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Estimates of the Benefits and Detriments of Electric Industry Restructuring in North Carolina

Volume 1: Overview of Methodology and Summary of Results
Final Report

Prepared for

Legislative Study Commission on the
Future of Electric Service in North Carolina
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Prepared by

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Executive Summary

This report describes the results of a study conducted to estimate the economic benefits and detriments of restructuring the North Carolina electric utility industry. Restructuring refers to opening the generation portion of the electric industry to competition.

The material in this report was developed pursuant to Task Order Authorization #5 between Research Triangle Institute (RTI) and the Study Commission on the Future of Electric Service in North Carolina. The Study Commission is investigating whether or not to restructure the North Carolina electric utility industry, and several ancillary questions related to that question.

We assume in our reference case that restructuring will begin in 2004. However, because other start dates are possible too, we have included the years 2002 and 2004 in our analysis, and the results for these dates are presented in Volume 2. The sensitivity of our reference case results to other key assumptions are also presented in Volume 2.

The reference case in this study is tied to the reference case we defined for our stranded cost study (RTI, 1999d, Vol. 3). As we note in that report, stranded costs are very sensitive to several key assumptions. We showed how widely stranded costs can vary with changes in those assumptions. Wide variations in stranded costs from the reference case can lead to wide variations in economic benefits and detriments.

Under restructuring, we assume that rate of return regulation—with allocated and protected service territories and rate bases—no longer exists for electricity generation. That is, customers are free to buy electricity from competitive electric service providers. We assume that the elimination of protected service territories applies to all electric service providers currently operating in North Carolina.

Those providers are: investor owned utilities (IOUs), municipal electric utilities, and electric membership cooperatives. This assumption is critical to our estimation of statewide and regional economic benefits and detriments. As part of our sensitivity analyses, we also use our economic model to evaluate the benefits and detriments of restructuring if it began in 2002 or 2006.

The measures of economic benefits and detriments used in this study are changes in economic output, employment, and earnings. These measures are estimated for the total state, seven economic development regions within the state, and 31 business, industry, and government groups. The 31 business, industry, and government groups cover all of the private- and public-sector economic activity in the state.

Economic benefits and detriments occur under restructuring because of differences between

- ➤ the estimated prices of electricity under restructuring, and
- ➤ the projected prices of electricity with no changes in the current method of regulating the electric industry in North Carolina (i.e., continued rate base/rate of return regulation and franchised service territories).

The methodology we use to estimate the economic benefits and detriments of electric industry restructuring captures the effect on both producers and consumers.

We create a reference case in which electricity market restructuring is assumed to commence in 2004. In our reference case, we assume 100 percent recovery of stranded costs over a 5-year period. This reference case is neither a policy recommendation nor a policy prediction. It is simply an analytical convention to facilitate presentation of our modeling results.

In our reference case, we estimate economic benefits and detriments for the 2004 through 2015 period. We do not generate estimates for years beyond 2015 because the forecasts of North Carolina output, income, and employment we used in this study ended in 2015. These forecasts were based on data prepared by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. We used the same forecast horizon in our tax considerations study.

We used a longer horizon (through 2020) for the reference case in our stranded cost study because we had forecasts of the market-clearing (competitive) price of power through 2020, and because several utilities have generating units whose whole expected lifetime extends until at least 2020. In our analysis of stranded costs, several utilities are anticipated to have negative stranded costs from 2015 through 2020. If negative stranded costs are excluded, our stranded cost estimates are larger, and the estimates of economic benefits in this report will be smaller.

Our stranded cost estimates do not include transition costs (e.g., for new equipment and software) associated with restructuring retail electric markets. These transition costs can be substantial. Were we to attempt to quantify these costs and include them in the economic benefits and detriments analysis, our estimates of benefits from restructuring would be reduced. On the other hand, if mitigation actions are taken which reduce stranded cost benefits from our estimates of restructuring would be increased.

In addition to our reference case, we examine seven other illustrative restructuring scenarios with hypothetical starting dates of 2002, 2004, and 2006. Taken all together, the eight scenarios are designed to offer alternative estimates of the benefits and detriments of restructuring. In six of these scenarios, we incorporate the recovery of stranded costs into our modeling. Therefore, these six scenarios recover 100 percent of stranded costs through a uniform surcharge (in ¢/kWh) on electricity prices over a 5-year recovery period. Two of the eight scenarios contain *no* recovery of stranded costs through electricity prices. The sensitivity analyses yield the expected results. If North Carolina accelerates restructuring with 100 percent recovery of stranded costs, the economic impacts are increased. This includes both economic benefits and economic detriments. If North Carolina approaches restructuring so as to limit the impacts (both benefits and detriments), the time it takes to transition to a restructured electricity market is extended. The general results of these sensitivity analyses are discussed in the text of this volume and presented in more detail in Volume 2.

The most prominent result of our analysis is the relatively modest impact of electricity market restructuring on employment in North Carolina. The net changes in employment are a useful summary measure of the balance between economic benefits and economic detriments. As expected, the general effect is a net positive gain in employment, but the size of this gain is not large relative to the overall base of employment in North Carolina. In our reference case, the average annual net employment change over the 2004 through 2015 period is a gain of 1,100 jobs per year. For any scenario, the total cumulative employment effects are relatively small when compared to a North Carolina employment base that averages 5,100,000 jobs over the period.

This average annual net gain in employment over the 2004 through 2015 period has a negative and a positive component. During the 5-year recovery period for stranded costs (2004 through 2008), the employment effect is an average annual loss of jobs of about 4,400 per year. This is not job loss in the sense of workers seeking but not finding work. Instead, it is a reduction in the amount of job growth that is projected in the base case. During the 7-year period that follows stranded costs recovery (2009 through 2015), there is an average annual gain of jobs of about 5,500 per year.

The average annual employment gain of 1,100 jobs per year is equal to 0.02 percent of the projected average annual North Carolina employment base of 5,100,000 jobs over the 2004 through 2015 time horizon.

Employment effects from electric industry restructuring are not uniformly distributed around the state. Because they have the largest employment bases, the Carolinas Partnership region (Charlotte area), Piedmont-Triad, and Research Triangle taken together experience about two-thirds of the total statewide employment gains or losses. However, an important determinant of a region's employment gain or loss due to electric industry restructuring is the electricity intensiveness of the industrial base in that region. Because their industrial bases are more electricity intensive, the Carolinas Partnership and Piedmont-Triad regions experience a greater relative share of employment gains and losses than the Research Triangle.

1 Introduction

The Legislative Study Commission on the Future of Electric Service in North Carolina is considering restructuring North Carolina's electric utility industry. The Study Commission has met in Raleigh, has held public hearings across the state, and has undertaken a number of studies to address the issues associated with retail competition in the sale of electric service. This report on economic benefits and detriments is one of the studies that the Study Commission has authorized Research Triangle Institute (RTI) to undertake.

Economic benefits and detriments will occur as a result of changes in electricity prices due to restructuring. Electricity is a pervasive and important component in the economic lives of North Carolina businesses, industries, and households. Restructuring the electric industry in North Carolina will change the conditions and prices under which electric service is provided. The responses of businesses, industries, public-sector institutions, and individuals and households to electricity price changes will affect economic activity in North Carolina. These effects are the basis on which we estimate economic benefits and detriments.

We developed a model of the economic responses to changes in electricity prices in North Carolina. We constructed eight different restructuring scenarios. In the two that begin in the year 2002 and in which there is no recovery through electricity prices of incumbent utilities' stranded costs, there is the largest positive impact on employment in North Carolina. (See Volume 3 of RTI's (1999c) report *Stranded Cost Estimates for a Restructured Electric*

Industry in North Carolina for a definition and estimates of stranded costs.) In six other scenarios, 100 percent of stranded costs are recovered over a 5-year period. These six scenarios are divided into two sets, and in each set we vary the year in which restructuring commences. Our reference case assumes that restructuring commences in 2004. To test the sensitivity of the benefits and detriments to the timing of restructuring, we also consider cases in which restructuring commences in 2002 or 2006.

In each of our scenarios, we separate electricity demand by customer class—that is, by residential, commercial, and industrial users. Within the commercial and industrial customer classes, we further separate by 31 business, industry, and government groups. The 31 business, industry, and government groups cover 100 percent of private-sector and public-sector economic activity in North Carolina. We also separate the total statewide effects geographically by seven economic development regions of the state. These seven economic development regions are the standard regions specified by the North Carolina Department of Commerce and are identified in Section 5. Because of the legislative and institutional changes required prior to restructuring, we assume in the reference case that the earliest that restructuring could commence in North Carolina would be 2004.

The indicators of economic activity on which we focus are total output, employment, and earnings. These are the measures of economic benefits and detriments for North Carolina. Economic output is sales revenues of North Carolina businesses and industries, including sales of all raw materials, intermediate goods, and final goods and services produced in North Carolina. Employment is measured in full-time equivalents (i.e., two half-time jobs equal one full-time job) for farm and nonfarm workers in both the public and private sectors. Total employment is the sum of full-time equivalent jobs across all sectors of the North Carolina economy. Earnings is defined as compensation earned in the private and public sectors for farm and nonfarm workers in terms of wages and salaries, including benefits. In the context of our model, "earnings" does not include corporate and noncorporate profits. Our measures of economic detriments—job losses, lower output, lesser earnings—do not include possible loss or degradation in the quality of electric service. Reliability issues are addressed in a separate report (RTI, 1999b). The treatment of stranded costs in the eight scenarios that we examine is as follows:

- two scenarios are without recovery of stranded costs, and
- six scenarios include 100 percent recovery of stranded costs.

To estimate the measures of economic benefits and detriments—output, employment, and earnings—we focused on the 2004 through 2015 period. To establish a baseline, we projected electricity prices by customer class from 1995 through 2003 assuming no institutional change due to restructuring of the electric industry. We held nominal (i.e., quoted) prices constant for the 1995 through 2003 period, meaning that real (i.e., after inflation) prices are declining. This baseline projection is predicated on the continuation of allocated service territories with rate of return/rate base regulation. For 2004 through 2015, the real baseline prices were derived from nominal prices based on projected cost and market share data provided to RTI by North Carolina electricity suppliers. For details, see the discussion in Section 4.

Depending on the circumstances represented by a scenario, prices may be higher or lower than the baseline projections. The differences between the price projections for a restructuring-specific scenario and the baseline price projections cause changes in economic activity. If the prices in a scenario are lower than the baseline prices, production and consumption are stimulated, causing economic activity in North Carolina to increase. If the prices in a scenario are higher than the baseline prices (as a result of recovering stranded costs over a short time period), production and consumption are inhibited, causing economic activity in North Carolina to decrease.

There are many potential scenarios that could have been developed and included in this analysis. These include scenarios that mitigate stranded costs and reduce or remove their impact on projected rates by customer class (e.g., by extending the stranded cost recovery period or copying existing rates for an extended period of time). We did not include any of these other stranded cost recovery scenarios because they were not formally “on the table” for Commission consideration when we designed our study.

The rest of the report is organized as follows. Section 2 contains a brief review of the economic and institutional background for our analysis of restructured electricity prices in North Carolina. Section 3 contains an explanation of the model used to forecast the benefits and detriments of restructuring. (Appendix A presents the formal details of the model.) Section 4 contains a summary of the statewide impacts. Section 5 examines the effects of alternative price scenarios on illustrative manufacturing and service industries, and summarizes the geographic distribution of the statewide effects among the seven economic development regions. Section 6 contains a summary and conclusion.

2 Economic and Institutional Background

2.1 INTRODUCTION

We estimate the future economic benefits and detriments for North Carolina under electricity market restructuring against a background of certain economic and institutional assumptions. The most important of those assumptions are outlined in this section.

2.2 BACKGROUND ASSUMPTIONS

2.2.1 Timing

For electricity market restructuring to be undertaken successfully, a number of institutional changes must be implemented. These changes may include organization of a power exchange (PX) and an independent system operator (ISO) to match supplies and demands for electricity in terms of pricing and load dispatch. Alternatively, the role of an ISO could be replaced by a stand-alone transmission company (Transco). The changes would also include the development of additional certification, consumer protection, information verification and dissemination, and other procedures that would be necessary to move to a restructured electricity supply environment. Because of the decision and design time and the costs associated with creating one or more of these institutions and making these changes, we assume in our reference case that January 1, 2004 is the earliest that electricity market restructuring would take place in North Carolina. We have, however, included the years 2002 and 2006 as alternative dates, and our results for these dates are included in the sensitivity analyses we present in Volume 2.

2.2.2 Electricity Market Competitive Conditions

We assume that whatever combinations of PX and Transco/ISO are created, they are large enough (with sufficient numbers of buyers and sellers), have adequate transmission capacity, and are operated in a sufficiently transparent manner to generate effective competition. We also assume that there is no "market power" on the buying side of the industrial market in the traditional sense of the term in the economic literature of antitrust and regulation; in other words, no single buyer can influence the competitive market price. However, in a restructured market, we would expect competition among sellers serving the industrial market to affect prices for that class.

2.2.3 Competitive Access Within the North Carolina Electricity Market

Our estimates are based on a statewide analysis. We assume that, after electricity market restructuring begins, there are no protected submarket service territories anywhere in North Carolina for any electric service provider, including investor-owned utilities (IOUs) as well as municipal electric utilities and rural electric cooperatives. This assumption covers *all* municipal electric utilities and rural electric cooperatives. We estimated potential geographic dispersion of economic benefits and detriments within North Carolina by the seven economic development regions of the state. These estimates are predicated on totally open competition on a statewide basis.

These assumptions do not mean that all rate disparities throughout North Carolina will be removed by restructuring. The current disparities will be reduced, especially those that exist at the borders of service territories between low- and high-cost providers. However, differences that are related to transmission and distribution cost differences, such as between urban and rural areas, will still be present in a restructured electricity supply environment.

2.2.4 Business and Industry Detail

We estimated our measures of statewide economic benefits and detriments by 31 types of business, industry, and government groups. This industry detail corresponds to the industry-level breakdown often used by knowledgeable analysts of North Carolina economic conditions. The measure of output is dollars of sales. This measure covers all raw materials, intermediate products, and final goods and services produced in North Carolina in the private and public sectors. In this report, we present state totals for all industries totaled together. The 31 business, industry, and government groups we used to estimate the results to be compiled into total results are shown in Table 2-1.

2.2.5 Nationwide Demand for the Output of North Carolina Industries

North Carolina is a relatively manufacturing-intensive state in terms of percentage of employment in the manufacturing industry. North Carolina manufacturing industries export products to the other 49 states and throughout the world. The demands for North Carolina industrial products are not limited to those originating in North Carolina. North Carolina manufacturers compete with manufacturers in the other 49 states and worldwide. The pattern by industry of North Carolina’s nationwide market penetration is also shown in Table 2-1.

If North Carolina industries experience a cost reduction due to electricity market restructuring, they will (in theory) be more competitive in national and worldwide markets. Obviously, the North Carolina producers who currently possess small shares of the U.S. market will have the greatest theoretical opportunity to increase output and market share under the lower price scenarios. However, this effect cuts both ways. Smaller market shares for exports may also reflect certain cost and/or product disadvantages for North Carolina manufacturers or cost and/or product advantages for manufacturers elsewhere. This consideration affects the price-sensitivity of the demand for North Carolina manufactured products. We incorporate this consideration into the model. (See Appendix A for more detail.)

2.2.6 The Importance of Electricity in the Total Costs of a Business/Industry

We use an input-output economic model based on the work of Nobel laureate Wassily Leontief as the basis for our analysis of supply-side effects of restructuring. In technical economic terms,

Table 2-1. North Carolina’s Share of U.S. Output, by Industry

North Carolina Business/Industry	Standard Industrial Classification (SIC) Code	Percentage Share of Total U.S. Output (%)
Agriculture and Forestry	01-09	3.62%
Mining	10-14	0.33%
Construction	15-17	3.13%
Manufacturing		
Food Products	20	2.68%
Tobacco Products	21	42.84%
Knitting Mills	225	40.93%
Yarn and Thread	228	43.71%
Other Textiles	220	18.31%
Apparel Products	23	6.42%
Lumber and Wood	24	5.00%
Furniture and Fixtures	25	12.35%
Pulp and Paper	26	3.75%
Printing and Publishing	27	1.75%
Other Chemicals	280	3.88%
Drugs	283	5.78%
Other Nondurables	29,31	0.32%
Rubber and Plastics	30	3.92%
Stone, Clay and Glass	32	3.67%
Primary Metals	33	2.04%
Fabricated Metals	34	2.04%
Nonelectrical Machinery	35	2.77%
Electrical Machinery	36	3.25%
Transportation Equipment	37	1.69%
Instruments	38	1.67%
Miscellaneous Manufacturing	39	1.77%
Services		
Transportation Services	40-47	2.59%
Communications and Utilities	48,49	2.40%
Wholesale and Retail Trade	50-59	2.73%
Finance, Insurance, and Real Estate	60-67	2.11%
Services	70-89	2.03%
Government	90-99	2.73%

Data source: Minnesota IMPLAN Group, Inc. 1998. *1995 IMPLAN Data for North Carolina*. Stillwater, MN: IMPLAN Group.

Note: This arrangement of the total North Carolina economy into 31 business, industry, and government groups is the classification used by the North Carolina Department of Administration, Office of Management and Budget in many of their analyses.

an input-output model relies on fixed coefficients of production (e.g., the dollar cost of each input required to produce a dollar's worth of output). In other words, there is no substitution between electricity and other production inputs. Therefore, the determinants of the importance of electricity as a component of the total costs of a business/industry are the price of electricity, the amount of electricity used per unit of output, and the amount of output produced.

The importance of electricity in terms of its percentage share of total costs for the businesses/industries shown in Table 2-1 is presented in Appendix Table A-1. Using 5 percent as an arbitrary break point, those businesses/industries in Tables 2-1 and A-1 for which electricity equals 5 percent or more of total costs are shown in Table 2-2. Holding other factors constant, these industries will experience the largest impacts from electricity price changes.[1]

Table 2-2. North Carolina Business and Industry Sectors for Which Electricity Accounts for 5 Percent or More of Total Cost

Mining	Stone, Clay, and Glass
Yarn and Thread	Primary Metals
Other Textiles	Wholesale and Retail Trade
Pulp and Paper	Government

Data source: Minnesota IMPLAN Group, Inc. 1998. *1995 IMPLAN Data for North Carolina*. Stillwater, MN: IMPLAN Group.

We assume that changes in business and industry cost structures due to changes in electricity prices (as a result of restructuring) flow completely through into output and product prices. Price changes cause output and product demands to change. Price increases cause reduced demands and lower output, employment, and earnings. Price decreases cause increased demands and higher output, employment, and earnings. This modeling assumption of complete pass-through of cost changes into output and product price changes is based on the argument that national and international economies in which North Carolina businesses and industries operate are highly competitive, and that aggressive pursuit of market share will generate this result. We believe that this will be the predominant result of restructuring. However, some

[1]For a related taxonomic discussion of electricity intensive industries, see Luger, Wu, and Komives (1998).

of the benefits of lower electricity prices could accrue to other groups directly; owners of industrial capital could earn higher profits and workers could earn higher wages. To the extent to which this result were to occur, it would be partially captured in the demand-side effects we explain below. But, if changes in electricity prices do not flow directly through into product prices, our estimates of benefits and detriments may be overstated. We discuss this assumption in more detail in Section 3.2.1.

2.2.7 Measures of Benefits and Detriments

There are many dimensions to the economic benefits and detriments that may accrue to North Carolina as a result of electricity market restructuring. These dimensions include financial market implications for state bond issues, environmental considerations, reliability of electric service consequences, and lifeline rates (to name a few).[2]

In this report, we focus on the following measures of economic benefits and detriments because of their importance and the availability of historical data:

- output,
- employment, and
- earnings.

The statewide totals for these measures are presented in Section 4. Key impacts by economic development region and industry are presented in Section 5.

2.3 SUMMARY

North Carolina is not considering restructuring of the electricity market in a vacuum. To facilitate orderly analysis capable of producing logically consistent estimates of economic benefits and detriments, certain key assumptions must be made. These assumptions provide structure and context to the modeling work that are the basis for our estimates of the economic benefits and detriments of restructuring electric service to introduce retail competition in North Carolina.

[2]See, for example, the public submissions to the Legislative Study Commission summarized in RTI's (1999e) report *Task 7: Summary of Written Public Comments*.

3 Modeling the Economic Effects on Output, Employment, and Earnings of Electricity Market Restructuring in North Carolina

3.1 INTRODUCTION

Restructuring the electricity market in North Carolina to replace rate base/rate of return regulation and franchised service territories with retail competition is expected to affect the overall average price of electricity in North Carolina. The principal customer classes are residential, commercial, and industrial. It is likely that restructuring will change the current relative price relationships among customer classes. Restructuring may also affect relative price relationships among electric service providers. The principal categories of electric service providers are investor-owned utilities (IOUs), municipal electric utilities, and rural electric cooperatives.

Changes in prices paid for electricity will, in turn, affect economic output, employment, and earnings. The economic benefits and detriments of electricity market restructuring are measured in terms of changes in North Carolina output, employment, and earnings. Increases in these measures are benefits; decreases are detriments. In this study, we used a standard economic modeling framework to estimate these effects. To generate alternative price paths in which electricity prices differ from a base case price trajectory under continued regulation with no institutional change, we assumed a set of eight different restructuring scenarios.

The details of the specific scenarios used do not imply any policy recommendations. Rather, their purpose is to frame the analytical boundaries of the modeling of the economic effects of electricity market restructuring.

These modeling results are summarized in Section 4. They are estimated on the basis of the conceptual framework and state-level scenario-based price trajectories presented in this section.

3.2 CONCEPTUAL FRAMEWORK

There are two primary, or "direct," effects from changes in electricity prices. First, because electricity is an input in the production process, one would expect that changes in electricity prices would result in changes in output and therefore in employment and earnings. For example, if electricity prices were to fall as a result of restructuring, then, firms could increase output and sales in response to this reduction in costs. At least some firms would take advantage of such a windfall, and in the process of increasing their output, they would hire more workers; these workers would in turn increase earnings, and so on. We can think of this effect as the "direct supply-side" effect.

The second primary, or direct, effect from changes in electricity prices results from the effect on consumer expenditures. Because the vast majority of households spend a portion of their incomes on residential electricity, changes in electricity prices would tend to alter household expenditures on both electricity and other goods and services. To see how this effect works, consider a family with a given income. If electricity prices were to fall as a result of retail competition, then that part of the family's income could be spent elsewhere—that is, on other goods and services—which increases the demand for these other items. This increase in demand results in increases in production, employment, and earnings. One can think of this second effect as the "direct demand-side" effect.

The details of estimating these two direct effects, and the resulting total effect due to industry multipliers, are explained in

Appendix A. Conceptually, however, the total process is quite straightforward. An overview is shown in the flow chart presented in Figure A-1.

3.2.1 Direct Supply-Side Effects

Consider the direct supply-side effects. Expenditures on electricity are a proportion of the total expenditures of most firms, and, as discussed above, a change in electricity prices results in a change in the firm's costs. Using the example of a decrease in electricity prices, consider the pulp and paper industry. Suppose the price of electricity purchased by firms in the pulp and paper industry falls by 10 percent, and suppose that electricity costs are 8 percent of the total costs in that industry. In such a case, the average reduction in output prices would be 0.8 percent (10% x -8% = -0.8%).

Employing a measurement economists call the "price elasticity of demand," or simply "elasticity," we can derive the increase in the industry's final demand, which is measured in dollars, by multiplying the percentage change in price by the elasticity.[1] Suppose the elasticity of demand for pulp and paper products is -1; then the resulting increase in final demand would equal 0.8 percent (-0.8% x -1 = 0.8%). This figure represents the direct supply-side effect on the pulp and paper industry from a reduction in electricity prices. Obviously, there are additional, or "indirect," supply-side effects. Before we consider indirect effects, we turn to the estimation of the direct demand-side effects.

For the purposes of our model, we have assumed that competitive pressures force the reduction in costs caused by a decrease in electricity prices to be fully passed through to the purchasers of a firm's output in the form of lower product prices. It is the demand response to lower product prices that causes the increase in output, which in turn drives increases in employment and earnings. Obviously, the benefits of lower electricity prices could accrue to other groups directly; namely, owners of capital would benefit from

[1] The price elasticity of demand is simply the percentage change in the quantity demanded divided by the percentage change in the price. Thus, the percentage change in price times the elasticity yields the percentage change in quantity demanded. For a more detailed discussion of how elasticities of demand are used in the economic analysis, see Appendix A.

higher profits, and workers would benefit from higher earnings. To the extent this were to occur, it would partially be captured in the demand-side effects described below. But, if changes in electricity prices do not flow directly through into product prices, our estimates of benefits and detriments may be overstated.

3.2.2 Direct Demand-Side Effects

To understand how the direct demand-side effects are estimated, suppose that, as a result of restructuring, residential electricity prices fall by 5 percent. Because the demand for residential electricity is relatively insensitive to price movements,[2] some of this decline will be reflected in an increase in the consumption of other goods and services—that is, in final household demand for goods and services other than electricity. So suppose the sensitivity of final household demand to changes in residential electricity prices is in the neighborhood of -0.25. That is, a 1 percent decrease in electricity prices results in a 0.25 percent increase in final household demand for all goods and services. This increase in final household demand would be 1.25 percent (-5% x -0.25 = 1.25%). This increase in household demand is spread over all of the household's expenditures. Thus, if the typical household spends 10 percent of its income on pulp and paper products, then the increase in the final demand in pulp and paper products as a result of the decrease in residential electricity prices will be 0.125 percent (1.25% x 10% = 0.125%).

This figure (0.125 percent) does not represent the net increase in the demand for pulp and paper products produced in North Carolina, however, because not all of the typical household's expenditures are on goods produced in the state. Suppose that the typical household spends 10 percent of its income on products produced in North Carolina; then the net demand-side effect is 0.0125 percent (0.125% x 10% = 0.0125%). This figure represents the direct demand-side effect on the North Carolina pulp and paper industry from a reduction in electricity prices.

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[2] Economists refer to demands that are relatively insensitive to price changes as "inelastic." That is, the percentage increase in quantity demanded is less than the percentage reduction in price.

3.2.3 The Total Direct Effect

The sum of the direct demand-side effect and the direct supply-side effect equals the total direct effect—in this case, an increase of 0.8125 percent in the final demand for North Carolina pulp and paper production. In other words, if the value of pulp and paper production in North Carolina were, say, $7 billion, then the reductions in electricity prices noted above would result in a $57 million increase in final demand. However, because the economic impact of a change in electricity prices does not end with these direct effects, we must also consider the indirect, or multiplier, effects.

3.2.4 Indirect Effects

To understand the economic logic behind the indirect effects, consider again our example of the pulp and paper industry. One would naturally expect the 0.8125 percent increase in final demand resulting from the decrease in electricity prices to positively impact output, employment, and earnings in the pulp and paper industry. Furthermore, this growth in employment and earnings leads to an increase in the final demand for other goods and services as pulp and paper workers spend those additional earnings. In addition, the pulp and paper industry increases its demand for the inputs necessary to expand its production in response to both the direct supply-side and direct demand-side effects. The earnings generated thereby lead to another round of increases, and so forth. Thus, a $1 increase in the final demand for pulp and paper products results in a more than $1 increase in total output of all North Carolina businesses and industries. There are, in turn, multiplier effects on employment and earnings. The measures used to estimate the total effect from the change in electricity prices are appropriately called multipliers.

3.2.5 Total Direct and Indirect Effects

Returning to our example, say the output, employment, and earnings multipliers per million dollars in final demand for the pulp and paper industry are equal to 2, 3, and 2.5, respectively.[3] Then the total multiplier effect on economic activity in North Carolina of

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[3]Where for simplicity the employment multiplier is "3 jobs per $1,000,000 change in final demand."

an initial $57 million increase in output of the pulp and paper industry caused by a decrease in electricity prices will be $114 million in output, 171 workers, and $143 million in earnings. The initial $57 million increase in final demand for the North Carolina pulp and paper industry and associated increases in employment and earnings are included within these multiplier effects. The total multiplier effects include and extend the "direct supply-side" effect and the "direct demand-side" effect. In other words, compared to a base case of no institutional change in the organization of the electricity market in North Carolina, the hypothetical reductions in electricity prices noted above would result in a total additional $114 million in output from the pulp and paper industry, 171 new jobs, and $143 million in earnings. These results would equal the direct, plus the indirect, economic impact for the pulp and paper industry of restructuring the market for electricity. The total statewide impact is the sum of these total direct and indirect effects across all 31 business, industry, and government groups. All of the above calculations were based on a *hypothetical* decrease in electricity prices. In practice, many possible price scenarios are plausible, including price increases. We now turn to the scenarios for which we provide industry and regional analysis.

3.3 ALTERNATIVE SCENARIOS

The many possible scenarios for restructuring electricity prices in North Carolina all share certain elements. The characteristics of any of the possible restructuring plans that would ultimately affect the economic benefits and detriments include, among other variables,

- the date at which restructuring begins,
- the amount of stranded costs to be recovered,
- the way in which stranded costs are recovered, and
- the market-clearing price of electricity.

To illustrate the effects of these characteristics, we focus on our reference case scenario. Our reference case has the following characteristics:

- restructuring commences in 2004;
- 100 percent of stranded costs are recovered over a 5-year recovery period;

- total statewide stranded costs for all incumbent electric service providers (IOUs, municipal electric utilities, and rural electric cooperatives) are recovered through a uniform ¢/kWh surcharge applied to all kWh of electricity sold to every user of electricity in North Carolina by every electric service provider (incumbents and new entrants);
- restructuring is assumed to change the relative price relationships among customer classes (i.e., realign rates); so the major effect of this rate realignment is to lower industrial rates and raise residential rates from what they would otherwise be; and
- the market-clearing price of electric power is estimated from data supplied to RTI by the North Carolina IOUs and the Electric Power Research Institute in conjunction with the U.S. DOE national energy modeling system's electricity market model and Resource Data International's interregional electricity market model. (See Volume 3, Appendix C of RTI's report *Stranded Cost Estimates for a Restructured Electric Industry In North Carolina* for a detailed discussion of the market clearing price of power [RTI, 1999d]. The RTI intermediate estimate is used in the modeling work reported here.)

To generate estimates of economic benefits and detriments, we compare our reference case to a base case that involves no institutional change. To test the sensitivity effects of changing one or more of the characteristics of our reference case, we also examine seven other cases. These seven alternative cases accelerate or slow down the commencement of restructuring, include examples of recovery and nonrecovery of stranded costs, and/or change the assumption about the effect of restructuring upon relative prices of electricity among customer classes. The results for these alternative cases are mentioned in the text below and are reported in detail in Volume 2.

The reader should note that the reference case and alternative scenarios are neither policy recommendations nor forecasts of the outcome of the public policy process; rather, they should be interpreted as "if-then" exercises—that is, "if this policy were chosen, then (given what we currently know about the North Carolina economy and the assumptions we have made) these are the likely net impacts in terms of economic benefits and detriments."

3.4 BASE CASE: NO INSTITUTIONAL CHANGE

Our base case contains the projections for output, employment, and earnings with no restructuring of electricity prices. Table 3-1 shows the estimates of the state average price per kilowatt-hour for each customer class for 2004 and 2015. These figures are a weighted average of the production revenue requirements, with capital additions, of the individual utilities. The figures are based on data supplied to Research Triangle Institute (RTI) by the North Carolina IOUs, municipal electric utilities (munis), and rural electric cooperatives (co-ops).[4] Table 3-1 also shows the assumed rates of change in the base prices over the 2004 through 2015 period. Year-by-year average price detail by customer class is shown in Appendix Table B-1. These are the "baseline" prices from which the price changes that occur under the reference case are measured. These price changes drive the estimations of output, employment, and earning effects (see Appendix Figure A-1).

Table 3-1. Base Prices with No Institutional Change

	Electricity Prices (in 1995 ¢/kWh)		
Sector	**2004**	**2015**	**Average Percentage Change per Year**
Residential	7.320	7.274	-0.05%
Commercial	5.810	5.774	-0.05%
Industrial	4.355	4.328	-0.05%

Note: See Appendix Table B-1 for year-by-year price detail.

Differences between the baseline prices under no institutional change and the prices assumed under the reference case drive the economic model. The model is then used to estimate economic output, employment, and earnings for the reference case. These estimates are then compared to the baseline projections under no institutional change. Differences between the baseline projections and the estimates under the reference case are the measures of economic benefits (positive differences) and economic detriments (negative differences) reported here.

[4]For a more complete explanation of these calculations, see RTI's (1999d) report *Task 4: Analysis of Options for Resolving Stranded Cost Issues, Volume 3*.

The starting point for the "No Institutional Change" prices for the base case are the 1996 average North Carolina residential, commercial, and industrial rates shown in Table 3-2 of RTI's (1998) report *Task 2: Rate Comparisons*.[5] These prices are in 1996 ¢/kWh:

Customer Class	¢/kWh
Residential	8.05
Commercial	6.39
Industrial	4.79

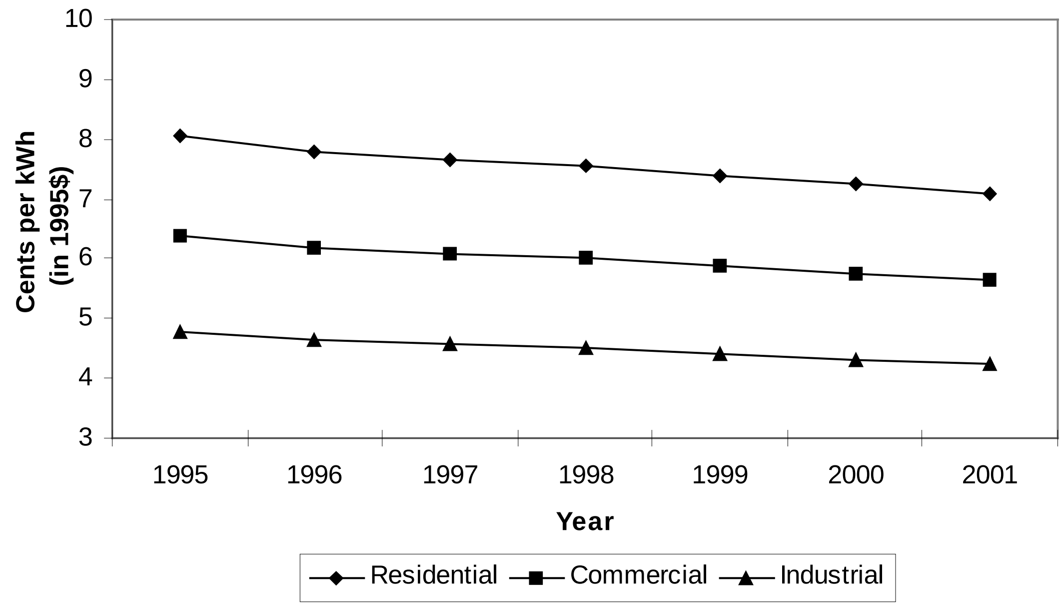
Much of the background economic data underlying the base case projections are from IMPLAN, which uses 1995 dollars.[6] The model is also calibrated according to IMPLAN's data. Therefore, we converted the 1996 dollar prices in RTI's *Rate Comparisons* report into 1995 dollars to be consistent with the reporting basis of the IMPLAN data. Also, we assume that there are no general rate cases or other causes of nominal price changes over the 1995 through 2001 period so that nominal prices are constant over that interval. This assumption means that real prices (in 1995 dollars) decline over this interval, reaching 7.10¢/kWh for residential consumers, 5.64¢/kWh for commercial customers, and 4.23¢/kWh for industrial users in 2001. Beginning in 2002, we assume that real prices reflect the production revenue requirements of IOUs, based on the data supplied to RTI. These 1995 through 2001 trends are shown in Figure 3-1.[7]

[5]For a detailed discussion of these data, see RTI's (1998) report *Task 2: Rate Comparisons*.

[6]IMPLAN is an input-output model that provides economic impact estimates at the national, state, and substate regional levels. The model is frequently used by researchers in economics at North Carolina State University to study the state, and substate regional, and county-level impacts of public policies in North Carolina.

[7]Note that the assumption of constant nominal prices over the 1995 through 2001 period implies that, in 1995 dollars, the real 1995 prices are the 8.05, 6.39, and 4.79 ¢/kWh figures reported by RTI. But because there was inflation between 1995 and 1996, as measured by the consumer price index (CPI), the real 1996 prices in 1995 dollars are lower than these figures. The real 1996 prices in 1995 dollars are residential—7.79 ¢/kWh, commercial—6.19 ¢/kWh, and industrial—4.64 ¢/kWh. The CPI inflation rates used are 1995 through 1996, 3.3 percent; 1996 through 1997, 1.7 percent; 1997-98, 1.4 percent (based on data through July 1998); and 1999 through 2001 is specified as the average of 1995-1998 inflation rates, or 2.1 percent per year.

Figure 3-1. Base Case Scenario Prices, 1995-2001



The residential, commercial, and industrial prices for which the 1995 through 2001 trends are shown in Figure 3-1 are statewide average prices across all electricity service providers and all customer sizes and other individual customer characteristics (e.g., load factor) within customer classes. As shown in RTI's (1998) report on rate comparisons, there is considerable price dispersion around the statewide overall average prices for the residential, commercial, and industrial customer classes. For each customer class, there is dispersion across electric service providers (see RTI's rate comparisons report, Figures 3-1 through 3-11). Within customer classes, there is price dispersion by level of use (see RTI's rate comparisons report, Tables 4-1 through 4-3 and Appendix E). The dispersion around average rates can be substantial. For example, Duke's largest 20 nonresidential customers pay a net rate of 3.55¢/kWh versus an overall industrial average of 4.56¢/kWh. But for a given provider, if the percentage changes (+ or -) in electricity prices for individual users within a customer class are approximately the same as the average percentage change for the class, the direction of the effects will be consistent and the magnitudes of effects will be relatively unbiased.

The base prices in Table 3-1 were estimated using a weighted average of projected prices. The projected prices were based on the expected costs of producing power with existing generation facilities during the 2002 through 2015 period. For electricity demand above that generated with existing facilities, the market-clearing prices for electricity (see above) are used; thus, the weight for each in-state electricity supplier (e.g., Duke, CP&L, and so forth) is the ratio of that supplier's future capacity to the expected statewide demand. Demand beyond that supplied by the in-state suppliers is priced at the market-clearing price.[8] Both the underlying prices based on the in-state supplier's costs and the market-clearing price of power rise in nominal dollar terms throughout the 2002 through 2015 period (the weighted average grows at roughly 2 percent a year). However, in real constant dollar terms, the base prices are essentially stagnant, falling by only 0.05 percent a year on average.

The projections for output, employment, and earnings associated with these prices form the base case against which the reference case is compared. These projections are reported in Section 4.

3.5 MARGINAL COST BASED PRICING

In a world of scarce resources with alternative uses, marginal costs are assumed to increase with increases in output (and vice versa). In an environment in which buyers and sellers are generally free to determine the prices and quantities that are mutually acceptable to facilitate exchange, market price will tend to equal the cost of producing the last unit sold. Economists typically refer to the scenario in which the "marginal cost" equals the market price as simply "marginal cost pricing." To understand why market forces tend to generate this outcome, consider two other cases that exhaust the set of possible outcomes. First, suppose that the market price was above the marginal cost. In that case, firms would be able to increase profits by expanding output, but such an action would tend to drive up costs. Profit-maximizing firms would cease to increase output when marginal costs equal price.

[8]See Volume 3, Appendix C of the RTI (1999d) report *Stranded Cost Estimates for a Restructured Electric Industry in North Carolina*. See Appendix Table B-1 for the year-by-year baseline price series by customer class for 2002-2015.

Second, suppose that the market price was below the marginal cost. In that case, firms would be able to increase profits (or to minimize losses) by decreasing output, but such an action would tend to drive costs down. Again, profit-maximizing firms would cease to reduce output when marginal costs equal price. Thus, in each case, firms cease to adjust output to increase profitability when marginal costs equal price. In either case, the profit-maximizing scenario for the firm is to price at marginal cost.

One institutional approach to create market forces to ensure that prices equal marginal costs under retail competition in electricity markets is to have transparent power exchange (PX) and independent system operator (ISO) operations with sufficient buyers and sellers on each side of the market to generate competitive market conditions. This approach has been undertaken in California.[9] Another alternative is to rely on a stand-alone transmission company, or Transco, in place of an ISO. Whichever alternative is implemented in North Carolina, we assume appropriate care has been taken with the structuring of the institutional arrangements to assure competitive market conditions in the electricity market.

Whatever legal and institutional arrangements are used to organize the market for electricity, the quantity of electricity suppliers offer must equal the quantity demanders purchase, so that there is a "market-clearing" price of power. In a world in which there are many potential suppliers, the market-clearing price will tend to be determined by the marginal cost of the last unit demanded. It is to be expected, however, that in a deregulated market with completely open competition, higher-cost producers of electricity will lose market share. If the high-cost providers do not lower their prices to match those of the low-cost provider, then buyers have no economic reason to purchase undifferentiated electricity (i.e.,

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[9]At this point, we should note that transition costs have been associated with restructuring electricity markets. These are separate from stranded costs. We do not explicitly model transition costs, but they would include consumer education, regulatory staffing, information technology costs, etc., that are likely to be needed to move from a regulated environment to one of retail competition. For example, California has implemented restructuring with an ISO and a PX. The start-up costs for the California ISO/PX were approximately $400 million, and annual operating costs are expected to be $350 to $400 million. California costs are informative because the California ISO/PX was created from scratch, much like what would have to be done in North Carolina if an ISO and a PX were created, though North Carolina might derive some "learning curve" benefits from California's experience (Aguilar, 1998).

electricity as a commodity) from the high-cost providers. In a world in which marginal cost is increasing per unit of output supplied, high-cost producers reduce their marginal costs to equal the market-clearing price by reducing output and sacrificing market share.

3.5.1 Marginal Cost Pricing in the Reference Case

The reference case (and each of the alternative scenarios used for sensitivity testing) is based on the basic economic principle of marginal cost pricing—suppliers and demanders adjust outputs and purchases until the marginal costs of the last, or marginal, kW of capacity and kWh of energy are just covered by the ruling market price.[10] In practice under retail competition, there will be an ever-changing array of prices that may reflect, for example, season of the year, time of day, size of load, customer load factor, degree of firmness/interruptibility, length of contract, location and other circumstances, terms, and conditions. However, the basic economic principle that the prices paid by representative residential, commercial, and industrial customers are equal to the marginal costs of providing electric service remains the operative market-clearing mechanism. If electricity prices equal marginal costs, electric service providers would earn the same rate of return from serving each customer class.

There is some evidence that IOUs do not earn equal rates of return from service to each customer class. In other words, if electricity prices do not equal marginal costs, a supplier earns different rates of return from supplying electricity to customers in different customer classes. J.A. Wright and Associates (1997) use publicly available 1995 cost of service studies filed with the Utilities Commissions in North and South Carolina to determine that industrial customers and large commercial customers currently pay regulated electricity prices

[10]The marginal cost price of electricity used in this report is the retail price estimated, with appropriate adjustments for "line loss" and taxes, from RTI's (1999d) report *Stranded Cost Estimates for a Restructured Electric Industry in North Carolina, Volume 3*. Essentially, it is an "intermediate" price derived from a combination of four different scenarios and/or methodologies, including (1) the National Energy Modeling System, (2) Resource Data International, Inc., (3) RTI's projections on the "revenues lost" methodology, and (4) RTI's projections based on the expected costs of supplying electricity using a gas-fired combined-cycle generating unit. For details, see RTI's report *Stranded Cost Estimates for a Restructured Electric Industry in North Carolina, Volume 3*.

that generate higher rates of return than the prices paid by residential customers. In summary, these relationships among rates of return by customer class are as follows:

Customer Class	Deviation from System Average Rate of Return
Residential	lower return than average
Commercial	slightly higher return than average
Industrial	higher return than average

Based on this finding, Wright and Associates estimate the average percentage changes in electricity prices by customer class to bring the rates of return earned on sales to each customer class into equality. We applied this finding to North Carolina by calculating the percentage by which the Wright and Associates equalized rate of return prices for each customer class deviated from their base case scenario, and we then applied these percentages to the marginal cost prices discussed above. The adjustments required to generate the marginal cost prices used in the reference case were as follows:

Customer Class	Price Increase (+) or Decrease (-)
Residential	+3.22%
Commercial	-1.40%
Industrial	-3.76%

Table 3-2 contains estimated marginal cost based market-clearing prices, by customer class, for 2004, 2008, and 2015. These prices are used in the reference case. Year-by-year price detail for 2002 through 2015 are shown in Appendix Table B-2. The adjustments are made to delivered prices, which include transmission and distribution costs that are not affected by restructuring. The rates realignment adjustment originates in the effect of competitive forces operating in the market for generation to cause industrial rates to be lower and residential rates to be higher than they would be otherwise. Because generation is only one component of delivered prices, each one percentage point change in generation prices will result in a less than one percentage point change in delivered prices.

Table 3-2 also shows average annual rates of price change for 2004 through 2008, and 2008 through 2015. The prices in Table 3-2

Table 3-2. Reference Case Prices Excluding Stranded Cost Recovery

	Price (in 1995 ¢/kWh)			Average Compound Percentage Change per Year	
	2004	**2008**	**2015**	**2004-2008**	**2008-2015**
Restructuring Starts 2004					
Sector					
Residential	6.753	6.991	7.547	0.71%	1.10%
Commercial	5.120	5.301	5.723	0.71%	1.10%
Industrial	3.746	3.879	4.187	0.71%	1.10%
Statewide Average Price for All Customer Classes	5.170	5.393	5.822	0.71%	1.10%

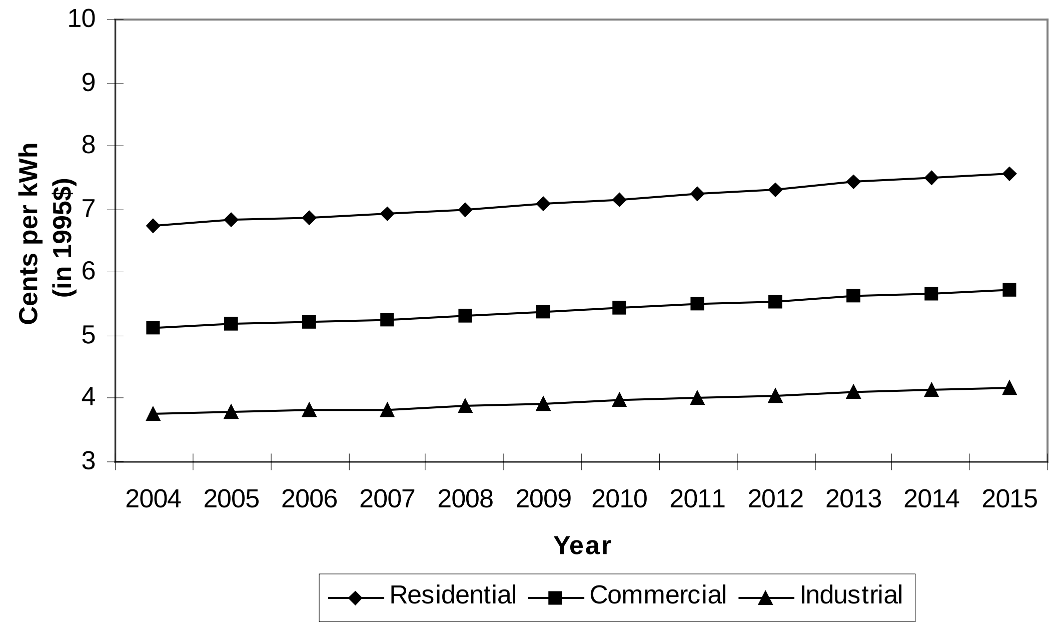
Note: See Figure 3-2 for year-by-year price detail. The reference case prices in Table 3-2 and Appendix Table B-2 are based on rates realignment among customer classes. These prices exclude stranded cost recovery surcharges. They are market clearing, marginal cost based prices.

represent prices based on marginal costs derived from equalized rates of return across customer classes.

As with the prices in Table 3-1, those in Table 3-2 are statewide averages. The overall statewide average price across all customer classes does not change as a result of applying the adjustment to reflect equalized rates of return across customer classes. However, the shares of this statewide average price that each customer class pays are distributed differently. For commercial and industrial customers, the marginal cost prices derived from equalized rates of return are lower than they would otherwise be, but residential prices are higher. As shown in Sections 4 and 5, this difference has an impact on the year-by-year and regional and industrial distribution of benefits and detriments. Figure 3-2 graphs the 2004 through 2015 trends in marginal cost based prices after adjustment for realignment of rates among customer classes, but before any recovery of stranded costs.

The marginal cost based prices are compared to the base case prices and the reference case prices in Figures 3-4 through 3-6 (Section 3.6.5). Figure 3-4 focuses on industrial prices, Figure 3-5 focuses on commercial prices, and Figure 3-6 focuses on residential prices for each case. These comparative figures are presented after we explain the treatment of stranded cost recovery in the reference case.

Figure 3-2. Marginal Cost Based Prices, 2004-2015



3.6 APPROACHES TO STRANDED COSTS

The prices reported in Table 3-2 contain no component for recovery of stranded costs. Although much controversy surrounds the definition and estimation of stranded costs, they can be described as costs that utilities incurred under a traditional regulatory environment (such as that discussed in our base case scenario), but that would not otherwise be recovered in a world with market-clearing prices (such as those in our marginal cost based market-clearing price discussion). Once such costs—stranded costs—have been identified, and once they have been estimated, the question remains: "How will they be recovered?"[11] The economic model we described above, and which is presented in detail in Appendix A, can be adapted to include recovery of stranded costs. This adaptation involves specifying price "surcharges," which are additions to the marginal cost based prices

[11]For a detailed discussion of the stranded cost estimates on which our stranded cost scenarios are based, see RTI's (1999d) report *Task 4: Stranded Cost Estimates for a Restructured Electric Industry in North Carolina, Volume 3*.

that are sufficient to recover estimated stranded costs over the assumed recovery period. To specify these surcharges, a number of questions must be resolved:

(1) What is the date at which recovery begins?

(2) How many years does the process require?

(3) What percentage of stranded costs are to be recovered?

(4) From whom and how are they to be recovered?

To specify our analytical benchmark (the reference case), we assume that the answers to these questions are as follows:

(1) Recovery of stranded costs begins in 2004.

(2) Recovery of stranded costs occurs over a 5-year period.

(3) There is 100 percent recovery of stranded costs.

(4) Stranded costs are assumed to be recovered on a statewide basis with a uniform charge per kWh that is equal in each year for each customer of all electric service providers in North Carolina.

Again, these assumptions are not in any way a prediction of the outcome of the policy formulation process. Rather, they provide a simplified way to view the relationships.

3.6.1 Defining and Estimating Stranded Costs

Stranded costs are costs which utilities have incurred under the existing institutional and regulatory framework. These costs are currently being recovered under this framework as it exists today, but they would not be recovered under projected competitive market prices in a restructured regulatory and institutional environment for electric utilities.[12] The major components of stranded costs are

- assets such as relatively high-cost generating plants,
- liabilities such as power purchase contracts and fuel supply contracts,
- regulatory assets such as deferred rate increases, and
- public policy programs now funded through electricity rates.

[12]See RTI's (1999d) report *Task 4: Stranded Cost Estimates for a Restructured Electric Industry in North Carolina*, Volume 3, for a more detailed discussion.

We use the estimates of stranded costs found in the RTI reference case scenario. The issues considered in the reference case include the following:

(1) Is there nexus for tax purposes for new entrant, out-of-state based, electric service providers?

(2) What is the benchmark market-clearing price of electricity?

(3) Which assets and liabilities should be included?

(4) How far into the future should the analysis period extend?

(5) What discount rate should be used for bringing future year asset and liability values back to a net present value at the beginning of restructuring?

(6) What discount rate should be used to generate a levelized nominal charge for recovery of stranded costs over the assumed recovery period?

The RTI reference case scenario for stranded costs is based on the following analytical framework:

(1) There is nexus for tax purposes for new entrant, out-of-state, electric service providers.

(2) The benchmark market-clearing price of electricity is the RTI intermediate case.[13]

(3) All generating assets, including capital additions to existing plants, are included. Also included are regulatory assets and purchased power contractual liabilities. Environmental or social expenditures beyond the mandates of existing legislation are not included.

(4) The period over which stranded cost estimates are calculated extends through 2020. This extension admits the possibility of negative stranded costs.

(5) The discount rate used for bringing future values back to a net present value is the cost of equity for IOUs and the cost of debt for municipal electric utilities and rural electric cooperatives.

(6) The discount rate used to generate the levelized nominal stranded costs recovery charge is the risk-free rate.

These are the basic underlying assumptions for the RTI reference case scenario on stranded cost definition, estimation, and recovery. In addition, the actual recovery experience may result in either over-recovery or under-recovery of stranded costs, so that on-going true-ups between projected and actual stranded costs, to be

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[13]See Volume 3, Appendix C of RTI's report *Stranded Cost Estimates for a Restructured Electric Industry in North Carolina* (RTI, 1999d).

administered by the North Carolina Utilities Commission (NCUC), may be required.

3.6.2 Alternative Assumptions Regarding Recovery of Stranded Costs

The recovery of stranded costs through a uniform surcharge on all customers has been widely discussed. Alternative suggestions have also been discussed. These informal suggestions have included recovering a larger share of the municipal power agencies' (MPA) stranded costs from their customers than they would be responsible for under uniform statewide surcharges. Another informal suggestion has been to use a service territory approach under which Duke ratepayers would contribute (in some unspecified sharing arrangement) to the recovery of North Carolina Municipal Power Agency #1 (NCMPA1) stranded costs, and CP&L ratepayers would likewise contribute to the recovery of the North Carolina Eastern Municipal Power Agency (NCEMPA) stranded costs. Another suggestion is to "cap" or "freeze" costs until stranded costs are recovered by all utilities, which implies that the lower stranded cost utilities assist the higher stranded cost ones, and that the recovery period possibly be extended. The problem with these suggestions is that they are not fully formed, and their details are not specified. In contrast, the uniform statewide surcharge over a 5-year recovery period is completely specified. In addition, it provides a readily understandable vehicle for sensitivity analysis. For these reasons, our reference case analysis focuses on a uniform statewide surcharge for stranded cost recovery and a 5-year recovery period.

3.6.3 Recovery of Stranded Cost Surcharges

For purposes of this study, stranded costs are recovered by equal ¢/kWh surcharges for all customer classes in each year. Prices are specified in real (after inflation) 1995 dollars, so the underlying nominal uniform recovery of stranded costs must also be specified in constant 1995 dollars. Because we assume some inflation over the recovery period for stranded costs, the constant nominal price surcharges translate into declining real recovery of stranded costs.

Our reference case is based on restructuring commencing in 2004 with 100 percent recovery of stranded costs over a 5-year period (2004 through 2008). To illustrate the sensitivity of the stranded cost recovery surcharge to acceleration or delay of the commencement of restructuring, Table 3-3 shows the stranded cost recovery surcharges for an accelerated restructuring commencing in 2002 and a delayed restructuring commencing in 2006. Each of these hypothetical alternatives is also based on 100 percent recovery of stranded costs over a 5-year period.

Table 3-3. Stranded Cost Recovery Surcharges

	Charges (in 1995 ¢/kWh)								
Period	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2002-2006	1.132	1.109	1.086	1.064	1.042				
2004-2008			0.813	0.796	0.780	0.763	0.748		
2006-2010					0.565	0.554	0.542	0.531	0.520

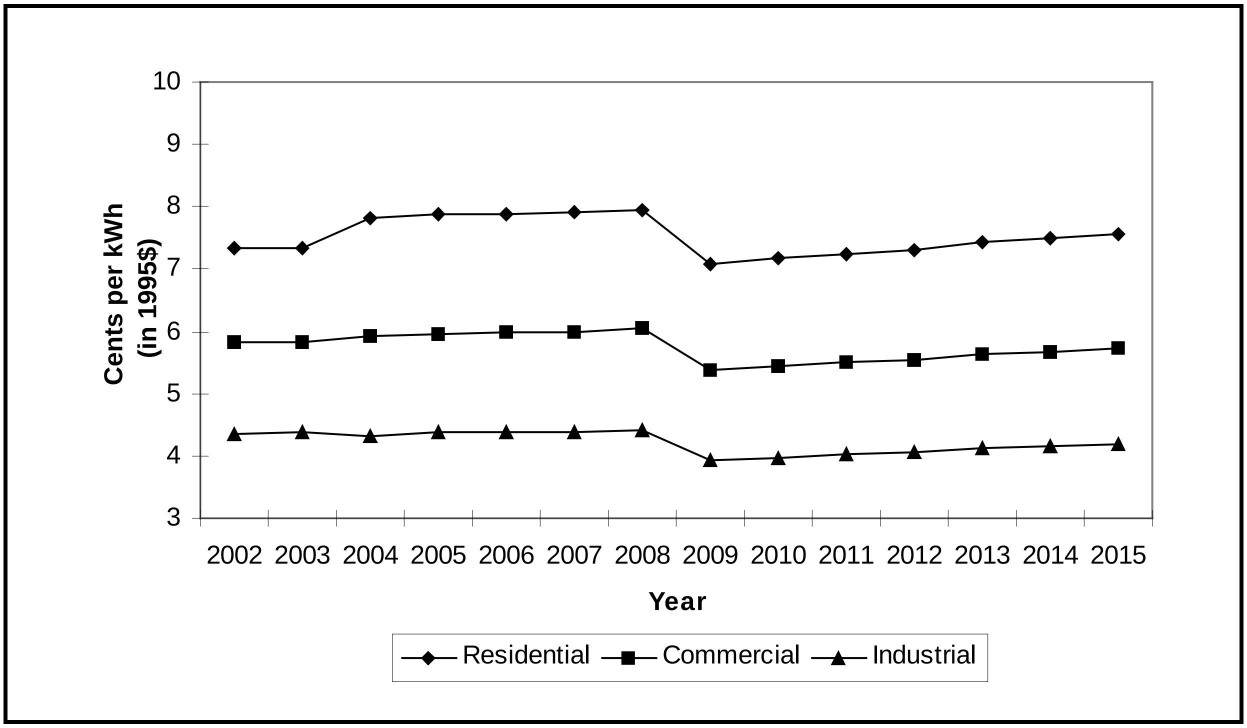
Postponement of the beginning of recovery of stranded cost means that there are fewer stranded costs to be recovered, so that the year-by-year uniform recovery of stranded cost charges is lower for the 2006 through 2010 period than for the 2004 through 2008 period. The reverse of this relationship also holds for a comparison of year-by-year recovery charges for a hypothetical 2002 through 2006 period versus the 2004 through 2008 period. The year-by-year recovery of stranded cost charges in ¢/kWh shown in Table 3-3 is in 1995 dollars.

To reiterate, stranded costs are assumed to be recovered on a statewide basis with a uniform charge that is equal in each year for customers in each customer class for all providers of electric service in North Carolina—the IOUs, the municipal-owned utilities, the rural electric cooperatives, and all new entrant electric service providers.

3.6.4 Prices Including Recovery of Stranded Cost Surcharges

Figure 3-3 charts the 2002 through 2015 trends of prices by customer class for the reference case electricity market restructuring and recovery of stranded cost beginning in 2004. The drop in

Figure 3-3. Reference Case Prices: 2002-2015



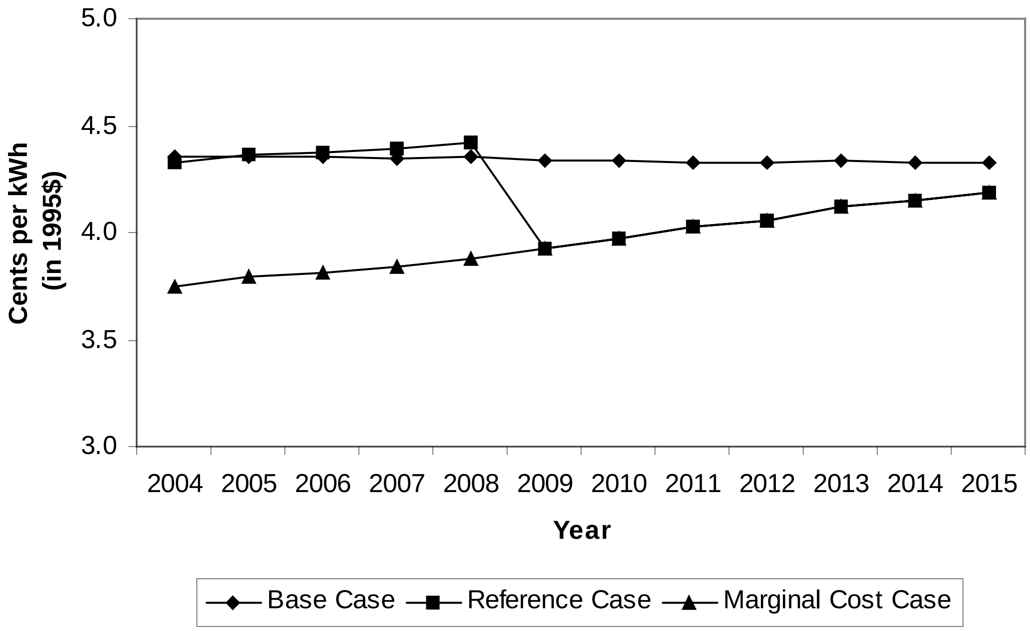
Note: The price detail for this figure is in Appendix Table B-2.

prices for each customer class during 2008 through 2009 reflects the end of the stranded cost recovery period and the transition to market-clearing prices based only on marginal costs. Prices for the residential customer class increase by a little less than one-half cent per kWh when the joint effects of the stranded cost recovery surcharge and equalized rates of return across customer classes are felt in 2004. Residential prices remain elevated for the 2004 through 2008 recovery period. The effects of the stranded cost recovery surcharge to raise prices and equalized rates of return to lower prices approximately cancel each other out for the commercial and industrial customer classes. The higher prices for residential users in the time period for recovery of stranded costs are followed by an even sharper transition to lower marginal cost prices when this time period ends. Termination of the stranded cost recovery surcharge in 2009 also causes a clear reduction in prices for commercial and industrial users.

3.6.5 Price Comparisons with the Base Case

The economic benefits and economic detriments that result from electricity market restructuring flow from differences in electricity prices between a policy scenario and the base case. In the reference case, stranded costs are recovered over a 5-year period through a uniform statewide surcharge. In addition to a comparison between the reference case and the base case of no institutional change, the price paths for purely marginal cost based pricing scenarios with no stranded costs recovery are also in interest.[14] In Figures 3-4 through 3-6, these price paths are presented by customer class.

Figure 3-4. Industrial Rates: Various Scenarios, 2004-2015



[14]These purely marginal cost based price paths with no stranded cost recovery are the basis for sensitivity scenarios B and C in Volume 2.

Figure 3-5. Commercial Rates: Various Scenarios, 2004-2015

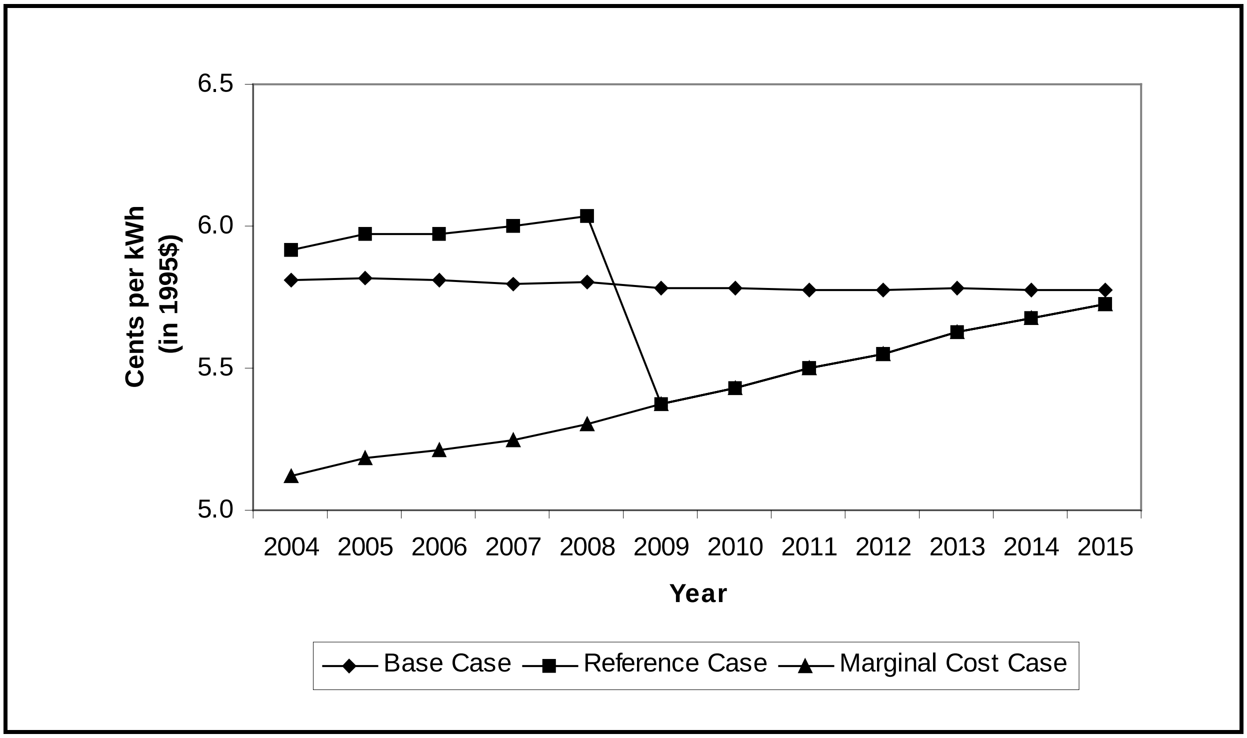
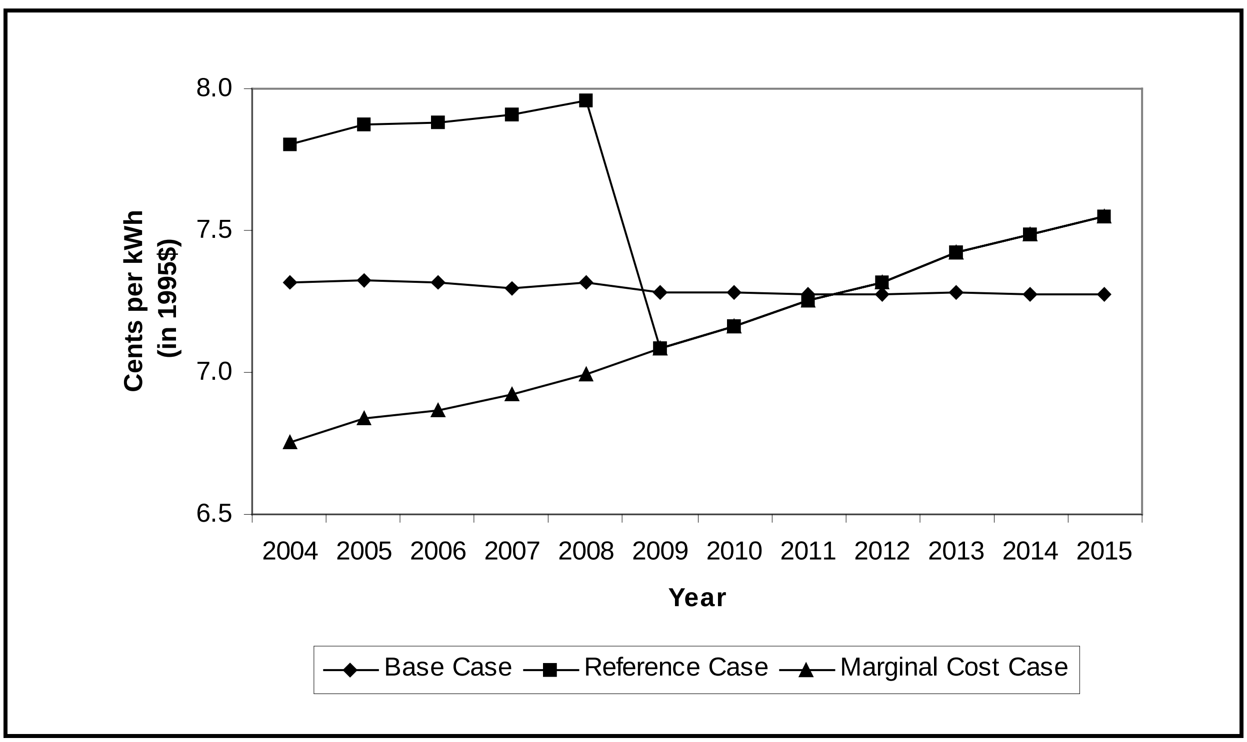


Figure 3-6. Residential Rates: Various Scenarios, 2004-2015



In each of these figures, the recovery of stranded costs causes the reference case price path to lie above the marginal cost case price paths for the years 2004 through 2008. In 2009, the reference case price path becomes coincident with the marginal cost case price path and remains so for 2009 through 2015. This is true for each of the three customer classes.

The reference case includes rates realignment as well as stranded cost recovery. A net result of this inclusion is that reference case prices for industrial rate payers do not deviate much from the base case prices over the stranded cost recovery period, 2004 through 2008. However, commercial and residential rate payers see a significant elevation in reference case prices relative to the base case prices for the stranded cost recovery period. For each of the three customer classes, reference case prices are below base case prices in 2009 after the stranded cost recovery period has terminated. Industrial and commercial class prices in the reference case stay below base case prices for 2009 through 2015. But because of the effect of competitive market forces to create rates realignment, residential prices for the residential class begin to exceed base case prices by 2012.

3.7 SUMMARY

The conceptual framework for estimating the economic benefits and detriments of electricity market restructuring is based on an economic supply and demand approach in which changes in electricity prices—either increases or decreases—cause North Carolina economic output and consumer demand to change. Changes in consumer demand and economic output flow through into changes in employment and earnings. Yearly changes in electricity prices by customer class are measured against a base case scenario built on the assumption that there is no institutional change in electricity market regulation and that prices in the base case continue to be set on the basis of franchised service territories and rate base/rate of return regulation.

Economic benefits and detriments are calibrated in terms of increases (benefits) and decreases (detriments) in North Carolina economic output, employment, and earnings.

The reference case used to illustrate the economic benefits and detriments of restructuring the North Carolina electricity market is based on the following assumptions:

- Restructuring commences in 2004.
- There is 100 percent recovery of stranded costs.
- The recovery period during which the stranded cost surcharge applies is the 5-year span between 2004 and 2008.
- Stranded costs are recovered on a statewide basis with a uniform ¢/kWh surcharge that is equal in each year for each customer class for all providers of electric service in North Carolina—the IOUs, the municipal electric utilities, the rural electric cooperatives, and all new entrant electric service providers.
- Competitive market forces cause the rates of return that electric service providers earn on sales to each customer class to equalize across classes.

The most prominent features of the 2002 through 2015 price profiles in the reference case are the increase in residential prices relative to commercial and industrial prices during the stranded cost recovery period and a decrease in prices for all customer classes at the end of the stranded cost recovery period (see Figure 3-3).

The increase in residential prices relative to commercial and industrial prices is due to the competitive market adjustment to equalized rates of return across customer classes. This adjustment is based on 1995 cost of service studies that are now 5 years old (and will be 10 years old in 2004 when restructuring commences in the reference case). There have been pricing developments since 1995 that include, for example, real-time pricing. There will be additional developments between now and 2004. Therefore, it is prudent to treat this rates realignment effect as a directional prediction rather than a quantitatively precise estimate. Nevertheless, it is also prudent to acknowledge that movement toward a restructured competitive market environment is apt to involve some rates realignment across customers classes.

4 Estimates of State Benefits and Detriments

4.1 INTRODUCTION

The base case projections of North Carolina economic output, employment, and earnings are based on figures supplied by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. The BEA makes its projections on the basis of changes in the institutional economic environment that are actually in place and in operation. The BEA specifically does not incorporate what it regards to be hypothetical future changes in the institutional economic environment, such as the possibility of one form or another of electricity market restructuring (BEA, 1998). Therefore, projections of North Carolina output, employment, and earnings based on the BEA analysis conform closely to the expected trends under the base case of no institutional change in the regulation of electricity prices and the continuation of franchised service territories with rate base/rate of return regulation.

The BEA-based projections for North Carolina output, employment, and earnings for 2002 through 2015 are shown in Table 4-1.[1] Economic output and earnings are in millions of 1995 dollars. Employment is in thousands of workers. These are the baseline projections of output, employment, and earnings against which economic benefits (increases in these measures) and economic detriments (decreases in these measures) are estimated.

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[1]Economic output includes public-sector and private-sector services as well as products and commodities. For ease of exposition, the construction "industry/business/government" is often shortened to "industry," but this usage is meant to include the total economy of North Carolina, including the public-sector and private-sector service industries.

Table 4-1. North Carolina Output, Employment, and Earnings with Base Prices and No Institutional Change: 2002-2015

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Output (millions of 1995$)	413,131	421,079	429,209	437,524	446,031	454,732	463,633	472,739	482,054	491,584	501,334	511,309	521,515	531,956
Employment (thousands)	4,716	4,772	4,830	4,889	4,949	5,010	5,072	5,135	5,200	5,266	5,333	5,402	5,471	5,542
Earnings (millions of 1995$)	125,483	127,701	129,966	132,279	134,641	137,053	139,517	142,033	144,604	147,229	149,912	152,652	155,452	158,312

	Growth Rates 2002-2015
Output	1.96%
Employment	1.25%
Earnings	1.80%

Notes: 1. The base case prices are the prices discussed in Section 3.4 and presented in Table 3-1 and Appendix Table B-1.
2. Under the assumption of no institutional change, there is a continuation of rate base/rate of return regulation with allocated service territories and regulatory determination of just and reasonable prices.

4.2 OUTPUT, EMPLOYMENT, AND EARNINGS UNDER EACH SCENARIO

Table 4-2 presents the projections of output, employment, and earnings for the reference case. The format for this table is the same as that for Table 4-1, which facilitates a direct comparison of the reference case results (Table 4-2) with the base case results (Table 4-1).

Table 4-3 presents the absolute changes in output, employment, and earnings for the reference case compared with the base case. Table 4-3 also presents the percentage changes for each year for each of these measures of economic benefits and detriments. Both absolute and percentage changes are calculated relative to the base case of no institutional change. Percentage changes are used to standardize the measures of economic benefits and economic detriments.

Changes in employment are good summary measures of the economic benefits and detriment impact of a particular policy choice. For our reference case, there are both economic benefits and economic detriments. The economic detriments occur during the stranded cost recovery period (2004 through 2008) when there is lower job growth than would otherwise occur. The economic benefits occur after the end of the stranded cost recovery period (2009 through 2015). Over the whole period analyzed in the reference case (2004 through 2015) the average annual change in employment is a net economic benefit of 1,100 additional jobs per year.

For the reference case, it is assumed that there are *no* protected service territories for *any* providers. That is, there is free and open retail competition among existing North Carolina electric service providers and new entrants in all former service territories of the investor-owned utilities (IOUs), municipal electric utilities, and rural electric cooperatives.

The reference case is constructed on the assumption that retail competition causes rates of return earned by electric service providers to be equalized across customer classes. Industrial prices decrease relative to the other two customer classes. Residential prices increase relative to the other two customer classes.

Table 4-2. North Carolina Output, Employment, and Earnings Under the Reference Case: 2002-2015

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Output (millions of 1995 dollars)	413,131	421,079	429,131	437,247	445,715	454,330	463,219	473,466	482,692	492,098	501,777	511,627	521,737	532,092
Employment (thousands of workers)	4,716	4,772	4,828	4,885	4,944	5,004	5,066	5,144	5,208	5,272	5,338	5,405	5,474	5,543
Earnings (millions of 1995 dollars)	125,483	127,701	129,929	132,185	134,535	136,920	139,377	142,265	144,806	147,390	150,049	152,748	155,516	158,348

	Growth Rates 2002-2015
Output	1.97%
Employment	1.25%
Earnings	1.81%

Notes: 1. The reference case prices are the prices discussed in Section 3.6.3 and shown in Figure 3-3 and Appendix Table B-2.
2. Output, employment, and earnings for 2002 and 2003 are the same for the reference case and the base case.

Table 4-3. Reference Case Changes in North Carolina Output, Employment, and Earnings Growth: 2002-2015

Scenario	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Panel A: Absolute Changes														
Output (millions of 1995 dollars)	0[a]	0[a]	**-77**	**-277**	**-316**	**-402**	**-414**	727	637	513	442	318	222	136
Employment (thousands of workers)	0[a]	0[a]	**-1.91**	**-4.09**	**-4.54**	**-5.57**	**-5.83**	9.02	7.82	6.17	5.22	3.57	2.29	1.13
Earnings (millions of 1995 dollars)	0[a]	0[a]	**-37**	**-93**	**-106**	**-133**	**-140**	232	202	161	137	96	64	35
Panel B: Percentage Changes														
Output (percentage of base)	0.00%[a]	0.00%[a]	**-0.02%**	**-0.06%**	**-0.07%**	**-0.09%**	**-0.09%**	0.15%	0.13%	0.10%	0.09%	0.06%	0.04%	0.03%
Employment (percentage of base)	0.00%[a]	0.00%[a]	**-0.04%**	**-0.08%**	**-0.09%**	**-0.11%**	**-0.11%**	0.18%	0.15%	0.12%	0.10%	0.07%	0.04%	0.02%
Earnings (percentage of base)	0.00%[a]	0.00%[a]	**-0.03%**	**-0.07%**	**-0.08%**	**-0.10%**	**-0.10%**	0.16%	0.14%	0.11%	0.09%	0.06%	0.04%	0.02%

Note: The years in which the recovery of stranded costs surcharge is in effect are shown in bold type. In years subsequent to the years shown in bold type, marginal cost based pricing is in effect. In years prior to the years shown in bold type, rate base/rate of return regulation with allocated service territories remains in effect. All absolute and percentage changes are calculated relative to the data for the base case with no institutional change reported in Table 4-1. As a result, there are changes in the *growth* of output, employment, and earnings over the 2002 through 2015 time horizon.

[a]Zero entries indicate no percentage change from the base case projections because restructuring has not yet commenced and rate base/rate of return regulation with allocated service territories is still in force.

Commercial prices increase slightly relative to industrial prices and decrease relative to residential prices.[2] In the two marginal cost based pricing scenarios, there is no recovery of stranded costs. This is an analytical assumption, not a policy recommendation. Juxtaposed with the six pricing scenarios that are based on 100 percent recovery of stranded costs, the two marginal cost based pricing scenarios with no recovery of stranded costs illustrate the analytical boundaries of the treatment of recovery of stranded costs. States that have implemented retail competition have also implemented procedures for recovering stranded costs.[3] Failure to include adequate recovery of stranded costs in restructuring plans has resulted in legal challenges to the implementation of retail competition in Pennsylvania (J.A. Wright and Associates, 1998).

Should North Carolina choose to restructure the electricity industry without providing for the recovery of stranded costs, the state will incur economic detriments that are not included in the calculations presented here. These economic detriments could include capital losses suffered by the equity owners and debt holders of IOUs and cash flow/debt service problems for the two municipal power agencies (MPAs) and the North Carolina Electric Membership Corporation (NCEMC). Other "off the balance sheet" economic detriments include transition costs for implementing retail competition. California is reported to have spent approximately $1 billion in transition costs (not stranded costs) and faces substantial ongoing operating costs for its independent service operator (ISO) and power exchange (PX) (Aguilar, 1998).

The recovery of stranded costs in the reference case is based on the assumption that 100 percent of stranded costs are recovered over a 5-year period using a uniform surcharge per kWh applicable to all electric energy sales in North Carolina. This assumption about the recovery of stranded costs is not a policy recommendation. Rather, it is intended to frame the discussion for one treatment of the recovery of stranded costs.

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[2]These marginal cost based price paths are presented in Table 3-2 and Appendix Table B-2 and illustrated in Figure 3-2.

[3]Massachusetts, California, and Rhode Island have implemented retail competition and have implemented procedures for utilities to fully recover stranded costs. See J.A. Wright and Associates (1998).

The percentage changes in the measures of economic benefits and economic detriments reported in Table 4-3 are relatively small numbers in percentage terms. But the North Carolina economic base to which they apply is large. The resulting absolute changes in the economic base can therefore be substantial. For example, consider the effect of a one-tenth of 1 percent, or 0.1 percent, change (up or down) on the North Carolina base for 2002. This effect is shown in Table 4-4.

Table 4-4. Effect of a 0.1 Percent Change in Base Output, Employment, and Earnings in the Year 2002

Measure	North Carolina Economic Base	Assumed 0.1% Change	Absolute Change
Output (in 1995$)	$413,131,094,344	±0.001	±$413,000,000
Employment	4,715,776	±0.001	±4,700
Earnings (in 1995$)	$125,483,159,655	±0.001	±$125,000,000

A one-tenth of 1 percent change in output amounts to over $400 million dollars. A one-tenth of 1 percent change in employment amounts to an increase or decrease of over 4,700 jobs.[4] And a one-tenth of 1 percent change in earnings amounts to $125 million dollars.

4.3 CAVEATS

Recall that stranded costs are estimated for all North Carolina electric service providers—IOUs, municipal electric utilities, and rural electric cooperatives—and statewide total stranded costs are recovered by a ¢/kWh surcharge that is uniform across all customer classes for all electric service providers on a year-by-year basis over the 5-year recovery period. We also assume that there is open competition on a statewide basis and that all protected service

[4]Note that the figures in Table 4-4 do not represent jobs in the usual sense in which that term is used. Rather, they represent additional employment or person-years required to produce the additional output resulting from restructuring at given levels of productivity. In other words, the actual change in employment could be substantially different from the figures in the table, as workers currently employed full-time could work overtime, and part-time workers could go to full-time employment.

territories are eliminated—including those for municipal electric utilities and rural electric cooperatives.[5]

In an open market competition, it is likely that, at the margin, municipal electric utilities and rural electric cooperatives would lose kWh sales to IOUs and other electric service providers. This loss would occur if North Carolina IOUs and large new entrants were to offer more attractive prices, more sophisticated terms and conditions for service, and/or the reality or perception of greater reliability.

As a result of any loss in kWh sales, the cash flow/debt service economic detriments identified above, but not included in the calculations of employment, output, and earnings effects, would be a problem. This problem would be most severe should North Carolina decide to restructure the electric industry without providing for the recovery of stranded costs. The extent of this potential problem would also depend on the financial details of the program through which stranded costs are identified, estimated, and assembled into a statewide pool. For a more complete discussion of some of the policy dimensions involving the MPAs, see RTI's (1999d) report *Policy Options for North Carolina's Municipal Power Agencies* (*Task 4: Analysis of Options for Resolving Stranded Cost Issues, Volume 1*).

The estimates of economic impacts in this report are based on our reference case, which assumes that nexus is established for tax purposes. If nexus is not established for tax purposes, out-of-state electricity suppliers will be able to charge lower prices that do not include North Carolina taxes, and current incumbent North Carolina based sellers will have to meet those prices competitively. As a result, prices in general will be lower with resulting positive effects on economic output, employment, and earnings. But these estimated incremental benefits will be accomplished by correspondingly greater economic detriments that are not included in our calculations.

[5]This assumption is an integral part of the estimation of the statewide changes in output and demand that are the basis for the percentage changes in the measures of economic benefits and detriments.

4.4 SENSITIVITY ANALYSES

Sensitivity analyses based on alternative scenarios yield the expected results. If the commencement of restructuring is postponed until 2006, there are fewer stranded costs to recover, stranded cost recovery surcharges are smaller, and the average annual net gain in employment approximately doubles to 2,200 jobs per year compared with a net employment change of 1,100 jobs per year in the reference case.[6] On the hypothetical assumption that restructuring commences in 2002, there are more stranded costs to recover, stranded cost recovery surcharges are larger, and the average annual net effect on employment is 600 fewer new jobs per year than would have occurred under the base case of no institutional change.

However, we believe that one of the effects of restructuring electricity markets to introduce competition in generation at the retail level will be a realignment of rates from their current relative levels. Industrial rates will be lower. Residential rates will be higher. We impose rate realignment as an assumption, but in actuality we believe it is apt to be an inevitable consequence of restructuring. When competition is introduced, market forces will rule. It is the action of competitive market forces that will cause rates realignment in a restructured electricity market. We can "assume" that rates will not realign themselves, but that does not mean that we can actually avoid rates realignment in a restructured market.

For purposes of determining the potential impact from the realignment of rates among customer classes, we developed comparative sensitivity scenarios in which rates realignment (by assumption) is excluded. When rates realignment is excluded, industrial rates are higher and residential rates are lower than in the reference case.

The reductions in industrial rates in the reference case are a principal source of increases in output, employment, and earnings. Therefore, without the rates realignment feature of the reference case, we estimate that restructuring commencing in 2004 would

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[6]See Volume 2, *Estimates of the Benefits and Detriments of Electric Industry Restructuring in Electricity Markets in North Carolina* for more detail on these sensitivity analyses (RTI, 1999a).

result in an average annual employment effect of over 2,000 fewer new jobs per year than would have occurred under the base case of no institutional change.

Comparative sensitivity analysis of scenarios with and without rates realignment illuminates two significant findings. First, a large part of the benefits identified in our study are derived from the realignment of rates. Second, while this realignment of rates reduces electricity prices for industrial users, it increases utility prices for residential customers. As noted earlier, rates realignment has already begun under the direction of regulatory authorities. Rates realignment can be continued either through regulatory innovation and initiative or through electricity market restructuring.

If North Carolina should decide to commence electricity market restructuring in 2004, but make no provision for the recovery of stranded costs, then the lower electricity rates that would be experienced would lead to average annual employment effects of about 8,000 new jobs per year. But, as discussed in Sections 4.2 and 4.3, the state would incur economic detriments not included in our calculations here.

4.5 SUMMARY

North Carolina experiences economic benefits and economic detriments as a result of electricity market restructuring. The measures of benefits and detriments estimated here are changes in statewide economic output, employment, and earnings. In the reference case, electricity prices include a surcharge for recovery of stranded costs. During the stranded cost recovery period, 2004 through 2008, North Carolina experiences economic detriments in terms of negative effects on output, employment, and earnings growth. After this period, in the years 2009 through 2015, North Carolina experiences economic benefits from electricity market restructuring that creates marginal cost based pricing. The economic benefits outweigh the economic detriments. For example, there are average annual net employment gains of 1,100 jobs per year in the reference case. However, employment in North Carolina averages 5,100,000 jobs over this period, so the total net employment gain is equal to 0.02 percent of the average North Carolina employment base over the years 2004 through 2015.

5 Estimates of the Geographic Dispersion of Benefits and Detriments within North Carolina

5.1 INTRODUCTION

The economic benefits and detriments of any restructuring scenario will be distributed unevenly across the state because the distribution of industries/businesses, output, employment, and earnings is uneven across the state. In this section we analyze effects of our various scenarios across geographic regions and industries/businesses.

Our modeling effort and results do not separate the effects of restructuring on new industry location, relocation, or expansion. However, these effects are implicitly included in our results, because the effects of restructuring are larger in industry groups that are more electricity intensive and, as a result, regions that have higher concentrations of these industries are more affected.

5.2 THE REGIONAL MODEL

So far we have focused on the benefits and detriments from restructuring electricity prices at the state level. Although the model used to derive those estimates is a state model, it is possible to obtain estimates of the geographic dispersion of the effects of a change in electricity prices. To accomplish this, the state must first be divided into regions. Obviously, the counties offer a possible choice here, but the counties represent political (not economic) regions. Furthermore, because the state has 100 counties, the number of permutations for presenting, summarizing, and comparing the data and results makes county-level analysis somewhat intractable. Therefore, we chose to organize the regional data in terms of the seven state economic development regions. Table 5-1 contains the seven regions. (The counties that compose each region, and their geographic location within the state are shown in Appendix C.) With the exception of Carolinas Partnership, which is centered on the Charlotte area, and Global Transpark (Kinston), the names correspond with recognizable geographic areas.

Table 5-1. Regional Shares of State Totals: Output, Employment, and Earnings (1995)

	Output	Employment	Earnings
Advantage West	10.27%	11.81%	9.96%
Carolinas Partnership	26.63%	23.64%	26.06%
Global Transpark	9.72%	11.22%	10.59%
Northeast North Carolina	3.41%	3.59%	2.77%
Piedmont-Triad	21.92%	19.59%	19.64%
Research Triangle	18.46%	19.35%	20.43%
Southeast North Carolina	9.60%	10.80%	10.55%
North Carolina Total	100.00%	100.00%	100.00%

Table 5-1 illustrates the 1995 regional distributions of each of our measures of economic activity. Appendix A contains the conceptual details on which our estimates of the regional effects from changes in electricity prices are based. Essentially, the process involves using the regional distributions of state output, employment, and earnings to allocate the changes in those variables as reported in Section 4. Thus, for every $1,000 of output at the state level that is generated from, say, a reduction in electricity prices, $220 can be expected to be generated in the Piedmont- Triad area. This $220 is distributed across the 31 business, industry, and government groups in the Piedmont- Triad.

For example, because the Piedmont-Triad produces roughly 25 percent of the state's printing and publishing, for every $100 in additional printing and publishing output generated at the state level, we would expect $25 to originate in the Piedmont-Triad area.[1]

5.3 REGIONAL EFFECTS

For ease of exposition, we report here only on the total effects on regional employment. Table 5-2 shows the average annual employment effects of the reference case for the seven North Carolina economic development regions. There are regionally disproportionate effects of restructuring due to differences in the size and electricity intensiveness of the industrial base, among other factors, among regions. For example, the average number of jobs added annually in the combined Carolinas Partnership (the Charlotte area), the Piedmont-Triad, and the Research Triangle regions (+739) is roughly twice as large as it is in the combined Advantage West, Northeast, Southeast, and Global Transpark regions (+367).

This finding is not surprising when one considers that five of the six most electricity-intensive industries (yarn and thread; other textiles; pulp and paper; stone, clay, and glass; and primary metals) have their largest share of output originating in either the Carolinas Partnership or Piedmont-Triad region, and in four of these five industries those two regions are number one *and* two in terms of output.

As Table 5-1 shows, the Carolinas Partnership and the Piedmont-Triad have the largest shares of employment in the state, so they would be expected to have the largest shares of any change in employment. The Piedmont-Triad and the Research Triangle currently have roughly the same share of state employment. But the industries in the Piedmont-Triad are more electricity-intensive than those in the Research Triangle. To see the effects of this difference in electricity intensiveness, examine job growth in each

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[1]Note that these shares are based on the current regional structure of output, employment, and earnings by county across service areas, and the model does not contain forecasts of changes in this structure.

Table 5-2. Average Annual Employment Effects for the Seven North Carolina Economic Development Regions

	Average Annual Job Gains and Losses[a]		
Region	**2004-2008**	**2009-2015**	**2004-2015**
Advantage West	-506	622	152
Carolinas Partnership	-1,030	1,371	370
Global Transpark	-510	510	88
Northeast North Carolina	-163	164	28
Piedmont-Triad	-837	1,022	248
Research Triangle	-869	829	121
Southeast North Carolina	-480	512	99
Total Statewide Effect	-4,400	5,000	1,100

Note: These estimates are based on the reference case with restructuring commencing in 2004, 100 percent recovery of stranded costs, and competitive realignment of rates across customer classes.

[a]Total net employment changes are the sum of job losses during the recovery of stranded costs period and job gains during the marginal cost pricing period divided by the number of years in which restructuring is in place.

region in Table 5-2 after the recovery of stranded costs period ends. Beginning in 2009, the Piedmont-Triad gains 248 jobs over the 2009 through 2015 period, while the Research Triangle gains only 121 jobs over this same period. The growth of jobs in the Triad is more than double that in the Triangle primarily as a result of the difference in electricity intensity.

5.4 SUMMARY

These regional breakdowns reflect the regional allocation of industrial production and demonstrate disproportionate regional effects of changes in electricity prices due to differences in the size and electricity intensity of each region's industrial base. For example, the average annual net job gains for the combined Carolinas Partnership (Charlotte), Piedmont-Triad, and Research Triangle regions are twice as large as those for the combined Advantage West, Global Transpark, Northeast North Carolina, and Southeast North Carolina regions. In the period during which stranded costs are being recovered with a uniform ¢/kWh surcharge, the estimated job losses should not be thought of as unemployment in the traditional sense of laid-off workers seeking but not finding work. Rather, these losses reflect a reduction in the *growth* of employment opportunities and thus fewer available jobs relative to the base case. Our sensitivity analyses show that the longer the delay before electricity market restructuring and recovery of stranded costs begin, the smaller the absolute effects on economic benefits and detriments in terms of gains and losses. In addition, the longer the delay, the greater the ratio of later job gains relative to earlier job losses.

6 Summary and Conclusions

In this report, we present estimates of the economic benefits and detriments resulting from restructuring the electricity industry in North Carolina. We estimate benefits and detriments for a reference case and present them not only for the state as a whole but also for the seven economic development regions within the state. We define benefits and detriments in terms of three different measures of economic activity—output, employment, and earnings. But we use changes in average annual employment as our summary measure. In addition, we perform sensitivity analyses. One of the dimensions across which we test the sensitivity of our results to alternative assumptions is the assumed starting date for restructuring. Our reference case is based on the assumption that restructuring commences in 2004. Our reference case is also based on the assumptions that there is 100 percent recovery of stranded costs through a uniform ¢/kWh surcharge over a 5-year period and that a restructured competitive market results in a realignment of rates among customer classes. The total cumulative net change in employment over the 2004 through 2015 period is a good summary measure of economic benefits (positive change) and economic detriments (negative change). The results indicate a positive economic impact—that is, net economic benefit—for our reference case restructuring scenario.

The regional breakdown of these impacts focuses on the seven economic development regions of North Carolina. The regions that will benefit the most from restructuring will be the urban regions with the most electricity-intensive industries. The Carolinas Partnership (Charlotte), Piedmont-Triad, and Research Triangle regions show the largest absolute employment changes under our reference case. These three regions account for over 60 percent of North Carolina employment. But these three large urban regions together account for approximately two-thirds of the employment gains or losses under each alternative scenario. The overall geographic distribution of employment gains and losses, however, also depends on the electricity intensity of the industrial base in each region. For example, although the Piedmont-Triad and Research Triangle each account for 19 to 20 percent of North Carolina employment, job gains or losses for the Piedmont-Triad are on average almost 50 percent greater than for the Research Triangle under the alternative scenarios because of the greater concentration of electricity-intensive industry in the Piedmont-Triad. For our reference case, each of the seven North Carolina economic development regions incurs positive net job gains, but for some of the regions the average annual employment gains are quite small.

On a statewide basis, the economic benefits of restructuring also outweigh the economic detriments. For our reference case, there are average annual net employment gains of 1,100 jobs per year over the 2004 through 2015 period. North Carolina averages 5,100,000 jobs over this period, so the total net employment gain is equal to 0.02 percent of the average North Carolina employment base over the years 2004 through 2015.

References

Aguilar, Ms. Arocles, Counsel, California Public Utilities Commission. October 29, 1998. Personal communication with Edward W. Erickson, North Carolina State University.

Bureau of Economic Analysis (BEA). 1998. Personal communication with Edward W. Erickson, North Carolina State University.

Chernoff, Harry, and Gabriel Sanchez. July 1998. "The Impact of Industry Restructuring on Electricity Prices." Prepared for the American Gas Association Policy Analysis Group.

Houthakker, H.S., and L.D. Taylor. 1970. *Consumer Demand in the United States*. Cambridge: Harvard University Press.

Johnson, P.R. February 1971. *Studies in the Demand for U.S. Exports of Agricultural Commodities*. Economics Research Report, No. 15, Department of Economics, North Carolina State University, Raleigh, NC.

Luger, Michael I., Xun Wu, and Kristin Komives. Research Memorandum, "Retail Competition and Economic Development in North Carolina," April 1998.

Minnesota IMPLAN Group, Inc. 1998. *1995 IMPLAN Data for North Carolina*. Stillwater, MN: IMPLAN Group.

Philips, L. 1974. *Applied Consumption Analysis*. North Holland.

Research Triangle Institute. 1998. *Task 2: Rate Comparisons*. Prepared for the Legislative Study Commission on the Future of Electric Service in North Carolina. Research Triangle Park, NC: Research Triangle Institute.

Research Triangle Institute. 1999a. *Estimates of the Benefits and Detriments of Electric Industry Restructuring in Electricity Markets in North Carolina, Volume 2*. Prepared for the Legislative Study Commission on the Future of Electric Service in North Carolina. Research Triangle Park, NC: Research Triangle Institute.

Research Triangle Institute. 1999b. *Reliability Considerations in Electric Industry Restructuring*. Prepared for the Legislative Study Commission on the Future of Electric Service in North Carolina. Research Triangle Park, NC: Research Triangle Institute.

Research Triangle Institute. 1999c. *Task 3: State and Local Tax Considerations in Electric Industry Restructuring, Volumes 1 and 2*. Prepared for the Legislative Study Commission on the Future of Electric Service in North Carolina. Research Triangle Park, NC: Research Triangle Institute.

Research Triangle Institute. 1999d. *Task 4: Stranded Cost Estimates for a Restructured Electric Industry in North Carolina*. Prepared for the Legislative Study Commission on the Future of Electric Service in North Carolina. Research Triangle Park, NC: Research Triangle Institute.

Research Triangle Institute. 1999e. *Task 7: Summary of Written Public Comments*. Prepared for the Legislative Study Commission on the Future of Electric Service in North Carolina. Research Triangle Park, NC: Research Triangle Institute.

Varian, Hal R. 1984. *Microeconomic Analysis*, 2nd ed., New York: W.W. Norton.

Wright, J. A. and Associates. February 1997. *The Impact of Electricity Competition in South Carolina*. Prepared for Carolina Power & Light by J.A. Wright and Associates in cooperation with Utility Strategies, Inc., Texas Perspectives, and Ridgewood Economic Associates.

Wright, J. A. and Associates. September 1998. “The Impact of Electric Competition on the Price of Electricity.” Marietta, Georgia: J.A. Wright and Associates.

Appendix A: Economic Impacts Model Details

The economic effects of electricity price restructuring can be estimated using the coefficients from an input-output (IO) model. IO analysis was first developed by Nobel prize-winning economist Wassily Leontief. An IO model represents the mathematical relationship between the inputs required for production—such as electricity—and the outputs that result from the production process. To see how such a model works in the context of electricity price restructuring, one must first have base paths for the various measures of economic activity. In this case these measures include gross state output (Q), employment (L), and earnings (E).[1] The variables to be changed—or "shocked," in economic parlance—are average state electricity prices (P^n) by sector, where the *n* sectors are residential (R), commercial (C), and industrial (I).[2]

After obtaining base paths for economic activity and electricity prices, the first step in the model for estimating the effect of changes in economic activity on electricity prices involves deriving a set of alternative price scenarios.[3] For any alternative scenario, let the deviation from the base path of prices be expressed in percentage terms by

$$\Delta \ln P_t^n = \Delta P_t^n / P_t^n$$

$$\text{for } t = 1, 2, ..., 14 \text{ years, and } n = \text{R, C, and I.} \qquad \text{(A.1)}$$

The second step in the model involves estimating the share of total costs (TC_i) in the *ith* industry resulting from expenditures on electricity (EC_i)—that is

$$\alpha_i = (EC_i/TC_i), \qquad \text{for } i = 1, 2, ..., 31 \text{ groups.} \qquad \text{(A.2)}$$

The α_i are obtained from an IO model of the state of North Carolina,[4] and Table A-1 contains the average electricity share of

[1]The base paths for these variables are shown in Table 4-1. These base data are derived from those estimated for the state of North Carolina by the U.S. Bureau of Economic Analysis (BEA). The BEA data are fairly comprehensive; however, in cases in which BEA's base data were missing for a particular industry, we used the growth rates from related industries.

[2]The base paths for these variables are shown in Appendix B, Table B-1.

[3]The eight alternative prices scenarios are described in Section 3.

[4]Minnesota IMPLAN Group, Inc. 1998. *1995 IMPLAN Data for North Carolina.* Stillwater, MN: IMPLAN Group. We are indebted to Professor Michael Walden of the North Carolina State University Department of Agricultural and Resource Economics for providing us with these data.

Table A-1. Electricity's Share of Total Costs (by industry): North Carolina

Business/Industry	Standard Industrial Classification (SIC) Code	Percentage Share
Agriculture and Forestry	01-09	3.41%
Mining	10-14	8.16%
Construction	15-17	0.46%
Manufacturing		
Food Products	20	2.69%
Tobacco Products	21	0.94%
Knitting Mills	225	3.46%
Yarn and Thread	228	7.62%
Other Textiles	220	5.73%
Apparel Products	23	2.06%
Lumber and Wood	24	2.62%
Furniture and Fixtures	25	2.48%
Pulp and Paper	26	6.93%
Printing and Publishing	27	2.95%
Other Chemicals	280	3.79%
Drugs	283	1.66%
Other Nondurables	29,31	3.02%
Rubber and Plastics	30	4.94%
Stone, Clay and Glass	32	9.52%
Primary Metals	33	10.50%
Fabricated Metals	34	4.85%
Nonelectrical Machinery	35	2.25%
Electrical Machinery	36	2.91%
Transportation Equipment	37	1.42%
Instruments	38	2.46%
Miscellaneous Manufacturing	39	2.11%
Services		
Transportation Services	40-47	1.42%
Communications and Utilities	48,49	0.54%
Wholesale and Retail Trade	50-59	5.45%
Finance, Insurance, and Real Estate	60-67	2.48%
Services	70-89	2.59%
Government	90-99	6.63%

Data sources: Minnesota IMPLAN Group, Inc. 1998. *1995 IMPLAN Data for North Carolina*. Stillwater, MN: IMPLAN Group.

Note: This arrangement of the total North Carolina economy into 31 business, industry, and government groups is the classification used by the North Carolina Department of Administration, Office of Management and Budget in many of their analyses.

total costs for the 31 business, industry, and government groups analyzed in this report.

It follows that the percentage change in total costs in the *ith* industry in year *t* resulting from electricity price restructuring is the product of the percentage deviation in prices from the base price and electricity's share of total costs. In other words,

$$\Delta \ln P_t^n \alpha_i = \Delta \ln TC_{it} \qquad \text{for } n = \text{C and I only.} \qquad \text{(A.3)}$$

If the reduction in total costs is passed on to customers in the form of an identical percentage change in output prices (π), then the change in output prices would equal

$$\Delta \ln TC_{it} = \Delta \ln \pi_{it}. \qquad \text{(A.4)}$$

The relationship between the percentage change in prices and the percentage change in quantities sold is captured by a measure economists call the "price elasticity of demand" (ε_i) or simply the "elasticity."[5] The product of the price elasticity of demand and the percentage change in prices yields the percentage change in final demand (FD) for each industry in each year.[6] Table A-2 contains the (national) price elasticities employed in the model.

Thus, an initial measure of the change in final demand for each industry can be estimated by[7]

$$\varepsilon_i \Delta \ln \pi_{it} = \Delta \ln FD_{it}^n \qquad \text{for } n = \text{C and I only.} \qquad \text{(A.5)}$$

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[5]The price elasticity of demand is simply the percentage change in the quantity demanded divided by the percentage change in the price. Thus, the percentage change in price times the elasticity yields the percentage change in quantity demanded.

[6]Although final demand is measured in dollars rather than quantities, because the price elasticities are in general quite low (see Table A-2), we implicitly assume that the change in quantity demanded is fully reflected in the change in final demand. Although this assumption imparts a slight upward bias on the effect, to do otherwise would violate the income constraint on consumer expenditures.

[7]It is a general proposition of economic theory that competition yields efficiency gains not associated with other market structures (see, for example, Varian [1984]). One measure of these efficiency gains is the so-called "welfare triangle," which is estimated by the product of one-half the change in price times the change in quantity demanded resulting from restructuring. Using the prices from Tables B-1 and B-2 and an elasticity of demand for electricity of -0.25, it can be shown that the maximum size of this triangle would be in the neighborhood of 0.125 percent of the value of electricity sold in the state.

Table A-2. Price Elasticity of Demand for Various Sectors: North Carolina

Business/Industry	Standard Industrial Classification (SIC) Code	Elasticity of Demand
Agriculture and Forestry	01-09	-0.02
Mining	10-14	-0.09
Construction	15-17	-0.07
Manufacturing		
Food Products	20	-0.02
Tobacco Products	21	-0.46
Knitting Mills	225	-0.31
Yarn and Thread	228	-0.31
Other Textiles	220	-0.31
Apparel Products	23	-0.31
Lumber and Wood	24	-0.07
Furniture and Fixtures	25	-0.72
Pulp and Paper	26	-0.31
Printing and Publishing	27	-0.31
Other Chemicals	280	-0.31
Drugs	283	-0.31
Other Nondurables	29,31	-0.31
Rubber and Plastics	30	-0.46
Stone, Clay and Glass	32	-0.46
Primary Metals	33	-0.46
Fabricated Metals	34	-0.46
Nonelectrical Machinery	35	-0.46
Electrical Machinery	36	-0.46
Transportation Equipment	37	-1.94
Instruments	38	-0.46
Miscellaneous Manufacturing	39	-0.46
Services		
Transportation Services	40-47	-0.40
Communications and Utilities	48,49	-0.22
Wholesale and Retail Trade	50-59	-0.22
Finance, Insurance, and Real Estate	60-67	-0.22
Services	70-89	-0.22
Government	90-99	-0.22
Residential Electricity	NA	-0.25

Sources: Philips, L. 1974. *Applied Consumption Analysis*. North Holland.

Houthakker, H.S., and L.D. Taylor. 1970. *Consumer Demand in the United States*. Cambridge: Harvard University Press.

This initial measure must be adjusted for market share considerations to yield an estimate of the elasticity of demand facing North Carolina industries. Assuming final demand equals final supply, and after adjusting for market share considerations, Eq. (A.5) yields what we refer to in the text as the direct supply-side effect.

The elasticities noted above do not immediately enter the model. Market share considerations affect the elasticity of output demand assumed to face North Carolina industries. Consider North Carolina to be a small subeconomy within the much larger U.S. economy. As a simplification, ignore international trade. For the *ith* industry, let Y be North Carolina output, D be U.S. demand, and S be the supply from the rest of the U.S. Then it follows that

$$Y = D - S \tag{A.6}$$

and differentiating (A.6) with respect to price (P) yields

$$dY/dP = (dD/dP) - (dS/dP). \tag{A.7}$$

Multiplying through by (P/Y) yields

$$dYP/dPY = dDP/dPY - dSP/dPY. \tag{A.8}$$

Multiplying the first term on the right-hand side by D/D and the second term on the right-hand side by S/S yields

$$\varepsilon_{NC} = \varepsilon_{US}(D/Y) - \Omega_{US}(S/Y) \tag{A.9}$$

where ε_{NC} is the price elasticity of demand for North Carolina; ε_{US} is the price elasticity of demand for the U.S., and Ω_{US} is the price elasticity of supply for the U.S. Therefore, adjusting for the inverses of North Carolina's shares of total U.S. demand and U.S. supply other than supply from North Carolina results in an adjustment of the national industry demand elasticities, that is ε_{US}, to higher absolute values for North Carolina, that is ε_{NC}. We incorporate this adjustment on a dynamic basis that varies over time. This reflects the fact that there will be reactions by producers in other states. Even if North Carolina is a leader in electricity market restructuring, other states will soon follow, and North Carolina producers will find themselves "sliding down" the national demand curve, rather than operating against the state-specific demand curve adjusted for market share. Of course, in the actual industrial world, there are capacity constraints and transportation and adjustment costs, thus the dynamic, rather than immediate, adjustment.[8]

The calculations to this point yield the direct effects from the change in the costs of producers for whom electricity is an input into the production process; however, there is another effect from restructuring, namely the effect on consumer expenditures from changes in the residential price of electricity. In the text we refer to this as the direct demand-side effect. This effect is estimated from the product of the (cross) price elasticity of demand between residential electricity and all other goods (ϕ^R) from Table A-2 and the percentage deviation in residential prices from the base prices:[9]

$$\phi^R \Delta \ln P_t^R = \Delta \ln FD_t^R. \tag{A.10}$$

To distribute this total effect across our 31 business, industry, and government groups, we must first estimate the share of household expenditures going to each of those groups. This is estimated from IMPLAN data by dividing expenditures on output from the *ith* industry (X_i) by total expenditures (TX):

$$\beta_i = X_i/TX \qquad \text{for } i = 1, 2, ..., 31 \text{ groups.} \tag{A.11}$$

It follows, then, that the change in final demand in the *ith* group in year *t* resulting from the change in residential electricity prices is the product of the expenditure shares and the percentage change in final demand and the share of expenditures of North Carolina households on North Carolina products (ρ_i):

$$\rho_i \beta_i (\Delta \ln FD_t^R) = \Delta \ln FD_{it}^R \qquad \text{for } i = 1, 2, ..., 31 \text{ groups.} \tag{A.12}$$

The coefficient ρ reflects the economic logic that a change in electricity prices in North Carolina that creates income effects for North Carolina households affects the demand for products produced in North Carolina, but it does not create income effects

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[8]None of the demand elasticities reported in Table A-2 exceed two in absolute value. In the dynamic calculations in the model, we set ε_{NC} equal to -2.0 initially—that is, in the year restructuring begins—and linearly adjust it so that $\varepsilon_{NC}=\varepsilon_{US}$ at the end of 5 years. We uniformly set Ω_{US}=1.0 for all groups. This adjustment is adopted from the work of P.R. Johnson (1971). Johnson's work draws on contributions by Zvi Griliches, Arnold Harberger, and Lester Telser, among others.

[9]For the cross-price elasticity of demand between residential electricity and all other manufacturing and commercial goods, we used - 0.02; for services - 0.025.

for residents of Wyoming, Minnesota, etc. This logic is the converse of that used to adjust the direct supply-side effect discussed above.[10]

The sum of the percentage changes in final demand from Eqs. (A.5) and (A.12) yields the total percentage change in final demand resulting from changes in the prices of industrial, residential, and commercial electricity in North Carolina. The product of this sum and the base figure for final supply in each year (Q_{it}) yields the change in output for each industry for each year resulting from the restructuring of electricity prices. We refer to this as the direct effect (DE_{it}):

$$DE_{it} = (\Delta \ln FD_{it}^{I} + \Delta \ln FD_{it}^{C} + \Delta \ln FD_{it}^{R})Q_{it}. \qquad \text{(A.13)}$$

Of course, there are secondary or indirect effects from these changes in final demand and final supply, as the direct effects ripple through the economy. Economists refer to these indirect effects as "multiplier effects." The product of the state multipliers for output (μ_i^Q), employment (μ_i^L),[11] and earnings (μ_i^E) for each industry from the IMPLAN data and the direct effect yields the total (direct plus indirect) effect from a change in electricity prices:

$$\Delta Q_{it} = (\mu_i^Q)DE_{it} \qquad \text{(A.14a)}$$

$$\Delta L_{it} = (\mu_i^L)DE_{it} \qquad \text{(A.14b)}$$

$$\Delta E_{it} = (\mu_i^E)DE_{it}. \qquad \text{(A.14c)}$$

The sum of the industry-level effects yields the total statewide effects for output, employment, and earnings:

$$\Delta Q_t = \Sigma_i^{31} \Delta Q_{it} \qquad \text{(A.15a)}$$

$$\Delta L_t = \Sigma_i^{31} \Delta L_{it} \qquad \text{(A.15b)}$$

---

[10] In the aggregate, North Carolina consumers import roughly 10 to 30 percent of the goods and services they consume (Minnesota IMPLAN Group, Inc., 1998). Of course, this varies from sector to sector, with the services sector generally having lower import shares than the other sectors. In the model, ρ varies from 0.375 to 1.00 in such a way that 25 percent of spending by North Carolina consumers is on imported goods.

[11] The employment multipliers supplied by IMPLAN are for final demand per worker, so $\mu_i^L = \mu_i^{L*} (L_{i0}/Q_{i0})$, where μ_i^{L*} is the employment multiplier per million dollars of final demand.

$$\Delta E_t = \Sigma_i^{31} \Delta E_{it}. \qquad \text{(A.15c)}$$

These statewide effects can then be distributed across the state's seven economic development regions using the share of each measure of economic activity originating in that region (δ^{nr}).[12]

$$\Delta Q_{it}^r = \delta^{Qr} \Delta Q_{it} \qquad \text{(A.16a)}$$

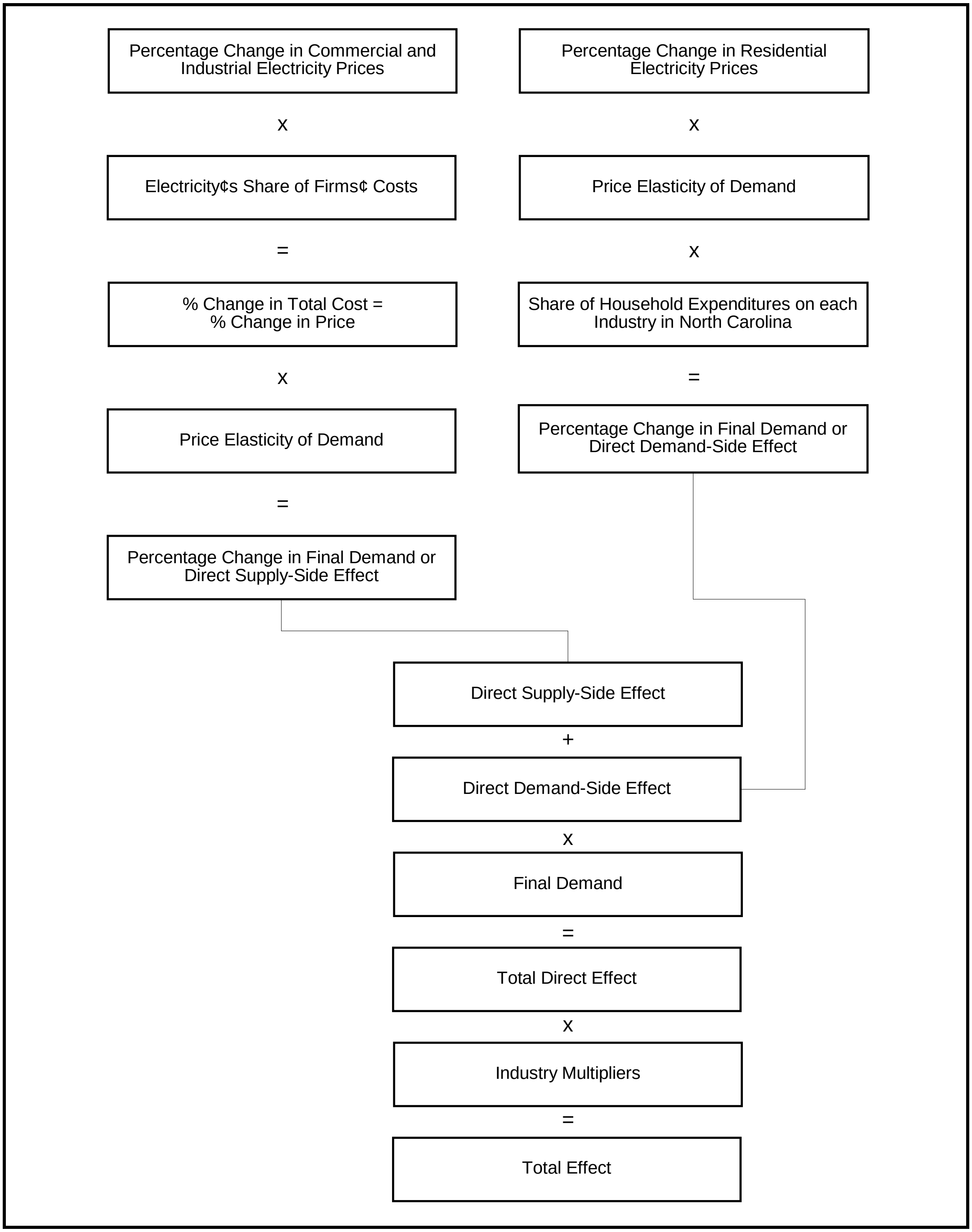
$$\Delta L_{it}^r = \delta^{Lr} \Delta L_{it} \qquad \text{(A.16b)}$$

$$\Delta E_{it}^r = \delta^{Er} \Delta E_{it}. \qquad \text{(A.16c)}$$

An overview of the model is shown in the flow chart presented in Figure A-1.

[12]These figures are derived from the IMPLAN model as shown in Table 6-1 in the text.

Figure A-1. A Flow Chart of the Conceptual Framework of Demand Side and Supply Side Effects



Appendix B: Year-by-Year Price Detail by Customer Class

Appendix Tables B-1 and B-2 contain the 2002 through 2015 year-by-year price detail by customer class for the base case and reference case, respectively.

Table B-1. Base Prices with No Institutional Change

	In 1995 ¢/kWh													
Electricity Prices	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Sector														
Commercial	5.810	5.828	5.810	5.815	5.807	5.793	5.805	5.783	5.780	5.773	5.776	5.781	5.773	5.774
Residential	7.319	7.342	7.320	7.326	7.315	7.298	7.314	7.285	7.281	7.273	7.276	7.283	7.273	7.274
Industrial	4.355	4.369	4.355	4.359	4.353	4.342	4.352	4.335	4.333	4.327	4.330	4.334	4.328	4.328

Note: These prices are based on the assumption of continued franchised service territories with rate base/rate of return regulation.

Table B-2. Reference Case Prices

	In 1995 ¢/kWh													
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Reference Case: Restructuring Starts 2004														
Sector														
Commercial	5.810	5.828	**5.919**	**5.969**	**5.975**	**5.997**	**6.036**	5.371	5.429	5.501	5.549	5.627	5.674	5.723
Residential	7.319	7.342	**7.806**	**7.872**	**7.879**	**7.909**	**7.961**	7.083	7.160	7.254	7.318	7.421	7.484	7.547
Industrial	4.355	4.369	**4.331**	**4.367**	**4.371**	**4.388**	**4.416**	3.929	3.972	4.025	4.060	4.117	4.152	4.187

Note: Years for which stranded cost recovery charges are in effect are shown in bold type.

Appendix C: North Carolina Economic Development Regions

The seven economic development regions and their constituent counties are shown in Table C-1 and Figure C-1. The seven economic development regions are

- ➤ Advantage West,
- ➤ Carolinas Partnership,
- ➤ Global Transpark,
- ➤ Northeast North Carolina,
- ➤ Piedmont Triad,
- ➤ Research Triangle, and
- ➤ Southeast North Carolina.

Table C-1. County Makeup of the Seven Economic Development Regions

Advantage West	Carolinas Partnership	Piedmont Triad Partnership	Research Triangle Partnership	Southeast	Global Transpark	Northeast
Cherokee	Cleveland	Surry	Person	Richmond	Nash	Halifax
Clay	Gaston	Yadkin	Orange	Scotland	Edgecombe	Northampton
Graham	Lincoln	Davie	Chatham	Hoke	Wilson	Hartford
Swain	Catawba	Davidson	Moore	Cumberland	Pitt	Bertie
Macon	Alexander	Montgomery	Lee	Roberson	Greene	Martin
Jackson	Iredell	Randolph	Harnett	Sampson	Wayne	Beaufort
Transylvania	Mecklenberg	Forsyth	Johnston	Bladen	Duplin	Gates
Haywood	Union	Stokes	Wake	Columbus	Lenoir	Chowan
Madison	Anson	Rockingham	Durham	Pender	Craven	Washington
Buncombe	Stanly	Guilford	Granville	New Hanover	Pamlico	Hyde
Henderson	Cabarrus	Alamance	Vance	Brunswick	Carteret	Dare
Polk	Rowan	Caswell	Warren		Jones	Tyrell
Rutherford			Franklin		Onslow	Perquimans
McDowell						Pasquotank
Yancey						Camden
Mitchell						Currituck
Avery						
Burke						
Caldwell						
Watauga						
Ashe						
Wilkes						
Alleghany						

Figure C-1. Economic Development Regions and Constituent Counties