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Concentration and Profitability in Non-MSA Banking Markets

by Gary Whalen

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Introduction

Until quite recently, industrial-organization economists, bank regulators, and the Justice Department shared the view that market structure, that is, the number and size distribution of competitors in a market, is the primary determinant of the conduct and performance of banks operating in that market. More particularly, the traditional structuralist view is that the greater the share of the market controlled by the largest competitors or, alternatively, the higher the market concentration, the greater the likelihood that the firms will be able to agree collusively to raise prices above costs and so earn supranormal or monopoly profits.

Concentration and bank profitability have been found to be positively related in a number of empirical studies, and these findings have been interpreted by structuralists as evidence that their position is correct.[1]

The presumption that the structuralist view is valid is reflected in the Justice Department's merger guidelines, which are used by regulators to identify bank acquisitions and mergers likely to have anti-competitive effects. In essence, the guidelines generally proscribe bank regulators from approving acquisitions and mergers that would cause market concentration to rise above an assumed critical collusion-facilitating level.

In the 1980s, however, a number of legal, regulatory, and technological developments and additional theoretical and empirical work have raised questions about the appropriateness of using the structuralist paradigm as a basis for antitrust policy. In particular, the growing importance of potential competitors in an increasingly deregulated environment has been emphasized by critics of the traditional view.[2]

Other critics have suggested that the positive relationship between concentration and profitability found in previous empirical studies may not be attributable to collusion and does not necessarily indicate unidirectional causation running from structure to performance.[3] They suggest that performance determines market structure rather than the reverse. One author has dubbed this the "efficient structure" hypothesis.[4] Superior efficiency, management, or luck cause firms to be profitable and to increase their market share, resulting in market concentration. Market share, a proxy for relative firm efficiency, is thus positively related to profitability. The positive relationship between concentration and profitability is spurious and simply reflects the correlation between market share and concentration.

1 See, for example, Rhoades (1982).

2 For a discussion of these developments and their implications, see McCall and McFadyen (1986). See also the work on contestable market theory in Baumol, et al. (1982) and the discussion of the structuralist view in Brozen (1982).

3 See Demsetz (1974) and Smirlock (1985).

4 Smirlock, op. cit.

This study represents an attempt to provide additional insight on the nature of the relationship between market structure and bank performance. Specifically, the relationship between bank profitability and concentration will be examined using recent data for a sample of 191 institutions drawn from non-metropolitan statistical area (MSA) counties in Ohio and Pennsylvania.

In the following section, some criticisms of the traditional view will be discussed and previous empirical studies will be briefly reviewed. Next, the data and sample design will be discussed. In the fourth section, the data will be analyzed in several ways. Finally, a summary of the results and conclusions will be presented.

I. Problems with the Traditional View

The traditional structuralist view reflects several implicit assumptions that appear to be questionable. The first is that creating and enforcing tacit collusive agreements is relatively easy. For a collusive agreement to be stable, participating firms must institute some mechanism to set and adjust price(s) and allocate market shares. This is not a trivial exercise, particularly for banks, which are multiproduct firms selling complex, heterogeneous products and services in a number of different geographic markets.

The second is that technological conditions, regulation, other barriers to entry, or the threat of predation allow colluding firms in concentrated markets to disregard potential competitors. Concentration-related monopoly power and profits can exist and persist only when entry by potential competitors can be effectively prevented by incumbent firms. In recent work, theorists have demonstrated that when barriers to market entry and exit are low, or a market is contestable, it is possible to have outcomes approximating those of perfect competition even if the number of actual competitors is quite small or concentration is high.[5]

Geographic and product market barriers to competition faced by banks and other financial intermediaries admittedly were formidable prior to the 1980s. Price competition was constrained by interest rate ceilings on deposits and on some types of loans as well. However, this situation has changed dramatically in the past few years. Intrastate and interstate barriers to geographic expansion by commercial banks and by savings and loan institutions (S&Ls) have been removed in a large number of states. Remaining barriers have been circumvented in various ways (with loan production offices and nonbanking holding company subsidiaries, for example). The Monetary Control Act of 1980 and the Garn-St Germain Act of 1982 essentially allow S&Ls to offer all the financial products and services of commercial banks. Largely unregulated nonbank financial companies also now compete aggressively for both loan and deposit customers of banks. In addition, the increasing sophistication and declining cost of computer and telecommunications technology have made it possible for financial institutions to compete effectively in a geographic area without an extensive investment in brick and mortar offices. Financial intermediaries also now are basically free to compete on a price as well as a nonprice basis.

These developments have made it much easier for banks and other types of financial-services providers to compete for customers in any given local loan or deposit market. The implication is that market structure may not be the primary determinant of bank performance in the current environment.

II. Review of Previous Empirical Studies

Comprehensive reviews of structure-performance studies in banking published prior to 1984 have been done by Rhoades (1982) and Gilbert (1984). Although the two authors reviewed many of the same studies, their evaluation of the empirical evidence differs considerably. The former concluded that the results suggest that bank market structure influences both profit and price performance in the manner predicted by the structuralist paradigm. The latter concluded that the results do not consistently support or reject the hypothesis that market concentration influences bank performance. Both concur that where a significant positive concentration impact on prices or profitability was found, the magnitude of the impact was typically slight. Gilbert emphasizes that the positive impact does not necessarily imply that collusion is the cause.

More recent studies of the structure-performance relationship have been done by Burke and Rhoades (1985), Smirlock (1985), Smirlock and Brown (1986), and Whalen (1986). Burke and Rhoades explore the relationship between bank profitability averaged over the 1980-84 interval and the number of bank competitors faced using a national sample of more than 7600 institutions. First, they calculate and compare mean profit rates for sample banks operating in 1-bank, 2-bank, 3-bank and 4-bank non-MSA markets and MSA markets and find results consistent with the traditional structuralist view. The mean profitability of banks in 1-bank markets is significantly greater than the means of the other classifications. Consistent results were found for

5 See Baumol, et al., op. cit.

the other non-MSA markets (that is, mean returns in 2-bank markets are above those in markets with a larger number of competitors, and so on). Burke and Rhoades also explore the relationship between their profitability variable and a binary market structure variable (equal to one for MSA banks, equal to zero otherwise) using regression analysis. Additional nonstructural control variables are also employed in the regression. Again, the results are in line with the traditional view. The estimated coefficient on the market structure variable is negative and significant, indicating banks operating in urban markets with large numbers of competitors are less profitable than rural-market banks facing four or fewer competitors.

The authors conclude that the results suggest "...banks in monopolistically or oligopolistically structured markets likely pay lower rates on deposits, charge higher rates on loans and services, or both... [suggesting] that out-of-market and limited-purpose competitors do not provide effective competition to banks in highly concentrated markets. Such markets are apparently not contestable probably because barriers to entry exist in real-world markets."[6]

Although the results were interpreted by the authors as support for the traditional structure-performance view, alternative explanations for the findings exist. In particular, the significant differences in mean returns may be largely due to temporary regional differences in economic activity rather than differences in the number of competing banks faced in local markets. Mean returns were calculated for each sample bank over the 1980-84 interval. Over the first three years of this period, the energy and agricultural sectors were booming. As a result, banks located in agricultural and energy-producing states were highly profitable. Coincidentally, many of these states have restrictive geographic branching laws and so have a relatively large number of local markets with few competing banks. Thus, it is possible that local economic conditions rather than the number of competitors are responsible for the observed differences in mean bank profitability in the sample.

In the regression analysis, the authors attempt to control for other factors thought to impact bank profitability. However, several potentially important variables were not included and may have affected the reported results. In particular, no thrift-presence variable was employed even though S&Ls possessed much the same powers as banks after 1982. Also, a bank-market-share variable was not employed. As noted above, it has been argued by some that the positive relationship between profitability and market concentration found in empirical studies is spurious and will not be evident if differences in market share are taken into account.[7]

Finally, it is not clear that the reported results suggest that potential competition is unimportant. The mean returns used in the t-tests are computed for each market type using all such banks in the sample. That is, banks in each class are pooled regardless of differences in state branching laws. Since differences in bank branching restrictions should have an important impact on the intensity of potential competition, the mean-profitability test results do not provide any insight on the potency of this force. In fact, the regression results do provide support for the hypothesis that potential competition is important. Specifically, the two state branching dummies included in the estimated equation (for unit banking and limited branching states) have positive significant coefficients, indicating that bank profitability is higher in states with branching restrictions.

Smirlock (1985) uses regression analysis to investigate the profitability-concentration relationship using a sample of more than 2,700 banks drawn from unit-banking states in the Tenth Federal Reserve District. The relationship was examined for a single year, 1978. In essence, the study represents an attempt to determine if a positive concentration-profitability relationship remains evident when a bank-market-share variable is also included in the estimated equation. If it does, it suggests that the traditional view is the correct one. If not, and if the market-share variable is significant, it suggests that the "efficient structure" hypothesis is correct. The market structure variable used was the three-bank-concentration ratio. The market-share variable is each bank's share of commercial bank market deposits. Several other additional common control variables are also employed.

Smirlock concludes that the regression results support the efficient structure rather than the traditional concentration-collusion view. Market share is positively and significantly related to profitability even when concentration is included in the estimated equation. However, he finds a significant positive concentration-profitability relationship only when the market-share variable is omitted from the estimated equation. When both are included, the coefficient on the concentration variable becomes insignificant.

6 Burke and Rhoades (1985), p. 11.

7 See the discussion in Smirlock, op. cit., pp. 70-71.

In the later Smirlock and Brown (1986) paper, additional empirical evidence in support of the efficient structure hypothesis is presented. The same sample of banks is used to estimate several variants of a profit function. If the traditional concentration-collusion hypothesis is valid, the expectation is that secondary or fringe firms will act as price-setters. Conversely, if the efficient structure hypothesis is valid, the fringe firms should act as price-takers. Leading firms may act as price-setters under either hypothesis. The profit function can be, and is, used to test whether a firm is a price-setter or price-taker. The estimation results indicate that leading firms exhibit price-setting behavior, while secondary "fringe" firms act as price-takers, regardless of market concentration. Further, there is no evidence that collusion increases with market concentration.

The study by Whalen (1986) represents a simple attempt to examine the relationship between the number of banks competing in a market and bank profitability for a sample of banks drawn from Ohio and Pennsylvania over the 1976-85 interval. The study was designed to provide insight on whether potential competition had become an effective disciplinary force over the past decade. Both states liberalized their bank-branching laws over the period of observation. Further, thrifts are an important force in both states, and possessed essentially all the powers of banks after 1982. Thus, barriers to competition were presumably lower at the end of the period than they were at the outset.

Following the approach of Burke and Rhoades, sample banks were classified according to the number of competing banks faced in the market. Three classes were created for non-MSA banks: 1-3 competing banks, 4-6 competing banks, and 7 or more competing banks. A separate class was created for MSA banks. Mean returns were calculated for the banks in each class for three subperiods: 1976-78, 1979-81, and 1982-85. If the traditional concentration-collusion hypothesis is valid, the mean profitability of banks operating in highly concentrated markets should be significantly higher than for banks operating in markets with larger numbers of actual competitors in each of the three subintervals.

Empirical support for the traditional view was found only in the first time period, before relaxation of either state's bank branching laws and the expansion of S&L asset and liability powers. The findings suggest that the lowering of barriers to actual and potential competition during the last two subintervals largely eliminated any concentration-related impact on bank profitability.

Thus, researchers have found support for the concentration-collusion hypothesis in only one of the four most recent empirical studies of the structure-performance relationship in banking.[8] Further, it is not clear that the results of this one supportive study demonstrate that the higher profitability observed in concentrated markets is due to collusion. A deficiency of all of the studies is that the market presence of thrift institutions is not taken into account.

III. Sample and Methodology

The structure-performance relationship is reexamined in this study, using a sample of 191 non-MSA banks located in Ohio and Pennsylvania. Non-MSA banks are studied because potential competition should be relatively weak in such areas, and so the sample is likely to provide evidence in favor of the concentration-collusion hypothesis—if it is in fact valid.

The relationship is investigated over the 1982-84 interval. This period was chosen for several reasons. Bank branching restrictions in both states were liberalized by early 1982. Further, the 1982 Garn-St Germain Act had given S&Ls essentially the same asset and liability powers as commercial banks. Both of these developments should have intensified potential as well as actual competition in local banking markets in both states. Thus, the sample may indicate if these developments, in conjunction with technological changes in the funds-information transfer area, have rendered rural banking markets contestable.

The particular banks analyzed were selected in the following way. In each state, all single-market banks in continuous operation over the 1976-85 interval headquartered in non-MSA counties were included. Single-market banks are those with all their offices located within their home office county. The presumption is that non-MSA counties approximate rural banking markets. The sample must be restricted to single-market banks so that market structure can be related to profits earned in that market.

The profitability measure employed is annual return on assets (net income after taxes, before securities transactions, divided by average total assets) averaged over the 1982-84 interval.

8 Two other interesting studies provide evidence that market concentration need not result in anticompetitive bank performance. Hannan (1979) finds a significant relationship between a potential entrant variable and the rate paid on savings deposits in local markets in Pennsylvania. Shaffer (1982) obtains estimates of the elasticity of bank gross revenue with respect to input prices and concludes that the results indicate that the banking markets he studied are neither perfectly competitive nor monopolistic. He finds that the coefficient on a concentration variable in his estimated equation is insignificant and concludes that the competitive forces preventing monopolistic conduct were primarily potential rather than actual or that the concentration measure did not adequately proxy actual competition.

Mean ROA by Market Concentration Level (Banks only)

Market concentration	Mean ROA	S.D. ROA	T-Stat
HHI < 1800 (N=62)	1.179	0.529	1.89
HHI > 1800 (N=129)	1.015	0.621	
HHI < 2000 (N=71)	1.171	0.512	1.95
HHI > 2000 (N=120)	1.001	0.635	
HHI < 2500 (N=104)	1.116	0.599	1.22
HHI > 2500 (N=87)	1.011	0.591	
HHI < 3000 (N=133)	1.101	0.591	1.15
HHI > 3000 (N=58)	0.992	0.606	
HHI < 3500 (N=155)	1.078	0.602	0.51
HHI > 3500 (N=36)	1.023	0.575	

SOURCE: Author's calculations, based on Reports of Income and Condition, Board of Governors of the Federal Reserve System; and on Summary of Deposit Data, FDIC.

TABLE 1

The deposit data for the sample banks and the non-MSA markets comes from the FDIC Summary of Deposits tape.

The deposit data were used to generate Herfindahl-Hirschman indexes (HHI) of market concentration for the sample banks, both excluding and including S&Ls.[9] Others have used alternative concentration measures for various reasons.[10] The HHI was employed because this is the measure used by the Justice Department and the bank regulatory agencies in implementing antitrust policy in banking.

The relationship between concentration and bank profitability is investigated in two ways. First, mean returns are calculated for the sample banks after the sample has been split into two concentration categories—"high" and "low"—that are defined in a variety of ways. If the concentration-collusion hypothesis is correct, the mean return of the high-concentration class should be significantly greater than that of the low-concentration class.

Since this approach does not control for other factors that may impact bank profitability, regression equations similar to those employed by others are also estimated. The definitions of the variables employed in the regressions appear in the appendix. Specifically, the bank profitability variable was regressed on a measure of bank size, a multibank holding company (MBHC) affiliation dummy, a market-size variable, market deposit growth, and the S&L share of total market deposits, in addition to bank market share and market concentration.

The traditional view implies that the estimated coefficient on the market-concentration variable should be positive and significant when other independent variables are included in the equation, including a firm market-share variable.

The bank-size variable is included to determine if larger banks realize scale economies or have diversification opportunities not available to smaller competitors. If size does confer advantages, the sign of the estimated coefficient should be positive.

If MBHC affiliation allows subsidiary banks to realize performance advantages relative to independent competitors, the estimated coefficient of the MBHC dummy should be positive.

The market-size variable is included because rural markets in the sample vary greatly in size. It has been suggested that this variable proxies ease of market entry. If this is the case, the expected sign of the coefficient should be negative.

The market-growth variable is employed to proxy the strength of demand for banking services in each market relative to supply. Rapid market growth suggests robust demand, and so the estimated coefficient on this variable is expected to be positive.

The S&L variable is used to proxy the intensity of nonbank competition in each market. Presumably, the higher the S&L share of market deposits, the greater their competitive impact and the lower the level of bank profitability.

Mean ROA by Market Concentration Level (Banks and S&Ls)

Market concentration	Mean ROA	S.D. ROA	T-Stat
HHI < 1800 (N=109)	1.094	0.594	0.70
HHI > 1800 (N=82)	1.033	0.600	
HHI < 2000 (N=129)	1.100	0.598	1.09
HHI > 2000 (N=62)	1.001	0.590	
HHI < 2500 (N=153)	1.087	0.599	0.90
HHI > 2500 (N=38)	0.991	0.585	
HHI < 3000 (N=170)	1.055	0.618	-1.27
HHI > 3000 (N=21)	1.173	0.368	
HHI < 3500 (N=180)	1.061	0.607	-1.08
HHI > 3500 (N=11)	1.190	0.368	

SOURCE: Author's calculations, based on Reports of Income and Condition, Board of Governors of the Federal Reserve System; and on Summary of Deposit Data, FDIC.

TABLE 2

9 The HHI index is the sum of the squared market shares of firms competing in a market. The HHI takes on its maximum value of 10,000 in monopoly markets.

10 The three-firm-concentration ratio is typically employed. Stated reasons for its use are ease of computation and tendency to exhibit the significant positive relationship between concentration and profitability predicted by structuralists.

Regression Results*
Independent variables

Equation	HB	MSB	BSize	Mkt	MG	SLS	MBHC	Constant
(1)	-.000007		-.00073	.00027	-.00006	-.00815	.1207	1.179
	(-0.17)		(-0.53)	(1.65)	(-0.51)	(-2.71)	(0.82)	(7.20)
			$\bar{R}^2$	F				
			.025	1.80				
(2)		.00798	-.00341	.00051	-.00005	-.00791	.1438	1.012
		(1.96)	(-1.81)	(2.75)	(-0.44)	(-2.65)	(0.98)	(7.68)
			$\bar{R}^2$	F				
			.045	2.47				
(3)	-.000122	.01682	-.00548	.00054	-.00004	-.00715	.1732	1.221
	(-2.21)	(2.97)	(-2.63)	(2.93)	(-0.31)	(-2.41)	(1.19)	(7.58)
			$\bar{R}^2$	F				
			.064	2.87				

*The dependent variable in each equation is bank return on assets averaged over the 1982-84 interval.
SOURCE: Author's calculations, based on Reports of Income and Condition, Board of Governors of the Federal Reserve System; and on Summary of Deposit Data, FDIC.

TABLE 3

IV. Results

Mean returns for the sample banks, broken down by concentration class, appear in table 1. The concentration measures in table 1 are calculated using only the commercial banks operating in the market. The first dichotomy, using HHI equal to 1800 as the breakpoint, reflects the Justice Department's definition of a highly concentrated banking market, presumably prone to collusion. The other breakdowns represent an attempt to determine if there is some higher level of market concentration at which supranormal bank profits become evident.

The results do not support the concentration-collusion hypothesis. In particular, for all breakdowns examined, mean profitability is higher for banks in the low-concentration class. T-tests indicate that the observed differences in mean returns are statistically significant for the HHI=1800 and HHI=2000 breakdowns.

The results differ somewhat if S&Ls are considered. These results appear in table 2. Once again, for HHI breakdowns up to 2500, mean returns are higher for the low-concentration class than they are for the more concentrated one. When the HHI breakpoint is 3000, mean returns are higher for banks in the more-concentrated class. However, none of the differences in mean returns are statistically significant. Thus, the results do not support the traditional view.

The regression results are presented in tables 3 and 4.[11] Once again, the concentration-collusion hypothesis is not supported. Instead, the results mirror those of Smirlock and suggest that the efficient structure view is the correct one. Specifically, whether S&Ls are included in the concentration and market-share calculation or not, the concentration variable has a negative, insignificant coefficient when the market-share variable is excluded from the estimated equation. When a market-share variable is also employed, the concentration-variable coefficient remains negative and becomes significant. The estimated coefficient on the market-share variable is consistently positive and significant in equations with and without a concentration variable.

These results are not sensitive to the concentration measure employed. When the three-firm concentration ratio is used, similar results are obtained, both when thrifts are included and excluded.

The reasons for the negative, significant coefficient on the concentration variable in several of the estimated equations are unclear, although a similar result was reported in Smirlock (1985). One possible explanation is that non-price competition may be more intense in more concentrated markets and so bank profitability is lower. Another is that managers in more concentrated markets can more easily engage in expense-preference behavior and so bank costs in such markets are higher and profitability is lower.[12] Some researchers have suggested that managers in concentrated markets will limit the amount of risks they take (i.e., choose the "quiet life") and so could earn lower returns.[13] Other

11 A formal test was conducted to determine if it was appropriate to pool the Ohio and Pennsylvania banks. The calculated F-statistic was roughly 0.50, which is well below the critical level, and so pooling was deemed acceptable.

12 For a discussion of expense-preference behavior, see Edwards (1977).

13 The possibility that managers might opt for the "quiet life" in concentrated markets is explored in Heggestad (1977).

Regression Results*
Independent variables

Equation	HS	MSS	BSize	Mkt	MG	SLS	MBHC	Constant
(1)	-.000001		-.00078	.00028	-.00006	-.00816	.1205	1.156
	(0.02)		(-0.58)	(1.71)	(-0.52)	(-2.60)	(0.82)	(6.18)
			$\bar{R}^2$	F				
			.025	1.79				
(2)		.00893	-.00288	.00050	-.00005	-.00627	.1423	0.979
		(1.89)	(-1.66)	(2.70)	(-0.42)	(-1.99)	(0.97)	(6.77)
			$\bar{R}^2$	F				
			.043	2.42				
(3)	-.000175	.02063	-.00489	.00052	-.00003	-.00666	.1559	1.234
	(-2.17)	(2.88)	(-2.51)	(2.85)	(-0.26)	(-2.14)	(1.08)	(6.66)
			$\bar{R}^2$	F				
			.062	2.79				

*The dependent variable in each equation is bank return on assets averaged over the 1982-84 interval.
SOURCE: Author's calculations, based on Reports of Income and Condition, Board of Governors of the Federal Reserve System; and on Summary of Deposit Data, FDIC.

TABLE 4

explanations exist.[14] Additional research appears necessary to explain this finding and is beyond the scope of the present paper.

V. Summary and Conclusions

The empirical results obtained using this sample of non-MSA banks do not support the concentration-collusion hypothesis. That is, a strong positive relationship between market concentration and bank profitability was not detected using either type of statistical analysis. Instead, the findings are in line with those reported in Smirlock (1985). That is, bank market share was found to be positively and significantly related to bank profitability both when concentration was included in the estimated regressions and when it was not. In fact, in equations that included both variables, the concentration variable had a negative, significant coefficient, rather than the expected positive one. The fact that the results closely mirror those of Smirlock, despite the much smaller sample size and different time period, with S&Ls excluded and included, lends credence to the view that the efficient structure hypothesis is the correct one.

The results suggest that high market concentration is unlikely to lead to collusion and monopoly profits, at least in states that allow banks some freedom to branch. The implication is that a purely structuralist antitrust policy should be tempered with judgment, particularly in the determination of critical tolerable concentration levels.

14 See Smirlock (1985), p. 78, footnote 18.

APPENDIX

DEFINITION OF VARIABLES

HB: Herfindahl-Hirschman Index of market concentration, defined using commercial banks only.

HS: Herfindahl-Hirschman Index of market concentration, defined using both commercial banks and S&Ls.

MSB: Bank share of commercial bank deposits in the market.

MSS: Bank share of total bank and thrift deposits in the market.

BSIZE: Bank total deposit size.

MKT: Total bank and thrift deposits in the market.

MG: Percentage change in total market deposits, 1980-84.

SLS: S&L share of bank and thrift market deposits.

MBHC: Dummy variable equal to one if a bank is a member of a multibank holding company, equal to zero otherwise. All variables, unless otherwise noted, are calculated using June 1984 data.

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The Effect of Regulation on Ohio Electric Utilities

by Philip Israilevich
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Introduction

During the pioneering days of the electric utility industry, it was believed that utilities were natural monopolies, meaning that one utility could service a geographic area more cheaply than any combination of smaller utilities. More recently, the economic viability of transferring or wheeling electricity over long distances, the development of small-scale generators and efficient windmill and solar power, and the increased use of cogeneration have undermined the view of electric utilities as natural monopolies. Nevertheless, electric utilities continue to be monopolies because regulatory agencies, such as the Public Utilities Commission of Ohio (PUCO), give them exclusive rights to produce and distribute electricity in designated markets.

These regulatory agencies also attempt to impose profit ceilings on electric utilities in order to push the price and consumption of electricity away from monopolistic levels and toward competitive levels. This is accomplished by regulating the rate of return on capital of electric utilities. The regulator determines a "fair" rate of return that is sufficient to allow a utility to cover its capital costs. With production costs and the demand for electricity, this "fair" rate determines the price of electricity.

The impact of this type of regulation on the production decisions of regulated utilities was first described by Averch and Johnson (1962). They argued that this regulation gives utilities the incentive to overcapitalize, that is, to employ a capital-labor ratio that is larger than one that minimizes costs for a given output level.[1] Thus, utilities operating under this constraint are not producing electricity as cheaply as they could. Virtually all empirical tests of regulatory bias to date have adopted the Averch and Johnson (A-J) model, and most have found an overcapitalization bias.[2]

The major challenge to the A-J model concerns the nature of the regulatory environment. Implicit in the A-J model is a regulator that constantly monitors capital returns and adjusts electricity prices to keep capital returns at "fair" levels. Joskow (1974) argues that regulators are more concerned with nominal electricity prices than with the rate of return on capital. As long as nominal electricity prices do not increase, regulators will not actively enforce the rate-of-return constraint, thereby eliminating the source of the A-J bias. Moreover, utilities face additional constraints, such as fuel-cost-adjustment clauses, environmental regulations, strict rules about what capital is allowed in the rate base, and the requirement to meet all demand at given electricity prices. When these additional constraints are taken into account, the net impact on a utility's production decisions is not clear.

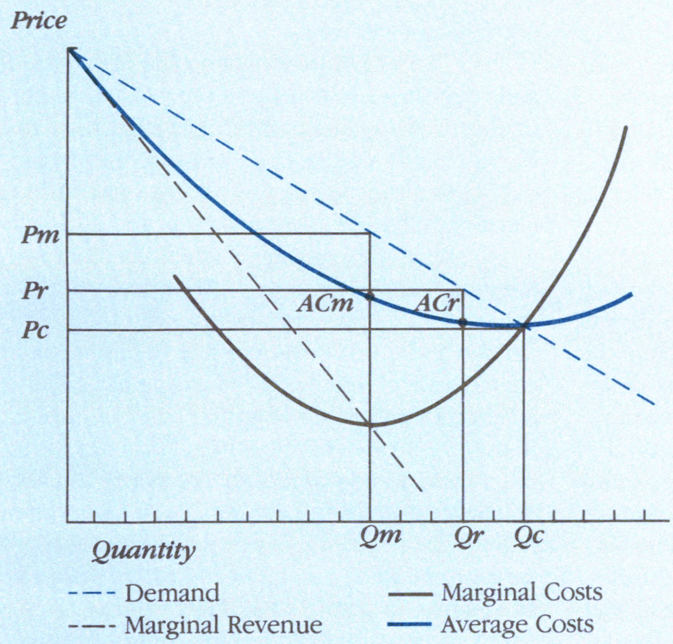
Atkinson and Halvorsen (1984) developed a generalized cost model that allows for the impact of additional regulatory constraints and found empirical evidence of their impact on

1 This interpretation of the A-J result is attributed to Baumol and Klevorick (1970).

2 Courville (1974), Spann (1974), Petersen (1975), Cowing (1978), and Nelson and Wohar (1983), for example, test only for an overcapitalization bias against an alternative hypothesis of no bias. Of these papers, only Nelson and Wohar do not find an overcapitalization bias.

utility production decisions. However, no one has formally tested the implications of Joskow's view. The purpose of this paper is to fill this gap by estimating a modified version of Atkinson and Halvorsen's model. The modifications are of two sorts. The first allows for different regulatory impacts over time as argued by Joskow. The second permits the use of panel data and the estimation of total factor productivity and its components to evaluate more accurately the impact of regulation on the technical change implemented by utilities.

The Short-Run Effect of Regulation on Utility Prices



SOURCE: Authors.

FIGURE 1

The data are a panel sample of the seven major electric utilities in Ohio over the period 1965 to 1982.[3] Ohio utility data were used because of general interest to most residents of the Fourth Federal Reserve District. Also, because these utilities are all privately owned, coal-burning plants that are subject to the same regulator, their technologies should be fairly similar. Thus, the estimation of a common cost structure for these utilities should yield a smaller potential for specification bias than is true of all previous studies of electric utilities, whose samples include utilities that employ varying technologies and/or face different regulators.

We find considerable circumstantial evidence consistent with Joskow's more general regulatory mechanism. However, the estimation results suggest that the impact of regulation in Ohio does not completely square with Joskow's expectation. In opposition to Joskow's view, we find that these utilities produce electricity with their prevailing technologies more efficiently during the years when Joskow expects regulatory constraints to be more binding. In Joskow's favor, we find that regulation retards the rate of technical change implemented by these utilities to a greater extent during the years when Joskow expects tighter regulatory constraints. To our knowledge, this is the first paper to explicitly estimate a regulatory impact on technical change in the electric utility industry.[4] Moreover, this type of inefficiency is surprisingly large in magnitude. Thus, the emphasis regulators and economists place on efficient production using a given capital stock appears to be misplaced; the retardation of technical change implemented by these utilities appears to be an important source of bias.

The first part of this paper reviews the regulatory process and contrasts the A-J and Joskow views. Next, the rate hearing experience in Ohio during the 1965 to 1982 period is discussed and is found to correspond quite well with Joskow's view of the regulatory mechanism. The third section describes the empirical results.

I. The Regulatory Process

It is useful to view the regulatory process in two parts: 1) the *mechanics* of setting a utility's electricity price structure, and 2) the *events* that initiate a rate hearing or a review of a utility's electricity price structure. There is little disagreement among economists about the first part. Simply put, a regulatory agency such as PUCO attempts to maintain a competitive price for electricity by regulating the rate of return on a utility's capital. It establishes a "fair" rate of return (r), taking into account all of a utility's production costs and the demand for its electricity, that is consistent with a "fair" level of profit and that is slightly higher than the utility's cost of capital. The "fair" return or profit on capital is then

$$\pi_r = Br,$$

where B is the rate base or the book value of the utility's net capital stock. The basis for a rate change and, hence, a change in the price of electricity, is the difference between this "fair" return on capital and the utility's accounting return on

3 The seven major electric utilities in Ohio are Ohio Power; Cincinnati Gas and Electric; Cleveland Electric Illuminating; Columbus and Southern Ohio Electric; Dayton Power and Light; Ohio Edison; and Toledo Edison. Over the 1965 to 1982 period, they accounted for about 90 percent of electric power sales in Ohio.

4 Nelson and Wohar (1983) estimated the impact of a rate-of-return constraint on *TFP* and calculated its impact on technical change as a residual. Israilevich and Kowalewski (1987) argue that this residual is an incorrect estimate of the regulatory impact on technical change.

capital (π), which is the difference between the utility's operating revenues (R) and its operating costs (OC):[5]

$$\pi = R - OC.$$

Electricity prices are set by the regulator to equate π with π_r on the date of the hearing. If π is less than π_r, electricity prices are raised, while if π is greater than π_r, electricity prices are decreased.

This mechanism is shown in figure 1, assuming there is only one utility serving the market for electricity. If there were no regulation, the utility would maximize profits (or minimize costs) by equating marginal revenues with marginal costs, producing quantity Q_m and charging a price P_m. Its profits would be $Q_m(P_m - AC_m)$. If the utility was acting like a perfectly competitive firm, it would maximize profits (and minimize social costs) by equating the market price, P_c, to its marginal costs and to its average costs and would produce the quantity Q_c. In this case, its profits would be zero. Note, however, that at both P_m and P_c, production is efficient in the sense that input-factor marginal products are equated to their market prices. A regulator picks some price P_r that is less than P_m but greater than P_c, giving the utility a "fair" profit of $Q_r(P_r - AC_r)$ to cover capital costs. At this point, production is inefficient.

This is a general description of the price-adjustment mechanism of an electric utility regulator. What brings a utility to a rate hearing and what motivates a regulator are questions debated by economists. The predominant answers to these questions were influenced by Averch and Johnson. They investigated the optimal response of a cost-minimizing utility in static equilibrium to a "fair" rate of return on capital regulatory constraint. They showed that when the rate of return on capital constraint is binding, and when the "fair" rate of return is larger than the cost of capital, a utility has the incentive to overcapitalize; that is, to employ a capital-labor ratio that is larger than the one that minimizes costs for the chosen output level.[6] This is called the *A-J bias.*

Implicit in the A-J model is the assumption that the motivating factor behind regulatory action is the rate of return on capital. In the A-J model, the constraint on a utility's profit-maximization actions is that the actual rate of return on capital earned by a utility is no greater than the "fair" rate. Another assumption is that an active regulator continually monitors utility returns and pounds on a utility with a "visible hand" to maintain the equality of a utility's profits with its "fair" profits. When a utility's profits are less than its "fair" level of profits, the regulator calls a rate hearing to raise r and, hence, the utility's price of electricity. When a utility's profits are above the "fair" level, the regulator calls a rate hearing to lower r and the price of electricity.

With minor amendments, this view of regulatory behavior predominates in the economics literature, especially in empirical studies of electric utility behavior, with the exception of Joskow (1974).[7] Joskow agrees that rate-of-return regulation will give a utility the incentive to employ an inefficient mix of input factors, but he argues that the A-J bias may not always occur. In Joskow's view, regulators are political institutions whose objective is to minimize "conflict and criticism," not to keep the rate of return on capital equal to the "fair" rate.

One important source of conflict and criticism is an increase in the nominal price of electricity. Consumers will agitate against increases in electricity prices because they typically view these increases as price-gouging. If electricity prices are not increasing, and especially if they are falling, consumers are indifferent to the profits earned by a utility. Thus, Joskow argues that if utilities are able to adjust their production and investment decisions to raise their earned rates of return without raising electricity prices, they will not be thwarted by the regulator. In this case, there may be little A-J bias. On the other hand, Joskow argues that regulators do not initiate any actions to raise the rate of return on a utility's capital when it is below the "fair" rate unless requested to do so by the utility. Before a rate increase is granted, the utility will earn a return on capital below the "fair" return. In this case, an A-J bias may appear.

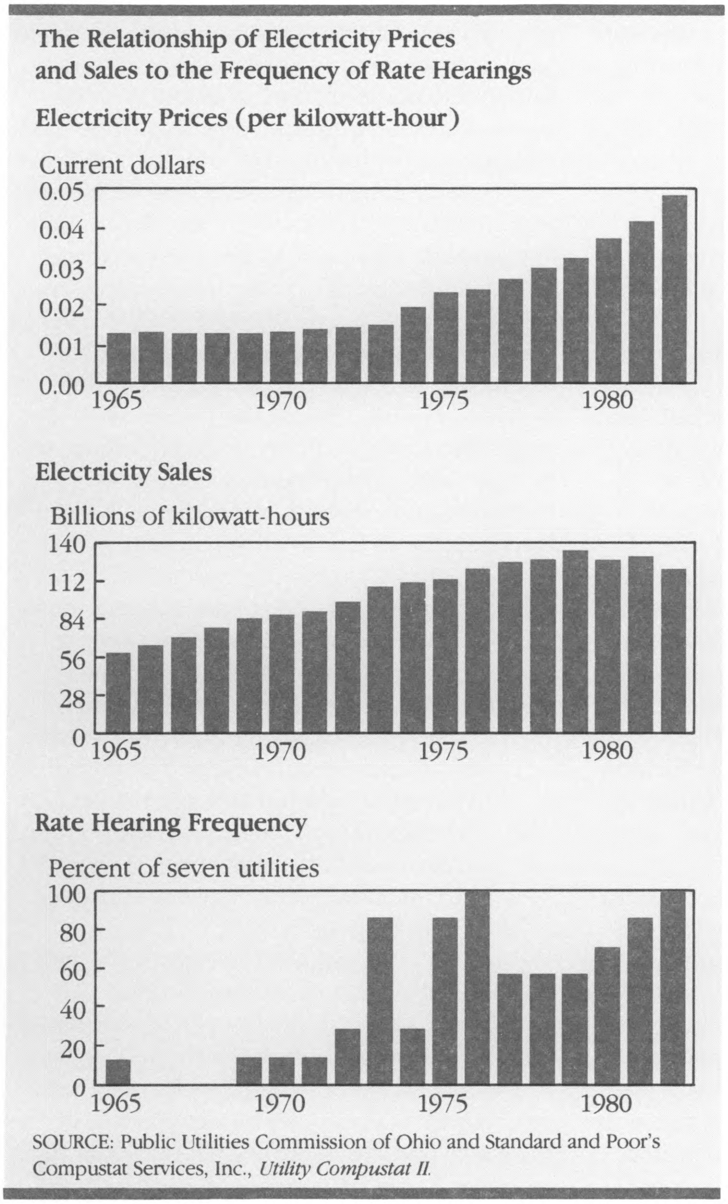
Thus, in contrast to the active A-J regulator, the Joskow regulator is passive, adjusting the rate of return on a utility's capital only when requested to do so by a utility or by a consumer advocate. As time passes, earned profits may deviate from "fair" profits if input prices, electricity demand, and other factors change, but the regulator does not initiate a price change to re-equate earned profits with "fair" profits until the next rate hearing. In the meantime, a utility can alter its production and investment decisions in ways opposite to those predicted by the A-J model. The "fair" rate of return is a means to an end (uncontroversial electricity prices), not an end in itself, in Joskow's view. After reviewing the regulatory experience across the U.S. between the 1950s and early 1970s, Joskow concludes that:

Contrary to the popular view, it *does not* ap-

5 Operating costs include all noncapital costs of production.

6 Actually, Baumol and Klevorick (1970) argue that Averch and Johnson did not prove this as a general result. Note that if there are additional production factors, then the amount of capital relative to these other inputs also will be higher than for the cost-minimizing firm.

7 A slight modification to the A-J regulatory process was the introduction of a "regulatory lag"; see, for example, Bailey and Coleman (1971) and Baumol and Klevorick (1970).



SOURCE: Public Utilities Commission of Ohio and Standard and Poor's Compustat Services, Inc., *Utility Compustat II.*

FIGURE 2

This regulatory process is therefore extremely passive. Regulators take no action regarding prices unless major increases or structural changes are *initiated by* the firms under its jurisdiction. In short, it is the firms themselves which trigger a regulatory rate of return review. There is no "allowed" rate of return that regulatory commissions are continually monitoring and at some specified point enforcing. (p. 298)

Because they work in a political environment, public utility commissions face other sources of conflict and criticism, which have resulted in two additional constraints on utility behavior. First, when energy costs increased rapidly in the mid-1970s, utilities requested rate hearings in greater numbers than in the past. This increased caseload put a large burden on regulatory agencies, who were accustomed to only a few hearings per year. The time lag between the request for a rate hearing and a change in electricity prices increased, and many utilities were forced to request another rate hearing immediately after their previous hearing. In order to shorten this lag and to appease utilities, regulators instituted fuel-cost-adjustment clauses that permitted utilities to pass on higher fuel costs to consumers without the need for a formal rate hearing.

Second, the fossil-fuel generators operating before the mid-1970s emitted a considerable amount of pollution into the atmosphere. Successful agitation by environmental advocates forced public utility commissions to establish limits on the amount of pollution that utilities could emit. These additional constraints complicate the analysis of the impact of a rate-of-return constraint on utility behavior.

pear that regulatory agencies have been concerned with regulating rates of return per se. The primary concern of regulatory commissions has been to keep *nominal prices from increasing.* Firms which can increase their earned rates of return without raising prices or by lowering prices (depending on changing cost and demand characteristics) have been permitted to earn virtually any rate of return that they can. *Formal regulatory action in the form of rate of return review is primarily triggered by firms attempting to raise the level of their rates or to make major changes in the structure of their rates.* The rate of return is then used to establish a new set of ceiling prices which the firm must live with until another regulatory hearing is triggered. General price *reductions* do not trigger regulatory review, but are routinely approved without formal rate of return review.

II. Rate Hearings and Average Costs of Ohio Utilities: 1965 to 1982

Some evidence consistent with Joskow's view of the regulatory mechanism is found in the history of rate hearings in Ohio between 1965 and 1982. To put this evidence into perspective, first consider the behavior of the average price per kilowatt-hour of electricity charged, and the quantity of kilowatt-hours sold, by the seven major Ohio electric utilities (figure 2).

For the purposes of this discussion, three distinct periods of different electricity price and consumption behavior can be seen: 1965 to 1968, 1969 to 1975, and 1976 to 1982.[8] Within

8 Note that the average price shown in figure 2 is not the regulated price, but the ratio of average total revenue for the seven utilities to their average total sales. In general, different consumers face different regulated price schedules, and utilities serving different geographic markets may be allowed to charge different prices for the same category of consumer.

each period, the directions of change in price and quantity were the same for each utility in the sample. During the 1965 to 1968 period, the average price of electricity changed very little and electricity sales rose considerably. During the 1969 to 1975 period, the average annual growth rate of electricity sales slowed, while that of prices increased greatly. Between 1976 and 1982, the electricity sales declined for the first time in Ohio's history, while prices increased at their fastest average annual percentage rate.

It is important to note that the average price shown in figure 2 is also the average cost of electricity. All regulators, including the PUCO, define the price of capital to be π divided by B, hence equating operating revenues with operating costs. The neoclassical economist's measure of average cost uses a market price of capital and, hence, the neoclassical measure of average costs can differ from the PUCO's definition. Berndt and Fuss (1986) argue that a capital price measure such as that used by the PUCO is more appropriate because it is a rental price or user cost of capital and because it controls for changes in capacity utilization. For these reasons, and because it is the measure the PUCO uses and to which utilities respond, the rental price of capital is employed in this paper.

Figure 2 also shows the percentage of the seven utilities requesting rate hearings in each year. In the first period, utilities rarely requested rate hearings, and their average costs were falling. This behavior corresponds with Joskow's first proposition: "During periods of falling average cost we expect to observe virtually no regulatory rate of return reviews" (p. 299). The average price of electricity was also falling during this period, consistent with Joskow's second proposition: "During periods of falling average costs we expect to observe constant or falling prices charged by regulated firms" (p. 299). Given that there were few rate hearings in this period, it is plausible that utility returns on capital were greater than or equal to the "fair" returns the PUCO would have defined had they been requested to do so.[9] According to Joskow, if actual returns were lower than the "fair" return, then the utilities would have asked for price increases. Hence Joskow's third proposition: "During periods of falling average costs we expect to observe rising or constant (profit maximizing) rates of return" (p. 299).

During the 1969 to 1975 period, average costs increased slightly, triggering a modest increase in the frequency of hearings, while during the 1976 to 1982 period, average costs increased tremendously. Production costs increased in the late 1960s because of inflation stimulated by economic policies; they increased very quickly and unexpectedly in the mid-1970s because of inflation engendered by worldwide food shortages and by the Arab oil embargo. For a given electricity price, such increases in operating costs drove utility profits below their "fair" levels. Utilities promptly responded to these cost increases by requesting electricity price increases that, in most cases, were granted by the PUCO. The frequency of hearings increased sharply as utilities had trouble keeping up with the effects of the rapid rise in costs. Viewing the 1969 to 1975 period as a transition from a period of falling average costs to one of rising average costs, the modest increase in rate hearings during this period is consistent with Joskow's fifth proposition:

> The transition from a period of falling average costs to one of rising average costs for a particular regulated industry will at first yield no observable increase in the number of rate of return reviews filed by the regulatory agency, but as cost increases continue more and more rate of return reviews are triggered as firms seek price increases to keep their earned rates of return at least at the level that they expect the commission will allow in a formal regulatory hearing. (p. 300)

For estimation purposes, the 1965 to 1982 interval was divided into two periods: 1965 to 1973 and 1974 to 1982. Testable hypotheses of the A-J and Joskow views deal with the absolute and relative production inefficiencies of the utilities in these two periods. The near absence of regulatory hearings in the first period would suggest, to both Joskow and A-J, that earned rates of return of these utilities were at least as great as "fair" rates of return. Averch and Johnson would argue that earned rates of return were lower than monopoly rates of return and, hence, that the A-J bias should exist in the first period. On the other hand, Joskow would argue that earned rates of return may have been close to monopoly rates. If this were true, then because monopoly rates are consistent with efficient production, there may have been very little A-J bias in the first period. Indeed, as Joskow argues in his seventh proposition, production may have been very efficient in the first period because reducing costs would have contributed to higher earned rates of return that were not taken away by regulators:

> During periods of falling or constant nominal average costs firms have an incentive to produce efficiently since all profits may be kept as long as prices stay below the level established by the regulatory commission in the last formal rate of return review. (p. 303)

9 It can never be known whether earned returns were greater than "fair" returns because there were no rate hearings for all firms during these years.

The high frequency of hearings in the 1974 to 1982 period suggests that earned rates of return for these utilities were lower than "fair" rates of return for most of the period; that is, $\pi < \pi_r$. Because these earned rates were even further away from monopolistic rates of return, Joskow would argue that it is more likely there are inefficiencies of the A-J type in the second period. His proposition eight says: "During periods of rising average costs A-J type biases may begin to become important" (p. 304). He does not exclude the possibility that firms may continue to try to be as efficient as they were in the first period in order to earn greater than "fair" rates of return. However, he argues:

> Unless the direction of the cost path can be changed, however, the continuous interaction of firms and regulators in formal regulatory hearings, resulting from the necessity to raise output prices, is exactly the situation for which the A-J type model (with some modifications) would hold. I would therefore expect that it is under this situation of continuously rising output prices, triggering rate of return reviews that the A-J type models and the associated results are most useful. (p. 304)

Thus, Joskow would argue that utilities would try to organize their production more efficiently in the first period than in the second period. His concept of production efficiency includes the static notion of employing currently available production inputs in the least-cost way for any given level of output (that is, employing the least-cost combination of inputs along a given isoquant) and the dynamic notion of investing in more productive capital over time (that is, investing in productive capital to push the family of isoquants toward the origin). Averch and Johnson deal only with the static notion of productive inefficiency because their model analyzes a static equilibrium. They would argue that the amounts of this static inefficiency are the same in both periods because they assume a regulator who maintains the earned rate of return on capital at its "fair" rate.

The distinction between the static and dynamic notions of production efficiency is important. When a public utility commission conducts a rate hearing, it pays attention only to the static notion of production efficiency. Indeed, most models of regulatory impact deal only with the static notion. However, it is conceivable that regulation also affects the rate of technical change implemented by utilities; if regulation biases the amount of capital employed by a utility, it may also bias the type of capital employed. Regulatory impacts on overall inefficiency and on the rate of technical change are estimated below.

III. Empirical Evidence About the A-J and Joskow Views

The A-J and Joskow views are examined using a modified version of the Atkinson and Halvorsen (1984) generalized long-run cost-function approach with capital (K), labor (L), and fuel (F) as inputs.[10] Atkinson and Halvorsen argued that the long-run neoclassical cost-function approach is incorrect for a regulated firm because it assumes the firm is minimizing costs in a perfectly competitive world constrained only to produce a given level of output.[11] When a firm is subject to a number of regulatory constraints, as is generally true today, firms view all input prices differently from their market or rental prices. The exact specification of these nonmarket or "shadow" prices depends on the exact form of the additional constraints. Atkinson and Halvorsen approximated these shadow prices by simple proportional relationships with market prices; that is, the shadow price of input i: $P_i^* = k_i P_i$, where P_i is its market price and k_i is a constant. Thus, the generalized cost function is simply the neoclassical cost function with P_i^* substituted for P_i. Instead of minimizing long-run actual costs, a utility is assumed to minimize long-run *shadow* costs by equating the *shadow* marginal cost of each input with the amount of the input used.

The modifications made to the Atkinson and Halvorsen approach are 1) the inclusion of time variables to accommodate panel data and to permit the estimation of total factor productivity (*TFP*) and its returns to scale and pure technical change components, and 2) the distinction between the 1965 to 1973 and 1974 to 1982 time periods.

TFP is measured as the change in the cost of production not due to changes in input prices, and reflects the overall productivity of all inputs rather than the productivity of a single input such as labor. The neoclassical approach to the measurement of *TFP* assumes an optimal distribution of production resources in a firm, which is an inappropriate assumption for regulated electric utilities. The generalized-cost-function approach yields an estimate of *TFP* that is consistent with regulated behavior. The most important variable for examining Joskow's view on productivity behavior is the pure technical change component of *TFP*. Gollop and Roberts (1981), among others, argue that this component is a better measure of productivity than *TFP*.

10 See Israilevich and Kowalewski (1987) for complete details about the data, the specification and estimation of the shadow-cost model, and the results.

11 Nevertheless, some authors, for example Gollop and Roberts (1981, 1983), use the neoclassical approach to study electric utilities.

The distinction between the two periods is made by estimating separate coefficients for them. This allows the production decisions, as well as the degree of regulatory constraint, to differ between the two periods.[12]

The k_i coefficients measure the degree to which the neoclassical first-order conditions are not satisfied and, hence, serve to test for production input biases. If all k_i equal one, then shadow prices equal market and rental prices, and regulation does not affect production decisions; actual, not shadow, long-run costs are minimized. If the k_i for all inputs except capital equal one, then there is only an overcapitalization bias. If any other k_i do not equal one, regardless of the k_i value for capital, then the A-J view is rejected.

The results of estimating the model over the 1965 to 1982 period show that both k_K and k_F are separately and jointly statistically different from one at better than a 5 percent significance level in both periods.[13] Thus, production efficiency is rejected, and the neoclassical cost-function approach for regulated firms employed by Gollop and Roberts (1981) and others is inappropriate for this sample. Moreover, these results reject the A-J view over the whole sample; regulation affects the efficient utilization of all production inputs by these utilities.

Another test of the A-J view, and a test of the implications of Joskow's view, is whether production inefficiencies resulting from regulation differ in the 1965 to 1973 and 1974 to 1982 periods. The A-J view is that the inefficiencies should be the same in each period, while the Joskow view is that there should be greater inefficiencies in the second period than in the first. Two approaches are taken here. In the first, the differences in k_K and k_F are examined. The A-J view is not rejected if the difference in k_K between the two periods is insignificantly different from zero and both k_F equal one. If the k_i suggest greater inefficiencies in the second period than in the first, then the Joskow view is not rejected.

The test results show that the A-J view is rejected at better than 0.5 percent, and the differences in the k_K and k_F coefficients between the two periods are significantly different from zero at better than 5 percent. However, the Joskow view is also rejected, because the differences in the k_K and k_F coefficients, second period minus the first, are significantly negative; to not reject Joskow, this difference should have been positive. Unfortunately, due to technical reasons related to the specification of the cost function, the sources of the differences in these coefficients cannot be identified.

The second approach examines estimates of the differences in total and dynamic inefficiency due to regulation between the two periods. The full cost of regulation and, hence, the magnitude of the inefficiencies created by regulation, cannot be estimated because there is no evidence to suggest how the utilities would have organized their production had regulation not existed over the sample period. Of course, it is impossible to know how these utilities would have behaved without regulatory constraints. For example, the activities of production and distribution might have been separated, different amounts of capital might have been employed, and different technologies might have been chosen.[14] Hence, it is impossible to know what these firms' cost functions and associated returns to scale and productivities would have been.

"Instantaneous" inefficiency estimates can be computed, however. A total inefficiency measure compares actual utility costs predicted by the estimated model with the actual costs predicted by the model, but with k_K and k_F set equal to one in both periods. That is, current production costs for actual levels of output, which are generated by current capital, labor, and fuel inputs; production techniques; and regulatory constraints, are compared with the costs generated with the same input levels and production techniques and for the same actual output levels, but without the regulatory constraints. This estimate, also examined by Atkinson and Halvorsen, measures the shift in the cost curve due to regulation.

An estimate of the dynamic notion of inefficiency can be obtained by examining the technical change experienced by these utilities with and without regulation. Technical change is defined here as the negative of the derivative of total costs with respect to time, holding all other factors constant. It is a function of a constant term, shadow input prices, output (returns to scale), and time, and it shifts the position of a firm's average cost curve over time. As above, technical change with regulation is that implied by the estimated model; technical change without regulation is that implied by the estimated model, but with k_F and k_K set equal to one. The difference does not have a real-world coun-

12 A test of similar production behavior in the two periods was convincingly rejected.

13 For technical reasons, only two of the three k_i can be estimated. The k_i coefficient on the price of labor is normalized to one, and only k_K and k_F, for capital and fuel, respectively, are estimated.

14 Under the current regulatory environment, the production and distribution of electricity must be handled by each utility. Moreover, the transferal of electric power across state lines is also impeded.

terpart or explanation, but it does indicate the direction of regulatory bias.

These inefficiency estimates provide mixed evidence about Joskow's view. The difference in the total inefficiency measure between the two periods is the opposite of Joskow's expectation. Instead of greater total inefficiency in the second period, when Joskow expects regulatory constraints to be binding, our estimates show greater total inefficiency in the first period, when Joskow expects regulatory constraints to be less binding. In the first period, the total inefficiency varies between 26 percent and 49 percent and averages 36 percent. In the second period, it varies between 16 percent and 19 percent and averages 17 percent. This difference in total inefficiency squares with the differences in k_K and k_F between the two periods described earlier.

An interesting feature of these total inefficiency estimates is their large magnitude in the first period. Atkinson and Halvorsen find much smaller inefficiency losses (9.0 percent) in their cross-section sample, which includes two of our firms.[15] However, the Atkinson and Halvorsen result captures only the static portion of total inefficiency costs because the authors do not use time variables in their cost equation. Our estimates include the dynamic inefficiency costs and, hence, are more representative of the total costs of regulation.

The difference between the Atkinson and Halvorsen result and ours suggests that the dynamic inefficiency may be quite large. Indeed, we find that regulation retarded the growth of technical change, on average, by 0.3 percentage point per year in the first period and by 0.4 percentage point per year in the second. This is an important result, and one that has been neglected by economists and regulators alike. Regulation not only affects the efficient utilization of existing production inputs, but it also affects the implementation of efficient capital and management techniques over time. Unlike our total inefficiency estimates, our dynamic inefficiency estimates support Joskow's view.

The behavior of technical change over time also confirms Joskow's view. Table 1 shows the technical-change estimates over the whole period, averaged over all firms for each year. As Joskow argues, the rate of technical change is lower in the second period, when he expects regulatory constraints to be more binding.

The most notable characteristic about these technical-change estimates is their strong downward trend.[16] Starting at 0.3 percent in 1965, the annual average rate of technical change drops steadily each year to -4.6 percent in 1982. This rather uniform decline, except around 1973 and 1974, when period one ends and period two begins, is due to dominant estimated time trends in each period. That shadow input prices have little influence on technical change is not surprising, because electricity production offers little opportunity for input substitution in the short and medium runs. The time trend captures the effects of pure technical change embodied in the capital investments of these utilities and may be additional evidence in favor of Joskow's seventh proposition. Although this is not conclusive proof of Joskow's seventh proposition, because we do not know the nature of the capital investments made in these and earlier periods, it at least does not contradict it.

Estimated Technical Change

Year	Technical change in percentage points, average over firms
1965	0.3
1966	-0.1
1967	-0.3
1968	-0.6
1969	-1.0
1970	-1.2
1971	-1.4
1972	-1.7
1973	-2.0
1974	-3.4
1975	-3.6
1976	-3.6
1977	-3.8
1978	-3.8
1979	-4.0
1980	-4.2
1981	-4.4
1982	-4.6
Average over year	
1965-1973	-0.9
1974-1982	-3.9

SOURCE: Authors.

TABLE 1

15 It is likely that our estimates are more accurate for Ohio because our sample includes only Ohio firms, which are fairly similar in a number of important respects, as mentioned earlier.

16 A strong downward trend in the rates of technical change experienced by utilities also was found by Nelson and Wohar (1983), Gollop and Roberts (1981), and Gollop and Jorgenson (1980), all of whom used samples that ended in the 1970s. Thus, the results reported here confirm these earlier findings for the late 1970s and early 1980s.

IV. Summary and Conclusions

Electric utility regulators attempt to maintain a competitive price for electricity by adjusting the rate of return on a utility's capital. At first blush, this price-setting scheme appears sensible. It seems reasonably efficient to allow utilities to pass along operating costs and cover their cost of capital. However, potentially serious problems with this type of regulation relate to consumer reactions to price increases and to the types of incentives given to utilities. First, price increases may lower the consumption of electricity, which may reduce earned rates of return below "fair" rates and trigger a price increase, which in turn may lower consumption and trigger another price increase, and so on. That is, the proper response to falling utility profits because of lower demand may not be to raise prices.

Second, utilities may be able to effect price increases by overcapitalizing, which inflates their rate base. Indeed, rate increases lower the risk of capital investment below the risk level of unregulated industries, clearly giving utilities the incentive to overcapitalize. This potential bias was recognized by Averch and Johnson, and many empirical studies that adopted their model found an overcapitalization bias.

Finally, the ability to pass along operating cost increases that originated from productivity declines suggests that utilities may not have the incentive to raise productivity. This dynamic source of inefficiency was recognized by Joskow, who also argued that the regulatory mechanism is more complicated than that assumed by Averch and Johnson.

This paper is, to our knowledge, the first to test the A-J view against Joskow's more general view. Using a modified version of the generalized long-run cost function derived by Atkinson and Halvorsen (1984) and a sample of the seven major electric utilities in Ohio over the 1965 to 1982 period, substantial evidence is found against the A-J view. However, the evidence is not wholly in agreement with Joskow's view, either. The circumstantial rate hearing evidence is consistent with Joskow's view of the regulatory mechanism, but our estimation results do not wholly confirm the implications Joskow draws from his regulatory mechanism. Two sets of results imply that regulatory constraints were more binding during the years in which Joskow expects them to be less binding. Nevertheless, in accordance with Joskow's view, we find that regulation substantially retards the rate of technical change experienced by these utilities, and the retardation is greater when Joskow expects regulation to be more binding. This is the first demonstration of a regulatory impact on technical change. It clearly suggests that regulators ought to pay closer attention to the incentives they give utilities to innovate.[17]

A reconciliation of these findings is difficult. They may suggest that the circumstantial rate hearing evidence is not closely correlated with the degree of regulatory constraint. Utilities may have been constrained in the 1965 to 1973 period by the possibility or fear of a rate hearing that would eliminate the above "fair" returns they were currently earning. Another possibility is that frequent rate hearings in the 1974 to 1982 period prevented utilities from artificially fattening their rate bases. That is, given the incentive to overcapitalize, utilities were prevented from taking advantage of the regulatory system by frequent and accurate regulatory review. In this case, the price of electricity may have remained close to competitive levels, where production, though different from monopolistic levels, nonetheless is efficient. The poor technical-change performance between 1974 and 1982 may be the primary cause of the greater rate-hearing frequency, and not the reverse.

Or Joskow may be correct, and utilities were simply lax about maintaining efficient production in the first period, or they anticipated future regulatory constraints and took actions to fatten their rate bases while they had the opportunity.[18] Clearly, there is much to learn about the impact of regulation on utility performance.

17 The poor technical-change performance also may be due to increased investment in nuclear power plants. Many of these plants were cancelled after the mid-1970s, but they diverted managerial attention and funds away from conventional power-generation capital investments.

18 Joskow can also be defended by arguing that our inefficiency measures are incorrect. As was mentioned earlier, it can never be known how utilities would have behaved without regulation. Without this knowledge, any inefficiency measure can be faulted. Nevertheless, the estimated change in k_F and k_K between the two periods is hard evidence against Joskow's view.

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Views from the Ohio Manufacturing Index

by Michael F. Bryan
and Ralph L. Day

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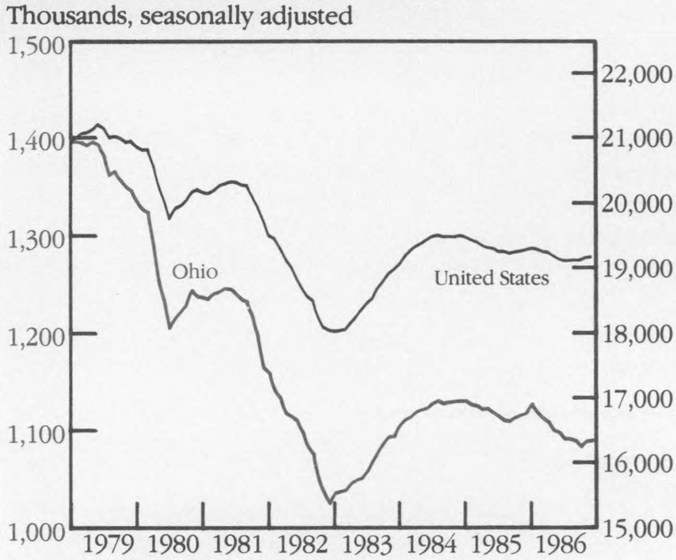
A Preview

Economists and other observers are closely examining the manufacturing sector these days, fearing that America's industrial base is disappearing. Certainly, the steady decline in the proportion of total jobs in manufacturing, as shown in figure 1, supports this view. However, a more careful look reveals that manufacturing's overall share of real national output has remained essentially unchanged since 1950.[1]

Ohio and U.S. Manufacturing Employment
Thousands, seasonally adjusted



SOURCE: Bureau of Labor Statistics and Ohio Bureau of Employment Services.

FIGURE 1

A more reasonable worry, it would seem, is the uneven regional distribution of manufacturing growth that is obscured by nationally aggregated data. Unfortunately, the information used by analysts to evaluate regional manufacturing output has been limited to quinquennial census data and, when available, annual survey data.

Lack of timely regional data prompted the establishment of regionally based production indexes by the Federal Reserve Banks of Atlanta, Boston, Dallas, and San Francisco.[2] The Federal Reserve Bank of Cleveland has recently developed a monthly manufacturing production index for the state of Ohio—the Ohio Manufacturing Index (OMI).

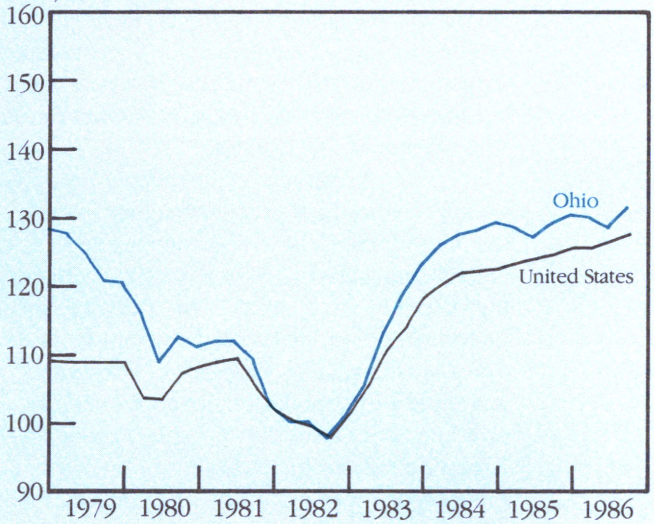
The OMI is an experimental index of real output by Ohio manufacturers that is derived from state-level manufacturing employment and electric power consumption data. The OMI tracks manufacturing output at the two-digit standard industrial classification (SIC) level of aggregation, beginning in January 1979 and ending in December 1986. The methodology and procedures used to develop the index are outlined in the technical appendix that follows this article.

1 For an overview of developments in the U.S. manufacturing sector, see Michael F. Bryan, "Is Manufacturing Disappearing?" *Economic Commentary*, Federal Reserve Bank of Cleveland, July 15, 1985; and Patricia E. Beeson and Michael F. Bryan, "The Emerging Service Economy," *Economic Commentary*, Federal Reserve Bank of Cleveland, June 15, 1986.

2 Regional production indexes produced by the Federal Reserve Banks of Boston and Atlanta have been discontinued, primarily due to budget reductions.

In 1984, Ohio firms represented 6.3 percent of the nation's manufacturing output, making Ohio the third-largest manufacturing state, trailing only California (11.0 percent) and New York (7.4 percent) in manufacturing prominence.[3]

Manufacturing Output
Index, 1982 = 100



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 2

Despite this size, the cyclical patterns of Ohio's manufacturing output remain largely unseen and are often thought to mirror national manufacturing trends. Yet, evidence from the OMI suggests that important differences exist between U.S. and Ohio manufacturers, particularly within individual industries. In this article, we introduce the OMI and discuss the new perspective it provides of manufacturing trends in Ohio.

Distribution of Manufacturing Output by State, 1984 (ten largest manufacturing states, nominal dollars)

State	Value Added (millions $)	Share of Nation	Distribution of Output: Durable (%)*	Nondurable (%)
United States	983,560	—	57.6	42.4
1. California	108,373	11.0	68.1	31.9
2. New York	72,361	7.4	53.7	46.3
3. OHIO	62,346	6.3	68.3	31.7
4. Texas	55,556	5.6	49.9	50.1
5. Illinois	55,246	5.6	56.1	43.9
6. Michigan	53,069	5.4	75.8	24.2
7. Pennsylvania	51,725	5.3	56.2	43.8
8. N. Carolina	36,682	3.7	38.7	61.3
9. New Jersey	36,543	3.7	43.3	56.7
10. Indiana	33,762	3.4	70.3	29.7

*Durable-goods manufacturing is defined to include SICs 24, 25, and 32-39.
SOURCE: 1984 Annual Survey of Manufactures, Bureau of the Census.

TABLE 1

I. A View of the Forest

Manufacturing employment in Ohio reached a peak of 1.4 million workers in March 1979. At that time, manufacturing industries employed more than 30 percent of the state's workers. Since 1979, however, manufacturing employment in Ohio has fallen by more than 20 percent. In recent months, it was roughly 1.1 million workers, or about 20 percent of Ohio's civilian work force (figure 1). As in the nation, Ohio's manufacturing sector has failed to register significant employment growth in nearly three years.

However, because the relationship between employment and output is not constant over time, due to changes in productivity and to the substitution of capital for labor, inferences about the manufacturing sector drawn exclusively from a labor perspective can be misleading.

Unlike employment, real manufacturing output in Ohio, as measured by the OMI, has been rising throughout most of the current economic expansion (figure 2). Between the recessionary trough occurring in the fourth quarter of 1982 and the fourth quarter of 1986, real manufacturing output in the state rose 34.7 percent. Manufacturing output at the national level grew at a slower pace over the period, 30.4 percent.[4]

Differences between U.S. and Ohio manufacturing output trends arise principally from two related sources. First, the level of real output per worker (labor productivity) and the growth rate of labor productivity are greater in Ohio than in the rest of the country. Furthermore, the Ohio manufacturing business cycle tends to be more sharp than the national cycle, a consequence of the state's concentration of durable-goods manufacturing.

For example, 1984 census data show that Ohio workers produced roughly 8 percent more real manufacturing output per worker than is produced nationally. Between 1982 and 1984, the rate of growth in labor productivity for Ohio manufacturers was roughly 20 percent, compared with only a 16 percent gain for the nation.[5] More-

3 Output estimates are based on value added.

4 The U.S. and Ohio manufacturing indexes may not be perfectly comparable because of differences in methodology. However, many of the data sources and the fundamental structure of the indexes are the same.

5 These productivity estimates are based on real value added per worker. Value added and employment data come from the Survey of Manufactures. Nominal value-added estimates were deflated using national price deflators supplied by the U.S. Department of Commerce.

over, evidence from the OMI indicates that Ohio's leading growth industries generally have above-average labor productivity. As a result, slightly slower rates of growth in total manufacturing employment since 1982 generated somewhat greater real manufacturing output gains for Ohio manufacturers than for U.S. manufacturers.

Distribution of the Ohio Manufacturing Sector by Industry, 1984
(durable-goods industries in CAPITALS)

Industry (SIC)	Industry Importance To Ohio (%)	Industry Importance To U.S. (%)	Ohio Share of U.S. (%)	Rank in the U.S.
1. TRANSPORTATION EQUIPMENT (37)	17.8	11.6	9.7	3
2. FABRICATED METALS (34)	12.6	6.9	11.6	1
3. NONELECTRICAL MACHINERY (35)	11.5	11.4	6.4	3
4. PRIMARY METALS (33)	9.7	4.3	14.3	1
5. Chemicals and Allied Products (28)	8.9	9.6	5.9	5
6. ELECTRICAL MACHINERY (36)	8.8	11.2	4.9	5
7. Food and Kindred Products (20)	7.7	10.0	4.9	6
8. Rubber and Plastics (30)	5.5	3.5	10.0	1
9. Printing and Publishing (27)	4.9	6.8	4.6	6
10. STONE, CLAY, AND GLASS (32)	3.6	2.8	8.1	2
11. Paper and Allied Products (26)	2.6	4.2	4.0	8
12. INSTRUMENTS	1.7	4.1	2.6	17
Remaining Manufacturers	4.7	13.6	2.2	—

SOURCE: 1984 Annual Survey of Manufactures, Bureau of the Census.

TABLE 2

Ohio's manufacturing recovery was also preceded by a contraction that occurred earlier and was more severe than that experienced nationally. To illustrate, Ohio's last manufacturing recession may be more accurately viewed as a combination of two recessions. Between the first quarter of 1979 and the third quarter of 1980, manufacturing output in Ohio declined by slightly over 15 percent—about three times the percentage drop felt at the national level (5.2 percent). Ohio's second manufacturing contraction began in the third quarter of 1981, and by the fourth quarter of 1982, manufacturing production had fallen 12.6 percent, compared with a 10.7 percent decline over the same period for all U.S. manufacturers.

The relatively sharp business cycle experienced by Ohio manufacturers reflects the state's industrial composition (table 1). In the latest survey year, 1984, durable-goods manufacturing represented 68.3 percent of the state's total manufacturing output. Ohio is not the most durable-goods-intensive state of the 10 largest manufacturing states—Michigan's durable-goods share was 75.8 percent in 1984 and Indiana's share was 70.3 percent. However, the relative size of durable-goods manufacturing is considerably greater in Ohio than is the case nationally, where durable-goods manufacturing accounted for only 57.6 percent of the 1984 total.

Michigan's dependence on durable-goods production is primarily a consequence of the automobile industry's dominance in that state (representing about 36 percent of its manufacturing output in 1984), while Ohio's durable-goods sector is more broad-based. For example, in 1984, Ohio's manufacturing output was distributed among five important durable-goods and one nondurable-goods industry (table 2). The state's largest manufacturing industry was transportation equipment, representing 17.8 percent of its overall manufacturing production, compared with a contribution of only 11.6 percent at the national level. Following transportation equipment were the fabricated metals (12.6 percent), nonelectrical machinery (11.5 percent), primary metals (9.7 percent), chemicals (8.9 percent), and electrical machinery (8.8 percent) industries.

In 1984, Ohio led all states in output for two durable-goods industries, fabricated metals and primary metals, and for one nondurable-goods industry, rubber and plastics. In addition, Ohio manufacturers were the second-leading producers of stone, clay, and glass products and the third-leading producers of transportation equipment and nonelectrical machinery, all durable-goods industries.

Historically, durable-goods producers have suffered more pronounced business-cycle swings than nondurable-goods producers; a phenomenon, it would seem, that is not yet clearly understood (figure 3). One view is that changes in the economic climate, which are accompanied by fluctuations in income and interest rates, result in intertemporal substitutions by consumers. Because durable goods, by definition, involve a longer consumption horizon than nondurable goods, these intertemporal substitutions are more keenly felt in the consumer durables market.

A possibly complementary view, from the perspective of the firm, is that changes in the desired capital stock, such as those arising from changes in consumer demand, generate exaggerated swings in net investment. This "acceleration principle" implies that the more "durable" the capital stock, the more pronounced

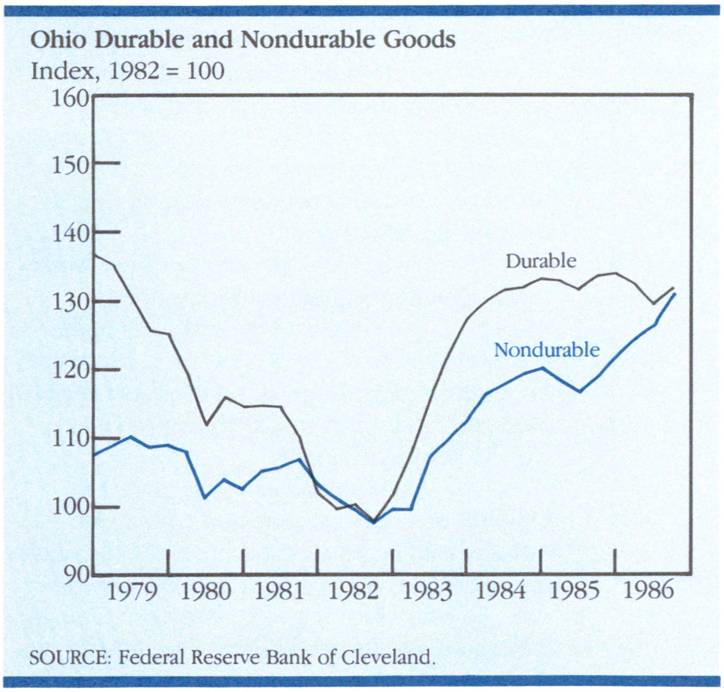


FIGURE 3

the production cycle for capital goods.

Beyond its business-cycle implications, Ohio's industrial mix probably makes the state's manufacturing sector more vulnerable to pressure from foreign rivals, and implies that Ohio's manufacturing economy is more sensitive to international trade fluctuations than is the national manufacturing economy. A recent analysis of the impact of exchange-rate movements on manufacturing revealed that a 10 percent increase in the value of the dollar generates about a 0.8 percent decrease in U.S. manufacturing output, whereas in Ohio, a similar exchange-rate increase generates roughly a 1.0 percent decrease in manufacturing output.[6]

Indeed, the 6 percent plunge in the value of the dollar between June and September 1986 was probably welcomed by Ohio's manufacturers, as the OMI showed five consecutive monthly advances between July and December 1986, and increased 2.3 percent in the final quarter, compared with only a 0.8 percent increase nationally.

From the broad perspective, then, Ohio's manufacturing economy seems to be characterized by a rather pronounced cycle, resulting from the combined influence of a large concentration of durable-goods manufacturers and a relatively high and growing level of productivity.

II. A View of the Trees

At the industry level, differences between the Ohio and national manufacturing economies are more striking. In some industries, the performance of Ohio's manufacturers between 1979 and 1986 exceeded national growth rates, and in a few cases, such as chemicals and fabricated metals, Ohio's growth has been impressive. Other industries, including paper, printing, electrical machinery, and stone, clay, and glass manufacturing, have lost ground relative to the rest of the country since 1979.

It is not the intention of this analysis to discuss each industry in detail, and only the state's largest industries have been singled out for comment. Industries that are not expressly considered in this section are presented in figures 4h through 4o at the end of the article.

• Transportation Equipment

Transportation equipment manufacturing, traditionally a pivotal industry in the national business cycle, was hit particularly hard by the recessions of the 1980s. The ensuing expansions, however, allowed transportation manufacturers in the U.S. and Ohio to surpass the output peaks established in 1979 (figure 4a).

Over the expansionary period spanning the fourth quarter of 1982 and the fourth quarter of 1986, transportation equipment output in the U.S. grew 48.2 percent. Over the same period, this industry's growth rate in Ohio was 50.4 percent, making transportation equipment production one of Ohio's fastest-growing manufacturing industries in recent years. Indeed, evidence from the OMI suggests that transportation

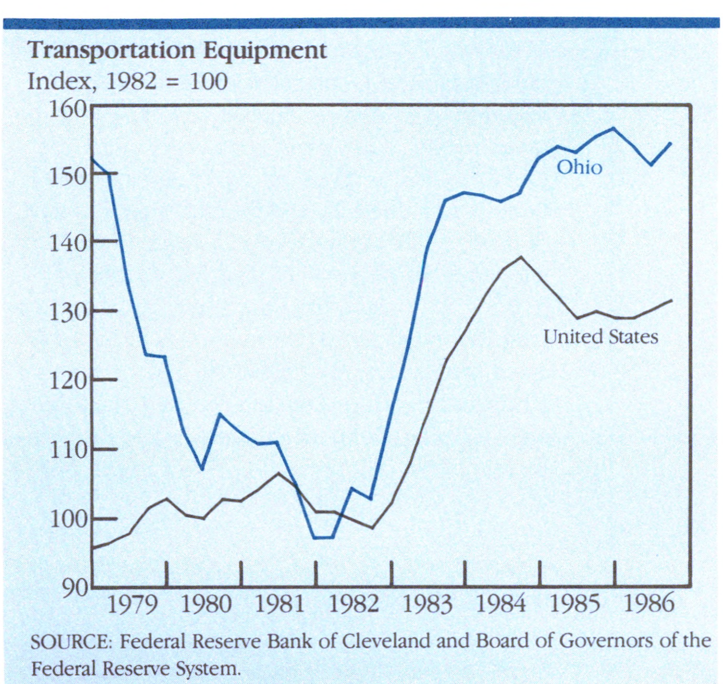
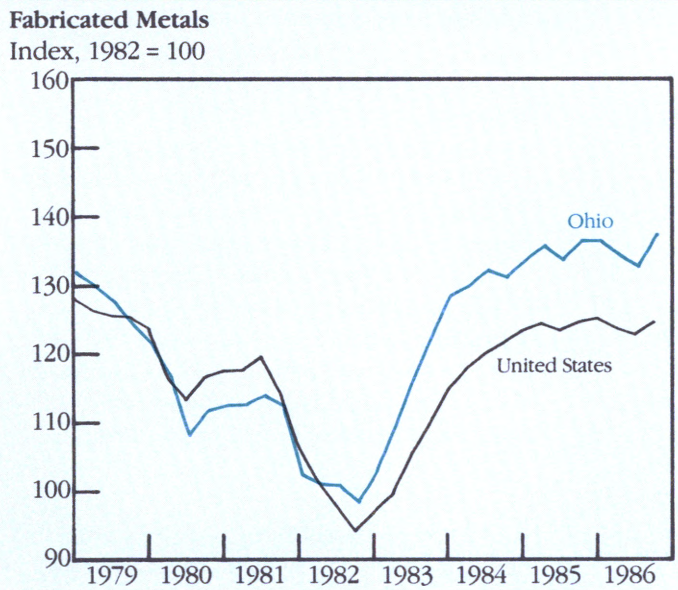


FIGURE 4A

6 See CBO Staff Working Paper, "The Dollar in Foreign Exchange and U.S. Industrial Production," December 1985; and Amy Durrell, Philip Israilevich, and K.J. Kowalewski, "Will the Dollar's Decline Help Ohio Manufacturers?" *Economic Commentary*, Federal Reserve Bank of Cleveland, August 15, 1986.



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 4B

equipment production has generated about 25 percent of the state's manufacturing output growth since 1982 and may currently represent more than 20 percent of its manufacturing economy.

There are a number of reasons that Ohio's transportation equipment producers have expanded rapidly since 1982. For one, motor vehicle production, the fastest-growing component in the transportation field in this decade, represents a larger share of transportation equipment output in Ohio (about 70 percent) than it does nationally (about 48 percent). It would seem that motor vehicle production also contributed to Ohio's relatively severe decline in real transportation equipment output between 1979 and 1982.

Despite some strength since 1983, production of aircraft, railroads, and ships changed little between 1980 and 1985. These industries are significantly less important to the state's manufacturing economy than they are to the national economy.

In addition, real output per worker in transportation equipment production is roughly 15 percent greater in Ohio than in the U.S., and the rate of growth in labor productivity for transportation equipment workers between 1982 and 1984 was about 28 percent, compared with 19 percent nationally.

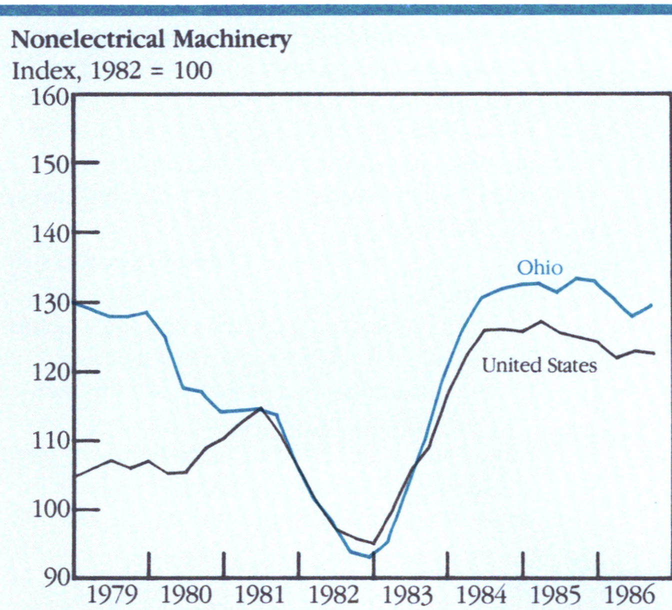
Another contributing factor to Ohio's recovering transportation equipment industry has been the establishment of a Japanese auto plant, and its supporting suppliers, in the state. Honda, which began producing in Ohio in 1982, currently assembles more than 145,000 cars there annually, generating roughly $650 million in annual manufacturing output.[7]

Fabricated Metals

Fabricated metals has been a growth industry in Ohio's manufacturing economy (figure 4b). Although the state's fabricated metals manufacturers experienced approximately the same contraction as national manufacturers did over the 16 quarters between 1979 first quarter and 1982 fourth quarter (-25.6 percent versus -26.5 percent nationally), the recovery of fabricated metals production in Ohio has been stronger than the pace set nationally (40.0 percent over the 16 quarters ending in 1986 fourth quarter, compared with 32.3 percent for the nation).

Again, some of Ohio's improvement in fabricated metals production can be traced to a decided productivity advantage for the state. In 1984, real output per worker in fabricated metals was about 21 percent greater in Ohio than in the U.S., and the state's growth rate of productivity in this industry exceeded the U.S. rate (roughly 22 percent versus 14 percent).

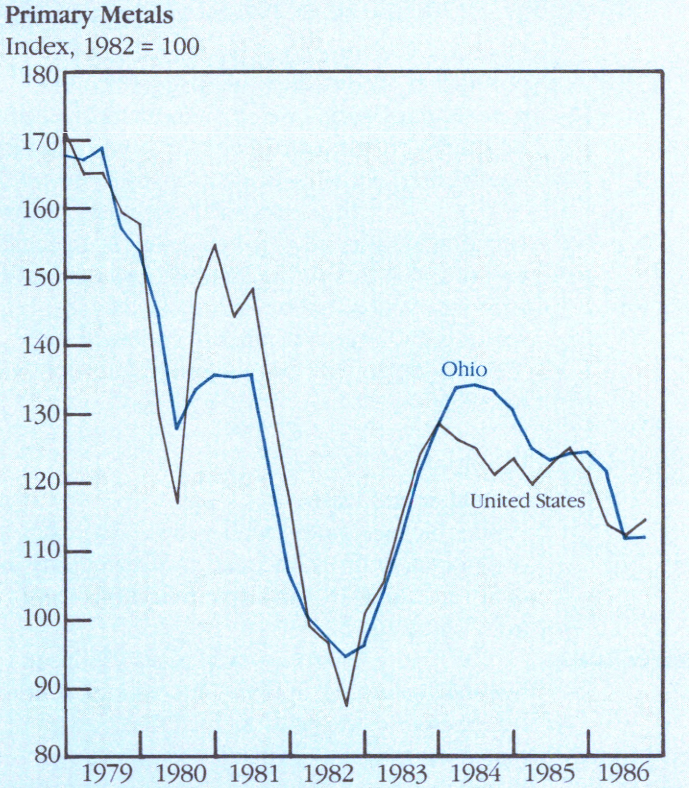
Industrial mix also appears to be a contributing factor to Ohio's success in the fabricated metals area. About one-third of the state's fabricated metals production occurs in the forging and stampings field, whereas nationally this industry represents only about 18 percent of the fabri-



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 4C

7 These estimates assume domestic content of 50.0 percent, on an average 1985 new-car cost of $8,845. Not all of the U.S. content is captured in Ohio, as some domestic suppliers are located outside the state. See Michael F. Bryan and Michael W. Dvorak, "American Automobile Manufacturing: It's Turning Japanese," *Economic Commentary*, Federal Reserve Bank of Cleveland, March 1, 1986.



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 4D

cated metals output. The forging and stampings industry generates much of its demand from production of consumer durables, particularly motor vehicles which, as stated earlier, have been important contributors to the current economic expansion.

At the national level, the fabricated metals industry has been dominated by the production of structural metals, which are used primarily in construction—an industry that has not fared as well as consumer durables during the recovery to date.

• Nonelectrical Machinery

Although the recovery in Ohio's nonelectrical machinery industry has been slightly greater than that experienced nationally (figure 4c), production of nonelectrical machinery in the state suffered a sharper decline during the recessions of 1980 to 1982. Between 1979 first quarter and 1982 fourth quarter, Ohio nonelectrical machinery production was off 27.8 percent versus a decline of only 8.6 percent nationally.

In this industry, at least, differences in productivity and productivity growth rates are not a major factor in industrial growth rate differences between the U.S. and Ohio. Here, the differences in national and Ohio industry performance are probably related to the mix of industries within the nonelectrical machinery category.

Ohio manufacturers rely heavily on the production of metalworking machinery, an industry dependent on durable-goods demand and one that has been under pressure in recent years from foreign competition. Approximately 20 percent of Ohio's nonelectrical machinery involves the production of metalworking machinery, more than twice the national incidence.

Surprisingly enough, the national nonelectrical machinery industry is heavily dominated by computer manufacturing, which generates roughly 25 percent of the nation's nonelectrical machinery output, but which accounts for only about 7 percent of the nonelectrical machinery output in Ohio. Computer production, which set a blistering pace early in this decade, has slowed appreciably since 1984.

• Primary Metals

Ohio is the largest producer of primary metals in the nation, as a result of its heavy concentration of steel and iron makers. And, as is true nationally, the performance in Ohio's primary metals industry has failed to regain the ground lost since 1979 (figure 4d). Data from the OMI indicate that at year-end 1986, Ohio primary metals makers were producing at only about 68 percent of their average 1979 output.

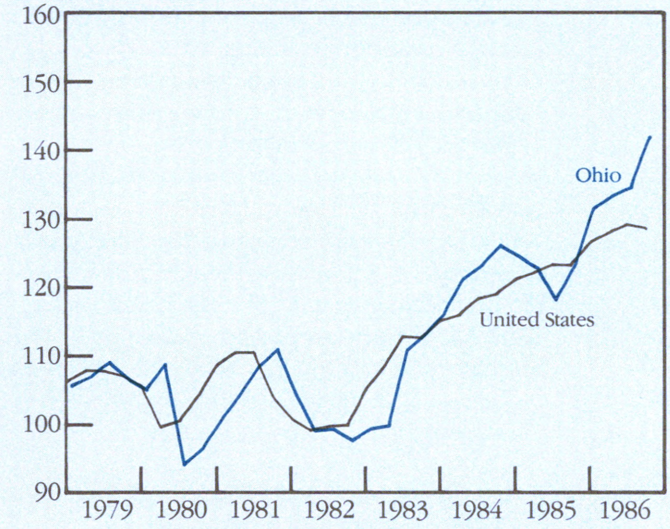
Ohio's experience in the primary metals area has been virtually identical to the nation's, even though real output per worker in this industry is apparently greater in Ohio than in the U.S. (about 23 percent more in 1984).

• Chemicals and Allied Products

In the U.S., the chemicals and allied products industry means drugs (more than 22 percent compared with 5 percent in Ohio), but in Ohio it means soaps (34 percent versus 18 percent nationally). The patterns outlined by the OMI suggest that, despite similar performances between 1979 and 1985, Ohio chemicals producers substantially outpaced the nation last year (figure 4e). During the current expansion (ending in the fourth quarter of 1986), the growth rate of the chemicals industry nationally was 28.5 percent, which is well below the 45.2 percent advance registered for Ohio.

Differences in productivity between Ohio and U.S. manufacturers are also influential in this industry; real output per worker in Ohio was 19 percent greater than for workers nationally, and the growth rate of productivity in Ohio between 1982 and 1984 exceeded the nation's (33 percent versus 25 percent).

Chemicals and Allied Products
Index, 1982 = 100



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 4E

• Electrical Machinery

At the national level, electrical machinery production enjoyed a boom between 1982 fourth quarter and 1984 third quarter because of an enormous increase in the output of communications equipment and electronic components (figure 4f). These industries manufacture products essential to the skyrocketing telecommunications field. But Ohio's experience in electronic equipment manufacturing has been unimpressive, rising only to its pre-recession levels.

At the national level, one-third of the electrical machinery industry involves the manufacture of communications equipment. This compares with only about a 12 percent share in Ohio. Moreover, electrical components used in the production of computers, namely semiconductors, are much more important to national electrical machinery manufacturing than to manufacturing in Ohio (about 26 percent versus 9 percent).

Ohio's electrical machinery manufacturing industry relies primarily on the manufacture of appliances. Although the household appliance industry has been relatively healthy in recent years, its growth pales in comparison to the gains felt in the communications and computer fields.

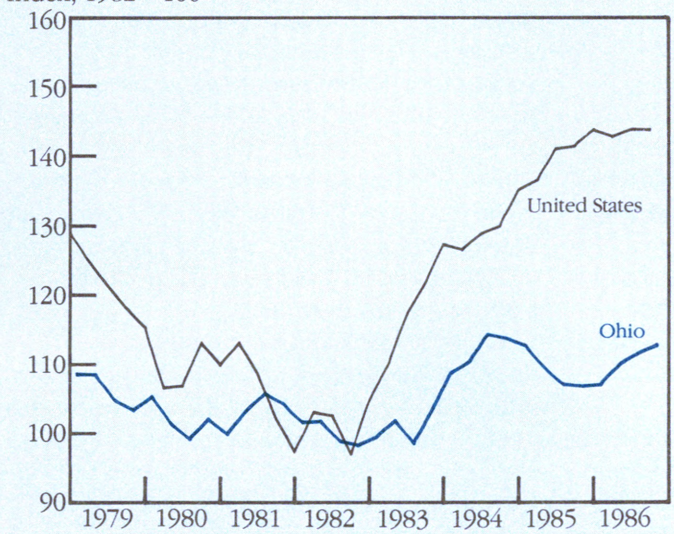
• Rubber and Plastics

Plastics has supplanted rubber as the dominant component of the rubber and plastics industry in Ohio, and the OMI appears to reflect this transition (figure 4g).

The rubber and plastics industry has enjoyed growth in both Ohio and the nation over the present expansion, but Ohio's experience has been more volatile. The sharp cycle here is probably a result of Ohio's rubber-makers, whose production follows the often-turbulent fortunes of the transportation equipment industry.

Ohio seems to be shedding its dependence on rubber production. In 1977, Ohio's rubber and plastics industry was dominated by rubber-makers (54 percent versus 46 percent in plastics). Yet, within six years the roles were reversed, as rubber-makers accounted for only 39 percent of the state's output in the rubber and plastics industry.

Electrical Machinery
Index, 1982 = 100



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

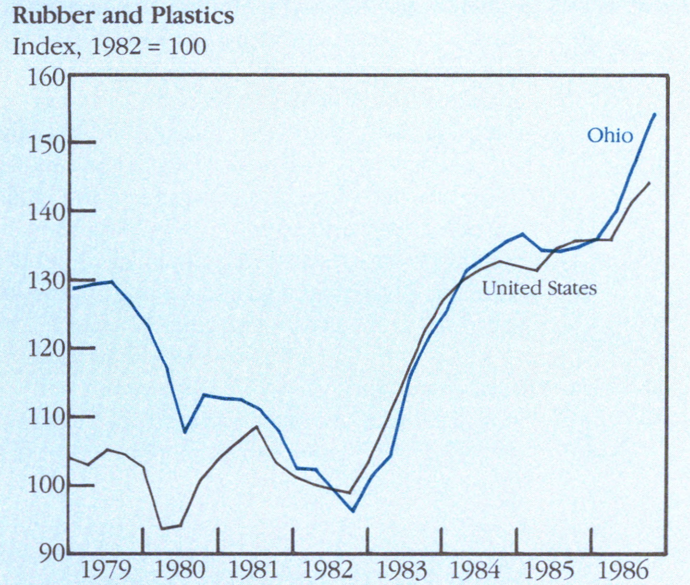
FIGURE 4F

III. An Overview

The OMI and its subindexes are a product of ongoing research at the Federal Reserve Bank of Cleveland. It is therefore important to emphasize that these indexes are experimental and may not be wholly reliable from month to month, or within some industries. The structure of the indexes and the data used in their construction are subject to revisions. Future revisions may be especially large between 1984 and 1986, over which period the productivity assumptions were intentionally conservative.

With these caveats noted, the patterns traced by the index make sense in light of Ohio's manufacturing mix and differences in productivity levels and growth rates. The state's manufacturing cycle tends to be sharper than that experienced at the national level.

Industry-level data show that Ohio manufacturers are recovering the transportation equipment output lost in the last recession, as a result of the state's active motor vehicles industry.



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 4G

Indeed, the demand for consumer durables in this decade probably accounts for much of the growth experienced by Ohio manufacturers since 1982, such as that experienced by Ohio's fabricated metals producers.

In addition, many of these recovering industries are characterized by relatively high and rising productivity levels, which in part explains why the growth of Ohio manufacturing production since 1982 exceeds the national experience, despite slightly more modest gains in manufacturing employment.

Unfortunately, not all manufacturing industries in the state have improved their position relative to the rest of the country. Ohio manufacturing growth in recent years appears to be most prominent in industries whose futures are regarded by many as uncertain. However, Ohio has lost ground in manufacturing fields that are considered growth industries nationally, such as printing and publishing, and electrical machinery manufacturing.

Technical Appendix — Methodology for the Ohio Manufacturing Index (OMI)

A number of production index methodologies have been proposed. The procedure chosen for the construction of the Ohio Manufacturing Index (OMI) involves a minimum of time to produce and has been shown to be relatively accurate for the Texas economy (see Fomby [1986]). The OMI is structurally similar to the regional production indexes produced at other Federal Reserve Banks and is virtually identical to that produced by the Federal Reserve Bank of Atlanta (see Stroebel [1978]).[1]

We begin by assuming that Ohio manufacturers are profit maximizers who operate in a competitive market. If we further assume that Ohio manufacturers are subject to a two-factor (labor and capital) linear homogeneous production function (constant returns to scale), we can use Euler's theorem to show that:

(1) $VA = (P_L L) + (P_K K)$,

where VA is manufacturing output measured by value added, P_L and P_K are the unit price of labor and capital inputs, respectively, and L and K are the industry's employment of labor and capital.

Equation 1 can be algebraically manipulated to yield the more complex, but easily estimable, time series:

(2) $$VA_t = (P_L L/VA)\,(VA/L)_t\,L_t + (P_K K/VA)\,(VA/K)_t\,K_t = \Sigma(S_i O_{i,t} i_t) \text{ for } i = L, K,$$

where S_i are the factor shares for labor (L) and capital (K) inputs, $O_{i,t}$ are the output ratios for inputs in period t, and i_t represents the level of inputs in period t.

The Ohio Manufacturing Index uses fixed shares of labor and capital, but allows for monthly productivity increases by a factor C_i. Specifically, the output ratios are adjusted monthly such that:

(3) $O_{i,t} = O_{i,t-n}(1 + C_i\, n)$,

where n represents the number of months that have elapsed since the last survey of Ohio manufacturers. The productivity factor is defined by:

(4) $$C_i = \left[\frac{VA_m/i_m}{VA_o/i_o}\right]^{1/\phi} - 1$$

where m and o are two survey years and ϕ is the monthly interval separating the two surveys. Input productivity factors since 1984, for which data do not yet exist, were assumed to be equal to the average productivity factor between 1978 and 1984.[2]

1 The Sixth District Manufacturing Production Index uses man-hours to measure labor inputs, while the OMI uses employment levels. In addition, the Sixth District Index seasonally adjusts the computed indexes, while the OMI seasonally adjusts the factor inputs prior to index construction.

Percentage Share of Labor and Capital For Ohio Manufacturers

Industry (SIC)	Labor (%)	Capital (%)
Manufacturing	40.3	59.7
Durable-Goods Manufacturing	44.0	56.0
Nondurable-Goods Manufacturing	31.9	68.1
Food and Kindred Products (20)	24.9	75.1
Apparel and Other Textile Products (23)	43.2	56.8
Lumber and Wood Products (24)	44.0	56.0
Furniture and Fixtures (25)	46.2	53.8
Paper and Allied Products (26)	46.1	53.9
Printing and Publishing (27)	41.5	58.5
Chemicals and Allied Products (28)	19.7	80.3
Rubber and Miscellaneous Plastic Products (30)	45.2	54.9
Stone, Clay, and Glass Products (32)	43.2	56.8
Primary Metals Industries (33)	43.8	56.2
Fabricated Metal Products (34)	45.5	54.5
Machinery, Except Electrical (35)	50.1	49.9
Electric and Electronic Equipment (36)	38.0	62.0
Transportation Equipment (37)	40.9	59.1
Instruments and Related Products (38)	44.6	55.4

SOURCE: 1984 Annual Survey of Manufactures, Bureau of the Census.

APPENDIX TABLE 1

The fixed factor shares (S_i) were estimated using Ohio manufacturing data from the 1984 Survey of Manufactures. The share of labor (S_L) was calculated as the ratio of the total manufacturing payroll to the value added in manufacturing in nominal dollars. The share of capital (S_K) was derived by:

(5) $S_K = 1 - S_L$.

The factor shares are reported in table 1 of this technical appendix.

The output ratios were calculated for the survey years 1978, 1983, and 1984 and for the census year 1982. The labor output ratio (O_L) is real value added to total employment. The capital output ratio (O_K) is similarly constructed, using electric power consumption as a proxy for the employment of capital.[3]

The OMI was produced for 15 two-digit SIC industries and for the durable-goods, nondurable-goods, and total manufacturing aggregates (appendix table 1). Five manufacturing industries are not reported because of constraints on the data: tobacco products (21), textile mill products (22), petroleum and coal products (29), leather and leather products (31), and other miscellaneous manufacturing (39). Fortunately, these five industries are relatively small contributors to the Ohio economy, representing only about 2 percent of this state's value added in 1984.

The OMI and components are available monthly ($n = 96$) and quarterly ($n = 32$), both seasonally adjusted and nonseasonally adjusted. Index values are reported on a 1982 = 100 basis.

Description of the Data and Procedures

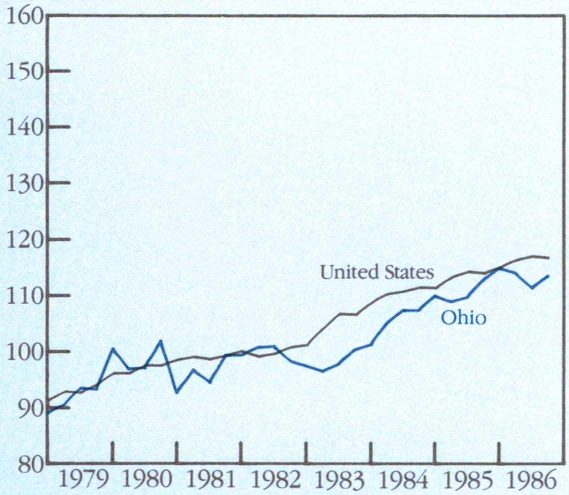
- The Ohio Manufacturing Index and the durable- and nondurable-goods aggregates represent a summation of the industry-level indexes, weighted according to share of real value added in 1984.
- Ohio manufacturing value added and payroll data are available for the census year 1982 and for the survey years 1978, 1983, and 1984.
- Value added was deflated using national price deflators for these two-digit industries, supplied by the U.S. Department of Commerce.
- Monthly employment data in Ohio by two-digit industrial classifications were supplied by the U.S. Bureau of Labor Statistics and the Ohio Bureau of Employment Services.
- Ohio electric power, measured in kilowatt-hours, is used as a proxy for capital use. Electric power data were collected by two-digit SIC codes by the Data Services Department of the Federal Reserve Bank of Cleveland.[4] The data include self-generated electric power. The monthly timing of electric power consumption data is not exact and tends to overlap between months. For this reason, electric power data are entered into the OMI as a three-month moving average.
- The input series are independently seasonally adjusted using the X-11 ARIMA adjustment procedure.

2 In many industries, this period is associated with little or no growth in factor productivity. Consequently, this assumption may be unrealistically low. Without firm data to the contrary, however, a conservative approach seemed appropriate.

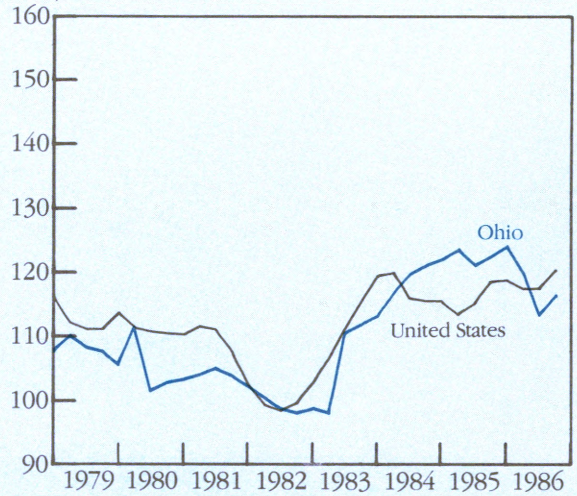
3 Virtually all regional and national industrial production indexes employ electric power data to approximate capital usage. See Moody (1974) for a justification of this procedure.

4 A short description of electrical consumption data sources used in this study is available from the authors upon request.

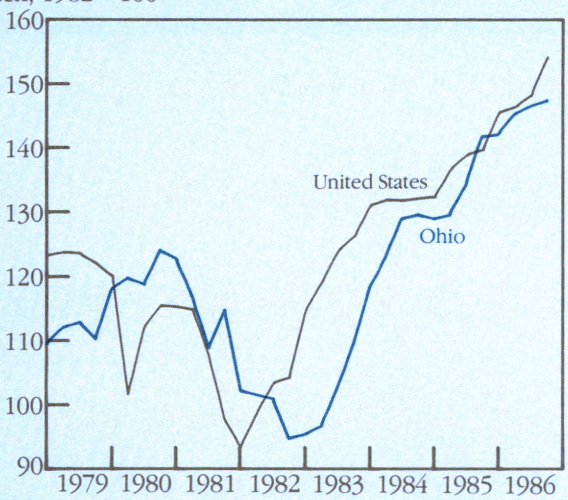
H. Food Production Index
Index, 1982 = 100



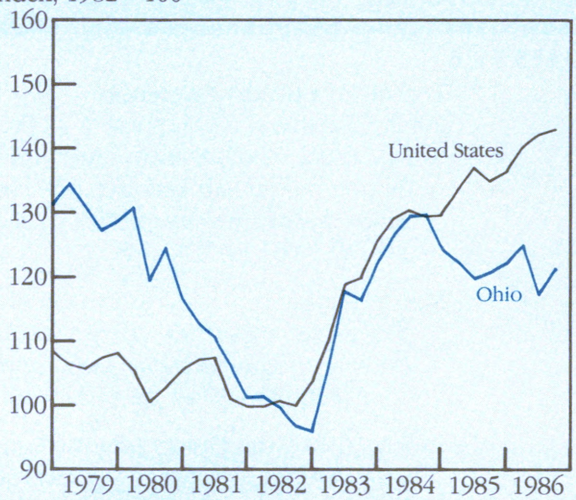
I. Apparel and Other Textiles
Index, 1982 = 100



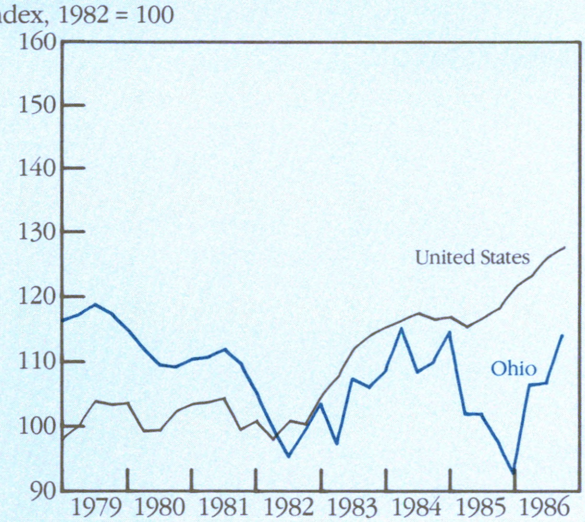
J. Lumber and Wood Products
Index, 1982 = 100



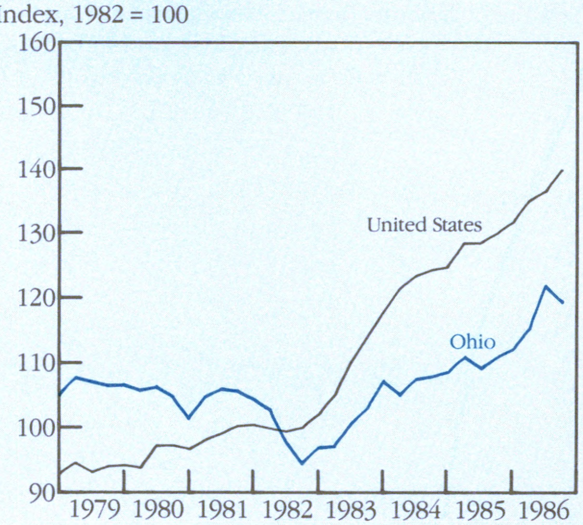
K. Furniture and Fixtures
Index, 1982 = 100



L. Paper and Allied Products
Index, 1982 = 100

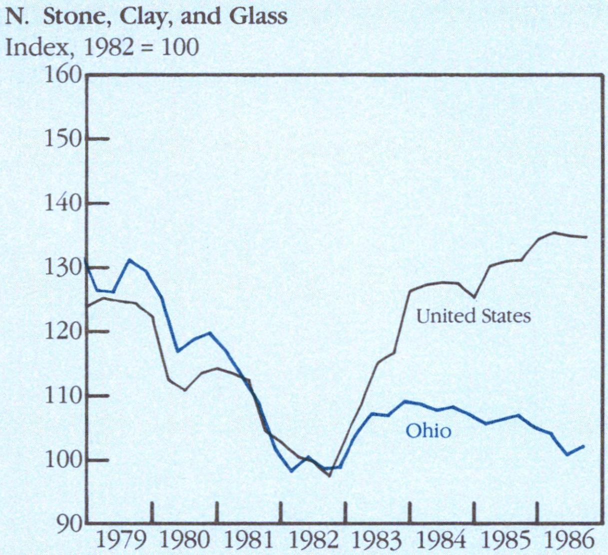


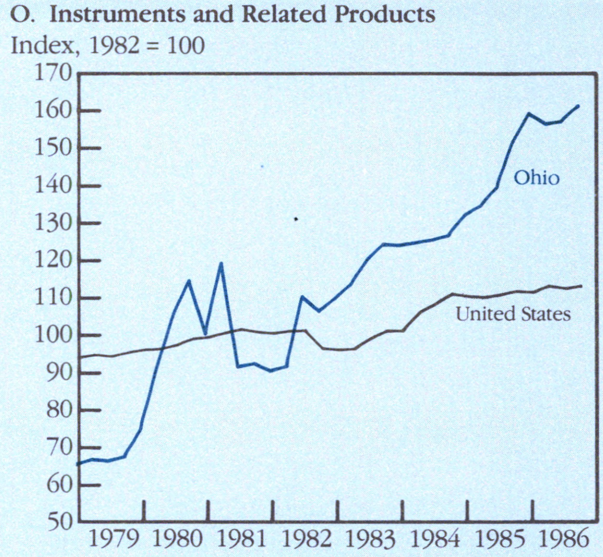
M. Printing and Publishing
Index, 1982 = 100



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURES 4H-M





SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURES 4N,O

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