The Impact of Regulatory Events
on the Value of Bidders in a Restructured Wholesale Electricity Market

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One possible impact of restructured wholesale electricity markets is that the market value of bidders will change in response to changes in auction rules by regulatory agencies. Assuming efficient capital markets, such regulatory decisions ("events") should be translated, perhaps quickly, into repriced share values. This event study uses a database of the daily share prices of major bidders in the PJM auctions from the mid-'90s through 2006 to determine (a) whether FERC decisions approving or denying major changes in proposed PJM auction rules were translated by capital markets into changes in share values, (b) how the FERC decisions affected share values, (c) how changes in auction rules affected the value of individual bidders, and (d) how fundamental differences among the bidders (i.e., cost structures) can explain firm-specific effects. Ten FERC decisions are examined, ranging from the initial authorization to charge market-based prices (March 1999) through approval of the Reliability Pricing Model (December 2006). Using simple OLS in a traditional event study framework, statistically significant effects are identified for some FERC decisions for a portfolio of bidders, and potential explanations for these effects are discussed. Simple OLS is then used to identify firm-specific differentials, and the estimated firm-specific coefficients on the event dummies are used as dependent variables in a model using panel techniques that explains inter-firm differences in responses to the FERC decisions. In contrast to publicly stated policy objectives, the analysis shows that some FERC decisions significantly raised market expectations regarding the future profitability of bidders.

Introduction

Since the mid-1990s, the U.S. and several other countries have been experimenting with a radically different approach to price formation in wholesale electricity markets. Traditionally, these prices were tied, more-or-less, to some measure of the "cost" of production (generation plus transmission), as approved (in the U.S.) by the Federal Energy Regulatory Commission (FERC). Transactions in wholesale markets typically involved only vertically-integrated utilities: companies (for-profit or not-for-profit) that owned, or controlled via long-term contracts, the entire vertical chain of assets required to generate, transmit, and deliver electricity to end-use consumers. Measures of cost allowed under FERC regulation did, however, vary, especially with the passage of the Public Utility Regulatory Policy Act (PURPA) in 1978. In the wake of the energy

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crises of the mid-1970s, the federal government decided to promote the development of a new class of independent generators, typically "cogeneration" facilities, which produced both heat and power. Later statutory and regulatory changes led to a broadened class called Independent Power Providers (IPPs). Payments to both cogenerators and IPPs were, however, typically tied to some measure of "cost" until the 1990s. For example, under PURPA, vertically-integrated utilities were required to pay cogenerators at "avoided cost" prices: projections of the per-unit costs that the utilities would otherwise incur by building generation assets or buying electricity from other utilities.[2]

For a variety of reasons, regulated prices, both wholesale and retail, began to be replaced by "market-based prices" in the 1990s. The reasons for this transition were both practical and ideological. On a practical level, those states with higher-than-average electricity prices pushed earliest for restructuring, goaded in part by industrial customers who saw spot market prices lower than regulated average cost-based prices and thus an opportunity to reduce input costs. Another impetus was the legacy of years of administrative attempts to manage electricity costs, either through PURPA contracts for non-utility generation or conservation and energy efficiency investments, which had yielded retail prices that were deemed "too high". (Joskow (2003) provides more details on the motivations for this transition at the state level.) In order to promote competition in both wholesale and retail markets, some vertically-integrated utilities were required, under state law, to divest themselves of some or all of their generation assets, thus moving the generation from state to federal regulation. Joskow (2000, Table 4-3) found that in the three years 1997-99, almost 90,000 MW of generation either had been divested

Association. David Jackson's expert advice on econometrics generally and his considerable skills with Stata in particular have been invaluable. The usual caveats apply.

or was for sale. Of this total, over 16,000 MW was in PJM. The initial divestiture yielded "market values that were far higher than utilities and their regulators had expected" according to Joskow (2000, 143), who attributes this to some combination of anticipated efficiencies brought on by competition and higher wholesale prices in "unregulated" markets. (Joskow, 2000, 143, n. 43). However, this wave of divestitures was halted, in large part by the West Coast energy crisis of 2000-01 and concerns about the impacts of restructuring on consumers.[3] Ultimately, the question before FERC was how to oversee these new responsibilities. The divestitures were intended to create new wholesale markets for power, which could have remained regulated by FERC under traditional approaches (e.g., embedded-cost or average-cost pricing), or not.

FERC chose "not". As a result of a series of parallel actions at the federal level, the divested assets are constantly repriced in "designed auctions" that permit bids at any level the market will bear, subject in some cases however to price caps or other forms of "price mitigation".[4] Regulation of these new markets has been, at least in the U.S., of the relatively "light-handed" variety: FERC responds to complaints and may investigate the behavior of specific markets, but otherwise has generally shown little interest in demanding that auctions take one form or another. For example, wholesale auctions in the U.S. use entirely "market-clearing prices", also known as single-price auctions, as opposed to "pay-as-bid prices", also known as discriminatory auctions. In contrast, the English experience with auctions has implemented both forms, and currently relies on

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[2] See also Newbery (1999, 258-264) for a summary.
[3] For a more recent status report, see Weigt et al. (2009).
[4] See Helman et al. (2008) and O'Neill et al. (2006).

pay-as-bid, because of concerns about market power.[5] In the U.S., state regulation of wholesale prices, via approval of investments and expenditures by privately-owned vertically integrated utilities, has disappeared in some parts of the country, notably those where FERC has approved the operation of ISOs and RTOs following divestiture of generation.

The welfare effects of these changes are the subject of considerable controversy. Some studies have found considerable cost-savings and thus increased efficiency at the generation stage of production. For example, Zhang (2007) found evidence of cost reductions and increased plant utilization among nuclear generators in the 1990s due to restructuring. Mansur and White (2007) argue that "employing an organized market design substantially improved overall market efficiency, and that these efficiency gains far exceeded implementation costs".[6] Saravia (2003) found that the introduction of speculators reduced forward price/cost margins in western New York. Some critics of FERC believe that the agency has not gone "far enough" to liberate prices from regulatory oversight, and that the various forms of price or bid mitigation interfere with efficient investment decisions. See Hogan and Pope (2007), for example. On the other hand, clear examples of "market meltdown" exist, most notably in the 2000-01 West Coast energy crisis, and arguments about the efficiency and competitiveness of restructured markets continue at FERC and in state arenas, both regulatory and legislative. See Borenstein, Bushnell, and Wolak (2002) for a study of the West Coast crisis. Critics of restructured markets suspect tacit collusion in the presence of repeated

[5] For some contributions to the debate on auction form, see Cramton and Stoft (2007), Kahn et al. (2001), Federico and Rahman (2003), Fabra et al. (2006) and Wolfram (1999).

[6] This is especially relevant because Mansur and White studied a transition in PJM, the market studied here, in 2004.

games, which can describe daily (even hourly) wholesale auctions, and are especially concerned about the possibility that during some hours of the year the number of effective competitors falls so low that one or two firms control the entire market, leading to price spikes that are both (a) effective at transferring income from consumers to producers but (b) not lengthy enough to justify new long-run investments. Blumsack, Lave, and Apt (2008) found "significantly higher price-cost markups" at restructured utilities compared with those that "remained traditionally regulated", and concluded that "restructuring has been beneficial to companies that restructured, but the evidence is far less clear concerning benefits to consumers." Finally, but not exhaustively, both Bushnell and Saravia (2002) and Mansur (2008) found that costs exceeded competitive levels in restructured markets in the mid-Atlantic and New England. In short, the jury is still out.

This paper tries to make a modest contribution to the debate, by using the theory of efficient capital markets to discover whether FERC's decisions have made bidders in one restructured wholesale market more or less profitable, defined by changes in share prices. Although the focus here is PJM, the technique can be replicated in other markets and for other time periods, to determine whether specific FERC decisions have been viewed by capital markets as enhancing or diminishing profitability.[7] Eventually, measures of producer surplus should be brought together with other indicators of the "competitiveness" of restructured markets, and measures of welfare constructed that account for both consumer and producer surplus.

[7] It may also help explain the "higher than expected" result noted by Joskow (2000) when these assets were initially auctioned off in the 1990s.

FERC Reforms of Wholesale Electricity Markets

Since the mid-1990s, the FERC has encouraged, via several general orders, the establishment and spread of market-based pricing at the wholesale level throughout the country. This followed on FERC's relatively successful experience (after some problems caused by the Congressionally mandated "vintaging" of prices) in the deregulation of wellhead natural gas prices, and the general perception that deregulation in transportation and some commodities had been successful. For reviews of these developments, see Gaskins (2007), O'Neill and Helman (2007), Newbery (1999, 258-264), Gilbert and Kahn (1996), and Hunt (2002, Ch. 13). Actions taken by FERC in the late 1990s and early part of this century have also been interpreted as the result of an ideological shift toward markets and away from regulation. See Kuttner (2002) and Weaver (2004).

FERC's stated objectives in all this are the enhancement of competition and the improvement of consumer welfare. Although non-utility generation had been promoted in the late 1970s by the Public Utility Regulatory Policies Act (PURPA), the 1990s witnessed much more significant changes, especially via mandated opening of access to the high voltage transmission systems that facilitated interstate commerce in wholesale power. The passage of the Energy Policy Act (EPAct) of 1992 led FERC to issue Order 888 in 1995, mandating open access and addressing related issues in the transition to increased competition. According to Hunt (2002, Figure 13.1), this led to a dramatic increase in power trading, from almost nil in 1994 to 4.5 million kilowatt-hours in 2000. The next dramatic step was Order 2000, which encouraged investor-owned utilities to divest (either operationally or by outright sale) their transmission assets, which would be operated (or even owned) by independent transmission companies. In practice, these assets continue to be owned by traditional utilities, but daily operational control has been transferred to new entities known as Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs). In parallel with federal action, many states have mandated the divestiture of generation assets to non-utility entities, which complements the FERC initiatives. For a brief review, see MacAvoy (2007, 29-34 and Chapter 3).

Although sometimes referred to as "deregulation", FERC's decisions have actually led to the creation of regulated wholesale auctions for a variety of products and services. In specific cases, FERC has supplemented its general orders with more detailed approval of proposals for specific markets. For example, in the case of PJM, a series of orders (studied here) from 1999 to the present has addressed proposals for the operation of markets in energy, capacity, and transmission rights. See Bowring (2008). Because of the complexity of such markets, a glance at the universe of initial filings, FERC orders, compliance filings, protests, orders of clarification, and in some cases litigation through the courts would confirm that "deregulation" is not the most accurate description of what has actually happened. Auction mechanisms are adopted and modified over time, sometimes dramatically, sometimes very incrementally, but always subject to FERC approval.

The Efficient Market Hypothesis and Event Studies

The use of event studies to test the theory of efficient capital markets has a long history, going back as early as the 1930s. Events can be considered as exogenous shocks to the capital markets, providing new information about future prospects for profitability. This new information is then assumed, via the operation of efficient markets, to be translated into changes in the prices of shares of affected companies. Efficient markets are assumed to take into account all available information, resetting share prices to account for newly formed prospects about future revenues and costs. For surveys of the field, see Brown and Warner (1985), MacKinlay (1997), Binder (1998), and Serra (2002). “Efficiency” in this context is of course a hypothesis to be tested, not a fact to be observed. Capital markets, like other markets, may or may not be based on perfect information, for a variety of reasons. Recent experience in the banking industry has called into question the assumption that capital markets are actually “efficient”. See Nocera (2009), for example.

Nonetheless, one can ask whether identifiable events have predictable effects on stock market prices, and whether the effects on individual firms can be explained by the fundamental characteristics of the firms (e.g., cost structures). We would expect, for example, that the unanticipated announcement of a new technology would have a positive impact on the share prices of the innovator, and a negative impact on the share prices of potential competitors. Earnings announcements, on the other hand, might have a consistently positive impact across an entire industry, if they portend higher profits for that industry generally.

Although event studies began with financial news, e.g., earnings announcements, more recently the impact of regulatory decisions on the market value of firms have also been considered. One area is the regulation of externalities. For example, Billger (2007) found that the passage of the Occupational Safety and Health Act of 1970 depressed the market value of over 1,400 firms. Wooster and Gallet (2005) found that antismoking policies had a significant negative effect on the market value of U.S. cigarette producers;

a similar conclusion regarding antismoking policies was reached by Tomlin (2009) for the Indian hospitality industry. On the other hand, Diltz (2002) found that the Clean Air Act Amendments of 1990 did not negatively affect share prices of certain electric utilities. A second area is telecommunications. Hoag (2002) discovered that the Cable Communications Policy Act of 1984 was probably less important that other fundamental determinants of market value in the cable industry at the time. Different regulatory regimes were considered by Dnes and Seaton (1999) tried to determine whether British Telecom had "captured" its regulator, and Cable et al. (2002) checked for the "winner's curse" in the same industry. A third area is quality standards. McGuire and Dilts (2008) examined the adoption of quality standards (specifically, ISO 9000) and determined that the announcement by a firm that it had been certified affected the market value of the firm. Fourth, Joo, et al. (2007) examined the impact of the widespread blackout of 2003 on both electricity producers and manufacturers of electrical equipment, finding that the former were harmed and the latter positively affected, as might be expected. Finally, and more broadly, Schwert (1981) reviewed the experience of several regulated industries, including electricity, in an attempt to assess the theory of capture more generally, and Lamdin (2001) and Binder (1985) reviewed problems associated with the study of regulatory events generally.

In this study, the regulatory decisions of the FERC are the "events" to be examined. Expectations regarding the impacts of these events are broadly based on FERC's stated policies, as described above. One important purpose of these policies is the promotion of competition. If so, then the FERC decisions should have a consistent and negative effect on share prices, because more competition should drive down future profits, which should in turn drive down the current willingness to pay for shares of affected companies. It is of course possible that the capital markets have not yet figured out how to interpret FERC rulings, or that the rulings are vague in their economic consequences, or that the information required to accurately reprice shares is not available to capital markets. For all these reasons, one might expect to find *no* impact of FERC orders on share prices. (It is also possible that FERC's effect on profitability is positive because costs are "competed down" without a commensurate impact on prices.) Thus, the null hypothesis is that the relevant estimated coefficients will be not significantly different from zero.

However, FERC orders may, by intent or inadvertence, have an effect contrary to the stated purposes. Imperfect understanding of the operation of markets, and the impacts of regulatory decisions on markets, may exist both on Wall Street and Capitol Hill. Thus, FERC may "do no harm" and not affect the state of competition in organized wholesale markets, or FERC may actually cause wealth or income to shift to stockholders from customers by their decisions. If costs are "competed down" but prices are not, then profitability will increase but rents will be shifted from consumers to producers. We are left with the basic questions. Have regulatory decisions affected the market value of bidders in these auctions? Do capital markets quickly incorporate information about regulatory changes into share prices? Have federally approved changes in auction design for wholesale electricity made shareholders better off? Have FERC decisions been interpreted by capital markets as increasing or decreasing the profitability of bidders in organized wholesale electricity auctions?

The Market: PJM

In the current study, the theory of efficient capital markets, as tested via event studies, is applied to a specific restructured wholesale electricity market: PJM, which has been a FERC-authorized Regional Transmission Operator (RTO) since 2002 under Order No. 2000.[8] "PJM" here is shorthand for the successor to the "Pennsylvania-New Jersey-Maryland" (hence, PJM) coordinated power pool, started in 1927.[9] Until the mid-1990s, PJM was a traditional "tight power pool", operating in several mid-Atlantic states under "cost-based" rules, in which wholesale transactions between vertically-integrated utilities were organized, by the Pool itself, to minimize the total cost of generation. Inter-utility payments (net financial obligations) were used to compensate owners of generation whose energy production was scheduled or dispatched to meet the obligations of another pool member. The objective of a power pool in general was to minimize the cost of energy produced through contractual exchanges. Wholesale transactions among members of the power pool were determined by "least cost dispatch" with after-the-fact financial settlements.[10] Between the mid-1990s and the early part of this decade, PJM evolved into an RTO under FERC regulation, operating various electricity auctions (energy, capacity, transmission rights). This began with a real-time energy market in 1997, followed by Locational Marginal Pricing (LMP) energy markets in 1998, and Financial Transmission Rights (FTR) markets in 1999. Most recently, PJM has been approved to operate a Reliability Pricing Model (RPM) market.[11] LMP, FTR, and RPM markets are defined by different kinds of transactions; in LMP markets, spot market

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[8] See FERC (1999, "Order 2000") and (2002, approving PJM as an RTO).

[9] See PJM (2005), available at http://www2.pjm.com/services/training/downloads/20050718-lse-intro-to-pjm-system.pdf.

[10] See Joskow and Schmalensee (1983), 66-77 for a general discussion of power pools before restructuring.

energy is traded at specific nodes in the PJM system; FTR markets provide hedging rights against locational differentials in spot market energy prices; and in RPM markets, future commitments to provide generation capacity are bought and sold.

The choice of PJM is a fairly natural one for this study. First, FERC decisions that may have affected share prices can be identified with ease. Second, as with any organized power market, record-keeping requirements provide a clear path to identify the relevant bidders at any given time. Third, Bodmer's recent studies (2007, 2009) have provided evidence of the growth in value of bidders in this market over time. Finally, this organized market has been the source of considerable controversy recently for several reasons. Allegations that the market monitor was insufficiently independent of the PJM Board led to a decision to spin-off the monitor into a new company, Monitoring Analytics, in 2008, and controversy continues over the newly implemented Reliability Pricing Model (RPM).

In event studies, "ideal events" occur at distinct, well-specified moments (e.g., release of an earnings report), at times when the capital market did not "expect" the news and thus did not have an opportunity to "buy (or sell) on the rumor". In contrast, the regulatory process is slow at best, often glacial. Initial filings by regulated entities are sometimes made years before FERC issues a final order in the case. Interim orders may or may not provide any useful information about the final orders. Some cases are handed to Administrative Law Judges (ALJs), who themselves may issue a series of orders before reaching a conclusion, which then must be reviewed by the entire Commission. On the other hand, some regulatory decisions *are* "surprises" to the capital markets, in the

[11] See FERC (2006).

sense that FERC is known to *not* leak the content of its decisions beforehand. In order to simplify the effort, we have focused on "final orders" of the Commission that allowed or modified PJM auctions. This gives us a population of ten decisions between 1999 and 2006, shown in Table 1. Note that these ten decisions all have something in common: they all authorize market operations in some way or, at the outset, allow shifts from cost-based bidding to market-based bidding. Thus, they are all consistent with FERC's overall direction toward greater reliance on market forces to set wholesale prices.

Expectations on the effects of FERC's decisions in this setting require some discussion. First, one might believe that capital markets do not have sufficient information to translate FERC decisions into new asset prices. In this case, we would expect to find insignificant estimated coefficients. Capital markets may be "efficient" at translating some information, but not enough to accurately predict the effects of FERC's orders. Second, one might believe that capital markets reflect the overall objective of FERC, greater competition into wholesale electricity markets, and that capital markets have sufficient information to determine how much reduction in profitability is associated with a given FERC decision. In this case, we should expect that estimated coefficients are negative and significant. Finally, it is possible that some FERC decisions have unintended consequences: they may cause wholesale markets to become *less* competitive, thus *increasing* expected profitability of bidders and, via efficient capital markets, *increasing* their share prices.

<u>Construction of a Portfolio of Bidders</u>

The first step in constructing the dataset was the identification of bidders: publicly-traded firms that do business in the PJM auctions on a regular basis in sufficient volume that their share prices might be affected by PJM's auction rules. One place to start would be "PJM membership", but this includes over 300 entities, many of which are not bidders into wholesale auctions. We focused instead on the largest generation owners who bid into PJM's auctions. An initial list of firms was taken from Bodmer (2007); this was supplemented by identifying some firms that joined PJM later than Bodmer's study, and by eliminating firms whose non-PJM generating capacity was deemed to be "too large" for inclusion in the portfolio. Several complications with the resulting portfolio should be noted. First, PJM expanded significantly over time, so the constructed portfolio of bidders grows in size during the sample period, although some firms enter the portfolio only near the end of the sample. Second, many companies operating within PJM have significant assets outside of PJM; share prices reflect the overall value of a firm, though only a fraction of the firm's operations may be in PJM. We take this into account in the firm-specific analysis of share price responses to FERC decisions. Third, many firms had serious financial problems due to issues not related to PJM (including bankruptcies and severe stock price decreases). We have not yet taken these additional events into account. Fourth, companies have different degrees of traditionally regulated (cost-based) and deregulated (auction-based) power generation; some entities must fulfill long-term obligations to deliver energy at regulated cost-based prices. We have not yet found a simple way to identify the relevant shares of cost-based and auction-based generation assets. Finally, some companies merged into other companies or went bankrupt, creating gaps in the data set. In any event, the result is a portfolio of 19 firms based on sales of generation services in 2005 and large service territories, as shown in Table 2.

For these firms in the portfolio, daily information on share prices of identified bidders was collected for the period 1/1/95 through 12/31/07: approximately 3,400 observations per firm.[12] This price data is available in "unadjusted" and "adjusted" formats, where the latter includes the effects of dividends and share splits; we used the adjusted data because we wanted to include all potential returns to shareholders. Daily prices were then converted into simple "one-day holding period returns": the percentage return to a shareholder of buying the stock on day *t* and selling it on day $t + 1$. One-day holding period returns (HPRs) are a common method for measuring change in value to shareholders over time in event studies. One-day HPRs for individual firms were then aggregated into a return to the portfolio of bidders. The one-day HPRs are the dependent variables in the initial analyses.

Effects of FERC Decisions on the Value of the Portfolio

The initial test of FERC's impact on shareholder value via the efficient market hypothesis is the calculation of "abnormal returns", which are defined here as the difference between a one-day holding period return for a share and the same return for the market as a whole. We start with a "very simple market model". First, we estimate

$$HPR_{it} = f(S\&P_t) = a_i + b_i * S\&P_t + e_{it} \qquad (1)$$

For the i^{th} firm, the HPR_i for day *t* is assumed to be simply a linear function of the S&P index for that day, and e_{it} is assumed to be independent and normally distributed. The

12 The source was finance.yahoo.com.

first step is to estimate (1) for the portfolio of bidders: aggregating over firms. This "washes out" the overall effects of the capital markets and leaves a residual to be further investigated. A subsample of the entire time series defines the "estimation window" (or set of windows) during the sample period, by eliminating "event windows": periods assumed to be affected by the FERC decisions. In our case, the estimation window was defined to be all daily observations *except* those in ten 23-day periods, one for each FERC/PJM event. The 23-day period was chosen because that is the shortest time period between any two of the ten identified events. Event windows from one to 23 days were all tested, and the results shown in Table 3. The conclusions reached here are not substantially altered by consideration of shorter event windows.

The next step is to use the estimated coefficients (b_i) from (1) to predict HPRs for the portfolio during the ten event windows. The residuals from these predictions are defined as "abnormal returns" (ARs) for each day. The ARs are accumulated over the event windows to illustrate "cumulative abnormal returns" (CARs) for each event for the portfolio of firms. The CAR on each day is a measure of the value of the portfolio of stocks relative to the day of the announcement. On the day of each event, the portfolio's stock is indexed at 100, so if by day 23 the level of the CAR has risen to 110, the value of the portfolio has risen by 10%. The null hypothesis for this particular stage of the analysis is that there would be no discernable effects on the market value of the portfolio of firms due to the ten FERC decisions: capital markets do not have a consistent and accurate method to translate regulatory decisions into new values for share prices. The CARs tell a different, and much more interesting, story. In Figure 1, we can see that although some events have what might be called erratic or insignificant effects on CARs, in a few cases there are persistent effects that leave share prices at the end of the 23-day event windows noticeably different from prices on the day of each event. It would appear that capital markets are repricing the shares of bidders into PJM auctions based on the expected effects of FERC's decisions, at least in some cases.

Are these results statistically significant? To answer this question, we estimated a simple equation for the portfolio:

$$HPR_t = a + b*S\&P_t + D_j + e_t \quad (2)$$

where D_j is an array of ten dummy variables, each of which takes on the value of one during its respective event window. Simple OLS yields the results in Table 3, which demonstrates that we probably have some combination of all three types of response by capital markets to FERC decisions: indifference or ignorance, rising share prices, and falling share prices. For most of the ten events, it appears that capital markets did not react to FERC's decisions: coefficients on most dummy variables are insignificantly different from zero. However, we get different results for Events 4, 6 and 8; from the list above,

- Event 4 permitted market-based pricing for Regulation Service;
- Event 6 granted "provisional RTO" status *but* instructed PJM to join NYISO and New England ISO to form a single Northeastern RTO; while
- Event 8 granted "full RTO" status *and* removed the directive to form a single Northeastern RTO.

Events 4 and 8 consistently *increased* share prices of the portfolio of bidders, across the entire spectrum of event windows, although it appears to have taken somewhat longer for capital markets to adjust to Event 8 than Event 4. Event 6, on the other hand, had the opposite effect: after a few days, capital markets drove share prices for the portfolio *down*. Note that these conclusions for Events 4, 6, and 8 are generally robust to the duration of the event window: shortening the event window down from 23 days still generates estimated coefficients that are significantly different from zero on most days.[13] One additional observation is that the capital markets apparently became more aware of the impact of regulatory decisions over time. That is, of the ten events studied, there was no observable response by capital markets to Events 1-3, which took place in 1999, but the period 2000-2002 witnessed three significant responses by capital markets. Two explanations come to mind. First, the capital markets may have become more sophisticated over time; second, and perhaps equally important, the period 2000-2002 includes the West Coast energy market crisis, which drew much attention to previously quiet segments of the economy.

Interpreting these results for these three events requires a bit more detail about each decision. Event 4 provided for market-based pricing of regulation service. The Letter Order issued in mid-April 2000 was a mere two pages long, but accepted, without modification and with no objections, a filing made by PJM in mid-February of the same year. The capital markets thus had about two months to consider the implications of the PJM filing. Market-based pricing in PJM of energy imbalance and operating reserves had previously been approved by FERC in 1999 (86 FERC ¶61,248), but this new Letter Order extended market-based pricing to regulation service. Thus, Event 4 was an authorization to operate a new market, one expected by capital markets to be more profitable for bidders. Interestingly, the February filing had contained information

[13] All reported standard errors are robust, using the Huber/White/sandwich default approach in Stata.

deemed so commercially sensitive that it was submitted only with the understanding that it would be treated as "confidential and privileged", but capital markets reacted anyway. Event 6, an order of July 2001, approved a compliance filing by PJM of the previous October, in which PJM sought approval as a Regional Transmission Operator as described in Order 2000. (See "Order Provisionally Granting RTO Status", 96 FERC ¶ 61,061, Docket No. RT-01-2-000.) In this case the capital markets had over six months to consider the implications of the filing. The Commission conditionally approved PJM's application, subject to modifications however. The most significant condition imposed by FERC was that PJM enter into an expedited 45-day mediation process to merge with the ISOs of New York and New England, and to create a single RTO. Finally, in Event 8, an order of December 2002, FERC *removed* the condition of merger with the ISOs of New York and New England, and allowed PJM to commence operations as a fully-recognized RTO. (See "Order Granting PJM RTO Status, Granting in Part and Denying in Part Requests for Rehearing, Accepting and Directing Compliance Filing, and Denying Motion for Stay", 101 FERC ¶61, 345, December 20, 2002.) In this case, capital markets had had the opportunity to observe PJM's actions since the summer of 2001.

Thus, although Events 4 and 8 can be interpreted as moving PJM fairly straightforwardly into the operation of new markets, Event 6 had a major constraint on that movement. Events 4 and 8 were interpreted positively from the perspective of the capital markets, and share prices rose accordingly. Event 6 was interpreted negatively, and reduced share prices significantly. The negative impact of the conditional approval of July 2001 can be interpreted in (at least) two ways. First, the merger with New York and New England could have introduced considerable uncertainty into the design of the resulting markets, and certainly would have raised transactions costs of bidders both in the short-run (getting to agreement) and the long-run (making changes to staffing, software and hardware to accommodate new market designs). Second, the merger with New York and New England might have effectively increased the size of "the market", introducing more competition and thus lowering profits and share prices. In any case, these three events demonstrate that FERC's decisions can be interpreted both positively and negatively by the capital markets.

Firm-Specific Responses to FERC Decisions

In addition to the portfolio, we can estimate the sensitivity of individual firms' share prices to these regulatory decisions. In general, one would expect that the adoption (or rejection) of a specific type of auction, or the adoption of auctions with conditions, would affect bidders differently depending on their individual cost structures and relative exposure to the PJM markets. The estimations described in this section are a replication of the approach immediately above, but focus on individual bidders rather than the entire portfolio. There are two purposes for this: first, the results for the portfolio may be dominated by the experience of one or a small number of bidders; and second, the procedure yields firm-specific and event-specific estimated coefficients that are used as inputs (dependent variables) in subsequent analyses.

Firm-specific data on cost structure and strength of exposure to PJM markets should help explain individual responses to FERC events.[14] In this section, panel data techniques are applied to a dependent variable defined as the individual firms' responses

[14] APPA's EMRI program has graciously made this data available.

to FERC events. The exogenous variables are firm-specific measures of cost structure; mean values of some independent variables are in Table 4, all variables are defined in Table 5, and results of the regressions are shown in Table 6. The use of estimated coefficients as dependent variables goes back at least to the work of Lave and Lave (1970) on differences in cost functions among Pennsylvania hospitals; more recently, Villalonga (2000) has applied this technique to determine the effects of privatization on Spanish firms.

Although the value of the portfolio of bidders has been affected by some of FERC's PJM decisions, we are also interested in understanding why these effects have not been the same for all firms in the portfolio. In general, we would *not* expect uniform results across the portfolio, because the cost structures of the bidders are not the same. Consider two hypothetical extremes. Firm A owns or holds contract rights to generation only from nuclear plants, with relatively high fixed and low marginal costs that are a function of long-term fuel contracts; this puts A at the lower left end of the aggregated bid or marginal cost curve. Firm B, on the other hand, is concentrated on small combustion turbines that have relatively low fixed but high marginal costs, and furthermore those marginal costs are dependent on fuels that themselves are relatively volatile, such as diesel or natural gas. Firm B finds itself at the top right end of the bid curve, which is also probably less stable or predictable because it is a function of the availability of specific generators in specific locations, the number of bidders on any given hour, and the prices of fuels. Any given FERC decision that affects market-clearing prices in PJM could have very different effects on Firms A and B. Firm A would generally be better off if prices rise, whereas Firm B might be better or worse off, depending on the interaction of wholesale power and fuel prices and the stability of the upper right end of the aggregated bid curve.

Consider the differences among firms in Table 4. Allegheny and PEPCO were almost completely dependent on the PJM markets during the sample period, but FirstEnergy sold less than 20 percent of its total energy on average into PJM during the same period. Allegheny and Pepco sold no nuclear-generated power during this period, but FirstEnergy and Exelon were both heavily dependent on nuclear. These differences can reasonably be expected to influence the responses of individual share prices to FERC decisions.

The discussion here will focus on Events 6 and 8, which had significant and opposite effects on the value of the portfolio of bidders. Event 6 tended to drive share prices down, whereas Event 8 had the opposite effect. Within these events, we further limit the review to firm-specific measures of generation shares that were statistically significant for both events. Perhaps the most interesting result is that a greater reliance on certain types of generation had *opposite* effects on share prices in the contexts of these two events. For example, although the value of the portfolio was reduced overall by Event 6, firms with more combustion turbines (*logratioCC_all)*, hydroelectric power (*logratioHY_WAT)*, uranium (*logratioNU_URA)*, and coal (*logratioST_COL*) benefited relative to firms with more gas turbines (*logratioGT_all*) and pumped storage (*logratioPS_WAT*). The latter group should be more dependent for value on peak period prices (gas turbines) or the ratio of peak to off-peak prices (pumped storage), which suggests that the capital markets expected *both* lower power prices on average *and* lower differences between peak and off-peak prices, as a result of Event 6. In contrast, although Event 8 was interpreted as beneficial to share prices for the portfolio, the signs of the coefficients on these same variables were all the opposite of those for Event 6, suggesting that the capital markets expected *both* higher overall prices *and* higher differentials between peak and off-peak prices after Event 8.[15] These differences confirm the interpretations offered above for the differential in the impacts of Events 6 and 8: expectations in capital markets after Event 6 were pessimistic about the prospects for profits, which would be reduced by lower price levels *and* lower intertemporal price differentials, whereas the FERC decision to allow PJM to operate additional auctions without the need to integrate with New York and New England meant that both price levels *and* intertemporal price differentials in PJM were expected to increase. The expected additional profitability after Event 8 can be explained by the cost structures of the bidders themselves, confirming the theory that capital markets acted in a manner at least consistent with efficiency as defined by the cost structures of bidders.

Conclusions

This paper is believed to be the first attempt to use the responses of capital markets to FERC decisions to help understand the impacts of regulatory events in restructured wholesale power markets. The results are instructive, given the rhetoric surrounding federal regulatory policy, and cannot be easily dismissed. Some blanket decisions to allow the development of auctions, or the shift to bid-based prices from cost-based prices, have been interpreted by Wall Street as opportunities for additional profits, thus increasing share prices. The sources of such increased profitability need to be

[15] The coefficient on GT was, however, not significantly different from zero in Event 8.

considered. Do these new electricity markets drive costs down faster than prices? If so, what causes the gap between prices and costs to grow? In the alternative, do the auctions simply drive prices up? Did capital markets expect FERC's decisions to push costs down or prices up, or both? If the first, how does that help us understand the results of Event 6? Was the decision, later overturned, to push PJM into a single Northeastern RTO expected to increase costs or reduce prices, or was it interpreted as simply an increase in the uncertainty associated with investments in these firms? Did Event 8 resolve that uncertainty, or did it effectively reduce competitive pressures? Given that cost-minimization is the dual of profit-maximization, and the fact that these bidders were presumably profit-maximizing in the first place, it would seem reasonable to conclude that the capital markets thought that output prices would be further increased by these FERC decisions, rather than costs further reduced, or reduced more than prices would fall. If so, then we can conclude that some of FERC's decisions have not enhanced competition, at least when viewed through the lens of the theory of efficient capital markets.

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Table 1: Major FERC Decisions Affecting PJM

1. 1/13/1999: Allowed the creation of a capacity market
2. 3/10/1999: Removed cost-based price caps; permitted market-based bids
3. 4/13/1999: Conditionally approved compliance filing for Fixed Transmission Rights (FTR) auction procedures
4. 4/12/2000: Permitted market-based pricing and new market rules for Regulation Service
5. 5/18/2000: Approved a two settlement system (some but not all transmission costs could be fixed ahead of the actual transmission transaction)
6. 7/12/2001: Granted "provisional RTO" status; instructed PJM to join NYISO and New England ISO to form a single Northeastern RTO
7. 10/31/2002: Granted authority to begin a real-time spinning reserve market
8. 12/20/2002: Granted "full RTO" status; removed the directive to form a Northeastern RTO
9. 3/12/2003: Permitted expansion of FTR markets: yearly, daily, peak and off-peak products
10. 12/22/2006: Approved the Reliability Pricing Model (new capacity market)

Source: Bowring (2008), 384-5.

Table 2: Bidders in the Portfolio

1. Edison International
2. Exelon Corporation
3. PSEG
4. PPL Corp.
5. Reliant Energy
6. Allegheny Energy Inc.
7. Constellation Energy Group
8. Mirant Corporation
9. Pepco Holdings Inc.
10. Dominion Resources Inc.
11. FPL Group
12. AES Group
13. NRG Energy Inc.
14. Duquesne
15. Dynegy
16. First Energy
17. AEP
18. Duke Energy
19. Dayton Power & Light

Figure 1: Cumulative (Normalized) Abnormal Returns for the Ten FERC Events

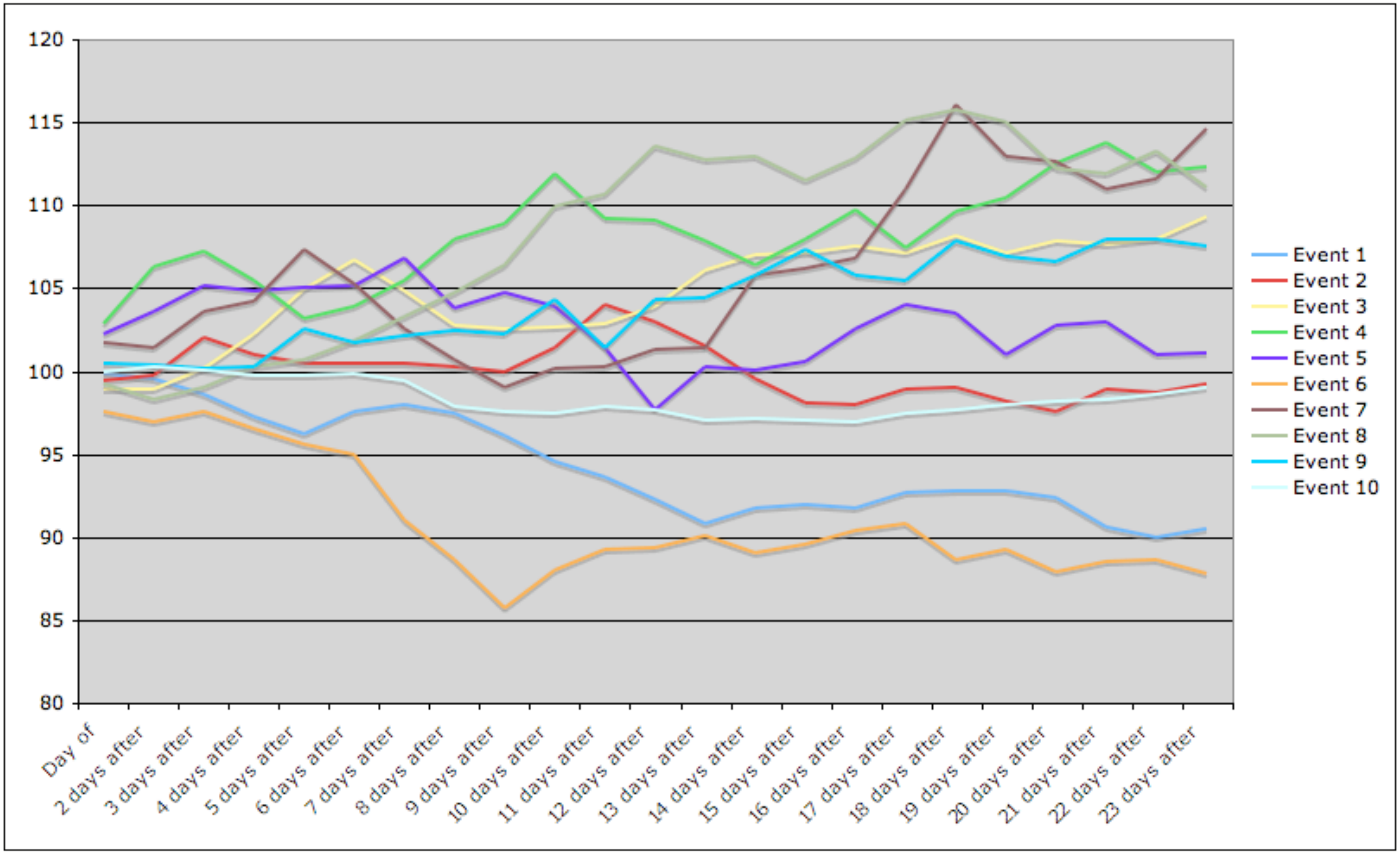

Table 3: Effects of FERC Decisions on the Value of the Portfolio

Window Length (days)	23	22	21	20	19	18	17	16	15	14	13
VARIABLE	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr
sphpr500	0.537***	0.537***	0.537***	0.537***	0.537***	0.536***	0.536***	0.537***	0.537***	0.537***	0.537***
	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178
dummy1	-0.00734**	-0.00464**	-0.00454*	-0.0038	-0.00379	-0.00402	-0.00434	-0.00523*	-0.00545*	-0.00608**	-0.00734**
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy2	0.00129	-0.000461	-0.000381	-0.00105	-0.000796	-0.000351	-0.000498	-0.00116	-0.00115	-0.000207	0.00129
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy3	0.00466	0.00362	0.00367	0.00394	0.00382	0.00458*	0.00423	0.00471*	0.00473*	0.00498*	0.00466
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy4	0.00607**	0.00539**	0.00643***	0.00618**	0.00548**	0.00541**	0.00448*	0.00604**	0.00532*	0.00466	0.00607**
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy5	0.000446	0.000675	0.00166	0.00162	0.000771	0.0022	0.00255	0.0018	0.000611	0.000223	0.000446
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy6	-0.00779**	-0.00523**	-0.00554**	-0.00620**	-0.00572**	-0.00639**	-0.00544**	-0.00603**	-0.00711**	-0.00803***	-0.00779**
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy7	0.00122	0.00531**	0.00529**	0.00629**	0.00678***	0.00866***	0.00642**	0.00435	0.0042	0.00424	0.00122
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy8	0.00934***	0.00585***	0.00555**	0.00598**	0.00758***	0.00836***	0.00850***	0.00772***	0.00742***	0.00886***	0.00934***
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
dummy9	0.00344	0.00364	0.00384	0.0034	0.00369	0.00441*	0.00334	0.0037	0.00485*	0.00412	0.00344
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00266	-0.00274	-0.00283	-0.00292	-0.00303
dummy10	-0.00229	-0.000526	-0.000708	-0.000832	-0.00096	-0.00117	-0.00143	-0.00189	-0.00196	-0.002	-0.00229
	-0.00303	-0.00234	-0.00239	-0.00245	-0.00251	-0.00258	-0.00265	-0.00274	-0.00283	-0.00292	-0.00303
Constant	0.000492**	0.000436**	0.000430**	0.000433**	0.000430**	0.000409**	0.000436**	0.000459**	0.000475**	0.000482**	0.000492**
	-0.000195	-0.000198	-0.000197	-0.000197	-0.000197	-0.000196	-0.000196	-0.000196	-0.000195	-0.000195	-0.000195
Observations	3272	3272	3272	3272	3272	3272	3272	3272	3272	3272	3272
R-squared	0.225	0.225	0.225	0.225	0.225	0.227	0.225	0.224	0.224	0.225	0.225
***p < 0.01, **p < 0.05, *p < 0.1 (Note: the fact that all s.e. are negative is an artifact of Stata talking to Excel.)											

Table 3 (cont.)

Window Length (days)	12	11	10	9	8	7	6	5	4	3	2	1
VARIABLE	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr	meanhpr
sphpr500	0.538***	0.537***	0.536***	0.537***	0.538***	0.540***	0.540***	0.539***	0.542***	0.545***	0.543***	0.541***
	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0178	-0.0179	-0.0179	-0.0179	-0.0179	-0.0179	-0.0178
dummy1	-0.00660**	-0.00595*	-0.00556	-0.00431	-0.00319	-0.00291	-0.00399	-0.00768	-0.00682	-0.00457	-0.00251	-0.00108
	-0.00316	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00547	-0.00631	-0.00772	-0.0109
dummy2	0.0025	0.00367	0.00151	-3.63E-05	0.000349	0.000773	0.000868	0.00109	0.0026	0.00668	-0.00111	-0.00596
	-0.00315	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00547	-0.00631	-0.00772	-0.0109
dummy3	0.00333	0.0027	0.00276	0.00294	0.00352	0.00697*	0.0110**	0.00976**	0.00571	0.000562	-0.0056	-0.0106
	-0.00315	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00547	-0.00631	-0.00772	-0.0109
dummy4	0.00750**	0.00826**	0.0115***	0.00965***	0.00984**	0.00788*	0.00672	0.00657	0.0136**	0.0239***	0.0313***	0.0283***
	-0.00316	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00548	-0.00633	-0.00773	-0.0109
dummy5	-0.00176	0.00141	0.00399	0.0052	0.00474	0.00952**	0.00850*	0.00996**	0.0121**	0.0170***	0.0178**	0.0220**
	-0.00315	-0.0033	-0.00345	-0.00364	-0.00387	-0.00414	-0.00447	-0.00489	-0.00547	-0.00631	-0.00773	-0.0109
dummy6	-0.00915***	-0.0101***	-0.0124***	-0.0169***	-0.0148***	-0.0132***	-0.00848*	-0.00886*	-0.00872	-0.00812	-0.0157**	-0.0248**
	-0.00316	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00547	-0.00631	-0.00773	-0.0109
dummy7	0.00127	0.000438	0.000349	-0.000914	0.00101	0.00389	0.00874*	0.0143***	0.0105*	0.0118*	0.0069	0.0172
	-0.00316	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00547	-0.00631	-0.00772	-0.0109
dummy8	0.0108***	0.00934***	0.00964***	0.00694*	0.00587	0.00468	0.00311	0.00149	0.000709	-0.00321	-0.00875	-0.0077
	-0.00316	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00547	-0.00631	-0.00772	-0.0109
dummy9	0.00365	0.0014	0.00432	0.00255	0.00303	0.00301	0.00283	0.00515	0.000635	0.000627	0.00166	0.00466
	-0.00316	-0.0033	-0.00346	-0.00364	-0.00387	-0.00414	-0.00447	-0.0049	-0.00548	-0.00631	-0.00773	-0.0109
dummy10	-0.00192	-0.00191	-0.00248	-0.00272	-0.00271	-0.000794	-0.000157	-0.000384	-0.000648	0.000211	0.00116	-0.000144
	-0.00315	-0.0033	-0.00345	-0.00364	-0.00387	-0.00413	-0.00447	-0.00489	-0.00547	-0.00631	-0.00772	-0.0109
Constant	0.000492**	0.000496**	0.000487**	0.000521***	0.000509***	0.000484**	0.000473**	0.000479**	0.000490**	0.000483**	0.000510***	0.000519***
	-0.000194	-0.000194	-0.000194	-0.000193	-0.000193	-0.000193	-0.000193	-0.000193	-0.000192	-0.000192	-0.000192	-0.000192
Observations	3272	3272	3272	3272	3272	3272	3272	3272	3272	3272	3272	3272
R-squared	0.226	0.224	0.227	0.226	0.224	0.223	0.222	0.223	0.222	0.224	0.224	0.222
***p < 0.01, **p < 0.05, *p < 0.1												

Table 4: Mean Values for Individual Firms in the Portfolio

	Allegheny Energy Inc	American Electric Power Co Inc	Constellation Energy Group	Dominion Resources Inc	Exelon Corp	FirstEnergy Corp	Pepco Holdings Inc	PPL Corp	Public Service Enterprise Group Inc
PJM/non-PJM generation	99.96%	72.90%	84.33%	88.34%	91.73%	17.63%	98.47%	89.91%	78.16%
log[(CCCT/TotGen)+1]	0.25%	0.08%	0.00%	4.22%	0.00%	0.00%	29.46%	0.53%	6.61%
log[(GT/TotGen)+1]	0.37%	0.01%	0.62%	0.49%	0.04%	0.25%	2.46%	0.23%	2.11%
log[(Hydro/TotGen)+1]	0.39%	0.72%	3.31%	0.99%	1.34%	0.00%	0.00%	1.62%	0.00%
log[(IC/TotGen)+1]	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%	0.00%
log[(Nuclear/TotGen)+1]	0.00%	7.43%	34.37%	31.67%	65.20%	70.51%	0.00%	31.72%	47.04%
log[(PS/TotGen)+1]	-0.92%	-0.14%	0.00%	-0.89%	-0.28%	-2.69%	0.00%	0.00%	-0.22%
log[(Coal/TotGen)+1]	69.26%	64.95%	43.47%	43.24%	6.55%	0.00%	47.56%	44.57%	26.20%
log[(Wood/TotGen)+1]	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%
log[(Steam/TotGen)+1]	0.00%	0.00%	0.29%	3.32%	0.19%	0.00%	0.65%	3.73%	0.73%
Observations	156	156	156	156	85	74	65	156	156

Table 5: Variable Definitions for Firm-Specific Analysis

COMPANY: company name

DAY23COEFF#: Firm-specific values of estimated coefficients (beta-hat) for 23-day event window for regulatory event #. For example: day23coeff1 is the vector of beta-hats from each firm-specific event window regression for the 23rd day of the event window.

DEFLATOR: seasonally adjusted GDP-deflator, calculated quarterly

DEFLATOR1: *DEFLATOR*/100

fuel(PM abbreviation)_(fuel abbreviation): fuel costs by prime mover (PM) and fuel, all firm-specific and monthly

> *fuelCC_all* is the sum of combined cycle (CC) turbine costs using Natural Gas and Light Oil
>
> *fuelGT_all* is the sum of gas turbine (GT) costs using Gasoline, Kerosene, Natural Gas, Light Oil, and Heavy Oil
>
> *fuelIC_all* is the sum of internal combustion (IC) costs using Light Oil and Gasoline
>
> *fuelST_WDS* is the total cost for steam (ST) generated by woody debris
>
> *fuelST_allnoncoal* is the sum of steam costs using Gasoline, Natural Gas, Light Oil, and Heavy Oil

generationPJM: total generation within PJM

generationoutside: total generation outside PJM

generationtotal: *generationPJM* + *generationoutside*

generationratioPJM: *generationPJM*/*generationtotal*

index: numeric equivalent of company, used for (tsset index month) in Stata

logratio(PM abbreviation)_(fuel abbreviation): combinations of prime movers and fuels, similar to *fuel(PM abbreviation)_(fuel abbreviation)*. For each combination, the value is:

> log((*netget(PM)_(F)*/*generationPJM*) + 1)
>
> *logratioCC_all* = log((*netgenCC_all*/*generationPJM*) + 1)

This prevents undefined logarithms. Coefficients show the effect of a one percent relative change in prime mover composition.

month: time variable

netgen(PM)_(F): net generation by fuel type; variable combinations identical to those listed above for *fuel(PM abbreviation)_(fuel abbreviation)*

ratio(PM)_(F): ratio of generation by a given prime mover to total generation within PJM; combinations are identical to those listed above for *fuel(PM abbreviation)_(fuel abbreviation)*

realfuel(PM)_(F): same as fuel(PM)_(F) above, but inflation-adjusted

realtotalcost(PM)_(F): generation costs by PM and fuel; combinations of *PM* and *F* as above; inflation-adjusted

totalcost(PM)_(F): total variable costs; combinations of *PM* and *F* as above

Table 6: Explanation of Firm-Specific Estimated Coefficients

Events →	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	day23coeff1	day23coeff2	day23coeff 3	day23coeff 4	day23coeff5	day23coef f6	day23coeff7	day23coeff8	day23coeff 9	day23coeff 9
INDEPENDENT VARIABLES										
generationPJM	6.88e-11	-2.27e-10***	1.38e-10	1.39e-10	-2.03e-10***	0	5.83e-10***	-5.15e-11	2.60e-10	2.37e-10
	(0.457)	(-3.250)	(1.545)	(1.344)	(-3.313)	(0.0371)	(4.310)	(-0.158)	(0.703)	(0.917)
generationratioPJM	0.00265*	-0.000672	0.00335***	-0.00485***	0.00464***	-0.00117	0.00242**	0.00385*	0.00709***	0.00615**
	(1.746)	(-0.884)	(3.571)	(-5.565)	(6.950)	(-0.480)	(2.221)	(1.755)	(2.894)	(2.436)
logratioCC_all	0.0289***	-0.0120***	-0.00714	-0.00730	-0.00921	0.0748***	-0.0546***	-0.0731***	-0.0870***	-0.0370***
	(3.032)	(-3.892)	(-1.017)	(-0.632)	(-1.459)	(4.413)	(-5.135)	(-3.818)	(-6.374)	(-4.424)
logratioGT_all	0.00642	-0.00739***	0.00687	-0.0133	0.00310	-0.108***	0.0338	0.0139	-0.0549	-0.153***
	(1.165)	(-2.708)	(1.225)	(-1.627)	(0.707)	(-3.542)	(1.258)	(0.235)	(-0.986)	(-2.853)
logratioHY_WAT	0.0105	-0.0124***	0.0124**	-0.0134***	0.00776***	0.0316**	-0.0232***	-0.0634***	-0.0442***	0.0431**
	(0.968)	(-6.821)	(2.600)	(-3.090)	(2.746)	(2.329)	(-3.125)	(-5.561)	(-3.250)	(2.292)
logratioIC_all	-5.589	-0.677	2.996	-6.063	7.613***	-2.923	-0.269	-6.038***	-4.095***	-0.493
	(-1.178)	(-0.573)	(1.048)	(-1.368)	(2.840)	(-0.438)	(-0.427)	(-6.531)	(-3.427)	(-1.603)
logratioNU_URA	0.0227***	-0.0172***	0.00422	-0.00660*	-0.000618	0.0366***	-0.0414***	-0.0615***	-0.0726***	-0.0358***
	(3.817)	(-10.16)	(1.344)	(-1.823)	(-0.331)	(4.956)	(-10.32)	(-11.53)	(-13.72)	(-6.848)
logratioPS_WAT	-0.0863***	0.0186**	0.0258	0.0147	0.00304	-0.493***	-0.0317**	0.0688***	-0.0112	-0.0370**
	(-3.118)	(2.093)	(1.358)	(0.515)	(0.202)	(-7.270)	(-2.164)	(2.981)	(-0.578)	(-2.035)
logratioST_COL	0.0220***	-0.0176***	0.00684**	-0.00839*	-0.00167	0.0371***	-0.0302***	-0.0456***	-0.0638***	-0.0115

	(3.582)	(-9.238)	(2.002)	(-1.870)	(-0.684)	(3.493)	(-5.964)	(-6.803)	(-8.033)	(-1.459)
logratioST_WDS	0	0	0	0	0	0	0	0	0	-0.625
	()	()	()	()	()	()	()	()	()	(-1.106)
logratioST_allnoncoal	0.0376***	-0.0254***	-0.00766	6.50e-05	-0.00271	0.0474***	-0.0240*	-0.00702	-0.00410	-0.00661
	(2.670)	(-12.80)	(-0.919)	(0.00930)	(-0.624)	(3.347)	(-1.760)	(-0.315)	(-0.173)	(-0.322)
realtotalcostCC_all	-1.62e-07*	-2.55e-08	1.59e-07***	1.32e-07	8.43e-08*	-4.21e-08	3.99e-07***	4.93e-07***	2.97e-07***	-1.51e-09
	(-1.749)	(-0.937)	(2.822)	(1.630)	(1.965)	(-0.596)	(4.802)	(3.554)	(3.107)	(-0.0472)
realtotalcostGT_all	-6.66e-08*	2.54e-08*	1.59e-08	-7.91e-08***	3.98e-08***	2.74e-07***	-1.63e-07	7.25e-08	4.32e-07	5.14e-07***
	(-1.952)	(1.872)	(0.647)	(-3.405)	(3.533)	(2.937)	(-1.386)	(0.284)	(1.628)	(3.672)
realtotalcostHY_WAT	8.10e-07	-3.88e-07	-2.21e-06**	9.17e-07	-2.25e-06***	-9.72e-06***	-1.88e-06**	-4.62e-06***	-1.08e-06	-1.50e-06
	(0.328)	(-1.167)	(-2.031)	(1.261)	(-5.352)	(-5.366)	(-2.535)	(-3.906)	(-1.103)	(-0.902)
realtotalcostIC_all	8.42e-05***	-2.99e-06*	-4.51e-05***	9.77e-05***	-6.74e-05***	2.57e-05*	-2.20e-05***	2.61e-05***	-4.18e-06	-4.27e-06
	(8.766)	(-1.835)	(-9.623)	(6.222)	(-7.478)	(1.717)	(-3.826)	(5.196)	(-0.877)	(-0.987)
realtotalcostNU_URA	-1.87e-08	2.87e-08***	-3.42e-08***	-3.85e-09	-7.84e-09**	-3.91e-08***	-1.87e-08**	1.14e-08	-4.16e-08**	-3.71e-08
	(-0.964)	(5.493)	(-3.345)	(-0.630)	(-2.441)	(-3.389)	(-2.221)	(0.638)	(-1.977)	(-1.566)
realtotalcostPS_WAT	4.31e-06***	5.89e-08	-5.49e-06***	4.28e-06***	2.51e-07	4.94e-06***	6.49e-08	2.66e-07	-1.50e-07	4.72e-06***
	(4.446)	(0.238)	(-11.44)	(7.821)	(1.025)	(4.951)	(0.384)	(0.849)	(-0.635)	(6.022)
realtotalcostST_COL	9.07e-09	-3.87e-09	-1.67e-08***	2.11e-09	2.51e-09	5.93e-08***	-3.01e-08***	-4.67e-08**	-3.69e-08	-3.76e-08**
	(0.860)	(-0.748)	(-2.768)	(0.346)	(0.736)	(4.376)	(-4.149)	(-2.370)	(-1.384)	(-2.251)
realtotalcostST_WDS	0	0	0	0	0	0	0	0	0	1.54e-06
	()	()	()	()	()	()	()	()	()	(0.854)
realtotalcostST_allnoncoal	-9.62e-08	1.07e-07***	3.79e-08	-7.03e-08	1.28e-08	-7.72e-08	-6.63e-08	-2.40e-07*	-3.52e-07***	-1.46e-07*

	(-0.888)	(5.939)	(0.585)	(-1.166)	(0.347)	(-1.056)	(-0.850)	(-1.683)	(-2.671)	(-1.844)
Constant	-0.0269***	0.0133***	-0.000401	0.0131***	-0.00195	-0.0386***	0.0257***	0.0422***	0.0509***	0.0145***
	(-6.518)	(8.371)	(-0.164)	(3.819)	(-1.151)	(-5.496)	(8.676)	(10.53)	(13.48)	(2.968)
Observations	150	150	150	150	150	158	188	194	200	225
R-squared	0.905	0.974	0.961	0.946	0.966	0.936	0.927	0.869	0.904	0.900

Robust t statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1