Restructuring the Rate Base

By Steve Cicala*

In the late 1990s and early 2000s, many U.S. utilities underwent a process of deregulatory 'restructuring.' This introduced market competition in electricity generation, while leaving the transmission and distribution (T&D) segments subject to cost-of-service regulation. Research indicates that restructuring has yielded significant generation cost savings. Deregulated power plants have been found to use less labor (Fabrizio et al. (2007)), less capital-intensive pollution abatement technology (Cicala (2015b); Fowlie (2010)), secure lower cost fuel (Chan et al. (2017); Cicala (2015b, 2021)), and reduce maintenance downtime (Davis and Wolfram (2012)).

In spite of these cost reductions, it does not seem that retail prices have fallen for customers (Bushnell et al. (2016); Joskow (2005); Kwoka (2008); Mackay and Mercadal (2021)). Where did the cost savings go, if not to consumers? Restructuring separated formerly vertically-integrated utilities into at least two prospective beneficiaries: deregulated generators who produce power, and the transmission and distribution utilities that charge regulated rates to deliver it.[1]

In this paper I study one potential mechanism through which utilities facing restructuring might have prevented cost savings from making their way to consumers: by bulking up capital stocks in the downstream T&D operations that remained rate-regulated.

During the rate-setting process, regulators add up variable costs and an allowed rate of return on the capital stock, or 'rate base' to derive the utility's 'revenue requirement.' Dividing by expected quantities yields the retail rate. The allowed rate of return typically exceeds the cost of capital, making capital investment lucrative for utilties (Averch and Johnson (1962); Dunkle Werner and Jarvis (2024)). When approving capital investments, the regulator locks in long-term earnings for the utility. If regulators focus on the nominal price of electricity as argued in Joskow (1974) and Hausman (2019), T&D utilities may increase profits without increasing retail prices by capitalizing cost reductions into their rate base.

I test whether formerly vertically-integrated IOUs disproportionately increased their T&D capital stocks following power plant divestiture in the United States using an annual panel of utility assets collected by the Federal Energy Regulatory Commission (FERC) from 1993-2009. Following the estimation strategy of Cicala (2015b), I use a matched-difference-in-difference (DD) estimator to compare utilities in close geographic proximity, with similar pre-divestiture capital stocks. During the baseline period, the average utility held about \$6B in capital assets, half of which was in generation. I find that divestiture utilities on average held an additional \$0.45B in T&D assets nine years after divestiture relative to their predicted counterfactual. This represents a 9.5% increase over the counterfactual end-line, with most growth in capital occurring in the distribution system (\$0.4B per utility on average).

* I am grateful to Lucas Davis, Meredith Fowlie, and seminar participants at UC Berkeley, and the UC Energy Institute POWER Conference for helpful comments and suggestions. Daisy Lu and Ziqi Zhou provided excellent research assistance. All errors remain my own. e-mail: scicala@gmail.com

[1] A third prospective party would be competitive retailers who procure wholesale power and offer plans to final customers. Outside of Texas, this is overwhelmingly the same firm as the incumbent T&D utility, where the most popular 'default' rates remain regulated. Texas' T&D utilities are "wires only" and are prohibited from offering retail plans to final customers.

This change takes the form of a persistent increase in annual investments rather than a one-time jump in capital stocks. T&D investments were growing over time for all utilities, so the combination of industry trends and this additional capitalization means that divestiture utilities held nearly as much nominal aggregate capital in 2009 as they did in 1993, even though half of their regulatory assets had been sold off in the interim.

These results suggest additional regulatory vigilance is required as renewable generation subsidies are expanded. While low-cost supply may depress prices in wholesale electricity markets, consumers will fail to benefit from (and make electrification decisions in response to) lower prices if regulated T&D utilities respond by expanding their rate base, converting the savings into a long-term flow of delivery charges.

I. Data and Estimation Strategy

The main data source of this analysis is the FERC Form 1 - Electric Utility Annual Report. These are comprehensive financial reports filed by major utilities operating under FERC jurisdiction. I identify 123 FERC-reporting utilities serving end-use customers that owned generation, transmission, and distribution assets before 1997. Of these, 44 would eventually divest some or all of their generation assets as part of state-mandated electricity restructuring policies. In cases where the restructured utility became a new wires-only FERC-reporting entity, I connect reports to the legacy utility to create a nearly-balanced panel from 1993-2009.

The process of generation divestiture can be seen in aggregate in Figure 1, which plots total nominal capital separately for utilities that would eventually be restructured ("divestiture utilities"), and utilities that would retain their traditional structure ("traditional utilities"). Leading up to 1997 there were over $500B in total utility assets, evenly split between divestiture and traditional utilities. Total assets owned by divestiture utilities declined during the divestiture period from 1997-2002 as power plants were sold off. After bottoming out, however, transmission and distribution assets at divestiture utilities grew so that they owned as much nominal capital in 2009 as they did in 1993, but without power plants on their books.

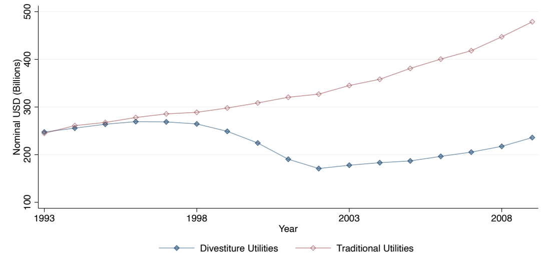


Figure 1. Aggregate Electric Utility Capital 1993-2009

From 1997-2009, regulated utilities continued to build and own new power plants, accumulating nearly $100B in additional capital (a 67% increase). Of course new power plants were also constructed to serve customers in restructured territories, but those deregulated assets are outside of FERC's Form 1 data collection and are not needed to study the evolution of capital in transmission and distribution systems.

Appendix Table A.1 presents summary statistics of utility profiles in 1997 by divestiture status. While aggregate total assets are evenly divided between divestiture and traditional utilities, there were fewer divestiture utilities and so their portfolios tended to be larger on average. In addition to having more assets, they served more customers, and sold more power. Combining this larger volume with higher prices meant that the average divestiture utility earned nearly $1B/year more in revenue than the average traditional utility (double).

These differences between divestiture and traditional utilities motivate a matching strategy to address confounding from local, time-varying unobservables. I alternatively match utilities based on the proximity of borders (within 100 or 300 miles), or within 500 miles and based on the total capital stock reported by utilities averaged

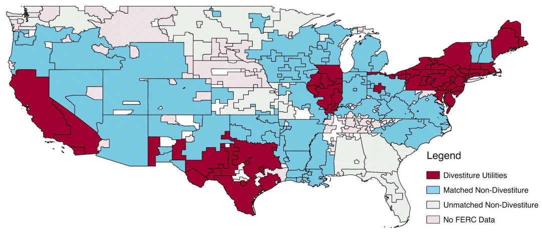


FIGURE 2. UTILITY SERVICE AREAS IN THE UNITED STATES BY GENERATION DIVESTITURE POLICY

between 1993-1997, the final year before any divestitures began. I also control directly for annual load, though results for capital stocks are similar without this additional control.

As shown in Figure 2, utilities on the diagonal between Florida and Washington states are typically omitted from matched specifications. Note that utilities whose power tends to come from federally-administered generation (i.e. Tennessee Valley Authority and U.S. Bureau of Reclamation) are not reported in the FERC data. In total there are 44 divestiture utilities, 41 with borders within 300 miles of a traditional utility service area. There are 50 traditional utilities whose borders are within 500 miles of a divestiture utility.

Within distance bands, matching based on total capital stocks during the baseline period ensures that utilities being compared are of similar size. This means, for example, that a small Vermont utility may serve as a counterfactual for a similarly-sized rural upstate New York or Massachusetts utility, but is less likely to stand in for the changes that would have occurred in New York City.

I estimate difference-in-differences (DD) models of the form

$$y_{it} = D_{it}\tau + X_{it}\beta + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

where y_{it} is the outcome of interest for utility i in year t, γ_i and δ_t are utility and year fixed effects, respectively, X_{it} represents annual load, and D_{it} is an indicator that turns on after utility i begins to divest its power plant holdings based on Cicala (2015a). When using matched-DD specifications, control observations are weighted in proportion to the role they play in constructing counterfactuals for various treated facilities (matching is conducted with replacement). In event study-type figures I expand τD_{it} to be a comprehensive sequence of indicator variables in 'event time', so that $\tau_p \chi(r_{it} = p)$ measures the relative difference in outcomes at divested utilities in year p relative to the onset of divestiture. The year prior to first divestitures ($p = 0$), is omitted as a normalization to complete the DD interpretation. Regarding inference, I cluster standard errors at the utility level.

II. Results

Figure 3 presents the main results as event study figures. All outcomes are measured in levels to facilitate adding up across asset categories. I plot results for four years prior to divestiture and nine years after, as differences in the timing of divestiture create substantial compositional changes in the sample: There are a limited number of utilities that had already been divested for ten years by 2009, for example. The results presented here are based on matching the 5 most similar utilities based on initial capital stocks, within 500 miles. The analogous figures without matching (i.e. unweighted DD) and for total and generation capital are presented in Appendix Figures A1-A3.

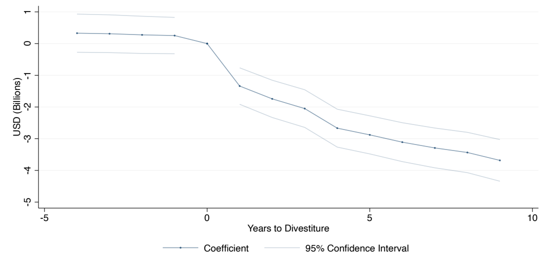
Total assets were trending similarly between traditional and divestiture utilities before power plants were sold off. The growing gap in production capital in Figure 3(B) is because power plants were not necessarily all sold at once, and because generation capital continued to grow for traditional utilities. We get a sense of the total magnitude of the relative growth in non-generation capital by comparing the ~\$4B relative drop in production capital in Figure 3(B) with the ~\$3.5B drop to total capital overall in Figure 3(A).

Figure 3(C) shows that the relative distribution capital stock was flat prior to divestiture, after which it begins to progressively rise, indicating a persistent increase in net investment among divestiture utilities. This relative growth in distribution reaches \$0.4B per utility in the ninth year after initial divestitures.

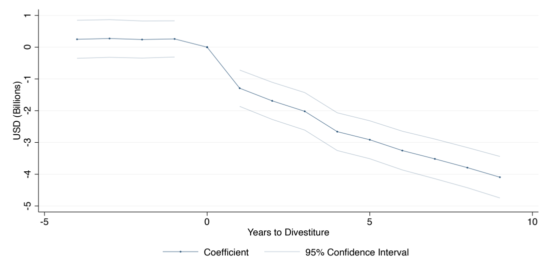
For transmission capital, it appears that divestiture utilities were growing less slowly prior to divestiture. This differential pre-trend does not appear when estimating equation (1) without controls for annual load, which means that divestiture utilities were not keeping up with transmission capital per MWh delivered, even though their nominal capital investments were parallel. Consistent with transmission investments requiring time to get going, there is a reversal in this relative trend two years after initial divestitures. At end-line there is about \$50M in extra transmission capital per utility, which could perhaps be more like \$100M if one thinks the appropriate 'onset' of treatment actually occurred with a lag.

Combining the relative growth in T&D capital there is about ∼\$0.45B extra per divestiture utility nine years after divestiture. Supposing T&D assets grew in parallel with traditionally regulated utilities, divestiture utilities would have held an average of \$4.7B in T&D capital. Thus the increased capital accumulation amounts to excess of about 9.5% at end-line.

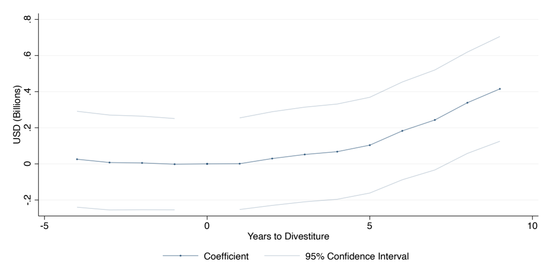
Appendix Table A2 presents regression results using net investment in each asset class as the outcome variable (in billions of dollars). It measures a single post-divestiture treatment effect as in equation (1), and represents the average change in annual net investment due to divestiture policy. The first column presents unweighted DD results including data from all utilities. Columns (2) and (3) include all utilities whose borders are within the specified distance band. Each divestiture utility receives a weight of one if there are any traditional utilities within the specified distance, and zero otherwise. Each traditional utility receives a weight equal to the sum of its match weight across divestiture utilities. Columns (4) and (5) use a 500 mile distance band as an initial



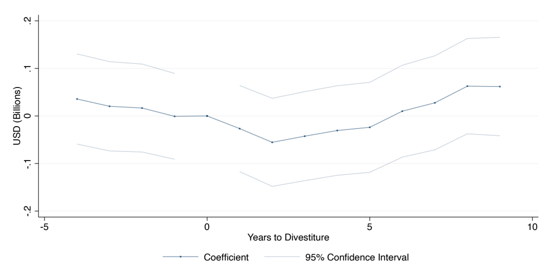
(A) Total Capital



(B) Production Capital



(C) Distribution Capital



(D) Transmission Capital

Note: Matching criterion: Nearest five utilities based on mean total capital stock between 1993 and 1997 and within 500 miles. Standard errors are clustered by utility.

FIGURE 3. MATCHED DD ESTIMATES BY YEAR TO FIRST DIVESTITURE

filter, but then match the m closest utilities based on total capital, averaged between 1993-1997.

The difference between total net investment and production net investment yields about a $30M gap per year. When measuring single post-divestiture coefficients, this appears to be driven entirely by distribution system investments, but the relative trend in pre-period capital for transmission observed in Figure 3(D) indicates the impact on transmission investment might be modestly underestimated with this approach. Appendix Figure A4 presents the event study figures for T&D net investment (i.e. flows) that are analogous to the capital stocks presented in Figure 3. For distribution, the level shift in investment indeed tracks the accumulating bend in stocks observed earlier. The change in investments is not statistically significant year-by-year in the event study figure, and as a single coefficient it is significant at the 10% level. That said, the persistence of the change means that distribution capital continued to grow, so that at end-line the differential capital stock has a p-value of 0.005. This is an excess capital stock that is both economically and statistically significant.

Looking across columns of Table A2, it appears that matching yields small changes in the estimates. Each of these columns represent specifications designed to account for different types of unobserved confounders. The first column controls for time-invariant differences between utilities, and uniformly accounts for changes over time. These estimates would be biased if there were an unrelated determinant of capital stocks that was correlated with divestiture, differentially changing over time. The second two columns allow for such differential changes that might be occurring in a spatially-correlated manner: population growth, input prices, regional development, etc. The final two columns further allow for such shocks to be specific to the size of utilities: small utilities in the northeast might be subject to different shocks from large utilities in the northeast, for example. All estimates include controls for annual load served. The fact that estimates are so similar across columns indicates that these types of unobservables are not meaningfully confounding estimates. This cannot entirely rule out the possibility of omitted variables bias, but limits the nature of what such a variable might be: correlated with divestiture and changing over time specifically at divestiture utilities, but not their similarly-size neighbors.

III. Conclusion

Restructuring the U.S. electricity sector has reduced generation costs, but does not appear to have lowered customer bills. Where did the surplus go? This paper suggests a way that regulated T&D utilities could have captured part of restructuring's savings with greater capital investments. Because restructuring left T&D regulation intact, local utilities were entitled to a return on their T&D assets in the form of a delivery charge added to restructured customers' bills. Cheaper energy, but higher delivery charges would offset one another in retail prices.

I find evidence consistent with this story in the annual filings of utilities to FERC. Nine years after divestiture, I find T&D capital stocks were $0.45B higher than predicted for the average utility whose generation assets had been divested. This amounts to 9.5% above counterfactual T&D assets.

It is possible that this excess investment makes up for long-delayed upgrades in traditional IOU systems, and is actually welfare-enhancing. On the other hand, the regulated electricity sector is widely known for its enthusiasm for capital projects. Whether these investments were warranted or not, T&D utilities would be entitled to earn a rate of return on their rate base, and this excess capital would make its way into customers' delivery charges.

REFERENCES

Averch, Harvey and Leland L. Johnson, "Behavior of the Firm Under Regulatory Constraint," *The American*

Economic Review, 1962, *52* (5), 1052–1069.

Bushnell, James B., Erin T. Mansur, and Kevin Novan, "Review of the Economics Literature on US Electricity Restructuring," Technical Report 2016.

Chan, H. Ron, Harrison Fell, Ian Lange, and Shanjun Li, "Efficiency and environmental impacts of electricity restructuring on coal-fired power plants," *Journal of Environmental Economics and Management*, January 2017, *81*, 1–18.

Cicala, Steve, "Replication data for: When Does Regulation Distort Costs? Lessons from Fuel Procurement in US Electricity Generation," 2015.

_ , "When Does Regulation Distort Costs? Lessons from Fuel Procurement in US Electricity Generation," *The American Economic Review*, 2015, *105* (1), 411–444.

_ , "When Does Regulation Distort Costs? Lessons from Fuel Procurement in US Electricity Generation: Reply," *American Economic Review*, April 2021, *11* (4), 1373–1381.

_ , "Replication Data for Restructuring the Rate Base," 2025.

Davis, Lucas W. and Catherine D. Wolfram, "Deregulation, Consolidation, and Efficiency: Evidence from U.S. Nuclear Power," *American Economic Journal: Applied Economics*, 2012, *4* (4), 194–225.

Fabrizio, Kira R., Nancy L. Rose, and Catherine D. Wolfram, "Do Markets Reduce Costs? Assessing the Impact of Regulatory Restructuring on US Electric Generation Efficiency," *The American Economic Review*, 2007, *97* (4), 1250–1277.

Fowlie, Meredith L., "Emissions Trading, Electricity Restructuring, and Investment in Pollution Abatement," *The American Economic Review*, 2010, *100* (3), 837–869.

Gosnell, Christina and Zane Selvans, "PUDL Raw FERC Form 1," 2020.

Hausman, Catherine, "Shock Value: Bill Smoothing and Energy Price Pass-Through," *Journal of Industrial Economics*, 2019, *67* (2), 242–278.

Joskow, Paul L., "Inflation and Environmental Concern: Structural Change in the Process of Public Utility Price Regulation," *The Journal of Law and Economics*, 1974, *17* (2), 291–327.

_ , "The Difficult Transition to Competitive Electricity Markets in the United States," *Electricity Deregulation: Choices and Challenges*, 2005, pp. 31–97.

Kwoka, John, "Restructuring the U.S. Electric Power Sector: A Review of Recent Studies," *Review of Industrial Organization*, 2008, *32* (3), 165–196.

Mackay, Alexander and Ignacia Mercadal, "Deregulation, Market Power, and Prices: Evidence from the Electricity Sector," Technical Report 2021.

Werner, Karl Dunkle and Stephen Jarvis, "Rate of Return Regulation Revisited," 2024.

A Restructuring the Rate Base Supplementary Results Appendix: For Online Publication

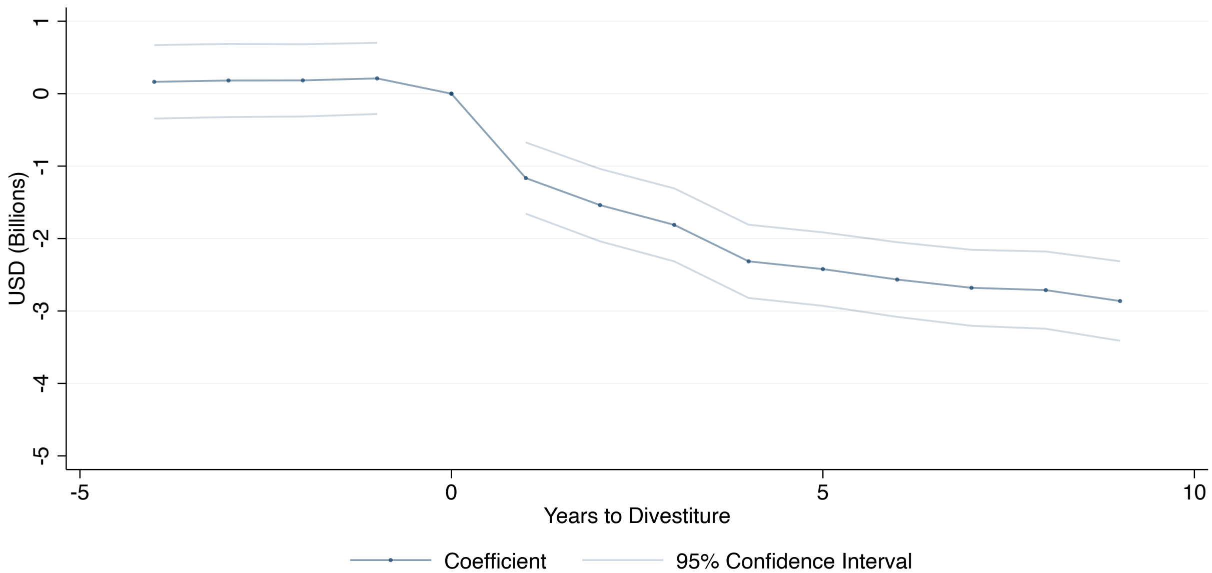
Table A.1: Electric Utility Summary Statistics in 1997

	All Utilities			Matched Utilities		
	Divested	Not Divested	Difference of Means	Divested	Not Divested	Difference of Means
A. Assets (Billion $)						
Total Capital	6.11	3.62	2.49**	6.55	5.04	1.51
	[6.65]	[3.95]	(1.09)	[6.68]	[4.08]	(1.31)
Production	3.32	1.87	1.45**	3.57	2.67	0.89
	[4.03]	[2.17]	(0.65)	[4.07]	[2.33]	(0.78)
Transmission	0.63	0.47	0.16	0.68	0.68	–0.00
	[0.70]	[0.47]	(0.12)	[0.70]	[0.45]	(0.14)
Distribution	1.89	1.07	0.81**	2.02	1.45	0.58
	[2.13]	[1.16]	(0.35)	[2.15]	[1.18]	(0.41)
Other	0.26	0.20	0.06	0.27	0.24	0.03
	[0.34]	[0.28]	(0.06)	[0.34]	[0.30]	(0.08)
B. Generation and Sales						
Capacity (GW)	5.23	4.26	0.97	5.61	6.33	–0.72
	[5.95]	[4.68]	(1.04)	[5.99]	[4.76]	(1.31)
Sales (TWh)	21.70	16.50	5.20	23.26	23.95	–0.69
	[22.90]	[16.64]	(3.92)	[22.96]	[16.82]	(4.92)
Revenue ($	1.88	0.98	0.90***	2.02	1.37	0.65*
B)	[1.99]	[1.07]	(0.32)	[1.99]	[1.01]	(0.37)
C. Prices ($ / kWh)						
Residential	0.11	0.08	0.03***	0.11	0.08	0.03***
	[0.02]	[0.02]	(0.00)	[0.02]	[0.02]	(0.01)
Commercial	0.09	0.07	0.03***	0.09	0.07	0.02***
	[0.02]	[0.02]	(0.00)	[0.02]	[0.02]	(0.01)
Industrial	0.06	0.04	0.02***	0.06	0.05	0.02***
	[0.02]	[0.01]	(0.00)	[0.02]	[0.02]	(0.00)
D. Share of Sales						
Residential	0.32	0.32	0.01	0.33	0.31	0.01
	[0.05]	[0.09]	(0.01)	[0.05]	[0.06]	(0.02)
Commercial	0.34	0.29	0.05**	0.34	0.27	0.07***
	[0.12]	[0.10]	(0.02)	[0.12]	[0.09]	(0.03)
Industrial	0.32	0.37	–0.05*	0.31	0.39	–0.08**
	[0.13]	[0.18]	(0.03)	[0.13]	[0.14]	(0.04)
Utilities	44	79	123	41	44	85

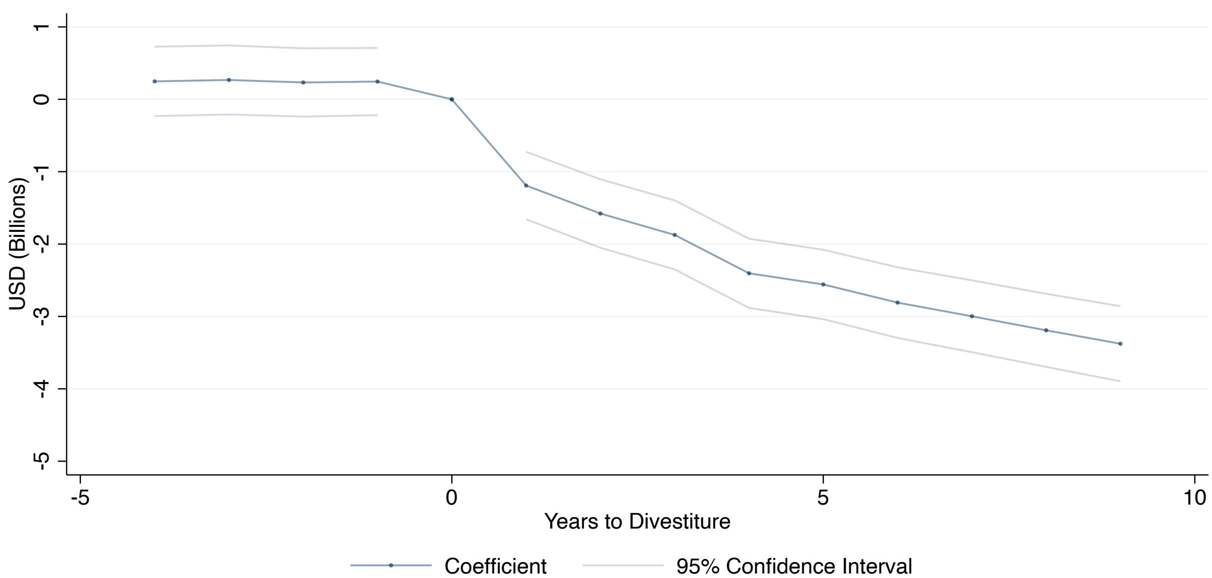
Note: Data from non-divestiture utilities in the matched sample receive weight $\frac{1}{m_j}$ for each matched divestiture utility. Matching criterion: Nearest five utilities based on mean total capital stock between 1993 and 1997 and within 500 miles. Standard errors are clustered by utility in parentheses, and standard deviations are in brackets.
* p<0.1, ** p<0.05, *** p<0.01

Figure A.1: Unmatched DD Estimates by Year to First Divestiture: Total and Production Capital

(A) Total Capital



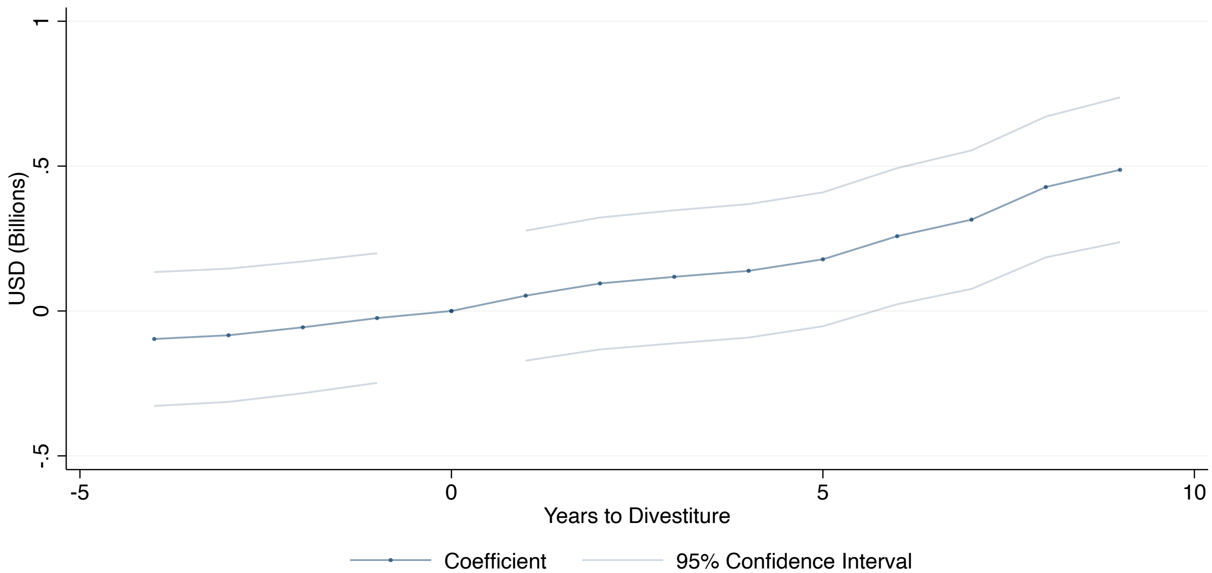
(B) Production Capital



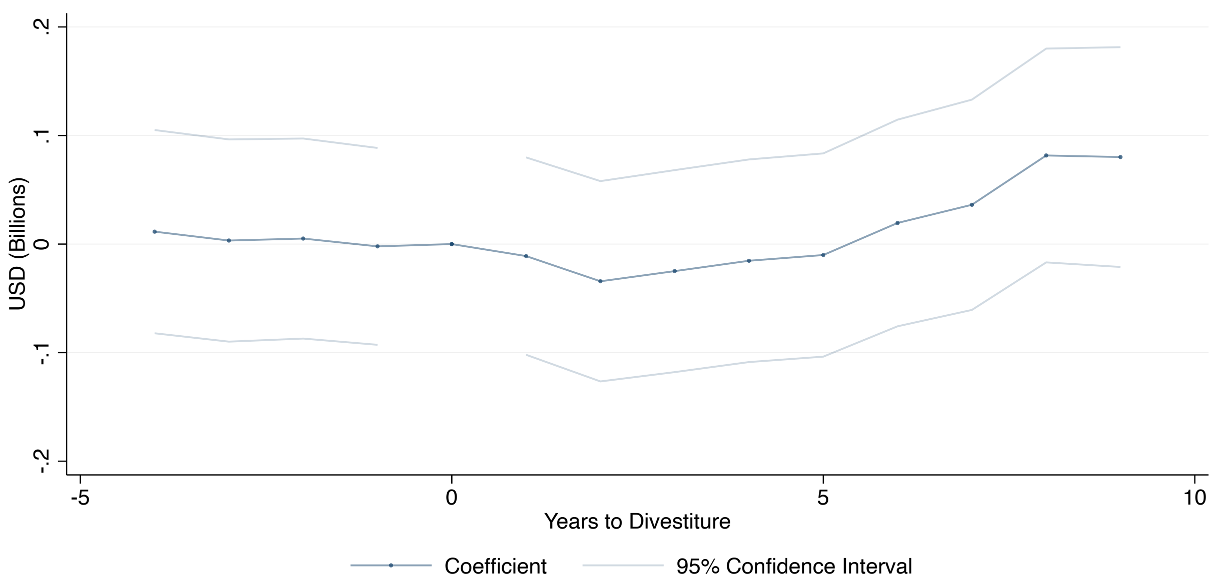
Note: These estimates are based on the complete, unweighted dataset without matching. Standard errors are clustered by utility.

Figure A.2: Unmatched DD Estimates by Year to First Divestiture: Distribution and Transmission Capital

(A) Distribution Capital



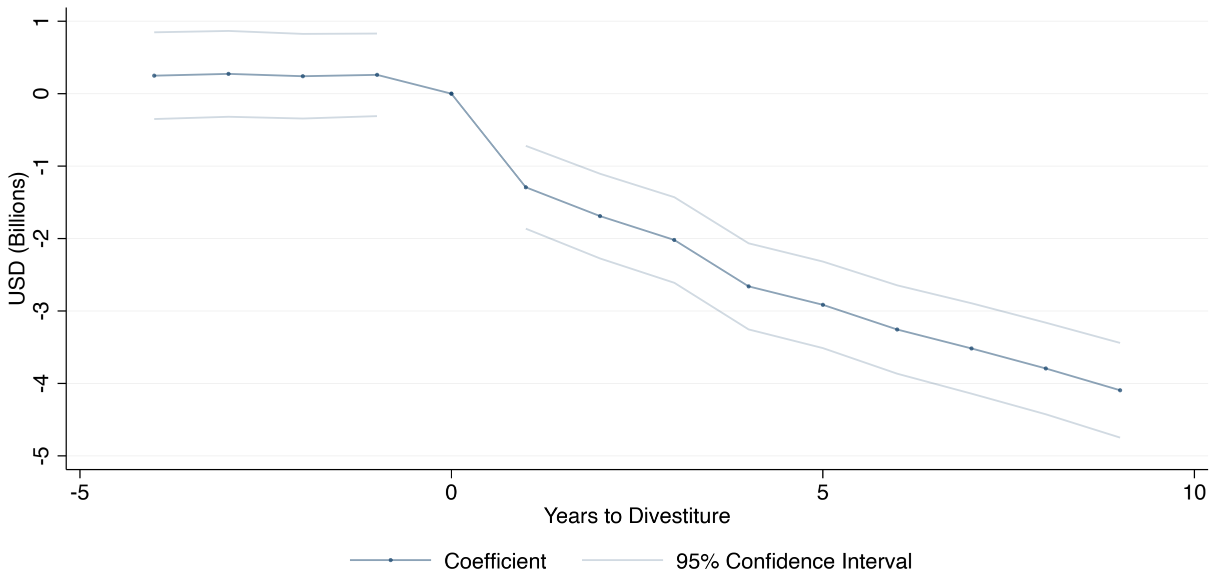
(B) Transmission Capital



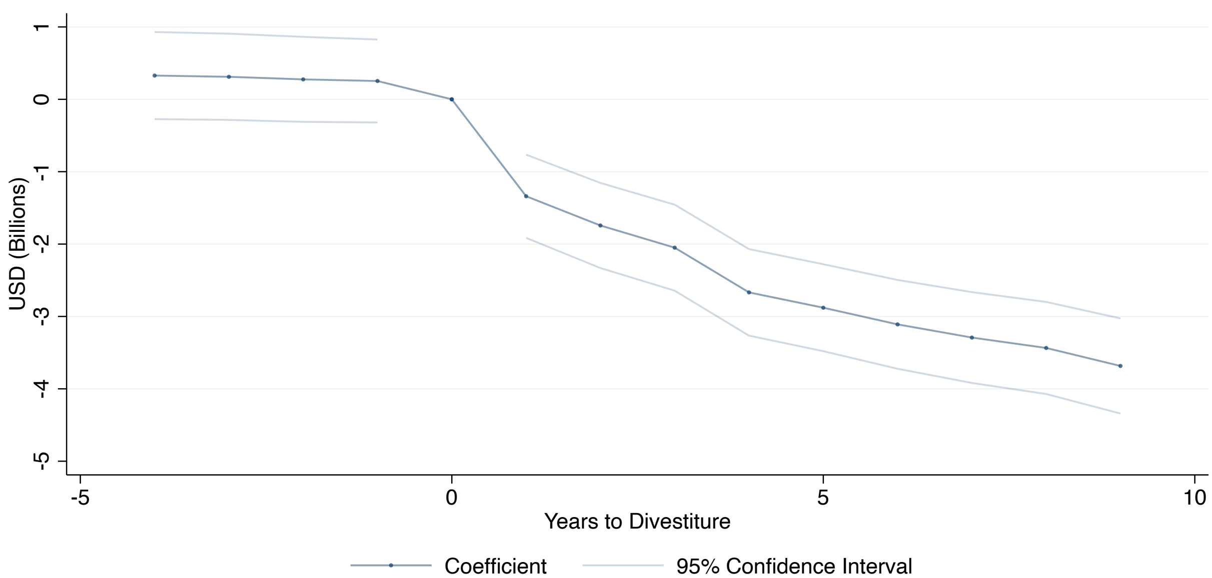
Note: These estimates are based on the complete, unweighted dataset without matching. Standard errors are clustered by utility.

Figure A.3: Matched DD Estimates by Year to First Divestiture: Total and Production Capital

(A) Production Capital



(B) Total Capital



Note: Matching criterion: Nearest five utilities based on mean total capital stock between 1993 and 1997 and within 500 miles. Standard errors are clustered by utility.

Table A.2: Effects of Divestiture on Net Investment by Capital Type

A. Distribution Net Investment ($ B)	(1)	(2)	(3)	(4)	(5)
Post-Divest	0.032**	0.033*	0.031*	0.027	0.029*
	(0.016)	(0.020)	(0.017)	(0.017)	(0.017)
m nearest neighbors	–	–	–	1	5
Proximity Threshold (mi.)	–	100	300	–	–
Utilities	123	75	91	64	85
Divested Utilities	44	35	41	41	41
R^2	0.462	0.441	0.445	0.412	0.435
Obs.	1953	1192	1447	1002	1350

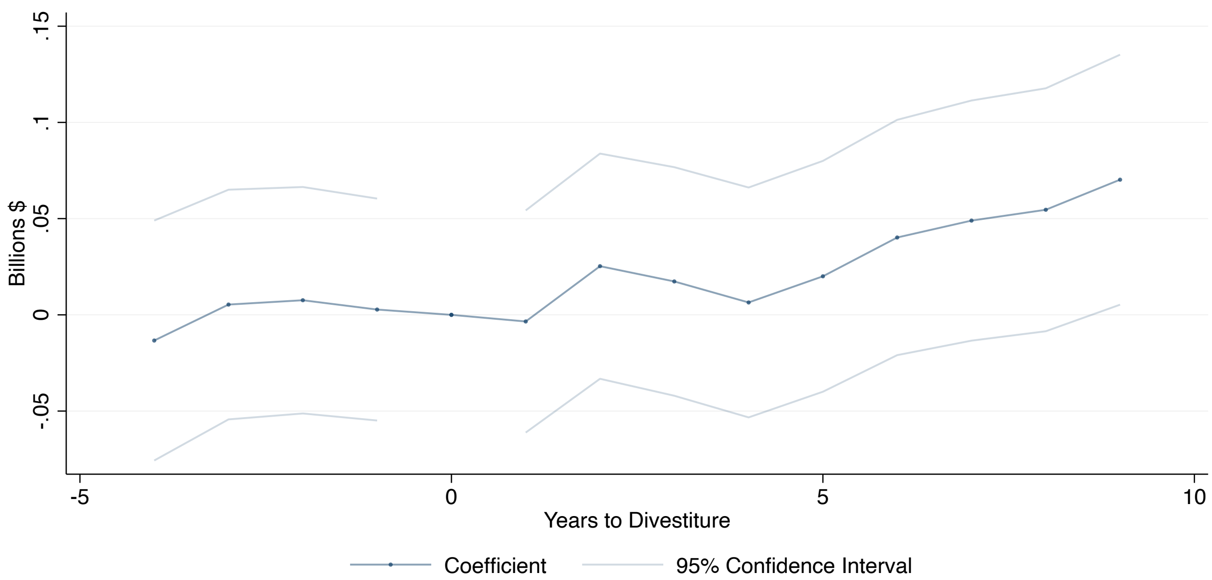
B. Transmission Net Investment ($ B)	(1)	(2)	(3)	(4)	(5)
Post-Divest	0.012	0.003	0.006	0.009	0.004
	(0.009)	(0.013)	(0.010)	(0.011)	(0.010)
m nearest neighbors	–	–	–	1	5
Proximity Threshold (mi.)	–	100	300	–	–
Utilities	123	75	91	64	85
Divested Utilities	44	35	41	41	41
R^2	0.280	0.293	0.262	0.248	0.261
Obs.	1953	1192	1447	1002	1350

D. Transmission & Distribution Net Investment ($ B)	(1)	(2)	(3)	(4)	(5)
Post-Divest	0.043**	0.036	0.037*	0.036	0.032
	(0.021)	(0.026)	(0.022)	(0.022)	(0.021)
m nearest neighbors	–	–	–	1	5
Proximity Threshold (mi.)	–	100	300	–	–
Utilities	123	75	91	64	85
Divested Utilities	44	35	41	41	41
R^2	0.463	0.457	0.449	0.399	0.438
Obs.	1953	1192	1447	1002	1350

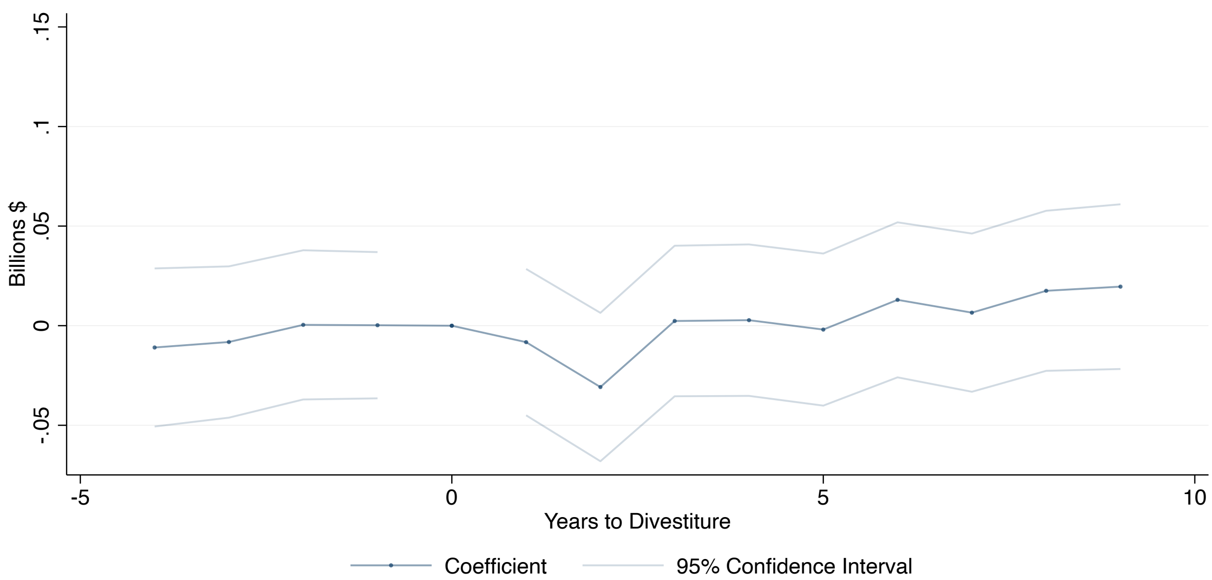
Note: The dependent variable is the year-to-year change in the capital stock reported in each respective category, in billions of dollars. Estimates in the first column are unweighted, while remaining columns are weighted by the indicated matching metric. All specifications include utility and year fixed effects. Standard errors clustered by utility in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Figure A.4: Matched DD Estimates by Year to First Divestiture: Distribution and Transmission Net Investment

(A) Distribution Net Investment



(B) Transmission Net Investment



Note: Matching criterion: Nearest five utilities based on mean total capital stock between 1993 and 1997 and within 500 miles. Standard errors are clustered by utility.