



Measuring and Explaining Electricity Price Changes in Restructured States

Mark L. Fagan

2006

RPP-2006-02

Regulatory Policy Program

Mossavar-Rahmani Center for Business and Government
John F. Kennedy School of Government
79 John F. Kennedy Street, Weil Hall
Cambridge, MA 02138

Citation

This paper may be cited as: Fagan, Mark L. 2006. "Measuring and Explaining Electricity Price Changes in Restructured States." Regulatory Policy Program Working Paper RPP-2006-02. Cambridge, MA: Mossavar-Rahmani Center for Business and Government, John F. Kennedy School of Government, Harvard University. Comments may be directed to the author.

Regulatory Policy Program

The Regulatory Policy Program at the Mossavar-Rahmani Center for Business and Government provides an environment in which to develop and test leading ideas on regulation and regulatory institutions. RPP's research aims to improve the global society and economy by understanding the impacts of regulation and creating better decisions about the design and implementation of regulatory strategies around the world. RPP's efforts are organized around the following three core areas: regulation, markets, and deregulation; regulatory instruments; and regulatory institutions and policymaking.

The views expressed in this paper are those of the author and do not imply endorsement by the Regulatory Policy Program, the Mossaver-Rahmani Center for Business and Government, the John F. Kennedy School of Government, or Harvard University.

For Further Information

Further information on the Regulatory Policy Program can be obtained from the Program's director, Jennifer Nash, Mossavar-Rahmani Center for Business and Government, John F. Kennedy School of Government, 79 JFK Street, Cambridge, MA 02138, telephone (617) 384-7325, telefax (617) 496-0063, email jennifer_nash@harvard.edu.

The homepage for the Regulatory Policy Program can be found at: <http://www.ksg.harvard.edu/cbg/rpp/home.htm>

Measuring and Explaining Electricity Price Changes in Restructured States

Mark L. Fagan

*Senior Fellow, Mossavar-Rahmani Center for Business and Government
Harvard University*

June 2, 2006

Abstract

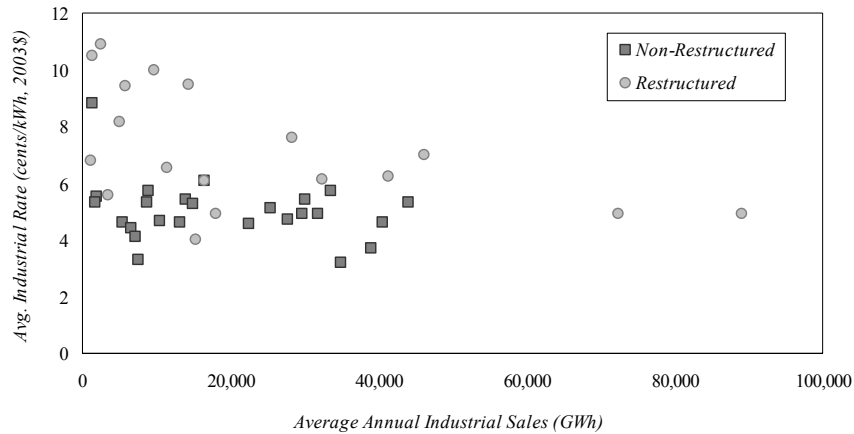
An effort to determine the effect of restructuring on prices finds that, on average, prices for industrial customers in restructured states were lower, relative to predicted prices, than prices for industrial customers in non-restructured states. This preliminary analysis also finds that these price changes are explained primarily by high pre-restructuring prices, not whether or not a state restructured.

Introduction

A decade ago, Rhode Island, Massachusetts and California began the process of restructuring their electricity industries to introduce competition into the generation portion of the retail electricity supply chain. Since then, a total of 23 states and the District of Columbia actively pursued more competitive electricity industries through restructuring. A variety of factors spurred states to restructure, ranging from the success of deregulation in other network industries to concerns about utility investment decisions – especially in the wake of nuclear power plant cost overruns.¹ While the factors were wide-ranging, a key impetus for change was the desire of industrial customers in high-priced states to reduce their electric bills.² The promise of lower prices provided the political justification as well. Figure 1 below shows that the states with higher prices were generally those that restructured, independent of their size. More rigorous analyses by Andrews³ and Teske⁴ confirm this finding.

Figure 1

***Distribution of Industrial Electricity Prices and Sales,
Restructured and Non-Restructured States, 1993-1995***



Source: EIA, Fagan Analysis

The California energy crisis, the collapse of Enron, the August 2003 blackout, and the high cost of natural gas led some to question the wisdom of these restructuring efforts.⁵ Six states that had decided to restructure subsequently delayed or repealed their restructuring efforts. Notwithstanding these challenges, 18 restructured jurisdictions pushed forward toward a competitive marketplace.

How have prices in the restructured states changed? Has the retail price reduction objective been achieved? Several studies have examined wholesale price changes in recent years, but their results do not provide a consistent answer to the price change question.⁶ In an article titled “Competition Has Not Lowered U.S. Industrial Electricity Prices”⁷, Apt examines the rate of change of industrial electricity prices in restructured and non-restructured states in the pre- and post-restructuring periods. Apt finds that restructured states as a group have a 1.4% average annual price increase, compared with a 1.0% increase for non-restructured states.

A recent Cambridge Energy Research Associates (CERA) study compares real electricity prices with counterfactual prices – prices that would have been expected had restructuring not occurred.⁸ It finds that actual prices were lower (in real terms) than counterfactual prices and in all regions except the West. In total, CERA estimates that power deregulation has saved US consumers \$34 billion.

In light of these conflicting findings, this study’s first objective is to determine if industrial prices in two groups of states (restructured and non-restructured) were higher or lower than prices predicted by a counterfactual model.⁹ The second objective is to explain the observed relationships between actual prices and predicted prices by looking at state-level characteristics, including initial price levels, restructuring status and participation in a well-functioning regional transmission organization (RTO).

Research Methodology

This study used distinct methodologies for its two objectives: a counterfactual model to measure the difference between actual and predicted prices, and a two-stage least squares model to explain causality.

Objective 1: Counterfactual Assessment of Price Changes

The counterfactual portion of the study compares average retail industrial electricity prices from 2001-2003 with predicted prices for the same period. Predicted prices are determined by the following equation for year t and state i :

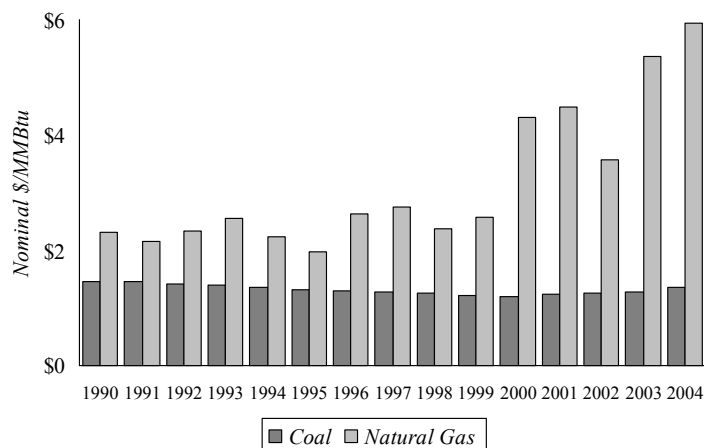
$$P_{it}^E = \alpha_i + \beta_i t + \theta_i P_{it}^G + \varepsilon_{it}$$

Where P^E is the real (2003\$) price of electricity paid by industrial customers, t is the year from 1990-1997, and P^G is the real (2003\$) average city gate price of natural gas in the state's region.¹⁰ The regression constant (α) and coefficients (β and θ) are determined for each state i using real (2003\$) industrial electricity prices and real (2003\$) average city gate price of natural gas for all years (1990-1997).

Gas is explicitly incorporated into the predictive regression because gas prices were highly volatile during the study period, while other fuels used in electricity generation (such as coal) remained relatively flat. (Figure 2) The gas variable explicitly accounts for the impact of fuel price changes on electricity prices. Since gas prices vary by region, this study uses regional gas prices, which are regional averages of state-level city gate prices.

Figure 2

Delivered Coal and Natural Gas Prices, 1990-2004



Source: EIA

For each year t (2001-2003) and state i , given the state-specific values of α , β , and θ described above, the predicted real (2003\$) industrial price of electricity is as a function of the regional gas

price. These state-level predicted prices are used to create consumption-weighted average prices for restructured and non-restructured states.¹¹ The group average predicted prices are compared to group average actual prices, and the absolute and percentage difference is reported.

The consumption-weighted group averages are calculated as follows: for actual prices, the average restructured (non-restructured) industrial price is the total industrial revenue divided by total industrial sales for all restructured (non-restructured) states; for predicted prices, the average restructured (non-restructured) industrial price is the total predicted industrial revenue divided by the total industrial sales for all restructured (non-restructured) states. A state's predicted industrial revenue in year t is the state's predicted industrial price (from the counterfactual regression, above) in year t multiplied by its actual industrial sales in year t . For both actual and predicted average prices, revenues and sales for three years (2001-2003) are used to limit the impact of anomalous years.

The source of the electricity price data is the U.S. Department of Energy's Energy Information Administration (EIA) Form 861. EIA data have been used in prior electricity price examinations.¹² The EIA's nominal prices are converted to real (2003) prices using the U.S. GDP (chained) price index. The post-restructuring period (2001-2003) includes three years of data to minimize the effect of outliers.

In one version of the analysis, 2001-2003 prices in restructured states are adjusted to remove revenues paid as stranded asset recovery fees (also called competitive transition charges, or CTCs), before being compared with predicted prices. Since this research seeks to understand the long-term impact of restructuring on electricity prices, removing CTCs is appropriate. CTCs are short-term additions to electricity prices that typically recover stranded investments made under regulation in 5-7 years, rather than the 20+ years under regulation. For each state with CTC data (available from the Edison Electric Institute's *Typical Bills and Average Rates Report* and supplemented with public utility commission data), the CTC's share of the total electricity price is removed from the post-restructuring average price. In another version of the analysis, prices are not adjusted for CTCs; findings from both are reported.

Objective 2: Causality of Observed Price Changes

The second part of this study seeks significant determinants of the difference between predicted prices and actual prices at the state level. Five potential explanatory variables are examined: the state's restructuring status; the state's participation in a well-functioning RTO¹³; the state's initial pre-restructuring (i.e. 1993-1995) electricity price; the state's difference between the actual 1993-1995 electricity price and the counterfactual 1993-1995 price; and the change in 2001-2003 predicted price from 1993-1995 predicted price (based on the counterfactual model). Inclusion of the change in predicted price as an independent variable accounts for the state-specific impact of gas prices and various regulatory forces on electricity prices.

The primary explanations of the price changes could be:

1. *Restructuring impacted the difference between actual and predicted prices;*
2. *Prices regressed toward the mean for all states, independent of whether the state restructured.*

3. *Effective wholesale market design and the associated well-functioning regional transmission organizations (RTOs) impacted the difference between actual and predicted prices.*

Two regression models are specified to test the potential explanations. The first model measures the impact of restructuring on the difference between a state's predicted (counterfactual) price and its actual price. The second model measures the impact of several factors (restructuring, counterfactual price change, RTO participation, pre-restructuring price, and pre-restructuring actual vs. counterfactual differential) on the observed change in prices between 1993-1995 and 2001-2003. The formulations are provided below:

Model 1:

$$Diff_{i,2001-2003} = \beta_0 + \beta_1 Rest_i + \varepsilon_i$$

Where $Diff_i$ is the differential between state i 's 2001-2003 real industrial electricity price and its 2001-2003 counterfactual-predicted price (actual price – predicted price), and $Rest_i$ is the restructuring status in state i .

Model 2:

$$\Delta P_{i,01/03-93/95} = \beta_0 + \beta_1 Rest_i + \beta_2 \Delta Predicted_{i,01/03-93/95} + \beta_3 RTO_i + \beta_4 Initial_Diff_{i,1993-1995} + \beta_5 P_{1993-1995} + \varepsilon_i$$

Where ΔP_i^E is the actual change in average real industrial electricity prices in state i between 1993-1995 and 2001-2003; $Rest_i$ is the restructuring status in state i ; $\Delta Predicted_i$ is the change in the counterfactual model prediction for state i between 1993-1995 and 2001-2003; RTO_i is a dummy variable indicating whether state i participated in a well-functioning RTO; $Initial_Diff_i$ is the difference between the actual 1993-1995 real industrial electricity price in state i and the 1993-1995 price predicted by the counterfactual model; and $P_{1993-1995}$ is the pre-restructuring (1993-1995) electricity price.

In both models, $Rest_i$ is instrumented with an additional variable (as indicated in the results tables) to limit the effects of endogeneity between electricity prices and restructuring.

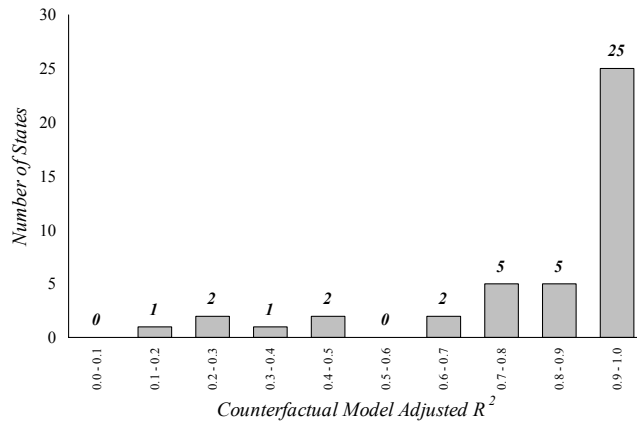
Findings

Counterfactual Regressions

The state by state counterfactual regressions, where each state's electricity price is a function of time and gas price, appear to have strong statistical results. As illustrated in Figure 3 below, most of the state regressions have an adjusted R² greater than 0.9.

Figure 3

Adjusted R² Values for State Counterfactual Models



Source: Fagan Analysis

It should be noted that the vast majority of explanatory power lies with the time variable. The gas variable is rarely statistically significant in the state models.

The counterfactual prices estimated from the regressions are sometimes higher and sometimes lower than the actual prices in both the restructured and non-restructured states, as shown in Figure 4.

Figure 4

Distribution of Industrial Electricity Differentials and Sales, Restructured and Non-Restructured States, 2001-2003

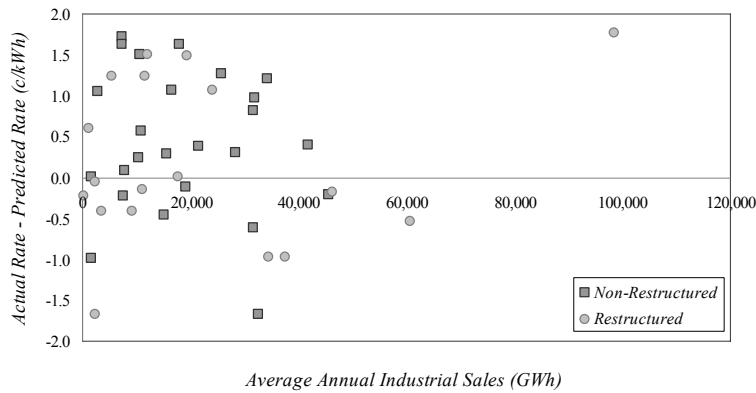
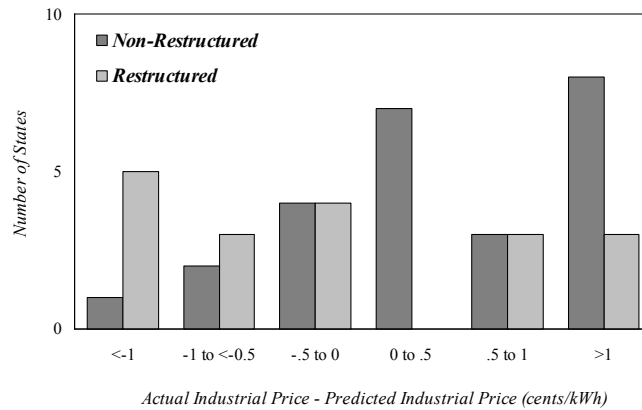


Figure 5

Frequency of Price Differentials by Magnitude
[2001-2003 CTC-Adjusted Actual] - [2001-2003 Counterfactual Predicted]



Source: Fagan Analysis

A difference of means test shows that there is a statistically significant difference between differentials in restructured and non-restructured states. (The t statistic is 2.07, compared to a two-tailed critical t value of 2.05.)

Aggregate Price Changes

The individual state price changes were aggregated into group averages, following the consumption-weighting methodology described above. The results show that actual prices were 1.3% higher than the counterfactual predicted prices in the restructured states and 9.2% higher in non-restructured states, adjusting for the impact of gas price volatility and the effect of accelerated stranded cost payments. (Figure 6)

Figure 6

CTC-Adjusted Industrial Rates vs.
Predicted Industrial Rates
(2003 Cents per kWh)

	2001-2003 Predicted	2001-2003 Actual (CTC-Adjusted)	Difference (Actual - Predicted)	Percent Difference
Restructured States	4.95	5.02	0.07	1.3%
Non-Restructured States	3.92	4.28	0.36	9.2%

Even if revenues paid as competitive transition charges are not removed from actual prices, restructured states still appear to have performed more favorably than non-restructured states relative to their predicted prices. (Figure 7)

Figure 7

***Unadjusted Industrial Rates vs.
Predicted Industrial Rates***
(2003 Cents per kWh)

	2001-2003 Predicted	2001-2003 Actual (Unadjusted)	Difference (Actual – Predicted)	Percent Difference
Restructured States	4.95	5.32	0.37	7.5%
Non-Restructured States	3.92	4.28	0.36	9.2%

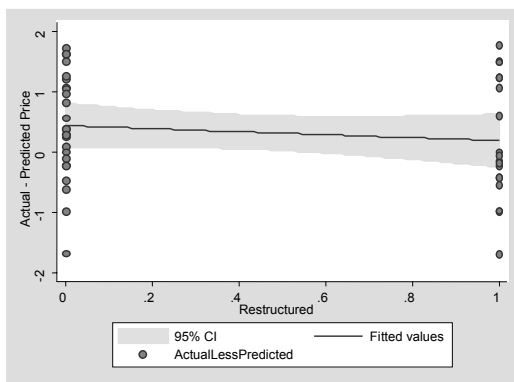
Explaining the Price Changes

What accounts for the difference in price changes between restructured and non-restructured states? Restructuring status, pre-restructuring price, 1993-1995 differential (actual price minus predicted price) price, changed in predicted price, and participation in a strong RTO are tested as explanatory variables. The simple correlations below show that restructuring has a weak relationship with the differential between actual and counterfactual price. In contrast, there is a stronger correlation between initial price and the price differential. High initial prices are negatively correlated with the difference between the actual price and the price predicted by the counterfactual.

Figure 8

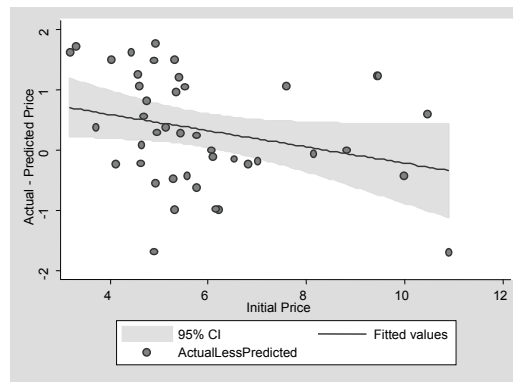
Correlations

***Differential (Actual Predicted)
and Restructuring Status***



Correlation = .13

***Differential (Actual Predicted)
and Initial Price***



Correlation = .28

The results of the two-stage least squares regressions indicate that, of the explanatory variables, only initial (pre-restructuring) price and the change in predicted price between 1993-1995 and 2001-2003 are significant. In Model 1, restructuring is not a significant driver of the differential between actual and predicted prices. (Figure 9) In Model 2, neither the RTO variable nor the restructuring variable is a statistically significant driver of real price change, and restructuring status lacks the anticipated sign. (Figure 10)

Figure 9

Model 1 Two-Stage Least Squares Results

Independent Variable	Coefficient	Std. Error	t Statistic	P> t 	Adjusted R²	F-Statistic
<i>Restructuring Yes = 1; No = 0</i>	-0.46	0.46	-1.01	0.32	-0.02	1.01
<i>Constant</i>	0.52	0.24	2.19	0.03		

Dependent variable: (Actual 2001-2003 Price)-(Predicted 2001-2003 Price)

Restructuring is instrumented with a dummy variable indicating participation in a well-functioning RTO.

Figure 10

Model 2 Two-Stage Least Squares Results

Independent Variable	Coefficient	Std. Error	t Statistic	P> t 	Adjusted R²	F-Statistic
<i>Restructuring Yes = 1; No = 0</i>	0.14	0.69	0.20	0.84	0.58	12.49
<i>93/95 Actual Price</i>	-0.19	0.07	-2.78	0.01		
<i>93/95 Actual Price – Predicted 93/95 Price</i>	-0.06	0.09	-0.67	0.51		
<i>RTO Participation Yes = 1; No = 0</i>	-0.11	0.46	-0.25	0.81		
<i>Change in Predicted Price (01/03 – 93/95)</i>	0.53	0.11	4.93	0.00		
<i>Constant</i>	1.04	0.35	3.01	0.01		

Dependent variable: (Actual 2001-2003 Price)-(Actual 1993-1995 Price)

Restructuring is instrumented with a George W. Bush's share of 2004 major party presidential votes.

These results suggest that restructuring cannot be attributed as a driving factor in the observed price changes.

Conclusion and Further Research

This research indicates that, on a consumption weighted basis, average prices adjusted for CTC in restructured states were only marginally above predicted levels (1.3%), while prices in non-restructured states were significantly above predicted levels (9.2%). These aggregate trends are not uniform for all states, however – there is significant state-by-state variation. The actual prices in two-thirds of restructured states were lower than predicted, and one-quarter of non-restructured states had prices that were lower than predicted.

The models above suggest that neither regulatory reform at the retail level (restructuring status) nor at the wholesale level (RTO participation) is a significant driver of the restructured states' superior price performance. Only the 1993-1995 electricity price and the change in counterfactual-predicted prices between 1993-1995 and 2001-2003 are significant.¹⁴

The significance of pre-restructuring price as a determinant of price change may be evidence for a national pressure between 1993 and 2003 to reduce prices in all high-priced states, regardless of their restructuring status. In restructured states, the pressure may have come from price competition; in non-restructured states, it may have come from the desire of integrated utilities to appease consumers and regulators with lower prices, to keep them from choosing to restructure.¹⁵

The findings should be viewed as preliminary because the impact of restructuring on prices was still evolving in the post restructuring period (2001-2003) examined in the study. Most states were (and still are) in the transition period where rates are set by a mix of competitive and regulatory forces. Because industrial customers are further down the path to a competitive market, this paper focuses on the industrial segment. However, it should be noted that the market is still developing even in the industrial segment. Consequently, the study should be replicated in the future once the transition period is over and the conversion to a competitive market for retail power is complete. Furthermore, a more exhaustive specification of the counterfactual regression could yield greater insights.

Endnotes

¹ Hogan, W. (2001) *Electricity Market Restructuring: Reforms of Reforms*. 20th Annual Conference, Center for Research in Regulated Industries, Rutgers University.; Joskow, P. (2000) Deregulation and Regulatory Reform in the U.S. Electric Power Sector. In Peltzman & Winston eds., *Deregulation in Network Industries: What's Next?* Washington, D.C.: Brookings Institution Press.; Borenstein, S. & J. Bushnell. (2000) "Electricity Restructuring: Deregulation or Reregulation?" *Regulation* 23(2). 46-52.

² Joskow, 2000

³ Andrews, C. (1999) Innovation and Imitation in U.S. Electricity Sector Regulation. Mimeo. Rutgers University.

⁴ Teske, P. (2004) *Regulation in the States*. Washington, D.C.: Brookings Institution Press.

⁵ VanDoren, P. & J. Taylor. (2004) *Rethinking Electricity Restructuring*. Cato Institute: Cato Policy Analysis No. 530.

⁶ Bushnell, J., E. Mansur, & C. Saravia. (2003) *Market Structure and Competition: A Cross-Market Analysis of U.S. Electricity Deregulation*. Working Paper 126. University of California Energy Institute: Center for the Study of Energy Markets.; Synapse Energy Economics (2004), *Electricity Prices in PJM: A Comparison of Wholesale Power Costs in the PJM Market to Indexed Generation Service Costs*.; Sutherland, R., (2003) *Estimating the Benefits of Restructuring Electricity Markets: An Application to the PJM Region*. Center for the Advancement of Energy Markets.

⁷ J. Apt, "Competition has not Lowered U.S. Industrial Electricity Prices." *The Electricity Journal* 18(2). 52-61, 2005.

⁸ Cambridge Energy Research Associates *Beyond the Crossroads: The Future Direction of Power Industry Restructuring*. Washington, D.C.: Cambridge Energy Research Associates, 2005.

⁹ Standard offer prices in most restructured states continue to be set by a mix of competitive and regulated forces. Industrial prices tend to more closely reflect the competitive marketplace than residential prices, both because of different regulatory approaches and because of higher rates of industrial switching.

¹⁰ Gas price regions roughly correspond to NERC reliability regions.

¹¹ Six states that delayed or repealed restructuring (AR, CA, MT, OK, NM, and NV) are excluded from the analysis, as well as AK and HI. States that delayed or repealed are excluded because this study looks for the long-term impacts of regulatory policy on electricity prices. While the list of states that delayed restructuring is somewhat subjective, this study uses the definition from the U.S. Department of Energy's Federal Energy Management Program, at http://www.eere.energy.gov/femp/program/utility/utilityman_staterestruc.cfm.

¹² Lave, L., J. Apt, & J. Blumsack. (2004) "Rethinking Electricity Deregulation." *Electricity Journal* 17(7). 11-26.; Andrews, 1999; Apt, 2005

¹³ "Well functioning" is defined as having an LMP-based energy market in place during the post-restructuring period (2001-2003). Thus, members of ISO New England and New York ISO, as well as states in northeastern PJM have a value of 1 and the other states are coded 0. Southern and western PJM, including parts of Illinois, Ohio, Virginia, and West Virginia, did not participate in PJM markets until after 2003. (Northeastern PJM includes Delaware, Maryland, New Jersey, Pennsylvania, and the District of Columbia.)

¹⁴ The fact that a state's 1993-1995 average price is significant, while the 1993-1995 differential between actual and predicted prices is not, suggests that price change between 1993 and 2003 may result from something other than "regression to the mean". The "mean" in this case is a state-specific expected electricity price, rather than a single national price. If prices were regressing to the mean between the 1993-1995 period and the 2001-2003 period, we would expect the difference between 1993-1995 actual price and 1993-1995 counterfactual price (i.e. the state's deviation from the predicted price) to be significant, rather than the absolute magnitude of the 1993-1995 price.

¹⁵ Further research, examining the relative rates of change among high-priced and low-priced non-restructured states, is needed to test this hypothesis.