Do Markets Make Good Commissioners?
A Quasi-Experimental Analysis of Retail Electric Restructuring in Ohio

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Abstract:
Empirical support for the purported benefits of retail electric deregulation is mixed at best. Prior studies that refer to states as simply “retail deregulated” overlook the fact that efforts in many states to introduce retail competition have been muddied by various degrees of regulatory intervention. Those studies are often based upon Energy Information Administration (EIA) 826 data that does not account for large costs that end-customers incur—which amount to more than 50 percent of the total bill in states like Ohio. Using robust time series household final bill survey data from the Public Utilities Commission of Ohio (PUCO), this paper provides a quasi-experimental analysis of the price impacts of retail electric restructuring in Ohio. The results suggest that residential electricity prices have increased following retail restructuring in all service territories in Ohio, with the exception of the Cincinnati area. We also provide welfare impact estimates for each utility service territory—which indicate a statewide net loss of approximately a billion dollars to residential standard service offer (SSO) customers since retail restructuring.

Keywords: Deregulation; Public Utilities; Electricity Markets; Quasi-Experiments

JEL Classifications: L43; L94

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1. Introduction

The promise of electric deregulation has long eluded the dinner table conversation in the American household. While scholars argued that liberalizing electricity markets could reform some of the long-understood distortions of regulation (Joskow & Schmalensee, 1983; Peltzman, 1989; Phillips, 1993; Stigler & Friedland, 1962), they pushed for reforms predominantly in the wholesale markets. Moreover, they maintained that in deregulated markets the regulator should still oversee fair and efficient retail rates and that deregulation should not eliminate regulatory price-setting at the retail level (Joskow & Schmalensee, 1983). The “textbook” model of electric restructuring called for retail deregulation only after extensive and careful market development (Hunt, 2002; Joskow, 2005A; Joskow, 2008). While most states today that deregulated have done so in wholesale markets, an increasing number are fully, or at least partially, liberalizing retail electricity service as well, often contrary to the guidance of early scholars (Hilke, 2008).

While it is tempting to simplify the issue by identifying states as either “regulated” or “deregulated,” we caution against this oversimplification. Ultimately electric deregulation exists on a continuum that varies by the degree of commission involvement in rate setting. Many states that introduced competition into their electricity markets still maintain some level of commission oversight, and thus prudence review, over the behaviors of regional monopoly providers and distribution services. An increasing number of states such as Ohio are moving further on that continuum away from traditional regulatory oversight and towards competitive standards.

The promise of deregulation is increased efficiency and decreased retail rates to households and businesses through the introduction of competition (Winston, 1993; many others). In practice, retail deregulation, or “retail choice” as it is often called, means that residential customers can either “shop” from among competing marketers to supply their electricity on a contractual basis, or remain with the regional monopoly supplier and be charged a rate that is set by some competitive process, such as a

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1 The following states have adopted various forms of liberalized electric choice markets: TX, IL, OH, PA, MD, NY, CT, RI, DE, ME, NH, and MA. Partial or capped electric choice exists in CA, MI, MT, VA, AZ, OR, MT, and NV (DNV-GL, 2015).

2 This is often referred to as “switching” from the retail monopoly provider.
supply auction, detailed below. Full retail deregulation effectively divorces commission oversight from setting electric rates. Despite much advocacy both for and against retail choice, there is a lack of definitive empirical evidence regarding how electricity restructuring has ultimately impacted the welfare of businesses and households (Eto, et al., 2006; Joskow, 2008; Kwoka, 2008). Moreover, prior evaluations of electric restructuring’s impacts focused on generation efficiencies (Bushnell & Wolfram, 2005; Craig & Savage, 2013; Cicala, 2014; Markiewicz et al., 2004) and wholesale prices (Chapman et al, 2004; Davis & Wolfram, 2012; Dias & Ramos, 2014; Green & Newberry, 1992; Hortacsu & Puller, 2008; Mansur, 2008; Puller, 2007), setting aside the important link between wholesale prices and the retail rates that are ultimately paid by households and businesses.

Existing empirical research into the effect of retail restructuring on consumer welfare is incomplete, often contradictory, and increasingly dated. Apt (2005), using a diff-in-diff approach and looking at the rate of change in industrial prices, found that restructuring did not lead to lower prices. Fagan (2006), in contrast, found that industrial prices in restructured states outperformed predicted prices projected using a counterfactual model. Su (2015) similarly found that retail competition led to mixed-to-lower prices, with benefits mainly seen by residential customers. Taber, Chapman, and Mount (2006) tested a variety of model specifications and deregulation definitions and observed that consumers in deregulated states faced higher relative prices. Their research, however, importantly omitted to account for retail choice. Joskow’s (2006) econometric study of electric restructuring identified between a 5 and 10% decrease in retail prices (in real terms) due to wholesale and retail competition. This work, however, is also limited by problems stemming from the extent of restructuring and measurements of consumer prices. Similar methodological issues plague many electricity restructuring studies (Kwoka, 2008).

Additional recent studies of restructuring have focused on the relationship between deregulation, retail markets, and consumer behavior. Nakajima and Hamori (2010) found that retail consumers in deregulated markets are not more price sensitive. Assessments looking at a variety of retail choice markets identified residential customer inertia (Brennan, 2007; Gamble, Juiliusson, and Gärling, 2009; Giulietti, Waddams Price, and Waterson, 2005; Hortacsu, Madanizadeh, and Puller, 2015; Yang, 2014).
Lack of switching behavior allows incumbent utilities and retailers to extract consumer surplus. While useful to understanding potential welfare changes, these studies do not evaluate the effect of retail restructuring as a policy intervention as we do.

The State of Ohio offers a robust opportunity for evaluating the effects of retail restructuring and provides insights that will inform other states. Though complex in its history like most states, Ohio is technically deregulated in both the wholesale and retail markets; however, important regulatory interventions remain that have affected prices in key ways. The state maintains accurate residential bill information, described below, that provides for a far more detailed and thorough assessment than is possible in other states or using Energy Information Administration (EIA) data. Additionally, the transition towards market-based retail rates and more limited commission rate setting was sudden, allowing for a robust quasi-experimental evaluation with a clean cut/interruption point to provide for a pre- and post- assessment.

We begin by providing a short and concise case history of electric restructuring in Ohio to provide both context for our empirical work and to elucidate the specific market design elements that place the state within the deregulation continuum. We then describe our utility rate survey data and describe general trends in the costs customers have faced. From this, we provide the results of quasi-experimental analyses for the seven largest indicative metro areas, or service territories in Ohio, representing the majority of the state and excluding only rural coops, municipal power, and municipal aggregators.\textsuperscript{3} We provide robust estimates of the impacts of retail market restructuring on residential electricity bills. We also provide welfare impact estimates for these territories, and we conclude with insights for the current re-regulation debate, and the design of electricity markets and public policy more broadly.

\textsuperscript{3} Ohio allows municipal governments to enter into retail energy contracts on behalf of unswitched residents after ballot approval via “aggregation.” See Littlechild (2008) for a more thorough discussion of this innovative policy in Ohio.
2. The Case of Restructuring in Ohio

Prior to restructuring, Ohio’s predominant electric utility model relied on vertically-integrated monopolies. These monopolies oversaw all four major stages of electricity provision: generation, transmission, distribution, and retail services. These utilities were overseen by the Public Utilities Commission of Ohio (PUCO) and subject to price and cost regulation, consisting of the cost of operation plus a return on “used and useful” capital investment (Shapiro & Tomain, 2003). Four investor-owned utilities (IOUs) in particular—FirstEnergy, American Electric Power (AEP), Duke Energy, and Dayton Power & Light (DP&L)—provided nearly 90% of electric market services in 1999. The remaining power came from rural cooperatives or other related public service provision. Under regulation the combined Ohio consumer bill emerged from traditional rate-base proceedings and declining block pricing. Utilities, driven to secure higher revenue, sought higher rates of return for generation. The PUCO attempted to balance this pressure against consumer interests through regulatory proceedings.

Ohio, like many peer states, faced a political climate favorable to electric restructuring in the 1990s. At this time, low natural gas prices contributed to low marginal costs in the recently liberalized wholesale markets. The Federal Energy Regulatory Commission (FERC) put forth rules for accessing a nondiscriminatory wholesale power market with FERC Order 888 in 1996, essentially opening up wholesale markets. This order installed independent system operators (ISOs), run by impartial dispatchers, to oversee the flow of generated electricity across transmission networks (Hogan, 1998; Hunt, 2002; Joskow, 2005B; Pollitt, 2012). FERC later refined the ISO concept with FERC Order 2000 in 1999, tasking newly created regional transmission organizations (RTOs) to manage wholesale market design and administration (Chandley, 2001; Hunt, 2002; Joskow, 2005B).

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4 Inclusive of Toledo Edison, Ohio Edison, and Cleveland Electric Illuminating Co.
7 There is also much discussion about incentives to inflate the rate-base, particularly through excessive and expensive capital improvements (i.e. gold-plating), as first hypothesized by Averch and Johnson (1962) (aka the A-J effect).
Second, Ohio utilities charged customers high average costs under the traditional monopoly system. Though the average utility retail price of 9.09 cents/kWh (2014 dollars)\(^8\) in 1999 was only 22\(^{nd}\) highest out of the fifty U.S. states, Ohio’s electric consumption, led by a large industrial sector, was the fourth highest in the country (EIA, 2001).\(^9\) Given the prospect of accessing cheaper wholesale electricity through restructuring, industrial and commercial users intensely lobbied in support.

Ohio initiated its effort to deregulate electric utilities by passing Senate Bill (SB) 3 in June 1999. A timeline of major events in the history of Ohio electric restructuring starting with SB 3 is included in Figure 1 and specific dates are listed in Appendix Table A1. SB 3 established January 1, 2001 as the starting date of competitive retail electric service and unbundled electric services to allow customers to “shop” for a retailer of choice.\(^10\) SB 3 also established a five-year Market Development Period during which time incumbent utilities could collect market transition revenues either through a rate freeze with

\(^8\) 6.4 cents/kWh in 1999 dollars. This amount can be further divided into average residential (8.68), commercial (7.67), industrial (4.33), and other (5.96) costs, all in terms of cents/kWh in 1999 dollars (EIA, 2001). Conversion to 2014 dollars made using CPI.

\(^9\) Estimated at 165,717,257 MWh (EIA, 2001).

\(^10\) Specifically, SB 3 declared “electricity generation service, aggregation service, power marketing, and power brokering as competitive retail electric services” and conditionally authorized “ancillary service, metering service, and billing and collection service to be declared competitive services” (OLSC, 1999).
specified adjustments or transition charges paid by customers who switched supply (Ohio Legislative Service Commission [OLSC], 1999).

Instead of first developing an adequate retail market, Ohio’s restructuring process started with efforts to subsidize switching. This approach was ill-advised as the subsidy had no basis in actual market price, little progress had been made to reduce market concentration or create firewalls between regulated utilities and deregulated subsidiaries, and few rules of conduct existed for new retailers. These supply-side issues imposed issues related to market power, gaming, and inefficiency that all deterred suppliers from participating in the retail market (Hunt, 2002). The Commission, proceeding under the assumption that frozen rates would be sufficient for IOUs to recover stranded costs, required a five percent rate reduction for residential customers and tied transition revenue to IOU’s ability to obtain a twenty percent customer switch rate during the development period (Littlechild, 2008). Switch rates refer to the proportion of customers who shop for a marketer from whom to buy the energy component of their electricity bill. Those who do not contract with a third party marketer default to the standard service offer (SSO) through the regulated, incumbent utility.

A competitive electric market did not develop as envisioned by the proponents of SB 3. Instead, auctions conducted in 2004 and 2005 with the intention of competitively setting FirstEnergy’s rates failed due to no or uncompetitive participation (Thomas, Lendel & Park, 2014). The PUCO, concerned that a clean change to market-based rates would lead to “rate ‘sticker shock’” (PUCO, 2007), opted instead to delay the end of the market development with the backing of the Ohio Legislature. Between October, 2002 and January, 2005 the PUCO approved individually negotiated Rate Stabilization Plans (RSPs) with all four major Ohio IOUs. All four agreements were largely upheld by the Ohio Supreme Court after challenges to the PUCO’s decisions. Notably, FirstEnergy and AEP were required to submit proposals to establish competitive service options (PUCO, 2007).

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11 Standard service is alternatively referred to as provider of last resort service. Regulators adopted negotiated tariffs—an alternative regulatory proceeding—for SSO determination. In theory, utilities had no instrumental incentive to seek high returns for unbundled supply or to inhibit customer switching-off of standard service.

12 The PUCO attributes these problems to volatile and rising market prices due to slowing electricity demand, increasing input costs, and the halting development of regional ISOs (NARUC, 2013).

13 All four agreements were largely upheld by the Ohio Supreme Court after challenges to the PUCO’s decisions. Notably, FirstEnergy and AEP were required to submit proposals to establish competitive service options (PUCO, 2007).
stranded costs officially ended December 31, 2005, the RSPs allowed regulated rates to continue until December 31, 2008 for FirstEnergy, AEP, and Duke Energy, and until December 31, 2010 for DP&L. These dates thus become the key policy intervention dates for our quasi-experimental estimation as these dates identify the end of complete commission rate setting.

The transitional status of Ohio’s electric restructuring was clarified with the passage of SB 221 in May 2008. SB 221 required that Ohio’s incumbent utilities obtain PUCO approval for either a Market Rate Offer (MRO)\textsuperscript{14} or an Electric Security Plan (ESP) to fulfill their SSO obligations by the end of the aforementioned RSP period. While MROs represent pure market-based rate setting, ESPs allow for a mix of market-based rates (set by Competitive Bidding Process\textsuperscript{15} [CBP] auctions) plus regulatory-approved costs.\textsuperscript{16} While MROs were the legislative default, utilities preferring ESPs had to show that their ESP pricing was “more favorable in the aggregate as compared to the expected results that would otherwise apply under an MRO” (OLSC, 2008).

Under SB 221, ESPs were subject to periodic testing in accordance with a newly established “significantly excessive earnings test” (SEET) standard (PUCO, 2015). The legislation also specified that these plans “exclude any previously authorized allowances for transition costs” (OLSC, 2008). We note that utilities prefer ESPs to MROs, as ESPs provide protections on revenues that the competitive market does not—ESPs are the proverbial goose that laid the golden egg. To date, Ohio has not had an MRO in any of its service territories; ESPs have been the exclusive avenue by which utilities have fulfilled their SSO obligations.

The impact of the policy change of SB 221 on SSO price is, in theory, indirect. The biggest change is a shift in regulatory proceedings and adoption of a “competitive” standard of comparison. The

\textsuperscript{14} MROs entail a “competitive bidding process” (OLSC, 2008) after which the selected bids of least-cost bid winners are used to determine the standard service offer (SSO). The process is overseen by an independent third party and certified by the PUCO.

\textsuperscript{15} Ohio's SSO auctions – the first of their kind in the country – reduce the role of the PUCO in setting rates via negotiating and traditional rate-making formulas. Instead, auction markets determine the price for generating services through competitive bidding. The auctions are also referred to as competitive bidding process (CBP) auctions.

\textsuperscript{16} ESPs allow for regulated “provisions related to the supply and pricing of electric generation” (OLSC, 2008), including cost recovery and surcharges for transmission, distribution, and related services, to remain. The ESP is less of a fully-market-oriented approach than the MRO. For example, FirstEnergy’s latest ESP proposal “requests to add two new riders, modify 12 existing riders and remove six expiring riders” (PUCO, 2016C).
conclusion of the Rate Stabilization Period serves as a transition point in the structure of SSO pricing because it marks the explicit end of rate-based pricing through regulatory proceedings. How “competition” as a mechanism should effect changes in SSO rates is not entirely clear, just as the theoretical constructs supporting market liberalization are similarly unclear. Ongoing rent-seeking behavior of utilities has the potential to shift rates in either direction. For example, a utility that manages to count standard service offer customers in their rate-base has incentive to bring down SSO prices as a way to retain market share in a competitive market. This is known as an invest strategy (Klemperer, 1995). On the other hand, utilities with investors that expect certain levels of revenue also have incentive to inflate their transmission/distribution investments to increase the rate-base and make up for lost generation component profit. Utilities may also work to increase SSO rates as a way to collect rents from customers who otherwise signal high switching costs or satisfaction by staying on default supply. This is known as a harvest strategy (ibid). Consequently, lower generation component prices may not reflect in lower SSO rates and overall bills. Price changes might also reflect changes in the costs of inputs, not necessarily market pressure or utility interference.

Although the time until the first CBP auctions to set SSO prices varied by region,17 SB 221 set in motion competitive provision of electric services by establishing hybrid rate plans that coincided with the end of the recovery of regulatory stranded costs as established in SB 3. These hybrid plans allowed utilities “to ‘ramp up’ to market and operate under a blended generation price” (OLSC, 2008) through their initial ESP and eventual MRO proposals. A PUCO staff investigation into the state of Ohio’s retail electricity market between December 2012 and January 2014 concluded that Ohio’s hybrid model achieved “effective competition” (PUCO, 2012). Within the context of Ohio’s partially deregulated electricity market, this entailed “a level of competition that creates and encourages benefits to both buyers

17 The initial round of ESP and MRO proposals was followed by considerable litigation between the utilities and the PUCO over “fair and equitable” and “excessive earnings” standards. While the Ohio Supreme Court required that the PUCO revisit its processes in establishing satisfactory ESP terms, the courts ultimately upheld the PUCO’s position that utilities adopt competitive bidding processes.
As a result of this complex transition to market-based retail rates, the implementation of Ohio’s retail restructuring (SB 221) is the most appropriate policy intervention point by which to assess the effects of introducing competition into the retail electric market.

3. Data

3.1 Survey Data

The PUCO provides a monthly publication of utility rates in each utility service territory in Ohio. These Ohio Utility Rate Surveys comprise the main source of data for this analysis. These surveys are conducted as part of PUCO’s market evaluation and oversight function. They provide the commission with a useful comparison tool to evaluate changes and trends in monthly utility costs to households and businesses in major metro areas in Ohio. They include the costs of all utility services (electric, gas and telephone). The overarching purpose of these surveys is to support regulators with a comprehensive comparison of the total costs of all utility services that customers face.

The surveys provide total electric bill charges for fixed consumption levels by customer class (i.e., residential, commercial and industrial). We note that in this paper we focus solely on residential rates, which are the predominant focus of retail restructuring and for which the most robust market activity (i.e., entry by marketers) developed. The fact that the survey data includes total bill information for fixed consumption levels is important to this study for two reasons.

First, total bill information is not commonly provided in electric utility analyses. The typical data source for analyses of this sort is EIA data (e.g., EIA 826), which provides at best only the marginal rate that customers pay for their electricity (i.e., cents/kWh). However, in states with active utility commissions, such as Ohio, costs are borne by households and businesses through a long litany of additional riders and surcharges that itemize additional energy and energy-related costs on utility bills as

18 More specifically, the PUCO staff recommended the structural separation of retail sales arm from former vertically-integrated monopolies, 100% of SSO load procurement through competitive auctions, and that customers have adequate access to information about retail services and products (PUCO, 2012). Reviewing these standards, the PUCO staff found that “functional separation” and ongoing auction plans were sufficient and, absent some minor changes to billing formats, the competitive market was operational.
described in the prior section (i.e., the regulated price component of the ESP). These include everything from traditional charges for transmission and distribution (T&D), as well as additional cost pass-thrus for costs such as participating in competitive auctions, service reliability, deferred assets, etc. For example, in the American Electric Power (AEP) service territory (Columbus and Canton, Ohio metro areas in this study) there are approximately 20 additional riders on residential electric bills that amount to more than 50 percent of the total bill. These are costs that households face and that are not included in any competing analyses from EIA data. Moreover, utilities can pursue strategies to shift rents from the energy generation component of the consumer bill to other portions of the bill such as T&D or riders.

Second, the data provides customer bills for fixed consumption levels month-to-month. This is important, particularly given the quasi-experimental approach we utilize, because the data already inherently controls for consumption and seasonal variation in demand for electricity. All of the electricity data reported in the surveys provide total bill costs for customers using exactly 750 kWh. In this way, the surveys are really not “surveys” as the term is typically used—although the PUCO labels them as such.

This approach to the survey measure is also important because it accounts for heterogeneity in tariff pricing structures across utilities and across time. That is, some utilities have pricing structures for some or all of their customers that utilize stepwise (also called “tiered”) pricing rather than fixed rates. Stepwise pricing allows utilities to charge higher marginal rates for energy (and many of the rider charges as well) based on consumption levels. For example, customers in the AEP area roughly pay (for generation only) a marginal energy charge of 9.8 cents/kWh for the first 900 kWhs, 15 cents/kWh for the next 500 kWhs, and 20 cents/kWh thereafter. The fixed nature of our data allows us to evaluate the effects of retail restructuring across an important cross section of typical residential customers while avoiding the complexities of heterogeneity across pricing structures across both region and time. This feature also

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19 It is important to note that even with these inherent controls there are still seasonal features of our data (e.g., seasonally-approved charges and variable costs) that present seasonality in some of our metro area time series, and for which we appropriately account for utilizing seasonal components in our analysis, described below.
means that our findings represent a lower bound effect. Our analyses only report on the lowest consumption tier—reporting on other tiers, if such data were available, would indicate even higher rates.

Finally, the surveys provide data only for customers who are purchasing electricity from the dominant monopoly utility (i.e., SSO customers). This is important to note because retail restructuring allows households to “shop” from among competing marketers, also known as competitive retail electric suppliers (CRES), that supply the energy component (excluding transmission and all of the other riders just mentioned) of their utility service. Those customers receive a contract rate based on the marketers’ costs of procuring the electricity from the RTO, and there is significant heterogeneity across those providers in terms of both marginal rate and supplemental services offered (e.g., higher renewable percentages, longer-term fixed rate lock-ins).

The fact that our study evaluates total customer costs for only SSO customers is not a major limitation of the explanatory power of our analysis. This is because, first, the SSO is by far the prevailing rate in Ohio’s retail market throughout the time period studied. Appendix Table A2 provides indicative counts of utility customers served by the default offer over time. As this table shows, the majority of residential customers served by major utilities – approximately 57%, or 2.7 million customers – faced the SSO rate as recently as December, 2015, with an even higher proportion in previous years. The proportion of switched customers has plateaued over time.

Second, the potentially lower rates that CRES customers may receive only lowers the rates that they see for the generation portion of their total bill, which is often less than 50 percent of their total bill. The remaining regulated portion, and larger share, of the total bill is unchanged by switching to a marketer/CRES supplier. Thus, our results would indicate that any price effects associated with retail restructuring are due, to a large degree, by riders and other surcharges faced by all customers alike—CRES and SSO customers. And third, for the generation component of bills, the new competitive standards applied to SSO rates are intended to better reflect competitive market pressures. Consequently, SSO rates should approximate average CRES rates.
3.2 Data Summary & General Trends

The data provide monthly total electricity bill costs for each of the service areas. The data span the years of 2004 through 2015. In total, we utilize 144 monthly observations for each of the metro areas in our study. Table 1 below provides simple summary statistics for each of the metro areas, reporting summary statistics for monthly utility bills by area. It is important to note that the values are provided as marginal rates ($/kWh) that reflect the entirety of the bill that customers receive. This is an important distinction because utilities report to customers a lower marginal rate that only accounts for the generation costs. We report, on the other hand, the marginal rate for the entirety of the bill that reflects actual total electricity costs incurred by customers. Bills for these customers averaged between 11 and 13 cents per kWh. They ranged between 8 cents to over 18 cents per kWh.

Whereas Table 1 provides summary statistics within each of the major metro areas, we also provide the average by month across all of the metro areas to give a statewide aggregate electricity price. We show this as a time series plot in Figure 2. All time series data are adjusted by the general consumer price index to correct for inflation and all values are reported in real 2014 dollars. We avoid the use of electricity price CPI for inflation adjustment as it accounts for household electricity prices with an un-fixed consumption quantity, lags in inconsistent patterns with heterogeneous billing cycles, and varies heterogeneously across geographic borders that are not necessarily contiguous to utility service areas.

<table>
<thead>
<tr>
<th>Service Territory</th>
<th>Utility Provider</th>
<th>Mean Monthly Marginal Rate</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akron</td>
<td>FirstEnergy (FE)</td>
<td>.134</td>
<td>.007</td>
<td>.116</td>
<td>.150</td>
</tr>
<tr>
<td>Canton</td>
<td>American Electric Power (AEP)</td>
<td>.113</td>
<td>.022</td>
<td>.088</td>
<td>.164</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>Duke Energy (Duke)</td>
<td>.121</td>
<td>.014</td>
<td>.095</td>
<td>.151</td>
</tr>
<tr>
<td>Cleveland</td>
<td>FirstEnergy (FE)</td>
<td>.135</td>
<td>.009</td>
<td>.122</td>
<td>.158</td>
</tr>
<tr>
<td>Columbus</td>
<td>American Electric Power (AEP)</td>
<td>.129</td>
<td>.019</td>
<td>.102</td>
<td>.182</td>
</tr>
<tr>
<td>Dayton</td>
<td>Dayton Power and Light (DP&amp;L)</td>
<td>.133</td>
<td>.014</td>
<td>.112</td>
<td>.159</td>
</tr>
<tr>
<td>Toledo</td>
<td>FirstEnergy (FE)</td>
<td>.136</td>
<td>.007</td>
<td>.123</td>
<td>.178</td>
</tr>
</tbody>
</table>

Note: The values provided are marginal rates ($/kWh) for the entirety of the electricity bill, inclusive of riders and surcharges. All values are in constant 2014 dollars.
It is clear that there is a general upward trend over the timespan of our data and that retail restructuring did not, in general, keep rates constant or lower them. In Figure 2, we also indicate with a vertical separation bar the period at which retail restructuring begins. Whereas the mean statewide aggregate electricity price before restructuring was 12.63 cents/kWh, it was 13.29 cents following restructuring. Figure 2 excludes Dayton as it implemented restructuring two years later.

![Figure 2. Statewide Aggregate Electricity Price](image)

**Figure 2. Statewide Aggregate Electricity Price**

4. **Method of Analysis**

4.1 **Interrupted Time Series Models**

We utilize an interrupted time series design to evaluate the impact of retail restructuring\(^{21}\) on default electricity prices (i.e., SSO price). Interrupted time series analysis provides for statistically-

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\(^{20}\) Graph provides mean inflation-adjusted marginal rate for all utility service territories (excludes DP&L).

\(^{21}\) As noted earlier, Ohio’s transition towards retail restructuring is not complete in the textbook sense. Rather, our cut-point represents a change point at which Ohio adopted competitive standards for rates with a hybrid mix of market-based rates for generation plus commission rate setting for all other charges and riders.
controlled comparison of the two time periods before and after retail restructuring (Abadie & Gardeazabal, 1999; Campbell & Stanley, 1963; Shadish, Cook, & Campbell, 2002).

Our casual hypothesis is that retail electricity price will have declined following the introduction of a market-basis for rate setting. Such changes can take two forms: a change in intercept (i.e., a change in the average electricity price after retail restructuring) or a change in slope (i.e., a change in the trend of electricity price after retail restructuring).

The general functional form of our model is given by:

\[ Price_t = \alpha + \beta_1 (Month_t) + \beta_2 (Post-Restructuring) + \beta_3 (Month_t)(Post-Restructuring) + \epsilon_t \]  

\( Price_t \) provides our explanatory variable of interest, electricity price in a given month \( t \). \( Month_t \) is a month index beginning with our first available month of data, January, 2004. The coefficient \( \beta_1 \) provides the general month-to-month price trend ignoring any intervention (i.e., the trend before retail restructuring). \( Post-Restructuring \) is a dummy variable that provides the “interruption” of the series (i.e., our policy intervention point). \( Post-Restructuring \) takes a value of “0” for months before restructuring, and a “1” for subsequent months during restructuring. The coefficient \( \beta_2 \) provides the change in the intercept of the electricity price trend after retail restructuring began. The coefficient \( \beta_3 \) of the interaction term \( (Month_t)(Post-Restructuring) \) provides the change in the month-to-month price trend between the pre-restructuring period and the restructuring period. Thus, it provides the difference in the slopes of the two trend lines (post-policy minus pre-policy).

The coefficient of the interaction term, \( \beta_3 \), could indicate a number of possible policy effects. For example, for any given model, if the coefficient is negative (and statistically significant), this indicates that restructuring had the effect of decreasing the pre-restructuring price trend for a given utility. We also note that a positive and significant \( \beta_3 \) would indicate the opposite effect, namely that the post-intervention
monthly trend increased relative to before restructuring for all the same scenarios but in the opposite direction.

Additionally, we note that lack of statistical significance of $\beta_3$ does not necessarily indicate a null finding. Lack of statistical significance of this coefficient should be taken, as a whole, in consideration with $\beta_1$ (which is the pre-restructuring trend). Proponents of retail restructuring argued that ending commission oversight over rates would bring rates down. A positive and significant $\beta_1$ would indicate, for example, that prices were on the rise before retail restructuring. A non-significant $\beta_3$ would therefore indicate that restructuring did not have its intended effect, and that rates continued to rise after restructuring just as they had been rising on a monthly basis before.

The main modelling approach for accounting for this time series is the Autoregressive Integrated Moving Average (ARIMA) approach, which allows us to retain the controlled pre- and post- treatment effect measures while accounting for autocorrelation (Box & Jenkins, 1970; Box-Steffensmeier, Freeman, Hitt, & Pevehouse, 2014; Enders, 2004; Hamilton, 1994). Properly correcting for autocorrelation is both theoretically and contextually important with this data, as household electricity prices in a given month tend to be highly correlated with prices in prior months. The structure of an ARIMA (1, 0, 0) model is given by:

$$
(1-\Phi_1 B)\ Price_t = \alpha + \beta_1(Month_t) + \beta_2(Post-Restructuring) + \beta_3(Month_t)(Post-Restructuring) + \epsilon_t
$$

Building upon model (1), model (2) adds $(1-\Phi_1 B)$ that indicates the AR (1) process. $B$ is a backshift operator.

However, the data for some cities exhibit a fractionally integrated process. The fractional integration process has the characteristics of both unit root and stationarity. Similar to a stationary

---

22 These cities are Canton, Columbus, Cincinnati, and Dayton. The first-differenced data suffer from over-differencing based on the ACF and PACF plots.
process, fractionally-integrated time series are mean reverting in the long-run. And, similar to an integrated process (e.g., unit root), fractionally-integrated time series will exhibit strong dependence between observations over time. It has been argued that treating fractional integration as either unit root or stationary will threaten the validity of any statistical inferences (Baillie, 1996; Box-Steffensmeier & Smith, 1998; Sowell, 1992). Thus, we employ an Autoregressive Fractional Integrated Moving Average (ARFIMA) model that allows the integrated order (d) to take non-integer values (i.e., fractions).

The selection of AR and MA orders are based on the diagnosis of the characteristics of electricity price data for given utility service areas, which will be discussed later in more detail. Generally, the time series for the utility service areas associated with fractional integration can be best fit into the ARFMA (1, 0, 0) model, as given by:

\[
(1 - B)^d(1 - \Theta_1 B) \text{Price}_t = \alpha + \beta_1(\text{Month}_t) + \beta_2(\text{Post-Restructuring}) + \beta_3(\text{Month}_t)(\text{Post-Restructuring}) + \epsilon_t
\]

Building upon model (2), model (3) adds one variables: the estimate of fractional integration (d) Our hypothesis suggests that electricity prices should \textit{ceteris paribus} decrease after restructuring for one of the above-mentioned four scenarios. Therefore, we expect the coefficient of the interaction term ($\beta_3$) to be negative, which means restructuring has a negative impact on the fractionally-differenced electricity price.

For some service areas,\textsuperscript{23} we utilize a Seasonal Autoregressive Integrated Moving Average (SARIMA) model to handle the added complexity of seasonality. The SARIMA model is often denoted as an ARIMA (p, d, q) x (P, D, Q)\textsubscript{s}. Based on the diagnosis details that are discussed later, the electricity data for utility service areas with significant seasonality can be best estimated by the ARIMA (1, 0, 0) x (1, 0, 0)\textsubscript{12}, given by:

\textsuperscript{23} These cities are Akron, Cleveland, and Toledo.
Model (3) adds the seasonal AR (1) component \((1-\Phi_1 B^{12})\) and the AR (1) component \((1-\Phi_1 B)\) to model (2). Similar to models (2) and (3), a negative coefficient of the interaction term \(\beta_3\) would support the conclusion that restructuring lowered retail electricity prices.

4.2 Model Selection

Our approach to model selection begins with diagnosing the time series properties of the electricity price data for each utility service area/metro area; this is consistent with the longstanding approach taken by Box and Jenkins (1970). We first utilize the generalized Box-Jenkins approach of reviewing the autocorrelation function (ACF) plots and partial autocorrelation function (PACF) plots for each city to examine whether electricity prices exhibit unit root and seasonality (see Appendix Figure A1). Electricity prices in Canton, Cincinnati, Columbus, and Dayton have significant spikes even after 10 lags. Such patterns suggest that the data for those territories likely exhibit a unit root. Moreover, the periodic spikes around every 12 intervals (months) suggest that electricity prices in Akron, Cleveland, and Toledo exhibit yearly seasonality. We note that the main utility provider for these cities is FirstEnergy.

Second, we employ two formalized tests to complement the evidence obtained from the visual diagnosis of stationarity: the widely-used Dickey-Fuller test and Variance Ratio Test (Dickey & Fuller, 1974; Lo & MacKinlay, 1988). Table 2 provides the results of Dickey-Fuller tests (including time trend). We fail to reject the null hypothesis that electricity prices in Canton, Cincinnati, Columbus, and Dayton exhibit unit root behavior with trend. The Dickey-Fuller test results are consistent with our visual diagnosis.
The Effect of Retail Electric Restructuring

### Table 2. Dickey-Fuller Tests

<table>
<thead>
<tr>
<th>City</th>
<th>Test Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akron</td>
<td>-3.964**</td>
</tr>
<tr>
<td>Canton</td>
<td>-3.139</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>-2.136</td>
</tr>
<tr>
<td>Cleveland</td>
<td>-5.494***</td>
</tr>
<tr>
<td>Columbus</td>
<td>-2.769</td>
</tr>
<tr>
<td>Dayton</td>
<td>-2.142</td>
</tr>
<tr>
<td>Toledo</td>
<td>-5.853***</td>
</tr>
</tbody>
</table>

***p<0.01, **p<0.05, *p<0.1

However, some scholars argue that the Dickey-Fuller test has less definitive power, which means that we may too easily accept that we have a unit root for those territories in the face of fractional integration (Box-Steppensmeier et al., 2014). To compensate for that potential weakness in the Dickey-Fuller test we also run variance ratio tests for which the null hypothesis is a unit root (the integrated order d=1). The alternative hypothesis suggests either a fractional integration or stationarity (d<1) is appropriate. Table 3 presents the results of the variance ratio tests for various choices of the differencing interval (2, 4, 8, and 16 months). As the results suggest, the null hypothesis that the series has a unit root can be rejected for Toledo at all differencing intervals. We fail to reject that the null hypothesis of a unit root for Cincinnati and Columbus at all differencing intervals. For the other four cities (Akron, Canton, Cleveland, and Dayton), the variance ratio tests reject the null hypothesis at some differencing intervals. This implies that the series are likely fractionally integrated.

Finally, the hyperbolic decay in the ACF and a significant spike at the first lag in the PACF suggest that the electricity prices in all cities exhibit an AR (1) processes. For Akron, Cleveland, and Toledo, we also detect a seasonal AR (1) component in the corresponding PACF plots since the spikes around the 12th lag are significant.24

---

24 The PACF plots delineate a significant spike at the 13th lag. However, the seasonal order is more likely to be 12 months according to the periodic patterns in the ACF plots.
Based on the diagnostic results and the performance of multiple competing models on the post-estimation tests (e.g., nonlinearity tests, white noise tests, and information criterion) we identify the strongest model fit for Akron and Toledo to be an ARIMA (1, 0, 0) × (1, 0, 0)_{12} model, and an ARIMA (2, 0, 0) × (1, 0, 0)_{12} to best fit Cleveland. Likewise, we identify the strongest model for Cincinnati, Columbus, and Dayton to be an ARFIMA (1, 0, 0) model. Finally, we identify the strongest model for Canton to be an ARIMA (1,0,0) model given the ARIMA (1, 0, 0) has almost equal performance on the post-estimation tests as a more complicated ARFIMA(1, 0, 0) suggested by the diagnostic results, but with a higher degree of parsimony.

5. Empirical Results

5.1 Price Trend Summary

While proponents of market-based rate setting of retail electric service have vigorously argued that converting regulated rates to market-based rates will reduce them, the results of our analyses provide little confirmation—and in some cases provide a direct refutation of that claim. We note at the outset of the presentation of our results that input fuel prices have been trending downward for the past several years. However, the results of our analyses suggest that this trend is not reflected in the electricity prices.

---

25 We identify the strongest model for Cincinnati and Columbus to be both ARIMA (1, 1, 0) and ARFIMA (1, 0, 0) models. The ARIMA (1, 1, 0) model introduces the concern of over-differencing since first differencing removes all long-term and short-term memory in the time series. Therefore, we believe that the ARFIMA model is slightly better than the ARIMA for the Cincinnati and Columbus data.
years. Despite the expectation of lower prices from both declining input (i.e., fuel) prices and restructuring combined, much of Ohio has experienced higher electric bills than would have been expected had pre-retail restructuring trends continued alone.

Figure 3 (panels A-D). Interrupted Time Series Plots
The data suggests that Akron, Cleveland, and Toledo were experiencing downward trending electricity prices prior to retail restructuring. While Cleveland and Toledo experienced a decrease or cessation of that downward trend after intervention, Akron experienced a direct reversal. For Akron, the pre-restructuring downward trend in electricity bills became an upward trend. Canton, on the other hand, experienced a slight upward (if not flat) trend prior to retail restructuring that was turned abruptly and significantly upward thereafter. The capital city of Columbus was experiencing a steady increasing trend in electricity prices prior to retail restructuring and that trend continued at essentially the same rate.
thereafter. And although the post-restructuring prices maintained a similar trend, the average prices are higher than the prices should retail regulation continued.

Cincinnati and Dayton differ from the rest of the state entirely. Both Cincinnati and Dayton were experiencing increasing trends in electricity prices prior to retail restructuring, but have since experienced downward trends. It should be noted however, that post-retail restructuring prices in both metro areas exhibited higher average prices than before retail restructuring.²⁶

While in Figure 2 we provide the aggregate statewide time series plot of electricity prices, in Figure 3 we provide this for each of the seven major metro areas/utility service areas in Ohio, in panels A through G. The plots provide monthly SSO electricity prices for customers who consume 750 kWh of electricity in constant 2014 dollars. The results show that the post-retail restructuring path, or trend, of four of the seven areas (Akron, Canton, Cleveland, and Toledo) is less favorable to households than it was prior.

5.2 Interrupted Time Series Regression Results

In Table 4 we provide the results of our most robust time-series models. The models have relatively strong fitness and summary measures as indicated by the AIC and BIC statistics, indicating strong predictive power of the models overall. All model coefficients reported are in cents per kWh.

Recalling that the coefficients for “Month” indicate the pre-retail restructuring price trend, we see that the coefficients all align quite closely with visual inspection of the times series plots. This coefficient is statistically significant at the 10 percent level for all metro areas with the exceptions of Cleveland and Toledo, which comes close to statistical significance but exhibits strong seasonal variation which inflates the standard errors on even the most robust linear fit. The statistical significance of model fitness for the pre-restructuring time period gives us strong confidence in our difference (i.e., policy) measure, the interaction term, which we discuss next. It also gives us strong confidence in our ability to measure

²⁶ Whereas the mean monthly pre-restructuring price in Cincinnati is 11.21 cents per kWh, it is 12.85 cents post-restructuring. Those pre and post values for Dayton are 11.73 and 14.38, respectively.
welfare losses (or gains) from retail restructuring because of the presence of a robust baseline trend estimate.

The policy effect is provided in the interaction term. The interaction term, indicated by “Post 2009 x Month” is generally robust and similarly confirmed by visual inspection of the time series plots. Recall that the magnitude of the coefficient indicates the difference between the pre- and post-restructuring trends. And, recall that the statistical significance of that coefficient indicates the degree to which we can reject the null of pre-post price trend equality. This is important because lack of statistical significance of this coefficient does not indicate that the time series model does not fit the post-restructuring data in a robust manner; it indicates that there is no statistical difference between the slopes of the two trend lines. See Columbus, for example. Prices were rising on a monthly basis prior to retail restructuring in that service territory and continued to rise thereafter. The lack of statistical significance of the interaction term indicates that we cannot safely reject the null that retail restructuring had no effect. In other words, contrary to its proponents, retail restructuring had no statistically-significant effect on reducing the rising costs of electricity—they continued to rise in Columbus after.

For the FirstEnergy territory (Akron, Cleveland, and Toledo) we see consistent decreasing prices prior to retail restructuring. Cleveland and Toledo continued to experience decreasing prices following retail restructuring but at a decreasing (prices falling less quickly) rate. For those two cities, we fail to reject the null that retail restructuring had any effect. For Akron, as mentioned above, we see a direct reversal in price trend that is statistically-significant; an average monthly policy effect of increasing prices by 0.0275 cents/kWh. The post-retail restructuring price trend in Akron is 0.0064 cents/kWh (i.e., the pre-policy trend of -0.0211 cents plus the change/interaction term of 0.0275 cents). For residents in the Akron area who use an average of 750 kWh of electricity each month, the effect of retail restructuring translates to monthly increases in bills of approximately 21 cents above what would have been expected had the robust pre-retail restructuring trend gone uninterrupted.

For the AEP service territory (Canton and Columbus), the pre-retail restructuring trend in electric prices were a statistically-significant monthly increase of 0.0138 and 0.0349 cents/kWh, respectively. The
The Effect of Retail Electric Restructuring

post-retail electric restructuring price trend for those cities has been 0.0692 and 0.0344 cents/kWh, respectively. As also indicated by the time series plots, Canton (formerly the Ohio Power/AEP service territory) experienced a dramatic monthly price increase of 0.0554 cents/kWh, which is both large in magnitude and highly statistically significant. Columbus experienced no statistically significant policy effect; prices continued to rise after restructuring as they had been rising before restructuring. For residents in the Canton area who use an average of 750kWh of electricity each month, the effect of retail restructuring translates to monthly increases in bills of approximately 41.55 cents above what would have been expected had the robust pre-retail restructuring trend gone uninterrupted.

For the Duke service territory in the Cincinnati metro area, as well as for the Dayton Power and Light (DP&L) service territory in the Dayton area, the data indicates a more favorable effect. For both areas, the data suggests that the pre-retail restructuring trend of electric prices increasing by 0.0689 cents/kWh each month has effectively been reversed. The effect of retail restructuring has been a monthly decline of over 0.081 and 0.046 cents/kWh for Cincinnati and Dayton, respectively. The post-restructuring monthly price trend in Cincinnati has been a monthly decline of 0.0124 (-0.0813+0.0689) cents/kWh. For Dayton this figure is a 0.0096 cents/kWh decline. For residents in the Cincinnati area who use an average of 750kWh of electricity each month, the effect of retail restructuring translates to monthly decreases in bills of approximately 60.98 cents below what would have been expected had the robust pre-retail restructuring trend gone uninterrupted. For the Dayton area this figure is an average monthly price decrease of approximately 34.4 cents.
### Table 4. Regression Results

<table>
<thead>
<tr>
<th></th>
<th>Akron</th>
<th>Canton</th>
<th>Cincinnati</th>
<th>Cleveland</th>
<th>Columbus</th>
<th>Dayton</th>
<th>Toledo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ARIMA(1,0,0)</td>
<td>ARIMA(1,0,0)</td>
<td>ARIMA(1,0,0)</td>
<td>ARIMA(2,0,0)</td>
<td>ARIMA(1,0,0)</td>
<td>ARIMA(1,0,0)</td>
<td>ARIMA(1,0,0)</td>
</tr>
<tr>
<td>Post 2009</td>
<td>-1.8320***</td>
<td>-3.2005***</td>
<td>4.5050***</td>
<td>-1.2492</td>
<td>0.0367</td>
<td>-0.8755</td>
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<tr>
<td></td>
<td>(0.951)</td>
<td>(0.7022)</td>
<td>(1.525)</td>
<td>(1.0645)</td>
<td>(1.464)</td>
<td>(0.8921)</td>
<td></td>
</tr>
<tr>
<td>Month</td>
<td>-0.0211***</td>
<td>0.0138***</td>
<td>0.0689***</td>
<td>-0.0206</td>
<td>0.0349***</td>
<td>0.0363***</td>
<td>-0.0137</td>
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<tr>
<td></td>
<td>(0.0060)</td>
<td>(0.0041)</td>
<td>(0.0159)</td>
<td>(0.0140)</td>
<td>(0.0120)</td>
<td>(0.0108)</td>
<td>(0.0084)</td>
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<td>Post 2009×</td>
<td>0.0275**</td>
<td>0.0554***</td>
<td>-0.0813***</td>
<td>0.0223</td>
<td>-0.000481</td>
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<td></td>
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<tr>
<td>Month</td>
<td>(0.0124)</td>
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<td>(0.0182)</td>
<td>(0.0213)</td>
<td>(0.0137)</td>
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<td>Post 2011</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(Dayton only)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>AR (1)</td>
<td>0.7540***</td>
<td>0.7503***</td>
<td>0.8900***</td>
<td>0.4178***</td>
<td>0.9070***</td>
<td>0.3625</td>
<td>0.7250***</td>
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<tr>
<td></td>
<td>(0.0771)</td>
<td>(0.0887)</td>
<td>(0.0512)</td>
<td>(0.1230)</td>
<td>(0.0593)</td>
<td>(0.2251)</td>
<td>(0.0712)</td>
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<tr>
<td>AR (2)</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>0.1395</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0905)</td>
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<td></td>
<td></td>
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<td>AR (1)2</td>
<td>0.3690***</td>
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<td>0.6388***</td>
<td></td>
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<td>0.5783***</td>
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<td></td>
<td>(0.131)</td>
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<td>(0.1468)</td>
<td></td>
<td></td>
<td></td>
<td>(0.1092)</td>
</tr>
<tr>
<td>d</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>-0.0304</td>
<td></td>
<td>-0.0616</td>
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<td></td>
<td>0.4557***</td>
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<td></td>
<td>(0.0673)</td>
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<td>(0.1270)</td>
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<td>(0.0598)</td>
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<tr>
<td>σ²</td>
<td>0.1384***</td>
<td>0.1143***</td>
<td>0.1810***</td>
<td>0.2964***</td>
<td>0.1660***</td>
<td>0.1151***</td>
<td>0.1458***</td>
</tr>
<tr>
<td></td>
<td>(0.0369)</td>
<td>(0.0368)</td>
<td>(0.0546)</td>
<td>(0.0493)</td>
<td>(0.0374)</td>
<td>(0.0364)</td>
<td>(0.0288)</td>
</tr>
<tr>
<td></td>
<td>(0.1600)</td>
<td>(0.1132)</td>
<td>(0.5660)</td>
<td>(0.6314)</td>
<td>(0.4370)</td>
<td>(0.8269)</td>
<td>(0.3877)</td>
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<tr>
<td>Log-likelihood</td>
<td>-63.20</td>
<td>-48.60</td>
<td>-81.91</td>
<td>-120.06</td>
<td>-75.57</td>
<td>-50.1895</td>
<td>-68.5373</td>
</tr>
<tr>
<td>Wald χ²</td>
<td>159.64***</td>
<td>525.10***</td>
<td>547.85***</td>
<td>145.17***</td>
<td>650.38***</td>
<td>581.02***</td>
<td>137.66***</td>
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<tr>
<td>AIC</td>
<td>140.40</td>
<td>109.20</td>
<td>177.81</td>
<td>256.12</td>
<td>165.14</td>
<td>114.38</td>
<td>151.07</td>
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<tr>
<td>BIC</td>
<td>161.18</td>
<td>127.02</td>
<td>198.60</td>
<td>279.88</td>
<td>185.93</td>
<td>135.17</td>
<td>171.86</td>
</tr>
</tbody>
</table>

All models are Box-Jenkins ARIMA, ARFIMA or SARIMA and use the robust estimator of variance. N=144 months.
Standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1
Table 5. Pre- and Post- Retail Restructuring Mean Monthly Electric Prices by Metro Area

<table>
<thead>
<tr>
<th>Service Territory/Metro Area</th>
<th>Mean Monthly Electricity Price</th>
<th>Real Mean Monthly Electricity Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Retail Restructuring</td>
<td>Post-Retail Restructuring</td>
</tr>
<tr>
<td>Akron</td>
<td>13.89</td>
<td>13.11</td>
</tr>
<tr>
<td>Canton</td>
<td>9.20</td>
<td>12.72</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>11.21</td>
<td>12.86</td>
</tr>
<tr>
<td>Cleveland</td>
<td>13.64</td>
<td>13.32</td>
</tr>
<tr>
<td>Columbus</td>
<td>11.15</td>
<td>14.30</td>
</tr>
<tr>
<td>Dayton</td>
<td>12.34</td>
<td>14.60</td>
</tr>
<tr>
<td>Toledo</td>
<td>13.86</td>
<td>13.36</td>
</tr>
</tbody>
</table>

Note: Values represent the average of monthly values in across all months in our sample. All values are in constant 2014 cents/kWh.

One complicating factor in interpreting these results is the intercept term associated with the post-policy trend line. For several of the areas in our study, the policy change point at which retail restructuring took effect is given by a change in the intercept term. For example, the monthly declines in Dayton’s prices after retail restructuring do not necessarily mean that residents in the Dayton area are paying less on average for their electricity in real terms. We therefore provide the change in the intercept for each city in our regression outputs in Table 4, which is the coefficient on the policy intervention dummy variable. This change represents the difference between the y-intercept of the pre-restructuring trend and the y-intercept of the post-restructuring trend (at the beginning month of our sample, January, 2004). Accounting for this, we see a downward (post-policy) change for Akron, and an upward change for Canton, Cincinnati, Cleveland, Columbus, and Dayton. Moreover, we provide further insight by calculating the monthly pre and post policy averages in constant cents in Table 5. We note that both of the cities that exhibit downward (i.e., favorable) reversals in electric price trends (Dayton and Cincinnati), have been paying more in real terms for each kWh of electricity after retail restructuring, accounting for the post-policy intercept.

5.3 Welfare Effects

We extend our price impact analysis one step further by estimating welfare impacts for each of our seven metro areas and the state as a whole. By welfare, we mean the cumulative net total out-of-pocket expenditure differential of all residents in the seven major utility service areas that have electric
service through their distribution utility (i.e., SSO customers) in the time since retail restructuring took
effect in each respective service territory. In other words, we estimate the costs SSO customers would not
have had to pay if retail restructuring had not occurred and the general pre-retail restructuring price trend
continued.

To accomplish this, we utilize quarterly customer count data from the PUCO. These customer
count data provide the total customer counts for SSO customers and CRES customers. This data provides
the approximate number of residential customers who are paying SSO rates in each month of our pricing
data.27 Because our price data are limited to fixed customer demand levels of 750 kWh, as discussed
above, we make the lower bound assumption that the average residential customer uses 750 kWh each
month. Additionally, we construct a counterfactual linear trend forecast of the pre-retail restructuring
period utilizing our best-fitting time series model estimates. This provides us with an estimate of what
these customers would have paid in each service territory in the absence of retail restructuring (i.e., if the
pre-restructuring pricing trend had continued). We provide these estimates as reasonable lower-bound
approximations given that a) the majority of modern residential customers, particularly families, consume
more than 750 kWh, b) these are estimates of SSO customers only and do not include any price impacts
faced by CRES customers, and c) these estimates exclude commercial and industrial customers.

---

27 The 2012 merger of the two AEP-owned companies Columbus Southern Power and Ohio Power represent a peculiarity in our
data that requires a simplifying assumption in utilizing the PUCO’s customer count data. After 2012, the PUCO no longer
distinguished between customers in Canton (Ohio Power territory) and Columbus (Columbus Southern territory), and instead
provides only customer totals for all AEP service territories combined. This is not the case for price data however. We assume
that the ratio of total customers in the two combined service territories has not changed dramatically since 2011 (the last known
customer count year that is separated by the two service areas), at approximately 48% and 52% for Canton and Columbus,
respectively. We also assume that the AEP switching rates (i.e., proportion of customers who switched to a CRES provider) is
homogenous across all of the post-merger AEP service territory.
Table 6. Estimated Net Welfare Change from Retail Restructuring (Lower Bound)

<table>
<thead>
<tr>
<th>Service Territory/Metro Area</th>
<th>Net Welfare Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akron</td>
<td>-$12,927,621</td>
</tr>
<tr>
<td>Canton</td>
<td>-$848,899,035</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>+$544,190,655</td>
</tr>
<tr>
<td>Cleveland</td>
<td>-$139,312,795</td>
</tr>
<tr>
<td>Columbus</td>
<td>-$515,107,782</td>
</tr>
<tr>
<td>Dayton</td>
<td>+$35,268,959</td>
</tr>
<tr>
<td>Toledo</td>
<td>-$8,911,410</td>
</tr>
<tr>
<td>TOTAL (Statewide Net)</td>
<td>-$919,843,786</td>
</tr>
</tbody>
</table>

Estimates reflect cumulative welfare change for residential SSO customers in constant 2014 dollars by utility service territory (metro area) between the implementation of retail restructuring and December, 2015.

Table 6 provides our welfare estimates as cumulative total (net) loss estimates for each service territory for all months since retail restructuring. We estimate the lower bound statewide net effect of retail restructuring on SSO customers to be around $1 billion. By far, the largest net losses have been incurred in AEP’s service territory (central Ohio areas of Columbus and Canton). The net effect on customers in the Dayton territory has been relatively minor for the fewer years in which retail restructuring has been in effect there. The Duke service territory (i.e., Cincinnati metro area) on the other hand, we estimate to have net welfare gains of over $500 million. As is clear from Figure 3 (panel C), Cincinnati exhibited a significantly positive increasing trend in prices prior to retail restructuring and we similarly assume that that trend would have continued for purposes of these welfare estimates.

Finally, we note that these are only direct effect estimates and do not include any macroeconomic (i.e., direct + indirect) impacts that have been experienced by the State or the region more broadly. These second order (i.e., ripple) effects could easily be twice as large in magnitude, and undoubtedly much larger if the same general impacts were experienced in the commercial and industrial sectors (which we reserve for future research). Applied equilibrium analysis, such as a dynamic stochastic general equilibrium (DSGE) approach, would be an appropriate next step to estimate the total macro impacts of retail electric restructuring and the effects that it has had on welfare across various sectors of the economy more broadly.

We note that our welfare estimates assume that the trend in retail rates was altered by retail restructuring and that the counterfactual is the continuance of that trend. While our quasi-experimental
design provides for substantial control, there exists no direct method to predict with absolute certainty that residential rates would have differed significantly from our counterfactual. Further compelling evidence would extend our work with a multi-state evaluation of similarly situated states that did not restructure, or restructured at a later date. However, that extension is not directly possible without bill data of equivalent quality for those states. Moreover, there exists great diversity of regulatory design and restructuring across states that would similarly preclude this extension of our counterfactual.

We also feel that it is also important to acknowledge the utility’s complementary arguments about what these data show. The standard utility argument would suggest that the baseline of our analysis is corrupt, and would emphasize that the pre-restructuring period represents a “rate freeze” period in which rates were held fixed. This argument continues by suggesting that rates during this period were “uneconomic” and did not fully reimburse utilities for stranded costs. This implies that rates were expected to climb after the end of the rate freeze period. We reject that argument on its face. The PUCO required customers to reimburse utilities for stranded costs, and the rate freeze period rates met the commission’s “Significantly Excessive Earnings Test (SEET)”—a standard that is generally viewed as less favorable to ratepayers. Additionally, the PUCO specifically allowed for the Rate Stabilization Period to account for any exogenous shocks, therefore allowing for this form of rate increase in the time before the restructuring intervention.

6. Discussion

Our identification of welfare losses for residential customers bares important questions about the political economy of retail restructuring. In particular, it is unclear whether reciprocal welfare gains are experienced by incumbent utilities or large industrial and commercial customers. Su (2014), in finding short-term welfare gains from retail restructuring to residential but not industrial consumers, infers the possibility that restructuring undermined a system of cross-subsidies from residential to industrial...

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28 According to EIA data, the only state that would generally fit this description would be Pennsylvania. While we do not have data of equivalent quality for PA, we note that EIA data for the average price trend is nearly identical to that of Ohio during the period of our counterfactual and in prior years.
customers under traditional regulation. While this finding may hold true for the generation component of customer bills, data from the complete customer bill before and after restructuring significantly complicates this assessment.

Under a hybrid form of retail competition, large industrial customers retain both negotiating power with regulatory commissions and utilities as well as gain information and size advantages on the open market. In contrast, disaggregated residential customers are exposed to information asymmetries and collective action problems in facing an altered regulatory process, as well as switching barriers and high transaction costs in contracting with a CRES. Though we reserve the question of whether large customers experienced price declines subsidized by higher than expected residential customer prices for future research, we believe our research naturally extends to evaluating the welfare transfers inherent to retail restructuring. Given that large customers played a substantial role in driving the political process to undertake retail restructuring, our expectation is that commercial and industrial customers benefited from the process.

Relatedly, our research motivates a similar cross subsidy question for future research. The swelling of regulatory-approved riders and surcharges made possible by retail restructuring in Ohio may in fact be a complex system of subsidies for underperforming affiliated, arms-length generation. While the restructuring design in Ohio required a 100 percent divestiture of generation, it allowed investor-owned utilities to simply reincorporate that generation into subsidiary corporations (in some cases even retaining the utility’s name).29 It is likely, given the age and fuel type (i.e., mostly coal) of that generation, that those plants are experiencing some difficulty maintaining expected profit margins in the larger RTO wholesale and capacity markets.30 We conjecture that the increasing non-generation costs incurred by ratepayers are actually nothing more than a non-transparent cost-shifting to non-competitive generation assets retained by the utilities. Some immediate evidence to support this claim is the fact that Duke, the

29 As noted above, the PUCO staff previously identified these affiliations as a problem when it recommended the structural separation of retail sales entities from incumbent regulated entities (PUCO, 2012).
30 Recent regulatory history in Ohio provides affirmation of this claim as both AEP and FirstEnergy have aggressively pursued re-regulation for their coal-power plants (PUCO, 2016A; PUCO, 2016C).
provider in the greater Cincinnati metro area and the only area in our study to experience net welfare gains, divested the entirety of its generation assets following restructuring and did not retain those assets in an affiliated arms-length corporation. Thus, we conjecture that the savings incurred by residents of the Duke territory are a truer reflection of the potential benefits of market-basis pricing. Residents in that part of the state are not on the hook for supporting old coal plants retained in a pocket corporation.

Supporting research assessing the welfare effects of utility restructuring raises complementary arguments about welfare transfers to utilities. Blumsack, Lave, & Apt (2008), for instance, argue that the efficiency gains realized by utilities under restructuring are not passed on to residential consumers due to increased transaction costs and a reallocation of risk. Price (2005), in her discussion of the welfare consequences of liberalization in the UK, notes a variety of market power concerns through which incumbent utilities can exploit switching costs at the expense of the vulnerable residential class. In general, it is not apparent that retail restructuring can successfully eliminate complicated vestigial relationships and political pressure between utilities and regulators. Instead, our findings match the liberalization “lesson” that incomplete or incorrect implementation risks substantial costs (Joskow, 2008).

Finally, our research stands in direct contrast to arguments that there is a benefit to a high SSO in so far as it encourages switching behavior. To the extent that we treat the SSO as distinct from CRES rates, this argument is far outweighed by the substantial number of customers who have not switched and the significant costs they face. Additionally, all residential customers are affected by the swelling of the regulated portions of customer bills. Similarly, our research contrasts arguments in support of the claim that the costs of retail deregulation are front loaded (mostly through stranded cost recovery) and the benefits are back-loaded. There is no immediate evidence to suggest that riders and tariffs will not persist or swell further via subsequent regulatory actions.
7. Conclusions & Implications

This paper provided an interrupted time-series regression analysis of retail electric prices for all investor-owned utility service territories in the state of Ohio. It provided a controlled pre- and post-test of the effect of retail electric restructuring on SSO electric prices that are paid by millions of residents. Proponents of retail restructuring argued that markets would set more favorable rates for households than a public utilities commission. The results of our analysis suggest that claim cannot be supported in Ohio, as final residential bills were substantially higher in nearly all service territories following retail restructuring.

The results of our analysis bring into sharp relief the contrast between rhetoric and reality. For most of Ohio’s residential retail load, prices have not declined since retail restructuring. For four of the seven metro areas in our study, retail restructuring resulted in higher month-to-month price trends than the trend that existed before restructuring. And while the other three territories of Cincinnati, Columbus and Dayton have seen month-to-month price trends decline or not change relative to pre-restructuring, households in those territories paid a higher real (inflation-adjusted) price, on average, in the period following restructuring than they did in the period preceding.

Our findings stand in stark contrast to the competing analyses that have found mixed or favorable effects associated with retail restructuring. We believe that much of this is due to the fact that the retail restructuring design of SB 221 created a perverse system by which commission intervention distorted true market-basis pricing. Rather than moving to a fully market-based pricing system, the restructuring design allowed all investor-owned utilities to retain protections through a hybridized tariff system (an ESP instead of an MRO) by which substantial regulated costs are passed through to ratepayers. In essence, true retail deregulation never occurred in Ohio—and while wholesale prices declined, retail customers generally saw increasing total bills due to the regulated portion of their bill (i.e., riders and surcharges).

We have also noted that the price effects presented here represent a lower bound of the true effect. Many retail customers on SSO rates are on quantity-adjusted (or tiered) rate structures. Most
households with three or more persons use more than 750 kWh each month, especially in summer months and in homes heated by electricity in winter. The marginal rate (cents/kWh) that customers pay for the energy component of their electricity, as well as for a number of riders and T&D, in most cases, increase after customers use anywhere between 900 and 1,000 kWh. And in most areas this increases yet again when consumption exceeds 1,400 or 1,500 kWh. Thus, our analysis is based upon fixed 750 kWh customer rates and underestimates the much higher marginal rates, and thus total bills, paid by the average modern household.

On the other hand, we also note the importance of considering this tiered rate structure in SSO rates as a sign of the potential benefits of retail electric restructuring. Retail restructuring has brought with it the ability for residential customers (as well as industrial and commercial to a lesser degree) to exercise their Tieboutian option to “vote with their feet.” Customers can switch away from the standard service offer provided by the monopoly utility in their region and contract with a CRES provider. However, we similarly acknowledge that under Ohio’s retail restructuring regime, the majority of the riders, surcharges and T&D charges are unchanged by opting out to a CRES provider. Thus, even the benefits of switching to a marketer on a flat rate basis are heavily muted by the fact that those savings only apply to less than fifty percent of customers’ total bills.

While many prior studies have approached this issue with more breadth, such as national or multi-state studies, we approached this issue with greater depth by digging deeper into the dynamics of a major deregulated state. While our findings are not completely generalizable to all other states, we believe that the issues identified highlight important aspects of restructuring that can inform both the deregulatory and re-regulatory plans in many others. We thus maintain that in most states, simply declaring a state “regulated” or “deregulated” is too simplistic, devoid of fundamental institutional dynamics. Rather, we suggest that restructuring exists on a continuum of degrees of commission intervention. States such as Ohio have two choices in addressing flaws associated with restructuring: movement toward re-regulation or greater market-basis pricing with less commission intervention. While the former would represent a near reversal of current policy toward an established outcome, the latter represents policy adjustment
toward a less clear path forward. Thus, while we feel that we have informed the overall question of whether or not markets make good commissioners, we reflect on the perhaps equally important question of whether or not commissioners make good markets.
References:


The Effect of Retail Electric Restructuring


PUCO (2012). *Case Number 12-315J-EL-COI, Entry Order from PUCO, Entry 127 (Published 1/16/2014)*. Retrieved from [http://dis.puc.state.oh.us/TiffToPDf/A1001001A14A16A95144H29544.pdf](http://dis.puc.state.oh.us/TiffToPDf/A1001001A14A16A95144H29544.pdf)


Appendix

Figure A1. Correlograms of Electricity Prices

Figure (a) Akron

Figure (b) Canton

Figure (c) Cincinnati

Figure (d) Cleveland
Figure (e) Columbus

Figure (f) Dayton

Figure (g) Toledo
### Table A1. Key Market Events in the History of Ohio’s Four Major Investor-owned Utilities

<table>
<thead>
<tr>
<th>Event</th>
<th>AEP Ohio</th>
<th>FirstEnergy</th>
<th>DP&amp;L</th>
<th>Duke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third MRO/ESP Proposal</td>
<td>12/20/2013</td>
<td>4/13/2012</td>
<td>N/A</td>
<td>5/29/2014</td>
</tr>
<tr>
<td>Third MRO/ESP Proposal Approved by PUCO</td>
<td>2/25/2015</td>
<td>1/30/2013</td>
<td>N/A</td>
<td>4/2/2015</td>
</tr>
</tbody>
</table>
Table A2. Number and Proportion of Residential Customers Facing Standard Service Offer Rates by each Utility and Major City

<table>
<thead>
<tr>
<th>Date</th>
<th>FirstEnergy (Akron)</th>
<th>AEP (Canton)</th>
<th>Duke Energy (Cincinnati)</th>
<th>FirstEnergy (Cleveland)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSO Customers</td>
<td>% Switched</td>
<td>SSO Customers</td>
<td>% Switched</td>
</tr>
<tr>
<td>2009</td>
<td>582,482</td>
<td>37.4%</td>
<td>582,488</td>
<td>0.0%</td>
</tr>
<tr>
<td>2010</td>
<td>351,458</td>
<td>60.2%</td>
<td>575,964</td>
<td>0.0%</td>
</tr>
<tr>
<td>2011</td>
<td>329,680</td>
<td>64.1%</td>
<td>586,328</td>
<td>3.1%</td>
</tr>
<tr>
<td>2012</td>
<td>283,740</td>
<td>69.1%</td>
<td>1,012,682</td>
<td>20.4%</td>
</tr>
<tr>
<td>2013</td>
<td>253,945</td>
<td>72.4%</td>
<td>928,838</td>
<td>27.2%</td>
</tr>
<tr>
<td>2014</td>
<td>276,392</td>
<td>70.0%</td>
<td>887,667</td>
<td>30.5%</td>
</tr>
<tr>
<td>2015</td>
<td>300,004</td>
<td>67.5%</td>
<td>860,355</td>
<td>32.8%</td>
</tr>
</tbody>
</table>

Notes: The data for each date are derived from the public switching statistics posted in Q4 of each year (PUCO, 2016B). “SSO Customers” is the number of customers served by the utility on default supply. “% Switched” equals the proportion of total customers within the Utility territory who are served by a CRES.