Ohio Industry Employment Projections for 1995: An Evaluation

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Abstract

Economic modeling of long-term industry employment projections sound in Ohio. Insights gained from case studies where model specification errors were high.

The Ohio Bureau of Employment Services regularly evaluates its long-term projections of industry demand against actual historical data covering the projected years as the data become available to improve on past performance and gain insights about Ohio's economy. This report presents the results of the most extensive evaluation to date of Ohio's industry employment projections with the intention of providing general insights about regression modeling for industry forecasting done at the state level. Findings confirmed previous evaluation research. The more aggregated the industry level, the smaller the projection error. There is also an inverse relationship with employment size: as the employment level increases, the MAPE decreases. Single-equation linear regression (OLS), the preferred technique which is being used by most state analysts, was the projection method examined. The projection errors were decomposed and the percent distribution of the total error assigned to national, state, or model specification components. The model specification error was lower for 2-digit SICs than for 3-digit SICs. The average share of error arising from key economic variables for Ohio was always higher than that derived from the projection of U.S. employment. The case studies generally validated the analytical decisions that had been made to produce the 1986-1995 industry employment projections for Ohio. Those appropriate theoretical models with a combination of high explanatory power and good forecasting ability tended to have the least projection error. The selected economic model had an ex ante projection error that was usually lower than other models would have produced and was one-third lower, on average, than the time-series model. Selected industries were examined in case studies to gain insights into the economic modeling process. These case studies produced recommendations about evaluating the ex ante statistical data of alternative models.

Index

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Introduction

The Ohio Bureau of Employment Services (OBES) regularly prepares projections of future growth in employment by industry and occupation.[1] These projections are widely used for studying long-range economic and employment trends, planning education and training programs, and developing career information. Because of their widespread usage, OBES regularly evaluates the projections against actual historical data covering the projected years as the data become available to improve on past performance and gain insights about Ohio's economy. [2]

This report presents the results of the most extensive evaluation to date of Ohio's industry employment projections with the intention of providing general insights about regression modeling for industry forecasting done at the state level. The first purpose of the research is to evaluate the accuracy of Ohio's 1986-95 projections given expectations of the state and national economy prevalent at the time. The second and more important portion of the report reviews model selection and presents the decomposition of projection errors into national, state, and model specification categories. The final section takes a look at those 2-digit industries where the model specification error was higher than average. A more in-depth examination of alternative model specifications is conducted for these industries to see if better models could have been selected given existing information. I begin by providing some background on the Ohio economy of the 1980s and the prevalent view of the general outlook for the economy at that time.

Ohio's Changing Labor Market

Over the past decade, labor market conditions in the State of Ohio have changed dramatically. In the 1980s, the restructuring of Ohio's economy, especially with declines in durable goods manufacturing employment, resulted in many workers who were unable to find jobs and unemployment rates that were considerably higher than the national average. However, by 1991 Ohio's unemployment rate fell below that of the nation and remained lower through 1996. There were, on average, only 266,000 Ohioans unemployed per month in 1995, down sharply from the 425,000 unemployed per month in 1986.

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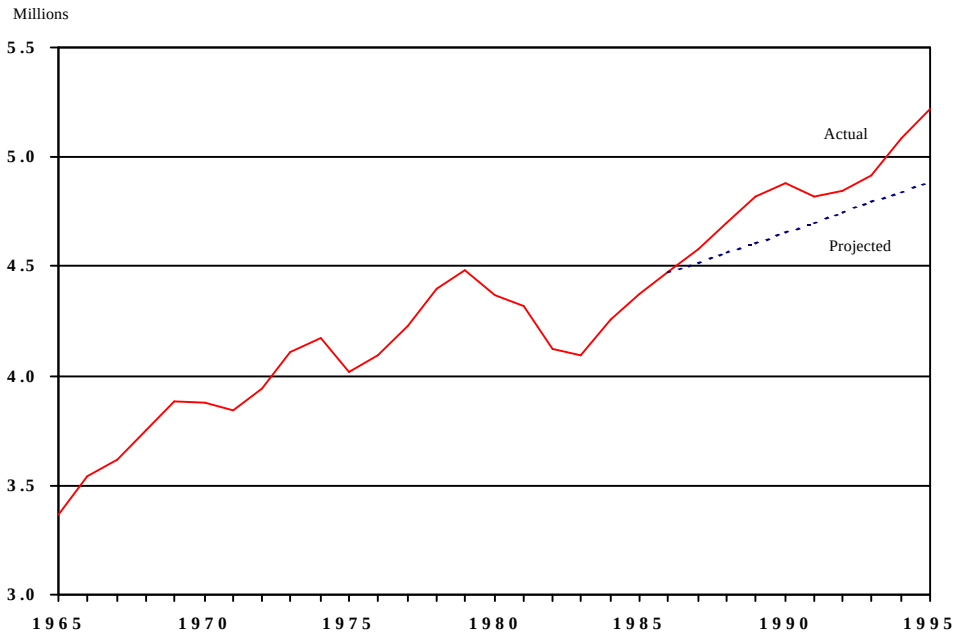
The state and national economies performed better than expected with the incidence of only one minor recession, which lasted only eight months during 1990-91. The assumption underlying the national projections was that there would be two recessions through 1995. Therefore, the implicit assumption of the Ohio analysis in using national industry projections as a key economic factor was also that there would be two recessions. It is not surprising then that the outlook under-projected employment growth over the 1986-95 period at both the state and national levels. Actual employment in Ohio in 1995 was also significantly higher than predicted by other private and public forecasting firms.[3]

Most of the key economic variables like Ohio total income, per capita income, and population from external sources (e.g., Bureau of Economic Analysis, Bureau of the Census) had been under-predicted, as were these variables expressed as a share of the U.S. total (Appendix Table 1). Some of this performance may be attributed to the sharply declining value of the dollar over the period and its positive impact on Ohio's large export trade market, primarily in manufactured goods. In addition, Ohio was not impacted as much as east and west coast states when defense spending waned.

Accuracy of Industry Projections

Total nonfarm wage and salary employment had been expected to increase from 4.475 million in 1986 to 4.888 million by 1995. Actual employment reached 5.221 million, surpassing the projection by 333,100 (Chart 1). Common ways to assess the accuracy of projections are to

Chart 1
Ohio Nonfarm Wage and Salary Employment, 1965-95



tabulate the percent of industries for which the direction of change was correctly projected; to measure the projection error, the difference between the predicted and actual employment for a given industry; and to display the projection error in percentage terms. The mean absolute percent error (MAPE) expresses the absolute value of the projection error, as a percentage of the actual employment level.

Expectations by major industry division were on the right track with the direction of change correctly predicted for all divisions, but the magnitude of change varied considerably (Table 1). Growth in employment in the services sector was 120,100 higher than predicted and accounted for more than one-third of the error, followed by an underestimate of trade employment of 87,900. These two sectors combined constituted three-fifths of the error.

The projection for manufacturing was closest to the mark, understating actual employment by only 2.7 percent, while the outlook for the finance, insurance, and real estate sector was low by only 4.5 percent. On the other hand, mining employment was off by more than 50 percent on the high side. Construction employment was underestimated by nearly one-fifth. Government employment was under-projected by 4.8 percent, and transportation, communication, and utilities by 7.5 percent. These results are in stark contrast to the 1985 and 1990 evaluations which both

Table 1: Projection Accuracy by Industry Division (in thousands)

Industry Level	Projected 1995 Employment	Actual 1995 Employment	Error	MAPE
Total Nonfarm Wage/Salary Employ	4,887.9	5,221.0	-333.1	6.4%
Mining	21.2	13.8	7.4	53.6%
Construction	167.0	205.0	-38.0	18.5%
Manufacturing	1,073.0	1,102.3	-29.3	2.7%
Transport, Communications and Utilities	212.2	229.3	-17.1	7.5%
Wholesale and Retail Trade	1,184.9	1,272.8	-87.9	6.9%
Finance, Insurance and Real Estate	258.1	270.3	-12.2	4.5%
Services	1,258.8	1,378.9	-120.1	8.7%
Government	712.6	748.7	-36.1	4.8%

reported the highest MAPEs, above 30 percent, for the manufacturing sector. The economic restructuring of Ohio's "Rust Belt" in the 1980s resulted in the permanent loss of nearly 300,000 manufacturing jobs.

A problem with the MAPE, however, is that it gives equal weight to the projection error of each industry subgroup, regardless of the relative size of employment in that industry. For example, the mining industry is Ohio's smallest industry division and had the largest absolute percentage of error. Therefore, the summary measure I used to evaluate the projection error among different levels of industry aggregation is a weighted MAPE, where the weights are the industry employment relative to total employment (Table 2).

Table 2: Projection Accuracy by Industry Level

Industry Level	Correct Direction of Change	Weighted MAPE
Total Nonfarm Wage/Salary Employment	100.0%	6.4%
1-digit SIC	100.0%	6.9%
2-digit SIC	84.9%	7.6%
3-digit SIC	72.2%	12.1%

Not surprisingly, the more aggregated the industry level, the smaller the projection error. It is easier to predict the overall employment level than to predict employment for more specific industries because sampling and reporting errors in the data, as well as nonsystematic events like a plant opening or closing, will have a smaller proportional effect due to a larger number of firms.[4] The weighted MAPE increased from 6.4 percent for total nonfarm employment to 6.9, 7.6, and 12.2 percent for division, 2-digit, and 3-digit levels, respectively.[5] The distribution of errors mirrored that shown in Table 1 with service, trade, and construction industries accounting for most of the employment-weighted error (see Appendix Tables 2 and 3).

These results compare favorably to MAPEs calculated for 20 states in an earlier study by Goldstein and Cruze (see note 4). Compared to my earlier evaluation of projections for Ohio, these MAPEs are generally half as large, in part because there were no major structural shifts in the economy as had occurred in the 1980s.

There is also an inverse relationship with employment size as found in earlier studies: as the employment level increases, the MAPE decreases. Table 3 displays the accuracy of 3-digit

Table 3: Projection Accuracy by Industry Employment Size

Employment Size Level	Correct Direction of Change	Weighted MAPE
Total nonfarm employment (3-digit industries)	72.2%	12.1%
Less than 5,000	63.2%	26.3%
5,000-9,000	70.9%	17.6%
10,000-24,900	73.3%	17.0%
25,000-49,900	90.0%	12.0%
50,000 or more	93.8%	7.3%

industry projections by size class. For example, the analysis of more than 200 3-digit industries in Ohio revealed a decrease in the MAPE from 26.3 percent in industries with fewer than 5,000 employees in 1995 to 7.3 percent in industries with 50,000 or more employment. Likewise, the percent of industries for which the direction of change was accurately predicted increased from 63.2 percent to 93.8 percent when comparing the respective size classes.

Model Specification

Single-equation linear regression (OLS) was the primary analytical technique used to project 1995 employment in Ohio. This is the preferred technique which is being used by most state analysts and the first choice recommended by the consortium.[6] In some states, this tool is combined with fully-specified econometric models which determine aggregate employment levels. OLS models also require less maintenance than a fully-specified econometric model for the state. Of the two-thirds of states that use single-equation economic models, one-third had been using either the Ohio or Illinois menu-driven software which both contain similar model specifications that use a combination of state and national key economic variables.

Ohio industries were classified as either export-oriented or local-serving with an array of theoretically appropriate models defined and calibrated (see Technical Notes in Appendix B). These competing models were evaluated across a broad range of statistical measures and the "best" forecasting model selected.[7] Nearly all of the 2-digit and 3-digit industry models selected contained the comparable U.S. industry and an Ohio economic variable as key predictors. The national industry employment/projection may have been formulated in per capita terms or as a share of total U.S. employment. The Ohio economic factors considered were income, population, and total employment, sometimes expressed as a share of the respective U.S. data.

Decomposition of Projection Errors

By decomposing projection errors, analysts can focus on how well they are modeling individual industries to improve future rounds of projections. A better understanding of how a state industry relates to the national industry can be gained by determining whether the national employment projection, a key economic variable for the state economy, or the model specification was the main source of the projection error. Analysts can use this diagnostic tool to review models for those industries where the projection error is relatively large and the share of error due to an inappropriate model specification is higher than average. Knowing that a particular model was a good predictor in the past is also useful information.

Because model specifications and coefficient estimates of single equation regressions from the 1986-95 projection round had been retained, the source of projection errors was able to be detected and decomposed. Nearly all of the model specifications contained the respective U.S. industry employment plus a key economic variable for Ohio. The projection error was decomposed in the following way. A U.S., Ohio, and model specification error were calculated independently by substituting the respective actual value in 1995 (ex post) in place of the projected value for 1995 (ex ante) that had been used:

> **U.S. Error:** Projected employment, national value known, minus actual employment:
> $\text{Projected employment}|_{\text{US (ex post)}} = a + b(\text{ US[ex post] }) + c(\text{ OH[ex ante] })$

Ohio Error: Projected employment, Ohio value known, minus actual employment:
Projected employment$|_{OH\ (ex\ post)}$ = a + b(US[ex ante]) + c(OH[ex post])

Model Specification Error: Projected employment, national and Ohio values known, minus actual employment:
Projected employment$|_{Model\ Specification}$ = a + b(US[ex post]) + c(OH[ex post])

where a, b, and c are the coefficient estimates from the projection model which had been selected.

Table 4 provides an illustration of how this decomposition was done for the projection of employment for food stores in Ohio (SIC 54). Employment had been projected to increase from 128,400 in 1986 to 140,300 in 1995. Employment in 1995 for grocery stores in Ohio was 156,500, an under prediction of 16,200. The two explanatory variables in the regression were

Table 4: Illustration of Error Decomposition

Ohio Food Stores		Ex Post U.S.	Ex Post Ohio	Ex Post Model
1986 Employment	128.4			
Projected for 1995	140.3	144.2	144.6	148.0
1995 Employment	156.5			
Error	-16.2	-12.3	-11.9	-8.5

U.S. employment in SIC 54 and total nonfarm wage and salary employment in Ohio. Both of these values for 1995 were higher than had been projected. Substituting these actual values yielded higher projections, given the original calibration of the model specification, that were closer to the 1995 employment level. Still, the model chosen would have under predicted employment by 8,500.

As a way to judge the relative importance of each factor (i.e., U.S., Ohio, and model) in explaining the projection error, the absolute values of these errors were summed and the percentage of total error calculated. In this case, the total error is 32.7 (12.3 + 11.9 + 8.5) with 37.6, 36.4, and 26.0 percent attributable to U.S., Ohio, and model specification errors, respectively. The comparisons among sources of error were limited to those models where both U.S. and Ohio independent variables were included in the model as was typical.

A summary of the results for Ohio are presented in Table 5 (see Appendix Tables 4 and 5 for the detailed analysis). The projections which had been published were bottom-up sums generally based on the regression analysis at the 2-digit SIC level with the 3-digit SIC projections being forced to the 2-digit sum. Division level models were also run for comparison purposes. The division models generated errors that were nearly equally distributed between U.S., Ohio, and

Table 5: Decomposition of Ohio Projection Error by Industry Level

Industry Level	U.S. Error	Ohio Error	Model Specification Error
1-digit SIC	32.0%	34.6%	33.4%
2-digit SIC	30.3%	40.1%	29.6%
3-digit SIC	29.1%	36.6%	34.3%

model specification errors. The model specification error was lowest at 29.6 percent for 2-digit SICs and rose to 34.3 percent for 3-digit SICs. This finding is consistent with the fact that it is more difficult to project at more detailed industry levels because of data issues alluded to above. The average share of error arising from key economic variables for Ohio was always higher than that derived from the projection of U.S. employment.

Alternative Model Specifications

The question that is addressed in this final section is whether we could have chosen a better model specification to project industry employment. To answer this question, I take a case-study approach to look at 2-digit industries where the portion of the projection error attributable to model specification was higher than average (29.6 percent). Table 6 presents a detailed analysis for 11 industries for those models where the coefficients were statistically significant and the signs of the coefficient estimates were in the proper direction as expected by economic theory. The first model listed is the one which had been used to generate the projection. A time trend regression with U.S. employment and time as the independent variables was also included for analysis purposes and used in the computation of an average or "consensus" projection, a method commonly presented as a way to reduce the forecast risk that may be associated with using a single forecast.

Before examining the individual industries, there are several general observations to note:

- The ex post error was always greater than the ex ante error, a reflection of the selection criteria that the model specification accounted for a larger-than-average share of the error.
- The model chosen generally had the most explanatory power and the "best" forecasting ability as measured by the Theil U statistic (from an ex ante perspective in 1986).
- The selected economic model had an ex ante projection error that was usually lower than other models would have produced and was one-third lower, on average, than the time-series model.
- The average prediction of the models under consideration would have produced a better ex ante forecast in only four of the eleven industries. However, no attempt had been made to weight the projections from these models or to average across classes of models besides OLS.
- When faced with a marginal decision between explanatory power and forecasting ability of alternative models, more preference should be given to the R-squared value. In cases where wide differences in explanatory power exist, choose the model with the highest R-squared value.

Case Studies: The 1987 SIC revision limited the potential for industry selection prior to focusing on the model specification error. Of the eleven industries examined, two were in nondurable goods manufacturing, three from the transport and utilities sector, three from trade, and three from services.

Food and Kindred Products: Employment in the food products industry has been on a long-term declining trend characterized by a cyclical ratcheting downward both nationally and in Ohio. There were seven model specifications which performed well with all projecting a decline in employment, but the model with U.S. employment and Ohio's share of national income had been selected because of its clearly better forecasting ability. The model with the lowest ex ante error had per capita employment and Ohio income as the key explanatory variables, but had one of the highest ex post errors. The original model still seems to have been the best choice.

Printing and Publishing: This industry has been on a slight long-term rise in Ohio with wide cyclical fluctuations and a projected increase in employment both for the state and nation. The model chosen had the best forecasting ability, but low explanatory power. The best model, from either an ex ante or ex post perspective, would have had U.S. employment and Ohio's share of national income as explanatory variables. This model had the highest R-squared by far and should have been chosen even though the Theil U was greater than 1.

Local/Interurban Passenger Transit: Employment had declined steadily in the 1970s, but was stable through the mid-1980s. Both economic models forecast an increase, while the time trend expected a decline. The selected model with Ohio income and national share of total employment had the best diagnostic statistics and lowest ex ante error in projecting an increase in employment, even though industry employment was under-predicted. The ex post error was also the lowest.

Communications: Both state and national employment had been increasing during the 1970s. Ohio employment declined steadily in the 1980s while U.S. employment ratcheted down with a projected decline. All but one of the models predicted a decline for Ohio. Per capita employment and Ohio population had the best explanatory power and forecasting ability, but projected only a slight decline. This model still appears to have been the best model, in retrospect, to have picked at the time. The ex post values, however, worsened as the U.S. employment trend diverged, resulting in an increase in employment by 1995.

Electric, Gas, and Sanitary Services: This industry has been on a slight long-term rise in Ohio with cyclical fluctuations and a projected increase in employment both for the state and nation. Employment in 1995 showed a decline for both areas. The model selected had the second-best explanatory power, but best forecasting ability. In this case, the best model from both an ex ante and ex post point of view would have included per capita industry employment and state population, suggesting that more weight in the analytical decision be given the adjusted R-squared versus the Theil U.

Table 6: Case Studies of Alternative Model Specifications

National* Variable	State** Variable	Adjusted R-square	Theil U	Ex Ante Projection	Ex Post Projection	Abs. Value of Ex Ante Error	Abs. Value of Ex Post Error
Food and Kindred Products				1995 Employment = 59.8			
u4200	ohincu	0.99	0.16	56.2	65.4	3.6	5.6
u4200	time64	0.98	0.43	51.9	63.1	7.9	3.3
u4200f	ohpop	0.94	0.48	57.4	67.3	2.4	7.5
u4200f	oh0000	0.97	0.37	64.8	74.4	5.0	14.6
u4200p	ohpop	0.99	0.31	54.5	63.4	5.3	3.6
u4200p	oh0000	0.99	0.33	57.0	64.8	2.8	5.0
u4200p	ohinc	0.98	0.45	60.2	67.4	0.4	7.6
Average				57.4	66.5	2.4	6.7
Printing and Publishing				1995 Employment = 75.5			
u4270f	ohpop	0.39	0.50	69.5	68.7	6.0	6.8
u4270	time64	0.44	6.94	65.9	64.0	9.6	11.5
u4270	ohincu	0.89	1.40	73.1	70.4	2.4	5.1
Average				68.9	67.7	6.6	7.8
Local/Interurban Passenger Transit				1995 Employment = 11.1			
u5410f	ohinc	0.90	0.72	7.8	16.1	3.3	5.0
u5410	time70	0.85	9.72	4.7	20.3	6.4	9.2
u5410	ohincu	0.76	2.77	6.6	24.1	4.5	13.0
Average				6.4	20.2	4.7	9.1
Communications				1995 Employment = 42.2			
u5480p	ohpop	0.97	0.03	47.7	53.7	5.5	11.5
u5480	time64	0.89	0.56	40.3	46.2	1.9	4.0
u5480	ohincu	0.94	1.60	45.2	50.6	3.0	8.4
u5480f	ohpop	0.95	0.38	48.7	57.9	6.5	15.7
u5480f	oh0000	0.96	0.90	48.3	54.6	6.1	12.4
u5480f	ohinc	0.95	0.11	52.9	56.4	10.7	14.2
Average				47.2	53.2	5.0	11.0
Electric, Gas and Sanitary Services				1995 Employment = 39.4			
u5490	ohpop	0.92	0.22	42.5	42.8	3.1	3.4
u5490	time64	0.87	2.37	43.3	41.9	3.9	2.5
u5490	ohincu	0.91	0.43	43.4	39.4	4.0	0.0
u5490f	oh0000	0.92	0.47	42.9	41.4	3.5	2.0
u5490f	ohinc	0.87	1.87	47.5	46.5	8.1	7.1
u5490p	ohpop	0.94	0.28	40.7	39.5	1.3	0.1
u5490p	oh0000	0.91	1.78	41.6	39.4	2.2	0.0
Average				43.1	41.6	3.7	2.2
Wholesale Trade-Nondurable Goods				1995 Employment = 101.7			
u6510	ohinc	0.99	0.30	101.7	106.0	0.0	4.3
u6510	time72	0.99	0.07	96.0	101.3	5.7	0.4
u6510	ohincu	0.99	0.06	97.9	103.0	3.8	1.3
u6510	oh0000	0.99	0.42	98.2	103.3	3.5	1.6
u6510f	ohinc	0.98	0.28	118.3	122.5	16.6	20.8
u6510p	ohinc	0.98	0.02	103.1	107.8	1.4	6.1
Average				102.5	107.3	0.8	5.6

Table 6: Case Studies of Alternative Model Specifications

National* Variable	State** Variable	Adjusted R-square	Theil U	Ex Ante Projection	Ex Post Projection	Abs. Value of Ex Ante Error	Abs. Value of Ex Post Error
Apparel and Accessory Stores				1995 Employment = 45.6			
u6560f	oh0000	0.89	0.05	46.2(a)	39.5	0.6	6.1
u6560	time64	0.64	0.86	38.1	35.9	7.5	9.7
u6560	ohincu	0.88	0.08	40.8	37.6	4.8	8.0
u6560	ohpop	0.83	0.33	37.6	40.4	8.0	5.2
u6560p	ohpop	0.86	0.31	37.3	39.0	8.3	6.6
Average				40.0	38.5	5.6	7.1
Eating and Drinking Places				1995 Employment = 352.3			
u6580p	oh0000	0.99	0.01	338.4	326.1	13.9	26.2
u6580	time64	0.99	0.15	358.1	350.7	5.8	1.6
u6580	ohincu	0.99	0.31	373.2	359.3	20.9	7.0
u6580	ohpop	0.99	0.18	353.6	350.7	1.3	1.6
u6580	ohinc	0.99	0.17	371.0	364.9	18.7	12.6
u6580	oh0000	0.99	0.11	358.1	355.9	5.8	3.6
u6580f	oh0000	0.99	0.29	327.8	313.3	24.5	39.0
u6580f	ohinc	0.99	0.15	350.3	333.7	2.0	18.6
u6580p	ohinc	0.99	0.06	344.7	331.4	7.6	20.9
Average				352.8	342.9	0.5	9.4
Hotels and Other Lodging Places				1995 Employment = 36.5			
u8700f	oh0000	0.73	0.20	38.3	39.0	1.8	2.5
u8700	time72	0.52	0.33	36.1	34.6	0.4	1.9
u8700	ohincu	0.73	0.59	42.4	39.7	5.9	3.2
u8700	oh0000	0.69	0.30	37.0	38.3	0.5	1.8
u8700p	oh0000	0.71	0.25	36.9	37.8	0.4	1.3
Average				38.1	37.9	1.6	1.4
Miscellaneous Repair Services				1995 Employment = 14.3			
u8760	ohincu	0.68	3.97	14.6	11.3	0.3	3.0
u8760	time70	0.33	4.22	11.9	9.3	2.4	5.0
Average				13.3	10.3	1.0	4.0
Private Educational Services				1995 Employment = 60.4			
u8820	ohpop	0.93	2.32	61.4	63.7	1.0	3.3
u8820	time70	0.90	6.52	67.5	65.3	7.1	4.9
u8820f	oh0000	0.77	8.71	70.6	66.7	10.2	6.3
u8820f	ohinc	0.85	8.18	75.4	73.4	15.0	13.0
u8820p	ohpop	0.91	4.15	66.2	71.7	5.8	11.3
Average				68.2	68.2	7.8	7.8

* The "u" before the industry code indicates this is national employment. The letter following the industry code indicates the following variation from national employment:

f = industry employment as a fraction of total U.S. employment
p = industry employment per capita for the U.S.

** The State variable used could either be time or an economic variable:

ohpop = population in Ohio
ohinc = total personal income in Ohio (1972 dollars)
ohincu = Ohio share of U.S. income
oh0000 = total employment in Ohio

a Model forecast adjusted up by 6,000 based on press announcement.

Wholesale Trade-Nondurable Goods: Employment had been rising steadily with only minor cyclical fluctuations nationally and statewide with more steady gains projected. National employment and Ohio income increased more than expected, resulting in a larger ex post model error. Six models were very competitive in explanatory power and forecasting ability, but one of the models generated an outlier for a projection. A model that could have been chosen instead had Ohio income expressed as a share of U.S. income because its explanatory power was identical, but it had the lowest Theil U. The ex ante error was slightly higher, but it proved to be a better model specification.

Apparel and Accessory Stores: This industry had been on a slight long-term rise in Ohio with wide cyclical fluctuations and a projected increase in employment both for the state and nation. The forecasting model used the national share of total employment and Ohio total employment for the key independent variables. This model had clearly the best diagnostic statistics and nearly the highest projection at 40,200. However, the projection from this model had been adjusted upward by 6,000 based on a press release at the time by one of the major employers in the central Ohio area announcing a major long-term expansion. Making this adjustment resulted in a prediction that turned out to be much more accurate than any of the economic models alone.

Eating and Drinking Places: Employment growth in this industry was very linear with only minor cyclical fluctuations. Nearly every local-serving model performed very well with the model with the best forecasting ability being chosen. Because all of the competing models could have each been used to predict employment, the better decision in this case would have been to use the average projected value which had the lowest ex ante error.

Hotels and Other Lodging Places: Because employment in Ohio was very cyclical and the business cycle was not apparent in the national trend, the explanatory power of these models was much lower than desirable. Additional variables (e.g., unemployment rate, GDP growth) which capture these effects should have been considered as additions to the existing models in this case. Even though the explanatory power of these models was relatively low for time series data, employment had increased as expected and the MAPE was under five percent.

Miscellaneous Repair Services: The relationship of state to national trends was much like that for hotels and lodging. The cyclical effect was especially apparent in data for the 1980s recessions with Theil U statistics that were much greater than one and only one of the economic models eligible for consideration. The interesting aspect to note here is that even with the poor diagnostic statistics, the ex ante and ex post errors were not that large.

Private Educational Services: Ohio private educational employment grew much more slowly in the 1980s compared to the U.S. Since 1980-86 was the calibration period for the Theil U statistic, it is not surprising to see poor (i.e., greater than 1) results. The explanatory variables, national employment and Ohio population, proved to be the best forecasting model with the highest portion of variance explained and had the lowest projection error both ex ante and ex post.

Insights from Case Studies

The case studies generally validated the analytical decisions that had been made to produce the 1986-1995 industry employment projections for Ohio. Those appropriate theoretical models with a combination of high explanatory power and good forecasting ability tended to have the least projection error. For six of the eleven industries examined, the model selection would have remained the same.

However, there were several lessons:

- Just because a model had a Theil U statistic greater than 1.0 was not necessarily a sufficient reason to reject a model, especially if the adjusted R-squared was high (e.g., printing and publishing).
- There were several industries where a decision to place more weight on the adjusted R-squared when the Theil U statistics were only marginally different would have generated less projection error (e.g., electric, gas, and sanitary services).
- There were several industries, especially in the trade sector (wholesale trade-nondurable goods and eating and drinking places) where statistics for all of the models were very competitive and using the average projection would have resulted in less projection error.
- Two industries (hotels and miscellaneous repair services) appeared to have cyclical effects that were not captured adequately by the model and would probably have benefited from the inclusion of a cyclical variable.
- There was one industry (apparel) where the projection was adjusted based on a corporate press announcement of a major expansion that was being planned. Incorporating this information produced a much better forecast than any of the models in isolation.

Conclusion

Over the past decade, labor market conditions in the State of Ohio changed dramatically. The state and national economies performed better than expected and the outlook under-projected employment growth over the 1986-95 period. Employment in Ohio in 1995 was also significantly higher than predicted by other private and public forecasting firms.

Expectations by major industry division were on the right track with the direction of change correctly predicted for all divisions, but the magnitude of change varied considerably. The trade and services sectors combined accounted for three-fifths of the error, while the projection for manufacturing was closest to the mark in sharp contrast to the last two rounds of projections. The mining and construction sectors, which tend to have wide cyclical swings, had the largest percentage errors.

The more aggregated the industry level, the smaller the projection error. The weighted MAPE increased from 6.4 percent for total nonfarm employment to 6.9, 7.6, and 12.2 percent for division, 2-digit, and 3-digit levels, respectively. The distribution of errors at the disaggregated

levels mirrored the divisions with service, trade, and construction industries accounting for most of the employment-weighted error. There is also an inverse relationship with employment size as found in earlier studies: as the employment level increases, the MAPE decreases.

Single-equation linear regression (OLS) was the primary analytical technique used to project 1995 employment in Ohio. This is the preferred technique which is being used by most state analysts and the first choice recommended by the consortium. Because model specifications and coefficient estimates of single equation regressions from the 1986-95 projection round had been retained, the source of projection errors was able to be detected and decomposed. The model specification error was lowest at 29.6 percent for 2-digit SICs and rose to 34.3 percent for 3-digit SICs. The average share of error arising from key economic variables for Ohio was always higher than that derived from the projection of U.S. employment.

The case studies generally validated the analytical decisions that had been made to produce the 1986-1995 industry employment projections for Ohio. Those appropriate theoretical models with a combination of high explanatory power and good forecasting ability tended to have the least projection error. The selected economic model had an ex ante projection error that was usually lower than other models would have produced and was one-third lower, on average, than the time-series model.

There were a number of important insights gained from the case studies. I think the most important was that a Theil U statistic greater than 1.0 was not necessarily a sufficient reason to reject a model, especially if the adjusted R-squared was much higher than other models. Also, when there were only marginal differences in the Theil U statistic, preference should be given to a model with higher explanatory power. When a number of models all perform well with no clear cut discrimination, an average of the projections would often do just as well if not better in forecasting employment. Finally, incorporation of reliable exogenous information from employers about expansions or contractions was found to improve the model projection.

Although the evidence indicated that the industry modeling process in Ohio was generally very sound, important insights were gained to help us do a better job of projecting long-term industry employment in the future. I encourage analysts to examine these results in the context of the model selection process for projecting employment in their own state.

The case study analysis was limited to models with higher-than-average projection error occurring because of model specification/mis-specification. It would be useful to discover if the findings from this subset of industries was generally true for models that turned out to be better specified. Is the projection error from an economic model two-thirds less than a time-trend projection error when all industries are examined? Would the arithmetic average projection have produced less error than using the single model? Would weighting the best models by their forecasting ability produce an average projection error that is less than the arithmetic average error or single model? These are all questions that may be useful to investigate further as we continue to refine the Long-Term Projections System.

Notes

[1] The latest projections, titled *Ohio Job Outlook: 1994-2005*, were published by the Ohio Bureau of Employment Services in June 1996.

[2] The last review, titled "An Evaluation of Industry Projections: A Case Study of the Ohio Economy," appeared in the August 1992 edition of the *Economic Development Quarterly*.

[3]The Bureau of Economic Analysis had predicted annual growth of 1.3 percent per year while Wharton Econometrics had forecast 1.2 percent growth per year compared to actual growth in nonfarm wage and salary employment of 1.9 percent per year.

[4] This is a finding that has been documented in earlier more comprehensive studies. See "An Evaluation of State Projections of Industry, Occupational Employment," *Monthly Labor Review*, 110:10 (1987) by Harvey A. Goldstein and Alvin M. Cruze. In their evaluation of state projections for 1982, they report weighted MAPEs for 3-digit industries ranging from 13.6 to 27.2 percent.

[5] Because of the revisions to the Standard Industrial Classification (SIC), comparison of projected to actual employment levels was, in general, limited to those SIC cells which were not affected by the code revision. I did, however, include industries in the MAPE and direction of change tables where the first quarter data for Ohio in 1988 that were dual-coded were not significantly different.

[6] *Guidelines for Long-Term Employment Projections*, Survey and Standards Committee, and *Producer Projections Survey*, ALMIS Long-Term Industry Employment and Census Tools Consortium, U.S. Department of Labor, Employment and Training Administration, April 1996. Previous evaluations of Ohio industry projections also found that single-equation regression models produced more accurate forecasts than extrapolation or allocation techniques (see note 2 above).

[7] See the *Technical Manual for Making Industry Employment Projections* prepared by the University of Dayton, Center for Business and Economic Research, in conjunction with software and training provided to the projections staff at the Labor Market Information Division of OBES, 1987. The main statistical criteria were sign and significance of the coefficient estimates; adjusted R-square of the model; and forecasting ability.

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Appendix A

Appendix Table 1: Key Economic Variables for Ohio Industry Regression Analysis, 1986-95: Comparison of Ex Ante and Ex Post Projections

Year	Ohio Total NF Employ.	Ohio Share of US Total	Ohio Mfg. Employ.	Ohio Share of US Mfg.	Mfg. Share of Ohio Emp.	Ohio Population	Ohio Share of US Pop.	Ohio Income (1972 dollars)	Ohio Share of US Income	Ohio Per Capita Inc. (1972 dollars)	US Unemp. Rate	% Change in GNP
1964	3,216.3	5.52%	1,259.1	7.29%	39.15%	10.125	5.29%	$37,898	5.42%	$3,743	5.2%	5.3%
1965	3,364.3	5.54%	1,326.0	7.34%	39.41%	10.262	5.29%	$40,342	5.47%	$3,931	4.5%	6.0%
1966	3,537.3	5.54%	1,404.4	7.31%	39.70%	10.396	5.31%	$42,442	5.47%	$4,083	3.8%	6.0%
1967	3,619.8	5.50%	1,401.4	7.21%	38.71%	10.489	5.30%	$43,518	5.38%	$4,149	3.8%	2.7%
1968	3,750.8	5.52%	1,433.5	7.25%	38.22%	10.587	5.30%	$45,520	5.41%	$4,299	3.6%	4.6%
1969	3,887.3	5.52%	1,471.0	7.29%	37.84%	10.563	5.25%	$46,609	5.41%	$4,413	3.5%	2.8%
1970	3,880.7	5.48%	1,409.9	7.28%	36.33%	10.669	5.24%	$47,230	5.31%	$4,419	4.9%	0.0%
1971	3,839.6	5.39%	1,333.8	7.16%	34.74%	10.735	5.19%	$47,299	5.26%	$4,405	5.9%	2.5%
1972	3,938.4	5.35%	1,346.8	7.03%	34.20%	10.747	5.14%	$49,023	5.18%	$4,572	5.6%	6.6%
1973	4,112.9	5.36%	1,426.3	7.08%	34.68%	10.767	5.09%	$50,945	5.15%	$4,742	4.9%	5.8%
1974	4,169.4	5.33%	1,416.6	7.06%	33.98%	10.766	5.05%	$50,995	5.14%	$4,749	5.6%	-0.6%
1975	4,016.2	5.22%	1,267.5	6.92%	31.56%	10.771	5.00%	$49,619	5.09%	$4,612	8.5%	-1.2%
1976	4,094.6	5.16%	1,295.3	6.82%	31.63%	10.753	4.94%	$50,426	4.98%	$4,717	7.7%	5.4%
1977	4,230.1	5.13%	1,344.1	6.83%	31.77%	10.771	4.90%	$52,494	5.00%	$4,907	7.1%	5.5%
1978	4,394.9	5.07%	1,377.2	6.72%	31.34%	10.795	4.86%	$54,316	4.89%	$5,032	6.1%	5.0%
1979	4,484.8	4.99%	1,382.3	6.57%	30.82%	10.799	4.81%	$55,436	4.82%	$5,134	5.8%	2.8%
1980	4,367.4	4.83%	1,264.3	6.23%	28.95%	10.803	4.75%	$55,135	4.71%	$5,105	7.1%	-0.3%
1981	4,317.7	4.74%	1,232.6	6.11%	28.55%	10.788	4.70%	$54,672	4.56%	$5,063	7.6%	2.6%
1982	4,124.3	4.61%	1,099.9	5.86%	26.67%	10.757	4.64%	$54,547	4.41%	$5,063	9.7%	-1.9%
1983	4,092.5	4.54%	1,066.0	5.78%	26.05%	10.738	4.59%	$55,377	4.36%	$5,157	9.6%	3.4%
1984	4,260.2	4.51%	1,127.0	5.82%	26.45%	10.740	4.54%	$57,809	4.33%	$5,383	7.5%	6.5%
1985	4,378.6	4.49%	1,123.3	5.82%	25.65%	10.744	4.50%	$59,118	4.29%	$5,502	7.2%	2.7%
1986	4,475.2	4.47%	1,109.3	5.78%	24.79%	10.752	4.46%	$59,843	4.24%	$5,566	7.0%	2.5%
1995 (ex ante)	4,900.0	4.36%	1,139.7	5.64%	23.26%	10.807	4.17%	$73,819	4.11%	$6,831	5.0%	2.4%
1995 (ex post)	5,221.0	4.48%	1,102.3	6.02%	21.11%	11.151	4.24%	$75,304	4.12%	$6,753	5.6%	2.0%

Appendix Table 2: Evaluation of Ohio Industry Projections, 1986-95, for 2-Digit Industries (in thousands)

SIC Code	2-Digit Industry	1986 Ann. Employ.	1995 Proj. Employ.	1995 Actual Employ.	Absolute Value of Error	MAPE	Actual Direction	Predicted Direction	Correct Direction Predicted	Weighted MAPE	Distrib. of MAPE
	Total for Comparable 2-Digit Industries	3,695.4	4,060.4	4,285.6	325.4	7.6%	u	u	84.9%	7.6%	100.0%
12	Bituminous Coal and Lignite Mining	10.1	9.0	4.0	5.0	125.0%	d	d	1	0.12%	1.5%
13	Oil and Gas Extraction	8.0	7.2	4.8	2.4	50.0%	d	d	1	0.06%	0.7%
14	Nonmetallic Mining and Quarrying	4.6	5.0	4.9	0.1	2.0%	u	u	1	0.00%	0.0%
15	General Building Contractors	41.1	43.1	48.2	5.1	10.6%	u	u	1	0.12%	1.6%
16,17	Heavy Construction & Special Trade Contractors	119.7	123.9	156.4	32.5	20.8%	u	u	1	0.76%	10.0%
20	Food and Kindred Products	62.6	56.2	59.8	3.6	6.0%	d	d	1	0.08%	1.1%
22	Textile Mill Products	4.4	4.0	4.1	0.1	2.4%	d	d	1	0.00%	0.0%
23	Apparel and Other Textile Products	16.3	14.5	14.6	0.1	0.7%	d	d	1	0.00%	0.0%
25	Furniture and Fixtures	14.5	16.0	15.9	0.1	0.6%	u	u	1	0.00%	0.0%
26	Paper and Allied Products	37.3	37.7	38.0	0.3	0.8%	u	u	1	0.01%	0.1%
27	Printing and Publishing Industries	68.6	69.5	75.5	6.0	7.9%	u	u	1	0.14%	1.8%
28	Chemicals and Allied Products	63.1	66.0	66.5	0.5	0.8%	u	u	1	0.01%	0.2%
29	Petroleum and Coal Products	8.8	9.5	7.2	2.3	31.9%	d	u	0	0.05%	0.7%
31	Leather and Leather Products	3.4	3.2	2.4	0.8	33.3%	d	d	1	0.02%	0.2%
33	Primary Metal Industries	95.4	80.2	96.5	16.3	16.9%	u	d	0	0.38%	5.0%
34	Fabricated Metal Products	136.8	123.9	131.8	7.9	6.0%	d	d	1	0.18%	2.4%
37	Transportation Equipment	153.5	140.9	139.3	1.6	1.1%	d	d	1	0.04%	0.5%
39	Miscellaneous Manufacturing Ind.	14.1	15.5	16.0	0.5	3.1%	u	u	1	0.01%	0.2%
40	Railroad Transportation	15.7	11.9	9.8	2.1	21.4%	d	d	1	0.05%	0.6%
41	Local And Interurban Passen. Transit	6.0	6.9	11.1	4.2	37.8%	u	u	1	0.10%	1.3%
42	Trucking And Warehousing	68.5	76.4	88.2	11.8	13.4%	u	u	1	0.28%	3.6%
44	Water Transportation	3.6	3.5	3.7	0.2	5.4%	u	d	0	0.00%	0.1%
45	Air Transportation	10.0	11.3	18.2	6.9	37.9%	u	u	1	0.16%	2.1%
47	Transportation Services	8.7	10.8	14.4	3.6	25.0%	u	u	1	0.08%	1.1%
48	Communications	50.7	47.7	42.2	5.5	13.0%	d	d	1	0.13%	1.7%
49	Electric, Gas, And Sanitary Services	41.5	43.0	39.4	3.6	9.1%	d	u	0	0.08%	1.1%
51	Wholesale Trade, Nondurable Goods	90.1	100.7	101.7	1.0	1.0%	u	u	1	0.02%	0.3%
52	Building Materials & Garden Supplies	31.1	33.7	40.0	6.3	15.8%	u	u	1	0.15%	1.9%
53	General Merchandise Stores	114.8	118.6	127.9	9.3	7.3%	u	u	1	0.22%	2.9%
54	Food Stores	128.4	140.3	156.5	16.2	10.4%	u	u	1	0.38%	5.0%
55	Automotive Dealers & Service Stations	91.0	90.9	100.5	9.6	9.6%	u	d	0	0.22%	3.0%
56	Apparel And Accessories Stores	38.5	46.2	45.6	0.6	1.3%	u	u	1	0.01%	0.2%
57	Furniture & Home Furnishings Stores	29.5	31.1	41.0	9.9	24.1%	u	u	1	0.23%	3.0%
58	Eating And Drinking Places	288.6	335.7	352.3	16.6	4.7%	u	u	1	0.39%	5.1%
60,61	Depository & Nondepository Institutions	98.0	107.7	104.3	3.4	3.3%	u	u	1	0.08%	1.0%

Appendix Table 2: Evaluation of Ohio Industry Projections, 1986-95, for 2-Digit Industries (in thousands)

SIC Code	2-Digit Industry	1986 Ann. Employ.	1995 Proj. Employ.	1995 Actual Employ.	Absolute Value of Error	MAPE	Actual Direction	Predicted Direction	Correct Direction Predicted	Weighted MAPE	Distrib. of MAPE
62	Security & Commodity Brokers,Dealers	7.2	7.8	12.0	4.2	35.0%	u	u	1	0.10%	1.3%
63	Insurance Carriers	62.9	70.2	61.7	8.5	13.8%	d	u	0	0.20%	2.6%
64	Insurance Agents, Brokers, and Services	19.8	22.8	23.1	0.3	1.3%	u	u	1	0.01%	0.1%
65	Real Estate	36.6	39.9	50.1	10.2	20.4%	u	u	1	0.24%	3.1%
67	Holding & Other Investment Offices	7.1	9.5	10.4	0.9	8.7%	u	u	1	0.02%	0.3%
70	Hotels & Other Lodging Places	33.5	38.3	36.5	1.8	4.9%	u	u	1	0.04%	0.6%
73,78,87,89	Business, Motion Picture, Architec., Misc. Serv.	256.6	355.8	368.7	12.9	3.5%	u	u	1	0.30%	4.0%
75	Automobile Repair, Services & Garages	32.7	37.0	42.6	5.6	13.1%	u	u	1	0.13%	1.7%
76	Miscellaneous Repair Services	11.5	14.6	14.3	0.3	2.1%	u	u	1	0.01%	0.1%
80	Private Health Services	344.0	453.6	452.7	0.9	0.2%	u	u	1	0.02%	0.3%
81	Legal Services	24.5	32.1	29.9	2.2	7.4%	u	u	1	0.05%	0.7%
82	Private Educational Services	58.5	61.4	60.4	1.0	1.7%	u	u	1	0.02%	0.3%
83	Social Services	55.7	74.0	91.7	17.7	19.3%	u	u	1	0.41%	5.4%
84	Museums, Art Galleries, and Zoos	2.9	3.3	4.4	1.1	25.0%	u	u	1	0.03%	0.3%
86	Membership Organizations	85.1	85.8	95.4	9.6	10.1%	d	u	0	0.22%	3.0%
91	Federal Government	93.8	98.9	91.0	7.9	8.7%	d	u	0	0.18%	2.4%
92	State Government	148.1	158.2	165.7	7.5	4.5%	u	u	1	0.18%	2.3%
93	Local Government	437.9	455.5	492.3	36.8	7.5%	u	u	1	0.86%	11.3%

Appendix Table 3: Evaluation of Ohio Industry Projections, 1986-95, for 3-Digit Industries (in thousands)

SIC Code	3-Digit Industry	1986 Ann. Employ.	1995 Proj. Employ.	1995 Actual Employ.	Absolute Value of Error	MAPE	Actual Direction	Predicted Direction	Correct Direction	Weighted MAPE	Distrib. of MAPE
	Total for Comparable 3-Digit Industries	4,016.3	4,356.7	4,578.0	552.1	12.1%	u	u	72.2%	12.1%	100.0%
131	Crude Petroleum And Natural Gas	3.5	3.3	2.8	0.5	17.9%	d	d	1	0.01%	0.09%
138	Oil And Gas Field Services	4.5	3.9	2.1	1.8	85.7%	d	d	1	0.04%	0.33%
142	Crushed And Broken Stone	1.6	1.8	1.9	0.1	5.3%	u	u	1	0.00%	0.02%
144	Sand And Gravel	2.3	2.5	2.3	0.2	8.7%	d	u	0	0.00%	0.04%
152	Residential Building Construction	18.1	18.1	21.8	3.7	17.0%	u	d	0	0.08%	0.67%
153	Operative Building	1.2	1.1	1.5	0.4	26.7%	u	d	0	0.01%	0.07%
154	Nonresidential Building Construction	21.8	23.9	24.9	1.0	4.0%	u	u	1	0.02%	0.18%
161,177	Highway, Street & Concrete Work	15.9	17.9	18.4	0.5	2.7%	u	u	1	0.01%	0.09%
162	Heavy Construction, Except Highway	11.4	11.7	16.1	4.4	27.3%	u	u	1	0.10%	0.80%
171	Plumbing, Heating, Air Conditioning	23.8	24.3	32.0	7.7	24.1%	u	u	1	0.17%	1.39%
172	Painting, Paper Hanging, Decorating	6.4	6.4	7.4	1.0	13.5%	u	d	0	0.02%	0.18%
173	Electrical Work	16.6	17.2	23.4	6.2	26.5%	u	u	1	0.14%	1.12%
174	Masonry, Stonework, And Plaster	13.0	14.3	16.6	2.3	13.9%	u	u	1	0.05%	0.42%
175	Carpentering And Flooring	7.1	7.0	10.4	3.4	32.7%	u	d	0	0.07%	0.62%
176	Roofing And Sheet Metal Work	8.5	8.7	8.9	0.2	2.2%	u	u	1	0.00%	0.04%
179	Miscellaneous Special Trade Contractors	16.4	15.9	22.6	6.7	29.6%	u	d	0	0.15%	1.21%
201	Meat Products	9.6	8.6	8.2	0.4	4.9%	d	d	1	0.01%	0.07%
202	Dairy Products	10.0	8.2	9.7	1.5	15.5%	d	d	1	0.03%	0.27%
203,205	Preserved Fruits & Veg. & Bakery Products	19.6	18.5	20.7	2.2	10.6%	u	d	0	0.05%	0.40%
204	Grain Mill Products	4.7	4.5	5.6	1.1	19.6%	u	d	0	0.02%	0.20%
206,209	Sugar & Confectionery Prod. & Misc. Food Prod.	6.4	5.7	6.7	1.0	14.9%	u	d	0	0.02%	0.18%
207	Fats And Oils	2.3	2.1	2.1	0.0	0.0%	d	d	1	0.00%	0.00%
208	Beverages	10.0	8.6	6.9	1.7	24.6%	d	d	1	0.04%	0.31%
229	Miscellaneous Textile Goods	2.7	2.5	2.3	0.2	8.7%	d	d	1	0.00%	0.04%
231	Men'S And Boy'S Suits And Coats	2.8	2.0	1.2	0.8	66.7%	d	d	1	0.02%	0.14%
232	Men'S And Boy'S Furnishings	2.8	2.6	1.5	1.1	73.3%	d	d	1	0.02%	0.20%
233	Women'S And Misses' Outerwear	1.8	1.4	0.5	0.9	180.0%	d	d	1	0.02%	0.16%
238	Miscellaneous Apparel And Accesories	1.0	0.6	0.8	0.2	25.0%	d	d	1	0.00%	0.04%
239	Miscellaneous Fabricated Textile Products	7.3	7.2	10.4	3.2	30.8%	u	d	0	0.07%	0.58%
242	Sawmills And Planing Mills	2.7	3.2	3.1	0.1	3.2%	u	u	1	0.00%	0.02%
243	Millwork,Plywood, And Structural Members	7.7	10.0	12.8	2.8	21.9%	u	u	1	0.06%	0.51%
244	Wooden Containers	2.3	3.0	3.3	0.3	9.1%	u	u	1	0.01%	0.05%
245	Wood Building And Mobile Homes	2.2	3.0	1.2	1.8	150.0%	d	u	0	0.04%	0.33%
249	Miscellaneous Wood Products	2.7	3.0	6.8	3.8	55.9%	u	u	1	0.08%	0.69%
251	Household Furniture	6.9	7.7	7.6	0.1	1.3%	u	u	1	0.00%	0.02%
252	Office Furniture	1.8	2.0	1.2	0.8	66.7%	d	u	0	0.02%	0.14%

Appendix Table 3: Evaluation of Ohio Industry Projections, 1986-95, for 3-Digit Industries (in thousands)

SIC Code	3-Digit Industry	1986 Ann. Employ.	1995 Proj. Employ.	1995 Actual Employ.	Absolute Value of Error	MAPE	Actual Direction	Predicted Direction	Correct Direction	Weighted MAPE	Distrib. of MAPE
254,259	Partitions, Fixtures & Misc. Furniture & Fixtures	5.0	5.5	2.4	3.1	129.2%	d	u	0	0.07%	0.56%
262	Paper Mills, Except Building Paper	9.7	9.7	8.5	1.2	14.1%	d	d	1	0.03%	0.22%
263	Paperboard Mills	2.9	2.5	2.2	0.3	13.6%	d	d	1	0.01%	0.05%
264=267	Miscellaneous Converted Paper Products	11.8	13.1	13.7	0.6	4.4%	u	u	1	0.01%	0.11%
265	Paperboard Container And Boxes	12.6	12.2	13.5	1.3	9.6%	u	d	0	0.03%	0.24%
271	Newspapers	19.1	18.9	18.3	0.6	3.3%	d	d	1	0.01%	0.11%
272	Periodicals	5.7	6.2	5.6	0.6	10.7%	d	u	0	0.01%	0.11%
273	Books	3.1	3.1	5.6	2.5	44.6%	u	d	0	0.05%	0.45%
274	Miscellaneous Publishing	2.3	2.4	3.3	0.9	27.3%	u	u	1	0.02%	0.16%
275,279	Commercial Printing & Printing Trade Services	28.5	28.8	33.3	4.5	13.5%	u	u	1	0.10%	0.82%
276	Manifold Business Forms	3.5	3.7	3.1	0.6	19.4%	d	u	0	0.01%	0.11%
277	Greeting Card Publishing	4.6	4.5	4.8	0.3	6.3%	u	d	0	0.01%	0.05%
278	Blankbooks And Bookbinding	1.8	1.9	1.6	0.3	18.8%	d	u	0	0.01%	0.05%
281	Industrial Inorganic Chemicals	10.0	10.5	10.1	0.4	4.0%	u	u	1	0.01%	0.07%
282	Plastics Materials And Synthetics	8.2	8.7	9.5	0.8	8.4%	u	u	1	0.02%	0.14%
283	Drugs	3.3	3.6	3.9	0.3	7.7%	u	u	1	0.01%	0.05%
284	Soap, Cleaners, And Toilet Goods	16.9	17.7	18.3	0.6	3.3%	u	u	1	0.01%	0.11%
285	Paints And Allied Products	6.6	6.5	6.0	0.5	8.3%	d	d	1	0.01%	0.09%
286	Industrial Organic Chemicals	4.7	5.1	7.8	2.7	34.6%	u	u	1	0.06%	0.49%
287	Agricultural Chemicals	2.4	2.3	1.7	0.6	35.3%	d	d	1	0.01%	0.11%
289	Miscellaneous Chemical Products	11.0	11.7	9.2	2.5	27.2%	d	u	0	0.05%	0.45%
291	Petroleum Refining	5.3	6.1	3.8	2.3	60.5%	d	u	0	0.05%	0.42%
295	Paving And Roofing Materials	2.8	2.7	2.4	0.3	12.5%	d	d	1	0.01%	0.05%
301	Tires And Inner Tubes	18.1	15.9	11.0	4.9	44.5%	d	d	1	0.11%	0.89%
304=5,329	Rubber & Plastic Hose & Belting & Misc. NM Min.	16.4	17.5	15.8	1.7	10.8%	d	u	0	0.04%	0.31%
306	Fabricated Rubber Products, N.E.C.	17.1	17.6	16.9	0.7	4.1%	u	d	0	0.02%	0.13%
307=308	Miscellaneous Plastics Products	53.2	62.2	61.6	0.6	1.0%	u	u	1	0.01%	0.11%
314	Footwear, Except Rubber	2.8	2.7	1.5	1.2	80.0%	d	d	1	0.03%	0.22%
322	Glass And Glassware, Pressed Or Blown	10.9	9.6	8.5	1.1	12.9%	d	d	1	0.02%	0.20%
323	Products Of Purchased Glass	5.6	5.0	5.6	0.6	10.7%	d	d	1	0.01%	0.11%
325	Structural Clay Products	4.8	4.4	3.8	0.6	15.8%	d	d	1	0.01%	0.11%
326	Pottery And Related Products	4.4	4.9	5.2	0.3	5.8%	u	u	1	0.01%	0.05%
327	Concrete, Gypsum, And Plaster Products	8.4	8.4	9.0	0.6	6.7%	u	d	0	0.01%	0.11%
331	Blast Furnaces And Basic Steel Products	42.8	33.1	40.9	7.8	19.1%	d	d	1	0.17%	1.41%
332	Iron And Steel Foundries	20.2	16.4	19.9	3.5	17.6%	d	d	1	0.08%	0.63%
333	Primary Nonferrous Metals	2.3	2.4	2.4	0.0	0.0%	u	u	1	0.00%	0.00%
334	Secondary Nonferrous Metals	1.6	1.7	1.3	0.4	30.8%	d	u	0	0.01%	0.07%

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SIC Code	3-Digit Industry	1986 Ann. Employ.	1995 Proj. Employ.	1995 Actual Employ.	Absolute Value of Error	MAPE	Actual Direction	Predicted Direction	Correct Direction	Weighted MAPE	Distrib. of MAPE
335	Nonferrous Rolling And Drawing	17.8	16.2	17.8	1.6	9.0%	d	d	1	0.03%	0.29%
336	Nonferrous Foundries	8.6	8.3	11.1	2.8	25.2%	u	d	0	0.06%	0.51%
339	Miscellaneous Primary Metal Products	2.1	2.2	3.2	1.0	31.3%	u	u	1	0.02%	0.18%
341	Metal Cans And Shipping Containers	4.9	4.1	4.3	0.2	4.7%	d	d	1	0.00%	0.04%
342	Cutlery, Hand Tools, And Hardware	10.5	9.7	8.7	1.0	11.5%	d	d	1	0.02%	0.18%
343	Plumbing And Heating, Except Electrical	4.8	4.0	4.8	0.8	16.7%	d	d	1	0.02%	0.14%
344	Fabricated Structural Metal Products	29.1	27.2	26.9	0.3	1.1%	d	d	1	0.01%	0.05%
345	Screw Machine Products, Bolts, Nuts	9.3	8.3	10.7	2.4	22.4%	u	d	0	0.05%	0.43%
346	Metal Forgings And Stampings	43.3	38.5	41.5	3.0	7.2%	d	d	1	0.07%	0.54%
347	Metal Services, N.E.C.	8.8	8.6	11.6	3.0	25.9%	u	d	0	0.07%	0.54%
348	Ordnance & Access., Ex Veh. & Guided Miss.	5.1	4.3	2.8	1.5	53.6%	d	d	1	0.03%	0.27%
349	Miscellaneous Fabricated Metal Products	21.0	19.3	20.5	1.2	5.9%	d	d	1	0.03%	0.22%
351	Engines And Turbines	3.2	2.9	3.1	0.2	6.5%	d	d	1	0.00%	0.04%
352	Farm And Garden Machinery	3.3	3.0	4.0	1.0	25.0%	u	d	0	0.02%	0.18%
353	Construction And Related Machinery	12.9	13.5	13.0	0.5	3.8%	u	u	1	0.01%	0.09%
355	Special Industry Machinery	17.2	16.5	17.1	0.6	3.5%	d	d	1	0.01%	0.11%
357	Office, Computing Machinery	13.6	15.7	9.5	6.2	65.3%	d	u	0	0.14%	1.12%
358	Refrigeration And Service Machinery	16.5	15.8	15.1	0.7	4.6%	d	d	1	0.02%	0.13%
361	Electric Distributing Equipment	3.9	3.2	3.1	0.1	3.2%	d	d	1	0.00%	0.02%
363	Household Appliances	17.0	16.0	16.0	0.0	0.0%	d	d	1	0.00%	0.00%
364	Electric Lighting And Wiring Equipment	17.9	16.1	15.4	0.7	4.5%	d	d	1	0.02%	0.13%
367	Electronic Components And Accesories	10.3	9.2	11.2	2.0	17.9%	u	d	0	0.04%	0.36%
369	Misc. Electrical Equipment And Supplies	12.4	11.1	8.1	3.0	37.0%	d	d	1	0.07%	0.54%
371	Motor Vehicles And Equipment (adj. for coding)	98.0	88.0	102.8	14.8	14.4%	u	d	0	0.32%	2.68%
372	Aircraft And Parts	46.2	43.3	19.8	23.5	118.7%	d	d	1	0.51%	4.26%
374	Railroad Equipment	1.3	1.0	1.1	0.1	9.1%	d	d	1	0.00%	0.02%
375	Motorcycles, Bicycles, And Parts	2.5	3.1	2.7	0.4	14.8%	u	u	1	0.01%	0.07%
379	Miscellaneous Transportation Equipment	4.9	5.0	2.6	2.4	92.3%	d	u	0	0.05%	0.43%
385	Ophthalmic Goods	1.4	1.7	0.7	1.0	142.9%	d	u	0	0.02%	0.18%
394	Toys And Sporting Goods	4.8	6.0	5.4	0.6	11.1%	u	u	1	0.01%	0.11%
395	Pens, Pencils, And Office And Art Supplies	1.1	1.3	0.7	0.6	85.7%	d	u	0	0.01%	0.11%
399	Miscellaneous Manufacturers	7.1	7.1	8.9	1.8	20.2%	u	d	0	0.04%	0.33%
411	Local And Suburban Transportation	3.4	3.7	7.3	3.6	49.3%	u	u	1	0.08%	0.65%
415	School Buses	1.1	1.4	2.0	0.6	30.0%	u	u	1	0.01%	0.11%
421	Trucking, Local And Long Distance	64.3	71.9	81.5	9.6	11.8%	u	u	1	0.21%	1.74%
422	Public Warehousing	3.2	3.4	6.4	3.0	46.9%	u	u	1	0.07%	0.54%
423	Trucking Terminal Facilities	1.0	1.1	0.3	0.8	266.7%	d	u	0	0.02%	0.14%

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451	Certificated Air Transportation	8.0	9.1	13.5	4.4	32.6%	u	u	1	0.10%	0.80%
458	Air Transportation Services	1.3	1.4	3.2	1.8	56.3%	u	u	1	0.04%	0.33%
481	Telephone Communication	37.8	34.2	27.9	6.3	22.6%	d	d	1	0.14%	1.14%
483	Radio And Television Broadcasting	8.0	8.3	8.5	0.2	2.4%	u	u	1	0.00%	0.04%
491	Electric Services	22.9	24.0	16.4	7.6	46.3%	d	u	0	0.17%	1.38%
492	Gas Production And Distribution	7.4	7.1	7.2	0.1	1.4%	d	d	1	0.00%	0.02%
493	Combination Utility Services	7.1	7.3	7.3	0.0	0.0%	u	u	1	0.00%	0.00%
495	Sanitary Services	3.5	4.0	7.7	3.7	48.1%	u	u	1	0.08%	0.67%
501,593	Motor Vehicles, Auto Parts & Used Merchandise	25.9	31.4	27.2	4.2	15.4%	u	u	1	0.09%	0.76%
502	Furniture And Home Furnishings	5.5	5.8	5.5	0.3	5.5%	d	u	0	0.01%	0.05%
503	Lumber And Other Construction Materials	7.1	7.4	9.7	2.3	23.7%	u	u	1	0.05%	0.42%
504,6,8,9	Miscellaneous Wholesale Trade Durables	100.2	111.3	112.0	0.7	0.6%	u	u	1	0.02%	0.13%
505	Metals And Minerals, Except Petroleum	10.0	10.9	11.4	0.5	4.4%	u	u	1	0.01%	0.09%
507	Hardware; Plumbing, And Heating Equipment	10.7	12.1	13.3	1.2	9.0%	u	u	1	0.03%	0.22%
511	Paper & Paper Products	8.6	10.4	11.5	1.1	9.6%	u	u	1	0.02%	0.20%
512	Drugs, Proprietaries, And Sundries	7.3	7.9	8.2	0.3	3.7%	u	u	1	0.01%	0.05%
513	Apparel, Piece Goods, And Notions	3.4	3.8	4.0	0.2	5.0%	u	u	1	0.00%	0.04%
514	Groceries And Related Products	28.4	31.1	33.8	2.7	8.0%	u	u	1	0.06%	0.49%
515	Farm-Product Raw Materials	4.8	5.1	4.5	0.6	13.3%	d	u	0	0.01%	0.11%
516	Chemicals And Allied Products	9.5	11.2	9.4	1.8	19.1%	d	u	0	0.04%	0.33%
517	Petroleum And Petroleum Products	6.0	6.1	4.7	1.4	29.8%	d	u	0	0.03%	0.25%
518	Beer, Wine, & Distilled Alcoholic Beverage	5.3	6.0	5.5	0.5	9.1%	u	u	1	0.01%	0.09%
519	Miscellaneous Nondurable Goods	16.8	19.1	20.1	1.0	5.0%	u	u	1	0.02%	0.18%
521	Lumber And Other Bldg. Materials Dealers	15.5	16.9	22.3	5.4	24.2%	u	u	1	0.12%	0.98%
523	Paint, Glass, And Wallpaper Stores	2.6	2.7	3.4	0.7	20.6%	u	u	1	0.02%	0.13%
525	Hardware Stores	8.0	8.9	8.6	0.3	3.5%	u	u	1	0.01%	0.05%
526	Retail Nurseries, Lawn And Garden Supplies	4.1	4.3	4.6	0.3	6.5%	u	u	1	0.01%	0.05%
531,539	Department Stores & Misc. Genl. Merchandise Stores	105.1	106.9	118.8	11.9	10.0%	u	u	1	0.26%	2.16%
533	Variety Stores	9.8	11.7	9.1	2.6	28.6%	d	u	0	0.06%	0.47%
541	Grocery Stores	110.5	120.4	139.0	18.6	13.4%	u	u	1	0.41%	3.37%
542	Meat And Fish (Seafood) Markets	3.0	3.2	2.4	0.8	33.3%	d	u	0	0.02%	0.14%
543	Fruit Stores And Vegetables Markets	1.3	1.4	1.7	0.3	17.6%	u	u	1	0.01%	0.05%
544	Candy, Nut, And Confectionery Stores	1.7	2.0	2.0	0.0	0.0%	u	u	1	0.00%	0.00%
545	Dairy Products Stores	2.6	2.7	0.8	1.9	237.5%	d	u	0	0.04%	0.34%
546	Retail Bakeries	8.0	9.1	8.8	0.3	3.4%	u	u	1	0.01%	0.05%
549	Miscellaneous Food Stores	1.4	1.5	1.8	0.3	16.7%	u	u	1	0.01%	0.05%
551	Motor Vehicles Dealers (New & Used)	41.0	40.0	45.1	5.1	11.3%	u	d	0	0.11%	0.92%

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552	Motor Vehicle Dealers (Used Only)	2.2	1.9	3.5	1.6	45.7%	u	d	0	0.03%	0.29%
553	Auto And Home Supply Stores	14.0	13.9	16.5	2.6	15.8%	u	d	0	0.06%	0.47%
554	Gasoline Service Stations	29.9	30.4	32.3	1.9	5.9%	u	u	1	0.04%	0.34%
555	Boat Dealers	1.2	1.4	0.9	0.5	55.6%	d	u	0	0.01%	0.09%
557	Motorcycle Dealers	1.4	1.6	1.3	0.3	23.1%	d	u	0	0.01%	0.05%
561	Men'S And Boy'S Clothing And Furnishings	3.9	4.3	2.9	1.4	48.3%	d	u	0	0.03%	0.25%
562	Women'S Ready-To-Wear Stores	14.9	19.6	17.6	2.0	11.4%	u	u	1	0.04%	0.36%
565	Family Clothing Stores	6.4	7.3	9.0	1.7	18.9%	u	u	1	0.04%	0.31%
566	Shoe Stores	9.6	10.7	9.3	1.4	15.1%	d	u	0	0.03%	0.25%
569	Miscellaneous Apparel And Accesories	1.6	1.9	2.8	0.9	32.1%	u	u	1	0.02%	0.16%
571	Furniture & Home Furnishings, Exc. Appl.	15.9	16.6	21.1	4.5	21.3%	u	u	1	0.10%	0.82%
572	Household Appliance Stores	3.3	3.9	2.7	1.2	44.4%	d	u	0	0.03%	0.22%
573	Radio, Television, And Music Stores	10.3	10.6	17.3	6.7	38.7%	u	u	1	0.15%	1.21%
581	Eating And Drinking Places	288.6	335.7	352.3	16.6	4.7%	u	u	1	0.36%	3.01%
591	Drug Stores & Proprietary Stores	26.7	30.4	31.4	1.0	3.2%	u	u	1	0.02%	0.18%
592	Liquor Stores	5.6	6.0	5.4	0.6	11.1%	d	u	0	0.01%	0.11%
594	Miscellaneous Shopping Goods Stores	29.2	32.8	41.5	8.7	21.0%	u	u	1	0.19%	1.58%
596	Nonstore Retailers	15.9	20.6	24.9	4.3	17.3%	u	u	1	0.09%	0.78%
598	Fuel And Ice Dealers	2.4	2.4	2.3	0.1	4.3%	d	d	1	0.00%	0.02%
599	Retail Stores, N.E.C.	15.3	16.4	22.5	6.1	27.1%	u	u	1	0.13%	1.10%
602	Commercial And Stock Savings Banks	60.0	66.3	65.0	1.3	2.0%	u	u	1	0.03%	0.24%
616	Mortgage Bankers And Brokers	3.8	4.5	7.1	2.6	36.6%	u	u	1	0.06%	0.47%
621	Security Brokers And Dealers	6.4	7.0	9.6	2.6	27.1%	u	u	1	0.06%	0.47%
631	Life Insurance	23.6	23.4	24.0	0.6	2.5%	u	d	0	0.01%	0.11%
632	Medical Service And Health Insurance	8.2	10.0	10.4	0.4	3.8%	u	u	1	0.01%	0.07%
633	Fire, Marine, And Casualty Insurance	28.5	33.7	31.1	2.6	8.4%	u	u	1	0.06%	0.47%
636	Title Insurance	1.6	1.8	2.5	0.7	28.0%	u	u	1	0.02%	0.13%
651	Real Estate Operators And Lessors	19.7	21.7	25.6	3.9	15.2%	u	u	1	0.09%	0.71%
653	Real Estate Agents And Managers	12.6	13.6	19.1	5.5	28.8%	u	u	1	0.12%	1.00%
654	Title Abstract Offices	1.1	1.5	1.5	0.0	0.0%	u	u	1	0.00%	0.00%
655	Subdividers And Developers	3.2	3.2	3.5	0.3	8.6%	u	d	0	0.01%	0.05%
671	Holding Offices	6.0	8.3	7.5	0.8	10.7%	u	u	1	0.02%	0.14%
701	Hotels, Motels, And Tourist Courts	32.5	37.2	35.1	2.1	6.0%	u	u	1	0.05%	0.38%
721	Laundry, Cleaning, And Garment Services	18.1	19.1	20.8	1.7	8.2%	u	u	1	0.04%	0.31%
722	Photographic Studios, Portrait	3.2	3.6	4.2	0.6	14.3%	u	u	1	0.01%	0.11%
723	Beauty Shops	18.0	20.4	20.7	0.3	1.4%	u	u	1	0.01%	0.05%
726	Funeral Service And Crematories	4.5	5.0	4.9	0.1	2.0%	u	u	1	0.00%	0.02%

Appendix Table 3: Evaluation of Ohio Industry Projections, 1986-95, for 3-Digit Industries (in thousands)

SIC Code	3-Digit Industry	1986 Ann. Employ.	1995 Proj. Employ.	1995 Actual Employ.	Absolute Value of Error	MAPE	Actual Direction	Predicted Direction	Correct Direction	Weighted MAPE	Distrib. of MAPE
731	Advertising	7.7	10.4	9.0	1.4	15.6%	u	u	1	0.03%	0.25%
732	Consumer Credit Reporting And Collection	4.6	5.7	4.9	0.8	16.3%	u	u	1	0.02%	0.14%
733	Mailing,Repro.,Comm.Art,& Steno. Services	8.1	10.7	9.9	0.8	8.1%	u	u	1	0.02%	0.14%
734	Services To Dwellings And Other Buildings	27.7	36.0	35.7	0.3	0.8%	u	u	1	0.01%	0.05%
737	Computer And Data Processing Services	17.6	29.3	38.3	9.0	23.5%	u	u	1	0.20%	1.63%
751	Automobile Rentals , Leasing, W/O Drivers	5.8	6.8	6.2	0.6	9.7%	u	u	1	0.01%	0.11%
752	Automobile Parking	1.8	1.8	3.0	1.2	40.0%	u	d	0	0.03%	0.22%
753	Automobile Repair Shops	19.2	22.6	23.5	0.9	3.8%	u	u	1	0.02%	0.16%
754	Automobile Services, Except Repair	5.9	5.9	9.8	3.9	39.8%	u	d	0	0.09%	0.71%
762	Electrical Repair Shops	3.3	4.0	3.5	0.5	14.3%	u	u	1	0.01%	0.09%
769	Miscellaneous Repair Shops	7.1	9.4	9.7	0.3	3.1%	u	u	1	0.01%	0.05%
783	Motion Picture Theaters	3.8	3.6	4.3	0.7	16.3%	u	d	0	0.02%	0.13%
792	Theatrical Producers, Bands, Entertainers	3.5	3.6	4.8	1.2	25.0%	u	u	1	0.03%	0.22%
793	Bowling Alleys And Billiard And Pool Estab	6.2	5.6	5.1	0.5	9.8%	d	d	1	0.01%	0.09%
794	Commercial Sports	3.4	3.5	4.7	1.2	25.5%	u	u	1	0.03%	0.22%
801,8,9	Offices of Physicians, Outpatient Care & Misc. Health	60.9	86.7	105.2	18.5	17.6%	u	u	1	0.40%	3.35%
802	Offices Of Dentists	20.3	27.2	24.3	2.9	11.9%	u	u	1	0.06%	0.53%
803	Offices Of Osteopathic Physicians	4.0	5.3	5.2	0.1	1.9%	u	u	1	0.00%	0.02%
804	Offices Of Other Health Practitioners	8.5	13.6	18.0	4.4	24.4%	u	u	1	0.10%	0.80%
805	Nursing And Personal Care Facilities	76.0	114.6	100.2	14.4	14.4%	u	u	1	0.31%	2.61%
806	Private Hospitals	169.9	200.1	193.2	6.9	3.6%	u	u	1	0.15%	1.25%
807	Medical And Dental Laboratories	4.6	6.1	6.8	0.7	10.3%	u	u	1	0.02%	0.13%
811	Legal Services	24.5	32.1	29.9	2.2	7.4%	u	u	1	0.05%	0.40%
820	Private Educational Services	58.5	61.4	60.4	1.0	1.7%	u	u	1	0.02%	0.18%
832	Individual And Family Social Services	13.3	17.1	23.6	6.5	27.5%	u	u	1	0.14%	1.18%
833	Job Training And Vocational Rehab Services	5.4	8.3	8.4	0.1	1.2%	u	u	1	0.00%	0.02%
835	Child Day Care Services	8.9	12.5	19.2	6.7	34.9%	u	u	1	0.15%	1.21%
836	Residential Care	17.0	23.4	31.1	7.7	24.8%	u	u	1	0.17%	1.39%
841	Museums And Art Galleries	2.2	2.6	3.2	0.6	18.8%	u	u	1	0.01%	0.11%
861	Business Associations	3.1	3.3	3.4	0.1	2.9%	u	u	1	0.00%	0.02%
862	Professional Membership Organizations	1.5	1.6	1.3	0.3	23.1%	d	u	0	0.01%	0.05%
863	Labor Unions & Similar Labor Organizations	12.2	12.3	12.3	0.0	0.0%	u	u	1	0.00%	0.00%
864	Civic, Social, And Fraternal Associations	17.3	17.9	21.8	3.9	17.9%	u	u	1	0.09%	0.71%
866	Religious Organizations	47.3	47.0	53.2	6.2	11.7%	u	d	0	0.14%	1.12%
869	Membership Organizations, N.E.C.	3.5	3.6	3.6	0.0	0.0%	u	u	1	0.00%	0.00%
891=871	Engineering, Architect. & Surveying Services	21.3	28.5	31.3	2.8	8.9%	u	u	1	0.06%	0.51%
893=872	Accounting,Auditing & Bookkeeping Services	17.4	21.2	21.6	0.4	1.9%	u	u	1	0.01%	0.07%

Appendix Table 3: Evaluation of Ohio Industry Projections, 1986-95, for 3-Digit Industries (in thousands)

SIC Code	3-Digit Industry	1986 Ann. Employ.	1995 Proj. Employ.	1995 Actual Employ.	Absolute Value of Error	MAPE	Actual Direction	Predicted Direction	Correct Direction	Weighted MAPE	Distrib. of MAPE
806	Federal Government Hospitals	8.6	9.1	8.3	0.8	9.6%	d	u	0	0.02%	0.14%
431	U.S. Postal Service	33.8	35.0	34.8	0.2	0.6%	u	u	1	0.00%	0.04%
919	Federal Government,Exc. P.O. & Hospitals	51.4	54.8	47.9	6.9	14.4%	d	u	0	0.15%	1.25%
806	State Government Hospitals	13.8	16.2	13.9	2.3	16.5%	u	u	1	0.05%	0.42%
820	State Government Education	76.3	82.0	86.1	4.1	4.8%	u	u	1	0.09%	0.74%
929	State Government, Exc. Educ.& Hospitals	58.1	60.1	65.7	5.6	8.5%	u	u	1	0.12%	1.01%
806	Local Government Hospitals	15.2	16.0	14.7	1.3	8.8%	d	u	0	0.03%	0.24%
820	Local Government Education	251.8	260.9	279.6	18.7	6.7%	u	u	1	0.41%	3.39%
939	Local Government, Exc. Educ. & Hospitals	171.0	178.6	187.0	8.4	4.5%	u	u	1	0.18%	1.52%

Appendix Table 4: Decomposition of Ohio 2-Digit Industry Projection Errors, 1986-95

	Proj.	Actual	Project: Actual Value of Ind. Vbl.			Absolute Value of Error				Decomposition of Error		
SIC	1995	1995	US	OH	US and OH	US	OH	Model	Total	US	OH	Model
12	9.0	4.0	5.1	11.3	6.2	1.1	7.3	2.2	10.6	10.4%	68.9%	20.8%
13	7.2	4.8	5.4	9.4	6.2	0.6	4.6	1.4	6.6	9.1%	69.7%	21.2%
14	5.0	4.9	5.3	6.1	5.5	0.4	1.2	0.6	2.2	18.2%	54.5%	27.3%
15	43.1	48.2	40.6	47.5	44.7	7.6	0.7	3.5	11.8	64.4%	5.9%	29.7%
20	56.2	59.8	65.3	56.2	65.4	5.5	3.6	5.6	14.7	37.4%	24.5%	38.1%
22	4.0	4.1	4.0	4.5	4.5	0.1	0.4	0.4	0.9	11.1%	44.4%	44.4%
23	14.5	14.6	13.7	16.0	15.2	0.9	1.4	0.6	2.9	31.0%	48.3%	20.7%
26	37.7	38.0	37.4	41.2	41.0	0.6	3.2	3.0	6.8	8.8%	47.1%	44.1%
27	69.5	75.5	65.3	71.1	68.7	10.2	4.4	6.8	21.4	47.7%	20.6%	31.8%
28	66.0	66.5	64.3	63.1	66.6	2.2	3.4	0.1	5.7	38.6%	59.6%	1.8%
29	9.5	7.2	7.1	12.8	8.4	0.1	5.6	1.2	6.9	1.4%	81.2%	17.4%
33	80.2	96.5	87.6	82.0	90.1	8.9	14.5	6.4	29.8	29.9%	48.7%	21.5%
34	123.9	131.8	131.0	126.1	133.8	0.8	5.7	2.0	8.5	9.4%	67.1%	23.5%
39	15.5	16.0	16.6	17.1	17.1	0.6	1.1	1.1	2.8	21.4%	39.3%	39.3%
41	6.9	11.1	15.7	8.2	16.1	4.6	2.9	5.0	12.5	36.8%	23.2%	40.0%
42	76.4	88.2	86.1	71.4	95.4	2.1	16.8	7.2	26.1	8.0%	64.4%	27.6%
45	11.3	18.2	14.9	11.6	15.2	3.3	6.6	3.0	12.9	25.6%	51.2%	23.3%
47	10.8	14.4	0.0	12.4	12.4	0.0	2.0	2.0	4.0	0.0%	50.0%	50.0%
48	47.7	42.2	50.1	51.3	53.7	7.9	9.1	11.5	28.5	27.7%	31.9%	40.4%
49	43.0	39.4	41.2	44.0	42.8	1.8	4.6	3.4	9.8	18.4%	46.9%	34.7%
51	100.7	101.7	105.4	102.3	106.0	3.7	0.6	4.3	8.6	43.0%	7.0%	50.0%
52	33.7	40.0	35.9	31.7	36.0	4.1	8.3	4.0	16.4	25.0%	50.6%	24.4%
53	118.6	127.9	113.3	144.3	140.3	14.6	16.4	12.4	43.4	33.6%	37.8%	28.6%
54	140.3	156.5	144.2	144.6	148.0	12.3	11.9	8.5	32.7	37.6%	36.4%	26.0%
55	90.9	100.5	95.7	98.1	103.2	4.8	2.4	2.7	9.9	48.5%	24.2%	27.3%
56	46.2	45.6	36.7	42.9	39.5	8.9	2.7	6.1	17.7	50.3%	15.3%	34.5%
57	31.1	41.0	34.6	34.0	37.2	6.4	7.0	3.8	17.2	37.2%	40.7%	22.1%
58	335.7	352.3	328.4	341.8	331.8	23.9	10.5	20.5	54.9	43.5%	19.1%	37.3%
62	7.8	12.0	9.1	8.4	9.2	2.9	3.6	2.8	9.3	31.2%	38.7%	30.1%
63	70.2	61.7	0.0	73.4	73.4	0.0	11.7	11.7	23.4	0.0%	50.0%	50.0%
64	22.8	23.1	22.6	21.4	23.4	0.5	1.7	0.3	2.5	20.0%	68.0%	12.0%
65	39.9	50.1	0.0	41.4	41.4	0.0	8.7	8.7	17.4	0.0%	50.0%	50.0%
70	38.3	36.5	36.5	40.6	38.8	0.0	4.1	2.3	6.4	0.0%	64.1%	35.9%
75	37.0	42.6	45.9	37.1	45.9	3.3	5.5	3.3	12.1	27.3%	45.5%	27.3%
76	14.6	14.3	11.3	14.6	11.3	3.0	0.3	3.0	6.3	47.6%	4.8%	47.6%
82	61.4	60.4	59.1	66.0	63.7	1.3	5.6	3.3	10.2	12.7%	54.9%	32.4%
83	74.0	91.7	92.8	75.4	94.3	1.1	16.3	2.6	20.0	5.5%	81.5%	13.0%
91	98.9	91.0	94.4	100.3	95.8	3.4	9.3	4.8	17.5	19.4%	53.1%	27.4%

Appendix Table 5: Decomposition of Ohio 3-Digit Industry Projection Errors, 1986-95

3-Digit	Proj.	Actual	Project: Actual Value of Ind. Vbl.			Absolute Value of Error				Decomposition of Error		
SIC	1995	1995	US	OH	US and OH	US	OH	Model	Total	US	OH	Model
131	3.3	2.8	1.7	4.4	2.1	1.1	1.6	0.7	3.4	32.4%	47.1%	20.6%
131	3.3	2.8	1.7	4.4	2.1	1.1	1.6	0.7	3.4	32.4%	47.1%	20.6%
138	3.9	2.1	4.0	n/a	4.0	1.9	0.0	1.9	3.8	50.0%	0.0%	50.0%
142	1.8	1.9	1.6	1.6	1.7	0.3	0.3	0.2	0.8	37.5%	37.5%	25.0%
144	2.5	2.3	2.2	2.2	2.3	0.1	0.1	0.0	0.2	50.0%	50.0%	0.0%
152	18.1	21.8	13.8	13.3	13.8	8.0	8.5	8.0	24.5	32.7%	34.7%	32.7%
154	23.9	24.9	21.7	n/a	21.7	3.2	0.0	3.2	6.4	50.0%	0.0%	50.0%
171	24.3	32.0	26.4	23.2	26.4	5.6	8.8	5.6	20.0	28.0%	44.0%	28.0%
172	6.4	7.4	6.7	7.1	7.3	0.7	0.3	0.1	1.1	63.6%	27.3%	9.1%
173	17.2	23.4	19.5	17.5	19.5	3.9	5.9	3.9	13.7	28.5%	43.1%	28.5%
174	14.3	16.6	16.5	18.6	18.6	0.1	2.0	2.0	4.1	2.4%	48.8%	48.8%
175	7.0	10.4	8.9	6.0	8.9	1.5	4.4	1.5	7.4	20.3%	59.5%	20.3%
176	8.7	8.9	8.9	13.6	13.5	0.0	4.7	4.6	9.3	0.0%	50.5%	49.5%
201	8.6	8.2	13.1	14.8	14.1	4.9	6.6	5.9	17.4	28.2%	37.9%	33.9%
202	8.2	9.7	9.1	9.2	9.2	0.6	0.5	0.5	1.6	37.5%	31.3%	31.3%
204	4.5	5.6	5.5	5.6	5.6	0.1	0.0	0.0	0.1	100.0%	0.0%	0.0%
207	2.1	2.1	2.3	2.4	2.3	0.2	0.3	0.2	0.7	28.6%	42.9%	28.6%
208	8.6	6.9	9.4	10.9	9.6	2.5	4.0	2.7	9.2	27.2%	43.5%	29.3%
231	2.0	1.2	2.1	2.2	2.1	0.9	1.0	0.9	2.8	32.1%	35.7%	32.1%
232	2.6	1.5	3.1	3.4	3.2	1.6	1.9	1.7	5.2	30.8%	36.5%	32.7%
239	7.2	10.4	10.3	10.6	11.1	0.1	0.2	0.7	1.0	10.0%	20.0%	70.0%
242	3.2	3.1	3.9	4.1	4.1	0.8	1.0	1.0	2.8	28.6%	35.7%	35.7%
244	3.0	3.3	3.5	3.3	3.6	0.2	0.0	0.3	0.5	40.0%	0.0%	60.0%
245	3.0	1.2	2.2	n/a	2.2	1.0	0.0	1.0	2.0	50.0%	0.0%	50.0%
251	7.7	7.6	6.8	8.3	7.5	0.8	0.7	0.1	1.6	50.0%	43.8%	6.2%
265	12.2	13.5	14.0	12.4	14.1	0.5	1.1	0.6	2.2	22.7%	50.0%	27.3%
271	18.9	18.3	19.8	n/a	19.8	1.5	0.0	1.5	3.0	50.0%	0.0%	50.0%
272	6.2	5.6	6.4	6.4	6.4	0.8	0.8	0.8	2.4	33.3%	33.3%	33.3%
274	2.4	3.3	2.5	2.4	2.5	0.8	0.9	0.8	2.5	32.0%	36.0%	32.0%
276	3.7	3.1	3.2	4.4	3.2	0.1	1.3	0.1	1.5	6.7%	86.7%	6.7%
277	4.5	4.8	3.4	n/a	3.4	1.4	0.0	1.4	2.8	50.0%	0.0%	50.0%
278	1.9	1.6	1.8	n/a	1.8	0.2	0.0	0.2	0.4	50.0%	0.0%	50.0%
282	8.7	9.5	8.8	9.5	9.4	0.7	0.0	0.1	0.8	87.5%	0.0%	12.5%
283	3.6	3.9	3.2	n/a	3.2	0.7	0.0	0.7	1.4	50.0%	0.0%	50.0%
284	17.7	18.3	17.6	n/a	17.6	0.7	0.0	0.7	1.4	50.0%	0.0%	50.0%
285	6.5	6.0	6.2	6.4	6.2	0.2	0.4	0.2	0.8	25.0%	50.0%	25.0%
287	2.3	1.7	2.3	2.5	2.3	0.6	0.8	0.6	2.0	30.0%	40.0%	30.0%
289	11.7	9.2	10.7	n/a	10.7	1.5	0.0	1.5	3.0	50.0%	0.0%	50.0%
291	6.1	3.8	4.6	11.0	7.2	0.8	7.2	3.4	11.4	7.0%	63.2%	29.8%
295	2.7	2.4	2.8	n/a	2.8	0.4	0.0	0.4	0.8	50.0%	0.0%	50.0%
301	15.9	11.0	16.4	20.5	19.8	5.4	9.5	8.8	23.7	22.8%	40.1%	37.1%
322	9.6	8.5	9.1	11.9	9.5	0.6	3.4	1.0	5.0	12.0%	68.0%	20.0%
323	5.0	5.6	6.8	7.0	6.8	1.2	1.4	1.2	3.8	31.6%	36.8%	31.6%
325	4.4	3.8	4.4	4.3	4.4	0.6	0.5	0.6	1.7	35.3%	29.4%	35.3%
327	8.4	9.0	5.9	n/a	5.9	3.1	0.0	3.1	6.2	50.0%	0.0%	50.0%
331	33.1	40.9	37.1	38.1	38.8	3.8	2.8	2.1	8.7	43.7%	32.2%	24.1%
332	16.4	19.9	19.3	18.3	19.5	0.6	1.6	0.4	2.6	23.1%	61.5%	15.4%
333	2.4	2.4	2.6	4.6	4.5	0.2	2.2	2.1	4.5	4.4%	48.9%	46.7%
335	16.2	17.8	16.4	n/a	16.4	1.4	0.0	1.4	2.8	50.0%	0.0%	50.0%
336	8.3	11.1	8.8	9.4	9.1	2.3	1.7	2.0	6.0	38.3%	28.3%	33.3%
345	8.3	10.7	9.1	10.6	9.9	1.6	0.1	0.8	2.5	64.0%	4.0%	32.0%

Appendix Table 5: Decomposition of Ohio 3-Digit Industry Projection Errors, 1986-95

3-Digit	Proj.	Actual	Project: Actual Value of Ind. Vbl.			Absolute Value of Error				Decomposition of Error		
SIC	1995	1995	US	OH	US and OH	US	OH	Model	Total	US	OH	Model
131	3.3	2.8	1.7	4.4	2.1	1.1	1.6	0.7	3.4	32.4%	47.1%	20.6%
348	4.3	2.8	4.1	n/a	4.1	1.3	0.0	1.3	2.6	50.0%	0.0%	50.0%
352	3.0	4.0	3.3	n/a	3.3	0.7	0.0	0.7	1.4	50.0%	0.0%	50.0%
353	13.5	13.0	11.6	14.9	11.7	1.4	1.9	1.3	4.6	30.4%	41.3%	28.3%
371	88.0	111.4	112.3	95.7	114.3	0.9	15.7	2.9	19.5	4.6%	80.5%	14.9%
375	3.1	2.7	n/a	3.9	3.9	0.0	1.2	1.2	2.4	0.0%	50.0%	50.0%
379	5.0	2.6	5.0	n/a	5.0	2.4	0.0	2.4	4.8	50.0%	0.0%	50.0%
394	6.0	5.4	5.7	n/a	5.7	0.3	0.0	0.3	0.6	50.0%	0.0%	50.0%
411	3.7	7.3	11.4	3.5	11.9	4.1	3.8	4.6	12.5	32.8%	30.4%	36.8%
415	1.4	2.0	1.8	1.3	1.8	0.2	0.7	0.2	1.1	18.2%	63.6%	18.2%
421	71.9	81.5	83.5	97.2	110.7	2.0	15.7	29.2	46.9	4.3%	33.5%	62.3%
422	3.4	6.4	5.6	3.9	6.1	0.8	2.5	0.3	3.6	22.2%	69.4%	8.3%
458	1.4	3.2	1.2	n/a	1.2	2.0	0.0	2.0	4.0	50.0%	0.0%	50.0%
481	34.2	27.9	35.7	38.9	37.4	7.8	11.0	9.5	28.3	27.6%	38.9%	33.6%
491	24.0	16.4	19.9	25.4	20.7	3.5	9.0	4.3	16.8	20.8%	53.6%	25.6%
492	7.1	7.2	6.4	8.4	7.7	0.8	1.2	0.5	2.5	32.0%	48.0%	20.0%
493	7.3	7.3	7.1	n/a	7.1	0.2	0.0	0.2	0.4	50.0%	0.0%	50.0%
495	4.0	7.7	7.5	n/a	7.5	0.2	0.0	0.2	0.4	50.0%	0.0%	50.0%
502	5.8	5.5	5.6	6.2	6.0	0.1	0.7	0.5	1.3	7.7%	53.8%	38.5%
503	7.4	9.7	7.5	7.4	7.5	2.2	2.3	2.2	6.7	32.8%	34.3%	32.8%
505	10.9	11.4	9.9	11.0	10.1	1.5	0.4	1.3	3.2	46.9%	12.5%	40.6%
507	12.1	13.3	12.1	n/a	12.1	1.2	0.0	1.2	2.4	50.0%	0.0%	50.0%
511	10.4	11.5	12.1	10.9	12.3	0.6	0.6	0.8	2.0	30.0%	30.0%	40.0%
512	7.9	8.2	7.7	n/a	7.7	0.5	0.0	0.5	1.0	50.0%	0.0%	50.0%
514	31.1	33.8	34.9	n/a	34.9	1.1	0.0	1.1	2.2	50.0%	0.0%	50.0%
517	6.1	4.7	5.1	n/a	5.1	0.4	0.0	0.4	0.8	50.0%	0.0%	50.0%
518	6.0	5.5	4.9	6.9	5.5	0.6	1.4	0.0	2.0	30.0%	70.0%	0.0%
519	19.1	20.1	19.1	19.1	19.9	1.0	1.0	0.2	2.2	45.5%	45.5%	9.1%
521	16.9	22.3	21.3	14.7	21.3	1.0	7.6	1.0	9.6	10.4%	79.2%	10.4%
523	2.7	3.4	1.7	1.7	1.7	1.7	1.7	1.7	5.1	33.3%	33.3%	33.3%
533	11.7	9.1	4.7	n/a	4.7	4.4	0.0	4.4	8.8	50.0%	0.0%	50.0%
541	120.4	139.0	122.5	122.9	125.8	16.5	16.1	13.2	45.8	36.0%	35.2%	28.8%
546	9.1	8.8	9.3	9.4	9.8	0.5	0.6	1.0	2.1	23.8%	28.6%	47.6%
553	13.9	16.5	14.7	n/a	14.7	1.8	0.0	1.8	3.6	50.0%	0.0%	50.0%
554	30.4	32.3	35.8	n/a	35.8	3.5	0.0	3.5	7.0	50.0%	0.0%	50.0%
561	4.3	2.9	2.5	5.3	3.2	0.4	2.4	0.3	3.1	12.9%	77.4%	9.7%
562	19.6	17.6	12.8	16.6	13.0	4.8	1.0	4.6	10.4	46.2%	9.6%	44.2%
565	7.3	9.0	7.0	n/a	7.0	2.0	0.0	2.0	4.0	50.0%	0.0%	50.0%
566	10.7	9.3	9.2	10.8	9.8	0.1	1.5	0.5	2.1	4.8%	71.4%	23.8%
571	16.6	21.1	17.4	18.2	18.5	3.7	2.9	2.6	9.2	40.2%	31.5%	28.3%
572	3.9	2.7	2.1	2.7	2.1	0.6	0.0	0.6	1.2	50.0%	0.0%	50.0%
573	10.6	17.3	14.8	9.8	14.8	2.5	7.5	2.5	12.5	20.0%	60.0%	20.0%
581	335.7	352.3	322.7	341.8	326.1	29.6	10.5	26.2	66.3	44.6%	15.8%	39.5%
591	30.4	31.4	32.6	33.1	33.3	1.2	1.7	1.9	4.8	25.0%	35.4%	39.6%
592	6.0	5.4	6.8	8.6	7.1	1.4	3.2	1.7	6.3	22.2%	50.8%	27.0%
594	32.8	41.5	34.5	35.7	36.8	7.0	5.8	4.7	17.5	40.0%	33.1%	26.9%
596	20.6	24.9	26.5	20.9	26.9	1.6	4.0	2.0	7.6	21.1%	52.6%	26.3%
621	7.0	9.6	8.7	8.0	8.7	0.9	1.6	0.9	3.4	26.5%	47.1%	26.5%
631	23.4	24.0	24.4	25.5	25.3	0.4	1.5	1.3	3.2	12.5%	46.9%	40.6%
632	10.0	10.4	13.4	10.5	13.7	3.0	0.1	3.3	6.4	46.9%	1.6%	51.6%
633	33.7	31.1	35.1	41.5	35.8	4.0	10.4	4.7	19.1	20.9%	54.5%	24.6%

Appendix Table 5: Decomposition of Ohio 3-Digit Industry Projection Errors, 1986-95

3-Digit	Proj.	Actual	Project: Actual Value of Ind. Vbl.			Absolute Value of Error				Decomposition of Error		
SIC	1995	1995	US	OH	US and OH	US	OH	Model	Total	US	OH	Model
131	3.3	2.8	1.7	4.4	2.1	1.1	1.6	0.7	3.4	32.4%	47.1%	20.6%
651	21.7	25.6	19.9	27.4	23.7	5.7	1.8	1.9	9.4	60.6%	19.1%	20.2%
655	3.2	3.5	1.1	n/a	1.1	2.4	0.0	2.4	4.8	50.0%	0.0%	50.0%
701	37.2	35.1	37.0	38.4	39.3	1.9	3.3	4.2	9.4	20.2%	35.1%	44.7%
722	3.6	4.2	2.1	4.0	2.3	2.1	0.2	1.9	4.2	50.0%	4.8%	45.2%
723	20.4	20.7	22.5	24.1	23.1	1.8	3.4	2.4	7.6	23.7%	44.7%	31.6%
726	5.0	4.9	6.3	6.4	6.5	1.4	1.5	1.6	4.5	31.1%	33.3%	35.6%
731	10.4	9.0	9.9	n/a	9.9	0.9	0.0	0.9	1.8	50.0%	0.0%	50.0%
732	5.7	4.9	5.8	5.3	5.9	0.9	0.4	1.0	2.3	39.1%	17.4%	43.5%
733	10.7	9.9	10.3	12.9	13.3	0.4	3.0	3.4	6.8	5.9%	44.1%	50.0%
734	36.0	35.7	32.2	37.1	34.4	3.5	1.4	1.3	6.2	56.5%	22.6%	21.0%
737	29.3	38.3	29.6	31.1	30.8	8.7	7.2	7.5	23.4	37.2%	30.8%	32.1%
753	22.6	23.5	23.1	23.9	24.0	0.4	0.4	0.5	1.3	30.8%	30.8%	38.5%
783	3.6	4.3	3.5	n/a	3.5	0.8	0.0	0.8	1.6	50.0%	0.0%	50.0%
805	114.6	100.2	106.3	110.3	108.4	6.1	10.1	8.2	24.4	25.0%	41.4%	33.6%
806	200.1	193.2	213.3	199.0	216.1	20.1	5.8	22.9	48.8	41.2%	11.9%	46.9%
807	6.1	6.8	3.6	6.3	3.8	3.2	0.5	3.0	6.7	47.8%	7.5%	44.8%

Appendix B

State of Ohio Industry Employment Projections Report, 1986-1995

Technical Notes for *Ohio Labor Market Projections, 1986-1995*