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# The Direct Costs and Benefits of US Electric Utility Divestitures*

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Competition increases firms performance. But in many industries, especially network based industries, effective competition requires the separation of firms. Separation can lead to a trade-off between technical efficiency gains from competition and losses from separation. But separation itself can be beneficial, too. We estimate the combined effect of competition and vertical separation (as well as the individual effects) for the case of US electric utility divestitures. We analyse the difference-in-difference in inefficient costs between divested units and non-divested units in either restructuring or non-restructuring states. We find that for our benchmark model of technology the combined effect is virtually zero. We analyze the uncertainty about the unobserved true technology and find that this number constitutes the lower bound whereas the upper bound is $24 billion. Generally, the effect of separation itself is much larger than the effect of competition. Also, the effect of separation is positive for most models of the technology.

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# 1. Introduction

Economists have shown that competition increases firm performance (Nickell, 1996; Fabrizio et al., 2007). But in many industries, in particular where delivery is over networks, effective competition requires the vertical separation of the firm. Several studies have shown that such separation can increase costs due to foregone fixed cost sharing or cost complementarity (Kaserman and Mayo, 1991; Kwoka, 2002; Arocena et al., 2012). There is a potential trade-off between technical efficiency gains from competition and efficiency losses from separation.[1] But the effect of separation is not necessarily negative. Separation might also increase efficiency due to increased management focus, i.e. due to a lower span of control and a reduction in asymmetric information for management and regulators. As one utility manager says: "[. . . ] separation [of activities] exposes the true costs of operation and presents the opportunity for challenge and change" Utility Week (2010).

In this paper, we estimate the combined effect of the introduction of competition and vertical separation on efficiency for the case of US electric utility divestitures. During the 1990s several US states restructured their electricity markets to introduce competition into electricity wholesale and retail markets. Distribution and transmission networks remained regulated franchise monopolies. In several states restructuring was accompanied by utility divestitures of generation plant.

We measure the effect as the difference-in-difference in the inefficiency of the divested unit and the average inefficiency of all non-divested units. The unit is the generation, distribution or transmission activity or the combination of all three activities. We multiply the inefficiency difference with the observed costs of the divested unit to express the effect in monetary terms. We employ two alternative counterfactuals. First, all non-divesting utilities in non-restructuring states, such that the implied treatment is the combination of the introduction of competition for generation and the vertical separation of generation plant. Second, all non-divesting units in restructuring states such that the implied treatment is divestiture only.

To the best of our knowledge this is the most comprehensive assessment of the combined effect of vertical separation and competition, as well as US electric divestitures to date. Our contributions are as follows. First, as both technology and effort are unobserved, we apply a model that separates technology and inefficiency (as a proxy for effort) explicitly. Second, our non-parametric model estimates inefficiency at the unit-level such that we can aggregate unit-level effects over the whole distribution as opposed to assessing the effects at the sample mean

[1] We ignore allocative efficiency. A more comprehensive analysis might also take into account how competition increases allocative efficiency.

only as is usually done with parametric techniques. The non-parametric nature of our model also allows for the easy comparison of different specifications of the technology, e.g. convex or non-convex. Third, we include all activities, i.e. generation, transmission, and distribution. This is obviously important for completeness but also because cost reallocation at restructuring or divestiture would bias the results for single activities. Fourth, we have a long panel which allows us to follow divested utilities for several years and to capture the effects of adjustment and learning. It also allows us to control for any differences prior to treatment as restructuring and divestiture are not random. Fifth, we proxy for the costs of stand-alone generation, which after divestiture is not required to file regulatory accounts and therefore often omitted by previous studies.

Previous studies for the US electric utility industry only offered a partial analysis. The existing evidence comes from two strands of the empirical literature. First, several papers estimate economies of scale and economies of vertical integration for electric utilities (Kaserman and Mayo, 1991; Kwoka, 2002; Arocena et al., 2012). Their findings generally suggest that there is a cost attached to vertically separating electric utilities. These studies do not model technical inefficiency. Also, their predictions are mostly out of sample as they do not study episodes where actual divestitures took place. A second strand of the literature evaluates actual policy changes. Several recent studies look at the actual impact of restructuring and/or divestitures on productivity (Bushnell and Wolfram, 2005; Fabrizio et al., 2007; Delmas and Tokat, 2005; Kwoka et al., 2010). These studies mostly analyze single activities only, e.g. generation or distribution; the exception being Delmas and Tokat (2005). Generally, these studies find that restructuring has (slight) positive effects on productivity.

Our data is for 138 investor owned electric utilities for the year 1994 and 2006. We record divestitures for 29 utilities. We find that the combined effect of competition and divestiture is $-16 million for our benchmark, i.e. conservative, model of technology (all numbers are in year 2000 dollars). This amounts to less than 0.01 per cent of the total costs of all divested units over our sample period. As the true technology is unobserved there is uncertainty about it. We estimate the effects for different specifications of the technology and find that $-16 million is the lower bound and that $24 billion is the upper bound, i.e. the results are very sensitive. We find that competition always has a positive effect and that the effect of separation is positive for most models. Also, unlike suggested by previous studies on vertical economies of scope the effect of separation itself is mostly positive (and much larger than the competition effect). Why our aggregate result is different can possibly be explained by our finding that the initial impact of divestiture is often adverse but firms adjust and learn so that eventually the effect is positive.

This paper is divided into seven sections. Section 2 provides some background for the divestitures we study. Section 3 briefly reviews the relevant empirical literature. Section 4 outlines our analytical approach. Section 5 summarizes the data and gives details on our variables. Section 6 gives the results and section 7 concludes.

## 2. Background

This section shortly discusses relevant regulatory change for the US electric industry. For a general overview of restructuring see Jurewitz (2001). Historically, most of the electricity in the US was provided by privately owned, vertically integrated franchise monopolies. Pricing was constrained by rate-of-return regulation.

Rising prices, technical change, and political change lead to federal regulatory changes from the 1970s on that culminated in fully liberalized electricity markets in some but not all states. The first phase of reform was driven by the federal government. The aims were competition in generation and transmission access. The second phase was driven by the states and lead to regulatory divergence at the state level. We are interested in the effects of state level regulatory change, the strengthening of competition and the vertical unbundling of generation plants. Efforts to create competitive wholesale markets started in 1978 with the federal Public Utility Regulatory Policies Act mandating local utilities to purchase all the electricity qualifying generators supplied. Entry by these merchant generators was regulated but not necessarily their prices. However, these merchant generators faced problems to access the utility owned transmission networks. To increase the effectiveness of third-party generation the 1992 Energy Policy Act regulated wholesale transmission access (later strengthened through FERC rule making in 1996 and 1999) and allowed generators to own non-connected plants in various states.

Several states considered this federal regulatory change insufficient and took the initiative to further improve wholesale competition and, in some cases, to also introduce retail competition. All states initiated hearings on restructuring between 1993 and 1999; California being the first. By 2000, about half the states had passed restructuring laws including retail access provisions. The scope of restructuring is highly state specific, as is the speed of implementation. Most states allowed for multi-year transition periods, e.g. four years in California. And it is not clear that all the provisions in the state laws were always implemented, especially after the California energy crisis.

In some states the introduction of competition was accompanied by the vertical separation of power plants. Power plants were sold to affiliated or non-affiliated entities. In any case, once divested plants no longer have to file regulatory accounts we can no longer observe them.

Divestitures were mandated, voluntary, or on a quid-pro-quo basis. For instance, states provided incentives for divestiture in the form of favorable stranded cost recovery, relaxation of wholesale price regulation, or merger approval. Typically, these deals did not require full divestiture. Irrespective of regulatory incentives many companies divested for business strategic reasons like diversification into non-utility businesses. Often utilities sold in-state generation assets and bought out-of-state assets "hoping that the state regulator of their local distribution business may feel less justified in reducing allowed returns on the local distribution business in response to higher profits earned in the out-of-state generation business" (Jurewitz, 2001, p. 289). Swapping generation assets in this way might increase overall distribution costs as regulators do not take into account economic rents from generation when setting distribution tariffs.

Restructuring states were keen to make restructuring a success and to minimize transition costs for utilities. For instance, to lower electricity prices regulators often allowed the reallocation of costs from generation to distribution. Whereas in some states the reallocation of costs from generation to distribution was sanctioned (and often welcomed) by the regulator (Maloney, 2001) in others costs were reallocated without the regulators consent and possibly the intention of gaining an unfair competitive advantage in generation. Such cost reallocation potentially biases the results when analyzing single activities. Many states capped or reduced regulated default tariffs. Regulated standard tariffs often implied fixed percentage reductions compared to the tariffs before restructuring and were often frozen for a transition period. Such regulated standard offers often turned out to be priced below competitive rates because these were higher than expected (Pfeifenberger et al., 2004, endnote 3). Not to suffer a margin squeeze like the Californian utilities, many distribution companies that divested their generation assets and faced capped retail tariffs entered into buy-back contracts with their former generation units, whether owned by holding companies or not (Pfeifenberger et al., 2004). And contract prices were often linked to regulated standard offers. In some states (e.g. California) buy-back contracts did not exist because all electricity had to be sold through central clearing mechanisms (including the power that utilities generate themselves). In total only nine states started such competitive procurement of regulated generation services before the end of our sample (Pfeifenberger et al., 2004, Table 2), i.e. by 2006. We use purchased power expenses (as reported by the distribution company) as a proxy for divested plant's generation cost. These buy-back contracts are likely to control margins and help us not to overestimate the cost of power generation. However, it would be a problem if these buy back contracts forced stand alone generators to sell below cost, which is unlikely. Last, regulators introduced transition charges to cover costs that cannot be recouped at lower competitive prices (stranded costs). To the extent that these transition charges are included in a distributor's cost of purchased power we overestimate the cost of stand alone generation.

## 3. Related Literature

The literature that provides evidence on the likely effects of restructuring and divestitures falls into two categories: studies that analyze the properties of the technology and studies that evaluate policy changes.

Studies in the first category estimate returns to scale and economies of scope (horizontal and vertical) and infer optimal industry structure. Most relevant for us is that these studies generally find negative economies of vertical integration. That is, they predict a cost associated with divestitures. The two most recent studies using U.S. data are Kwoka (2002) and Arocena et al. (2012). Kwoka (2002) finds strong evidence for cost complementarity and mixed evidence of indivisible inputs when separating generation from transmission and distribution (T&D). His evidence is for a cross-section of firms in 1989, long before any actual divestitures and modern computer based techniques for coordination across independent firms. He finds that the total cost saving from integration for mean-sized firms (in terms of T&D and generation output) is 42 per cent (p. 664). The study also ranks the sources of cost savings from integration. Lower operating and maintenance (O&M) costs for generation provide the biggest saving followed by lower O&M costs for T&D. A higher share of nuclear generation capacity and overall higher capacity utilization also increase the benefits from integration. Additionally, the study finds that certain holding structures can off-set losses from vertical integration but the same is not true for membership in power pools. This is evidence for the hypothesis that economies of scope do not necessarily require common ownership (Teece, 1980).

Arocena et al. (2012) find evidence for both horizontal (upstream, between fuel types) and vertical economies of scope for a cross-section of electric utilities in 2001. Their sample also does not include divested, non-utility generation plants. They estimate that vertically integrated firms save between 4.3 and 9.7 per cent of total cost. Estimates hardly depend on firm size in terms of distribution customers and generation output. But estimates depend on the generation mix and the balance between distribution and generation activity. Divesting nuclear generation carries the greatest penalty followed by fossil-fuel and hydro. If the utility retains all nuclear capacity and divests fossil-fuel and hydro only, no significant loss in economies of scope is incurred. Also, estimates of economies of scope are higher for firms that have greater generation to distribution ratios. Thus, who divests what matters. These studies do not model efficiency explicitly (though differences in mean efficiency between diversified and specialized firms would be captured by type specific intercepts) and therefore cannot identify any potential efficiency gains from specialization. Generally, empirical studies on optimal industry structure do not cover actual divestitures, because in most countries and especially in the U.S. the data is not observed. Thus, these studies infer potential losses from integrated firms, i.e. predict out of sample.

Another strand of the literature, instead of studying the properties of the production technology, directly estimates the impact of restructuring on productivity. A number of studies evaluate U.S. electric industry restructuring. Kwoka et al. (2010) study the impact of restructuring and divestiture on the efficiency for a sample of 73 distribution companies for the years 1994-2003. They find that the difference in distribution efficiency (measured between 0 and 1) between divested and non-divested firms is 0.003 points. When only looking at mandatory divestitures the difference is 0.055 points. And only for mandatory divestitures is the difference statistically significant. Firms that divest voluntarily (or on a quid-pro-quo basis) might even slightly increase their efficiency.

Fabrizio et al. (2007) studied the impact of US electric industry restructuring on generation plant productivity. They found that investor-owned utilities (IOUs) in restructuring states reduced non-fuel expenses by up to 5 percent, labor input by 3 percent, and fuel input by up to 1.4 percent (the latter being statistically insignificant) in comparison to firms in non-restructuring states. They also used an alternative counterfactual, municipality owned plants, and found that for labor and non-fuel expenses the effect of restructuring is about twice as large. This implies either, that IOUs in non-restructuring states are not a good control group, because restructuring had spill-over effects or, that the effect of ownership adds to the effect of competition and both effects are about the same size. Somewhat surprisingly, they found no economically or statistically significant effect for fuel efficiency. But they omit divested, non-utility plants from their sample. Non-divested plants could face lower competitive pressure if retail customers remain captive or they are able to relocate some costs to activities that remain regulated. Bushnell and Wolfram (2005) analyze the effect of divestiture on the fuel efficiency of fossil fuel powered plants. They found that divestitures increase fuel efficiency by 2 per cent compared to utility owned plants. However, they also found that higher powered regulatory incentives had about the same effect as divestitures for utility owned plants.

Whereas the studies above look at single activities only, Delmas and Tokat (2005) investigate the effects of restructuring on the entire utility. They analyze the effects of deregulation and vertical integration on efficiency for a large sample of U.S. electric utilities for the years 1998 to 2001. They find evidence that in states that mandate divestiture average efficiency is lower and that firms that have a higher share of own generation are more efficient. They do not explicitly compare divested and non-divested firms but their results suggest that divestitures increase total cost (generation, transmission and distribution). One important shortcoming of their analytical approach is that they specify a large number of input and output variables (seven and three respectively). As their efficiency estimator (Data Envelopment Analysis) compares like-with-like an unrealistically high number of firms are estimated to be fully efficient (45 per cent). This is likely to complicate their second stage regression as there is little variance for the dependent variable, efficiency. Also, they include cost of purchased power but do not control for changes in wholesale prices. Last, there are problems with the way in which they define indicator variables for integration and divestiture as explained by Kwoka et al. (2010, p. 90).

To sum up the empirical evidence, studies analyzing the properties of the technology largely find positive economies of vertical integration. Studies evaluating policy change typically find that a move towards higher powered incentives has (slightly) positive effects on productivity. Studies of economies of vertical integration include all activities but they typically do not compare explicitly divested and non-divested firms. Studies that evaluate policy changes often only look at single activities. It is virtually impossible to combine the results from these different studies into an overall assessment.

# 4. Analytical Approach

## 4.1. Net Benefit Calculation

We need to compare the performance of divested units in restructured states against a counterfactual. The counterfactual is non-divested units in either non-restructuring or restructuring states. Following the difference-in-difference concept we also control for any ex-ante differences.

Let $D$ denote the set of all divesting firms and $\overline{D}$ the set of all non-divesting firms. Also, let $R$ denote the set of all restructuring states and $\overline{R}$ the set of all non-restructuring states. Let, $i$ donate a single divesting unit and $j$ denotes a single non-divesting unit. We compute the average inefficiency for a control group at time $t$ as

$$\overline{\gamma_{X,t}} = \frac{1}{|X|} \sum_{j \in X} \gamma_{j,t},$$

where $|X|$ is the number of non-divesting units in non-restructuring states $\left|\overline{D} \cap \overline{R}\right|$ or the number of non-divesting units in restructuring states $\left|\overline{D} \cap R\right|$. For a divested unit $i$ net benefit of activity $A$ in year $t$ is,

$$NB_{i,t}^{A} = \left(\overline{\gamma_{X,t}^{A}} - \gamma_{i,t}^{A}\right) C_{i,t}^{A} - \frac{\sum_{t'=1}^{b} \left(\overline{\gamma_{X,t'}^{A}} - \gamma_{i,t'}^{A}\right) C_{i,t'}^{A}}{b}. \tag{1}$$

where $t = b$ is the date of divestiture, the activity $A$ is distribution, power sourcing, transmission, or all three combined and $C$ is total cost of the relevant activity. The second term subtracts the average net benefit across the years before divestiture. We assume that had the unit not divested its inefficiency would be equal to the average inefficiency of those units not divesting. The net benefit of divestiture is positive (negative) if the average inefficiency, i.e., average waste of all non-divested units is larger (smaller) than the inefficiency of the divested firm (corrected for any pre-divestiture differences). The ex-ante difference adjusts the net benefits for any initial differences between divested and non-divested units and corrects for any possible endogeneity due to heterogeneity between the treatment and control group.

Equation (1) measures a typical difference-in-difference. But instead of estimating average productivities as proxies for $\gamma$ we use nonparametric inefficiency scores. In the next section we introduce a model of production that estimates inefficiency. Also, instead of comparing the effect at the sample mean we sum over the differences between each treated unit and the mean of all the counterfactual units. Finally, we sum the net benefits across activities (if the technology is separate), units, and years to obtain the overall net benefit

$$NB = \sum_{t} \sum_{i} \sum_{A} NB_{i,t}^{A}. \tag{2}$$

## 4.2. Technology and Inefficiency

We want to evaluate the performance of a decision making unit against observed best practice. When units use inputs $x = \mathbb{R}_{+}^{N}$ and outputs $y = \mathbb{R}_{+}^{N}$ we can evaluate a unit's performance against a sample of units $i = 1, ..., I$ as

$$\begin{gathered} \max \frac{\mathbf{p}_i^T \mathbf{y}_o}{\mathbf{w}_i^T \mathbf{x}_o} \quad ; \\ \text{s.t.} \\ \left(\mathbf{w}_i^T \mathbf{x}_i\right)^{-1} \left(\mathbf{p}_i^T \mathbf{y}_i\right) \leq 1 \quad , \quad i = 1, ..., o, ...I \\ \mathbf{p}_i, \mathbf{w}_i \geq 0 \quad , \end{gathered} \tag{3}$$

where $(\mathbf{y}_o, \mathbf{x}_o)$ are the vectors of outputs and inputs of the unit we evaluate. And $\mathbf{p}_i$ and $\mathbf{w}_i$

are decision variables. These weights are not observed prices but choice variables. The weights are chosen as to maximize the aggregated outputs over aggregated inputs for each unit subject to the constraint that no unit has a ratio greater than 1, i.e. no positive shadow profit. This nonlinear program can be converted into a linear envelopment program of the following type

$$\begin{aligned} \min_{\theta,\lambda} \theta \quad &; \\ \text{s.t.} \quad & \\ \mathbf{y}_o \geq \mathbf{Y}\lambda \quad &; \\ \theta \mathbf{x}_o \leq \mathbf{X}\lambda \quad &; \\ \lambda \in \{0,1\} \quad &. \end{aligned} \tag{4}$$

where $\lambda$ is an indicator that decides against which other production plan, the plan of interest is evaluated. The scalar $\theta$ is the technical efficiency measure. Here $\theta$ ranges from 0 to 1 for the most efficient decision making unit. The measure captures the maximum radial contraction of inputs that project the decision making unit onto the frontier. Equation (4) gives the non-convex Free Disposable Hull (FDH) efficiency index. For our purposes we transform $\theta$ and obtain inefficiency as

$$\gamma = 1 - \theta$$

for the use in (1) above. The program is evaluated $i$ times, once for every decisions making unit. This program implies a set representation of the technology, where the distance to the set's boundary is a natural measure of inefficiency. The distance measure is input-oriented, which seems reasonable for electric utilities as they are mandated to satisfy any given demand. The set is made up of observed and unobserved production plans. The inclusion of the unobserved plans requires assumptions about the true production technology. The technology in (4) is a non-convex production reference set (Charnes et al., 1978; Deprins et al., 2006). Intuitively, the non-convexity implies that a unit that is special in its input or output dimension is more likely to be efficient than to be inefficient. We assume that all observed input-output combinations belong to the true set, which makes the set deterministic and that all the production plans that are weakly dominated by observed plans are also part of the set, i.e. inputs and outputs are strongly disposable (e.g. more inputs do not reduce the maximum output). Returns to scale are effectively variable. This nonparametric approach have several advantages. It does not require the specification of a parametric functional form and therefore does not require any assumptions on firm behavior (e.g. profit maximization or cost minimization) to estimate cost efficiency, which seems appropriate for regulated industries. Also, it easily accommodates multiple inputs and outputs.

We choose as our benchmark model a conservative model in the sense that it should favor the legacy structure of the industry. In addition to non-convexity we make the following assumptions. First, instead of specifying a technology for each activity as in (1) we specify a common technology for all three activities. A common technology makes sure that we do not underestimate the benefits of integration when the different activities are actually integrated. Second, we specify a sequential frontier in time, i.e. the production possibilities of period $t$ are nested in the possibilities of period $t + 1$. The reason for specifying a sequential technology is that divestitures might imply technological regress (e.g. the loss of technological complementarities) which we want to capture as inefficiency.

To analyze the uncertainty around these assumptions we specify several other technologies, where we change one assumption of the benchmark model at a time. First, we specify separate technologies for each activity (distribution, power sourcing, and transmission). This allows us to analyze the effects by activity although some effects, especially economies of integration, are not independent across the activities. Estimating the technology by activity also reduces the total size variation, making it less likely that results are driven by size differences *per se*. Second, instead of a sequential frontier we specify a contemporaneous frontier, where the technology set is period specific (the different sets might be related in any possibly way). We do so because there are some forms of technological regress we do not want to capture as inefficiency, e.g. increasingly stringent environmental regulation, changes in the economic regulation of the network franchises or adjustment costs due to for instance, the increased generation from renewable sources. Third, we specify a *convex* free disposable hull (Data Envelopment Analysis) technology with variable returns to scale. This is achieved by replacing the last constraint in (4) with $\lambda \geq 0$ and adding the constraint $\mathbf{1}^T\lambda = 1$. Unlike our baseline model this model allows convex combinations to be part of the technology set. The intuition is that such a convex model captures more of the underlying heterogeneity as inefficiency.

Besides the structural characteristics the technology for each activity is modeled in terms of inputs and outputs. For the distribution technology the two inputs are operating expenses (Opex) and capital expenses (Capex). The distribution outputs are number of units distributed, number of customers, and distribution network length. Network length accounts for dispersion. Together these three variables cover the long-run expansion of the distribution activity. Due to data limitations and the inability of our method to admit zero values we model power sourcing as a single input, single output technology. The input is the sum of the costs of own generation and costs of purchased power and output is the number of units distributed and resold. We can only use a single input because some integrated firms incur no costs for purchasing power and the DEA estimator does not admit zero values. Thus for the power sourcing activity the DEA efficiency score collapses to a simple input-output index. For transmission we use two inputs and a single output. The inputs are operating and capital expenses. The single output is the number of units distributed. When the technology combines all activities we include all inputs and outputs. Section 5 gives more detailed variable definitions.

### 4.3. Defining Divestiture and Restructuring

As most utilities own several power plants and divest any number of them we have to define divestiture at the utility level. We define a utility as divested if the book value of production plant drops by at least 50 per cent year-on-year and the proportion of own generation of total requirements is at least 25 per cent the year before divestiture. Additionally, we require that divested firms generate at most 50 per cent of their requirements. The firm counts as divested for all subsequent years. Thus, we only account for the first but not subsequent divestitures for the same firm. Instead of using book values one could use physical generation capacity or actual generation output as proxies for divestiture. Having manually checked the data we believe that book value is the best measure for this particular data set. Naturally the thresholds are somewhat arbitrary but follow Kwoka et al. (2010) who also use a 50 per cent drop in plant value given a “substantial fraction” of own generation. Table 3 lists the names of the 29 utilities we count as divested and the year the divestiture is recorded. Note that due to missing data the recorded year might be after the actual year of divestiture.

We defined a state as restructuring (a time invariant variable) following Fabrizio et al. (2007). They count a state as restructured if a restructuring law including retail access competition is passed before 2000 (according to them there were no further restructurings before the end of our sample).

## 5. Data and Variable Definitions

The data mainly comes from the regulatory accounts US utilities have to file with the Federal Energy Regulatory Commission (FERC). These filings are known as Form 1 and have to be submitted on an annual basis by utilities above a certain size. The data is publicly available on the FERC website. The Form 1 data is well established in the economic literature. Examples are Fabrizio et al. (2007), Kwoka et al. (2010), and Arocena et al. (2012). The main advantage of this data set is that data is consistently available for a large number of variables, a large number of firms, and several years. The main disadvantage is that it does not report data for divested generation plants.

As reporting is mandatory for utilities above the size threshold we basically observe the population of electric utilities. For our sample period we observe the distribution activity 138 firms out of 144 major utilities as counted by Sappington et al. (2001). Some observations are missing or dropped because they make no sense. In our sample the proportion of missing values is greater for distribution than for power sourcing. Also, the proportion of missing values drops after 2001 for distribution but stays constant for power sourcing. Last, data for the first year after a divestiture is more likely to be missing than data for subsequent years so that we observe only 18 out of 28 first year costs and benefits which would overestimate the benefit if costs are incurred in the first year of divestiture.

Distribution operating expenses (Opex) are measured as distribution operation and maintenance, customer accounts, customer service, and sales expenses plus a share of general and administrative expenses. The allocation key for the latter is based on the ratio of labor expenses for distribution, customer accounts, and sales to total labor expenses less general and administrative labor expenses. Opex is expressed in year 2000 dollars where the deflator is an index of state-level electricity distribution wages (or gas where electricity is not available). The index is based on the "Quarterly Census of Employment and Wages" series published by the Bureau of Labour statistics.

We measure distribution capital expense as current capital expenditure (i.e. plant additions) plus a share of general plant additions. The allocation key is the ratio of distribution plant over total plant. Kwoka et al. (2010) suggest that current expenditure has the advantages of being a controllable expense and being related to the investment program of the firm. It has the additional advantage of being observed at the firm level. Capital expense is expressed in year 2000 dollars where the deflator is a national US GDP deflator[2]. The distribution outputs are units delivered (Units), number of customers (Customers), and network length (Network length). Since Form 1 only reports units delivered and number of customers for bundled service we adjust the data to take into account that with the onset of retail competition actual numbers tend to be higher than bundled numbers. For this purpose we add data from the Energy Information Agency (Form EIA-861) and the state public utility commissions (PUC). Both the EIA and PUCs report distribution service only numbers. Where we have data from both the EIA and the PUC we take the minimum. If we cannot obtain data from either the EIA or PUC

[2]Source: http://www.gpoaccess.gov/usbudget/fy09/hist.html.

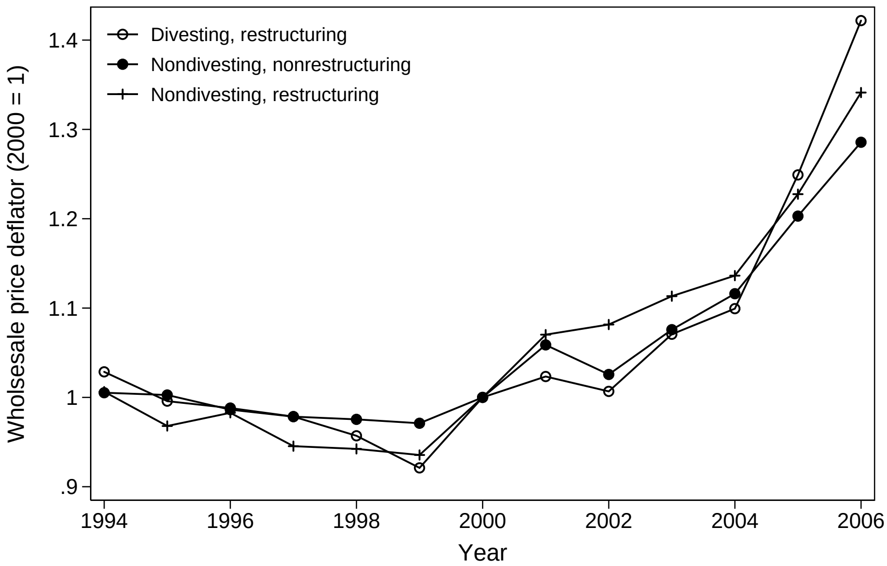



**Figure 1:** Group average state-level electricity wholesale price indices

we revert back to the FERC data.

Total cost of power sourcing is the sum of costs of own generation and purchased power. The total cost of own generation is measured as the sum of O&M and capital expenses. We measure capital expense as the sum of interest, dividends, tax, and depreciation expenses (Farsi and Filippini, 2005). Interest, dividends and tax are apportioned based on the share of production plant to total plant.

We use purchased power expense as a proxy for the generation cost of stand-alone plants (which no longer report their cost after divestiture). This potentially overestimates the cost of stand-alone generation by the profit margin.

Cost of power sourcing is deflated by an index of state-level prices (2000 = 1) for industrial customers[3] which serves as a proxy for a wholesale price index, because for some states there is no wholesale price for all years as wholesale markets were only introduced with restructuring. This is an attempt to account for factors that are beyond the control of the firm. This normalization neutralizes the effect of changes in market power and fuel price, which is ignored by earlier studies. It also reduces the problem of having to include profit in the cost of the divested plants to a time invariant mark-up. Figure 1 plots the yearly averages of the index for both the treatment group and our alternative control groups. It does not seem that the wholesale price is systematically higher for divesting firms or that its rate of increase is higher. The single output

[3] This data is taken from the EIA Electric Power Annual 2007, Table "1990 - 2007 Average Price by State by Provider (EIA-861)" which can be found at: http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html.

for the power sourcing activity is the sum of bundled distribution units and units for resale. The units that are generated by the firm itself are reflected by the bundled units distributed and units resold. The units not generated but bought are also included in the bundled distribution units.

Transmission costs are the sum of O&M and capital expenses. Transmission O&M is total transmission O&M expenses plus system control and load dispatching, and a share of general expenses where the allocation key is based on labor expenses. As system control and load dispatching is actually a generation item the key underestimates the share of general expenses allocated to transmission. O&M expenses are deflated by the same wage deflator as distribution expenses above. Capital expenses are measured as current year plant additions plus a share of general plant additions where the allocation key is based on the ratio of transmission to total plant. The deflator for Capex is again GDP. The single output for transmission is units distributed. This is a proxy as we do not observe the units transmitted. The appendix gives more detail on the construction of these variables as well as details on the sources.

A complication for transmission is the correct delineation of the transmission network and its costs and outputs. We only include the transmission costs accounted for by electric utilities but not system operators. Whereas utilities are responsible for investment and maintenance, system operators are responsible for trading systems (both for electricity and transmission rights) and ancillary services. As different transmission operators have different functional scope we capture the transmission costs where functions are operated by utilities but not where they are operated by system operators. Greenfield and Kwoka (2011) investigate the costs of transmission operators and estimate that for every 280,000 GWh (assuming constant returns to scale) a fully-fledged system operator costs about $150 million per annum and a minimum requirement operator costs about $68 million.

Table 1 provides summary statistics. It distinguishes between non-divested and divested (irrespective of the state's restructuring status) firms. About 14 per cent of the unit-year observations are for divested firms. The average costs of distribution and power sourcing are comparable for the two unit types. Divested firms have higher average transmission operating expenditures but only half the amount of capital expenditures. This might reflect the fact that transmission assets in restructuring states are held by system operators and not accounted for by utilities. The average (distribution) outputs are also comparable across the two types.

The average shares of own generation are about 70 per cent and 10 per cent for non-divested and divested firms, respectively. Figure 2 plots the evolution of average own generation shares for divesting firms as well as well as the cumulative count of divestitures. The first divestiture is recorded in 1998 and the bulk of divestitures are recorded between 1999 and 2001. The share of own generation for divesting firms mirrors the count of divestitures. Between 1994 and 1998 the shares of own generation are similar for divesting and non-divesting firms. From 2003 on the share of own generation for divested firms is stable again. The share of own generation does not differ much between the two control groups. We take this pattern as evidence that our definition of divestiture is reasonable.

Table 1 also compares the raw inefficiency scores for non-divested and divested firms. For our benchmark model the average scores are the same. For the separate technology model there are some differences. Divested distribution is more inefficient, divested power sourcing is less inefficient, and divested transmission is more inefficient on average. For the contemporaneous and convex technology models the inefficiency mean are again almost identical.

**Table 1:** Summary Statistics

| | Non-divested | | | | Divested | | | |
|---|---|---|---|---|---|---|---|---|
| | *mean* | *sd* | *max* | *min* | *mean* | *sd* | *max* | *min* |
| Data | | | | | | | | |
| Distribution Opex (M. US dollars) | 156.76 | 192.51 | 1673.81 | 0.72 | 167.86 | 147.16 | 866.76 | 17.97 |
| Distribution Capex (M. US dollars) | 94.94 | 115.06 | 797.46 | 0.14 | 91.68 | 107.77 | 679.17 | 13.62 |
| Units, distribution (GWh) | 20281.28 | 20427.39 | 103652.91 | 40.94 | 19195.21 | 16718.60 | 92362.80 | 1718.20 |
| Units, resale (GWh) | 6295.79 | 14896.80 | 266283.71 | 0.00 | 2638.78 | 3597.35 | 17583.48 | 0.00 |
| Customers (thd.) | 747.18 | 857.10 | 5121.49 | 3.35 | 792.86 | 689.79 | 3738.63 | 126.84 |
| Distribution network length (thd. miles) | 21.96 | 21.75 | 119.31 | 0.28 | 21.06 | 17.14 | 86.88 | 0.90 |
| Pow. Sourc. Exp. (M. US dollars) | 921.80 | 973.45 | 7161.65 | 2.91 | 770.69 | 608.34 | 3072.25 | 112.23 |
| Transmission Opex (M. US dollars) | 32.22 | 38.97 | 337.93 | 0.04 | 40.99 | 49.90 | 358.66 | 2.02 |
| Transmission Capex (M. US dollars) | 28.66 | 45.74 | 464.51 | 0.01 | 15.71 | 25.18 | 185.50 | 0.01 |
| Own generation (proportion) | 0.72 | 0.18 | 1.00 | 0.25 | 0.10 | 0.15 | 0.50 | 0.00 |
| Inefficiency scores | | | | | | | | |
| FDH (Benchmark) | 0.03 | 0.07 | 0.39 | 0.00 | 0.03 | 0.07 | 0.34 | 0.00 |
| FDH (Distribution) | 0.13 | 0.16 | 0.70 | 0.00 | 0.18 | 0.17 | 0.68 | 0.00 |
| FDH (Power Sourcing) | 0.52 | 0.32 | 0.94 | 0.00 | 0.46 | 0.32 | 0.93 | 0.00 |
| FDH (Transmission) | 0.44 | 0.28 | 0.97 | 0.00 | 0.50 | 0.26 | 0.97 | 0.00 |
| FDH (Cont. frontier) | 0.01 | 0.03 | 0.29 | 0.00 | 0.01 | 0.04 | 0.34 | 0.00 |
| DEA (Convex) | 0.21 | 0.18 | 0.63 | 0.00 | 0.23 | 0.19 | 0.62 | 0.00 |
| Observations | 1084 | | | | 176 | | | |

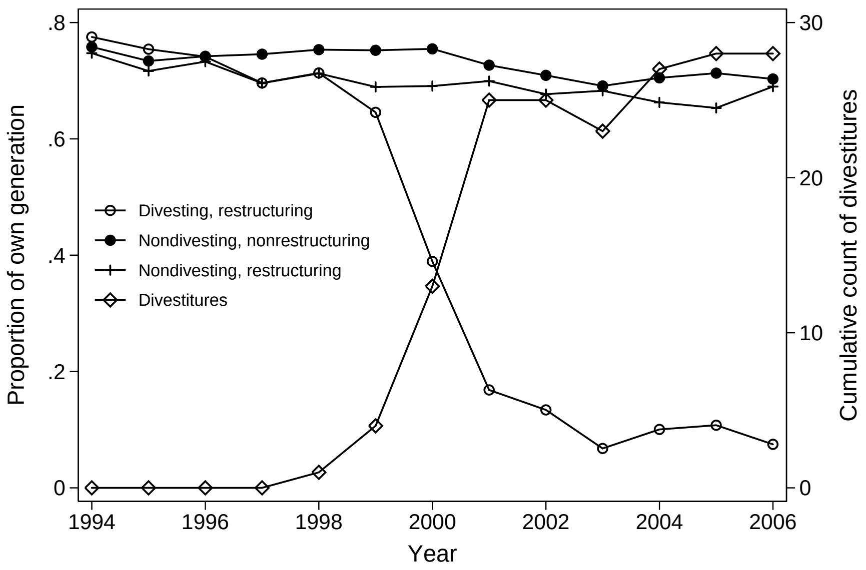



**Figure 2:** Average shares of own generation of total requirements.

*Notes*: This graph plots the yearly averages for own generation over total requirements for three groups: divesting plants, non-divesting plants in non-restructuring states, and non-divesting plants in restructuring states. It also plots the cumulative count of divestitures.

## 6. Results

Before giving the results for the net benefits we investigate the unit level inefficiency scores, the key ingredient of net benefit. In particular, we are interested in one key characteristic of the distribution of the inefficiency scores: the ratio of efficient firms. Table 2 gives the counts and percentages for the efficient units, i.e. the units that make up the frontier of the technology set. The first block of rows is for our benchmark model, the next three blocks are for the separate technology model, the fifth block is for the contemporaneous frontier model and the last block is for the convex technology model. The ratio of efficient firms varies greatly across the models. Intuitively, the higher the ratio of efficient firms the less heterogeneity the model ascribes to genuine inefficiency. For our benchmark model the ratio of efficient units is roughly three quarters. This is high but reflects the conservative nature of the model. The activity specific technology model produces fewer efficient firms than the benchmark model. Intuitively, at the level of a single activity the units are more comparable and more heterogeneity is ascribed to inefficiency. The contemporaneous frontier model produces an unrealistically high number of efficient firms, because there is an insufficient number of observations for individual years. This qualifies the net benefit results for this model below. Last, the convex technology model (DEA) produces fewer efficient firms, because it allows convex combinations of observed units to make up the frontier.

**Table 2:** Ratio of Efficient Firms

| FDH (benchmark) | Non-Divested | | Divested | | Total | |
|---|---|---|---|---|---|---|
| | *No.* | % | *No.* | % | *No.* | % |
| Inefficient | 254 | 23 | 48 | 28 | 302 | 24 |
| Efficient | 829 | 77 | 126 | 72 | 955 | 76 |
| Total | 1,083 | 100 | 174 | 100 | 1,257 | 100 |
| **FDH (Distribution)** | **Non-Divested** | | **Divested** | | **Total** | |
| | *No.* | % | *No.* | % | *No.* | % |
| Inefficient | 623 | 58 | 119 | 68 | 742 | 59 |
| Efficient | 460 | 42 | 55 | 32 | 515 | 41 |
| Total | 1,083 | 100 | 174 | 100 | 1,257 | 100 |
| **FDH (Power Sourcing)** | **Non-Divested** | | **Divested** | | **Total** | |
| | *No.* | % | *No.* | % | *No.* | % |
| Inefficient | 954 | 88 | 154 | 89 | 1,108 | 88 |
| Efficient | 129 | 12 | 20 | 11 | 149 | 12 |
| Total | 1,083 | 100 | 174 | 100 | 1,257 | 100 |
| **FDH (Transmission)** | **Non-Divested** | | **Divested** | | **Total** | |
| | *No.* | % | *No.* | % | *No.* | % |
| Inefficient | 941 | 87 | 160 | 92 | 1,101 | 88 |
| Efficient | 142 | 13 | 14 | 8 | 156 | 12 |
| Total | 1,083 | 100 | 174 | 100 | 1,257 | 100 |
| **FDH (cont. frontier.)** | **Non-Divested** | | **Divested** | | **Total** | |
| | *No.* | % | *No.* | % | *No.* | % |
| Inefficient | 61 | 6 | 13 | 7 | 74 | 6 |
| Efficient | 1,022 | 94 | 161 | 93 | 1,183 | 94 |
| Total | 1,083 | 100 | 174 | 100 | 1,257 | 100 |
| **DEA (convex)** | **Non-Divested** | | **Divested** | | **Total** | |
| | *No.* | % | *No.* | % | *No.* | % |
| Inefficient | 854 | 79 | 147 | 84 | 1,001 | 80 |
| Efficient | 229 | 21 | 27 | 16 | 256 | 20 |
| Total | 1,083 | 100 | 174 | 100 | 1,257 | 100 |

*Notes*: This table gives the counts of efficient and inefficient units for divested and non-divested units. The first block is for our benchmark model, where the technology combines all activities, is sequential in time, and non-convex. The next three blocks are for sequential, non-convex and activity specific technologies. The second to last block is for the combined, non-convex, contemporaneous technology, and the last block is for the combined, sequential, and convex technology.

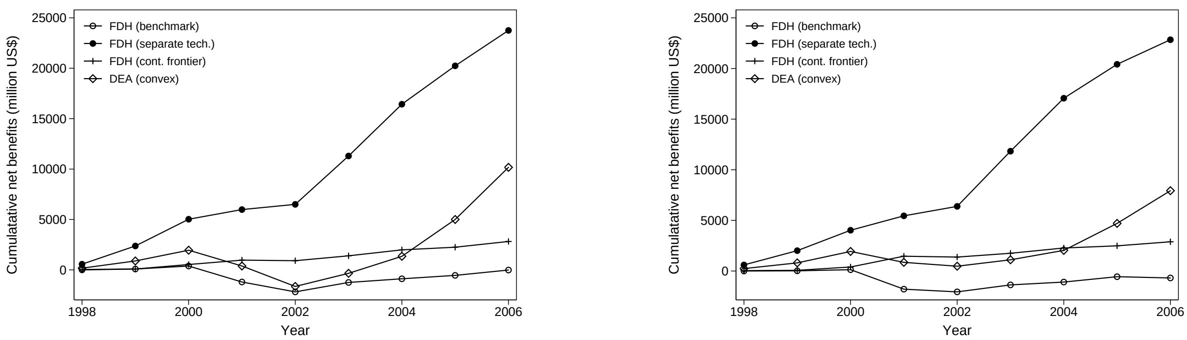
Now we describe the net benefits as in (1) using a series of graphs. We use the contrasts between the different models of technology and the different counterfactuals to better understand how competition and divestiture affect performance. Figure 3 plots the cumulative net benefits from the year of the first divestiture until the end of our sample for our four models of technology. Whereas 3a is for the non-restructuring counterfactual, 3b is for the restructuring counterfactual. For the former the implied treatment is the introduction of competition *and* divestiture. For the latter it is divestiture only. Remember that the bulk of divestitures occurred between 1999 and 2001.

We first focus on the cross-sectional difference at the end of our sample. Our benchmark model (FDH benchmark) gives the lowest cumulative net benefit at the end of our sample of $-16 million. To put this number into perspective we compare it to the total cost for all three activities, for all divested units, for the years 1997 to 2006 of $219 billion. In relation, the total net benefit is less than 0.01 per cent. In contrast, the activity specific technology model (FDH separate tech.) gives a cumulative net benefit of just under $24 billion, the highest across our models. Instead of artificially integrating some firms, this model artificially separates some other firms. It seems that the common technology model captures any losses in economies of scope better but captures any gains from separation less well. It is not that the results from the two models contradict each other but that each model emphasizes a different mechanism.

When the technology is contemporaneous (FDH cont. frontier) the net benefit is $2.8 billion. The fact that this number is higher than for the benchmark model suggests that divested units suffer technical regress. As the divergence occurs in the years 2000 to 2002 it seems that the regress is indeed related to divestiture. Assuming that we are able to control for the generation profit margins, a loss of economies of scope is likely to cause the regress.

Last, for the convex technology model the net benefit is $10 billion. The model allows convex combinations of observed units as comparators for inefficient units. That is, the technology is not necessarily fully combined or separate across activities. We believe this is the reason why the net benefit lies between these two extremes. Net benefits are higher than for the benchmark model, because actual divestitures influence the frontier. And net benefits are lower than for the activity specific model, because it also allows some combined firms to influence the frontier. And a convex technology generally produces fewer efficient units. Looking at the time path it is interesting to observe that the result first runs parallel to the result of the benchmark model but after 2002 seems to converge with the result from the activity specific model.

So far we only considered the results for the non-restructuring counterfactual in figure 3a. Now we contrast these with the results for the restructuring counterfactual in Figure 3b. As we would expect, the effect of divestiture only is smaller, i.e. the effect of competition is positive (except for the FDH cont. frontier). For our benchmark model the effect of separation is negative and roughly the same absolute size as the effect of competition. For all other models the effect of separation itself is positive. The positive effect for competition is in line with the previous literature. But the non-negative effect of separation is different from the previous findings on economies of scope. We believe the difference is due to the fact that we observe actual divestitures and do not infer the effect from integrated firms.




**(a)** Non-restructuring counterfactual

**(b)** Restructuring counterfactual

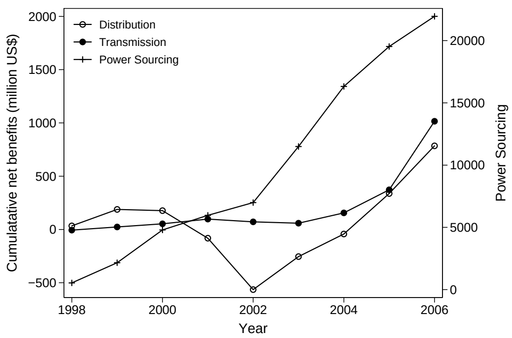
**Figure 3:** Cumulative net benefit

*Notes*: Both figures plot the cumulative net benefits for our four models of technology over time, starting with the year where the first divestiture occurred.

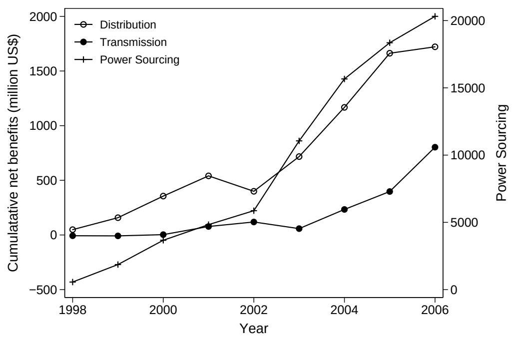
For the activity specific technology model we plot the cumulative net benefits by activity in Figure 4 (for the other models the inefficiency scores are constant across activities). We see that by the end of our sample period the contributions by all three activities are positive (for both counterfactuals). For the non-restructuring counterfactual in 4a we see that the distribution net benefit is substantially negative right after most divestitures occurred in 2002. As we do not observe a similar dip for the restructuring counterfactual in 4b it seems that the reason might be temporary cost reallocation in restructuring states. If the dip reflected a loss of economies of scope we would expect to see it for both counterfactuals. This temporary decrease might also explain why Kwoka et al. (2010) find that divestiture *increased* distribution inefficiency using a shorter sample (1994-2003).

The cumulative net benefit for power sourcing is positive and increasing over the entire sample period for both counterfactuals. The contribution of power sourcing is the largest by a wide margin despite potentially underestimating the net benefit by the generation profit margin that is included in the cost of power sourcing for divested units. At the end of the sample period the effect is about 14 per cent of the total cost of power sourcing of divested units over our sample period. Out of this roughly one tenth is due to competition and nine tenth are due to separation itself. If the effect of competition on non-divested units in restructuring states (which we omit) was different, this result would be biased. This effect of competition is at the lower end of the input-specific effects Fabrizio et al. (2007) find.

The transmission net benefit is first flat and then increases in the last years of our sample suggesting that there is no direct effect of competition or divestiture on transmission.




**(a)** Non-restructuring counterfactual

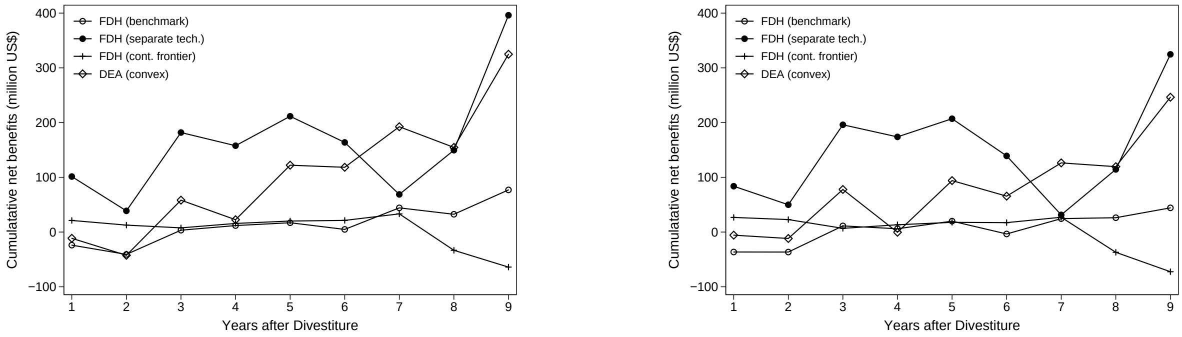



**(b)** Restructuring counterfactual

**Figure 4:** Cumulative net benefit by Activity

*Notes*: These figures plot cumulative net benefits by activity over time, starting with the year where the first divestiture occurred. The technology is activity specific.

So far we concentrated on the aggregate cumulative net benefits. Next we plot the average net benefits at points in time after divestiture in Figure 5 to highlight the performance dynamics after divestitures. The vertical axis now has the *average* net benefit and the horizontal axis has the years after divestiture, i.e. we normalize the observations around divestitures. The results are in line of what we saw above. The level differences between the technologies are not as pronounced but similar. The effect for the benchmark model is close to zero and the effect for the activity specific model is the highest. We also see that right after divestiture the effects are negative or decreasing suggesting that the introduction of competition and divestiture are themselves disruptive. After period seven the effects for the different models diverge substantially. This is likely to be an artifact of the small number of observations; only for a single divestiture do we observe nine years after.




**(a)** Non-restructuring counterfactual

**(b)** Restructuring counterfactual

**Figure 5:** Cumulative net benefit of divestitures for different counterfactuals and technology sets
*Notes*: These figures plot the average net benefit for the different models of technologies for years after divestiture, i.e. time is normalized around the year of divestiture.

To summarize, we find that the net benefit of the introduction of competition and divestiture is unlikely to be negative. It might be positive and large. Previous studies have found substantial economies of scope but we find that the effect of separation itself is unlikely to be negative. The effect of competition is smaller but certainly positive. Early effects are probably negative as change is disruptive, but after about two or three years effects increase. As the true technology is unobserved, we used several models and find that the variance across the models is large.

## 7. Conclusion

We study the combined effect of competition and vertical separation on firm-level performance. Often, effective competition requires that an industry is vertically separated, which can lead to a trade-off between higher powered incentives due to competition and a loss of synergies. However, separation itself can lower asymmetric information leading to efficiency gains that might outweigh any lost synergies. In this paper we quantify the combined effect of competition and separation (as well as the individual effects) for the case of the introduction of competition and divestiture in the US electric industry.

To quantify the effects we compare the difference-in-difference between a divested unit and the average of all non-divested units in either non-restructuring or restructuring states. As both the true technology and effort are unobserved we choose an empirical model that explicitly separates the technology and unit level inefficiency as a proxy for effort. Our non-parametric model also allows us to test different specifications of the technology, e.g. convex or non-convex. Finally, we express the effects in monetary terms, which provides a benchmark for any gains from allocative efficiency or direct set-up costs.

For our benchmark, i.e conservative, technology model, we find that the combination of restructuring and divestiture increased inefficient costs, relative to non-divested units in non-restructuring states, by about \$16 million over our sample period. That is less than 0.01 per cent of the total cost of divested firms. The increase in inefficient cost due to divestiture itself is about \$682 million. That is, the effects of competition and divestiture have roughly the same size but opposite signs for our benchmark model.

As the true technology is unobserved we investigate the uncertainty around the technology by specifying different technology models. We find that the results are very sensitive to the exact specification of the technology. For instance, when the technology is activity specific our estimate of the combined effect is a relative *reduction* in inefficient costs by \$24 billion over our sample period. Also, the relative sizes of the effects of competition and divestiture are different for the other models. For all models of technology different from the benchmark model the effect of divestiture itself is positive and much larger in size than the effect of competition, which contradicts previous results on economies of vertical scope in the literature. Partly, this contradiction might be explained by our finding that the initial impact of divestiture is adverse but that the effect turns positive several years after divestiture. As previous studies on economies of scope typically infer the effects from plants that are actually integrated they might underestimate the positive effects from adjustment and learning of plants that actually divest.

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# A. Data Description

All FERC data is taken from Form 1 which is freely available on the FERC website. All EIA data is taken from Form 861 which is available on the EIA website. Platts data is taken from hard copies of Platts "Directory of Electric Power Producers and Distributors". To complement the EIA data we also obtained data from state public utility commissions (PUC). In several cases data for unit sales and customer numbers could be found on the PUC's website. Where the data was not available online we contacted the PUC directly and in some cases obtained additional data. Note that for the FERC Form 1 data the line numbers might change across the years as new lines are added to the Form. The table below gives the lines for the year 2000. The power sourcing unit cost is deflated by an index of state-level industrial retail prices. The deflator is constructed as the retail price in a given year divided by the retail price in the year 2000.

**Table 3:** List of Divestitures

| *Name* | *Year* | *State* |
|---|---|---|
| Atlantic City Electric Company | 2001 | New Jersey |
| Baltimore Gas and Electric Company | 2000 | Maryland |
| Boston Edison Company | 1998 | Massachusetts |
| CENTRAL HUDSON GAS & ELECTRIC CORPORATION | 2001 | New York |
| Central Illinois Light Company (AmerenCILCO) | 2004 | Illinois |
| Central Illinois Public Service Company (AmerenCIPS) | 2001 | Illinois |
| Central Maine Power Company | 1999 | Maine |
| Cleveland Electric Illuminating Company, The | 2001 | Ohio |
| Commonwealth Edison Company | 2001 | Illinois |
| Consolidated Edison Company of New York, Inc. | 1999 | New York |
| Delmarva Power & Light Company | 2000 | Delaware |
| Duquesne Light Company | 2000 | Pennsylvania |
| Illinois Power Company (AmerenIP) | 2000 | Illinois |
| Jersey Central Power & Light Company | 2000 | New Jersey |
| Metropolitan Edison Company | 2000 | Ohio |
| Montana Power Company, The | 2000 | Montana |
| New York State Electric & Gas Corporation | 1999 | New York |
| Ohio Edison Company | 2001 | Ohio |
| Orange and Rockland Utilities, Inc. | 1999 | New York |
| PECO Energy Company | 2001 | Pennsylvania |
| POTOMAC EDISON COMPANY | 2000 | Pennsylvania |
| PPL Electric Utilities Corporation | 2000 | Pennsylvania |
| Pennsylvania Electric Company | 2000 | Ohio |
| Pennsylvania Power Company | 2006 | Ohio |
| Potomac Electric Power Company | 2001 | District of Columbia |
| Public Service Electric and Gas Company | 2000 | New Jersey |
| Rochester Gas and Electric Corporation | 2004 | New York |
| Toledo Edison Company, The | 2001 | Ohio |
| United Illuminating Company | 2000 | Connecticut |
| WEST PENN POWER COMPANY | 2000 | Pennsylvania |
| Western Massachusetts Electric Company | 2001 | Massachusetts |

| Variable/Formula | | FERC Name | Source | page-line |
|---|---|---|---|---|
| *Distribution Opex* | | | | |
| DE+AE+CE+SE+key1*GE | DE | TOTAL Distribution Expenses | FERC | 322-126b |
| key1=(DW+CW+CSW+SW)/(TOW-AW) | AE | TOTAL Customer Accounts Expenses | FERC | 322-134b |
| key2=(GW)/(TOW-AW) | CE | TOTAL Customer. Service and Information Expenses | FERC | 322-141b |
| key3=(TW)/(TOW-AW) | SE | TOTAL Sales Expenses | FERC | 322-148b |
| | GE | TOTAL Administration and General Expenses | FERC | 323-168b |
| | Labour expenses | | | |
| | TOW | TOTAL Oper. and Maint. | FERC | 354-25b |
| | GW | Generation | FERC | 354-18b |
| | TW | Transmission | FERC | 354-19b |
| | DW | Distribution | FERC | 354-20b |
| | CW | Customer Accounts | FERC | 354-21b |
| | CSW | Customer Service and Informational | FERC | 354-22b |
| | SW | Sales | FERC | 354-23b |
| | AW | Administrative and General | FERC | 354-24b |
| *Distribution Capex* | Plant | | | |
| DA+key4*(GA) | DA | TOTAL Distribution Plant Additions | FERC | 207-69c |
| key4=(DP)/(TOP) | GA | TOTAL General Plant Additions | FERC | 207-83c |
| | DP | TOTAL Distribution Plant | FERC | 207-69g |
| | TOP | TOTAL Plant | FERC | 207-88g |
| *Units (total)* | | | | |
| min(UE,UP) | UF | TOTAL Sales of Electricity (bundled) | FERC | 301-12d |
| or UF-UR if UE and UP missing | UR | Sales for Resale | FERC | 301-11d |
| | UE | total unit sales of electricity (delivery) | EIA | n/a |
| | UP | total unit sales of electricity (delivery) | PUC | n/a |
| *Units (residential)* | | | | |

| | | | | |
|---|---|---|---|---|
| min(RUE,RUP) | RUF | Residential Sales (bundled) | FERC | 301-2d |
| or RUF if RUE and RUP missing | RUE | residential unit sales of electricity (delivery) | EIA | n/a |
| | RUP | residential unit sales of electricity (delivery) | PUC | n/a |
| *Customers* | | | | |
| min(CE,CP) | CF | TOTAL Sales of Electricity (bundled) | FERC | 301-12f |
| or CF-CR if CE and CP missing | CR | Sales for Resale | FERC | 301-11f |
| | CE | number of customers (delivery) | EIA | n/a |
| | CP | number of customers (delivery) | PUC | n/a |
| *Network length* | | | | |
| | ND | Distr TOTAL Miles | Platts | n/a |
| *PDD* | | | | |
| | PP | TOTAL Prod. Plant | FERC | 207-42g |
| *Generation O&M* | | | | |
| PE-OE+PPE+(key2)*GE | PE | TOTAL Power Production Expenses | FERC | 321-80b |
| | OE | TOTAL Other Power Supply Exp | FERC | 321-79b |
| | PPE | Purchased Power | FERC | 321-76b |
| *Generation Capex* | | | | |
| key6*(NI+TO+ITF+ITO+DP+DC)+PD+key6*(GC) | NI | Net Interest Charges | FERC | 117-64 |
| | TO | Taxes Other Than Income Taxes | FERC | 114-13e |
| | ITF | Income Taxes - Federal | FERC | 114-14e |
| | ITO | Income Taxes - Other | FERC | 114-15e |
| | DP | TOTAL Dividends Declared-Preferred Stock | FERC | 118-29c |
| | DC | TOTAL Dividends Declared-Common Stock | FERC | 118-36c |
| *General Plant Capex* | | | | |
| key5*(TO+ITF+ITO+DP+DC+)+ | GC | n/a | | |
| key5=(GP)/(TOP) | GP | TOTAL General Plant | FERC | 207-83g |
| key6=(PP)/(TOP) | Depreciation | | | |
| | PD | Production | FERC | 336-(2-6) |
| | GD | General | FERC | 336-9 |

| | | | | |
|---|---|---|---|---|
| *GenUnitCost* | | | | |
| (Generation O&M+Generation Capex)/UF | | | | |
| *Transmission O&M* | | | | |
| TE+SC+key3*GE | TE | TOTAL Transmission Expenses | FERC | 321-100b |
| | SC | System Control and Load Dispatching | FERC | 321-77b |
| *Transmission Capex* | | | | |
| TA+key7*(GA) | TA | TOTAL Transmission Plant Additions | FERC | 207-53c |
| key7=(TP)/(TOP) | TP | TOTAL Transmission Plant | FERC | 207-53g |
| *TransUnitCost* | | | | |
| (Transmission O&M+Transmission Capex)/UF | | | | |
| *Ratio Res. Sales* | | | | |
| Units (residential)/Units (total) | | | | |
| *Own generation* | Power sources | | | |
| NG/(NG+P) | NG | Net Generation | FERC | 401-9b |
| | P | Purchases | FERC | 401-10b |
| *Nuclear* | | | | |
| Nu | Nu | Nuclear | FERC | 401-4b |
| *Hydro* | | | | |
| HC+HP | HC | Hydro-Conventional | FERC | 401-5b |
| | HP | Hydro-Pumped Storage | FERC | 401-6b |
| *Fossil* | | | | |
| Fo | Fo | Fossil-fuel | FERC | 401-3b |