANCE WITH FEDERAL AIR EMISSIONS STANDARDS - NEW MILL SOURCES
(1975 Dollar Increment from Economic Recovery Level)

Product Sector and Specific Products	Process Category	Mill Capacity (tpd) Pulp	Mill Capacity (tpd) Paper	Capital Costs ($ millions)	Operating Costs ($/ton) O&M	Operating Costs ($/ton) Capital Recovery	Operating Costs ($/ton) Total
Unbleached Kraft Paperboard:							
Kraft Linerboard	Unbleached Kraft	1000	1000	2.9	0.6	1.0	1.6
Unbleached Kraft Paper:							
Kraft Bag Paper	Unbleached Kraft	800	230	0.8	0.7	1.3	2.0
NSSC Corrugating Medium:							
Corrugating Medium	NSSC Pulping	450	450	1.1	0.7	0.9	1.6
Recycled Paperboard:							
Recycled Boxboard	Recyc. Paperbd.	400	400	0.3	0.5	0.3	0.8
Jute Linerboard	" "	330	330	0.3	0.5	0.3	0.8
Bogus Medium	" "	330	330	0.2	0.4	0.2	0.6
Gypsum Linerboard	" "	400	400	0.3	0.5	0.3	0.8
Construction Paper:							
None	Construction Paper	-	-	-	-	-	-
Bleached Board & Bristols:							
Bleached Paperboard (SBS)	BCT Kraft	800	500	2.1	0.8	1.6	2.4
Printing & Writing Paper:							
Bond Paper	Fine Kraft	800	300	1.2	0.9	1.5	2.4
Book Paper	Fine Kraft	800	300	1.3	0.9	1.6	2.5
Tissue:							
Tissue Paper	BCT Kraft	800	163	0.6	1.2	1.3	2.5
Tissue Paper	Nonint. from Waste Paper	-	76	0.1	0.4	0.5	0.9
Newsprint:							
Newsprint	Fine Kraft/GW	1,240	550	0.8	0.4	0.5	0.9
Newsprint	Deinking	-	330	0.2	0.4	0.2	0.6
Bleached Pkg. & Ind.Conv.:							
None	-	-	-	-	-	-	-
Uncoated Groundwood Papers:							
None	-	-	-	-	-	-	-
Dissolving Pulp:							
Dissolving Pulp	Diss. Sulfite	550	550	1.1	0.6	0.7	1.3
Bleached Paper Pulp:							
Bleached Market Pulp	Kraft Mkt. Pulp	800	800	3.1	0.8	1.3	2.1

capacity for nonintegrated examples. Second, for examples integrated to bleached kraft, the portion of total effluent control cost applicable only to paper capacity was calculated by direct proportion.

The effluent control costs are the allocated total for pulp and paper effluent based on paper capacity, but the level of cost takes into account the scale economies of integration to a larger pulp mill.

The complex pulp mill associated with integrated newsprint production was handled as a 1240-tpd fine kraft mill for purposes of estimating effluent control costs. The BOD, TSS, and hydraulic load for groundwood are all lower than for bleached kraft; thus, the estimating procedure slightly overstates total cost. However, there is no clear method for determining standards or applying the "pure" process data to complex pulp and paper mills.

Table III-15 summarizes the investment and operating costs of selected examples for compliance with NSPS. Note that whereas the costs to the existing mill (for both BPT and BAT) were incremental to treatment facilities already in place, the costs for NSPS cover the entire "battery limits" of the treatment facilities. Since there are no deductions for in-place facilities, the new mill models indicate the *total* cost for water effluent treatment rather than simply the increment beyond that assumed to be in place in 1974. The relationship of investment and operating costs for compliance to total mill investment and operating costs for the selected examples is discussed in Section E of this chapter.

4. Noise Control

Table III-16 presents the investment and operating costs for noise control at the 90-dBA level for the studied product/process examples. The capital costs ($1-3 million per plant) are order of magnitude only.

These estimates are significantly greater than those reported for existing mills. The difference reflects Arthur D. Little's opinion that, presented with the option of using either administrative controls or building sufficient "engineering control" into a new mill to comply with noise regulations, a producer would elect to take the latter route. Although administrative control is a much less capital-intensive method of compliance, it is subject to subsequent modification by OSHA if the mill is found to be in violation. Rather than risk being faced with the high costs of mill modification, most producers would choose to equip their new mills with adequate "engineering controls" initially. A more detailed discussion is contained in Appendix E-3 (Volume III).

E. RELATIONSHIP OF CONTROL COSTS TO TOTAL MILL INVESTMENT AND OPERATING COSTS

1. Approach

To add perspective to these estimates of the costs of compliance for the existing industry and for selected examples of new mills, Arthur D. Little prepared total investment and operating cost (I&O) schedules for the manufacture of selected products in *new mills*. Figure III-3 illustrates how these costs were analyzed and cost models developed.

TABLE III-15

UNIT COST OF COMPLIANCE WITH FEDERAL WATER EFFLUENT STANDARDS - NEW MILL SOURCES

(1975 Dollars)

Product Sector and Specific Products	Process Category	Mill Capacity (tpd)		Capital Costs	Operating Costs ($/ton)		
		Pulp	Paper	($millions)	O&M	Capital Recovery	Total
Unbleached Kraft Paperboard:							
Kraft Linerboard	Unbleached Kraft	1000	1000	19.0	5.0	6.7	11.7
Unbleached Kraft Paper:							
Kraft Bag Paper	Unbleached Kraft	800	230	4.8	5.7	7.6	13.3
NSSC Corrugating Medium:							
Corrugating Medium	NSSC Pulping	450	450	13.6	10.7	10.6	21.3
Recycled Paperboard:							
Recycled Boxboard	Recyc. Paperbd.	400	400	6.8	4.1	6.2	10.3
Jute Linerboard	" "	330	330	6.1	4.4	6.8	11.2
Bogus Medium	" "	330	330	6.1	4.4	6.8	11.2
Gypsum Linerboard	" "	400	400	6.8	4.1	6.2	10.3
Construction Paper:							
None	Construction Paper	-	-	-	-	-	-
Bleached Board & Bristols:							
Bleached Paperboard (SBS)	BCT Kraft	800	500	16.1	7.9	11.8	19.7
Printing & Writing Paper:							
Bond Paper	Fine Kraft	800	300	8.5	7.0	10.3	17.3
Book Paper	Fine Kraft	800	300	8.5	7.0	10.3	17.3
Tissue:							
Tissue Paper	BCT Kraft	800	163	4.8	7.2	10.8	18.0
Tissue Paper	Nonint. from waste-paper	-	76	3.4	11.6	16.4	28.0
Newsprint:							
Newsprint	Fine Kraft/GW	1,240	550	9.2	4.2	6.0	10.2
Newsprint	Deinking	-	330	12.9	11.3	13.9	25.2
Bleached Pkg. & Ind. Conv:							
None	-	-	-	-	-	-	-
Uncoated Groundwood Papers:							
None	-	-	-	-	-	-	-
Dissolving Pulp:							
Dissoliving Pulp	Diss.Sulfite	550	550	27.5	16.1	17.5	33.6
Bleached Paper Pulp:							
Bleached Market Pulp	Kraft Mkt. Pulp	800	800	20.3	6.9	8.9	15.8

TABLE III-16

UNIT COST OF COMPLIANCE WITH FEDERAL OSHA STANDARDS - NEW MILL SOURCES

(1975 Dollars)

Product Sector and Specific Products	Process Category	Mill Capacity (tpd)		Capital Costs	Operating Costs ($/ton)		
		Pulp	Paper	($millions)	O&M	Capital Recovery	Total
Unbleached Kraft Paperboard:							
Kraft Linerboard	Unbleached Kraft	1000	1000	3.0	0.3	1.0	1.3
Unbleached Kraft Paper:							
Kraft Bag Paper	Unbleached Kraft	800	230	2.0	0.4	3.2	3.6
NSSC Corrugating Medium:							
Corrugating Medium	NSSC Pulping	450	450	3.0	0.6	2.4	3.0
Recycled Paperboard:							
Recycled Boxboard	Recycled Paperboard	400	400	1.0	0.5	0.9	1.4
Jute Linerboard	" "	330	330	1.0	0.6	1.1	1.7
Bogus Medium	" "	330	330	1.0	0.6	1.1	1.7
Gypsum Linerboard	" "	400	400	1.0	0.5	0.9	1.4
Construction Paper:							
None	Construction Paper	-	-	-	-	-	-
Bleached Board & Bristols:							
Bleached Paperboard (SBS)	BCT Kraft	800	500	2.0	0.4	1.5	1.9
Printing & Writing Paper:							
Bond Paper	Fine Kraft	800	300	2.0	0.4	2.4	2.8
Book Paper	Fine Kraft	800	300	2.0	0.4	2.4	2.8
Tissue:							
Tissue Paper	BCT Kraft	800	163	2.0	0.4	4.5	4.9
Tissue Paper	Nonint. from Waste Paper	-	76	1.0	2.8	4.9	7.7
Newsprint:							
Newsprint	Fine Kraft/GW	1,240	550	2.0	0.5	1.3	1.8
Newsprint	Deinking	-	330	1.0	0.6	1.1	1.7
Bleached Pkg. & Ind.Conv:							
None	-	-	-	-	-	-	-
Uncoated Groundwood Papers:							
None	-	-	-	-	-	-	-
Dissolving Pulp							
Dissolving Pulp	Dissolving Sulfite	550	550	3.0	0.5	1.9	2.4
Bleached Paper Pulp:							
Bleached Market Pulp	Kraft Market Pulp	800	800	3.0	0.4	1.3	1.7

SOURCE: Arthur D. Little, Inc., estimates.

An example of an existing mill would not be particularly informative, because site- and mill-specific conditions would limit its applicability to the more generalized objective of this analysis, namely, to generate costs for the subsequent economic impact analysis.[4] Accordingly, new mill models were used to illustrate the relationship of costs of compliance to total I&O.

As noted, all the previously listed cost of compliance estimates were adapted from published sources. Arthur D. Little updated and modified them, but they are essentially those developed in the cited reference material. On the other hand, the figures for investment and operating cost for direct manufacture are Arthur D. Little estimates. Arthur D. Little has assessed their reasonableness and ascertained that they are well within the precision of pre-engineering cost estimates (±25%).

The number of examples selected to characterize the industry (and hence assess the impact of cost of compliance) is, of course, arbitrary. In choosing specific examples, Arthur D. Little was guided by the diversity of specific products within each product sector. Table III-17 lists the studied product sectors and the specific examples selected to characterize them. The table also indicates the importance of the selected product with respect to its share of the total capacity in the related product sector. Obviously, there are significant variations of any given product, hence, the sample calculations are intended simply to provide some perspective of the relationship between manufacturing costs and costs for compliance.

2. Sample Cost Model

Table III-18 is a sample of the investment and operating cost schedule developed for one of the previously listed product examples; similar schedules for the other products are contained in Appendix F (Volume III). Note that the operating costs exclude charges for capital recovery; these charges were intentionally excluded to facilitate the use of the models in the econometric analysis, where they are handled in the typical manner for cash flow analysis.[5] However, to provide a complete picture of costs, they have been included in Table III-19 at their weighted average value over the life of the sample mill. This table summarizes the *total* investment and operating costs and the relationship of cost of compliance for the selected examples. The capital requirements for compliance with the studied regulations comprise from 10% to 26% of the total fixed capital and constitute from 4% to 13% of the total mill operating cost.

F. DISCUSSION OF ANALYSIS

1. Application and Limitations

The methodology used in this section was designed to develop capital and operating costs for compliance with the studied regulations for *major product sectors* of the industry; a different methodology, more appropriate for showing the possible cost to a *single mill,* was used in the Closure Analysis (Chapter V).

Both the water effluent and air emission cost models are based upon current industry manufacturing practices and control technology. The likelihood that new technology may reduce costs has not been examined in the analysis; this exclusion is appropriate, since any effort to

4. Site- and mill-specific conditions are postulated for selected closure candidates. These examples are discussed separately in Chapter V.

5. That is, depreciation charges change from year to year.

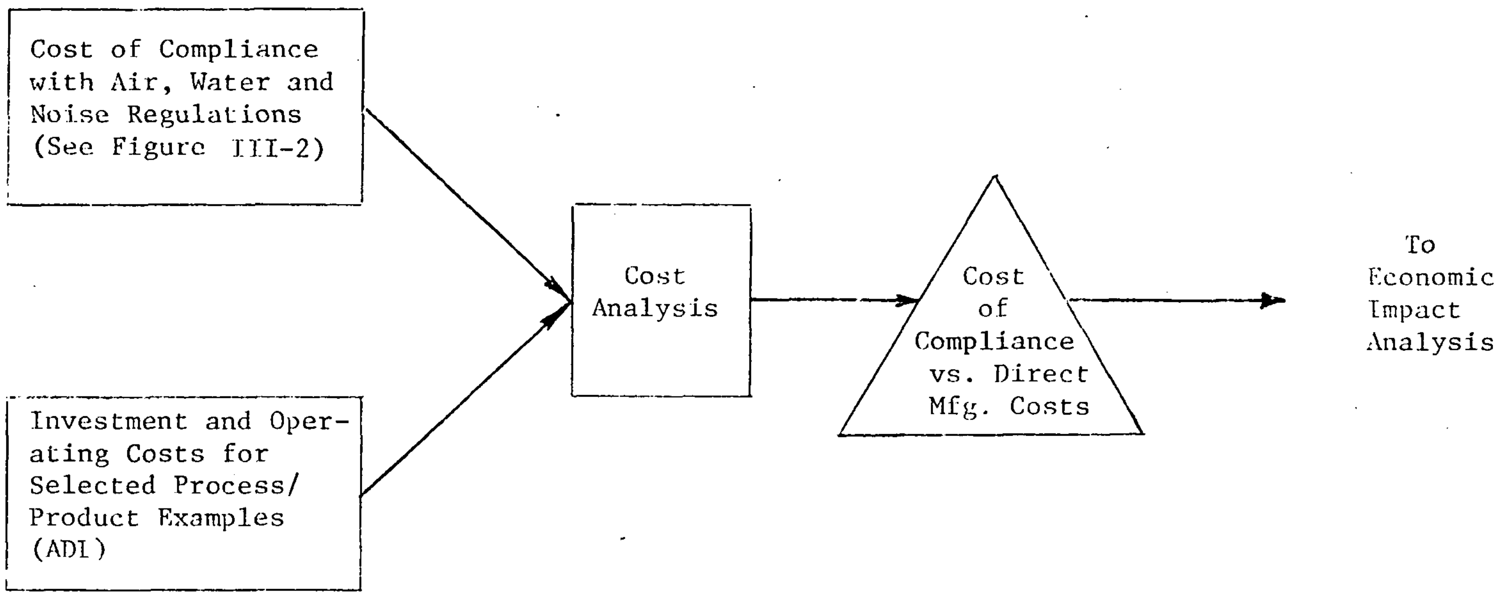


FIGURE III-3. INTERRELATIONSHIP OF COST OF COMPLIANCE AND DIRECT MANUFACTURING COSTS

TABLE III-17

RELATIONSHIP OF SELECTED PRODUCTS TO PRODUCT SECTORS

		1974 Yr-end Capacity (million tons)		Percentage of Sector Represented by
Product Sector	Selected Product	Sector	Product	Selected Product
Unbleached Kraft Paperboard	Kraft Linerboard	13.97	12.90	99.5
Unbleached Kraft Paper	Kraft Bag Paper	4.39	2.30[a]	52.4
NSSC Corrugating Medium	Corrugating Medium	4.43	4.43	100.0
Recycled Paperboard	Recycled Boxboard	8.68	2.67	30.8
	Jute Linerboard	-	0.43	6.0
	Bogus Medium	-	1.36	15.7
	Gypsum Linerboard	-	1.10	12.7
Construction Paper	-	2.16	-	-
Bleached Board & Bristols	Bleached Paperboard (SBS)	5.16	3.92	76.0
Printing & Writing Paper	Bond Paper Book Paper	11.60	7.05	60.0
Tissue	Tissue Paper (virgin)	4.32	3.22	74.5
	" " (recycled)	-	1.10	25.5
Newsprint	Newsprint (virgin)	3.72	3.31	89.0
	" (recycled)	-	0.41	11.0
Bleached Pkg. & Ind. Conv.	-	1.29	-	-
Uncoated Groundwood Papers	-	1.28	-	-
Dissolving Pulp	Dissolving Pulp	1.82	1.82	100.0
Bleached Paper Pulp	Bleached Market Pulp	6.15	6.15	100.0

[a] Estimated from 1974 production

Source: "Paper, Paperboard, Wood Pulp Capacity, Fiber Consumption, 1974-1977," API, October, 1975

TABLE III-18

SUMMARY OF CAPITAL AND OPERATING COSTS FOR THE MANUFACTURE OF UNBLEACHED KRAFT LINERBOARD

BASIS: Process: Continuous Kraft Pulping
Production: 1000 tons/day; 345,000 tons/year
Mill Location: Southeast

Capital Requirements	($millions)
1. Excluding Environmental Regulations	
Direct Manufacturing Process	121
OSHA Regulations	3
Total Fixed Capital	124
Total Working Capital (3 months delivered cost)	10
2. Plus Effluent Control Cost	
Water Control - Internal	6.3
- External	12.7
Air Control - Economic Level	2.8
- Environmental Level	2.9
Total Fixed Capital	148.7
Total Working Capital	10

Operating Cost Item	$/Ton	$000/Year
Fiber Cost	41.9	14,460
Other Raw Materials	4.5	1,550
Hourly Labor	11.4	3,930
Supplies	9.9	3,410
Energy	6.9	2,380
Factory Overhead	4.8	1,660
Capital-related (less capital recovery)	7.9	2,720
Sub-total, Factory Cost	87.3	30,110
GS&A	7.3	2,520
Freight Out	20.9	7,210
Total Delivered Cost, Direct Mfg.	115.5	39,840
OSHA Regulations	0.3	100
Total Delivered Cost, excluding Federal Environmental Regulations	115.8	39,940
Water Control Regulations	5.0	1,740
Air Control Regulations - Economic Recovery	(2.7)	(930)
Environmental Control	0.6	220
Total Delivered Cost, excluding capital recovery	118.7[a]	40,970

[a] Capital recovery charges add $52.2/ton to this cost, giving a total of $170.9/ton.

Source: Arthur D. Little, Inc., estimates.

TABLE III-19

RELATIONSHIP BETWEEN MANUFACTURING COSTS AND ENVIRONMENTAL CONTROL COSTS in 1975 Dollars

Product Sector and Specific Products	Process Category	Mill Capacity (tpd) Pulp	Mill Capacity (tpd) Paper	Total Delivered Mfg. Costs Capital ($MM)	Total Delivered Mfg. Costs Total Oper. ($/ton)	Environmental Control Costs: NSPS Water Effluent Standards Capital ($MM)	NSPS Water Effluent Standards Total Oper. ($/ton)	Air Emissions New Source Standards Capital ($MM)	Air Emissions New Source Standards Total Oper. ($/ton)	OSHA Requirements Capital ($MM)	OSHA Requirements Total Oper. ($/ton)	Total Cost of Compliance Capital ($MM)	Total Cost of Compliance Total Oper. ($/ton)	Cost of Compliance (Percent of Total Mfg) Capital	Cost of Compliance (Percent of Total Mfg) Operating Costs
Unbleached Kraft Paperboard:															
Kraft Linerboard	Unbleached Kraft	1000	1000	148.7	170.9	19.0	11.7	2.9	1.6	3.0	1.3	24.9	14.6	17	9
Unbleached Kraft Paper:															
Kraft Bag Paper	Unbleached Kraft	800	230	65.3	258.7	4.8	13.3	0.8	2.0	2.0	3.6	7.6	18.9	12	7
NSSC Corrugating Medium:															
Corrugating Medium	NSSC Pulping	450	450	67.7	196.1	13.6	21.3	1.1	1.6	3.0	3.0	17.7	25.9	26	13
Recycled Paperboard:															
Recycled Boxboard	Recycled Paperbd.	400	400	57.8	238.4	6.8	10.3	0.3	0.8	1.0	1.4	8.1	12.5	14	5
Jute Linerboard	" "	330	330	39.1	198.9	6.1	11.2	0.3	0.8	1.0	1.7	7.4	13.5	19	7
Bogus Medium	" "	330	330	32.1	178.9	6.1	11.2	0.2	0.6	1.0	1.7	7.3	13.3	23	7
Gypsum Linerboard	" "	400	400	49.8	203.0	6.8	10.3	0.3	0.8	1.0	1.4	8.1	12.5		6
Construction Paper:															
None	Construction Paper	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bleached Board & Bristols:															
Bleached Paperbd.(SBS)	BCT Kraft	800	500	144.8	326.0	16.1	19.7	2.1	2.4	2.0	1.9	20.2	24.0	14	7
Printing & Writing Paper:															
Bond Paper	Fine Kraft	800	300	96.7	389.1	8.5	17.3	1.2	2.4	2.0	2.8	11.7	22.5	12	6
Book Paper	Fine Kraft	800	300	94.8	403.6	8.5	17.3	1.3	2.5	2.0	2.8	11.8	22.6	12	6
Tissue:															
Tissue Paper	BCT Kraft	800	163	70.9	687.9	4.8	18.0	0.6	2.5	2.0	4.9	7.4	25.4	10	4
Tissue Paper	Nonint. from waste paper	-	76	28.4	748.2	3.4	28.0	0.1	0.9	1.0	7.7	4.5	36.6	16	5
Newsprint:															
Newsprint	Fine Kraft/GW	1,240	550	120.5	246.7	9.2	10.2	0.8	0.9	2.0	1.8	12.0	12.9	10	5
Newsprint	De-inking	-	330	55.9	237.1	12.9	25.2	0.2	0.6	1.0	1.7	14.1	27.5	25	12
Bleaching, Pkg. & Ind. Conv:															
None	-	-	-	-	-	-	-	-	-	-		-	-	-	-
Uncoated Groundwood Paper:															
None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolving Pulp:															
Dissolving Pulp	Dissolving Sulfite	550	550	161.6	332.5	27.5	33.6	1.1	1.3	3.0	2.4	31.6	37.3	20	11
Bleached Paper Pulp:															
Bleached Market Pulp	Kraft Market Pulp	800	800	184.0	261.3	20.3	15.8	3.1	2.1	3.0	1.7	26.4	19.6	14	8

SOURCE: Arthur D. Little, Inc., estimates.

project the significance of savings and the rate of implementation of new technology is speculative at best. Nevertheless, it must at least be acknowledged that new or modified pulping and bleaching processes could be developed whose effluent streams would be less costly to control. Cost reductions could result from less polluting manufacturing processes, water effluent or air emission treatment, or a combination of both. While the timing and impact of such technological developments are clearly unpredictable, it would be short-sighted not to recognize the continuous evolution of technology and its possible resultant impact upon both the capital requirements of the industry and the costs of compliance. Control regulations have, in fact, stimulated the development of less polluting processes and more economical treatment technology.

Another major assumption of the analysis is that product quality will not change during the studied period. Product specifications sometimes change without adversely affecting utility in the final application: during the past five years, for example, the basic weight of newsprint has been reduced from 32 to 30 pounds per ream, and a solid unbleached kraft board is capturing markets once served by solid bleached board and recycled board. Although more such changes could admittedly occur, they are a subject of considerable complexity and controversy, and Arthur D. Little considers it inappropriate to speculate on the products that might be affected.

Effluent- or emission-control cost models were used to estimate aggregate costs to a product sector. However, the resultant "average" costs obviously understate the cost to some mills and overstate the costs to others. Thus, while some mills report their cost of compliance to be significantly greater than those presented in the Development Documents, others report that they are now or soon will be in compliance with the BPT guidelines through the application of control technology that is simpler and less costly than that specified in the effluent-control cost models.

The accuracy or reasonableness of the estimated cost of compliance is, of course, an important issue in subsequently assessing the economic impact of the studied regulations. Considerable work has been done by EPA and others in assessing the costs of compliance with air and water regulations; the cost estimates for noise reduction are, in Arthur D. Little's opinion, an order of magnitude less accurate. Pre-engineering cost estimates generally have a possible variability of plus 25% and minus 10%. Arthur D. Little believes that these percentages would apply to estimates of *aggregate* costs for air and water control for a given product sector. (Obviously, as stated earlier, the variation for any one mill can be significantly greater than this range.) On the other hand, the variation in cost estimates for noise reduction is estimated at plus 25% and *minus 50%*. The large variability in the negative direction reflects that the cost estimates used in this analysis were based on achieving compliance via "engineering in the pathway"; reportedly, significant capital cost reductions could be achieved by substituting administrative control for some of this engineering. However, since the permissible level of administrative control is speculative, costs of compliance are more appropriately based on the more costly method of compliance. Clearly, however, additional work is required to raise the quality of the OSHA noise reduction cost estimates to the level of the air and water control cost estimates.

Overall, while there is significant variability in the cost of compliance estimates, it is well within the accuracy of other factors (growth in GNP, cost of capital, etc.) used in assessing the economic impact of the studied variations.

2. Causes of Cost Escalation

Table III-19 summarized the total capital investments for new plants and their relationship to the capital costs for compliance. Depending on the type and size of the plant used in each cost model, the capital cost associated with the studied regulations ranges from 10% to 26% of the total capital requirements. In relation to the industry capacity represented by each of the cost models, the weighted average cost of compliance is about 15% of the capital cost of additional industry capacity.

While the contribution of capital requirements for compliance with environmental regulations is substantial, it is not the only cause of cost escalation in new construction. Other factors include inflation and the tendency to build more capital-intensive facilities to reduce operating costs.

Inflation of course, has been a significant factor in the rising cost of new construction, particularly from the third quarter of 1973 through mid-1976. Its influence can be seen in numerous equipment cost and plant construction cost indices. However, a comparison of plant investment estimates presented in this report with one obtained by simply escalating say, a 1965 plant investment estimate via these indices, shows that the reported capital requirements are substantially higher. Clearly, costs for new plant construction have risen much faster than inflation plus the 15% increment associated with the cost of compliance.

The reason is that pulp and paper mills are simply becoming more capital-intensive; this reflects an effort by producers to slow the rate of increase in costs of raw materials, energy, and labor. They are turning to more sophisticated (and more costly) processes to reduce cost in these areas and to facilitate the external water effluent and air emission control treatments.

The use of fiber reclamation in modern pulp and paper mills is an example of greater plant investment to achieve savings in raw materials. Not many years ago, "knots" (wood chips and actual wood knots that failed to break up in the digester), screening/cleaning rejects, and some of the paper machine "white water" were discharged without further treatment. Today, reclamation of the "knots" and screening/cleaning rejects is an accepted industry practice. The equipment used for this purpose is costly, but it saves enough high-cost fiber to make the additional investment economically attractive.

In a similar manner, fiber traditionally has been recovered from water discharged at various points in the pulping and papermaking operation where the concentration of fiber per volume of water is high, but recovery has not been economical where concentration is low. The latter is no longer true, not only because of the increased cost of fiber but also because any fiber not recovered and reused internally in the manufacturing operation must now be recovered and disposed of in an external effluent treatment process.

To the extent possible, the Development Documents attempted to apportion the additional investment for fiber recovery between that due to economic recovery and that prompted by effluent control. Clearly, however, this apportionment of capital dollars is a complex and arbitrary process. The point is that a greater investment is being made today in fiber reclamation for economic reasons than some ten or even five years ago, when fiber costs were significantly lower.

Additional large investments are being made in new plants for more efficient use of energy. Higher pressure boilers that cost more but are more efficient are being included in new plant designs; additional or larger heat "economizers" are being installed, and new or additional on-site power generating equipment is being included. These and other process changes are being made to reduce energy consumption. However, they are not new or emerging technical developments; they have been available for years, but have become economically justifiable as energy costs have tripled.

Similarly, more automation has been designed into new plants. The additional investment dollars can be justified in terms of fiber and energy savings and labor cost reductions, but it has contributed significantly to the capital cost for building new production facilities.

Thus, while Arthur D. Little cannot quantify the relative importance of the various factors contributing to the escalating cost of new capacity, the causes clearly include others besides inflation and the cost of compliance with environmental regulations.

3. Comparison of Cost Estimates with Other Published Estimates

For purposes of this discussion, the costs of compliance with the studied regulations are divided into two discrete areas: those for proposed regulations or guidelines pertaining to air and water, and those proposed for noise reduction. A detailed analysis and comparison of the Arthur D. Little cost estimates with paper industry surveys and other published estimates are contained in Appendix E-4 (Volume III). This section is a summary of that information.

a. Control Costs for Water and Air

Estimates of industry's costs for compliance with the studied water and air regulations have been developed by the following:

Hazen and Sawyer, Inc.	— 1977 and 1983 water effluent control for existing industry.
National Council for Air and Stream Improvement	— SIP air costs for existing industry, and Federal water and air regulations for new capacity.

The results were summarized and used as the cost basis of a study[6] prepared for the American Paper Institute by the URS Research Company. The total costs were estimated at $8.2 billion (in 1974 dollars) for the period 1974 to 1983 exclusive.

To be on the same time basis as that used in this report, the above figure must be converted to mid-1975 dollars and reduced by the amount of reported expenditures through 1974; the result is $8.7 billion. (See Table E-22, Appendix E-4). Implicit in this estimate is that industry capacity would increase from some 73 million tons at the end of 1977 to some 89 million tons by 1984. In comparison, Arthur D. Little estimates the cost of compliance at some $6.6 billion, based on the assumption that industry capacity will increase to only 86 million tons.[7] Accordingly, one of the

6. "Economic Impacts on the American Paper Industry of Pollution Control Costs," report by URS Research Company to the American Paper Institute, September 1975.

7. Other industry growth scenarios are also postulated, with correspondingly different costs of compliance.

first and most obvious sources of variance between the two estimates is the difference in the capacity base. Simply correcting for the 3-million-ton difference in capacity would reduce the variation from $2.1 billion to $1.8 billion. The latter figure is about 27% higher than the Arthur D. Little estimate; it is also developed against a more stringent set of assumptions with regard to the required level of environmental control.

In view of the uncertainty and changing characteristics of the proposed regulations and/or guidelines, the two independent estimates are remarkably close and certainly within the precision of other key factors (growth in GNP, cost of capital, new technology, new products, etc.) that influence the economic impact of these estimated costs. Thus, while Arthur D. Little believes the estimates are well within the accuracy of the overall impact analysis, it appears appropriate to discuss them here in somewhat more detail.

(1) Water. Both URS (Hazen & Sawyer) and Arthur D. Little estimate that compliance with water regulations would cost the existing industry $2.2 billion. This apparent agreement is somewhat misleading, however; the URS estimate includes a higher *unit* cost for compliance, a more stringent set of regulations, and a higher level of in-place treatment facilities than were assumed in the EPA Development Documents, upon which Arthur D. Little's figures are based. The higher unit cost for the more stringent regulations and level of in-place treatment facilities coincidentally offset each other, so the net incremental capital requirement is the same as that estimated by Arthur D. Little.

A detailed comparison of these two estimates is given in Appendix E-4.

(2) Air. Arthur D. Little and URS disagree significantly on the cost for compliance with air regulations, particularly to the existing industry for the 1978-1983 period. Since the URS report contains no information to support the estimates or to explain the methodology used in deriving them, Arthur D. Little cannot be sure of the reasons for the variances. They appear to be the assumptions (hence related costs) associated with:

— the required level of control for the existing industry,

— the level of economic recovery (existing and new industry capacity), and

— capitalized maintenance and replacement of capacity.

- *Level of Control:* State Air Quality Implementation Plan (SIP) standards apply to the existing industry; Federal regulations do not. Furthermore, SIP requirements vary significantly from state to state; hence, a given type and size of mill can have greatly different costs of compliance, depending on its location.

Even though many states presently do not have regulations as stringent as those of Oregon (which require 99% particulate recovery), Arthur D. Little used that state's current SIP standards to calculate the existing industry's cost of compliance. Arthur D. Little postulated that the current Oregon regulations would be more broadly applied to those states that presently have less stringent regulations.

The URS (NCASI) estimates did not specify what regulations were used in deriving the cost estimates or whether more stringent controls — beyond those assumed through 1977 — would apply in the 1978 and 1983 period. Judging from its magnitude, however, one would suspect that the estimate for the existing industry's expenditures from 1978 to 1983 includes provision for the application of more stringent regulations.

- *Capitalized Maintenance/Replacement Cost:* Major capital expenditures are occasionally budgeted entirely for environmental controls. More frequently, however, they are primarily for the building of grassroots facilities, replacement of existing capacity (capitalized maintenance), or incremental expansion of existing mills and only a portion of the investment goes into environmental control. Unfortunately, it is difficult to generalize on the amount that is necessary for compliance with environmental regulations in relation to the expenditures for enlarging capacity or increasing the efficiency of the process.

For cost estimating purposes, Arthur D. Little has shown separately the capital investment associated with:

— capitalized maintenance to maintain the existing industry at rated capacity and

— investment requirements for new capacity, whether that new capacity is to replace existing capacity or add net additional capacity.

Hence, by deriving the cost of compliance empirically, Arthur D. Little has attempted to avoid the inappropriate allocation of industry expenditures.

Table III-6 summarized the derived capital cost for air emission control for the existing industry using the current Oregon SIP standards. The estimate of $1.3 billion includes costs for: (a) those mills using the kraft process, (b) power boiler controls for other process categories, and (c) earlier retirement of recovery boilers in the kraft process categories.

Deducting the reported industry expenditure of some $0.4 billion from the derived estimate results in an incremental cost of $0.9 billion in additional capital for the existing industry to achieve the 99.0% particulate recovery required by the Oregon standards.[8]

By way of comparison, the incremental air emission control cost reported by NCASI for the existing industry amounts to some $2.4 billion (mid-1975 dollars). On the assumption that perhaps 85% ($2.0 billion) of this total is associated with the kraft process, *each* of the 127 existing kraft mills in the industry would have to spend about $16 million to control air pollution. This figure appears to be much too high for the incremental cost of compliance; it must include provision for other capital requirements, such as incremental new capacity or capitalized maintenance items, which are shown separately in the Arthur D. Little cost analysis.

b. OSHA Noice Control Costs

Two sources of information deal with the costs of noise reduction to meet the proposed OSHA noise regulations — The American Paper Institute and Bolt Beranek & Newman, Inc. (BBN). Arthur D. Little used the American Paper Institute (API) data, estimated a $516 million for all sectors in SIC 26. Arthur D. Little modified this data, to reflect the fact that API had included certain SIC codes that were omitted from the Arthur D. Little analysis, and arrived at an estimated incremental capital cost to the existing industry of $400 million.

8. This estimate does *not* include capital expenditures for fuel conversion. The conversion of power boilers from oil to coal or from natural gas to oil or coal would add significantly to the derived cost.

The BBN study appears to extrapolate very limited data. Using the estimated costs of noise reduction in two mills (whose type, size, number of machines, etc., were not indicated), BBN divided these figures by the number of production workers in each plant and then extrapolated the cost per worker to the cost for the entire industry.

Arthur D. Little believes that the costs of noise reduction are more closely associated with the type and number of pulp and paper mills and the number of paper- or board-making machines. Accordingly, it relied on the API estimate, which takes these factors into consideration.

CHAPTER IV
PRICE AND SECONDARY IMPACTS

IV. PRICE AND SECONDARY IMPACTS

A. OVERVIEW

This chapter details the price increases that are likely to occur from the cost to the pulp and paper industry to meet the studied air, water, and noise regulations. The projected price increases provided the basis for calculating demand reductions, supply/demand imbalances, and effects on suppliers.

The price impacts of the environmental regulations can be summarized as follows:

- Average paper prices will increase a total of 8% over the general inflation in the long run as a result of new mill costs to comply with the water, air, and OSHA noise regulations. Paper prices will increase an additional 12% because of recent substantial increases in new mill costs not related to environmental regulations.
- Consumer product price increases in relative terms will be less than the price increase of the paper, except for tissue which should experience the same increase (about 4.1%).
- Demand for paper products is relatively price inelastic. The projected 8% average price increase will cause a 5% lower level of potential paper demand, equivalent to about 1-½ years of "normal" growth.
- The existing industry requires a lower price increase (6%) to recover incremental costs of environmental regulations, since it has already made substantial investments and progress toward meeting 1977 requirements.
- With the possible exception of saltcake suppliers, paper industry suppliers face minimal impacts as a result of the price increases and demand reductions caused by the studied environmental regulations.

B. FINDINGS

1. Price Impacts

a. Introduction

The price increases that will result from the studied environmental regulations were analyzed in three different ways:

1. The long-run price effects (beyond 1983) based upon studied environmental regulations on new mills.

2. The price increase necessary for existing mills to recover their total incremental costs of compliance with the studied regulations.

3. The average aggregate price level likely to prevail from 1976 to 1983 (in 1975 dollars) if the industry's return on total capital averages 10%.

The first two analyses were applied to estimate price impacts for the individual product sectors and the total industry. The third analysis is a by-product of the funds-flow analysis discussed in Chapter VI.

b. Long-run Price Effects

Prices will be $24 per ton, or about 8% higher, than they would otherwise have been in the long-run as a result of costs associated with the studied environmental regulations. EPA New Source Performance Standards (NSPS) for water effluent will have the greatest impact at $19 per ton or 6% of the long-run price without regulations ($327). OSHA noise regulations will add about a 1% price increase and EPA NSPS air regulations combined with State Implementation Plan and air regulations contribute an additional 1% (Table IV-1).

It should be noted that the price increase figures cited above represent the total long-run impact of the studied environmental regulations and *not* the incremental effect of going from the 1975 effluent level to NSPS. The long-run baseline "without regulation" average price of $327 per ton represents the price necessary to earn the industry's historic rate of return[1] on a new mill excluding any equipment that is not justified on economic grounds.

TABLE IV-1

LONG-RUN PRICE IMPACT OF MAJOR ENVIRONMENTAL REGULATIONS IMPOSED UPON THE PULP AND PAPER INDUSTRY

	1975 $/Ton	% Change
1975 Market Price	292	
New Mill Inflation Effect Without Regulation	35	
Subtotal		327
Incremental Price Increases Due To:		
EPA NSPS Water	19	6
OSHA Noise	3	1
EPA NSPS and SIP Air	2	1
TOTAL PULP AND PAPER	351	8

Source: Arthur D. Little, Inc., estimates.

Prices will also increase in the long-run because the cost of new plant construction and equipment replacement has increased so rapidly in recent years. The average 1975 price for a ton of paper was $292, but the long-run average price based upon the construction and operating costs of new mills without any environmental controls will be $327 per ton. This represents a 12% increase in price — a greater impact than that of all the studied regulations. The magnitude of the price inflation impact is sensitive to the cost of capital and the potential variability in operating costs. (See Section D.2, Sensitivity Analysis.)

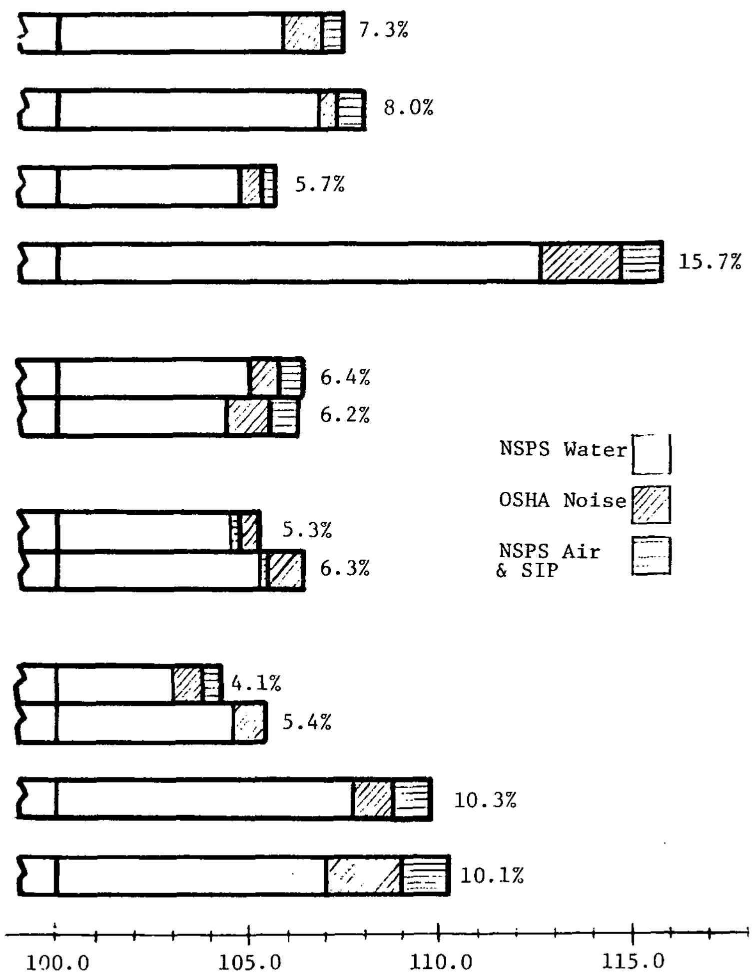
The impact of environmental regulations varies by product sector (Figure IV-1). The price increase for tissue, $35 per ton, is higher than for any other product. However, since tissue is the highest priced paper product, $769 per ton in 1975, the $35 represents an increase of only 4.1%, the smallest percentage increase that will be experienced by any product sector. A price increase for NSSC (neutral sulfite semi-chemical) corrugating medium of $32 per ton, is equivalent to a price increase of 15.7%, the highest relative price increase, because the price of NSSC is at the lower end of the spectrum for paper products ($193 per ton in 1975).

1. The long-run price impacts were estimated based upon a 10% cost of total capital (13% on equity capital). Although the price levels change with different costs of capital, the relative impact is insensitive to variability in the cost of capital. (See Section D.2, Sensitivity Analysis.)

FIGURE IV-1

LONG-RUN PRICE INCREASE
RESULTING FROM ENVIRONMENTAL REGULATIONS
IN THE PULP AND PAPER INDUSTRY[1]

	$/Ton Without Environmental Regulations
Industry Aggregate	$327
Bleached Board (SBS)	362
Newsprint	280
NSSC Corrugating Medium	198
Printing & Writing	
Bond Paper	436
Book Paper	449
Recycled	
Recycled Boxboard	260
Gypsum Linerboard	219
Tissue	
Tissue	754
Deinked Tissue	782
Unbleached Kraft Linerboard	185
Unbleached Kraft Bag Paper	297



Relative Price Increase Necessary
(100.0 = Price without Environmental Controls)

[1]Excluding woodland regulations.

C. PRICE INCREASE REQUIRED TO RECOVER EXISTING INDUSTRY'S INCREMENTAL COMPLIANCE COSTS

The price impacts discussed thus far are those that will prevail in the long run when the industry is dominated by plants that must comply with new source performance standards. Over the next several years, however, the price increases will be those required by existing mills to recover the costs of the following:

- EPA 1977 Water Effluent Guidelines
- EPA 1983 Water Effluent Guidelines
- OSHA Noise Standard
- SIP Air Emission Standards

The aggregate price increases necessary to recover the cost of these regulations to the existing industry are shown in Table IV-2. The 1977 and 1983 water effluent regulations require an average price increase of $8 and $6 per ton, respectively, to cover the incremental cost of compliance. Most of the incremental cost associated with OSHA noise and SIP air regulations will be borne by 1977, with a lesser amount incurred by 1983.[2] The price increases required to cover the incremental compliance costs amount to $11 per ton (3.8% of the average 1975 price) by 1977 and a total of $17 per ton (5.8%) by 1983.

The incremental cost of environmental regulations to the existing pulp and paper industry and the price increase needed to cover these costs vary by product sector (Figure IV-2). Tissue producers require the smallest percentage increase in price, 3.7%, to cover the cost of pulp and paper industry regulations. The greatest relative impact, 7.9%, will be on the price for uncoated groundwood.

Although the uncoated groundwood product creates less air and water pollution than tissue, its treatment costs are higher than average per ton because the mills are small. The higher than average treatment cost combines with the low per-ton price to yield a high relative impact. Thus, the potential relative price increase is related to the product's base price as well as its cost for environmental control.

The SIP air regulations vary considerably from state to state in both the emission level allowed and the timing required. As discussed in Section III-C.2, estimates for SIP costs were based on the assumption that all mills would meet current Oregon standards, the most stringent in existence. The Oregon standards are becoming progressively tighter, but most other states are far enough behind to permit the estimated price impact of these standards to be taken as an upper bound of the probable impact unless more stringent standards are imposed nationally. Among the product groups studied, the price increase necessary to recover the SIP costs ranges from a low of 0.3% of the 1975 price for tissue to a high of 1.2% for kraft paper.

In estimating the cost of the OSHA noise standard, Arthur D. Little assumed that compliance activity would occur over the period 1975-1983. (See Chapter III.) In total, the existing industry can recover the cost of the proposed OSHA Noise with just a small price increase, ranging from 0.1% of the 1975 price for bleached board, to 0.7% for NSSC corrugating medium.

2. See Chapter III, Section D for a more complete discussion.

TABLE IV-2

PRICE INCREASE
TO COVER COST OF ENVIRONMENTAL REGULATIONS
TO THE EXISTING INDUSTRY *
(1975 Dollars per Ton)

	By 1977	By 1983	Total	% Change
Average Price, 1975			292	
Type of Regulation				
EPA 1977 Water	8	--	8	2.9
EPA 1983 Water	--	6	6	1.8
SIP Air	2	0**	2	0.7
OSHA Noise	1	0**	1	0.4
Total Pulp & Paper	11	6	17	5.8

*Incremental cost of going from 1975 level to requirement.

**Less than 0.5%.

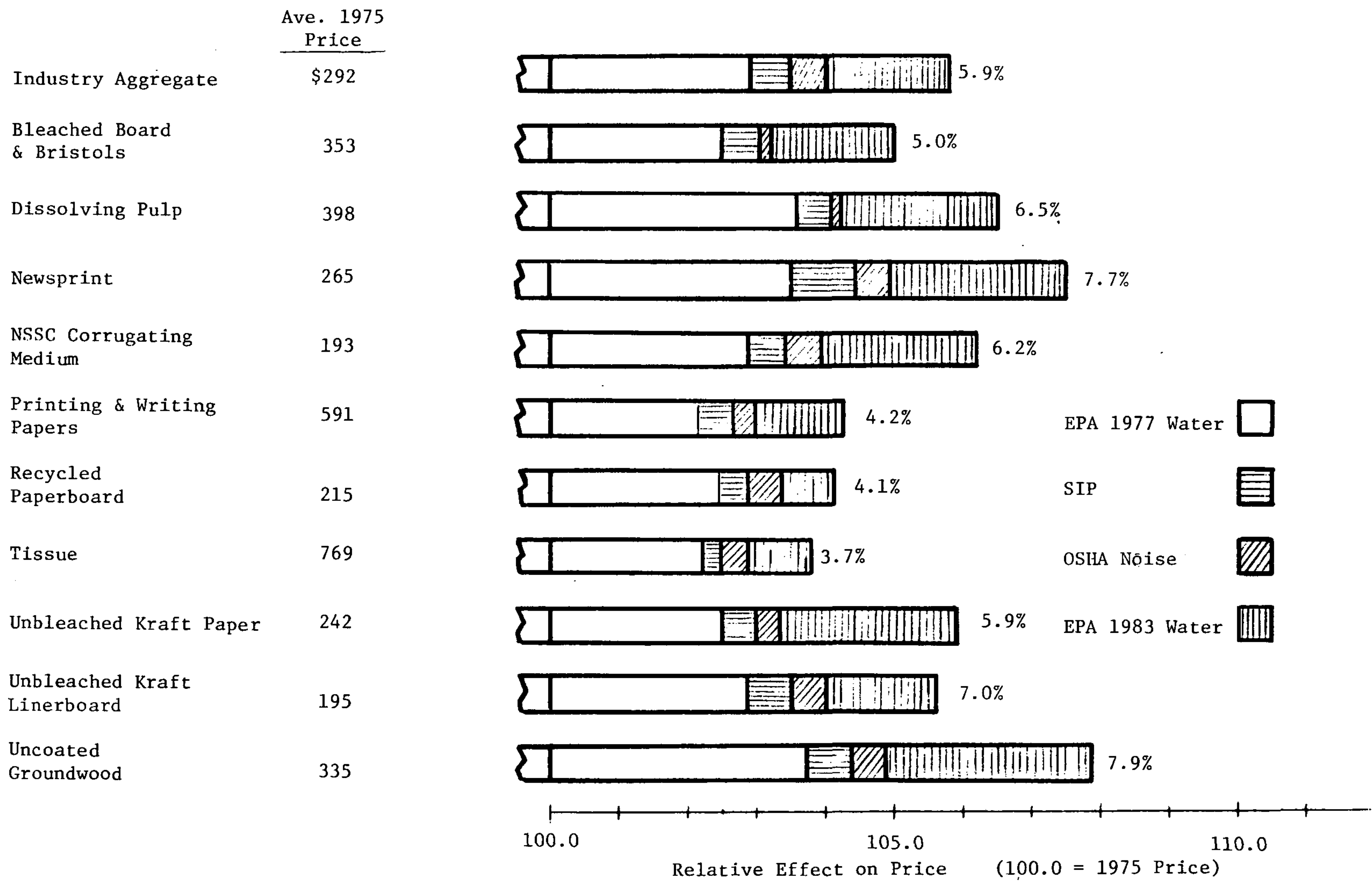
SOURCE: Arthur D. Little, Inc., estimates.

Environmental regulations will have a greater impact on increasing production costs for new mills than for existing mills. Compliance cost estimates for the existing industry represent the incremental expenditure from the various effluent (or noise) levels of 1975 to compliance with each of the regulations. For new mills these compliance costs are the incremental costs from the economically justified effluent control level to compliance with regulations for new sources. Other factors also make costs of compliance higher for new mills.[3] For example, new machinery runs at higher speeds than old machinery and is therefore noisier, which increases the cost of compliance with OSHA noise regulations. As a result, price increases related to environmental costs are generally lower for existing mills than the long-run price increases indicated in Table IV-1. The exception to this rule is newsprint, in which existing industry requires a 7.5% increase (Figure IV-2) to recover the cost of environmental regulations whereas the long-run price increase based on new sources is only 5.7% (Figure IV-1). However, the long-run price (without environmental regulations) for new sources will be $280 per ton compared to the 1975 price of $265 per ton, or a total price with regulations of $296 compared to $286 for the existing industry. Therefore, the total price level required for the existing industry to recover compliance costs is less than the long-run price that will prevail as a result of environmental regulations.

3. See Chapter III for the details of cost of compliance differences.

FIGURE IV-2

PRICE INCREASES NECESSARY
FOR EXISTING INDUSTRY
TO COVER THE COST OF ENVIRONMENTAL REGULATIONS
(Percent Change)



d. *Average Paper Price Increase 1976 to 1983*

From 1976 to 1983, the cost structure of existing mills in the pulp and paper industry will predominate. However, new capacity will come on-stream and some existing equipment will be replaced. Consequently, the price impacts of environmental regulations occurring over the next few years will be a result of the costs of environmental regulations to both the existing industry and new sources. The real price increases that occur will be the result of economic conditions, cash flow and Federal tax effects.

The aggregate price impact of the studied regulations over the period 1976-1983 was forecast using the industry flow of funds model described below, in Chapter VI and Appendix H. Table IV-3 sets forth the aggregate price impacts to be expected if the industry takes full account both of its immediate *and* its prospective cost of capital, investment requirements, achievable output levels, and operating costs in its current pricing decisions. Costs to the existing industry play the dominant role in establishing the price increases that will result from the studied regulations between 1976 and 1983. The net effect on the industry of the interplay between tax effects, output adjustments, and miscellaneous other factors results in an estimate of the impact of compliance beyond 1975 levels of $17 per ton which is coincidentally equal to the price increase necessary for existing industry to recover the cost of the studied regulations.[4] However, Table IV-3 also indicates that the aggregate price level over the 1976-1983 period will be increased further by about $13/ton over 1975 prices to compensate for inflationary increases in the basic cost of construction of new capacity and in the costs of environmental control equipment already installed by the existing industry.

2. Outlook for Demand and Capacity Utilization

The outlook for aggregate paper industry demand and capacity utilization was analyzed by two different methods.

(1) Demand adjusted for the 1976-1983 average paper price increase occurring in 1976 and the resulting capacity utilization rates in the funds flow model. (See Chapter VI.)

(2) Demand forecast adjusted to reflect price increases equal to average environmental cost increases to the existing industry.

The second method of projecting average industry demand and capacity utilization consists of forecasting aggregate paper demand (from the demand equation and the Chase Econometrics forecast *without a 1978 recession)* and adjusting for the price increase necessary for the existing industry to recover its compliance costs. This view of potential capacity shortage is more conservative because it projects a higher demand.

The demand forecast and upper and lower boundaries around the forecast are shown in Figure IV-3, along with the estimated capacity utilization rate. The announced capacity expansion plans of industry were combined with the expected demand level (without a 1978 recession) to arrive at an estimate of the industry capacity utilization rate through 1979. In addition, aggregate capacity growth rates were estimated for the years 1980 through 1983 and operating rates were projected for these years.

4. The similarity of these numbers is coincidental because the funds flow model assumed method of the incremental cost of compliance from December 1974 to July 1, 1977 was incurred in 1975. The analysis of costs to the existing industry included the total incremental cost from December 1974 to July 1977. The discounted cost of environmental regulations for new sources that will come on-stream from 1976 to 1983 is coincidentally equal to one-third of the cost of compliance for the existing industry.

TABLE IV-3

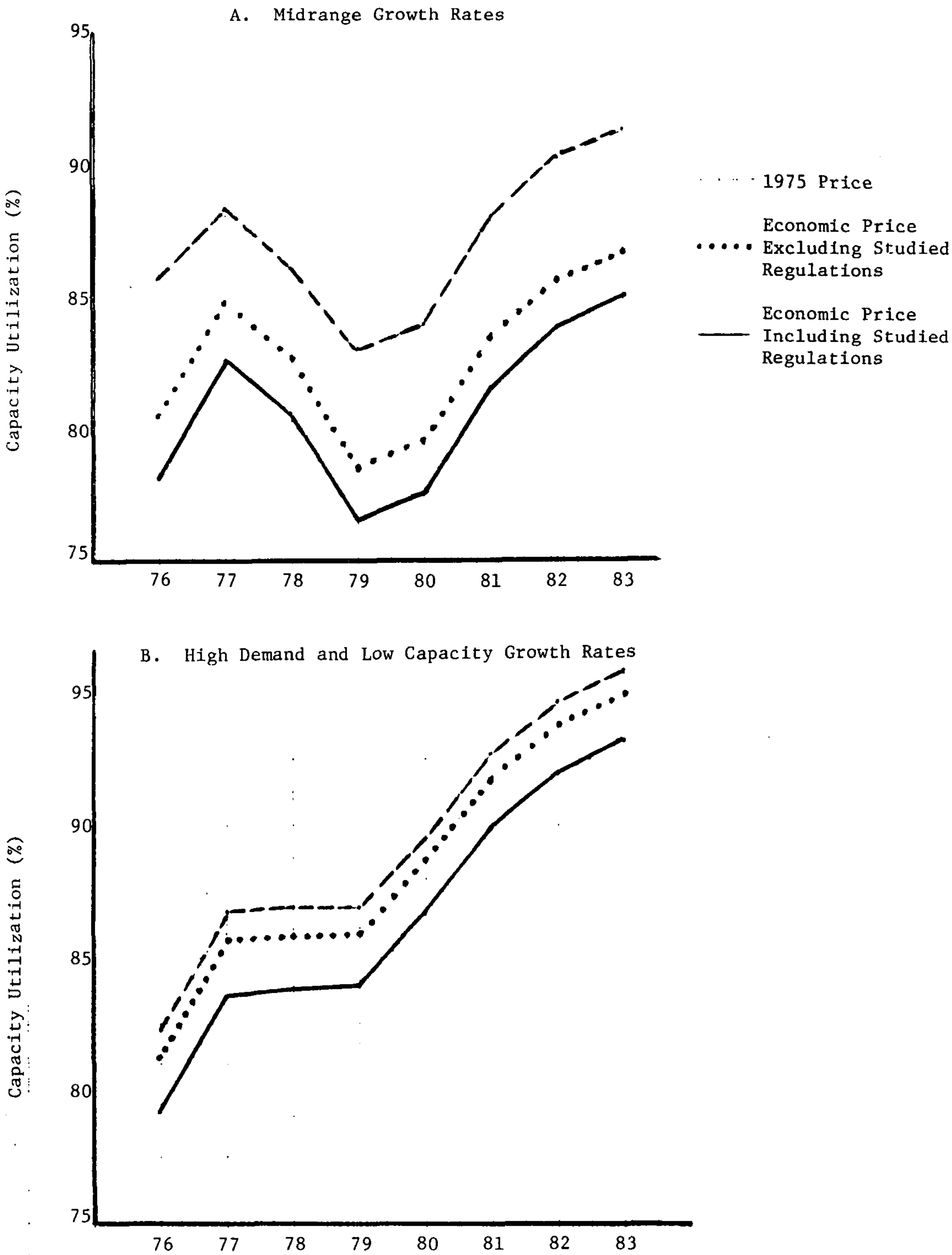
AVERAGE PAPER INDUSTRY PRICE INCREASES RESULTING FROM MAJOR ENVIRONMENTAL REGULATIONS, 1976-1983

	1975 $/Ton	% Change
1975 Price	292	
Aggregate Price Without Regulations	305	4.4%
Type of Regulation		
EPA 1977, 1983, and NSPS Water	14	4.8
OSHA Noise	1	0.3
EPA NSPS and SIP Air	2	0.7
Subtotal--Regulations	17	5.8%
Total Pulp and Paper	322	10.2%

SOURCE: Arthur D. Little, Inc., estimates based upon Chase Econometric's midrange economic scenario, with average annual growth of 4.6%, for GNP 6.5%,for industrial production and increased government spending to ameliorate the forecast 1978 recession.

FIGURE IV -3

IMPACT ON OPERATING RATES OF STUDIED REGULATIONS



This method indicates that capacity may be tight in the 1980's if the boundary of Chase Econometric's forecast and the upper boundary of demand materializes. Otherwise, no short-term price pressure is foreseen as a result of high operating rates. The cause of the tight capacity and resulting price pressure, if it materializes, will stem from demand growing at a greater rate than capacity and not mill closures from environmental regulations. Mill shutdowns induced by environmental regulations have a very small impact, representing 1,000,000 tons/year or 1.2% of 1983 paper and paperboard capacity.

For the individual product sectors, demand for paper and paperboard total demand for each sector was forecast using the demand equation and the Chase Econometric's Forecast (see Section C.4). Price increases to cover the incremental cost of environmental regulations to the existing industry were assumed to occur for 1977 requirements by 1977 and for 1983 requirements, by 1980. Demand levels were adjusted to reflect price elasticity.

The projected growth in demand varies by product sector, as seen in Figure IV-4. Higher than average growth rates in demand are forecast for unbleached kraft paperboard, NSSC corrugating medium and for printing and writing papers. Tissue and unbleached kraft paper are forecast to grow slower than the average, as well as U.S. production and consumption of newsprint. On the whole, the growth in paper demand will keep pace with the growth in the GNP driven by a much higher growth forecast for industrial production. Based upon the Chase Econometric forecast used in this study, the GNP will grow at an annual rate of 4.2% from 1975 to 1983. Paper and paperboard demand, under the same economic scenario, will grow at an annual rate of 4.6%,[5] spurred by an IIP growth forecast of 6.3% per year.

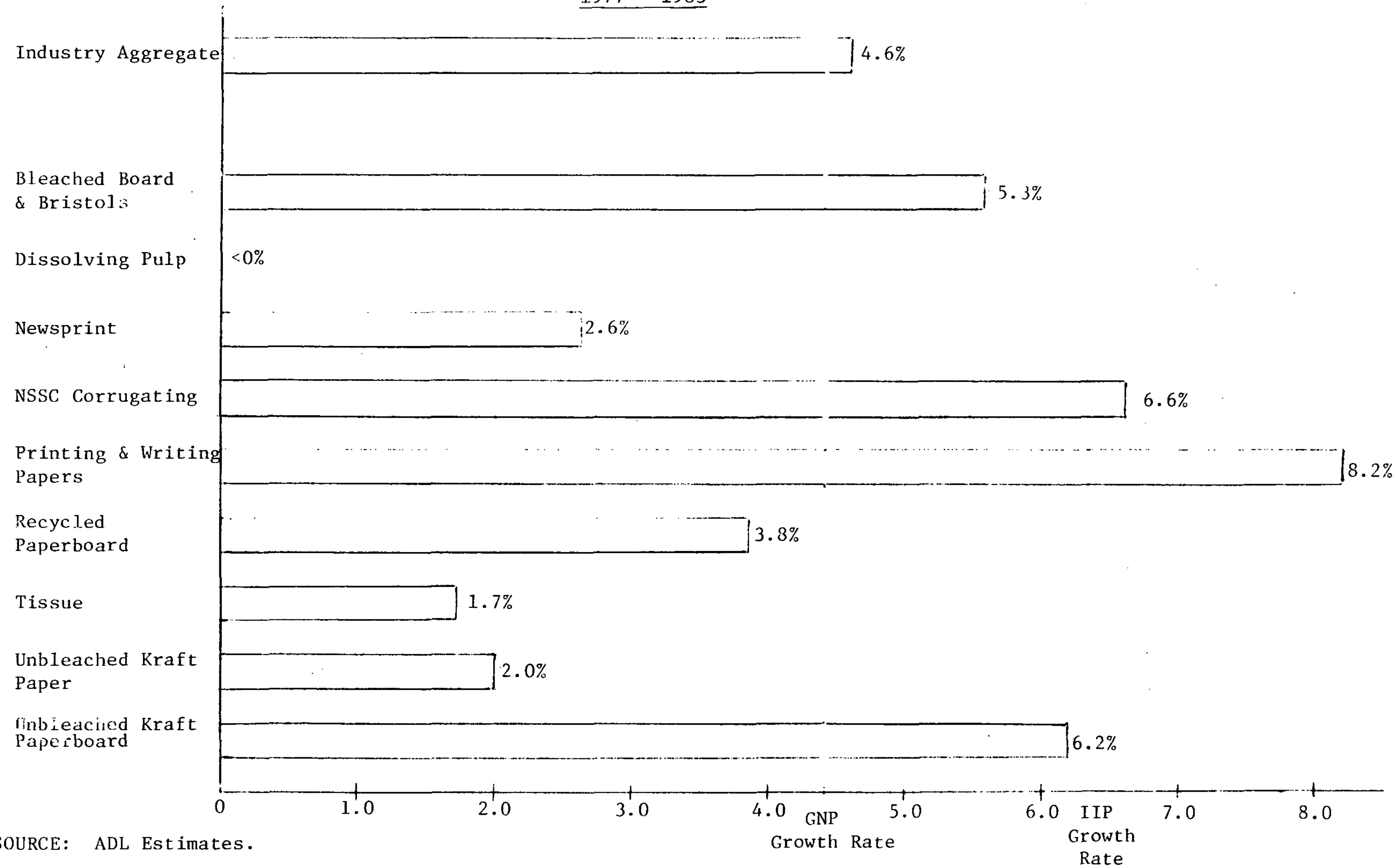
It was noted above that, under average conditions, an additional price increase of $13/ton will be needed to cover the cost inflation for new capacity and the enviornmental control equipment already in place, if the industry is to earn its required cost of capital. Figure IV-3 presents average industry operating rates obtaining under these conditions, and indicates that peak operating rates would not rise above 85%. These operating rates are the result of adjusting the demand forecast from the demand equation and the Chase Econometrics scenario for 1976-1983 price increases.

Variations in demand and capacity growth could lead to higher operating rates. Under the most unfavorable conditions from the point of view of capacity pressure, i.e., high demand growth and low capacity growth (cf. Chapter VI), the expected average prices are $298/ton without and $314/ton with the studied regulations, compared to the 1975 average price of $292/ton. These lower price increases compared to those expected under mid-range conditions reflect the lower level of capital investment which must be supported by operating margins and the lower unit fixed costs corresponding to higher output levels. Figure IV-5 shows the corresponding operating rates and indicates that while demand is less retarded by price than under mid-range conditions, peak operating rates are not realized until 1982-1983.

5. When comparing 1983 to 1975 to obtain a growth rate for the period, a business cycle peak year (1983) is compared to a business cycle through (1975). The corresponding average annual growth rates from 1974 to 1983 are 3.5% for GNP and 2.3% for paper.

FIGURE IV-4

ANNUAL GROWTH IN DEMAND
PAPER AND PAPERBOARD PRODUCTS
1977 - 1983

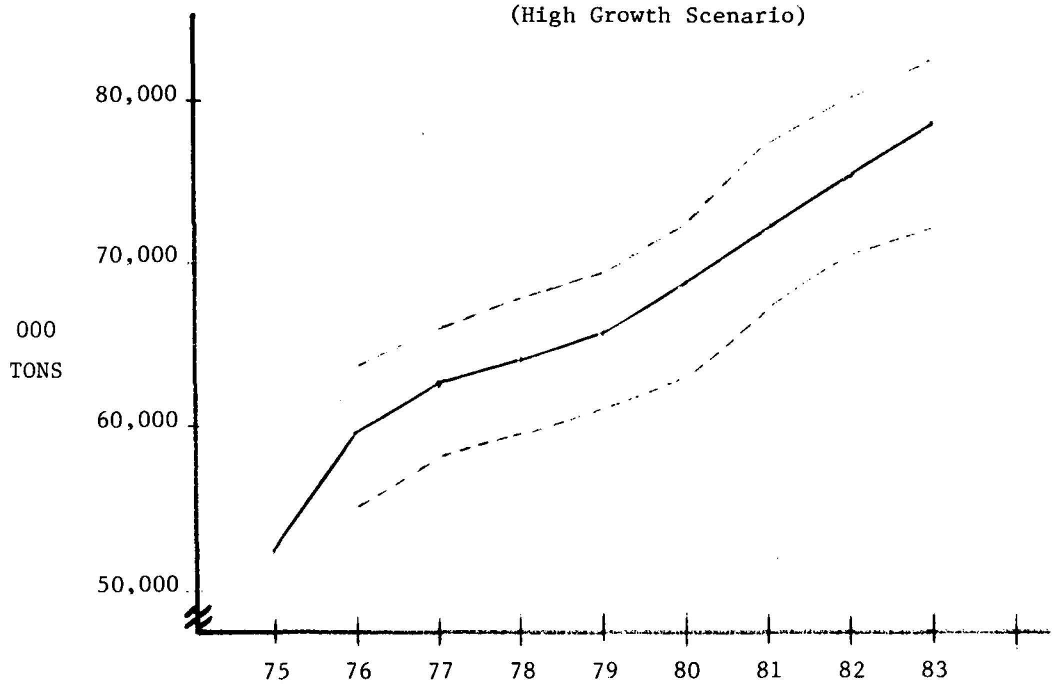


SOURCE: ADL Estimates.

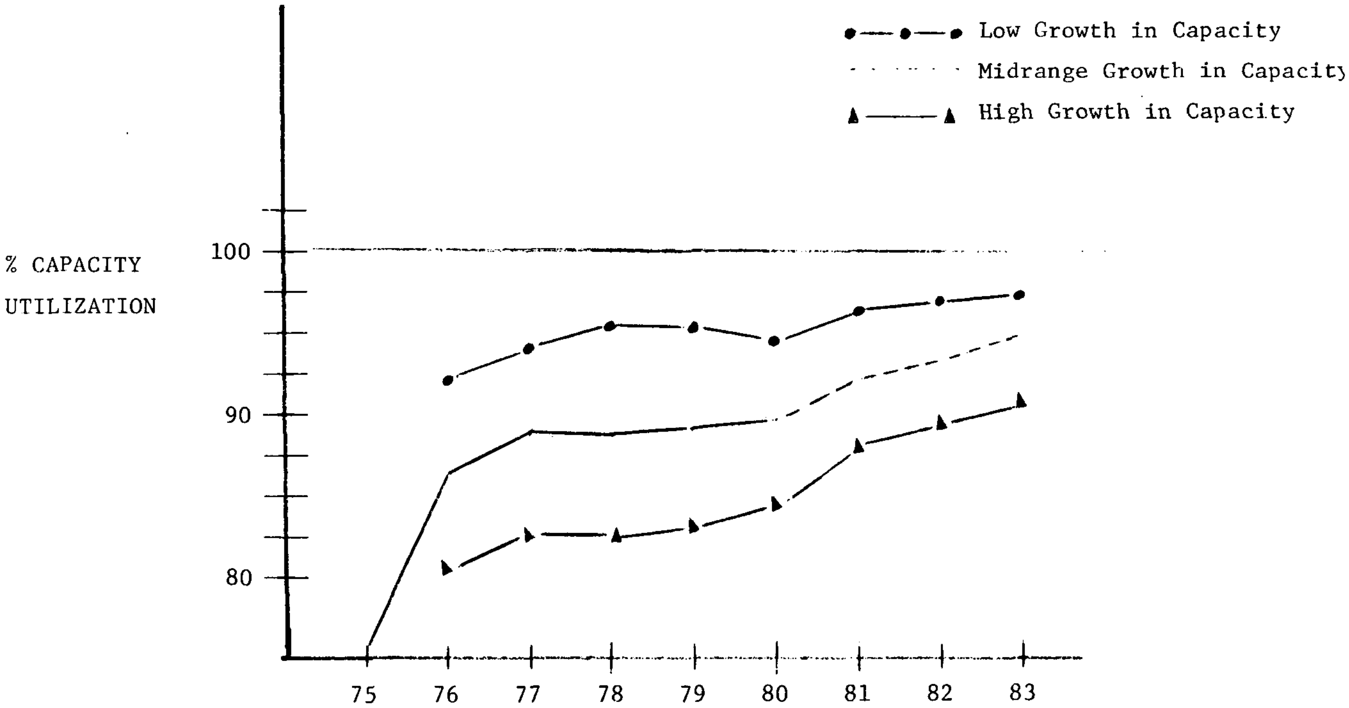
FIGURE IV-5

PROJECTED TOTAL U.S. PULP AND PAPER DEMAND AND CAPACITY UTILIZATION

DEMAND WITH NO RECESSION
(High Growth Scenario)



CAPACITY UTILIZATION [1]



[1]Capacity Utilization = U.S. Capacity.

The likelihood of high capacity utilization rates differs by product sector, as illustrated in Figure IV-6. Recycled board, a product traditionally with excess capacity, is forecast to remain that way. Bleached board and bristol, a sector historically operating at very high rates,[6] will continue to do so, and may experience real price increases as a result, despite the fact that price increases were not as large for this sector as others in the capacity crunch of 1973-74. If the Chase Econometric's Forecast materializes, printing and writing papers, NSSC corrugating medium and unbleached kraft board also could experience price pressure from high operating rates.

3. Consumer Price Increases

Because the demand for pulp and paper products is relatively price inelastic (0.57), it will be in the industry's economic interest to raise prices to recover all costs for environmental protection. Since the price elasticity of demand for pulp and paper is less than one, the producers will gain more revenue if they raise prices to cover costs, in spite of the resulting demand reduction. However, since demand elasticity is greater than zero, the pulp and paper industry will pay some of the "cost" of environmental controls through lower levels of long-run demand. The estimated loss of potential demand caused by the price effect of the studied regulations ranges from 2.3% to 8.9% for the major product sectors, with the industry average about 4.2%. This demand loss is equivalent to about one year of average paper industry growth, but the impact will be spread over at least seven years (1976-1983).

What will compliance with the studied regulations cost the consumer? In Table IV-3, a $17 per ton price increase at the paper mill level was projected for 1983, resulting from the paper industry's incremental costs for meeting EPA water effluent, SIP air and OSHA noise regulations. In practice, this mill price will be increased substantially by the time the paper reaches the consumer as a result of converter and wholesale/retail profit margins or commissions. Based on the 1967 (latest available) U.S. Department of Commerce Input-Output Table and industry data, the following average markups apply to the major paper products purchased by consumers:

Converter pretax profit on sales	10%
Wholesale and retail trade markups	70
Total	80%

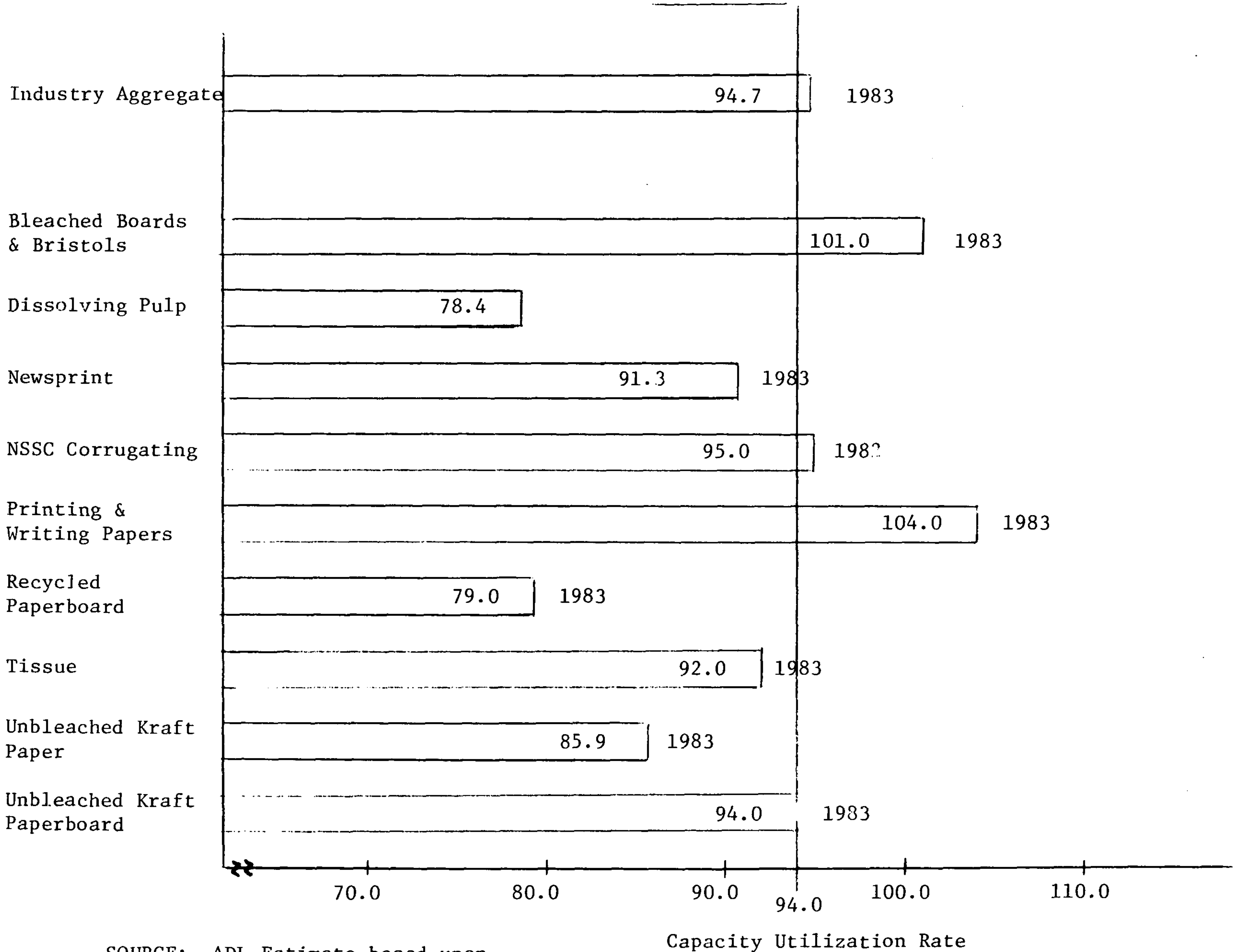
The above average markups on the cost of goods sold, particularly for wholesale and retail trade, will probably remain relatively stable through 1983. The direction and magnitude of yearly change is mainly dependent on whether labor costs at the wholesale/retail level increase faster or slower than purchased goods costs. Markups are also likely to decline when consumer demand is weak and increase when it is strong. For this analysis, however, it was assumed that on average, 1967 markups will approximate the markups on consumer paper products between 1975 and 1983. This means that the $17 per ton price increase by 1983 (ex-mill) due to the studied regulations will inflate to about $31 per ton at the consumer level.

Thus by 1983, the average consumer will pay about $10.50 a year more for paper products (1975 purchasing power) as a result of the studied regulations. Arthur D. Little estimated this impact by applying the $31 per ton price increase to an average per capita consumption of about

6. Capacity utilization rates for this sector are not strictly comparable to others due to a difference in the way capacity is defined. In general, the capacity is understated (operating rate is higher) compared to other products.

FIGURE IV-6

PEAK CAPACITY UTILIZATION RATE
PAPER AND PAPERBOARD SECTORS
1977 - 1983



SOURCE: ADL Estimate based upon Medium Growth Scenario

685 pounds (projecting from 1975 levels with annual growth rates of 4.6% for paper and 0.9% for population). In the long run (when mills constructed since 1975 become dominant in establishing market prices), the projected $24 per ton price increase at the mill will correspond to about $15 per capita increase for the average consumer.

As for relative effect on consumer product prices, the greatest impact will be felt on 100% paper products such as tissue, writing paper, newspapers and magazines. They not only use the most paper per unit, but also have relatively low product values. The estimated long-run price increase for tissue will be 4.1% of the consumer price. Somewhat lower relative increases will occur for the other listed examples because paper's share of their cost is diluted by converting, publishing, and printing costs.

The price impact for products packaged in paper is diluted even further, since the paper is usually a very small portion of both the weight and the value of the product. Typical long-run price markups on food packaged in folding cartons and corrugated containers will be less than 1%.

A number of examples will illustrate the range of price increases the consumer faces from paper industry compliance with the studied environmental regulations. The examples are divided into two categories: (1) paper products consumed directly (sanitary tissue, newspapers and magazines), and (2) packaging products (folding cartons and corrugated containers). In every case, paper products that are comsumed directly have a much larger consumer effect per unit than packaging consumed in conjunction with other consumer products. In general, paper products that are consumed directly contain much more paper per unit and thus have a much lower product value than consumer products packaged in paper or paperboard. Therefore, environmental regulation costs for primary pulp and paper production will cause a higher percentage price increase for consumer paper products than for products in paper or paperboard packages.

Sanitary tissue is the only consumer product where the consumer and primary product price increases are identical. The reason for the idential increase is that tissue converting (i.e., to small rolls) was included in the primary production cost and price. Since distribution markups apply equally to the basic paper price and to the environmental-control price increase, the relative price increase is the same at the retail level.

Note that as the value added for the consumer paper product increases, there is a corresponding decline in the percent price increase resulting from environmental controls. For most other consumer products — such as stationery, school and art supplies, the consumer price increases fall between those of tissue and magazines. The price increases for higher-value products such as books and decorative laminates fall below this range.

Because of the variety of products that are packaged in paper materials, the relative consumer price increase caused by environmental costs varies widely for packaging material. Therefore, absolute price increases per package were calculated for several popular consumer items (milk, cereal, and canned goods) and the resulting percent markup for typical products was calculated. These data indicate that the studied environmental regulation costs will cause relatively small increases for consumer products packaged in paper or paperboard.

4. Impacts on Supplier Industries

a. *General Reduction in Potential Growth*

Price increases related to the studied environmental regulations will have several effects on suppliers to the paper industry, but the most obvious impact will be a reduction in potential paper industry demand. As discussed previously, the estimated reduction in the paper industry's demand potential between 1976 and 1983 will be 3.3% of its 1975 demand. This is equivalent to about one year of average paper industry growth. However, the full effect will be spread over at least seven years and probably longer.

The supplier industries will experience lower rates of demand growth than they would have otherwise experienced. It is possible that the slower rate of growth in demand for paper supplies will be offset by growth in other products, because the paper industry is not the dominant market for most of its suppliers. Even its primary raw material, wood, derives about half of its demand from lumber and plywood applications. The paper market represents an even smaller portion of the total market for many of its chemical raw materials, for example, chlorine (20%), caustic soda (17%), soda ash (6.5%) and sulfur (3%). Thus, it is quite possible that offsetting growth in other applications for these raw materials will compensate for the lower rate of growth in their potential paper industry demand. Shifts in end use growth rates are to be expected and for the most part are anticipated and planned for by the industry's suppliers. The lower rate of growth in paper demand per se will not have any appreciable impact upon suppliers.

Of potentially greater consequence than the average loss of potential growth in the paper industry are the raw material substitutions that are taking place as the industry attempts to reduce its air and water emissions and costs. Appendix C (Volume III) describes a variety of substitution trends under way to replace or reduce:

- sulfur in NSSC and sulfite pulping;
- saltcake in kraft pulping; and
- chlorine in pulp bleaching.

The impacts of these substitutions are described below.

b. *Elemental Sulfur Use*

The paper industry's consumption of elemental sulfur has declined more significantly than that of any of its other raw materials; it dropped 26%, from 450 to 335 long tons, between 1969 and 1974 because of the combined effects of sulfite and NSSC mill closures, tightening up of the sulfur requirements of the remaining mills in these sectors, and shifts to green liquor and nonsulfur semi-chemical pulping. All of the above trends are likely to continue and are likely to be joined by the installation of oxygen pulp mills in the United States, which would add to the rate of elemental sulfur decline in the paper industry. On the other hand, the paper industry accounts for only 3% of sulfur's total demand; so even if elemental sulfur were to be replaced entirely in pulping, even modest growth in other markets would readily replace the loss. Thus, the impact on the sulfur industry will be negligible.

c. *Saltcake Use*

A trend with a potentially higher impact — replacing saltcake with caustic soda in kraft pulping — has begun. Saltcake consumption by the paper industry was about the same in 1974 as in 1968 after having dropped to about 74% of its 1968 level during the 1971 recession. In comparison, U.S. kraft pulp production grew 9% between 1968 and 1971 and 19% between 1968 and 1974. Thus, saltcake lost about 19% of its paper industry growth potential during 1968-1974. Furthermore, this loss is probably understated in that saltcake demand was given a boost in 1974 because there was a shortage of caustic soda and many mills also operated over their rated capacity, which increased sodium and sulfur losses. Caustic soda consumption by the paper industry on the other hand increased by about 45% between 1970 and 1974. This substitution trend is all the more serious because the paper industry currently accounts for about 75% of saltcake's total demand.

The main reason for saltcake's demise in kraft pulping (where it is used as a make-up for sodium and sulfur lost in the chemical recovery furnace and lime kiln) is that it provides more sulfur than the pulping reaction requires. Excess sulfur is the prime contributor to the sulfur compound air emissions of the kraft industry. Caustic soda enables sodium and sulfur in the process to be kept in closer balance and thereby reduces the excess sulfur problem. For many mills, this emission reduction benefit justifies caustic soda's price premium over saltcake.

Another factor behind saltcake's decline in kraft pulping is the increasing use of sulfur-containing by-products from the kraft mill tall oil recovery system and chlorine dioxide generators, and purchased oil refineries' caustic wash which contains sulfides. These low-cost sources of sulfur compound the excess sulfur problem thus making it more desirable to use caustic soda to balance the system and less desirable to use saltcake.

Arthur D. Little estimates that the kraft industry's purchased saltcake consumption will decline to 50% of 1974 levels and possibly less by 1983. This translates to a drop in demand from 1,220,000 short tons in 1973 to about 600,000 short tons in 1983. On the other hand, other applications for saltcake (primarily detergent and glass production) have increased their aggregate saltcake consumption at an average 5% per year since 1965. If this rate of growth continues, saltcake consumption in non-pulp applications will increase by about 400,000 short tons to a level of about 1,100,000 short tons in 1983, and substantially offset the consumption loss in the kraft pulp industry.

If these offsetting growth trends continue, total saltcake consumption would decline at an average rate of only 1% per year for the period 1973-1983. However, even such a modest net decline is likely to be accompanied by more drastic shifts among the various saltcake supply sources; imports and the Manheim Furnace process are likely to decline rapidly while production volumes of by-product, dichromate process, and natural (mined) saltcake are likely to remain close to their present levels. None of these trends, however, indicates any drastic unforeseen changes that the suppliers cannot compensate for to avoid significant reductions in profitability or employment. Most saltcake suppliers are already well aware that total demand for their product is leveling off and is likely to decline. Therefore, while the economic impact on this industry from the decline in paper industry consumption will require major adjustments, it is being anticipated and thus is unlikely to have serious net financial and employment consequences.

d. Chlorine Use

Substitution of chlorine by clorine dioxide and to a much lesser extent by oxygen pulping/bleaching and high consistency bleaching of kraft pulp mill will reduce chlorine's growth potential in this application. However, the paper industry's consumption of chlorine is still growing faster than its bleached pulp production; it averaged 4.4% per year between 1969 and 1974 compared with a 3.7% average growth in bleached kraft pulp production. Chlorine's growth in the paper industry has been bolstered by increasing use for intake water purification (e.g., for slime control), wastewater treatment and the achievement of higher pulp brightness levels. Pulp brightness levels appear to have reached their practical limit and probably will be lowered somewhat to help reduce water effluent loadings. However, it appears unlikely that chlorine consumption in the paper industry will see an absolute decline from the combined effect of the above trends. Also any growth-reduction effects will be mitigated since the paper industry represents only 20% of total chlorine demand. Therefore, it is unlikely that the chlorine producers will be faced with serious hardships as a result of these predictable trends in their paper industry market.

The chlorine substitution trend offers significant reductions in the water effluents from pulp bleaching operations. Chlorine dioxide has a much greater oxidizing power per chlorine atom than chlorine; moreover, chlorine dioxide's action does not produce chlorinated organics to the same degree that chlorine does. Of course, oxygen bleaching produces no chlorinated organics at all. Thus, the effluents from chlorine dioxide or oxygen bleaching stages are much less offensive than those from a chlorination stage.

e. Raw Materials Benefiting from Studied Environmental Regulations

Two of the paper industry's important raw materials, caustic soda and sodium chlorate, will benefit as a result of product substitutions caused by the studied air and water pollution regulations.

Caustic soda usage in the paper industry increased to a 10% average annual growth rate between 1970 and 1974, largely because of caustic's displacement of saltcake. (In fact, this stimulated demand was partly responsible for caustic soda shortages in 1973 and 1974.) Also because of the disparate growth in consumption of chlorine (5% per year) and caustic soda (10% per year) in the paper industry, the industry is moving toward a more balanced consumption of these chemicals approaching the proportion in which they are produced as co-products in the electrolytic process (i.e., 1/1.1 chlorine/caustic vs. the paper industry's current use ratio of 1/0.8). This trend in turn will provide the chlor-alkali producers more flexibility in serving this market, although it will also facilitate captive chlor-alkali production by pulp producers.

Increased use of sodium chlorate in the paper industry has also become apparent. Sodium chlorate is the raw material from which chlorine dioxide is generated at the pulp mill; hence it is the beneficiary of chlorine dioxide's displacement of chlorine in pulp bleaching. Between 1970 and 1974, the paper industry's use of sodium chlorate grew at a rate of 4.7% per year while bleached pulp production increased at a rate of 3.7% per year.

The chlorine displacement trend is just beginning; therefore, sodium chlorate's paper industry growth rate is likely to rise even higher through 1983. This increase will be particularly beneficial for the chlorate industry since the paper industry already represents about 78% of total sodium chlorate demand. Therefore, the higher growth will not be diluted appreciably by slower growth applications.

D. METHODOLOGY

Figure IV-7 displays the interrelationships of data and analytic techniques employed in the price impact analysis.

To estimate price and output effects, Arthur D. Little used information generated in the description of the industry and product sectors (Chaper II and Volume II), the cost of compliance with environmental regulations (Chapter III), and the mill closure analysis (Chapter V). The sequence was as follows: Compliance costs for new mills were analyzed with new mill models to arrive at estimates of the long-run equilibrium price effects. These price effects were traced through distribution channels for selected paper products to obtain representative consumer price impacts. Econometric models for the industry and the individual product sector supply/demand relationships were generated based upon the characteristics of each product sector, transaction prices, production and capacity. The econometric demand and supply equations were used with Chase Econometric macro-economic forecasts (prepared for the Council of Environmental Quality), to arrive at a forecast of demand. The paper industry's announced commitments for new capacity through 1979 and Arthur D. Little estimates of capacity from 1979 to 1983 were combined with demand forecasts to arrive at capacity utilization forecasts. The findings of the mill closure analysis also were incorporated into the estimate of capacity. These forecasts from the aggregate paper and paperboard model were then used in the capital requirements analysis described in Chapter VI.

1. Demand and Supply Relationships

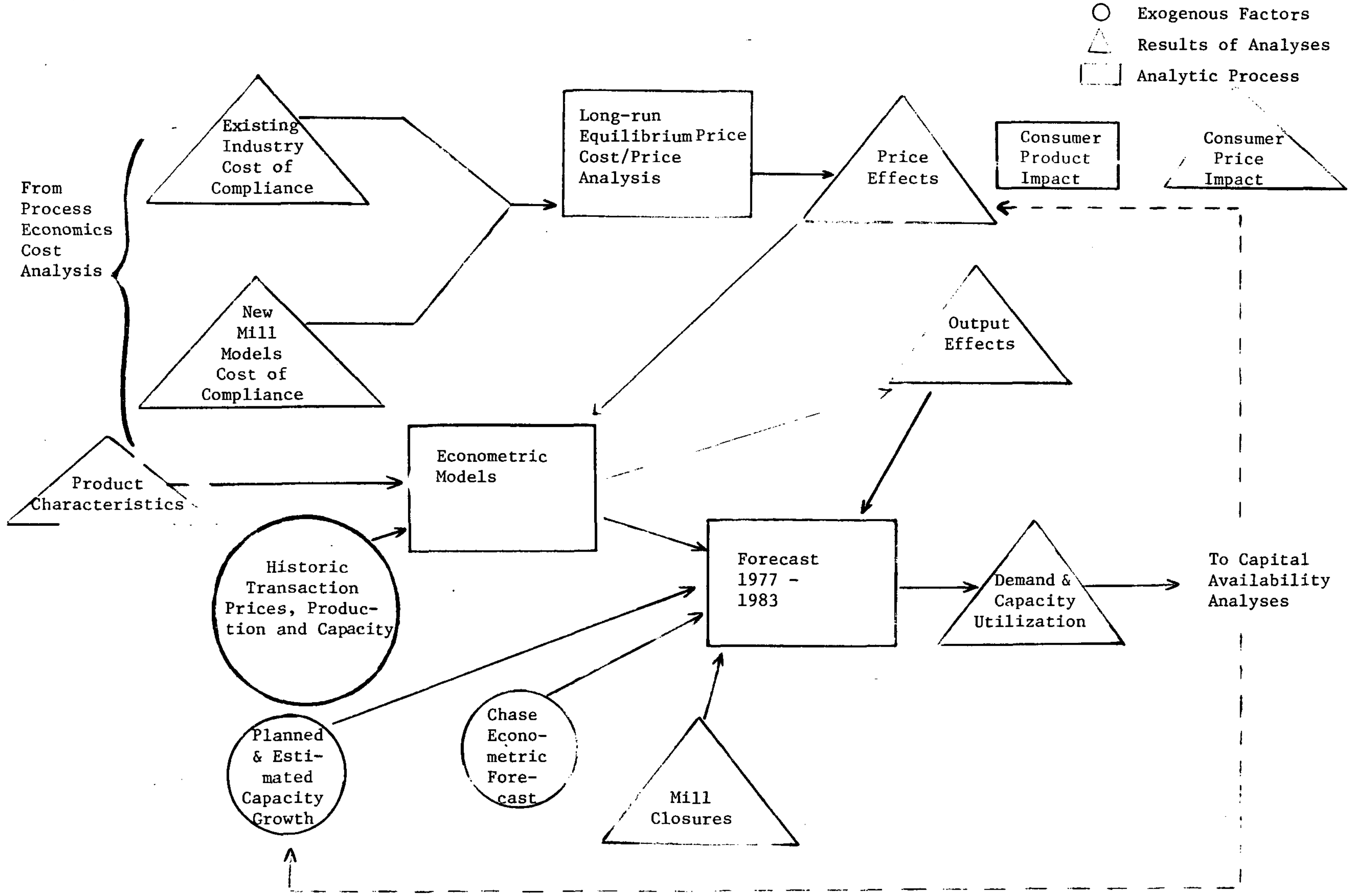
Demand and supply relationships for various product sectors of the paper industry were modelled through the use of econometric equations describing the demand and short-run supply functions. Historic market price and consumption, and prices of factor inputs (labor, wood, energy) formed the basis for estimating the demand and supply equations. The objectives of formulating these models were to estimate the price elasticity of demand for the various products and to provide a vehicle for identifying price pressure caused by short-term capacity problems for the product sectors.

Product demand was defined as U.S. consumption (U.S. production plus imports minus exports). Imports were a factor for the aggregate of paper and paperboard and for newsprint. Exports were significant for linerboard and dissolving pulp. When the demand models were applied to produce a forecast, it was assumed that import market share and export market share remained constant throughout the period. (This is consistent with the balance of trade impact analysis which concluded that no change in the United States balance of pulp and paper trade would result from the studied regulations.)

The industry was divided into groupings based on similarity of product characteristics or end uses. Most of the paper products studied are intermediate goods; that is, they are converted or combined with another product before reaching the end user. As a result, demand for these paper products is derived from the demand for the complementary goods. Since paper and paperboard end products are used throughout the economy, the demand for paper itself was expected to fluctuate with general economic conditions. Furthermore, specific economic indicators were expected to relate to each individual product sector. Sectors with heavy industrial use were found to be more closely related to indicators of industrial activity, such as the index of industrial production, than to GNP, which encompasses the service sector.

FIGURE IV-7

OVERALL METHODOLOGY--PRICE IMPACT



In some cases, paper products have substitutes, the chief of which are plastic films and containers. The two product sectors that historically have competed with plastics are bleached board and unbleached kraft bag and sack paper. In these cases, the relative price ratio of the major product competing with the paper product was incorporated in the demand equation. However, this empirical analysis yielded demand relationships in which the price of a substitute product relative to the price of the paper product correlated inversely with the demand for the paper product. This relationship is simply not credible in explaining movements in paper demand, because it means that as the price of a substitute product increases relative to the paper product, demand for the paper product decreases. One reason for these anomalous results may be that the significant displacement of these products by plastics has already occurred (see Volume II, Chapter II, Sections B and C) and that the recent prices of substitute products have increased at least as fast as paper product prices. This is not to say that there is no cross-elasticity of demand, but rather that the substitution effect and cross-elasticity cannot be measured econometrically over the 1968-1975 time span.

The demand for paper products is inelastic, as expected. When demand for a product is inelastic, it means that the relative decline in quantity demanded will be less than the relative increase in price. In the case of paper, an 8% increase in price is estimated to result in a 5% decline in quantity demanded. If demand were elastic, an increase in price would be offset by a greater relative decline in quantity demanded. For example, a 1% increase in price would be offset by a decline in quantity demanded greater than 1%.

When demand is inelastic, any price increase results in an increase in total revenue. If demand is elastic, a price increase results in a decline in total revenue. Conversely, when demand is inelastic, a reduction in price results in a reduction in total revenue. This explains the large profit erosions suffered by the paper industry in the past during weak markets when competitive price cutting to improve individual mill operating rates led to a general price decline.

The price elasticities of demand derived from the demand equations are shown on Table IV-4. Two demand equations were estimated for the aggregate of all paper products: one was based upon a weighted average price of the product sectors modelled, and another was based upon the wholesale price index (WPI) for all paper and paperboard. Neither series was completely satisfactory. The wholesale price index reflects list prices, and has not accurately reflected short-term changes in transaction prices until 1973. On the other hand, the weighted average of the sector transaction prices is higher than the aggregate prices in the industry and diverges from the general trend movement of the WPI for paper, particularly in recent years. Of the two equations, that based upon the WPI, had a higher estimated elasticity of demand (.59 versus .37). On balance, Arthur D. Little felt the WPI-based equation was more realistic to use in the aggregate demand forecasts and in capital availability analysis.

Supply relationships were utilized to identify price increases induced by supply bottlenecks. Results of the supply function analysis were not nearly as good as the analysis of the demand relationship for the paper products studied. The prices of factor inputs (labor, wood, energy, etc.) used in the production process do not solely explain price movements over the period studied and therefore a substantial amount of price variation is not explained by the supply function. Price increases in labor and materials do not completely account for the large price increases that

TABLE IV-4

PRICE ELASTICITY OF DEMAND
PULP, PAPER AND PAPERBOARD PRODUCTS

Product	Estimated Elasticity[1]	95% Confidence Interval
Bleached Board & Bristols	.18	± .18
Bleached Market Pulp	.46	± .35
Dissolving Pulp	.63	± .32
Newsprint*	.70	± .36
NSSC Corrugating Medium **	.35	± .09
Newsprint**	.74	± .36
Printing & Writing Paper	.26	± .14
Recycled Paperboard**	.46	± .35
Tissue	.45	± .18
Unbleached Kraft Linerboard**	.50	± .27
Unbleached Kraft Paper**	.90	± .26
All Paper & Board		
Eq. 1: Weighted Sector Prices **	.37	± .08
Eq. 2: WPI **	.57	± .27

[1] Equation for Arc elasticity of demand:

$$\varepsilon = \frac{\Delta Q}{(Q_1 + Q_2)/2} \div \frac{\Delta P}{(P_1 + P_2)/2}$$

Source: Derived from econometric models estimated by ADL.

Estimates for Sectors designated * were based on data through 1976; those with ** used data through 1975; all others were based on data through 1974.

occurred in 1973-74. This is consistent with findings of other research.[7] For some product sectors, however, it was possible to relate the paper product price to the sector's capacity utilization rate; this relationship provides a basis for estimating future effects of high rates of capacity utilization upon prices.

2. Product Sector Capacity Growth Assumptions

It is necessary to have an estimate of what the aggregate growth in capacity will be in order to evaluate capital availability and financing in the paper industry (Chapter VI). It was also desirable to have estimates of capacity for the individual product sectors in order to identify any short-term capacity problems which might cause price increases.

Econometric models were developed with a third equation, which modelled the change in capacity by product sector over time. In the modelling process, Arthur D. Little considered: timing of the investment decisions that brings new capacity on-stream, cost of capital during the life of the construction period, an approximation of what the industry might have foreseen for economic growth, and capacity utilization rates in the year in which the investment decision was made. The results of this empirical analysis produced function relationships that either were not statistically significant, had the wrong sign, or had standard errors in excess of 30%. Therefore, Arthur D. Little sought a more reliable projection method.

The alternative method chosen was based on the industry's own estimates of capacity scheduled to come on-stream through 1979, published by the API in September 1976. Therefore, this approach entailed projecting capacity growth rates for the four-year period 1979-1983. These were estimated by Arthur D. Little product sector experts after analyzing product market and profitability trends, historic capacity growth rates which prevailed from 1960 to 1975, planned growth rates for 1976 through 1979, and the Chase general economic forecast through 1983.

Table IV-5 contains the historic capacity growth rates, industry planned growth rate through 1979, and the rate estimated by Arthur D. Little for 1980 through 1983.[8] The aggregate growth rate in capacity of 3.2% per year is less than the aggregate growth rate in demand (4.2%) leading to the relatively high capacity utilization rates forecast for 1983. In general, products with high rates of growth in demand are also the most profitable, and these are the sectors whose capacity is forecast to grow at a higher than average rate. Dissolving pulp capacity is estimated to remain stable throughout the period with no net additions foreseen through 1983.

3. Mill Closure Effects on Price

The results of the mill closure analysis were incorporated into the capacity estimate for the period 1977 through 1983. As indicated in Chapter V, closures due to water pollution control regulations were assumed to occur in the years when compliance is mandated; that is, closures resulting from the promulgated 1977 water regulations were assumed to occur in 1977, while mill closures resulting from the 1983 proposed water regulations were assumed to occur in 1983. Mill closures are probable in three product sectors: printing and writing papers, tissue paper, and recycled boxboard, for a total of 1,000,000 tons of capacity by 1983.[9]

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7. See Barry Bosworth, "Capacity Creation in the Basic Materials Industries," The Brookings Institution, August 1976.

8. The relationship Arthur D. Little sought to model was capacity growth in terms of tonnage as opposed to investment dollars. Investment expenditures cannot be extrapolated from historic relationships for a variety of reasons, explained more fully in Chapter V.

9. See Chapter V and Volume II for product sector details.

TABLE IV-5

PRODUCT SECTOR RATE OF ANNUAL GROWTH IN CAPACITY
HISTORIC, PLANNED AND FORECAST

Product Sector	Historic Growth Rates[1] 1961 - 65	1966 - 70	1971 - 75	Planned 1976 - 79[2]	Estimated Range 1979 - 83[3] Low	Average	High
Bleached Boards & Bristols	2.4%	4.7%	2.4%	2.8%	2.0%	3.0%	4.0%
Dissolving Pulp	1.9	3.3	0.7	0.1	0.0	0.0	0.0
Newsprint	0.0[4]	8.3	1.0	1.8	1.5	2.0	2.5
NSSC Corrugating	7.0	5.2	3.4	2.7	4.5	5.9	7.5
Printing & Writing	5.6	4.7	4.4	2.8	3.0	4.0	5.0
Recycled Paperboard	NA	0.0[4]	0.4	1.4	1.2	1.7	2.2
Tissue	5.5	5.3	0.6	1.8	1.5	1.6	2.1
Unbleached Kraft Paper	4.3	1.5	1.8	0.3	1.0	1.4	1.8
Unbleached Kraft Paperboard	8.7	7.9	4.1	5.2	2.9	4.0	5.1
All Other	--	--	--	2.8			
Aggregate Paper & Paperboard	3.1	4.2	2.7	2.8	2.3	3.2	4.1

[1] Based upon year-end capacity figures, Paper, Paperboard & Woodpulp Capacity Reports, API, various years.

[2] Industry announced commitments, 1975-1978 Capacity, Paper, Paperboard, Wood Pulp Fiber Consumption, Sept. 1976, API.

[3] Arthur D. Little, Inc., estimates.

[4] Small decline in capacity.

4. Chase Econometric Model

As mentioned above, the forecasts for demand and capacity growth for the individual product sectors are based upon the Chase Econometric Forecast provided for the Council on Environmental Quality as of May 17, 1976. This forecast projects a mild recession in 1978-79, and a strong recovery with four successive years of sustained growth in the period 1980 through 1983. (A version of the forecast without recession or *eight* years of sustained economic growth also was used.)

Figure IV-8 depicts the Chase forecast in terms of industrial production and GNP for the years 1976 through 1983 and also the percent change in the level of the economy each year from the preceding year. Chase feels that this forecast is conservative and that the forecast for the 1980's is consistent with conditions that prevailed from 1962-1969.

As seen in Table IV-6, the Chase real GNP forecast was very close to the 1976 actual and is close to the administration's early 1977 published prediction for 1977.

TABLE IV-6

CHASE ECONOMETRICS FORECAST
COMPARED TO 1976 ACTUAL AND 1977 FORECAST

(Real GNP in 1972$)

	1976	1977	1978
Chase Econometrics Forecast for CEG (5/76)	1,267.0	1,320.2	1,320.4
"No Recession"	1,267.0	1,320.2	1,390.0
Actual 1976	1,265.0		
Current Administration 1977 Forecast[1]		1,328.2	1,394.6

[1] Derived from 5% growth in real GNP for 1977 and 1978.

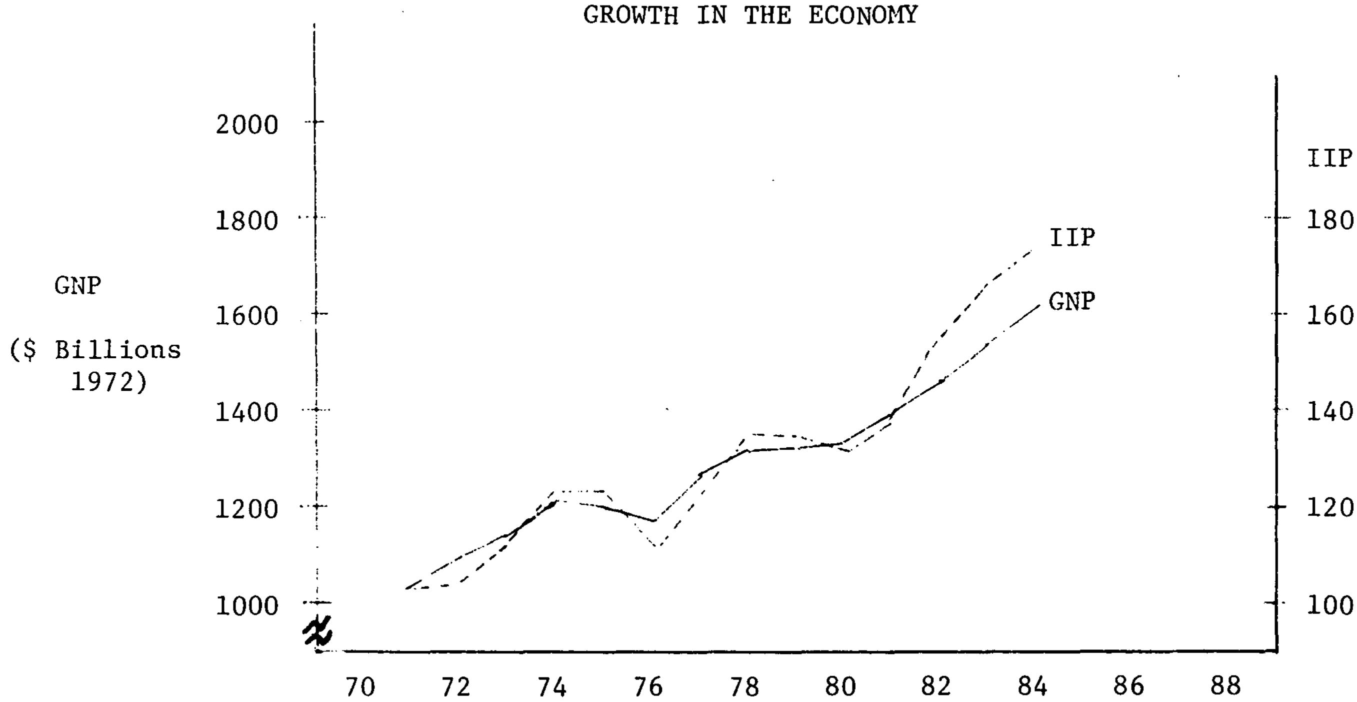
The administration forecast calls for a real growth in GNP during 1977 of 5%. The levels of real GNP that will result from a 5% growth in 1977 and 1978 will be .6% higher than the Chase Econometrics CEG forecast in 1977 and .3% higher than the "no recession" forecast for 1978.

The Chase forecast calls for five consecutive years of expansion from 1979 to 1983. The six economic expansions since World War II have averaged 48 months in duration. If the Korean War and the Vietnam War expansion periods are excluded, the average expansion was 34 months.[10] Continuation of this trend would point to a downturn in 1978-79 followed by another downturn during 1982 or 1983. Viewed in this light, the "no recession" version of the Chase forecast and the continuous growth in the early 1980's in the baseline forecast appear to be optimistic.

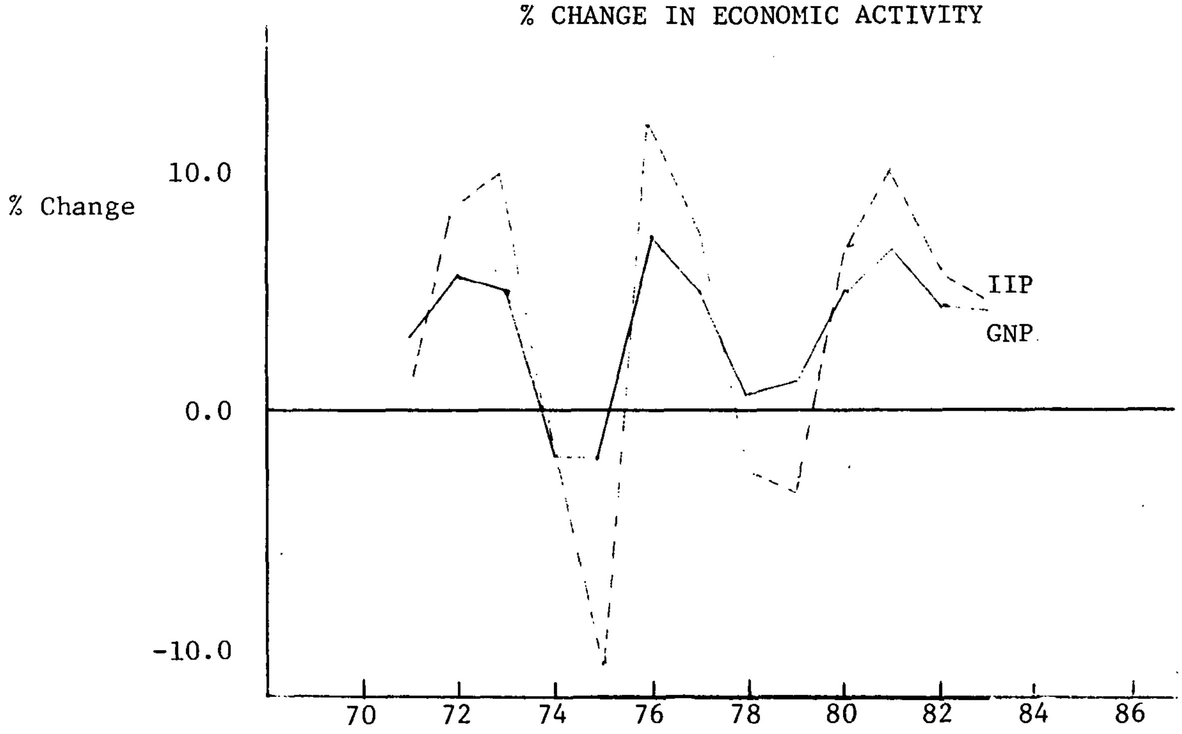
10. *Wall Street Journal*, March 14, 1977, p. 1.

FIGURE IV- 8
CHASE ECONOMETRICS
CEQ ECONOMIC SCENARIO, MAY 17, 1976

GROWTH IN THE ECONOMY



% CHANGE IN ECONOMIC ACTIVITY



The product sector forecast and the aggregate paper demand forecast are likely to be high if the Chase Econometric forecast is optimistic. If so, the forecast will overstate the capacity shortages and the industry's future capital requirements in the 1980's. Conversely, if economic growth is higher than indicated in the "no recession" version, near-term capacity pressure will be understated.

5. Estimation of Price Impacts

The long-run equilibrium price impacts for the various environmental regulations were based on new mill models for product sectors, using the discounted cash flow model that was used in the funds flow analysis and is described in detail in Appendix H (Volume III). The process economics cost estimates of the construction and operation of a new mill were simulated over the life cycle of that mill, with and without environmental regulation costs for water, air, and OSHA noise regulations. The financial parameters were different for the estimation of long-run price effects as compared with the funds flow analysis. The analysis was done separately for each new mill as follows:

- The initial balance sheet for each new mill was obtained from the process economic models (Appendix F).
- The working capital requirement was specified for each at 3 months delivered cost.
- Divided payment was 50% of earnings.
- The corporate tax rate was taken as 48%.
- Buildings were depreciated over 33 years and equipment over 16 years by the double declining balance method.
- The investment tax credit option for pollution control equipment allowing a tax credit of 10% of the investment was issued.

The baseline cost of total capital was 10% with a sensitivity analysis using plus 2.5%. In addition a sensitivity analysis was performed on costs for the new mills. (±10% for operating costs; +25%, -10% for investment).

In the long-run, prices in a competitive industry will cover all costs, including a normal rate of return to the industry. The Arthur D. Little analysis estimates long-run price effects, assuming a 10% cost of capital to the industry, which represents the normal return to the paper industry estimated in a recent EPA study.[11]

A different method was used to estimate price increases necessary for the existing industry, which will dominate the base capacity for the period 1977 through 1983 because the wide variability among mills precludes simple modelling of the existing industry. Given the current market price and an annualized value for the incremental cost of compliance to the existing industry for the various environmental regulations, a price increase was estimated that would fully recover these costs.

11. Gerald A. Pogue, *Estimation of the Cost of Capital for Major United States Industries.* The 10% cost of total capital is a weighted average of the reuturn on equity (13%) and debt cost.

The annualized value of capital expenditures and operating costs required by environmental regulations was calculated by the level annual recovery method. Total capital cost to the existing pulp and paper industry, including a normal rate of return on capital was annualized by amortizing capital costs over 18.4 years, the average book depreciation life of pollution control investment, with a 10% cost of capital.[12]

Rate of return on capital can be expressed as the total return to providers of capital divided by capital:

$$\text{Rate of Return} = \frac{\text{Profit + Interest}}{\text{Total Capital}}$$

It can also be expressed as the margin on sales multiplied by turnover:

$$\text{Rate of Return} = \text{Margin x Turnover}$$

$$= \frac{\text{Profit + Interest}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Total Capital}}$$

where: Sales = Price x Quantity.

When compliance with environmental regulations causes increases only in operating cost, the total change in cost will be equal to the change in operating cost and the change in price will be equal to the change in operating cost. Since an increase in investment is not required, the total return (profit plus interest) stays the same. In the more typical case, where industries must invest in capital equipment to comply with environmental regulations, they must earn a risk-commensurate return on this capital or the total rate of return to that industry will fall. Here, the annual capital recovery is given by the formula:

$$D = \frac{r(1 - r)^n I}{(1 + r)^n - 1}$$

where

D = the annual capital recovery

r = cost of capital (risk-commensurate rate of return)

12. Ibid.

I = initial investment

n = useful (book) life of capital investment.

The change in cost representing the return to capital is equivalent to:

$$\sum_{i=1}^{n} D - I$$

This method of annualizing investment or other capitalized expenditures plus the change in operating costs yields the change in total cost resulting from compliance with an environmental regulation.

The aggregate price impacts for 1976 to 1983 were a by-product of the funds flow analysis, described in Chapter VI. The financial parameters used and computational details are contained in Appendix H (Volume III).

E. LIMITATIONS AND SENSITIVITY ANALYSIS

1. Limitations of Models

The usefulness of any model lies in its appropriateness as an approximation of the real world. Because a model is an approximation rather than a mirror of the real world, it depends upon the structure or interrelationships that existed in the recent past. It serves essentially as an analytic tool which provides insight to probable effects and order-of-magnitude estimates.

The price impacts were estimated on the premise that the pulp and paper industry is competitive, and therefore, that long-run price increases resulting from environmental controls will be determined by new mills earning the normal (risk-commensurate) rate of return for the industry. While the paper industry is comprised of many firms and for the most part behaves in a competitive manner, certain product sectors are characterized by a few producers (bleached board) or dominant firms (newsprint). Nonetheless, competitive models were used for these two sectors because they provide a reasonable indication of price increases. The levels of demand estimated and the elasticities of demand may be misestimated if changes in price are caused for reasons other than cost increases. The possibility of errors in the calculation of price elasticity occurs because price may not equal marginal cost in a non-competitive industry, and the supply function parameters cannot be estimated accurately.

As discussed previously, the attempt to measure substitution effects was not successful, which may affect the estimates of parameters for the bleached board and unbleached kraft bag paper sectors, where substitution is likely. The impact is a tendency to overestimate the demand level for the study period if the relative price of substitute products does not increase as much as those paper products.

2. Sensitivity Analysis

Arthur D. Little examined the sensitivities of the price impact results to:

- variations in cost of capital,
- the depreciation period assumed for the pollution control equipment, and
- variations in the cost of compliance estimates.

Table IV-7 displays the sensitivity of the price increase estimated for existing industry to variations in the cost of capital and payback period for the industry in aggregate. The price estimation procedures for the existing industry utilized a level annual return concept. As the payback period for the pollution control investment is shortened or the cost of capital increases, the necessary price to recover costs increases. The effect of going from a 10% cost of total capital to 12.5% cost of capital is approximately a 10% difference in the estimated price effect. The impact of going from 18.4 years combined depreciation period for land, plant and equipment to 10 years accounts for a 17-20% increase in the estimated cost-recovery price necessary for the existing industry.

Table IV-8 demonstrates the variability that occurs as one modifies the payback period and after-tax rate of return. Factors shown in this table are the values which are multiplied times the original investment to produce annualized values for capital recovery.

Table IV-9 shows the sensitivity of existing mill price impacts to cost estimates. For a product sector, operating costs could vary by as much as 10% in either direction, and capital costs might vary as much as 10% lower or 25% higher than the expected values.

The sensitivity analysis for new sources was similar. Discounted cash flow analyses were done for the new mill models with both the upper and lower boundary cost estimates, and with the cost of total capital at 10% and 12.5%. As in the existing industry case, a range of ±10% was estimated for operating costs while the variability in capital costs (including the cost of construction of the basic mill) was estimated at +25%, -10%. For each cost of capital, there is a material difference in the baseline and projected prices, ranging from 10% on the low side to 15% on the high side over the range of cost estimates. If the cost of capital to new mills is 12.5%, the relative price effect of environment regulations is slightly lower than at the 10% cost of capital because the baseline price is raised by approximately 9% (Table IV-10).

TABLE IV-7

SENSITIVITY OF PRICE IMPACT ESTIMATION TO
VARIATIONS IN COST OF CAPITAL AND PAYBACK
(%)

Environmental Regulation	18.5 yrs. 10%	15 yrs. 10%	10 yrs. 10%	18.5 yrs. 12.5%	15 yrs. 12.5%	10 yrs. 12.5%
EPA--1977 Water Effluent	2.9	3.0	3.4	3.2	3.3	3.7
OSHA Noise*	0.4	0.4	0.5	0.4	0.5	0.5
SIPS	0.7	0.8	1.0	0.8	0.9	1.0
EPA--1983 Water Effluent	1.8	1.9	2.1	3.0	2.0	2.3
Total	5.8	6.1	7.0	6.4	6.7	7.5

Source: Arthur D. Little, Inc., estimates.

TABLE IV-8

CAPITAL RECOVERY FACTORS
FOR VARIOUS PAYBACK PERIODS
AND CAPITAL COSTS

Achieved After-Tax Return	10 Years	12 Years	15 Years	17.5 Years	18.4 Years	20 Years
7.5	.14569	.12928	.11329	.10447	.10194	.09809
10.0	.16275	.14676	.13147	.12325	.12094	.11746
12.5	.18062	.16519	.15076	.14323	.14116	.13810

$$\frac{\text{Annual Recovery}}{\text{Initial Investment}} = \frac{r\,(1 + r)^n}{(1 + r)^n - 1}$$

where r = achieved return on investment

n = payback period

TABLE IV-9

SENSITIVITY OF EXISTING MILL PRICE EFFECTS
OF ENVIRONMENTAL REGULATIONS
TO COST ESTIMATES

Product Sector	1975 Price	Expected Effect Price	Expected Effect % Δ	Lower Bound Price	Lower Bound % Δ	Upper Bound Price	Upper Bound % Δ
Bleached Boards & Bristols	$353	$371	5.0%	$369	4.5%	$374	5.9%
Bleached Pkg. & Ind. Conv.							
Construction Paper							
Dissolving Pulp	398	424	6.5	421	5.8	429	7.8
Newsprint	260	280	7.1	278	6.3	284	9.2
NSSC Corrugating	193	205	6.2	204	5.7	207	7.2
Printing & Writing	591	616	4.2	6.3	3.7	617	4.3
Recycled Paperboard	215	224	4.1	223	3.7	225	4.7
Tissue	769	798	3.7	795	3.4	803	4.4
Unbleached Kraft Paper	242	256	5.9	255	5.3	259	7.0
Unbleached Kraft Paperboard	195	206	5.6	207	6.1	211	8.2
Uncoated Groundwood	335	362	7.9	259	7.1	367	9.6
All Paper & Paperboard	292	309	5.8	307	5.2		

TABLE IV-10

SENSITIVITY OF LONG-RUN PRICE EFFECTS
OF NSPS WATER AND AIR REGULATIONS, SIPS AIR REGULATIONS AND THE OSHA NOISE STANDARD
TO COST ESTIMATES AND THE COST OF CAPITAL

A. Cost of Capital = 10% After Tax

	Expected Price			Lower Bound			Upper Bound		
Product	Baseline Price	After Reg.	% Δ	Baseline Price	After Reg.	% Δ	Baseline Price	After Reg.	% Δ
Aggregate Paper	$327	$351	7%	$294	$316	7%	$376	401	7%
Bleached Board	362	391	8	326	352	8	419	449	7
Newsprint	280	296	6	252	266	6	324	340	5
NSSC Corr. Medium	198	229	16	178	206	16	227	258	14
Printing & Writing									
Bond Paper	436	464	6	392	418	6	517	546	6
Book Paper	449	477	6	404	429	6	504	532	6
Recycled									
Recycled Boxboard	260	275	6	234	248	6	296	312	6
Gypsum Liner-board	219	234	7	196	210	7	250	264	6
Tissue									
Tissue	754	785	4	679	707	4	862	895	4
Deinked Tissue	782	826	5	704	743	5	887	932	5
Unbleached Kraft Linerboard	185	203	10	167	183	10	214	232	8
Unbleached Kraft Bag Paper	297	327	10	267	294	10	348	380	9

CHAPTER V

MILL CLOSURES AND EMPLOYMENT IMPACTS

V. MILL CLOSURES AND EMPLOYMENT IMPACTS

A. SUMMARY

1. Methodology

The identification of mill closures and employment impacts related to environmental control is a complex and imprecise analysis for at least three reasons. First, mill closures are caused by a variety of factors in addition to environmental control such as technical/economic obsolescence of product and/or manufacturing process, mill profitability, and general economic conditions.

Second, the decision-making frame of reference is subject to substantial variability; for example, the decision-making context for a private owner of a small mill may be quite different from that for an analysis of a major corporation or financial institution. Third, the various mills in the process/product sector categories considered in this study vary considerably in size, product mix, average prices, cost structures, etc.

Accordingly, a methodology was developed which considers each of these factors and attempted to identify those closures which are influenced primarily by the investment and operating costs associated with environmental control.

The potential capacity lost because of mill closures was estimated through a multistage screening process (Figure V-1). First, all mills studied were characterized and put through an internal screening analysis to identify an initial list of mills vulnerable to closure. Managers of these mills were then contacted to assess further the extent to which their mill complies with pollution regulations, management intentions, and mill conditions that might affect a possible closure decision. On the basis of this information, the number of mills requiring financial analysis was further reduced. Finally, a discounted cash flow analysis was used to determine whether the net present value of expected cash flows characteristic of groups of selected vulnerable mills was less than the net present value of closing and salvaging the mill in 1976, with and without additional water pollution control expenditures to meet EPA's 1977 and 1983 guidelines (BPT and BAT). This analysis provided a further adjustment to the list of plants that might close.

The estimated reduction in capacity from mill closures was used as an input to the econometric analysis to assess potential impact upon price. Employment losses provided the basis for the community impact analyses in specific regions where closures were predicted.

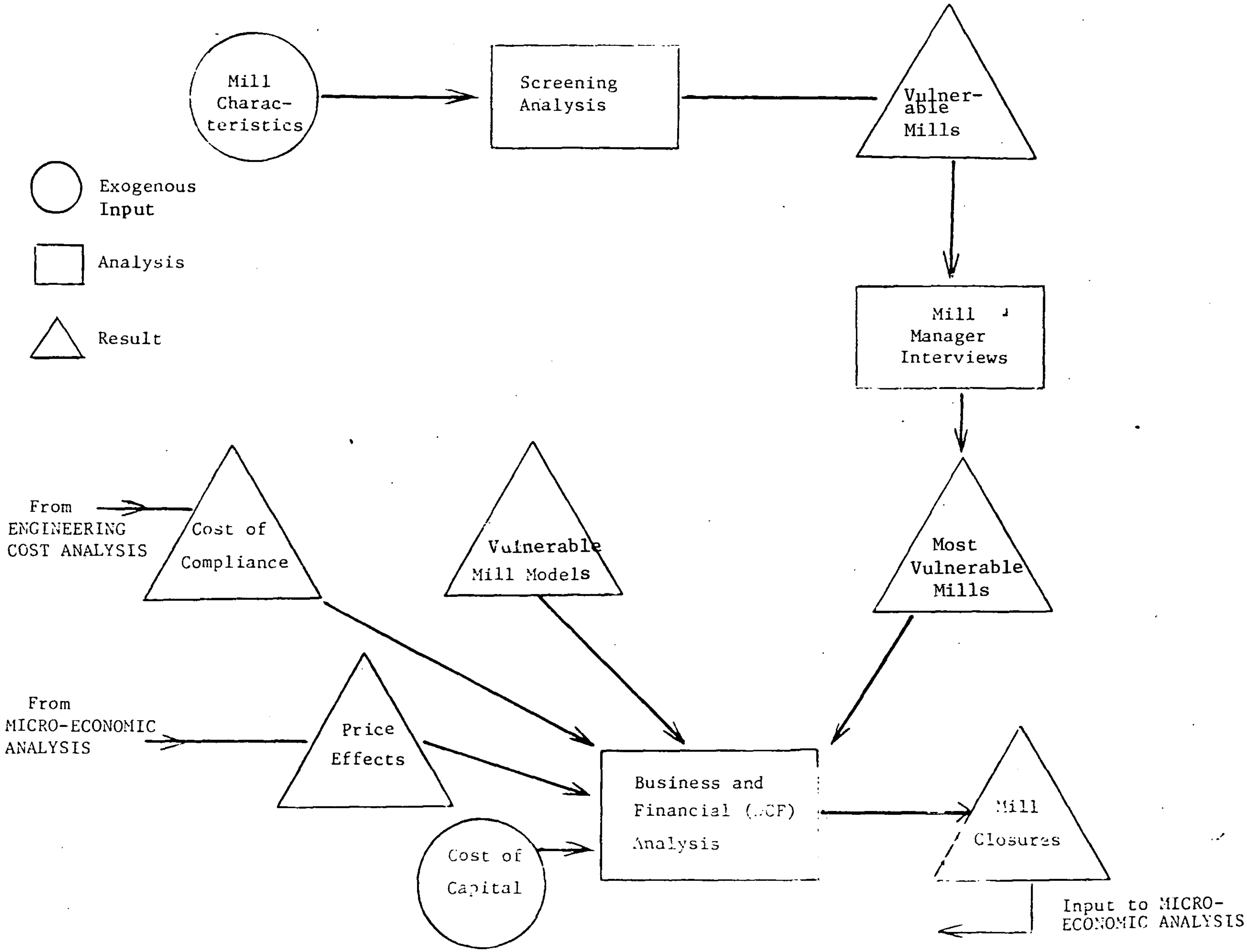
2. Findings

Of 566 U.S. pulp and paper mills studied, 27 mills, corresponding to about one million tons of capacity are projected to have difficulty complying with the studied pollution control requirements.[1] An additional two million tons of capacity is projected to be lost through normal attrition over the studied period. The timing of the projected environmental related closures follows.

1. Air pollution control requirements were addressed in the industry interviews but water effluent regulations were a far more serious problem for the selected mills. No effluent-related closures are projected for the kraft process mills which also face the largest air pollution control expenditure.

FIGURE V-1

PROCEDURE FOR THE MILL CLOSURE ANALYSIS



a. *1977 Closures*

Ten mills could close because of 1977 pollution control requirements, with a resulting loss of about 1400 TPD of product capacity. These capacity removals have an impact on the bleached market pulp (paper grade), printing/writing papers, tissue, construction papers and recycled paperboard product sectors. Primary unemployment associated with these mills represents about 2600 jobs or slightly more than 1% of total current pulp and paper industry employment. Total unemployment (primary plus secondary) is estimated to be about 3700 jobs.

b. *1983 Closures*

An additional 17 mills, representing about 1700 TPD of capacity removals, could close if proposed 1983 water effluent guidelines are adopted. The impact will be greatest on the non-integrated printing/writing, and tissue paper sectors. These 1983 projections, however, are much less certain than the corresponding estimates for the 1977 guidelines. Estimated primary unemployment resulting from these additional closures is 3500 jobs, or about 1.6% of total current industry employment. Total employment from these closures is estimated to be 7100 jobs.

3. Limitations

Each mill within the studied product/process sectors was not specifically analyzed in sufficient depth to enable prediction of individual closure candidates. Instead, groupings of potentially vulnerable mills were used as the basis of the estimates for each industry sector. The conclusions on 1983-related closures are based more heavily on Arthur D. Little's financial analysis instead of inputs from the individual mill managements; these conclusions are more limited by the uncertainties of the long-term financial projections that are required for such an analysis. Finally, the analysis did not attempt to estimate the effect of Section 301(c) of the Water Pollution Control Act of 1972 which provides that if a plant can demonstrate individual hardship, it may obtain a variance from the guidelines.

B. METHODOLOGY

1. Introduction

Because of the complexities of disassociating mill closures influenced by environmental regulations from those attributed to other technical/economic factors, a methodology was developed that focused on estimating the number of mills and amount of capacity and employment affected by environmentally-related mill closures. This methodology involves (1) screening each mill in the studied product/process sectors to identify mills that may have difficulty complying with EPA pollution control standards; (2) interviewing mill management to gain additional perspective on relevant mill characteristics; and (3) financial analysis of selected categories ofmills identified as having closure potential.

2. Screening Analysis

The screening analysis began with the collection and organization of published information on each mill, including data on mill capacity, major products produced, and external treatment in place. Based on these inputs, a panel of Arthur D. Little industry specialists met to review the closure possibilities for each mill. Marginal and questionable mills were segregated for further review. In the screening process, the judgment of Arthur D. Little industry experts was applied in evaluating mill production parameters and in-place treatment facilities. In addition the screening panel applied its knowledge of the process/product sectors and of many of the individual mills themselves.

a. *Mill Production Capacity*

In many cases, the larger mills enjoy a more favorable cost position. Most larger mills have economies of scale that allow them to more easily absorb pollution control costs; in addition they usually are newer and more efficient. Thus, mill size is an appropriate criterion for this screening analysis. Therefore, while size criteria were applied to each process sector on an individual basis, mills in the lower size quartile in each process sector received special scrutiny.

b. *Treatment Train Facilities In-Place*

It is reasonable to assume that mills that (1) currently comply with 1977 effluent standards, (2) have announced definite plans to comply, or (3) are so close to compliance that the mill's management has (at least implicitly) demonstrated a commitment to the mill, are less likely to close for environmental reasons. Therefore, mills that do not have in-place the following pollution control equipment were assessed more comprehensively in the screening analysis:

— Secondary treatment
— Chemical recovery or incineration (sulfite and NSSC mills)
— Municipal treatment facility tie-in (recycled paperboard mills)

Inputs for this part of the analysis included:

(1) National Council of the Paper Industry for Air and Stream Improvements, Inc., mill listings of the extent and type of effluent treatment processes in-place;
(2) EPA mill effluent load data;
(3) Other publicly available information sources; (e.g., trade directories and periodicals); and
(4) Arthur D. Little's familiarity with many of the mills under consideration. The above sources were also cross-checked wherever possible to assure their accuracy. With this information, a reasonably accurate data base was developed concerning a given mill's proximity to compliance with 1977 pollution control standards (as well as capacity and product mix).

c. *Process/Product Sectors*

The industry sectors under consideration have varying average prices, product mixes, cost structures, and effluent load characteristics. Pollution control requirements have had and will have varying impact on these process sectors. Process sectors which have had more severe closure impacts in the past (e.g., sulfite and recycled paperboard sectors) were assessed more comprehensively in the screening analysis.

d. *Knowledge of Specific Mills*

As noted above, the screening panel was familiar with many of the mills that were examined. In certain instances, this familiarity provided the opportunity to gain relevant additional perspective on specific mills.

3. Direct Industry Contact

The interview process was designed to validate and update published information, and to develop a more accurate understanding of the position of mills identified in the initial screening as requiring further review. In addition, a number of multi-mill companies were interviewed to review all their mills. This made it possible to validate the adequacy of the screening process by determining whether any potential closures could be identified that had not been identified in the initial screening phase. Issues involving mill economics, pricing, pollution control expenditure requirements, and perspectives and future plans of mill management were addressed in these interviews. (A copy of the guide used in these interviews is presented in Volume III, Appendix G.)

On the basis of the additional information developed via industry interviews, marginal and questionable mills from the first screening were screened again using the criteria described earlier. (Table V-1 shows the number of mills requiring further review that were identified in each of the screening phases.)

4. Financial (DCF) Analysis

As a result of the initial screening and follow-up interviews, a number of mills were identified as being vulnerable to closure. A discounted cash flow analysis was used to evaluate further the likelihood that these mills would close. Selected mills were grouped into homogeneous categories according to process sector, product mix and size.[2] On the basis of a "typical," mill(s) in each mill grouping, financial models were developed. The financial models were developed to be representative of typical vulnerable mills within a given mill category, but they are *not* meant to be representative of any individual mill situation. Based on these financial models, a discounted cash flow analysis (in constant 1975 dollars) was performed. (The basis of the DCF model utilized is discussed in Volume III, Appendix H.) Three scenarios were tested via DCF analysis.

a. Operation To 1983 (No Incremental Pollution Control Expenditures)

If the net present value (NPV) of expected cash flows generated by the mill model in question is less than the NPV of salvaging the mill in 1976, it is reasonable to assume that the mill would close, even in the absence of additional pollution control requirements. Such a mill closure should not be considered to be environmentally related.

b. Operation to 1983 (Compliance with BPT)

If the NPV of expected cash flows under this scenario is less than the NPV of salvaging the mill in 1976 (and Scenario A indicates that the mill is economically viable), it is reasonable to assume that closure resulting from BPT could be expected.

c. Operation to 1993 (Compliance with BPT and BAT)

If the NPV of expected cash flows under this scenario is less than the NPV of salvaging the mill in 1976 (and Scenarios A and B indicate that the mill would continue to operate), it is reasonable to assume that closure would result from the combined effects of BPT and BAT. A comparison of the results under Scenarios B and C indicates the relative contribution of BPT and BAT to the resulting closure impact.

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2. However, because of the unique characteristics of individual mills within a particular grouping, no category could be considered completely homogeneous.

The judgment of Arthur D. Little industry experts was used to extend findings resulting from these "typical" existing mill models to actions that may be expected in specific mill situations.

In essence the results of the DCF analysis were used as an additional method for verifying potential mill closures identified in the screening analysis and industry interviews.

5. Cost/Price/Inputs Used in Financial Analysis

Estimates of economic parameters for mill models of closure candidates (e.g., operating costs, pollution control costs, salvage value, working capital, maintenance/upkeep requirements) are based on process economics analyses of existing mills. (Summaries of the existing mill models are included in Section C. The methodology and assumptions used to develop these models are discussed in Volume III, Appendix F.)

Prices under cases with no controls are based on current transaction prices for the specific paper grades being modelled. Price increases under cases with pollution controls are based on the econometric model (Chapter IV) and are phased in over the periods 1976-1977 (BPT) and 1980-1983 (BAT).

The financial analysis employs 1975 dollars.

6. Sensitivity Analysis

The mills under consideration in the mill closure analysis vary greatly in terms of market characteristics, profitability and investment requirements. Moreover, projections of the above factors required in the financial analysis phase of the closure methodology are subject to a great deal of uncertainty. As a result, the impact of several key variables (including cost of capital, operating rate, and margin) on closure findings was tested. This sensitivity work was done for each mill model, since the degree of uncertainty/variability varied in each case. The sensitivity impact was quantitatively assessed only where a reasonable change in a given variable had the potential to reverse the findings of the financial model. (For example, if the financial model indicated a closure even at a 95% operating rate, an analysis using a lower operating rate assumption was not necessary.) For a more detailed discussion of the sensitivity work done in each process sector, refer to the specific financial conclusions in the closure analysis findings.

7. Community Employment Impact Analysis

a. Introduction

The total employment impact of a mill closure on a local economy consists of a primary and secondary impact. The primary impact is the immediate loss of jobs at the mill and is essentially a function of the size of the mill. The secondary (multiplier) impact is the additional reduction in employment incurred elsewhere in the economy as a result of an aggregate reduction in consumption. The magnitude of the secondary impact depands primarily on:

- The relationship between basic and non-basic employment in the region and;
- The capacity of the region to re-employ displaced workers.

b. Definition of Economic Region

An analysis of employment impacts in a local economy requires a geographic definition of the region. The boundaries of the local economy must be carefully delineated because the absorptive employment capacity depends strongly upon the economic size and composition of the region.

This analysis is based primarily on Standard Metropolitan Statistical Areas (SMSA) or counties surrounding the mill site.[3] As a first approximation, a 25-mile radius was used to define the area within the local economy. Counties or major towns which were substantially within this 25-mile radius were included. Additional counties were also included within the local economy if a relatively large city was within a 40-mile radius of the mill site and good access roads existed.[4]

c. Impact Estimation

The primary impact was estimated by surveying closure candidates for employment data. For pulp mills that were integrated back to woodlands operations, the employment data included both mill workers and loggers. The inclusion of woods workers in the primary impact is appropriate because their jobs are directly dependent upon the operation of the mill.

The secondary economic impact was assessed on the basis of Economic Base Theory from which regional employment multipliers are derived. Base theory asserts that in a given region a stable relationship exists between basic and non-basic employment. Basic employment in a region consists of employment oriented to markets outside the region. Non-basic employment provides support to basic employment and serves local needs. For most communities, agricultural, mining, manufacturing, and tourist-related employment are considered basic. All other economic activities are assumed to be non-basic.

The employment multiplier used to estimate secondary employment impacts was derived by dividing total employment (basic and non-basic) by basic employment. For example, if a local economy had 200 total jobs and 100 jobs in the basic sector, the multiplier would be 2.0. That is, a decrease of one basic job would result in a decrease of two jobs in the local economy.

Re-employment opportunities for mill workers and loggers in the area were also evaluated, since these opportunities reduce the secondary employment impact. Two criteria were used to measure these opportunities. The first deals specifically with the proximity of other paper mills in the area. It was assumed that some of the displaced workers would be able to obtain employment at these mills. The second criterion reflects the potential opportunities available in other manufacturing industries. Some of the skills acquired in a paper mill are transferable to other manufacturing sectors. However, if unemployment in a locality is high after a mill closure, re-employment will be more difficult. Based on past work, Arthur D. Little assumed that the displaced workers will be able to obtain up to 0.5% of total local manufacturing employment in a reasonable time (six months) under conditions of low unemployment (less than 5%). Under conditions of high unemployment, re-employment could conceivably be less than 0.1%. Note that re-employment does not reduce primary impact job losses, since those jobs are assumed to be lost forever with respect to the local economy. However, re-employment does reduce the base upon which secondary job losses are estimated.

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3. A standard Metropolitan Statistical Area (SMSA) is an integrated regional economy (with a minimum of 500,000 people) which is served by and influenced by its central city.

4. Most of the rural towns had populations of less than 10,000. Towns of over 30,000 were considered large enough to exert an influence on the smaller rural towns.

8. Limitations

a. *Mill Size and Diversity*

The scope of this study included 556 pulp and paper mills. These mills vary by size, product mix, average price, cost structure, and existing pollution control equipment. However, since an analysis of every mill in the industry was beyond the scope of this study, an approach was developed to screen a large number of mills on the basis of generalized criteria, and then focus in greater detail on a smaller number of endangered mills. This methodology made it possible to estimate *overall* closure impact (i.e., the number of mills, amount of capacity, and employment affected by mill closures) in specified product/process sectors. Although the sensitivity analysis considered some of this mill-to-mill variability and uncertainty, the approach was *not* designed to predict and identify individual mill closure probabilities. A significant amount of additional analysis of individual mills would be required to achieve the latter objective.

b. *Variability of the Decision-Making Frame of Reference*

Many types of decision makers may have a role in mill closure decisions. (For example, a private mill owner may have a very different decision-making frame of reference, compared to an analyst for a major paper company or financial institution.) Judgments and analysis in the closure study were made from the standpoint of a financially-oriented decision maker using objective profit maximizing criteria.

c. *Environmentally Related Closures Versus Closures for Other Reasons*

The problem of separating environmentally related closures from closures that would have occurred regardless of pollution control requirements complicates the predictions. Previous work in this area indicates that many impacted mills would have difficulty surviving because of various economic and competitive factors. Thus, future changes in economic conditions (both in the overall economy and in specific market sectors) are also important to the closure impact results reflected in this report. These factors could increase or decrease the future closure level from this study's projections.

d. *1983 Guideline Impact*

In general, the longer-term (1983) findings resulting from this study are less certain than those shorter-term (1977) findings described earlier. The managements of many mills that were contacted expect 1983 guidelines to be revised and, thus, are not sure what the ultimate parameters of these 1983 guidelines will be. For this reason, as well as the long lead time, the managements of many mills view 1983 pollution control cost requirements with much uncertainty, and were unwilling to speculate on their future actions. Hence, to a greater degree than in the short-run analysis, conclusions on 1983-related closures are based more heavily on financial analysis. Therefore, 1983 closure conclusions are limited by the uncertainties of the long-run financial projections that are required for such an analysis.

e. *Section 301(c)*

The analysis did not attempt to estimate the effect of Section 301(c) of the Water Pollution Control Act which provides that if a plant can demonstrate individual hardship, it may obtain a variance from the water effluent regulations.

C. CLOSURE IMPACT FINDINGS

1. General Findings

Table V-1 shows that of 556 U.S. pulp and paper mills 27 have a high closure potential, resulting from the burden of meeting 1977 or 1983 EPA water effluent guidelines. In general, most mills studied have either: (1) complied with 1977 effluent guidelines; (2) planned actions that will enable them to comply; or (3) already closed.

This section provides an overview of the closure findings resulting from this analysis. Section C.2 describes in greater detail the higher impact process sectors identified in the study.

a. Impact from 1977 Guidelines

Table V-2 shows that 10 mills, accounting for 1390 tons per day of finished product capacity, will be affected by 1977 water effluent guidelines. The sulfite process sector is subject to the heaviest impact with three closures accounting for 580 tons/day of finished product capacity. Table V-3 indicates the capacity removal effect from a product point of view. Bleached market pulp (paper grade) and printing/writing papers, with 3% and 2.4% of 1975 capacity removed, respectively, are the most seriously affected.

b. Incremental Impact from 1983 Guidelines

Table V-4 indicates that 17 additional mills representing 1715 tons/day of finished product capacity are projected to close as a result of 1983 water effluent guidelines. This impact is incremental and excludes closures resulting from the 1977 guidelines. The groundwood, sulfite, deinked, and non-integrated tissue process sectors are most heavily affected.

Table V-5 subdivides the impacts of the 1983 closures by product. The printing/writing papers and tissue sectors with 2.6% and 3.3% of 1975 capacity removed, respectively, are the most heavily affected.

In general, the study's findings concerning longer-term closure impacts are less certain than the shorter-term findings previously described. The managements of many mills that were contacted expect the proposed 1983 guidelines to be eased before they are promulgated and are not sure what the ultimate parameters of these guidelines will be. Industry interviews also indicate that mills that have invested recently in.pollution control equipment to comply with 1977 guidelines may not necessarily meet the proposed 1983 guidelines. Thus, the 1983 findings rely more heavily on the financial analysis phase of the screening and are limited by the uncertainties inherent in this analysis. As a result, these findings should be interpreted within the context of the relatively broadly-ranged confidence intervals shown in Table V-5, which reflect the above uncertainties.

2. Discussion of High Closure Impact Process Sectors

a. Sulfite Sector Closure

(1) Characteristics of Mills Vulnerable to Closure. Sulfite pulp/paper was identified as subject to the highest closure impact among the studied process sectors. Three mills, representing about 5% of total sulfite sector capacity, do not expect to comply with the 1977 guidelines. One of these has no chemical recovery facilities in place. The other two mills have partial recovery

TABLE V-1

RESULTS OF CLOSURE SCREENING ANALYSIS

Product/Process Sector	Total Number of Mills Examined (Year-end 1975)	Number of Direct Discharges	Mills Remaining After Initial Screening	Mills Remaining After Industry Interviews	Mills Remaining After Financial Analysis[1]
Bleached Kraft	80	77	6	0	0
Groundwood	23	19	11	4	4
Sulfite	27	26	11	14	5
Soda	3	3	1	1	1
Deinked	35	30	14	5	5
Tissue - NI	59	39	31	5	5
Printing & Writing Papers-NI	42	29	13	3	3
Unbleached Kraft	29	28	4	0	0
NSSC	18	14	6	0	0
Combined Unbleached Kraft/NSSC	10	10	1	0	0
Construction Papers	70	13	8	2	2
Recycled Paperboard	160	37	35	2	2
	556	325	141	36	27

[1] That is, potential closures resulting from primarily from 1977 plus 1983 water effluent guidelines.

Source: Arthur D. Little, Inc., estimates.

TABLE V-2

POTENTIAL CLOSURE IMPACT OF 1977 GUIDELINES BY PROCESS SECTOR

Process Category	Number of Closures	Productive Capacity Removed (tons/day)
Groundwood	1	75 (P&W papers)
Sulfite	3	320 (market pulp) 260 (P&W papers)
Soda	1	300 (P&W papers)
Deinked	1	25 (Tissue)
Tissue - NI	1	10
P&W Papers - NI	1	200
Construction Papers	1	100
Recycled Paperboard - NI	1	100
	10	1390

SOURCE: Arthur D. Little, Inc., estimates.

TABLE V-3

POTENTIAL CLOSURE IMPACT OF 1977 GUIDELINES BY PRODUCT SECTOR

	Productive Capacity Removed (tons/day)	Productive 1975 Capacity Removed (%)
Bleached Market Paper Grade Pulp	320	3.0
Printing & Writing Papers	835	2.4
Tissue	35	*
Construction Papers	100	1.5
Recycled Paper Board	100	1.1
	1390	

* Less than 1%

Source: Arthur D. Little, Inc., estimates

TABLE V-4

INCREMENTAL CLOSURE IMPACT OF 1983 GUIDELINES BY PROCESS SECTOR

Process Category	Number of Added Closures	Incremental Productive Capacity Removed (tons/day)
Groundwood	3	700 (P&W papers) 90 (newsprint)
Sulfite	2	300 (special industrial papers)[1] 80 Medium
Deinked	4	260 Tissue 60 (P&W papers)
Tissue - NI	4	175
P&W papers- NI	2	150
Construction Papers	1	100
Recycled Paperboard - NI	1	100
	17	1715

[1] Special Industrial Papers sector not included within this study's scope. Thus, this capacity not included in total estimates

Source: Arthur D. Little, Inc., estimates.

TABLE V-5

INCREMENTAL CLOSURE IMPACT OF 1983 GUIDELINES BY PRODUCT SECTOR

Market Category	Productive Capacity Removed (tons/day)	Productive 1975 Capacity Removed (%)	Confidence Intervals ± (%)
Newsprint	90	*	25
Printing & Writing Papers	910	2.6	30
Tissue	435	3.3	30
Corrugating Medium	80	1.8	30
Construction Papers	100	1.5	25
Recycled Paperboard	100	1.1	30
	1715		

*Less than 1%

Source: Arthur D. Little, Inc., Estimates

systems in-place and produce lignin by-products from the unrecovered liquor. None of the mills has secondary treatment. All three closure candidates have less than 200 tons/day of pulp capacity, which places them in the lowest quartile of U.S. sulfite mills ranked by size. Two additional sulfite mills are likely to close if 1983 guidelines are enacted. These are also small mills (less than 150 tons/day of pulp capacity). The managements of both these mills believe they comply, or will be able to comply with 1977 guidelines.

(2) Analysis of Results. Of the 27 U.S. sulfite mills examined, 11 were identified in the initial screening as requiring further information to clarify their closure potentials. After interviewing the managements of these mills either by telephone or in person, we judged two of these mills to be safe from pollution-related closure through 1983. These interviews also resulted in the identification of five additional mills that were originally eliminated in the first screen, but required further analysis based on company feedback.

To evaluate the 14 mills remaining after the second screen, Arthur D. Little developed two generalized financial models of the identified mills. (See Tables V-6 and V-7.) A large dissolving pulp mill model was chosen because there were several questionable mills (located both in Alaska and in the lower 48 states) that approximate the parameters of this model. A small paper-grade pulp mill model was chosen because four vulnerable mills identified in the second screening phase approximate the parameters of this model.

Because the 14 questionable mills differ significantly in size, product mix, average prices and costs, profitability, and cost of compliance, it was impossible for the two models to be representative of all 14 situations. Consequently, extrapolations were required to evaluate the closure likelihood of those mills not precisely represented by the models.

Table V-8 shows the results of the DCF analysis of the large dissolving pulp mill. The results indicate that the model can absorb both 1977 and 1983 pollution control expenditures from the standpoint of both net present value (NPV) and internal rate of return (IRR). This model requires external financing totaling $14 million. A maximum of $8 million in external financing is required in 1977. Internal cash flows generated by this model allow all external funds to be repaid by 1979.

In view of the model's high initial profitability, it should be possible to raise the external capital required, subject to the possibility of a very tight supply situation in the capital market.

Varying the operating rates from 95% to 85% and the cost of capital from 10% to 20% did not change the findings. Therefore, it was concluded that large dissolving pulp mills which have financial characteristics similar to this model generally have significant cash-flow generating capability and are unlikely to be vulnerable to closure because of 1977 and 1983 effluent control requirements.

Since the above analysis was completed, Arthur D. Little has made an intensive study of the Ketchikan Pulp Company (KPC) Mill in Alaska because of the Company's request for a hearing under Section 507(e) of the Federal Water Pollution Control Act. The latter study indicated that the KPC mill is also unlikely to close for pollution control reasons, but since this mill was not as strong financially as the generalized model shown here it is closer to the point where a closure could be forced for financial reasons. The reasons for this difference in financial performance involved site and mill specific factors (particularly with respect to projected logging costs) that only an in-depth analysis of a specific mill could reveal.

TABLE V-6

PROFILE OF LARGE DISSOLVING SULFITE MILL CLOSURE MODEL

BASIS: Product: Viscose Grade Dissolving Market Pulp

Process: Mg Base sulfite pulping with MgO recovery

Production: 600 tpd; 200,000 tpy (95% of capacity)

Location: Pacific Northwest

Fiber Furnish: 100% Whitewood (chips)

Power: On-site generation

Effluent Treatment: Primary clarification

Average Selling Price: (end of 1975): $396/ton

CAPITAL PARAMETERS:

Book Value: $30 million (assumed)

Working Capital: $14 million

Additional Capital Requirements:

a. Federal Water Regulations for 1977 BPT - $28 million
for 1983 BAT - $15 million

b. Upkeep $2 million/year

Salvage Value: $6 million (assumed)

OPERATING COSTS:	$/ton
Total Delivered Cost, (without controls)[1]	287
Additional operating cost for:	
Federal Water Regulations 1977	9
Federal Water Regulations 1983	5
Total Projected Delivered Cost (with Federal Water Regulations)[1]	301

[1]Excluding depreciation and interest

Source: Mill Survey and Arthur D. Little, Inc., estimates

TABLE V-7

PROFILE OF SMALL PAPER GRADE SULFITE MILL CLOSURE MODEL

BASIS: Product: Bond paper, in rolls

Process: Mg base sulfite pulping with MgO recovery

Production: 150 tpd; 50,000 tpy (95% capacity)

Location: North Central

Fiber Furnish: 100% chips from roundwood (50/50 SW & HW)

Power: On-site generation plus purchased

Effluent treatment: Primary clarification

Average selling price: (end of 1975): $495/ton

CAPITAL PARAMETERS:

Book Value: $24 million (assumed)

Working Capital: $4 million

Additional Capital Requirements:

a. Federal Water Regulations for 1977 BPT -	$6.1 million
for 1983 BAT -	$3.7 million
b. Upkeep	$0.5 million/year
Salvage Value:	$5 million (assumed)

OPERATING COSTS:	$/ton
Total Delivered Cost (without controls)[1]	341
Additional Operating Cost for:	
Federal Water Regulations 1977	12
Federal Water Regulations 1983	5
Total Projected Delivered Cost (with Federal Water Regulations)[1]	358

[1]Excluding depreciation and interest

Source: Mill Survey and Arthur D. Little, Inc., estimates

TABLE V-8

FINANCIAL COMPARISON OF CLOSURE ALTERNATIVES FOR LARGE DISSOLVING SULFITE PULP MILL MODEL

	No Controls - Operate Until 1983	Meet 1977 Standards and Operate Until 1983	Meet 1983 Standards and Operate Until 1993
Net Present Value Over Salvaging Mill Now; 10% cost of Capital	$54 Million	$40 Million	$65 Million
Implicit Internal Rate of Return[1]	55%	32%	32%
Total External Financing	-	$14 Million	$14 Million
Maximum External Financing in any One Year	-	$ 8 Million	$ 8 Million
Year of Maximum External Financing Load	-	1977	1977
Year Debt Retired	-	1979	1979

[1]IRR is relative to salvage value, which is defined as scrap value plus working capital; in this case $20 MM.

SOURCE: Arthur D. Little, Inc., estimates.

This finding underscores the fact that while the generalized mill model approach employed here can be used to estimate overall closure and employment impacts, much more specific analysis is needed to predict closures of individual mills.

Table V-9 shows the results of the DCF analysis resulting from the small paper-grade sulfite mill model. The results indicate that this model can also absorb 1977 and 1983 pollution control expenditures in terms of both NPV and IRR indices. This means that small paper-grade sulfite mills which produce high-quality printing and writing papers and otherwise fit the model's parameters should not be vulnerable to mill closure as a result of the studied effluent control levels.

However, several small mills judged to be marginal or questionable in the industry screening phase of the analysis do not fit parameters of the small sulfite mill model. In particular it was evident that their profitability is below that of the model. Factors (or a combination thereof) leading to this conclusion include:

- Greater capital expenditure requirements to achieve 1977 or 1983 guidelines because of site-specific conditions;
- Smaller mill size (up to half as large as the mill model) resulting in higher operating costs and lower profit margins;
- Lower average prices resulting from a lower-value product mix. (For example, one small paper-grade sulfite mill had an average price of $200/ton for its packaging product — less than half of the writing paper price used in the model.)

Thus, despite the healthy financial position reflected by the paper-grade sulfite mill model, a qualitative assessment of the aforementioned factors led Arthur D. Little to conclude that five sulfite mills perform less well than the model by a large enough margin to be considered vulnerable to closure.

It should also be noted that the closure impacts identified for the sulfite sector are conservative to the extent that they do not reflect three sulfite mills scheduled for closure and replacement by additional kraft pulp capacity at nearby sites. Since this tonnage removed will be replaced by kraft pulp, the resulting capacity and employment impacts were not considered significant.

b. Groundwood Sector Closures

(1) Characteristics of Closure Candidates. One groundwood sector closure is expected as a result of 1977 effluent guidelines. This mill is old, inefficient, and small, with a capacity of 75 tons/day. Three additional closures are expected as a result of 1983 effluent guidelines. Two of these mills are small (less than 100 tons/day of pulp capacity) and the third has a pulp capacity of 225-275 tons/day.

(2) Description of Analysis. In the initial screening analysis, 23 mechanical pulp mills (groundwood, thermo-mechanical and chemi-mechanical) were examined and 11 were identified as requiring company contacts. Updated information from these interviews indicated that seven of these mills were sufficiently viable to be invulnerable to closure because of pollution regulations. One model was developed for the financial analysis of the remaining four mills (Table V-10).

TABLE V-9

FINANCIAL COMPARISON OF CLOSURE ALTERNATIVES FOR PAPER GRADE SULFITE PULP MILL MODEL

	No Controls - Operate Until 1983	Meet 1977 Standards and Operate Until 1983	Meet 1983 Standards and Operate Until 1993
Net Present Value Over Salvaging Mill Now ; 10% Cost of Capital	$22 Million	$19 Million	$27 Million
Implicit Internal Rate of Return[1]	52%	40%	40%
Total External Financing	-	-	-
Maximum External Financing in any One Year	-	-	
Year of Maximum External Financing Load	-	-	-
Year Debt Repaid	-	-	-

[1] IRR is relative to salvage value, which is defined as scrap value plus working capital.

SOURCE: Arthur D. Little, Inc., estimates.

TABLE V-10

PROFILE OF GROUNDWOOD PAPER MILL CLOSURE MODEL

BASIS: Product: Uncoated Groundwood paper, in rolls

Process: Stone Groundwood (bleached SW)

Production: 150 tpd; 50,000 tpy (95% of capacity)

Location: North East

Fiber Furnish: 70% Groundwood; 20% Waste paper; 10% Market Pulp

Power: 50% of grinder power requirement from hydro; balance purchased electric power

Effluent Treatment: Primary Clarification

Average Selling Price: (end 1975): $320/ton

CAPITAL PARAMETERS:

Book Value : $10 million (assumed)

Working Capital: $4 million

Additional Capital Requirements:

a.	Federal Water Regulations	for 1977 BPT - $3.2 million
		for 1983 BAT - $1.5 million
b.	Upkeep	$0.5 million/year
Salvage Value:		$2.0 million (assumed)

OPERATING COSTS

Total Del'vd Cost (without controls)[1]	300
Additional Operating Cost for:	
Federal Water Regulations 1977	6
Federal Water Regulations 1983	3
Total projected Delivered Cost with Federal Water Regulations[1]	309

[1]Excluding depreciation and interest

Source: Mill Survey and Arthur D. Little, Inc., estimates

Table V-11 shows that the DCF analysis of this model indicates that with an internal rate of return of 10% the mill is marginally viable in the absence of pollution control investment requirements. Under both 1977 and 1983 guidelines, the NPV is negative. The model's cost of capital would have to be an unrealistically low, 5-6% (in constant dollars), in order for the mill to continue to operate. Note, also, that this DCF analysis was based on a 95% operating rate, the most optimistic condition that could be postulated in this industry sector. These results tend to verify the closure indications revealed in the industry screening and interviewing phases.

c. *Deinking Sector Closures*

(1) Characteristics of Closure Candidates. One deinking mill closure is anticipated because of 1977 effluent guidelines. This mill is very small (less than 50 tons/day). Its existing treatment consists of primary clarification. The mill does not anticipate being able to tie into a municipal treatment system. Four additional closures are expected as a result of 1983 effluent guidelines. Three of these mills are also in the 50-tons/day range. The fourth is 200-300 tons/day. These four mills anticipate that they will be able to comply with 1977 effluent guidelines.

(2) Description of Analysis. In the initial screening analysis, 35 deinking mills were examined and 14 were identified as requiring company contacts. Industry interviews indicated that nine of these mills were not vulnerable to closure for pollution-related reasons. One mill model was developed for the purposes of analyzing the five remaining mills (Table V-12).

Table V-13 shows the results of the DCF analysis generated by this model. These results indicate that while the mill is viable in the absence of further pollution control investment requirements, it cannot absorb 1977 or 1983 guideline-related investments. In both cases, the net present value of expected cash flows is less than current salvage value and the internal rate of return is 6% and 8%, respectively. Again, these results tend to confirm the signs of high closure probabilities observed via mill screening and industry interviews.

d. *Nonintegrated Tissue Sector Closures*

(1) Characteristics of Closure Candidates. One nonintegrated tissue mill closure is anticipated because of 1977 guidelines. This mill is very small (10 tons/day). Four additional closures are expected from the impact of 1983 guidelines. These mills are in the 25 to 75-ton/day range.

(2) Description of Analysis. In the initial screening process, 59 tissue mills were examined and 31 were identified as requiring further review. Industry interviews indicated that 26 of these mills were not in jeopardy of closure as a result of the effluent guidelines. One "typical" mill model was developed for the financial analysis of the remaining five candidates (Table V-14).

Table V-15 shows the results of the DCF analysis generated by this model. It indicates that the mill is marginally viable in the absence of pollution control expenditures and is not viable when impacted by 1977 or 1983 guideline capital requirements. The mill model has an IRR of 8% under these scenarios. Total external financing requirements are estimated to be $0.8 million with maximum financing of $0.6 million in 1977. This model also confirms descriptions of low profitability and high closure potential received during the company interviews.

TABLE V-11

FINANCIAL COMPARISON OF CLOSURE ALTERNATIVES FOR SMALL GROUNDWOOD PULP MILL MODEL

	No Controls - Operate Until 1983	Meet 1977 Standards and Operate Until 1983	Meet 1983 Standards and Operate Until 1993
Net Present Value Over Salvaging Mill Now; 10% Cost of Capital	0	($2.0 Million)	($2.3 Million)
Implicit Internal Rate of Return[1]	10%	5%	6%
Total External Financing	-	$1.5 Million	$1.5 Million
Maximum External Financing in any One year	-	$1.0 Million	$1.0 Million
Year of Maximum External Financing Load	-	1977	1977
Year Debt Retired	-	1980	1980

[1] Implicit IRR is relative to salvage value, which is defined as scrap value plus working capital.

Note: The additional decimal place in the dollar figures was added to indicate differences, if any, between 1977 and 1983; it does not reflect any additional precision.

SOURCE: Arthur D. Little, Inc., estimates.

TABLE V-12

PROFILE OF DEINKING MILL CLOSURE MODEL

BASIS: Product: Sanitary Tissue; 50% toilet, 40% towel, 10% napkins
Private Label & institutional grades

Process: Wastepaper deinking

Production: 76 tpd; 25,000 tpy (95% capacity) on 3 Machines

Location: Northeast

Fiber Furnish: 100% Waste Paper

Power: Purchased

Effluent Treatment: Primary Clarification

Weighted Average Selling Price (end of 1975): $650/ton

CAPITAL CONSIDERATIONS:

Book Value: $4 million (assumed)

Working Capital: $4 million

Additional Capital Requirements:

a. Federal Water Regulations for 1977 BPT - $5.0 million
for 1983 BAT - $0.6 million

b. Upkeep $0.4 million/year

Salvage Value $1.0 million (assumed)

OPERATING COSTS

Total Delivered Cost (without controls)[1]	582
Additional Operating Cost for:	
Federal Water Regulations 1977	18
Federal Water Regulations 1983	4
Total Projected Delivered Cost (with Federal Water Regulations)[1]	604

[1]Excluding depreciation and interest

Source: Mill Survey and Arthur D. Little, Inc., estimates.

TABLE V-13

FINANCIAL COMPARISON OF CLOSURE ALTERNATIVES FOR SMALL DEINKED PULP MILL MODEL

	No Controls - Operate Until 1983	Meet 1977 Standards and Operate Until 1983	Meet 1983 Standards and Operate Until 1993
Net Present Value Over Salvaging Mill Now; 10% Cost of Capital	$ 2.1 Million	($ 1.4 Million)	($ 0.9 Million)
Implicit Internal Rate of Return[1]	17 %	6 %	8 %
Total External Financing	-	$ 3.6 Million	$ 3.6 Million
Maximum External Financing in any One Year	-	$ 1.8 Million	$ 1.8 Million
Year of Maximum External Financing Load	-	1977	1977
Year debt retired	-	1982	1983

[1]IRR is relative to salvage value, which is defined as scrap value plus working capital.

NOTE: The additional decimal place in the dollar figures was added to indicate differences, if any, between 1977 and 1983; it does not reflect any additional precision.

SOURCE: Arthur D. Little, Inc., estimates.

TABLE V-14

PROFILE OF NONINTEGRATED TISSUE MILL CLOSURE MODEL

BASIS: Product: Sanitary Tissue; 50% toilet, 40% towels, 10% napkins
Private Label Grades

Process: Non-integrated papermaking

Production: 76 tpd; 25,000 tpy (95% capacity) on 3 Machines

Location: Northeast

Fiber Furnish: 70% Purchased Market Pulp; 30% Waste Paper (Pulp substitute Grade)

Power: Purchased

Effluent Treatment: None

Weighted Average Selling Price (end 1975): $800/ton

CAPITAL CONSIDERATIONS:

Book Value: $4 million (assumed)

Working Capital Requirements: $5 million

Additional Capital Requirements:

a. Federal Water Regulations for 1977 BPT - $2.1 million
for 1983 BAT - $0.9 million

b. Upkeep $0.4 million/year

Salvage Value: $1.0 million (assumed)

OPERATING COSTS:

Total Delivered Cost (without controls)[1]		748
Additional Operating Cost for:		
Federal Water Regulations	1977	8
Federal Water Regulations	1983	5
Total Projected Delivered Cost (with Federal Water Regulations)[1]		761

[1]Excluding Depreciation and Interest

Source: Mill Survey and Arthur D. Little, Inc., estimates.

TABLE V-15

FINANCIAL COMPARISON OF CLOSURE ALTERNATIVES FOR NONINTEGRATED TISSUE MILL MODEL

	No Controls - Operate Until 1983	Meet 1977 Standards and Operate Until 1983	Meet 1983 Standards and Operate Until 1993
Net Present Value Over Salvaging Mill Now 10% Cost of Capital	0.3	($ 0.7 Million)	($ 0.7 Million)
Implicit Internal Rate of Return [1]	11 %	8 %	8 %
Total External Financing	-	$ 0.8 Million	$ 0.8 Million
Maximum External Financing in any One year	-	$ 0.6 Million	$ 0.6 Million
Year of Maximum External Financing Load	-	1977	1977
Year Debt Retired	-	1979	1979

[1] IRR is relative to salvage value, which is defined as scrap value plus working capital.

NOTE: The additional decimal place in the dollar figures was added to indicate differences, if any, between 1977 and 1983; it does not reflect any additional precision.

SOURCE: Arthur D. Little, Inc., estimates.

e. *Recycled Paperboard Sector Closures*

(1) Characteristics of Closure Candidates. Two recycled paperboard mill closures are anticipated as a result of pollution control guidelines. Both mills are small (less than 75 tons/day), do not have access to municipal treatment facilities, and cannot afford the required secondary treatment to meet 1977 water effluent regulations.

(2) Description of Analysis. In the initial screening process, 160 mills were examined and 35 were identified as requiring further review. Industry interviews indicated that most of these mills have or will tie into municipal treatment facilities. Thus, only two mills could be considered to be jeopardized by pollution control requirements. One "typical" closure model was developed for the financial analysis (Table V-16).

Table V-17 shows the results of the DCF-analysis performed on this model. It indicates that with a 10% internal rate of return the model is marginally viable in the absence of pollution control expenditures. However, the IRR of the model drops well below 10% when 1977 or 1977 plus 1983 guideline cost impacts are factored in. Thus, this model is not economically viable under either effluent guideline regulation.

When relating the poor financial performance of the recycled paperboard mill closure model to the fact that only two closures out of 160 mills were projected, it is important to consider the following:

- By far, the greatest number of paper industry closures during the period January 1965 to June 1975 took place in the recycled paperboard sector (34 mills closed, accounting for 1.2 million tons of capacity). These historic closures have acted to "weed out" many of the less economically viable mills.
- Of the 160 mills studied in this sector, 123 have complied with effluent guidelines via low-cost approaches:
  - 94 mills have tied into municipal treatment facilities.
  - 25 mills have closed up or internalized their processes.
  - 4 mills utilize spray irrigation systems.

Financial analysis indicates that if it were not for the capability of many mills in this sector to take advantage of these lower-cost compliance approaches, the closure impact in the sector would be significantly higher. It also follows that if future regulations create incremental cost impacts for recycled paperboard mills (such as pretreatment as a prerequisite for municipal treatment tie-in), this sector should be carefully evaluated as a potentially high impact sector.

f. *NSSC Sector Closures*

In the initial screening process, 18 mills were examined and six were identified as requiring further review. Industry interviews indicated that:

- Three of these mills recently have changed their product mix. Two are now producing recycled paperboard and one is producing construction papers. These product mix changes had a negligible impact on capacity and employment.
- One mill has tied in to a municipal treatment plant.
- Two mills are installing secondary treatment facilities on-site.

TABLE V-16

PROFILE OF RECYCLED PAPERBOARD MILL CLOSURE MODELS

BASIS: Product: 60% Boxboard; 40% Chipboard

Process: Secondary Fiber Pulping; all production in sheets

Production: 100 tpd; 33,000 tpy.

Location: North Central Metropolitan

Fiber Furnish: Recycled Fiber

Effluent Treatment: Primary Clarification

Weighted Average Selling Price (Mid 1976): $265/ton

CAPITAL CONSIDERATIONS:

Book value: $6 million (assumed)

Working Capital Requirements: $2 million

Additional Capital Requirements:

a. Federal Water Regulations	for 1977 BPT	$2.3 million
	for 1983 BAT	$0.7 million
b. Upkeep	$0.3 million/yr.	
Salvage Value:	$1.5 million (assumed)	

OPERATING COSTS	($/ton)
Total Delivered Cost (without controls)[1]	243
Additional Operating Cost for:	
Federal Water Regulations 1977	7
Federal Water Regulations 1983	2
Total Projected Delivered Cost (with Federal Water Regulations)[1]	252

[1] Excluding depreciation and interest.

Source: Mill Survey and Arthur D. Little, Inc., estimates.

TABLE V-17

FINANCIAL COMPARISON OF CLOSURE ALTERNATIVES FOR RECYCLED PAPERBOARD MILL MODEL

	No Controls - Operate Until 1983	Meet 1977 Standards and Operate Until 1983	Meet 1983 Standards and Operate Until 1993
Net Present Value Over Salvaging Mill Now 10% Cost of Capital	$1.1 Million	($0.3 Million)	($0.9 Million)
Implicit Internal Rate of Return[1]	15%	8%	6%
Total External Financing	-	$0.8 Million	$0.8 Million
Maximum External Financing in Any One Year	-	$0.5 Million	$0.5 Million
Year of Maximum External Financing Load	-	1977	1977
Year Debt Retired	-	1979	1979

[1] IRR is relative to salvage value, which is defined as scrap value plus working capital.

SOURCE: Arthur D. Little, Inc., estimates.

Thus, while no mills were identified in the analysis as being closure candidates, three mills shut down their NSSC pulping processes to comply with effluent guidelines. To this extent, closure impacts in the NSSC process sector may be understated from a capacity standpoint although the product mix changes have reduced employment relatively little.

3. Community Employment Impacts

a. 1977 Guidelines

Ten mills in three geographic regions of the country are projected to close because of 1977 effluent guidelines. Total employment impact is estimated to be 2635 primary losses plus 1105 secondary losses, distributed as shown in Table V-18.

The heaviest loss of jobs will be in the Northeast, North Central, and Northwest regions. However, because many of these mills are in urban regions where the primary unemployment impact constitutes a very small percentage of total basic employment, re-employment opportunities are likely to limit the total employment impact to the primary impact.

b. 1983 Guidelines

Seventeen mills in four geographic regions of the country are projected to close because of 1983 effluent guidelines with a total employment impact of about 7125 jobs distributed regionally as shown in Table V-19. Again, the most seriously affected regions will be the Northeast (eight closures, 3000 jobs), in the North Central region (five closures, 3350 jobs), and the Northwest (two closures, 560 jobs). One closure in the North Central region — a large deinking mill — is in an area with little re-employment opportunities and has a relatively high secondary employment multiplier. This closure represents about two-thirds of the total employment impact in the North Central region.

TABLE V-18

REGIONAL EMPLOYMENT IMPACTS ASSOCIATED WITH 1977 (BPT) MILL CLOSURES

Region and Mill Type	Primary Impact	Secondary Impact[1]			Total Impact
		Re-employment	Multiplier[2]	Secondary Impact	
Northwest					
Sulfite	175	40	2.1	285	460
North Central					
Sulfite	220	> 220	1.4	0	220
Sulfite	450	15	0.8	350	800
Groundwood	210	15	1.9	370	580
Construction Papers	100	45	1.8	100	200
	980			820	1800
Northeast					
Deinked	100	> 100		0	100
Tissue - NI	50	> 50		0	50
Printing & Writing	660	> 660		0	660
Soda	600	> 600		0	600
Recycled Paperboard - NI	70	> 70		0	70
	1480			0	1480
TOTAL	2635			1105	3740

[1] Secondary Impact = (Primary Impact - Re-employment) X multiplier

[2] Multiplier = (Total Employment/Basic Employment) - 1

SOURCE: Arthur D. Little, Inc., estimates.

TABLE V-19

INCREMENTAL REGIONAL EMPLOYMENT IMPACTS ASSOCIATED WITH

1983 (BAT) MILL CLOSURES

Region and Mill Type	Primary Impact	Secondary Impact[1]: Re-employment	Secondary Impact[1]: Multiplier[2]	Secondary Impact[1]: Secondary Impact	Total Impact
Northwest					
Sulfite	150	130	2.1	40	190
Groundwood	150	40	2.0	220	370
	300			260	560
North Central					
Sulfite	200	15	2.1	390	590
Deinked	750	0	2.0	1500	2250
Deinked	150	85	1.1	70	220
Deinked	120	15	0.9	95	215
Printing & Writing - NI	75	> 75	1.4	0	75
	1295			2055	3350
Northeast					
Groundwood	250	0	1.4	350	600
Groundwood	600	75	1.3	685	1285
Tissue - NI	160	> 160	2.3	0	160
Tissue - NI	100	55	1.4	65	165
Tissue - NI	220	140	2.2	175	395
Tissue - NI	50	> 50	2.0	0	50
Printing & Writing - NI	300	> 300	2.3	0	300
Recycled Paperboard - NI	50	> 50	1.3	0	50
	1730			1275	3005
South					
Deinked	125	65	0.6	35	160
Construction Papers	50	> 50	2.0	0	50
	175			35	210
TOTAL	3500			3625	7125

[1] Secondary Impact = (Primary Impact - Reemployment) X multiplier

[2] Multiplier = (Total Employment/Basic Employment) - 1

SOURCE: Arthur D. Little, Inc., estimates.

CHAPTER VI
CAPITAL IMPACTS

VI. CAPITAL IMPACTS

A. INTRODUCTION

In assessing the economic impact of the studied environmental regulations, it is necessary to place the regulatory burden into the context of the industry's total projected operating and capital costs and to inquire whether these demands can be met within the constraints imposed by the discipline of the capital markets. This study does not attempt to estimate the impact of large new financing demands on the paper industry's cost of capital; rather, it attempts to assess the size and timing of the industry's external financing requirements to comply with the studied water, air, and noise regulations, and to place the magnitude of this burden into perspective.

1. Approach

The overall structure of the analysis is presented in Figure VI-1. The central analytical tool was a flow-of-funds model of the U.S. pulp and paper industry developed by Arthur D. Little. It differs from the other funds flow model recently applied to this problem in that it does *not* attempt to independently project sales, margins, etc.[1] Instead, it recognizes the importance of equilibrium conditions in both product and capital markets; hence, it assumes that over the period 1976-1983 the industry will continue to pursue its customary financial policies and to price its product and set its output level consistent with the demamd schedule which it faces to achieve the required rate of return. Key elements of the methodology are discussed in Section B and supporting details are presented in Volume III, Appendix H.

After experimenting with several approaches Arthur D. Little found that the most reliable method of forecasting the investment requirements of the paper industry was to work with the API's most recent survey of its members' planned capacity changes. These data provided a reasonably reliable forecast for each major grade to 1979. Arthur D. Little then projected this data to 1983 by taking into account the capacity growth trend since 1970 and the relative profitability of the various grades. Then two curves reflecting the upper and lower bounds of capacity expansion between 1979 and 1983 were selected for the sensitivity analysis. Finally Arthur D. Little's process economics models were used to convert the tonnage capacity projections to dollars of capital requirements. Thus the approach took full account of capacity expansions already committed and minimized the uncertainties of making long range projections.

2. Summary of Findings

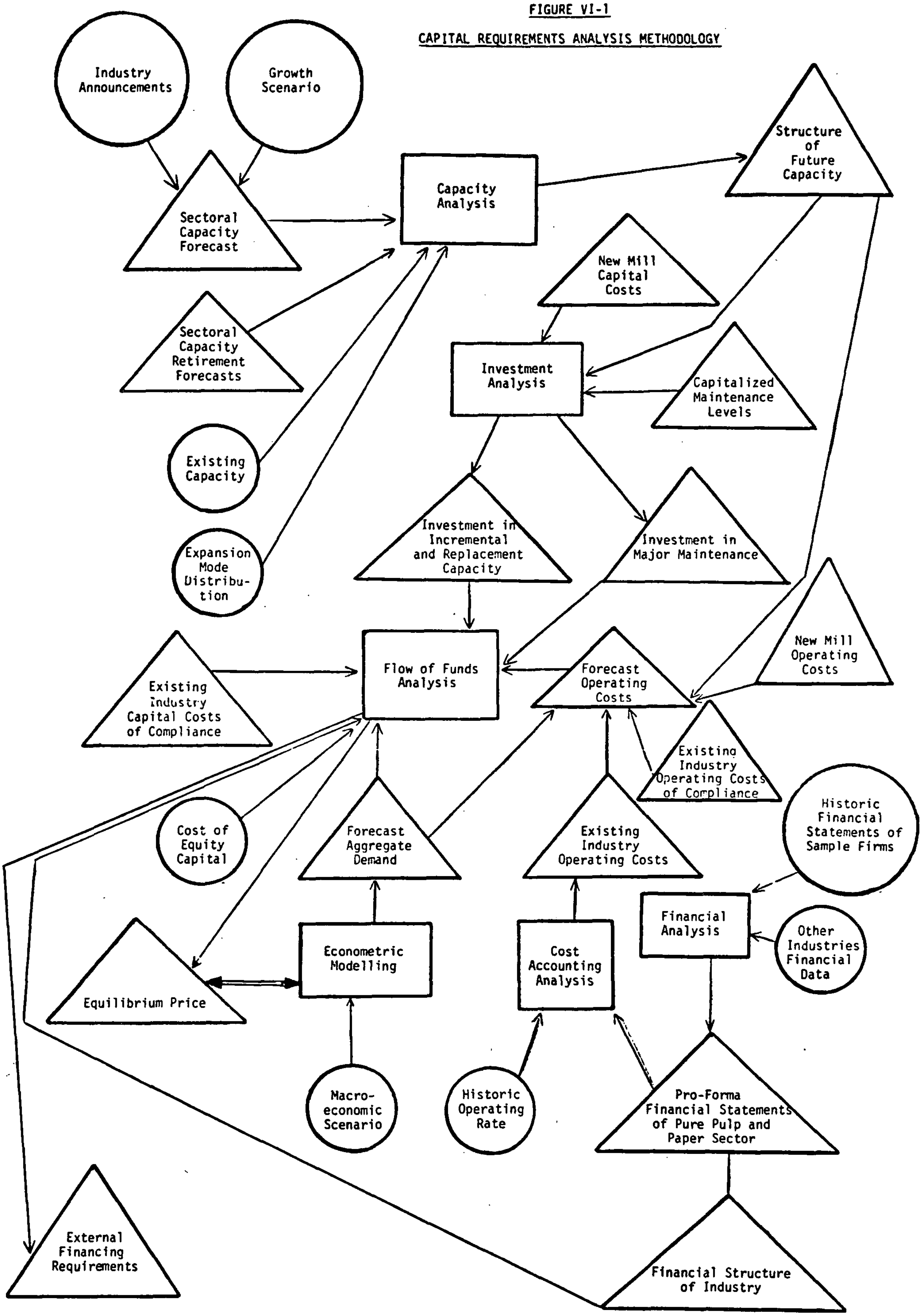
The analysis indicates that over the eight-year period 1976-1983, the U.S. pulp, paper and paperboard industry (exclusive of woodlands and converting operations) will invest approximately $21.3 billion (in 1975 dollars) in capital equipment, of which some $7.4 billion will be the direct result of compliance with the studied regulations. Of this $7.4 billion, almost $6 billion is attributable to water effluent controls, with air and noise regulations making up the balance.

To finance its investment requirements, the industry will need to raise substantial funds in the capital markets. Assuming average business conditions, a moderate level of capacity growth, and pricing policies which fully reflect the marginal cost of capital funds and the relative inelasticity of final demand for pulp, paper and paperboard, external financing requirements will amount to about $4.5 billion, of which about $3.5 billion is attributable to environmental

1. URS Research Company, *The Economic Impacts of Effluent Guidelines Compliance by the American Paper Industry*, American Paper Institute, 1975.

FIGURE VI-1

CAPITAL REQUIREMENTS ANALYSIS METHODOLOGY



regulations.[2] The bulk of these funds (about 77%) would have been required during 1976 and 1977 if EPA's original 1977 water effluent deadline were to have been met using the assumed technology.

This level of external financing, compared to aggregate financing in the economy, does not differ significantly from the share of available funds successfully obtained by the pulp and paper industry in the past. Therefore, it is difficult to assert that the demand for capital funds produced by compliance with the studied regulations will divert an inexpansible capital supply away from capacity expansion, or place an insurmountable barrier in the way of compliance. Table VI-1 presents a summary of the financial projections underlying these conclusions.

The analysis has also considered the impact on these conclusions over the range of uncertainty in the major assumptions. While reasonable variations in the assumptions have a substantial impact on the total amount of external financing over the period, they do not alter the qualitative conclusion that compliance is financially feasible. However, the analysis does indicate that the industry's actual rate of compliance to be expected given the industry's current and announced pattern of future compliance expenditures, will result in reduced financial pressure on the industry prior to 1978.

B. METHODOLOGY AND FINDINGS

1. Capital Investment Requirements

a. *Methodology*

Annual capital investment requirements for the pulp, paper, and paperboard sector of the industry were projected for each of the major components:

- Incremental expansion of the total capacity of the industry;
- Replacement of capacity retired either through normal obsolescence or because of inability to comply with the studied regulations;
- Major (capitalizable) maintenance of capacity in place; and
- Upgrading of existing capacity to comply with the studied regulations.

(1) Expansion of Capacity. In estimating the investment requirements for capacity expansion, Arthur D. Little used industry commitments for capacity expansion through 1979 and projected three different series of total year-end capacity for each of the years 1980 through 1983 for 15 product sectors. The capital cost for expansion in each product sector was based on the process economics new mill models, described in Chapter III, Section E, modified to reflect the fact that much of the expansion will be carried out either through rebuilding existing machines or installing new machines at an existing mill rather than by developing new "grassroots" sites. The time pattern for these capital *expenditures* was 40% in the year of completion, 40% in the first preceding year, and 20% in the second preceding year, which is the typical pattern in this industry once the capital has been committed.

2. Note that only part of the external financing requirements of the industry is attributable to the studied controls, despite the fact that pollution control investment exceeds total external financing, because the average price charged by the industry, its level of production, and its consequent internal cash flow are quite different in the two cases corresponding to presence and absence of the studied regulations.

TABLE VI-1

SUMMARY OF PROJECTED FINANCIAL PERFORMANCE OF THE U.S. PULP, PAPER AND PAPERBOARD INDUSTRY 1976-1983 (1975 Dollars)

	Eight-Year Totals and Averages	
	Excluding All Studied Regulations	Including All Studied Regulations
Operations		
Price/ton ($/ton)	305	322
Total Production thousand tons)	500,142	487.849
Sales Revenue ($ Millions)	152,476	157,146
General, Selling and Administrative Expenses	16,463	16,889
Cost of Goods Sold - excluding compliance costs	101,447	99,569
- compliance costs	--	2,365
Interest on debt	2,499	4,191
Depreciation (book)	11,758	13,460
Income taxes (book)	8,627	8,216
Net Income	11,683	12,457
Net Income/Sales (book)	7.66%	7.93%
Net Income/Equity (book)	12.11%	11.66%
Investment ($ Millions)		
Replacement and Expansion - excluding compliance costs [1)]	$ 6,934	$ 7,744
- compliance costs	--	1,391
Major maintenance	6,993	8,372
Compliance costs for existing capacity	--	3,834
Total Investment	13,927	21,341
Investment cost/ton of capacity - greenfield site	579	675
Investment cost/ton of capacity - average of greenfields, new machines, and improvements	363	458
External Financing ($ Millions)		
Gross Equity Raised	$ 143	$ 1,006
Gross Debt Raised	751	3,444
Total	894	4,450

1) The $810 million difference between columns 1&2 reflects cost to replace mills closed as a result of the studied regulations.

(2) Replacement of Retired Capacity. The investment requirements for replacement of retired capacity were based on historic mill closure rates in each of 15 product sectors projected through the period 1976-1983. Estimated mill closures resulting from water effluent regulations were also included in these projections, and were assumed to occur in 1977 and 1983, the deadlines for meeting EPA's water effluent guidelines. However, such closures were excluded from the analyses of cases that assumed water effluent guidelines were not in force. The methods of estimating capital cost levels and expenditure patterns described above under "Expansion of Capacity" were also used here.

(3) Major Maintenance. As is described in Vol. III, Appendix F, pulp and paper mills require large maintenance expenditures approximately one-third of the way through their useful life as well as at subsequent times. Detailed information on the age of equipment in place is not available. Therefore, these expenditures were approximated as an annual equivalent of 2% of capacity in place valued at new mill (replacement) cost, including the appropriate level of environmental control. This approach implicitly recognizes the need for maintenance of environmental control equipment as well as of productive equipment.

(4) Upgrading of Existing Capacity. The investment requirements for bringing existing capacity into compliance with Federal regulations were based on the data presented in Chapter III, "Cost of Compliance." These costs were originally estimated as increments over a 1974 baseline. Since the funds flow model starts in 1976, Arthur D. Little reduced these costs by one-third of the investment scheduled over the period 1975-1977, which is tantamount to the assumption that the industry is proceeding with compliance with proposed 1977 standards on schedule. Further, water effluent control and OSHA noise control costs have been increased for the cases which assume no water effluent regulations to be in effect to reflect the cost of compliance for capacity which would not be retired under these circumstances.

b. Results

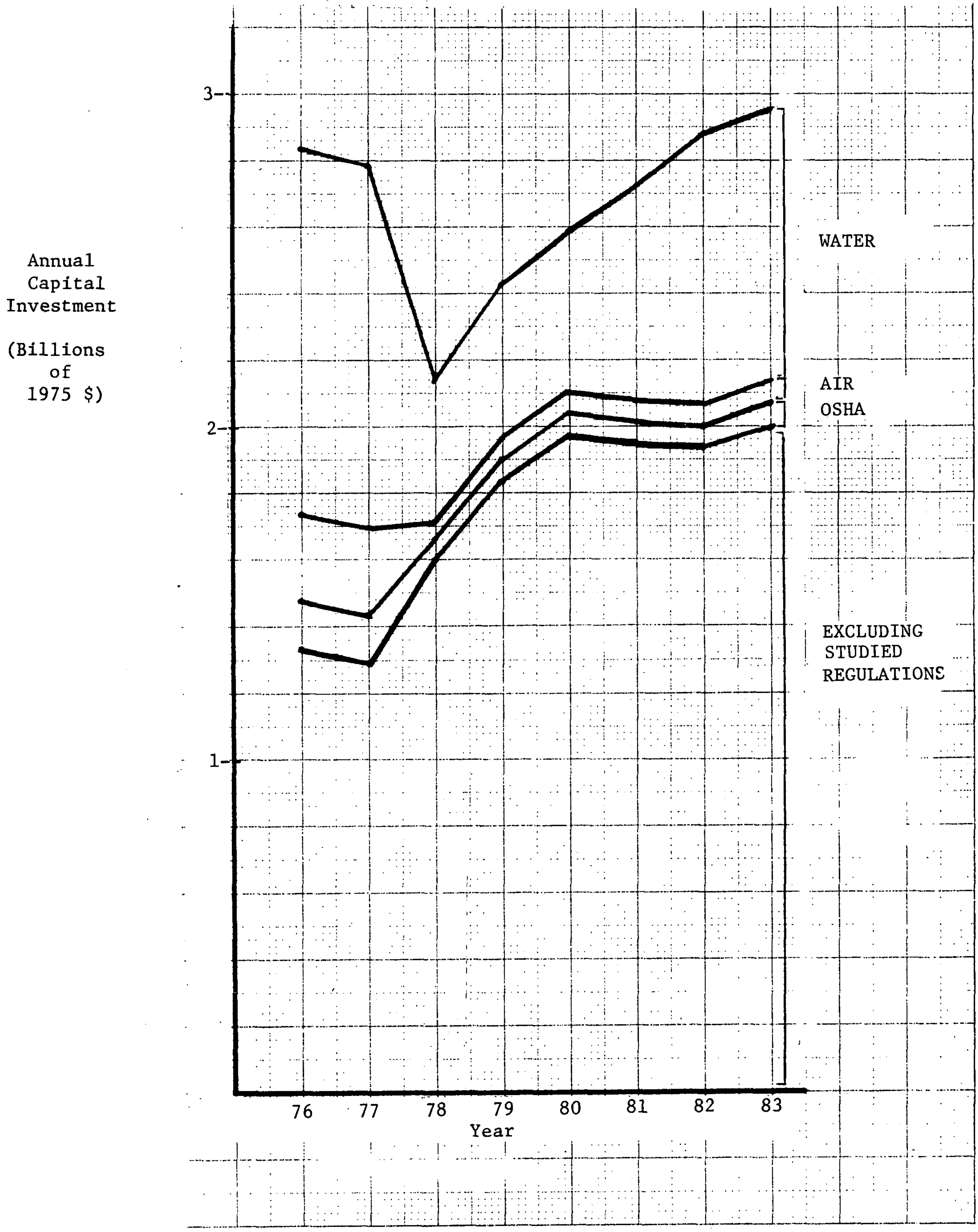
Figure VI-2, which summarizes the analysis, indicates that compliance with the studied regulations will require more than double the industry's capital investment in comparison with the investment which would be needed in the absence of these regulations during 1976 and 1977, and will require an increase of 35-50% during the period 1978-1983. The marked deviation of the curve that includes water effluent control requirements from parallelism with those that include only noise and air regulations is caused by the additional investment required to replace the capacity of plants projected to close because of their inability to comply with water effluent control regulations.

2. External Financing Requirements

The need for external financing in an intrinsically profitable enterprise arises from the inevitable lag between the time when expenditures on physical plant must be made and the time when gross profits produced by sales of the plant's output are available to defer the investment costs. In an ongoing enterprise, the magnitude of the external financing necessary to support further investment is usually less than the total investment level because of the availability of internally generated funds produced by the existing business. Further, the roles played by internally and externally generated funds are conditioned by the price and output relationships extant in the market faced by the enterprise.

FIGURE VI-2

CAPITAL INVESTMENT REQUIREMENTS OF THE U.S. PULP, PAPER AND PAPERBOARD INDUSTRY 1976 - 1983



a. Methodology

Arthur D. Little developed a financial model of the U.S. pulp and paper industry (excluding woodlands and converting operations) which incorporates the above considerations. The model operates through the creation of consistent annual sets of balance sheets, income statements, and flow-of-funds statements. The model provides for both equity and debt financing, but raises equity only when a specified debt/equity limit is exceeded. Numerous industry spokesmen and financial analysts have indicated that the paper industry is currently as highly leveraged as possible; therefore, the model set the debt/equity limit at the actual 1975 level. All analyses employed constant 1975 dollars.

The model utilizes five major types of data to determine the level of external financing required when the industry achieves equilibrium price and output levels:

- the financial parameters of the industry as it existed at the end of 1975;
- forecast investment requirements;
- forecast operating parameters of the industry;
- forecast price/quantity relationships; and
- required rate of return on equity.

The general procedures used to develop these data are described below.

(1) Financial Parameters of the Existing Industry The starting point for the analysis was a composite of the financial statements for the period 1966-1975 of the 32 major pulp and paper producers whose business activities are highly concentrated in primary pulp and paper production. These financial statements were then adjusted to eliminate woodlands operations, converting operations (except for tissue), merchant sales (jobbing), and other businesses unrelated to pulp and paper manufacturing. The adjustments were performed using financial ratios available from the FTC/SEC Quarterly Reports for Manufacturing Companies, Dun and Bradstreet Reports, annual financial reports, and Arthur D. Little industry expertise. The resulting "clean" financial statements for the composite were then scaled up by the ratio of total U.S. primary pulp and paper sales to the sales of the 32 company composite to produce pro-forma financial statements for the total U.S. primary pulp and paper sector. These pro-forma statements were then used:

- To establish an initial balance sheet for the industry which defined:
  - The initial equity base against which rates of return were measured;
  - The initial level of assets and the appropriate depreciation schedule; and
  - The initial level, maturity structure, and embedded interest cost of long-term debt.
- To determine the financial policies reflected in the balance sheet which should be used as ongoing constraints, including:
  - The debt/equity ratio of the industry; and
  - The relationships of the working capital accounts (including cash, receivables, inventories, and accounts payable) to the level of activity of the industry.

- To ascertain the cash operating costs of the existing industry, including:
  - — Manufacturing cost; and
  - — General, sales, and administrative expense.
- To establish the reinvestment behavior of the industry as reflected in its dividend payout policy.

(2) Forecast Investment Requirements. Capital investment requirements were developed as described above. In addition, incremental working capital requirements were forecast using the relationships determined by analysis of the historic financial statements.

(3) Future Operating Parameters of the Industry. In estimating the operating parameters of the industry in the forecast period, Arthur D. Little took into account changes in operating costs attendant upon the introduction of new equipment. Future manufacturing costs were computed as the weighted average of the costs corresponding to the existing industry and the costs developed in the new mill models. Because insufficient data were available to construct unit manufacturing costs for the existing industry on a product sector basis, all sectors were treated collectively for the existing industry, and the existing industry's unit cost was weighted in each year in proportion to the amount of 1975 capacity still in place. The unit operating costs for new mills were weighted sector by sector in proportion to the amount of new capacity installed on a replacement or incremental expansion basis.[3] The absolute level of costs was established separately for fixed and variable cost components. Fixed costs were determined by multiplying unit fixed cost by capacity in place; variable costs were determined by multiplying unit variable cost by tonnage produced.[4]

(4) Forecast Price/Quantity Relationships. An econometric model of aggregate U.S. demand for pulp and paper products was used to project sales volumes (described in Chapter IV). Final production tonnage and product price were estimated using an iterative process with the following steps:

1. Industry production tonnage was forecasted on the basis of average 1975 prices.
2. The industry's financial performance was forecasted using product price as a parameter which was varied until the internal rate of return on equity achieved its target value. (See below.)
3. A new forecast of industry tonnage at the forecast price was carried out, and steps 2. and 3. were repeated until the price projected using the rate-of-return criterion equalled the price assumed in the production tonnage forecast. This price increase was assumed to occur in 1976.

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3. This weighting procedure is tantamount to assuming uniform operating rates in all product sectors, which is an adequate approximation for present purposes.
4. Because of recent shifts in the real levels of operating costs and changes in the scale of production in the industry, the use of regression methods to extract fixed and variable cost components from the historic time series appeared unreliable. Hence, the split between fixed and variable cash manufacturing costs for the existing industry was assumed to be the same as the capacity-weighted average split corresponding to the new mill models, and existing industry costs were based solely on 1975 results.

The aggregate funds flow model estimate of the price that will prevail over 1976-1983 reflects the cost for new capacity. This additional increase in price brings with it an additional decline in the quantity demanded.

Under average conditions, an additional price increase of $13/ton will be needed to cover the cost inflation for new capacity and the environmental control equipment already in place, if the industry is to earn its required cost of capital. Figure VI-3 presents average industry operating rates obtained under these conditions, and indicates that peak operating rates would not rise above 85%. These operating rates are the result of adjusting the demand forecast from the demand equation and the Chase Econometrics scenario for 1976-1983 price increases, assuming the price increases occur in 1976.

Variations in demand and capacity growth will lead to higher operating rates. Under the most unfavorable conditions from the point of view of capacity pressure, i.e., high demand growth and low capacity growth, the expected average prices are $298/ton without and $314/ton with the studied regulations, compared to the 1975 average price of $292/ton. These lower price increases compared to those expected under mid-range conditions reflect the lower level of capital investment which must be supported by operating margins and the lower unit fixed costs corresponding to higher output levels. Figure VI-3 shows the corresponding operating rates and indicates that while demand is less retarded by price than under mid-range conditions, peak operating rates are not realized until 1982-1983.

(5) Required Rate of Return/Cost of Capital Assumption. The determination of the rate of return required by the pulp and paper industry is extremely difficult. To assure standard methodology, EPA provided an estimate of the cost of equity capital to the industry developed by Professor Gerald Pogue[5] based on the capital asset pricing model. While Professor Pogue's projections incorporate annual variations in the cost of capital, Arthur D. Little's analysis was performed using the average value of about 13% which prevailed both during the historic and forecast periods in Dr. Pogue's analysis.

This simplification was made for two reasons. First, most of the annual variation in the equity cost forecasts was produced by fluctuations in risk-free rate assumptions caused in turn by assumed variations in inflation rates which are excluded from the Arthur D. Little model. Second, the remaining variation was produced by assumptions concerning the rate of return on the market portfolio, which are of questionable reliability.

Arthur D. Little believes that use of a constant cost of equity capital had no material impact on its ultimate conclusions. However, three other issues must also be addressed to understand Arthur D. Little's use of Professor Pogue's estimates.

The first is the question of book vs. market values. Professor Pogue's analysis was quite properly based on the market value of the industry's equity, whereas Arthur D. Little's analysis is based on an estimate of the book value of equity. Arthur D. Little did not adjust its equity

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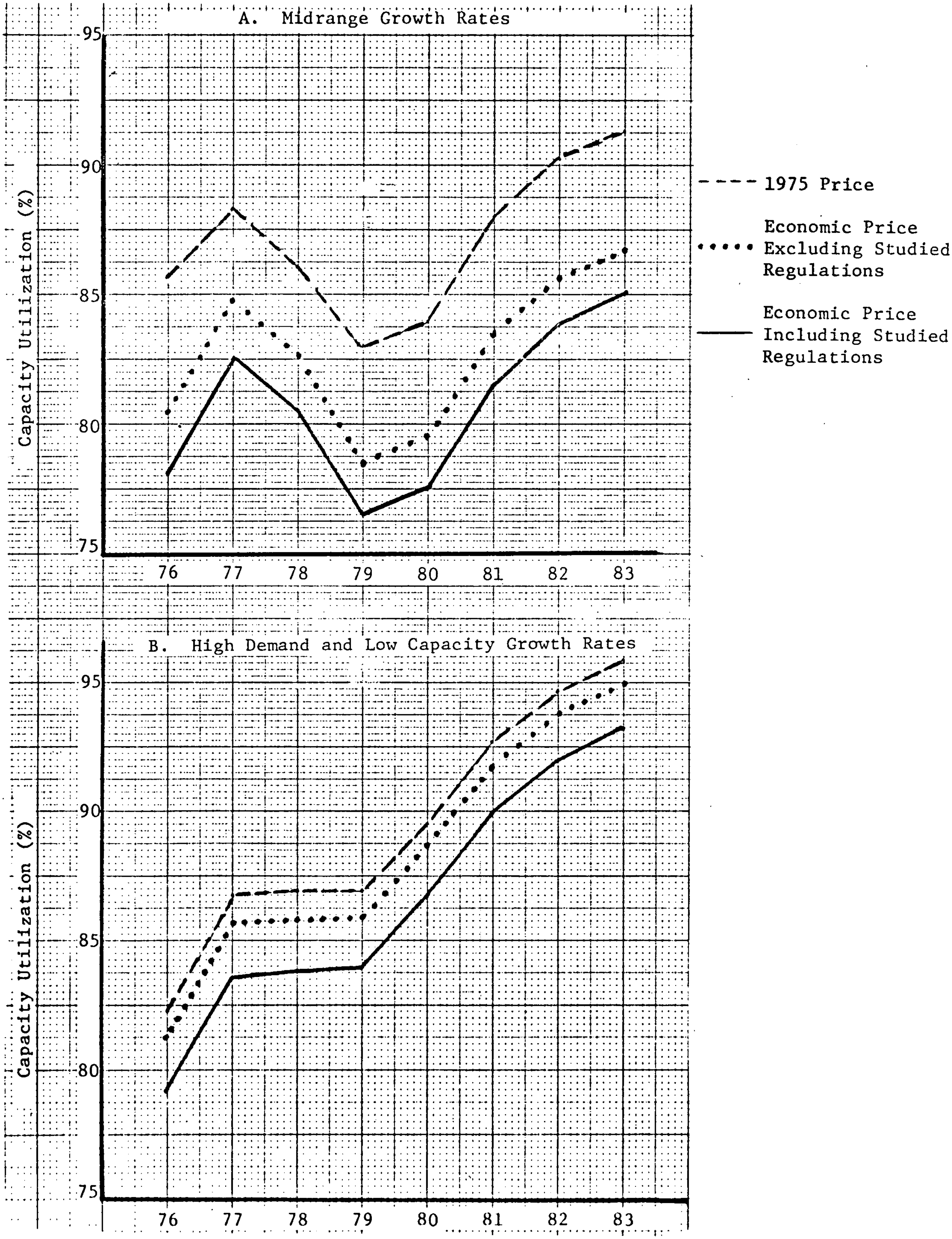
5. Dr. Gerald A. Pogue, *Estimation of the Cost of Capital for Major United States Industries*, 1975.

FIGURE VI-3

FUNDS FLOW MODEL
IMPACT ON OPERATING RATES OF STUDIED REGULATIONS



estimate because the market value of the industry's equity has fluctuated both above and below book value, and Arthur D. Little was unable to identify any criterion to select one market value as most appropriate to a long-run analysis. Further, Arthur D. Little's experience in working with management in numerous industries suggests that management decisions on pricing, investment, and related matters are frequently based on book rather than market values, and are not altered directly as a result of fluctuations in the market price of the firm's securities.

The second issue is the impact of Arthur D. Little's constant dollar assumptions. Economic theory teaches that the cost of capital can be represented as the sum of three terms: the pure time value of money, which measures the investor's preference for present consumption over future consumption; the inflation premium, which measures the investor's requirements for maintenance of the purchasing power of future returns; and the volatility premium, which measures the investor's price for assuming the risk of an uncertain future return. The sum of the first two terms constitutes the so-called "risk-free rate," which can be measured directly by the yield on short-term government securities or indirectly by the intercept of the capital asset pricing model regression equation. But it is not possible to measure the two components of the risk-free rate separately, and an attempt to simply subtract the realized rate of inflation from the risk-free rate to estimate the pure time value of money during the 1970's leads to negative values, which contradict both economic theory and common sense. Since no valid theoretical guide to performing a more sophisticated adjustment exists, Arthur D. Little made no adjustment for the elimination of inflation from its forecasts.

The third and most important issue is the questionable validity of using the results of the capital asset pricing model to establish a rate of return target for internal investment decisions by the firm or industry. This threshold issue is very much an open question in the finance and economics literature. The capital asset pricing model focuses only on the non-diversifiable risk of a stock market investment, and completely ignores the intrinsic or diversifiable risk. While this position may be reasonable for the holder of a fully diversifiable portfolio, it is difficult to assert that a prudent business entity should ignore any major element of business risk in deciding upon its own investments. Further, estimating the parameters of the capital asset pricing model from historic data implicitly assumes that the business environment has not recently changed enough to change the investor's risk expectations. Despite these and similar limitations, Arthur D. Little used the same return on equity as indicated by the capital asset pricing model results because it is consistent with the historic rates of return realized by the industry. Also Arthur D. Little did a sensitivity analysis of the capital and financing requirements using both higher (18% and 15%) and lower (9%) costs of capital to the industry.

b. Results

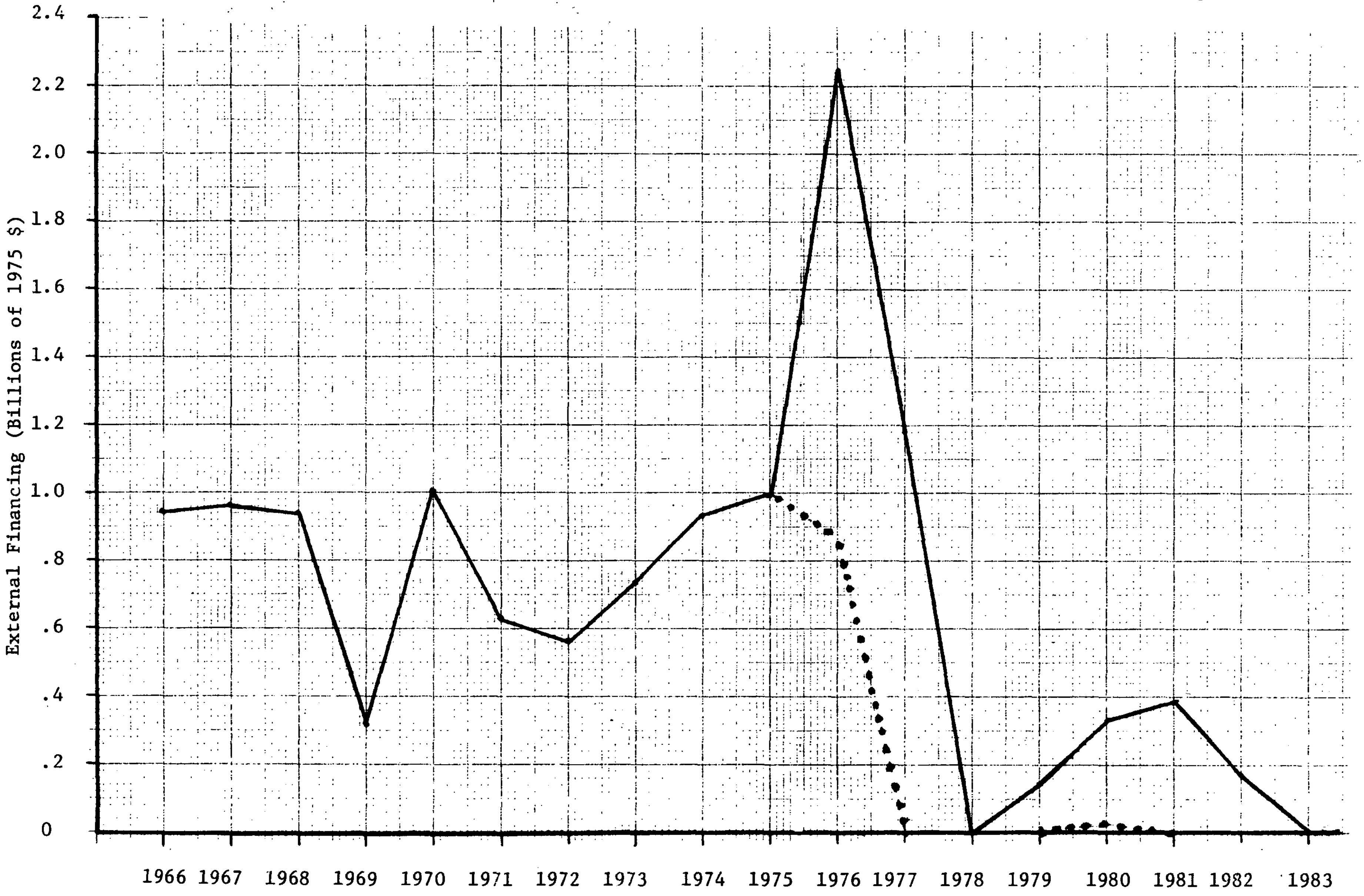
Figure VI-4, which presents the historic and projected annual external financing requirements of the industry in constant 1975 dollars over the period 1966-1983, indicates that the external financing requirements of the industry will be substantially increased in absolute terms by compliance with the studied environmental regulations. During 1976 and 1977, external financing will greatly exceed the annual levels required by the industry during any of the past ten years. However, the figure also indicates that *very high requirements for external financing do not persist beyond 1977;* in fact, annual external financing requirements during the period 1978-1983 should be significantly below their historic level. This conclusion flows from the assumption that the industry's realized rate of return will be equal to its required target rate of return. To the extent that capital market considerations are not fully reflected in the industry's pricing decisions, this conclusion could, of course, be altered.

FIGURE VI-4

EXTERNAL FINANCING REQUIREMENTS OF THE
U.S. PULP AND PAPER INDUSTRY
HISTORIC AND PROJECTED (MIDRANGE FORECAST)

•••••• Excluding Studied Regulations

——— Including All Studied Regulations



Despite the fact that the near-term external financing requirements of the industry are higher than their historical levels in absolute terms, they are not particularly high in the context of the overall rate of external financing in the private sector of the economy. Figure VI-5 presents the value of total annual corporate financing in the U.S. economy over the period 1966-1983 in constant 1975 dollars,[6] and Figure VI-6 presents the ratio of pulp and paper industry annual external financing to the U.S. corporate total for the same period. Figure VI-6 indicates that even when all environmental controls are included, the share of all corporate financing represented by pulp and paper industry financing is only about 3.8% in the year of highest demand (1976), which is not much higher than the industry's share of 3.2% achieved in 1966. Further, in 1977, the pulp and paper share drops to about 1.8%, and in the period 1978-1983 never exceeds 0.5%. The problems of raising large amounts of capital funds can be substantial, and vary from company to company. However, the analysis indicates that, in the aggregate and assuming free market pricing, the imposition of environmental controls will not require the industry to place relative demands on the capital markets significantly greater than it has in the past.

C. SENSITIVITY ANALYSIS

The results discussed in the preceding sections of this chapter have been based on central estimates of the rates of capacity and demand growth, the cost of equity capital, the cost of compliance with environmental regulations, and the actual compliance schedule. None of these quantities is known with absolute certainty. Therefore, Arthur D. Little carried out additional analyses to ascertain whether reasonable variations in any of these quantities would lead to significantly different conclusions.

Because of the complexity of the interactions among the various assumptions, it was not possible to consider all possible assumption combinations. Therefore, the analyses were performed by varying one class of assumptions at a time, holding all other quantities at their central values. Table VI-2 summarizes the impacts of variations in the assumptions on projected product prices, investment levels, and external financing requirements.

1. Sensitivity to Growth Rate Assumptions

Because in Arthur D. Little's model, the rate of capacity growth is an exogenous variable, the level of capital investment is insensitive to the assumed rate of growth of demand. In contrast, the level of external financing requirements depends jointly on both the capacity and demand growth rates because of the dependence of internal funds generation on price achieved and quantity sold.

Figure VI-7 sets forth the ranges of annual capital investment requirements of the industry corresponding to the capacity growth assumptions set forth in Chapter IV, Table IV-17. (Note that the capital investment requirements of the industry during the period 1977-1978 depend on variations in growth rates beyond 1979 because of the lead time for construction expenditures.)

6. The values for the historic period 1966-1975 are based on Standard and Poors Corporate statistics, adjusted by the GNP implicit price deflator. The values for the period 1976-1983 are based on a regression model described in Appendix I and on the Chase Econometrics CEQ forecasts of interest rates, corporate profits, and gross private fixed non-residential investment.

FIGURE VI-5

EXTERNAL CORPORATE FINANCING IN THE U.S. ECONOMY
HISTORIC AND PROJECTED (CEQ FORECASTS)

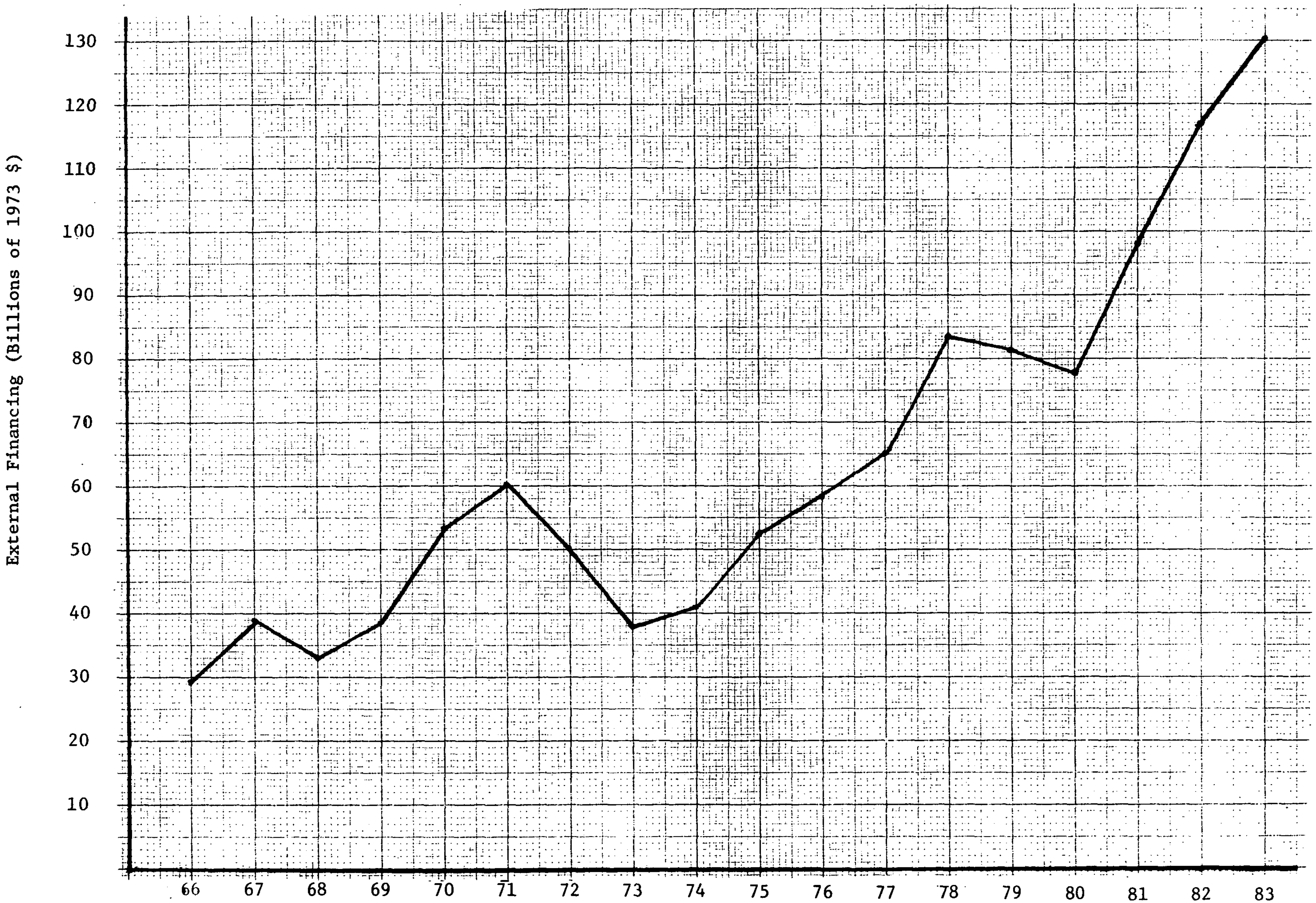


FIGURE VI-6

EXTERNAL FINANCING REQUIREMENTS OF THE U.S. PULP AND PAPER INDUSTRY
AS A PERCENT OF ALL CORPORATE EXTERNAL FINANCING
HISTORIC AND PROJECTED (MIDRANGE FORECAST)
(Including all Studied Regulations)

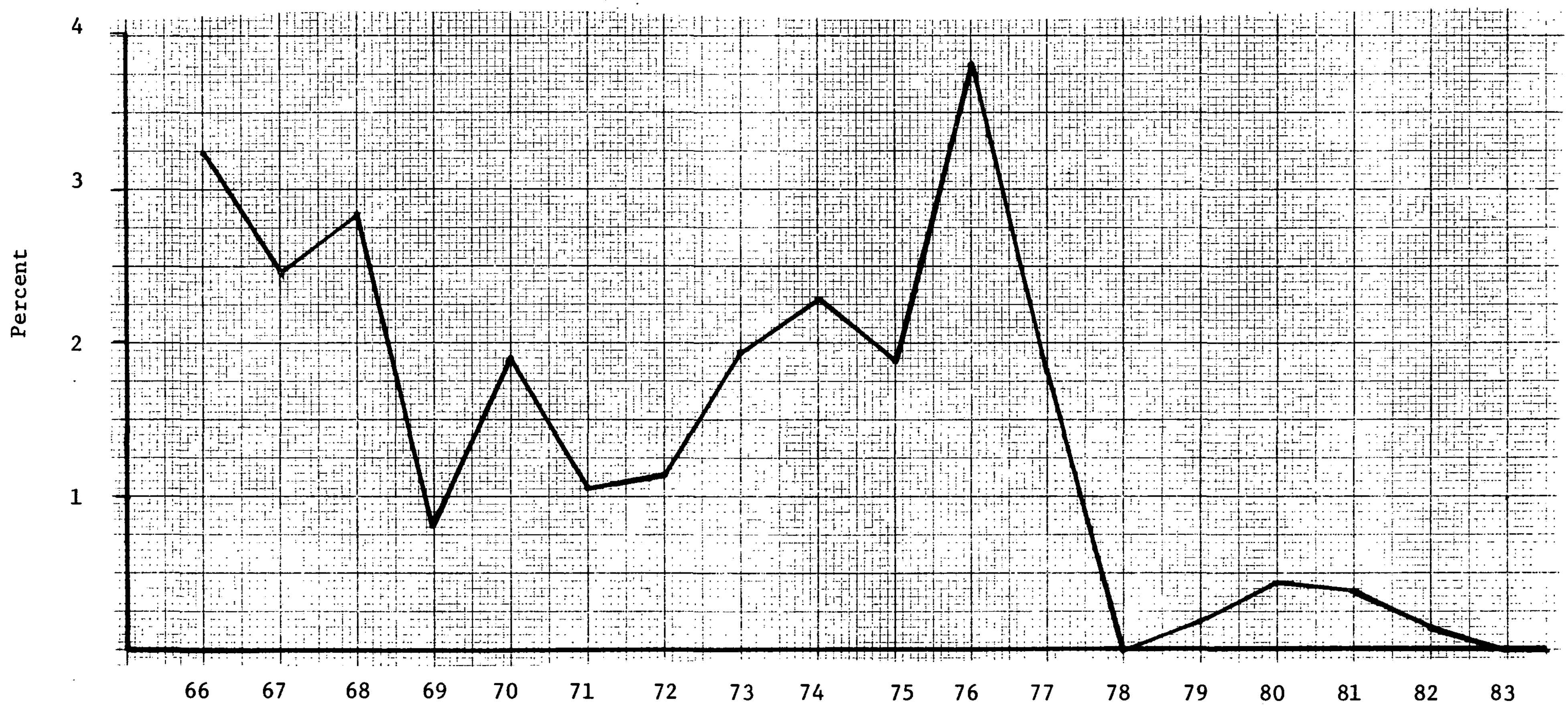


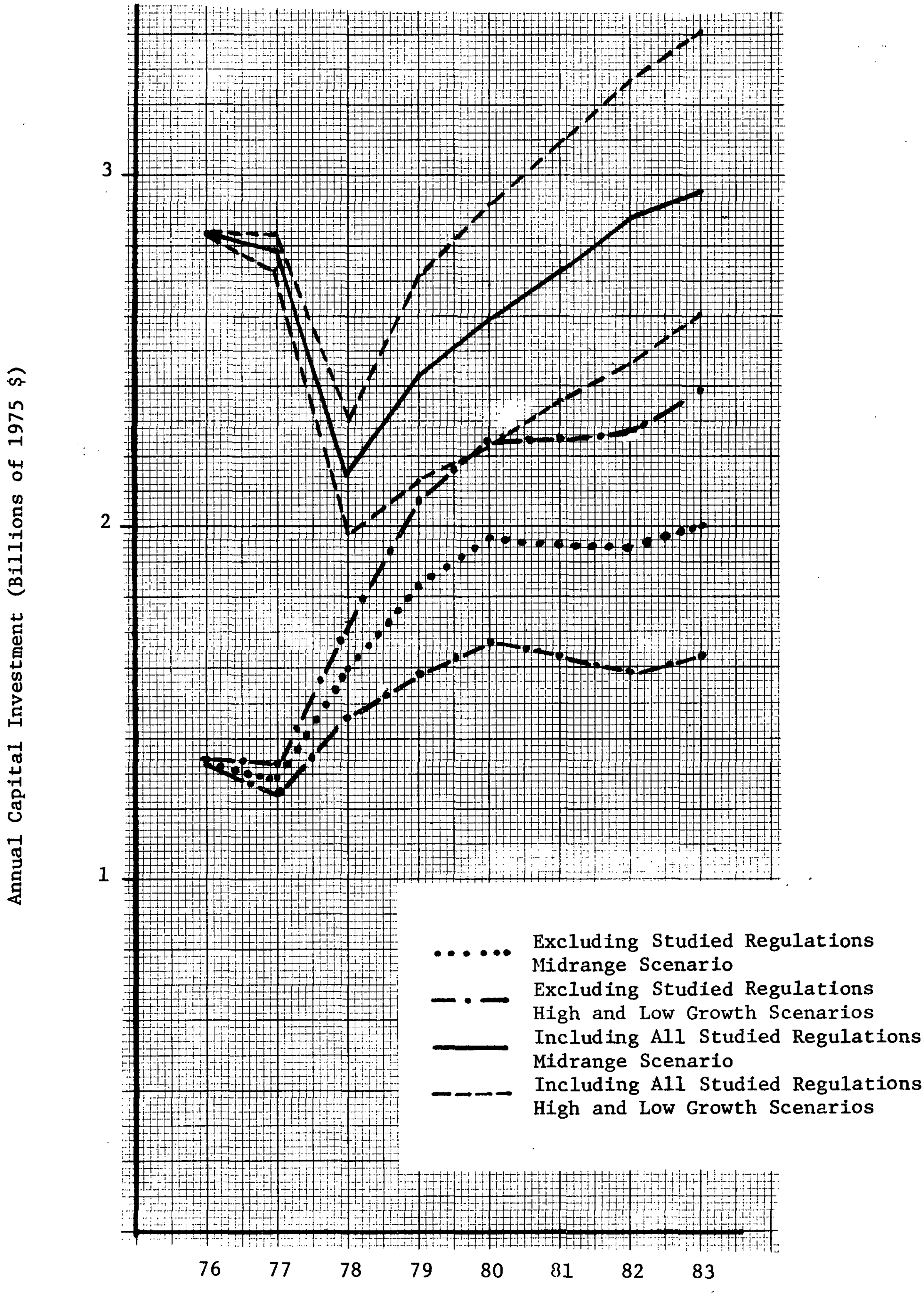
TABLE VI-2

SENSITIVITY OF PROJECTION TO VARIATIONS IN ASSUMPTIONS
(1975 Dollars)

CENTRAL VALUES		Price/ton	Total Investment 1976-1983 ($ Millions)	Total External Financing ($ Millions)
Without Studied Regulations		$305	$13,927	894
With noise regulations only		306	14,604	1,065
With noise and air emissions regulations		308	15,517	1,543
With all studied regulations		322	21,343	4,450
RANGES (With all studied regulations)				
Cost of Compliance:	High	327	22,938	5,416
	Low	320	20,426	3,947
Demand Growth/Capacity Growth:				
High /	High	317	23,370	6,318
High /	Low	314	19,239	3,545
Low /	High	324	23,370	6,317
Low /	Low	321	19,239	3,422
Cost of Equity Capital				
18%		353	21,343	2,694
15.5%		337	21,343	3,358
9%		301	21,343	6,893
Compliance Schedule				
1977 expenditures extended to 1980		320	21,931	5,381

FIGURE VI-7

SENSITIVITY OF CAPITAL INVESTMENT REQUIREMENTS TO ASSUMED CAPACITY GROWTH



The figure indicates that:

- Under high growth rate assumptions, total industry capital expenditures over the eight-year forecast period would be about $23.4 billion (compared to the midrange estimate of $21.3 billion), of which about $7.7 billion (compared to the midrange estimate of $7.4 billion) would be attributable to environmental controls.
- Under low growth rate assumptions, total industry capital expenditures over the forecast period would be about $19.2 billion, of which about $7.1 billion would be attributable to environmental controls.

The consequences of these possible variations in investment requirements under various demand growth assumptions[7] are set forth in Figure VI-8 which indicates that:

- Under high capacity growth rate assumptions, the external financing requirements of the industry over the eight-year forecast period, including compliance with all environmental regulations, would be about $6.3 billion (compared to the midrange estimate of $4.5 billion), irrespective of the assumed rate of growth in demand.
- Under low capacity growth rate assumptions, the external financing requirements of the industry would be about $3.5 billion assuming a high rate of growth in demand, and about $3.4 billion assuming a low rate of growth in demand.[8]

The range of total external financing requirements over the forecast period under the alternative growth scenarios is quite large in absolute terms. However, note that differences in growth rate assumptions have almost no impact on financing requirements during the period of highest relative financing demand (1976-1977), but have a significant impact in the period 1978-1983 during which the external financing load is relatively small.

Figure VI-9 presents the ranges of the share of all corporate external financing represented by pulp and paper financing. The level of all corporate financing is based on the Chase CEQ forecast, and so slightly underestimates total corporate financing under more expansive conditions; hence, the shares presented are conservative estimates, and would likely be somewhat lower in actuality. The figure indicates that, even assuming a high rate of capacity growth and compliance with all studied environmental controls, the annual level of external financing over the forecast period still does not indicate an unprecedented demand for funds.

2. Sensitivity to Cost of Compliance Estimates

As Chapter III points out, estimates of both capital and operating costs for compliance with the studied environmental control regulations are subject to the uncertainty inherent in all pre-engineering cost analyses. Arthur D. Little therefore analyzed the impact of the range of uncertainty discussed in Chapter III on investment and external financing demands. The limits used for both capital and operating costs both for the existing industry and new mills were:

7. The midrange demand growth estimates presented previously were based on a modification of the Chase Econometrics CEQ forecast developed by Chase assuming Federal action to mitigate the effects of a 1978 recession. The low demand growth scenario used in the analysis corresponds to the Chase CEQ macroeconomic forecast without the assumption of governmental intervention; the high demand growth scenario corresponds to a modified forecast developed by Chase assuming no recession in 1978.

8. This apparently paradoxical result is produced by the need to finance an increase in working capital to support higher sales levels under high demand growth assumptions.

FIGURE VI-8

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS
TO ASSUMED CAPACITY GROWTH AND DEMAND GROWTH

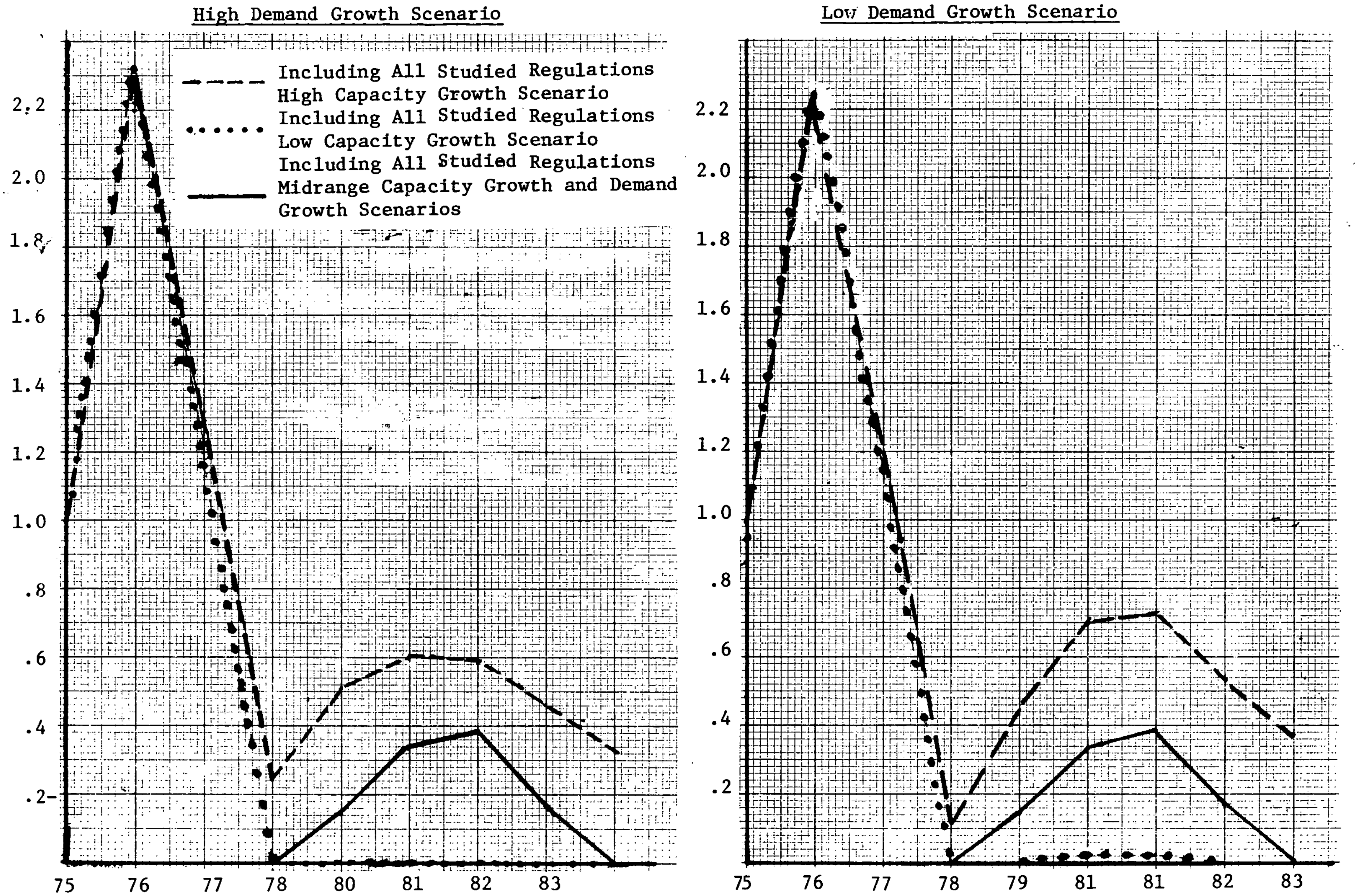
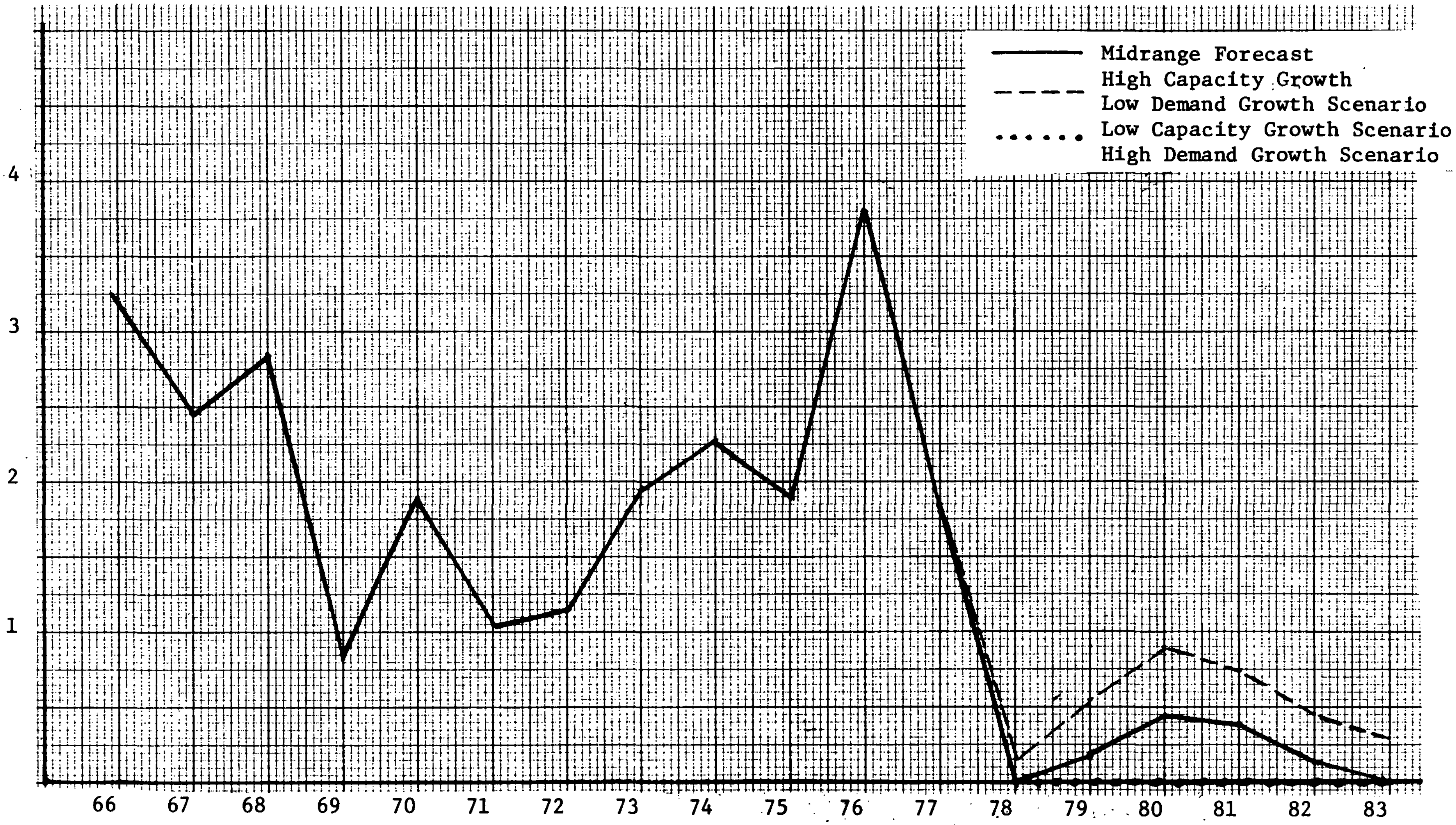


FIGURE VI-9

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS
AS PERCENT OF ALL CORPORATE EXTERNAL FINANCING TO ASSUMED CAPACITY GROWTH



- A high-side variation of 25% for OSHA noise regulations, SIP air emission control, and EPA water effluent guidelines; and
- A low-side variation of 10% for air and water effluent control, and of 50% for OSHA noise regulations.

Figure VI-10 presents the range of capital investment requirements corresponding to these limits, and indicates that:

- The total capital investment requirements of the industry over the eight-year forecast period, assuming midrange growth rates for capacity and demand, could vary between $20.4 billion and $22.9 billion (compared to the midrange estimate of $21.3 billion) depending on the realized level of compliance costs.

Figure VI-11, which sets forth the range of external financing requirements corresponding to the uncertainty in the cost of compliance, and Figure VI-12, which compares these requirements to the level of all U.S. corporate financing, indicate that:

- The total external financing requirements of the industry over the forecast period, assuming midrange growth rates for demand and capacity, could vary between $3.9 billion and $5.4 billion (compared to the midrange estimate of about $4.5 billion) depending on the realized level of compliance costs;
- The greatest impact of variations in compliance costs occurs during the period 1976-1977, as would be expected because of the large expenditures necessary during this period to bring the existing industry capacity into compliance with 1977 standards.
- The relative share of all corporate financing required by the industry could rise as high as about 4.3% (compared to a historic high of 3.2% and the midrange estimate of 3.8%) during the year of greatest financing demand.

3. Sensitivity to Cost of Capital Assumptions

As has been mentioned before, Arthur D. Little's analysis treated capacity growth as an exogenous variable, so the levels of capital investment requirements used are insensitive to the assumed cost of equity capital. However, the level of external financing needed by the industry does depend on capital cost, since the required rate of return influences pricing policy and thus the internal generation of funds.

The discussion of the cost of capital presented above describes the difficulty of estimating and deducting the inflationary expectations premium from the cost of equity capital. This implies that the cost of capital estimate used may be high when applied to an analysis which excludes general price inflation. However, a likely increase in investors' and industry participants' perceptions of the future riskiness of the industry more than offsets any tendency to overestimate the cost of capital.

In the context of Arthur D. Little's analysis, which abstracts from uncertainties about future changes in the real prices of the factors of production, there are two important new sources of perceived risk. In its external environment, the industry faces substantial uncertainties about the degree of direct and indirect governmental regulation and associated costs which will be

FIGURE VI-10

SENSITIVITY OF CAPITAL INVESTMENT REQUIREMENTS TO UNCERTAINTIES IN COST OF COMPLIANCE

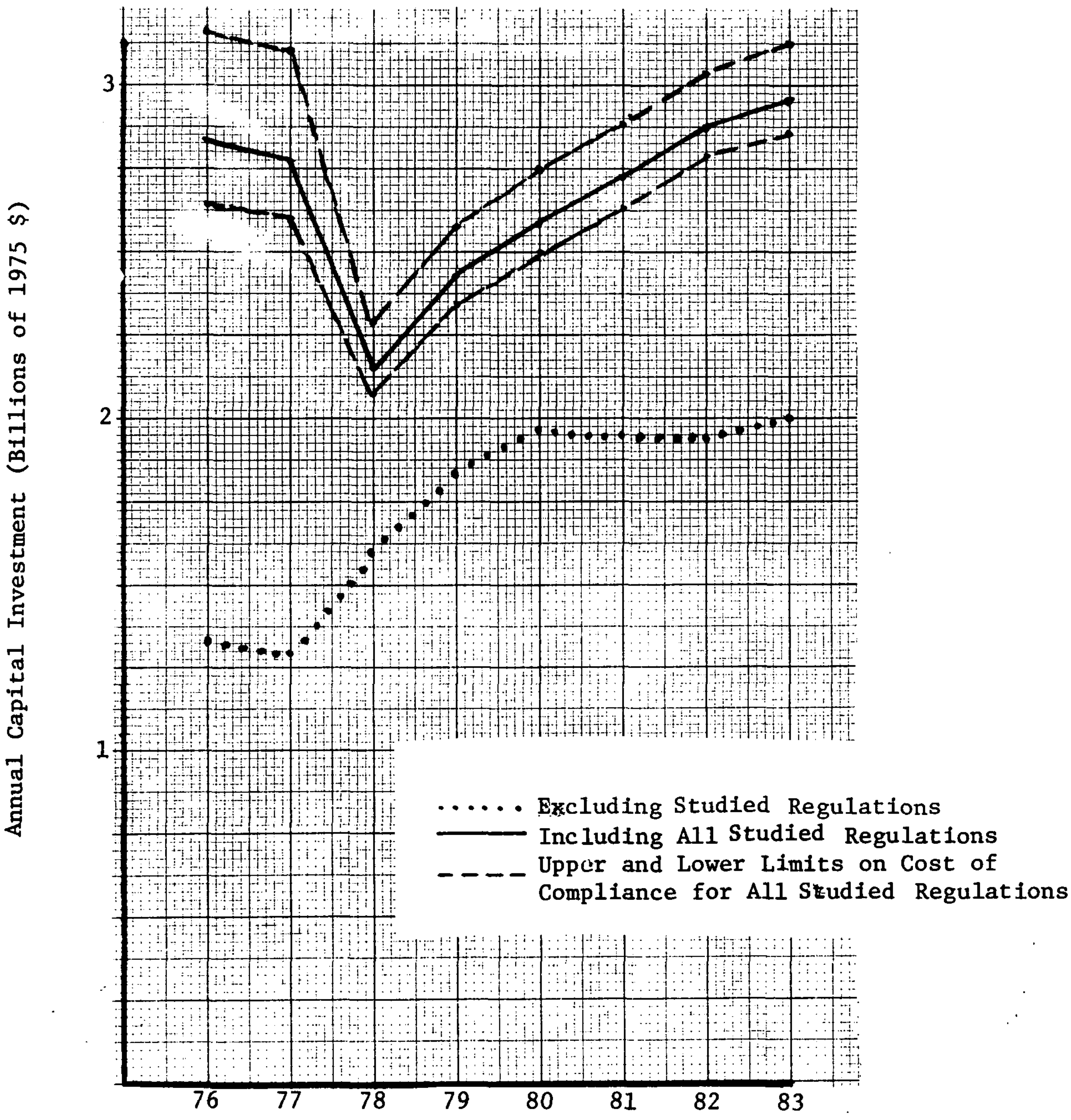


FIGURE VI-11

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS TO UNCERTAINTIES IN COST OF COMPLIANCE

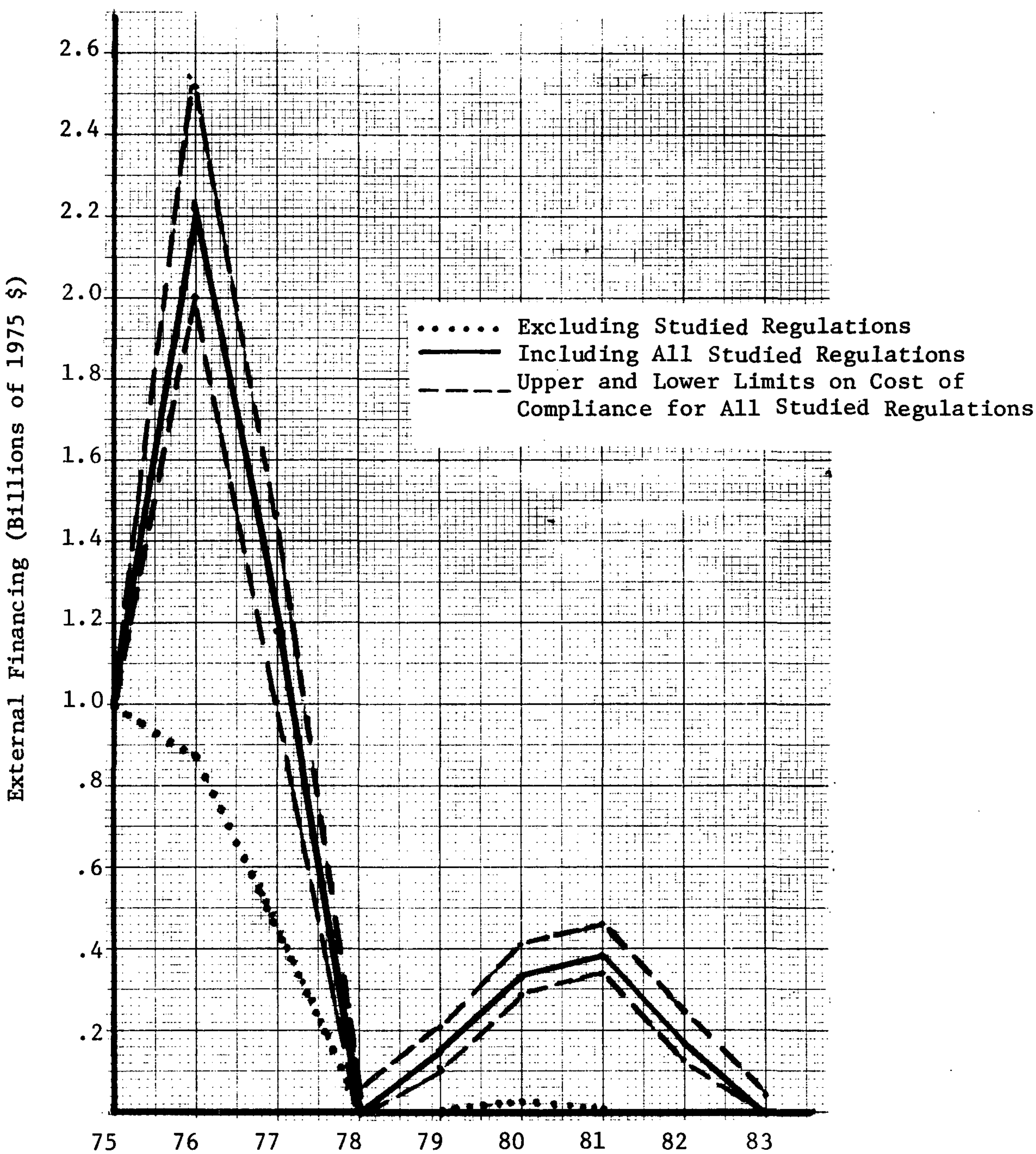
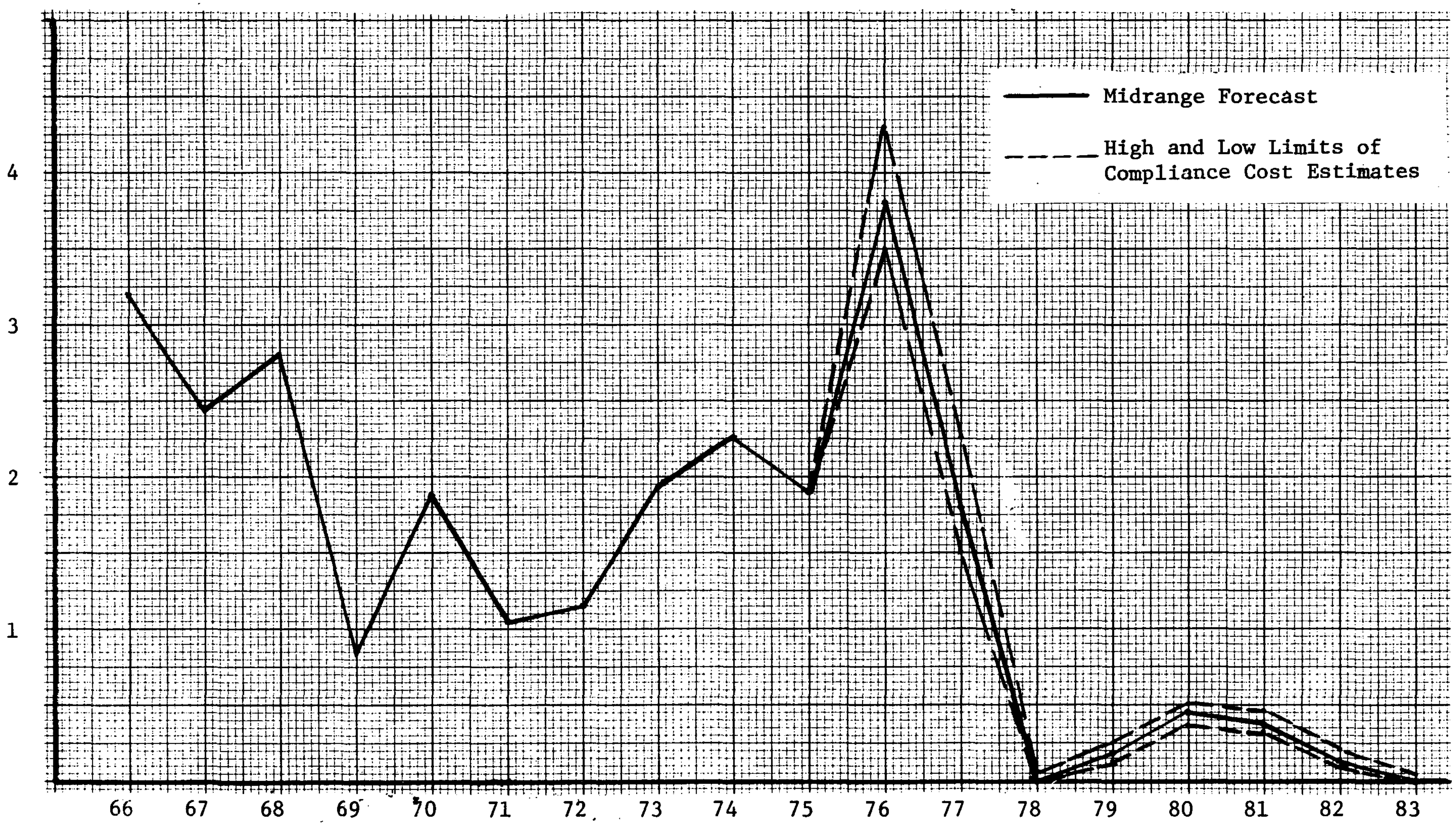


FIGURE VI-12

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS AS PERCENT OF ALL CORPORATE EXTERNAL FINANCING TO UNCERTAINTIES IN COST OF COMPLIANCE



imposed on it. In its internal environment, the industry is rapidly adopting a much larger scale of production than heretofore, which carries with it increased operating leverage risk and increased lead time to situate and install new capacity. In Arthur D. Little's judgment, these factors more than outweigh the inflationary expectations premium effect. Therefore sensitivity tests were made for upward variations in the cost of equity capital, assuming equity costs of 15.5% and 18% (compared to the standard estimate of 13%).

Despite the fact that the industry's cost of equity capital is likely to be higher in the future than in the past, the time frame in which the discipline of the capital markets will become effective on pricing policy is difficult to predict. Therefore, Arthur D. Little also considered the possibility that the rate of return on equity realized by the industry may be below its indicated target level. In order to determine a reasonable lower bound for such a realized return, the historic book return on equity for the pulp, paper, and paperboard sector of the industry was examined. Figure VI-13 presents the realized level of return on equity for the period 1966-1975, and indicates that the ten-year weighted average return was 8.8%. While the time series is extraordinarily volatile, the historic average level constitutes a floor on the average realized return that can reasonably be expected over the period 1976-1983. Accordingly, a sensitivity test was performed assuming an equity cost of 9%.

Figure VI-14 sets forth the results of these analyses, and indicates that:

- As the cost of equity capital increases, the external financing requirements of the industry decrease substantially, falling from about $6.9 billion at 9% to $4.5 billion at 13%, to $3.4 billion at 15.5% and to $2.7 billion at 18%. However, the absolute differences in required external financing levels are spread uniformly over the entire period, and are most pronounced on a relative basis in the period 1978-1983 during which external financing requirements are low in absolute terms.

Figure VI-15 compares these external financing requirements to total U.S. corporate financing, and indicates that:

- Irrespective of the assumed cost of equity capital, the peak levels of external financing as a percentage of all corporate financing slightly exceed the historic high. However, the average level of financing over the entire period 1976-1983 compared to all corporate financing is lower than the historic average.

4. Sensitivity to Compliance Schedule Assumptions

All the analyses described thus far in this chapter have assumed strict adherence to the promulgated 1977 and proposed 1983 water regulation deadlines. However, as has been noted elsewhere in this report, industry contacts indicate that the 1977 deadline will not be met by some firms. Therefore, Arthur D. Little has examined the impact of shifting BPT expenditures forward to 1980. In performing this analysis, Arthur D. Little has adjusted the incremental capital cost for bringing the existing industry into compliance based on its *actual* 1975 and planned 1976-1977 expenditures, and has delayed all closures induced by 1977 water effluent standards to 1980. Figure VI-16 compares the capital investment requirements of the industry under the modified and original compliance schedules, and indicates that:

FIGURE VI-13

PRO-FORMA BOOK RATES OF RETURN ON EQUITY
FOR THE U.S. PULP, PAPER AND PAPERBOARD INDUSTRY
FOR THE PERIOD 1966 - 1975

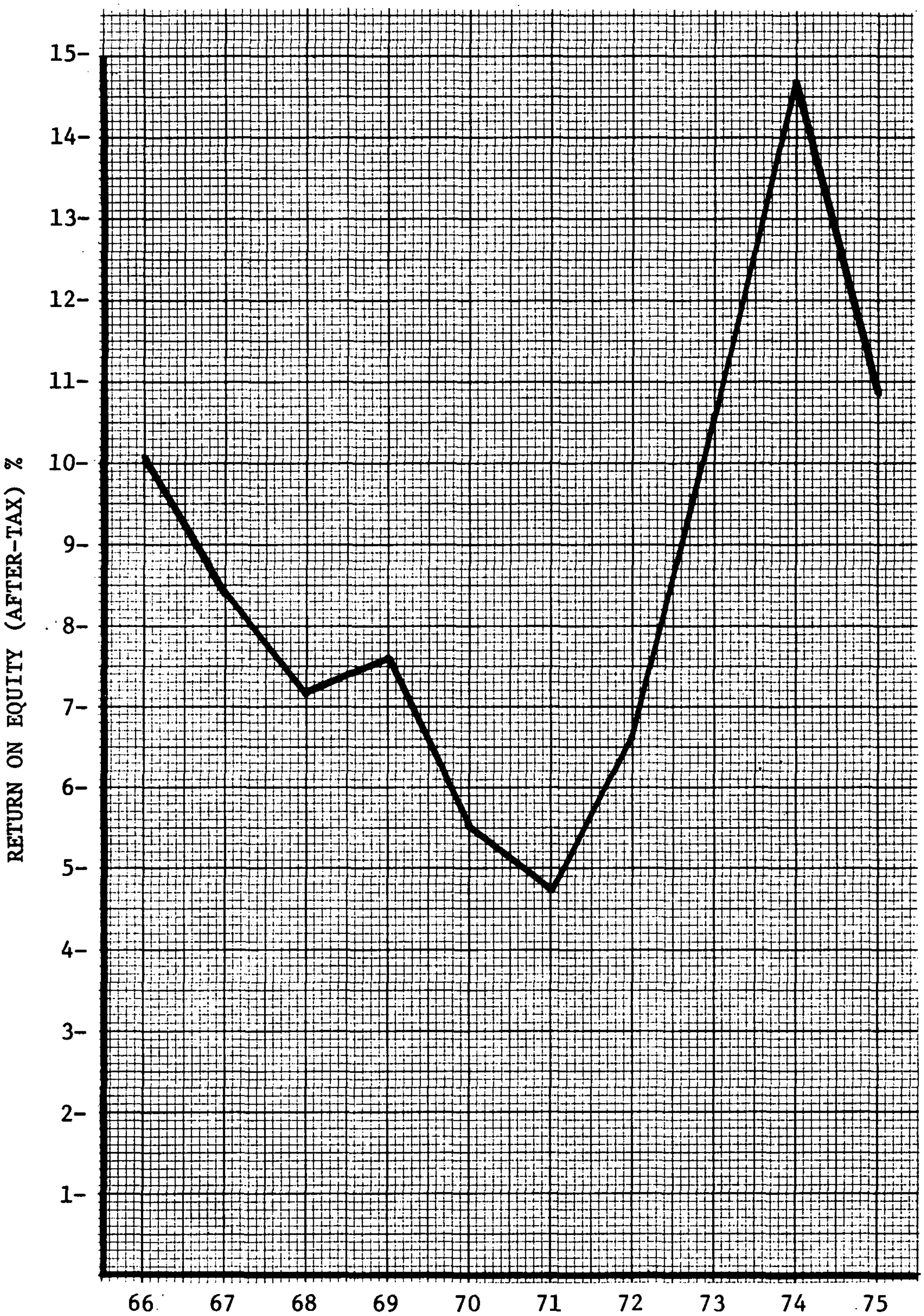


FIGURE VI-14

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS
TO ASSUMED COST OF EQUITY CAPITAL

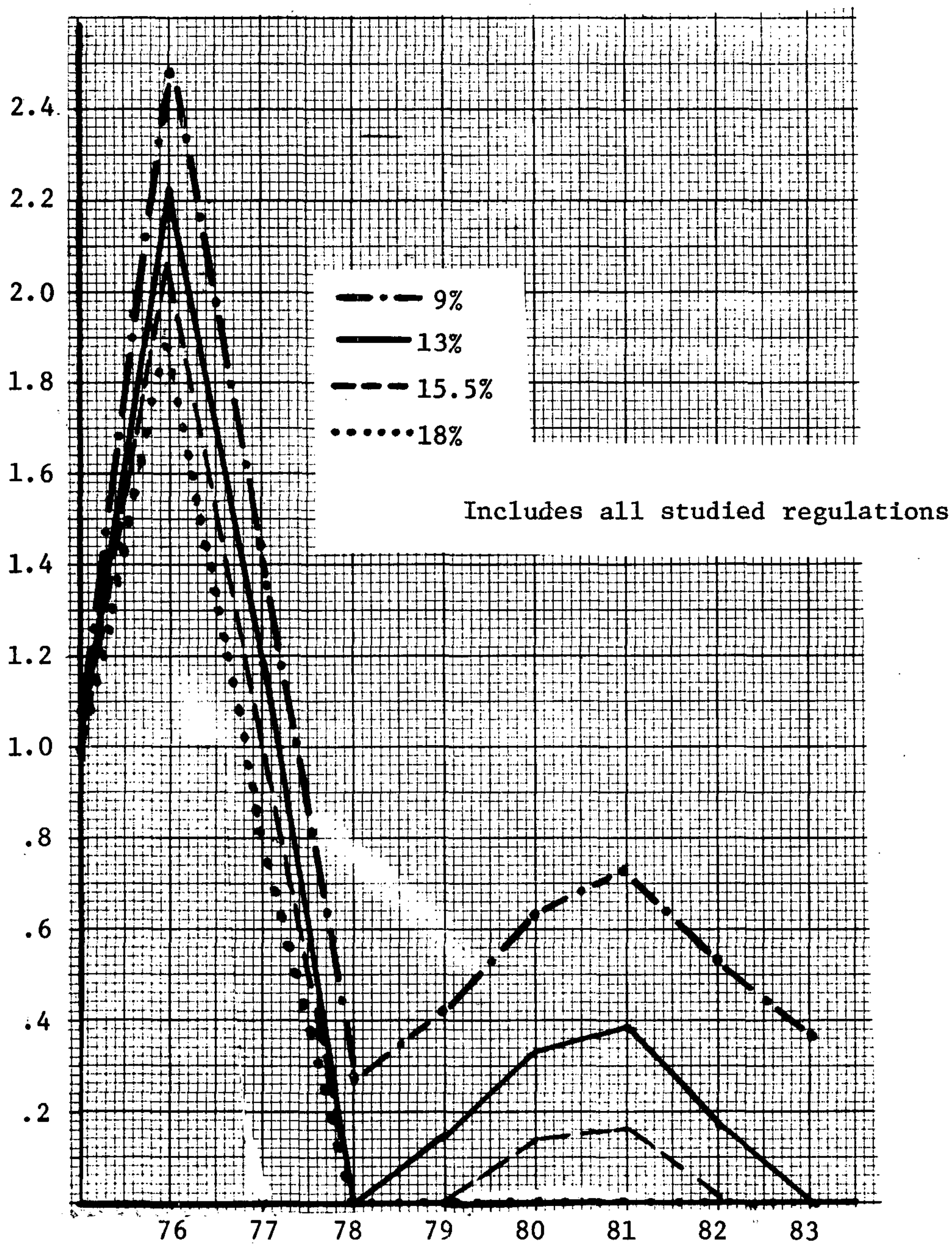


FIGURE VI-15

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS AS PERCENT OF ALL CORPORATE EXTERNAL FINANCING TO ASSUMED COST OF EQUITY CAPITAL

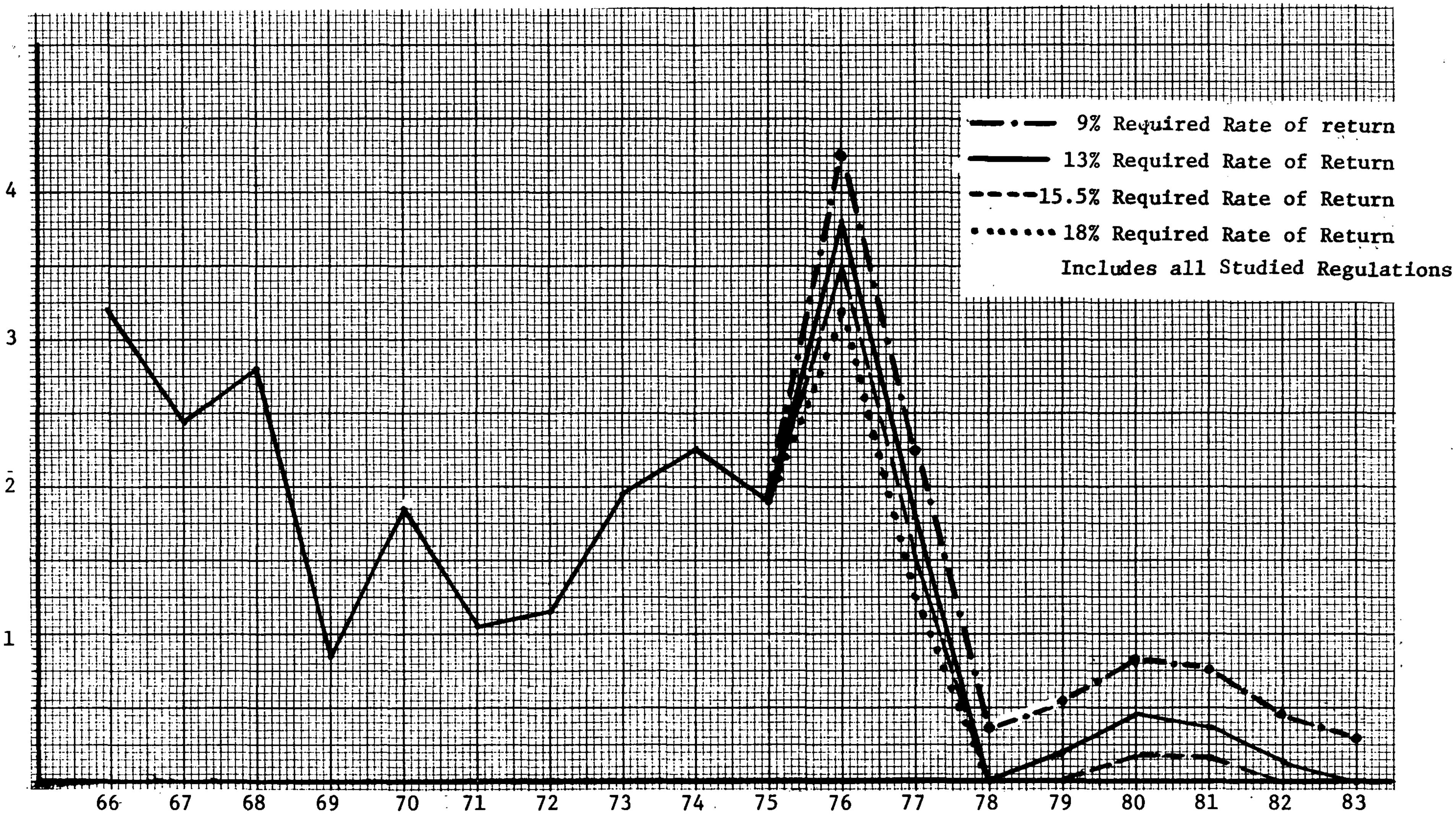
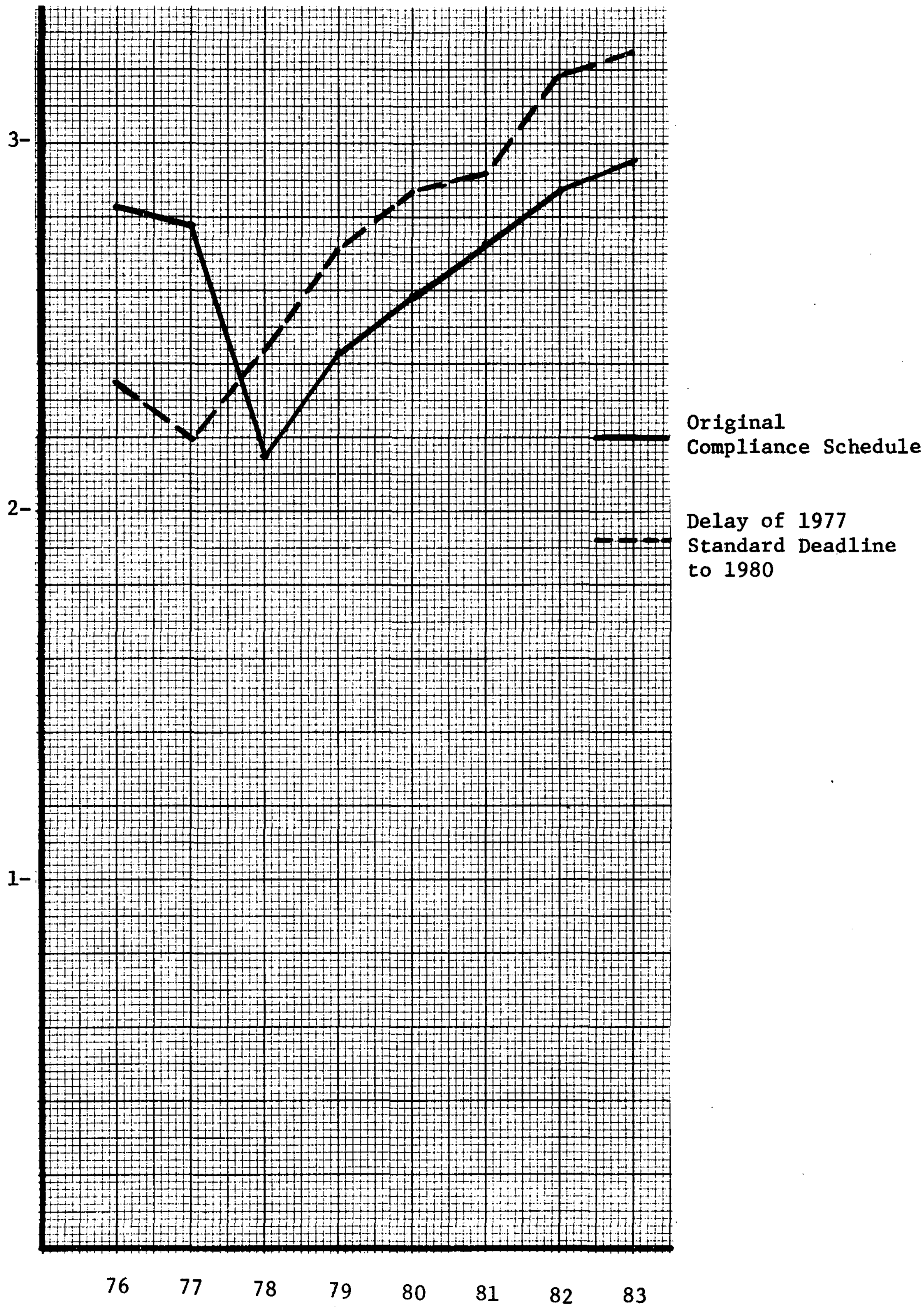


FIGURE VI-16

CAPITAL INVESTMENT REQUIREMENTS OF THE
U.S. PULP, PAPER, AND PAPERBOARD INDUSTRY UNDER
ALTERNATIVE COMPLIANCE SCHEDULES
1976 - 1983



- The incremental investment requirements to comply with all studied standards is about $8.0 billion (compared to the midrange estimates of $7.4 billion) because of the lower amount of 1975 compliance investment reported by the industry.
- Deferring implementation of the promulgated 1977 standards to 1980 would substantially reduce investment requirements during 1976 and 1977.

The external financing implications of altering the compliance schedule are set forth in Figures VI-17 and VI-18. These indicate that deferring implementation of the promulgated 1977 regulations to 1980 would reduce the annual external financing requirements of the industry to levels well below their historic high when compared to total corporate financing in the economy.

D. LIMITATIONS OF ANALYSIS

The Arthur D. Little analysis was restricted to the pulp, paper and paperboard sector of the total paper and allied products industry, and so did not consider capital investment demands attendant on woodlands acquisition or downstream converting. Such demands would be in addition to those considered here. Because all comparisons of projected financing requirements with historical experience have been made on a consistent basis, this restriction in no way invalidates the results. However, the financing requirements of the entire paper and allied products industry would be greater than those presented here for the pulp, paper and paperboard sector.

The analysis assumes free market pricing behavior of the industry. To the extent that such behavior is restricted, for example, by the imposition of Federal price controls or guidelines, the conclusions of this report could be altered.

The analysis was performed in dollars of 1975 purchasing power and has assumed no *real* inflation (i.e., inflation relative to the increase in the general price level) in the prices of capital goods, labor, wood, or other factors of production. To the extent that real inflation occurs, the investment and external financing requirements of the industry will be increased over the level reported here.

The analysis was based on a range of estimates of capacity expansion rates based on industry announcements, historic behavior, and Arthur D. Little expert judgment, but these growth rates were not adjusted dynamically to reflect emergent operating rates. The projected operating rates are somewhat lower than those realized historically until recent years. To the extent that the industry returns to high operating rate targets, its rate of capacity expansion will decline and its demands for investment funds will decrease below those projected here.

The analysis is based on the usual assumption of equilibrium in product and capital markets. In a dynamically changing economy, equilibrium is an objective sought but never exactly achieved. Therefore, it is to be expected that while the results presented here provide a reliable indication of the general effects which will occur, the actual performance of the pulp and paper industry will fluctuate over the years around the projections presented.

FIGURE VI-17

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS TO ASSUMED COMPLIANCE SCHEDULE

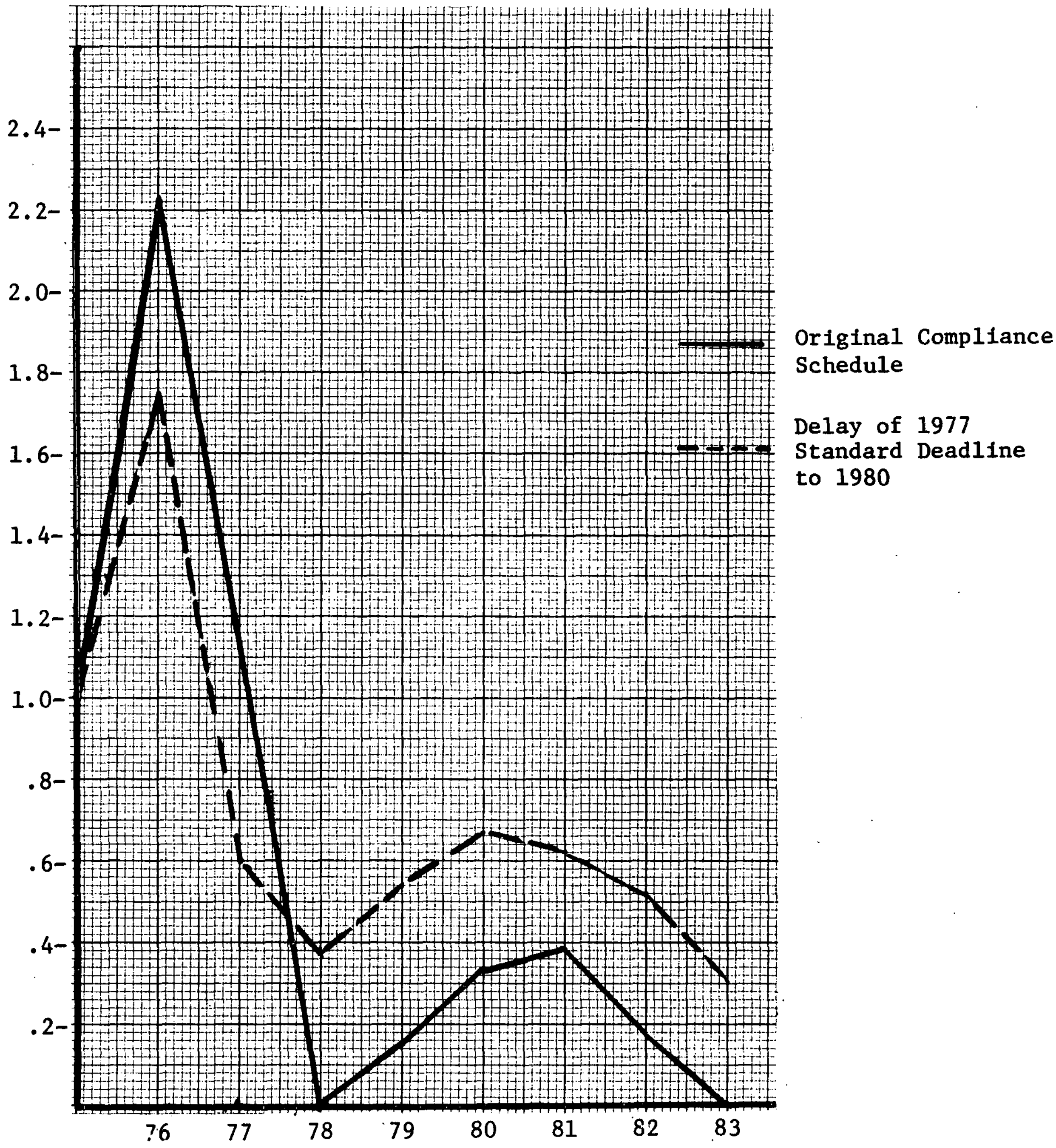


FIGURE VI-18

SENSITIVITY OF EXTERNAL FINANCING REQUIREMENTS AS PERCENT OF ALL CORPORATE FINANCING TO ASSUMED COMPLIANCE SCHEDULES

CHAPTER VII
BALANCE OF TRADE IMPACTS

VII. BALANCE OF TRADE IMPACTS

A. INTRODUCTION

1. Current Competitive Status of U.S. Pulp and Paper Industry

World production of pulp and paper products is centered in three major regions: United States, Canada, and Scandinavia. These regions account for 49% of world paper and paperboard capacity. They owe their dominance primarily to the fact that they were the first regions to develop a pulp and paper industry to utilize their large timber reserves, which amount to about 36% of the world's softwood and 10% of its hardwood growing stock. Russia is the only other country with large softwood inventories (54% of world), while Latin America has the largest hardwood inventories (52% of world). However, most of their wood is in remote regions which offsets their low stumpage and harvesting costs; in any case, their pulp and paper industries are in an early stage of development and have not begun to export in any significant amounts.

The U.S. pulp and paper industry generally has maintained a favorable cost position to all foreign competition, mainly because of economies of scale realized in its extremely large mills, coupled with relatively low-cost pulpwood delivered to the mill sites. In the early 1970's, U.S. pulpwood prices began to rise much faster than previously as competition for the essentially fixed supply of wood intensified. Most foreign wood prices, however, have risen at least as fast, so the U.S. has not begun to lose its chief competitive advantage in world pulp and paper markets.

Pulpwood costs in Scandinavia are two to three times those in the southern United States because the demand for Scandinavian wood now exceeds the timber growth rate in that region. Because of its high wood costs, Scandinavia's pulp and paper sales are now confined largely to Europe.

In eastern Canada, production centers heavily on newsprint, a substantial quantity of which is produced in comparatively old mills. In addition, pulpwood costs in eastern Canada tend to be higher than those in the southern and western United States because of the difficulties of harvesting and transporting the wood in Canada. Western Canada, on the other hand, supports large market pulp mills and integrated pulp and paper complexes with relatively low manufacturing costs that are similar to those of U.S. Pacific Northwest mills, but somewhat higher than those in the southern United States. Therefore, the southern U.S. kraft mills are generally the world's most profitable.

Despite its general cost competitiveness, the United States for some time has been a net importer of pulp and paper products. In 1974, it had a net trade deficit of about $400 million. This deficit has been caused primarily by large imports of newsprint and bleached pulp from Canada which has concentrated its production on these products while the U.S. industry sought other product opportunities; thus, the United States lacks the capacity to be fully self-sufficient.

Other parts of the world, such as Russia, South America, and Africa, have relatively low-cost wood reserves but do not yet have the plant capacity to be significant producers in the world market. In most cases, moreover, pulp/paper mills in these regions will incur significant transportation costs that will at least partially offset any production cost advantages.

The purpose of this analysis is to estimate the degree to which the cost advantage enjoyed by U.S. pulp and paper mills in the world market for certain commodities will be adversely affected by any production cost differences caused by the studied water, air and noise regulations among the major competing regions. The study also seeks to estimate whether decreases, if any, in the cost advantage of the U.S. mills will increase imports and decrease exports, and thereby reduce the U.S. balance of trade.

2. Scope of Analysis

The major pulp and paper items imported to or exported from the United States are unbleached kraft linerboard, bleached kraft pulp, dissolving pulp, and newsprint (Table VII-1). In total tonnage, these accounted for 79% of U.S. imports and 45% of U.S. exports of pulp and paper products in 1974. The analysis focuses on these major products since they are likely to be most sensitive to changes in relative costs between countries.

The remaining imports and exports are distributed over a large number of products. Trade volumes for these products are small because they typically face high tariff barriers which have already created high inter-country cost differentials and rendered them less sensitive to differences in environmental costs.

3. Overall Approach

The basic approach used to analyze balance of trade impacts was to estimate current production and distribution cost differentials among the major competing countries, project environmental costs among these countries and evaluate the changes they would cause in the relative cost differentials. Thus, foreign trade would be affected if environmental costs were to significantly change the relative cost advantage for U.S. mills in the studied products.

To simplify the basic production cost analysis without unduly sacrificing accuracy, Arthur D. Little concentrated on factors whose cost differences most significantly affect total delivered costs: wood cost at the mill, transportation costs and duties. Regional labor, chemicals, energy, and other manufacturing costs are generally comparable in aggregate and were assumed to remain so among the major competing regions. It was also assumed that long-term inflation rates for all the above cost items would be about the same, or that currency exchange rates would offset any inflation differentials between competing regions. Figure VII-1 illustrates the total data flow and analytical process.

B. CONCLUSIONS

1. Impact on Exports

The analysis indicates that water, air, and noise regulations through 1983, are unlikely to reduce significantly U.S. exports of unbleached kraft linerboard, bleached kraft paper pulp, and dissolving pulp — the three largest volume pulp and paper products exported by the United States. The basic reason for this conclusion is that projected environmental cost differences are unlikely to change the current relative cost advantage of U.S. exporters.

The environmental cost disadvantage of U.S. kraft linerboard mills relative to Swedish mills is expected to remain at about $6 per ton through 1983 (Table VII-2). Therefore, the studied environmental controls, *per se*, should not change the present U.S. total cost advantage. Present

TABLE VII-1

U.S. IMPORTS AND EXPORTS OF PULP AND PAPER, 1974

Product	Imports $MM	Imports %	Exports $MM	Exports %
Unbleached Kraft Linerboard	2	-	404	16
Bleached Kraft Pulp	756	26	432	17
Dissolving Pulp	63	2	260	10
Newsprint	1,484	51	53	2
All Other	515	21	1,378	55
TOTAL	2,920	100	2,527	100

SOURCE: U.S. Department of Commerce.

FIGURE VII-1

PROCEDURE FOR ESTIMATING BALANCE OF TRADE EFFECTS

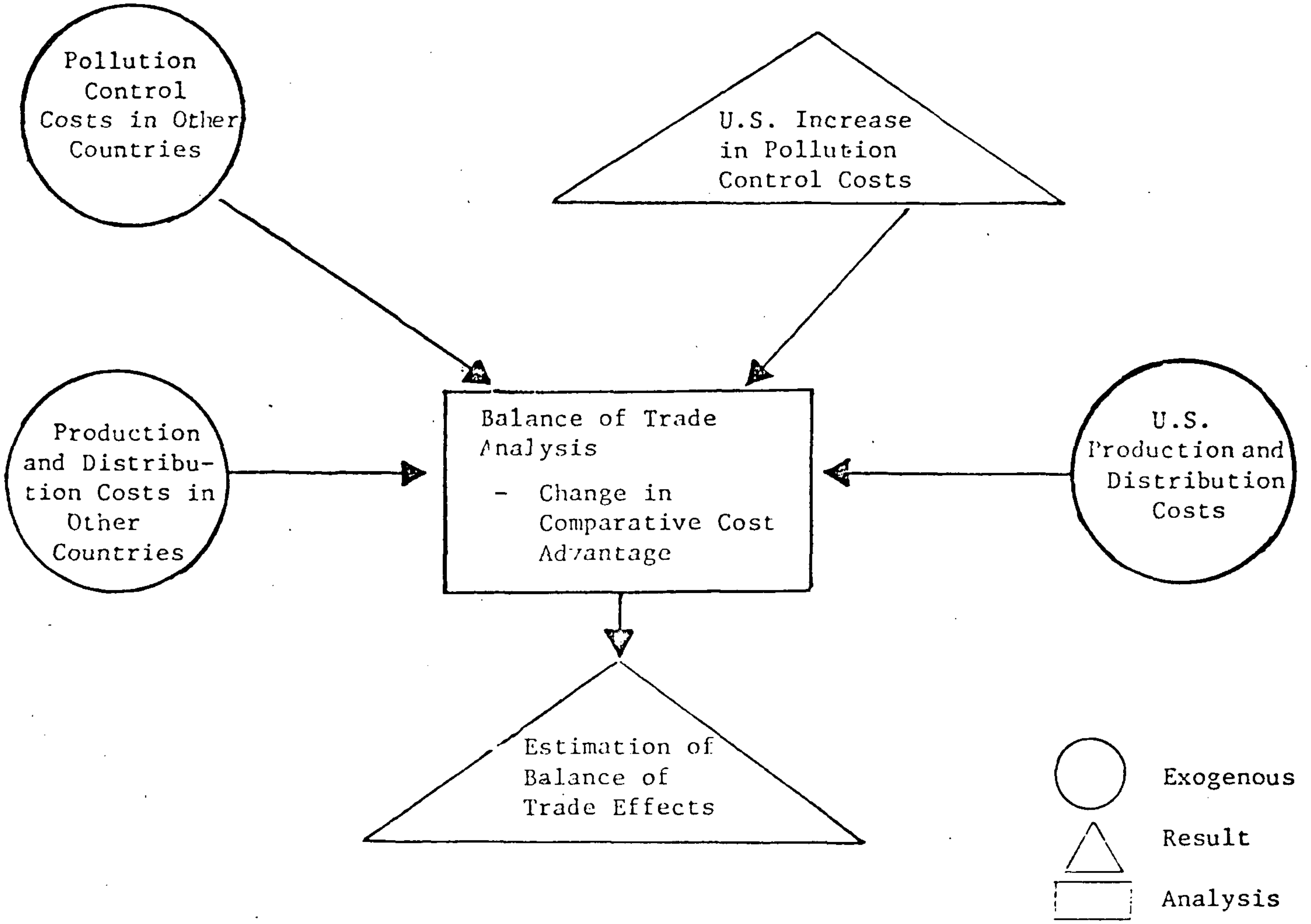


TABLE VII-2

KRAFT LINERBOARD COST DIFFERENTIALS LANDED IN GERMANY FROM SOUTHEAST U.S. AND SWEDEN

(1975 dollars per short ton)

Basis: Assume costs other than wood, transportation, duties and water/air/noise controls are the same in both producing locations. Control costs are based on reported OECD averages (1975) and ADL estimates (1983).

1975 Differential Items	Southeast U.S.	Sweden	U.S. Cost Advantage (Disadvantage)
Wood	40	108	68
Transportation	33	17	(16)
Duties*	17	17	0
Environmental Controls	See Table VII-7		(6)
Net Differential			46
1983 Differential Items			
Wood and Transportation	73	125	52
Duties	17	11	(6)
Environmental Controls	See Table VII-8		(6)
Net Differential			40

*Reflects planned tariff reductions for Scandinavian countries from 12% in 1972 to 0% in 1984.

SOURCE: Arthur D. Little, Inc., estimates.

Common Market tariff regulations, however, call for elimination of duties on Swedish imports by 1984, which obviously would improve Sweden's cost position relative to U.S. mills. However, the gap may not narrow, since the API is working hard to minimize or eliminate the projected differential in duties.

Environmental cost differentials also should not affect significantly the current U.S. cost advantage in bleached softwood kraft pulp through 1983 (Table VII-3). The present environmental cost differential itself is not likely to change appreciably and the southern U.S. mills should at least maintain their substantial wood cost advantage over Swedish producers. Thus, U.S. mills should retain their absolute and relative cost advantages.

A similar analysis (Table VII-4) for sulfite dissolving pulp indicates that a projected increase in the environmental cost differential between U.S. and Swedish mills will moderately reduce the large cost advantage now enjoyed by the southern U.S. mills. The total projected reduction of the U.S. cost advantage is about 11% ($9 per ton). Since the estimated southern U.S. cost advantage is very large (about $78 per ton), the projected $9 per ton reduction is comparatively modest. Thus, any resulting decline in dissolving pulp export volumes is likely to be too small to quantify.

2. Impact on Imports

The analyses of newsprint and bleached kraft paper pulp (which accounted for 77% of U.S. pulp and paper imports in 1974) indicate that imports will not increase appreciably as a result of environmental cost differences. Although increases in the U.S. environmental cost disadvantage versus Canada are projected through 1983, they are either small or offset by increasing U.S. cost advantages in other elements of production.

Western Canadian newsprint producers will apparently improve their present cost position, vis-à-vis southern U.S. mills, by virtue of the latter's increasing relative cost for environmental control. The indicated lowering of the U.S. mills' cost advantage from $22 to $14 per ton by 1983 (Table VII-5), might be expected to discourage expansion of U.S. newsprint mills and increase Canadian imports. However, these cost changes must be examined in the light of other cost changes not reflected in the analyses. Of prime importance is the fact that eastern Canada (the source of most U.S. newsprint imports) has many old, high-cost plants that include small sulfite mills. These mills face closure because they cannot economically justify the chemical recovery systems now required for water effluent control. Therefore, many eastern Canadian producers ultimately will have to rely on purchased market pulp for their chemical pulp requirements. The purchased pulp will make them even higher-cost producers and give them a strong incentive to support high newsprint prices in the United States, their major market. Also labor costs throughout Canada are rising much more than in the United States, so the assumption of parity in all costs other than those for wood, transportation, and environmental controls may not hold in this case. Furthermore, as noted earlier, the U.S. water pollution control estimates for newsprint may be somewhat overstated in that costs for the highest polluting process employed (i.e., sulfite or kraft) were applied to both the chemical and groundwood pulp production volumes. Finally, an increasing number of U.S. newsprint producers have found it advantageous to expand their capacity via deinked newsprint, and in so doing, to stop or reduce further market share gains by Canadian suppliers. Because of the above factors, Arthur D. Little believes that U.S. newsprint producers will actually increase their share of the U.S. market by as much as 5% (i.e., from 33% to 38%) by 1983, in spite of their higher cost burden for environmental controls.

TABLE VII-3

BLEACHED SOFTWOOD KRAFT PULP COST DIFFERENTIALS LANDED IN GERMANY FROM SOUTHEAST U.S. AND SWEDEN

(1975 dollars per short ton)

Basis: Assume costs other than wood, transportation, duties and water/air/noise controls are the same in both producing locations. Control costs are based on reported OECD averages (1975) and ADL estimates (1983).

1975 Differential Items	Southeast U.S.	Sweden	U.S. Cost Advantage (Disadvantage)
Wood	53	130	77
Transportation	32	12	(20)
Environmental Controls	See Table VII-7		(6)
Net Differential			51

1983 Differential Items	Southeast U.S.	Sweden	U.S. Cost Advantage (Disadvantage)
Wood and Transportation	85	142	57
Environmental Controls	See Table VII-8		(6)
Net Differential			51

SOURCE: Arthur D. Little, Inc., estimates

TABLE VII-4

SULFITE DISSOLVING PULP COST DIFFERENTIALS LANDED IN GERMANY FROM SOUTHEAST U.S. AND SWEDEN

(1975 dollars per short ton)

Basis: Assume costs other than wood, transportation, duties and water/air/noise controls are the same in both producing locations. Control costs are based on reported OECD averages (1975) and ADL estimates (1983).

1975 Differential Items	Southeast U.S.	Sweden	U.S. Cost Advantage (Disadvantage)
Wood	61	161	100
Transportation	32	12	(20)
Environmental Controls	See Table VII-7		(2)
Net Differential			78
1983 Differential Items			
Wood and Transportation	93	173	80
Environmental Controls	See Table VII-8		(11)
Net Differential			69

SOURCE: Arthur D. Little, Inc., estimates.

TABLE VII-5

NEWSPRINT COST DIFFERENTIALS IN U.S. MIDWEST FROM SOUTHEAST AND WESTERN CANADA

(1975 dollars per short ton)

Basis: Assume costs other than wood, transportation, duties and water/air/noise controls are the same in both producing locations. Control costs are based on reported OECD averages (1975) and ADL estimates (1983).

1975 Differential Items	Southeast U.S.	Western Canada	U.S. Cost Advantage (Disadvantage)
Wood	34	43	9
Transportation	24	37	13
Environmental Controls	See Table VII-7		-
Net Differential			22
1983 Differential Items			
Wood and Transportation	58	80	22
Environmental Controls	See Table VII-8		(8)
Net Differential			14

SOURCE: Arthur D. Little, Inc., estimates.

Environmental control costs will not appreciably change the current cost advantage that bleached softwood kraft pulp mills in the southern United States now enjoy over their counterparts in western Canada (Table VII-6). The projected increase in the environmental cost disadvantage for U.S. mills is small in comparison with the significant wood cost advantage now held by the southern U.S. mills. Therefore, no significant change in bleached softwood kraft pulp imports can be associated with the projected environmental control costs.

C. METHODOLOGY AND COMPUTATION DETAILS

1. Rationale for Selection of Major Export/Import Regions

West Germany was selected as the export destination because of its central location within the European Common Market, which consumes about 49% of U.S. exports of kraft linerboard, 35% of its bleached kraft pulp export, and 50% of its dissolving pulp exports. Sweden was chosen as the key competing export country for cost comparisons because it is a major producer of the above products and has the major share of the European market. Moreover, if Swedish producers, with their high wood costs, can obtain a competitive advantage in the Common Market by virtue of their lower environmental costs, Canadian producers, who have a large share of world bleached and dissolving pulp markets, also would improve their cost position relative to that of the United States both in Europe and in other export markets.

The major U.S. pulp and paper imports are newsprint and bleached kraft paper pulp, both of which are supplied almost entirely from Canada. Southern U.S. mills generally have a pulpwood cost advantage in producing these products. Therefore, if the studied environmental regulations were to significantly reduce the cost advantage of the southern U.S. mills, imports would increase for these products as well as for other pulp and paper products that are imported in lesser amounts. Western Canada was selected as the most likely source of future imports because it has Canada's lowest cost wood supply and most recent capacity expansion has taken place there. Note, however, that most U.S. newsprint imports currently come from eastern Canada.

2. Assessment of National Differences in Pollution Control Requirements and Costs

The degree to which environmental control requirements will affect the U.S. balance of payments will be determined by the differences in enforcement objectives and timetables in the major competing export regions. A review of reports concerning current progress of the objectives for paper industry environmental controls in Canada and Scandinavia shows that:

- The current focus of water effluent control is on standards that can be met by intensive internal control measures plus primary treatment of the remaining effluent. There are exceptions to this, such as British Columbia, a growing number of other Canadian provinces, and most inland areas of Sweden and Norway where the regulations require primary plus secondary water treatment by the late 1970's. As of 1975, however, virtually all U.S. mills had installed primary water treatment and many mills had also installed some degree of secondary treatment as they pointed toward meeting the 1977 standards.
- All of the studied countries are attempting to control air pollution through limitations on particulate emissions and most have begun or are planning to implement, sulfur emission control as well, at least on kraft recovery boilers. In general, the

TABLE VII-6

BLEACHED SOFTWOOD KRAFT PULP COST DIFFERENTIALS IN U.S. MIDWEST FROM

SOUTHWEST U.S. AND WESTERN CANADA

(1975 dollars per short ton)

Basis: Assume costs other than wood, transportation, duties and water/air/noise controls are the same in both producing locations. Control costs are based on reported OECD averages (1975) and ADL, estimates (1983).

1975 Differential Items	Southeast U.S.	Western Canada	U.S. Cost Advantage (Disadvantage)
Wood	53	90	37
Transportation	20	33	13
Environmental Controls	See Table VII-8		(6)
Net Differential			44

1983 Differential Items	Southeast U.S.	Western Canada	U.S. Cost Advantage (Disadvantage)
Wood and Transportation	73	123	50
Environmental Controls	See Table VII-9		(7)
Net Differential			43

SOURCE: Arthur D. Little, Inc., estimates.

Canadian and Scandinavian air emission levels and timetables are more ienient than typical regulations faced by the U.S. kraft pulp industry. Note, however, that the standards and timetable vary considerably among the 50 U.S. state implementation programs (SIP).

- No regulations are being promulgated or proposed in either Canada or Scandinavia to reduce pulp and paper mill noise levels.

Current (1975) cost differentials for water and air effluent control between the United States, Canada, and Sweden were taken from projections made in a 1972 survey by the Organization for Economic Cooperation and Development (OECD), for the product sectors selected in the trade analysis (Table VII-7). A comparison of reported 1970 and projected 1975 data indicates that, in general, U.S. mills are already spending more, but that Canada and Sweden, according to their projected 1975 expenditure levels, are rapidly catching up.[1]

In the absence of a more definitive and current assessment of pollution control expenditures through 1977 by foreign paper industries, Arthur D. Little's analysis employed the 1975 OECD data. Thus far, no foreign country has announced its intention of going further than the 1977 U.S. BPT water effluent controls. For this analysis, therefore, it was assumed that when U.S. mills reach the BAT water effluent level in 1983, competing mills in Canada and Sweden will have reached the BPT level and the corresponding cost differentials will reflect the maximum cost disadvantage to the U.S. mills resulting from water effluent regulations between 1977 and 1983.

Similarly, for air pollution control costs, it was assumed that by 1983, the cost differences between U.S. mills and those of Canada and Scandinavia would be equal to the cost increment for existing U.S. mills between 1977 and 1983. In essence, this amounts to moving the U.S. average control level to the current Oregon standards which are the most stringent SIP regulations in the country. (Oregon standards, however, will become even more stringent.)

It was assumed that neither Canada nor Sweden would have noise abatement regulations by 1983. Thus, the cost differential for the U.S. mills will equal their *full* cost for noise abatement by 1983. Table VII-8 shows the estimated 1983 U.S. environmental cost disadvantages versus Canada and Sweden for the products covered in the trade analysis.

3. Computation of Wood Cost Differences Between the United States, Canada, and Sweden

The second basic component of the balance of trade analysis was an assessment of the current manufacturing cost advantages by the United States, Canada, and Sweden for the major exported/imported products studied. The analysis assumed that the major cost differences, other than for environmental control, would continue to be those for wood, transportation and duties. To simplify the analysis, other manufacturing costs (labor, chemicals, energy, overhead, etc.) in aggregate were assumed to be about equal to each other in these countries. Costs for transportation and duties were obtained from current publications or from contacts with importers and exporters. Wood costs were obtained from recent Arthur D. Little studies and were updated to 1975 as necessary using current industry and government publications in North America and

1. The relative differences between these costs are likely to be more reliable than the absolute cost levels owing to OECD's methodology whereby producers' cost estimates were accepted without attempting to standardize their assumptions or the individual cost items included.

TABLE VII-7

INTER-COUNTRY COMPARISON OF WATER AND AIR POLLUTION CONTROL EXPENDITURES, 1970 and 1975

(1970 dollars per metric ton)

Basis: December 1970 Exchange Rates

Products	United States	Canada	Sweden
Sulfite Pulp 1970	3.47	0.62	9.76
Projected 1975	18.01	11.22	15.91
Kraft Pulp and Paper 1970	2.21	0.03	1.64
Projected 1975	11.80	5.02	5.25
Newsprint 1970	0.91	0.51	3.62
Projected 1975	3.75	3.55	4.86

SOURCE: Survey of member countries by Organization for Economic Cooperation and Development (OEDC) in 1972.

TABLE VII-8

ASSUMED INTER-COUNTRY POLLUTION CONTROL COST DIFFERENTIALS, 1983

(dollars per short ton)

Basis: Mid-1975 Dollars and assumptions that Canadian and Swedish mills will have reached U.S. BPT (1977) water effluent control level by the time U.S. mills reach BAT (1983) levels, these countries will have lower costs for air effluent control equal to the projected U.S. cost increment between 1977 and 1983 and that they will bear no costs for noise abatement.

Product	U.S. Disadvantage Versus Canada and Sweden			
	Water	Air	OSHA Noise	Total
Unbleached Kraft Linerboard	4.70	0.50	0.60	5.80
Bleached Kraft Pulp	6.10	0.60	0.60	7.30
Dissolving Sulfite Pulp	9.70	0.40	0.90	11.00
Newsprint	6.00	0.50	1.40	7.90

SOURCE: Arthur D. Little, Inc. (cost differentials)

Scandinavia. Table VII-9 shows the wood species and conversion factors employed in developing the critical wood costs estimates. Appendix I (Volume III) gives additional background for the estimates on Swedish wood costs and for newsprint wood costs in North America.

D. LIMITATIONS OF ANALYSIS

- Small volume import/export products were excluded since they typically face relatively high tariff barriers making them less sensitive to environmental cost differentials. If some of these products are affected, the tonnage involved would have little effect on the U.S. trade balance.

- Intercountry production/distribution cost differentials included only items whose cost differences most significantly affect total delivered cost: wood, transportation, and duties. To the extent that aggregate costs for other factors of production also vary, estimates of U.S. competitive advantages could change; currently rapidly rising labor costs in other countries are increasing the competitive advantage of U.S. mills.

- The analysis assumes that U.S. mills will maintain their approximate current six-year lead time (in implementing water, air, and noise controls) over their counterparts in key competing countries; the projected environmental cost differentials would change to the extent that this lead time changes and/or, if the proposed 1983 water effluent guidelines are changed.

- Since estimated national environmental cost differences were small in comparison with the current overall cost advantage enjoyed by U.S. mills in the domestic or export markets, any variances from the above assumptions and estimates would have to exceed their likely limits to change the conclusions.

TABLE VII-9

WOOD USAGE AND COSTS - BY REGION AND PRODUCT, 1975

Region	S.E. U.S.	W. Canada	Sweden
Wood			
Species	Slash & Loblolly Pine	Hembal - Spruce	Spruce & Pine
Density-lb/ft^3	32	24	24
Delivered Cost $/Cunit	36	46	72

Wood Usage and Cost/ Air Dried Short Ton (ADST) of Product

Product	Cu/ADST	$/ADST	Cu/ADST	$/ADST	Cu/ADST	$/ADST
Sulfite Dissolving (33% yield)	1.7	61	2.24	103	2.24	161
Bl SW Kraft (38-41% yield)	1.48	53	1.95	90	1.81	130
Linerboard (53% yield)	1.12	40	1.50	69	1.50	108
Newsprint (See Appendix I-3 for various furnishes)	--	34	--	43	--	--

SOURCE: Arthur D. Little, Inc., estimates.