Buyer Power and Horizontal Mergers:

Evidence from Plant-Level Input Prices and Supply Contracts

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Abstract

I study how firms achieve supply chain efficiency after acquisitions using comprehensive plant-level data on input prices and supply contracts. Using horizontal mergers between electric utility holding companies as an empirical setting, I find that input prices of coal-fired generation plants owned by merging firms decrease around 3-4% three years after merger completion. The procurement saving is mainly for target firms' plants, for plants in deals with more positive stock market announcement effects, and for firms with stronger incentives to capture market share. The level of input price reduction is significantly related to the shareholders' wealth gains in the mergers. These findings are not driven by pre-merger input price trends and are robust to controlling for input quality, quantity, and changes in production technologies. Evidence from detailed supply contracts suggests that the merging firm actively renegotiates existing procurement contracts and shortens supply chain shipping distances upon merger completion. Subsequently, the quality of input used by the merging firms improves. Additionally, merging firms also actively seek new suppliers in the factor market. These results suggest that buyer power is an important source of shareholder wealth creation in horizontal mergers.

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1. Introduction

Mergers and acquisitions (M&A) enable firms to streamline production processes and achieve efficiency gains. A combined firm has buyer power, thereby achieving lower input costs from the factor market. Merging firms can bargain for higher economic surpluses with suppliers (Snyder 1996, 1998) or achieve procurement efficiency through pooled purchasing (Inderst and Wey 2003; Inderst and Shaffer 2007). Practitioners also cite savings in procurement costs as an important synergistic gain in mergers (Timmermans et al. 2014). Although a growing literature studies the influence of mergers on upstream industries (Fee and Thomas 2004; Shahrur 2005; Bhattacharyya and Nain 2011; Ahern and Harford 2014; Greene, Kini, and Shenoy 2017), there is little empirical evidence that directly relates mergers to input prices and procurement practice. The paucity of evidence leaves several important questions unanswered. Can merging firms obtain lower input prices? Does shareholder's wealth gain reflect anticipated savings in procurement costs? Do merging firms renegotiate supply chain contracts? How do merging firms integrate the supply chain to obtain lower procurement costs?

One potential reason these questions have not been evaluated empirically is that the firms' supply procurement activities are generally unknown to researchers. A clean test on post-merger supply chain effects is to compare the merging firms' procurement costs before and after acquisitions. However, the existing merger literature has mainly focused on industry-level input prices due to a paucity of data at the firm-level (Bhattacharyya and Nain 2011; Greene, Kini, and Shenoy 2017). The data limitation also precludes a detailed analysis of the relation between merger announcement effects and changes in input prices. Additionally, existing literature ignores post-merger changes in non-price items such as supplier contract terms and execution, input quality, and supply chain logistics, which are likely part of merging firms' business strategies to revamp the supply chain.

This paper provides the first evidence on post-merger upstream restructuring using granular input prices and supply contracts in a unique setting. I analyze horizontal mergers in the electric utility industry to evaluate whether buyer power is a source of wealth creation in horizontal mergers from multiple aspects.

Unlike nationalized power sector in most other countries, the U.S. electric utility industries are dominated by private investor-owned holding companies traded on stock exchanges. Although the industry is subject to regulation on the prices charged on retail customers (output prices), utility firms are still incentivized to reduce procurement costs due to a competitive wholesale electricity market and losses of local monopoly power following federal and state deregulation in the 1990s (Fabrizio, Rose, and Wolfram 2007; Becher, Mulherin, and Walkling 2012; Cicala 2015). Therefore, evidence from the utility industries can contribute to our understanding of the business practice of for-profit organizations (Reinartz and Schmid 2016; Lin, Schmid, and Weisbach 2017).

The rich information in the electric utility industry provides a nice laboratory setting to study the supply chain effect of mergers. While input prices are not available for most industrial firms, utility firms in the United States provide detailed information on fuel cost, quantity, quality, supplier information, and supply contracts for a large group of coal-fired generation plants. I assemble a comprehensive data set of 375 coal-fired power plants spanning a 30-year horizon to track changes in fuel procurement following 43 horizontal mergers between utility holding companies. Subsequently, I also examine whether the observed input price changes are related to shareholder wealth creation for publicly traded utility companies. Another advantage of this setting is that coal-fired plants predominately use private long-term supply contracts, rather than the spot or futures market, to obtain fuel for generation. Further, the information in the supply contract allows me to comprehensively evaluate multiple theoretical arguments on the sources of buyer power in mergers.

In the main empirical tests, I use a matched difference-in-differences estimator with plant and year fixed effects to compare power plants of the merging firms with geographically proximate plants using the same category of generation coal. The empirical models also include important technological attributes in power plants to control for production technology changes that occur concurrently with the mergers. The empirical specifications and the granularity of the data set alleviate concerns of confounding factors in merger studies comparing aggregate industry-level input prices.

A preview of my finding is as follows. I find that horizontal mergers are associated with significant procurement costs savings. Specifically, coal procurement prices of power plants decrease around 3-4% three years following the mergers. Additionally, I use a dynamic treatment dummy model (Bertrand and Mullainathan 2003; Giroud and Mueller 2010; Brav, Jiang, and Kim 2015) to verify that the observed input price savings are not driven by a declining trend of coal prices before the mergers. Using exogenous variation in the length of regulatory approval for utility mergers, I find that the input price savings are only observable when acquirers have control over the targets' generation plants. Therefore supply chain savings are largely attributable to active post-merger restructuring of the combined firm.

Having documented an economically significant reduction in post-merger input costs, I turn to the analysis of the distribution of supply chain gains in various economic settings. I find that the magnitude of supply chain savings is larger for plants originally owned by the target firms, suggesting that target plants achieve efficiency gains following an active restructuring process of the acquirers (Maksimovic, Phillips, and Prabhala 2011). Plants involved in deals with more synergistic gains are also associated with larger post-merger input savings. Additionally, I also find that shareholders' total wealth gains in utility mergers are significantly related to both the likelihood and the level of input price reductions three years after merger completion. An interquartile change in the combined wealth creation in mergers is associated with about 2.7% additional savings on average prices. These results suggest that the capital market's assessment of horizontal mergers is consistent with the observed supply chain real effects. The regulatory regime also matters for the supply chain gains. I find that plants operating in states with deregulated retail electricity markets enjoy greater post-merger input savings possibly due to stronger incentives to capture larger market share in a competitive product market.

To further understand the sources of supply chain savings following mergers, I use detailed coal supply contracts to evaluate the theoretical underpinnings of buyer power. The buyer power theories can be broadly classified into two non-mutually exclusive categories: *Bargaining Power* and *Purchasing Efficiency*. Under the bargaining power argument, the merging firms can bargain for higher economic surpluses in price or non-price items when contracting with suppliers. Merging firms can exercise its monopsony power when suppliers are price takers by decreasing purchases from upstream firms, thereby reducing input prices (Snyder 1996, 1998). The purchasing efficiency argument suggests that buying common inputs from suppliers leads to more effective purchasing practice. For example, merging firms save on raw materials handling and shipping costs while suppliers realize selling efficiencies by dealing with a large common buyer (Inderst and Wey 2003; Inderst and Shaffer 2007). The supply contracts I use are mandatory filings by a large number of coal-fired plants. Each contract contains highly detailed information on contractual terms such as quality requirement, information of the delivered input, and details of shipping. The data set tracks each coal contract from the year of initiation to its termination. Similar to the analysis on coal input prices, I use a matched difference-in-differences estimator with contract and year fixed effect to analyze the repeated contracting processes between merging power plants and the coal suppliers.

The analysis of supply contracts indicates that merging firms achieve procurement savings through higher bargaining power and more cost-efficient purchasing. I find that acquiring firms tend to renegotiate existing supply contracts once mergers are completed. As a part of the contract revision process, merging firms enforce stricter quality standards for inputs. Following contract revisions, post-merger power plants are less likely to receive inferior products from their suppliers even after imposing higher ex ante quality standards. These findings are consistent with the bargaining power argument — merging firms renegotiate supply contracts to extract higher economic rents, and suppliers pay more attention to product quality for fear of losing a major customer. I also find evidence of purchasing efficiency. Firms significantly simplify supply chain shipping processes, suggesting that merging firms can utilize informational advantages in multiple markets to search for the most cost-efficient shipping route. This finding can contribute to input cost savings since shipping expense is a major component of coal generation cost (Preonas 2018).

Besides rewriting supply contracts with existing suppliers, merging firms also achieve input cost savings by changing suppliers. Cost savings can be achieved by switching to more cost-efficient coal mines or terminating costly transactions with existing coal suppliers. Analysis of power plants' coal supplying counties suggests that merging firms are more likely to add new suppliers but not more likely to stop purchasing from existing suppliers. The addition of new suppliers is another potential channel for procurement savings.

Overall, the findings in this paper suggest that mergers lead to significant cost reduction in factor prices and the achieved supply chain efficiency is attributable to the buyer power of the combined firms. It contributes to a large literature on the interaction between mergers and product market. The existing finance literature mostly focuses on the announcement effects of mergers on rival firms, suppliers and customers to understand the sources of gains in mergers (Eckbo 1983; Fee and Thomas 2004; Shahrur 2005; Shenoy 2012; Greene, Kini, and Shenoy 2017). In this paper, I take a different approach by directly examining the post-merger changes in input prices and subsequently linking realized procurement cost savings with the stock market announcement effects of mergers. To the best of my knowledge, this is the first paper to directly study the influence of mergers on actual transaction-based factor prices. My findings on the stock market announcement effects provide support for the existing approaches used in the finance literature. It also contributes to a large literature in industrial organization economics studying the real effects of mergers (Borenstein 1990; Kim and Singal 1993; Singal 1996).

Recent literature has shifted the focus of M&A studies to understand more granular changes in the merging firms (Maksimovic and Phillips 2001; Maksimovic, Phillips, and Prabhala 2011; Erel, Jang, and Weisbach 2015; Tate and Yang 2016). Studying changes in post-merger subsidiaries can open up the "black box" of firms' internal organizations to further our understanding of the real impacts of mergers. In this paper, I find that subsidiary-level contract renegotiation can be a potential driver for post-merger synergies as manifested by procurement cost savings. Contracting issues have played an increasingly important role in corporate finance ever since the corporation started being viewed as a nexus of implicit and explicit contracts among financial stakeholders and various other nonfinancial stakeholders such as suppliers, customer, etc. (Jensen and Meckling 1976). However, there is a paucity of research on contractual arrangements in business transactions largely because of the dearth of information on actual contracts (Kaplan and Stromberg 2003). My findings suggest that ownership changes are associated with an active renegotiation of existing contracts in multiple dimensions and that changes in product market contracts can be a source of wealth creation in mergers.

The remainder of the paper is structured as follows. Section 2 introduces the coal procurement practice and the electric utility industry. Section 3 describes key variables and data sets. Section 4 presents the main results on input prices. Section 5 reports the analysis on the channels of supply chain value creation. Section 6 concludes.

2. Institutional Details

2.1 Generation coal

Electricity generation is a process that converts various sources of energy to electric power. A heat generator converts the heat from burning fossil fuels to steam, which turns a turbine to rotate a generator shaft. The shaft rotates through opposing magnetic fields and creates alternating current. In the United States, the heat burned by coal is a major source of electricity generation (Figure 1) partly because the United States has the world's largest coal reserves. Additionally, coal-fired plants are cheaper to run for prolonged periods compared to other plants using other combustible energy sources such as natural gas and oil. However, burning coal is a leading cause of air pollution and green gas emission. As such, coal's dominating position has been gradually overtaken by natural gas thanks to mounting regulatory pressure from the environmental protection agencies and cheaper natural gas prices due to the rising shale gas production. In more recent periods, the share of electricity generated by coal heat roughly equals the share of natural gas generation. Nevertheless, the coal-fired utility plants still generate about 1/3 of the electricity in the country, and coal is still one of the most influential electricity source energy in the United States (U.S. Energy Information Administration 2018).

Coal cost is a major component of electricity prices. The cost of generation accounts for more than 50% of the electricity prices (U.S. Energy Information Administration 2018). Unlike natural gas and oil, coal mined from different regions varies in important dimensions. Roughly speaking, coal products can be separated into four ranks based on decreasing order of energy content: Anthracite, Bituminous, Sub-bituminous, and Lignite. In the United States, about 90% of the coal used for electricity generation is bituminous or sub-bituminous. Higher heat bituminous coal mined from the Appalachian Mountains is more energy efficient but also discharges more sulfur dioxide and other pollutants. Sub-bituminous coal from mines in the western states, such as Wyoming, contains lower heat but also lower sulfur. Since the 1990s, the U.S. generation coal procurement has shifted towards low-sulfur coal due to the Clean Air Act in 1990, which set up air pollutant emission caps for coal-fired plants. However, shipping coal across regions is expensive, preventing a large number of plants from obtaining low-sulfur coal produced by the western states. Moreover, generation boilers are tailored to perform most efficiently for coals with specific attributes (Kacker 2016).

Because of these features, coal procurement is highly specific to a plant's location (Joskow 1985, 1988)**.** The most frequently used form of coal purchase is long-term private contracting between coal mines and power plants (Joskow 1985, 1987, 1988). These contracts open up opportunities for merging firms to bargain with coal mines for lower prices and more favorable terms. Additionally, merging firms can also achieve supply chain savings by reducing shipping and handling costs during contract execution.

2.2 Electricity utilities and incentives to reduce fuel costs

Electricity utilities provide generation, transmission, and distribution of power to the general public. The dominant players in this market are investor-owned utilities[1], which provide power to about 70% of all customers in the country. These companies raise capital from investors and serve to maximize shareholders' wealth subject to regulations aimed to protect the public interest. In this study, I focus on power plants owned by investor-owned utilities to understand the supply chain effect of mergers between

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[1] There are also public utilities for electricity generation. Public utilities are government and municipal-owned utilities or member-owned cooperatives that usually serve in distant regions.

profit-maximizing firms. Additionally, most private utilities are publicly traded on the stock exchanges, allowing me to relate supply chain effect to shareholder wealth gains/losses in horizontal mergers.

Electric utility requires large, long-term capital investments to realize economies of scale in electricity generation. As such, utility firms conduct business as regulated “natural monopolies” in a particular service area since multiple competitors within the same geographic area will not be able to capture the full benefits of scale. In exchange for regional monopoly power on electricity generation, transmission, and distribution over the end-users, electricity prices are monitored by public utility commissions (PUC) to ensure that utility firms do not abuse their power. Through the early 1990s, government agencies determine a utility’s total revenue requirement to recover its costs and make a reasonable profit based on the allowed return of equity approved by the PUCs. Reasonable expenses, including fuel costs in electricity generation, are passed through to the consumers. However, the frictions of the cost of service regulation, such as the regulatory lags between price resetting hearings (Joskow 1974; Hendricks 1975), still provide incentives for the cost-reducing effort by utility firms since prices are set by asymmetrically informed regulators (Laffont and Tirole 1993). Over the 1980s and the early 1990s, many states also adopt incentives regulation to promote efficiency-increasing and cost-reducing effort from utility firms. Knittel (2002) finds that incentive regulations targeted at fuel cost increase plants’ generation efficiency.

The federal and state deregulation of the electricity industry in the late 1990s and early 2000s paved the way for a more competitive electricity generation market. The deregulation waves in the 1990s started from the Energy Policy Act of 1992, which ordered electric utilities to open their transmission grid to third-party suppliers and allowed non-utility power generators to sell outside the service territory of their host utility. Federal Energy Regulatory Commission (FERC) Order 888 in 1996 further stipulated that utilities that own transmissions networks must provide transmission services to other power generators at cost-based non-discriminatory prices. Under the new regime, generators are supposed to bid their capacity in day-ahead real-time auctions overseen by Independent System Operators (ISO) and will only be dispatched if marginal values are below the market-clearing prices. These orders created competitive wholesale markets for electricity generators to provide electricity generation at the lowest prices.

Following these trends, some states restructured the electricity market by offering retail choices to allow customers to switch power providers. A few state regulators mandated vertically integrated utilities to unbundle their generation assets so that multiple firms (mostly unregulated independent power producers) can jointly provide electricity services. In deregulated electricity markets, the customer can freely switch to alternative electricity providers, forcing utility companies to keep rates reasonable.

Overall, although utility firms are subject to price regulations for retail customers, electric utility companies still behave like cost-minimizers in the fuel input market. Even in the regulated markets, regulators tend to support utility firms' effort to reduce generation costs if input cost savings can be passed on to customers. More importantly, the federal deregulation in the wholesale market and the state electricity program promote efforts to reduce electricity generation costs. The majority of utility mergers in my sample take place in years following the 1992 federal deregulation. Additionally, I study service areas with different regulatory status to observe whether realized supply chain gains are more significant when utility firms have incentives to reduce costs to capture larger market share.

3. Data

3.1 Mergers

I obtain utility mergers from the Mergers & Acquisitions database maintained by Securities Data Company (SDC) Platinum. To ensure comparability with previous studies on horizontal merger literature (Shahrur 2005; Fee and Thomas 2004), I define a deal as a horizontal merger if the acquirer and the target have the same historical four-digit SIC codes in the COMPUSTAT database. Specifically, both the acquirer and the target's primary SIC codes are 4911(Electric Services) or 4931 (Electric and Other Services Combined). I also require the acquirer and the target to be publicly traded with valid daily returns on CRSP during the merger announcements and the acquirer sought 50% or more and owned 50% or more after the transaction. Additionally, I exclude deals that feature repurchase, recap, open market purchases, LBO, self-tender, going private, and privatization.

Since my study centers on the real effect of horizontal mergers on plant-level input procurement, I exclude deals which neither the acquirer nor the target owns a coal-fired generation plant. I identify coal plant ownership based on utility holding companies. Most public electricity utilities are organized as holding companies that own multiple geographically linked regional utility branches. Holding companies thus have control over generation assets in regional utility companies. For example, the Southern company owned both Georgia Power and Alabama Power before it acquired Savannah Electric in 1988. Therefore, I match the names of electric utility companies to the holding companies to obtain the ultimate parents for the merging plants. To ensure matching quality, I double-check deals in the sample with the *Profiles and Rankings of Investor-Owned Electric Companies* published by the Edison Electric Institute, the association that represents all private utility firms in the country. I verify that 1) all deals downloaded from SDC are recorded in the handbook and 2) the handbook does not record other deals satisfying my deal selection criteria. After these steps, I obtain 43 completed deals from 1985 to 2012. The sample size is smaller than the utility merger sample used by Becher, Mulherin, and Walkling (2012) since their study includes natural gas utility mergers.

Table 1 lists all utility mergers in the sample and the years of announcements and completion. Due to regulatory concerns, the gap between deal announcement and completion in the utility industry is significantly longer than the time of deal completion in other industries. The time required to complete mergers is significantly longer for deals between large utilities that span several states due to multiple regulatory inspections from federal and state administrators. In my study, I analyze post-merger periods beginning from the year of merger completion to ensure that the acquiring firm has total control over the targets' plants.

The distribution of the utility mergers is presented in Figure 2. The late 1990s saw a wave of electric utility merger following the state-level electricity market deregulation (Harford 2005; Becher, Mulherin, and Walkling 2012). In recent years, several mega-mergers revived the M&A market in the utility industry. The merger between Duke Energy and Progress Energy, the last deal in chronological order, created the largest utility in the United States.

3.2 Coal procurement

I obtain the procurement information from EIA-423 forms available for download on the Energy Information Agency (EIA)'s website. Federal regulation requires all fossil-fuel plants to report monthly procurement information to the FERC and the EIA. The electronic data set is available from 1972 and contains detailed information on the types of generation coal, the prices and quantities in each transaction, and other attributes of the purchased coal such as the sulfur and ash content. The price reported on the EIA-423 is a delivered price, which includes the commodity costs of the coal and the transportation costs to move the fuel to the plants. Therefore, post-merger saving in shipping is also reflected in procurement costs.

EIA-423 reports monthly coal procurement transactions in all regulated utilities. I aggregate monthly transactions into a plant-year panel on coal procurement information. Specifically, I calculate the annual prices in a plant using the following equation

$$Price_{i,t} = \sum_{m=1}^{12} (\frac{Heat_{i,t,m}}{Heat_{i,t}} \times price_{i,t,m})$$

where i denotes the plant, t denotes the year, m denotes the month, $Heat_{i,t,m}$ denotes the total heat purchased in a month, $Heat_{i,t}$ denotes the total heat purchased in a year, and $price_{i,t,m}$ denotes the monthly price of the coal.

Due to the heterogeneity in coal quality attributes, the prices of generation coal are more comparable when expressed as a dollar value per standard unit of heat, rather than the dollar value per standard mass unit. In this paper, I present coal prices as a dollar value per million British Thermal Units ($/MMBTU). I also calculate the heat weighted statistics for other major coal attributes such as the generation coal's sulfur and ash content. Sulfur particles embedded in carbon forms generate air pollutants in coal generation. Ash is the non-combustible part of coal products. I control for the sulfur and ash content in all subsequent regression analyses on coal prices.

3.3 Plant operation statistics

I collect information on coal plant operation and generation facilities from other EIA data tables: EIA-767, EIA-861, and EIA-923. EIA assigns a unique plant code to each plant in the United States and maintains consistent identifiers across all data sets maintained by the agency. The regulators also assign unique utility codes to investor-owned utility companies, allowing me to identify publicly-traded utility firms based on name-matching algorithms. After combing these tables, I obtain a plant-year panel from 1985 to 2015.

3.4 Supply contracts

I obtain actual coal supply contracts from the Coal Transportation Rate Database (CTRDB) compiled from FERC Form 580.[2] From 1979 to 2001, all investor-owned utilities that operate at least one steam-electric generating station of 50 megawatts or higher are required to report comprehensive information on coal supply contract and transportation-related details to regulatory agencies. Unfortunately, the data collection was suspended in the year 2002. The data set assigns a unique contract code to identify supply contracts for each plant. Each observation in the data set contains information on the contractual standards of the coal products, the information of the actually delivered coal products, and the detailed shipping information such as the shipping distances and means of transportation. The plant identifiers are consistent with other data tables maintained by EIA. I use the contract code together with the plant code and year to identify each unique observation in the data set. This data set has been widely used in academic studies in energy and industrial economics (Kozhevnikova and Lange 2009; Di Maria, Lange, and Lazarova 2014; Cicala 2015; Ron Chan et al. 2016; Kacker 2016).

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[2] Downloadable from EIA website: https://www.eia.gov/coal/transportationrates/archive/2008/ctrdb/database.html

3.5 Geographically matched control sample

To identify counterfactual effects for post-merger procurement changes, I need to obtain a list of control plants not affected by the mergers. Since coal procurement is regional, using propensity score matching will deliver unsatisfactory control plants operating in very different markets. Instead, coal plants with close serving areas tend to obtain coal inputs from comparable coal mine counties and are also subject to similar regulatory oversight. I follow Cicala (2015) to match the plants involved in a merger ("treatment plants") with unaffected plants based on geographic proximity and the rank of coal burned. Specifically, I choose the closest m plants burning the same rank of coal within a 200-mile radius as control plants. I set m to 1, 3, and 5 to obtain three samples in my empirical analysis. Control plants are not involved in any mergers throughout the sample period. Because some treatment plants are located in isolated geographic regions, I include government/municipal/co-op-owned plants as control plants to improve the quality of matching. I find that 172 out of 179 plants involved in mergers have at least a match within 200 miles. As can be seen from Figure 3, the treatment plants and control plants span a wide array of states and service geographically proximate regions. Most of the merging coal plants are concentrated in eastern states possibly due to the availability of coal supply in the Appalachian Mountains. The active state deregulation program in the New England states also spawns more takeover activities.

After the matching procedures, I obtain a data set of all matched plants and their control plants from three years before to three years after the merger completion. Given the availability of all EIA data sets, the final sample on coal prices spans from 1985 to 2015 and the supply contract data set spans from 1985 to 2001.

3.6 Summary statistics

In Table 2, I summarize the descriptive statistics for the variables used in this study. Panel A of Table 2 reports information on the 43 utility mergers in my sample. Both the acquirer and the target are public in these deals. I report the cumulative abnormal returns for (-1, +1) and (-2, +2) windows. Consistent with studies on horizontal mergers and utility mergers (Shahrur 2005; Becher, Mulherin, and Walkling

2012), the announcement period returns for the acquiring firms are negative in both windows, and the target shareholders earn positive risk-adjusted returns. For example, the cumulative abnormal return for the acquirer in (-2, +2) window is -0.7% while the target shareholders on average enjoy a 7% abnormal return during the announcement period. The average combined wealth gains for the (-1, +1) and (-2, +2) windows are about $24 million and $40 million, suggesting that these deals have positive synergistic gains for the shareholders of both companies. On average, the acquirer (target) owns 4.1(2.4) plants at the time of the merger.

Panel B of Table 2 presents the coal prices and coal plant's operating information. After standardizing the coal prices based on its total heat content, I find that the average price of coal per million BTU is $1.63. In comparison, the prices for gas and petroleum procurements are about $4 per million BTU. Therefore, coal is still an attractive energy source for electricity generation given its low price. I also obtain the quality and quantity of supply procurement. I find that the mean (median) of the standardized sulfur and ash content is 1.30 (1.00) and 8.84 (8.99) pounds per million BTU. The quantity of coal procurement is the total heat embedded in all coal purchased in a year. On average, annual heat purchased is about 40 million MMBTU for a plant. Given the coal prices, the average annual coal procurement cost for a plant is approximately 60 million dollars.

I also report coal plants' operating metrics. To capture investments in pollution abatement equipment, I collect information on the installed flue gas desulfurization unit (scrubber) in the boilers. This equipment reduces the emission of air pollutants coming from coal generation, thereby allowing the plants to burn high sulfur coal without violating the pollution caps. I define a dummy variable *Scrubber* that equals to one if at least one of the boilers in the plant has an installed scrubber. In my sample, about 37% of the plants have at least one installed scrubber. In my analysis, I also control the capacity of all generators in a coal plant. On average, the combined capacity of all generators in a coal plant is about 766 MW.

Given that state deregulation program incentivizes coal plants to reduce costs and improve efficiency, I create two dummies variables to reflect the status of state electricity market regulation. The first variable *Restructured* is assigned a value of one for states that held hearings on the electricity market deregulation and eventually deregulated the electricity markets. I follow Fabrizio, Rose, and Wolfram (2007) to set this dummy to one in the year immediately after the hearings of the deregulation program. The second variable *Retail Choice* equals to one for states that allow retail customers to switch between electricity providers. Offering alternative electricity providers to consumers is an essential agenda of electricity market deregulation, but not all states adopted this policy. I find that about 19% of the observations in the sample operate in states with deregulated electricity market and 11% of the sample observations give retail choice options to the end-users.

Panel C of Table 2 presents the information on the coal supply contracts. The mean (median) age of contract is 6 (3) years. I focus on three aspects of supply contracts: contract revision, input quality, and shipping. I define a dummy variable *Revision* that equals to one in the year of a major contract revision reported by the surveyed utility company. This variable allows me to identify whether the merging firms actively seek to renegotiate supply chain contracts following horizontal mergers. On average, about 12% of the contracts are renegotiated at a certain point. To construct the input quality of the shipments, I define a variable *Inferior Input* that equals to one if the delivered coals are 5% or more inferior to any one of the contractual standards for ash, moisture, and sulfur. Inferior inputs can impose additional costs on power plants such as higher maintenance expenses for the boilers or potential violation of Environmental Protection Agency emission standards due to high-sulfur coal. 26% of the delivered coal input does not perfectly meet the contractual standards, suggesting that quality violation is not uncommon amongst bilateral energy supply relations. Similarly, I also code the years in which a utility firm impose stricter standards for the delivered coal by raising the requirement for ash, moisture, or sulfur by more than 5%. These events are less common than contract quality violation with a mean of 6%.

I use the coal transportation information in the supply contract data set to examine changes in input shipping after mergers. I define two variables to capture the length of the coal shipment routes (*Shipping Distance*) and the number of transportation links (*Num Transportation Links*) for the coal shipments. The average shipping distance in my sample is about 480 miles. The variable *Num Transportation Links* captures the number of different transportation methods used in a coal shipping route, such as train or barge. Shipments with more links are costlier to handle and more prone to supply chain disruptions. On average, the number of transportation links in a shipping route is 1.3.

I report statistics on the initiation and termination of supply relations in Panel D of Table 2. The sample size is smaller than the coal price panel since EIA-423 start to report coal supplying county information after 1990. About 33 % of the firm-year observations in the sample added at least one new county, and about 47% of the observations terminate an existing supplier.

4. Post-merger Input Prices

4.1 Input prices

In this section, I study the changes in coal prices following horizontal mergers between utility firms. The empirical specification is a difference-in-differences specification aimed to compare the changes in treatment plants with the matched control plants within 200 miles:

$$Log(Coal\ Price)_{i,t} = \beta_0 + \beta_1 Post\_Merger_{i,t} + \beta\gamma_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$

The key independent variable $Post\_Merger_{i,t}$ is a dummy that equals to one from the first year to the third year after merger completion. I include plant and year fixed effects to absorb the treatment dummy and the after dummy in the single-event difference-in-differences specification. I also include plant characteristics and coal quality proxies as control variables ($\gamma_{i,t}$). In a log price model, the coefficient β_1 captures the percentage differences in coal prices between the treatment plants and their neighboring plants three years after merger completion. In all specifications, I control for determinants of coal prices such as the purchased quantity, quality, and other operating metrics of coal plants.

A potential confounding factor is the pre-merger trend of coal prices. Although I include year fixed effects for partial out potential national coal price trends, it is possible that treatment plants' input prices had been on a downward trajectory before the merger was completed. If this were the case, the difference-in-differences analysis would not be able to relate the declining coal prices to the real effects of mergers. To understand the dynamics of coal prices around the mergers, I include a set of plant-year dummy variables on the treatment plants corresponding to the two years before the merger and three years after the merger. This specification is similar to the methods adopted by Bertrand and Mullainathan (2003) and Brav, Jiang, and Kim (2015). Specifically, I run the following regression:

$$Log(Coal\ Price)_{i,t} = \beta_0 + \sum_k \beta_k Year[k]_{i,t} + \beta\gamma_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$

where $Year[k]_{i,t}$, k=-2,…,+3 equals to one if the plant belongs to the acquirer or the target in year k. Year 0 is the year of merger completion. The coefficient on $Year[k]_{i,t}$ captures the differences in coal prices between the treatment plants and the control plants in year *k*. If there exist pre-merger trends in coal prices, I expect the signs on the treatment dummies from year -2 to year 0 to be negative and significant.

Figure 4 plots the point estimates of the treatment dummies and their 90% confidence intervals using year dummies without control variables. I find that the differences between the two groups are close to zero until the year of merger completion. In the first year after the merger, the average coal procurement price of the treatment plants is about 3% lower than the control plants in geographically proximate areas. The difference in input prices persists in the second and the third year following the merger. The graph suggests that there are no pre-merger price trends in merging plants.

Table 3 reports formal tests of the difference-in-differences models for three matched samples respectively. The odd columns report difference-in-differences models with aggregated post-merge dummies. In all matched samples, the point estimates on the post-merger dummies are negative and statistically significant at least at the 1% level. Following utility mergers, the input prices of the merging plants drop 3% more on average compared to matched control plants within 200 miles. The even columns report models with individual year dummies surrounding the year of merger completion. The coefficients on the year dummies capture the year-by-year changes for the merging plants relative to the nearby coal plants. The point estimates on the year dummies from the year -2 to year 0 are all statistically insignificant from zero, suggesting that input prices do not differ between merging plants and their matched control plants. Additionally, the positive point estimates on these dummies indicate that the merging plants do not experience downward input price trends before the completion of horizontal mergers. The year dummies become negative and significant for one, two, and three years after the mergers, suggesting that the input prices of merging plants start to decline once horizontal deals are completed. Based on the model comparing merging plants to the closest 5 control plants, the magnitude of the price savings ranges from about 2.5% in the first year to about 3.8% in the third year. This finding suggests that the post-merger input price reduction is unlikely to be explained by a pre-merger trend that differentially impacts the treatment plants. Confirming the graphic analysis, the year dummy models indicate that the post-merger input prices do not reverse, suggesting that the supply chain saving is not a transient effect. Additionally, the signs on the amount of heat purchased are negative and significant, suggesting that firms can achieve a quantity discount with a higher amount of purchases.

Another potential explanation of my finding is the anticipation of input price trends for the target firms. If capable acquirers strategically initiate merger deals for plants that recently installed capital intensive cost-saving technologies, then my findings cannot directly attribute the post-merger price decline to the post-merger integration. Although I cannot randomly assign merging plants to estimate the average treatment effect, I exploit the gap between the merger announcement and completion to differentiate my findings from the merger anticipation argument. Utility mergers take a longer time to complete due to regulatory approvals from federal, state, and industry regulating agencies (Leggio and Lien 2000). Of all 43 deals in the sample, only 4 deals were completed in the same year of the announcement while 10 deals took more than 2 years to complete. The uncertainty of regulatory approval makes it difficult for acquirers to anticipate the timing of the merger completion accurately. If acquirers' anticipation were solely responsible for the post-merger reduction in input prices, one would predict a discernible downward trend in prices originating from the merger announcement year.

To implement the test, I study a subsample of 10 mergers which take two or more years to complete. I follow the same methodology in the main difference-in-differences test and replace the post-merger dummies by the treatment dummies defined based on the years of the merger announcement. The alternative aggregate post-merger dummy *Pseudo-Post-Merger* is set to one from year 1 to year 3 after the merger announcements. The separate year dummies *Pseudo-Year [k]* are set to one for merging plants k years relative to the year of merger announcements. Similar to the main test, the coefficients on the treatment dummies capture the relative price changes between merging plants and the control plants near the window of the merger announcements.

Table 4 reports the falsification test. The odd columns report the specifications with aggregate pseudo treatment dummies and the even columns report the tests with individual pseudo year dummies. All estimated coefficients are statistically insignificant at conventional levels. The signs of the point estimates also do not suggest a clear pattern on the differential effect of the mergers on input prices. For example, the signs of the one-year post dummy are positive. The magnitudes of most coefficients are also smaller than the main test except for the three-year post dummies, which likely capture some effect of the merger completion for deals that took two years to complete. In unreported tests, I analyze the falsification test for the all mergers in the sample and still obtain no statistically significant post-merger dummies in all six specifications. Overall, I conclude that post-merger input price savings are more likely to be driven by the active post-merger integration after utility holding companies obtain ownership of a larger fleet of generation plants.

4.2 Subsample analyses

As a first step to understand the sources of post-merger procurement cost savings, I turn to subsample analysis to examine the distribution of input cost reduction. To link stockholder wealth effects with the real effects in the supply chain, I conduct subsample analysis based on the total wealth gains in the merger. In an efficient capital market, shareholders' wealth gains at the time of merger reflect the expected future gains in procurement savings. In the second subsample analysis, I assess whether the market assessment of horizontal mergers is indicative of future input cost reduction. I expect that the level of post-merger price reduction will be significant for plants in deals with larger equity holder wealth creation. I also analyze the plants owned by the target firms. There are several reasons to expect that supply chain synergies will be more observable in the target firms. For example, target plants can negotiate a larger input price reduction under the umbrella of pooled purchasing of the merging firms. The new owners can integrate supply chain by actively restructuring the target plants (Maksimovic, Phillips, and Prabhala 2011). Meanwhile, fewer post-merger gains accrue to the plants initially owned by the acquirers since these plants may already be operated at relatively efficient levels.

To implement the subsample analyses, I interact the post-merger dummies with the dollar wealth gain in (-1, +1) window and an indicator for target plants and. Table 5 reports these findings for the three matched samples. The even columns of Table 5 report the findings of subsample analyses on wealth gains. I find that all coefficients on the interaction terms are negative and significant at the 5% level. The negative coefficients on the wealth gains indicate that the input price reduction is more significant for plants in synergistic deals. In other words, the capital market's response significantly correlates with future changes in the product market. In unreported tables, I obtain similar findings using the dollar wealth gains in (-2, +2) and (-5, +5). The models in the even columns suggest that, compared to plants owned by acquirers, target firms' plants experience a larger decline in input prices following the mergers. The findings are consistent across all three samples.

4.3 Input prices in deregulated regimes

Electricity market deregulation provides a unique setting to analyze the realized post-merger input savings in competitive output markets. In this section, I study whether input savings are more evident for plants in deregulated regimes. States which restructured the electricity market promote competition in the generation sector by spinning off the generation assets of regulated utility firms and allowing entries of independent power producers. Some restructured states permit in-state customers to select from a menu of electricity service providers freely. I follow the methodology in the previous section to interact the status of state electricity deregulation program with the post-merger treatment dummies. The coefficients on the interaction term capture the differential treatment effect between utilities in a different regulatory environment.

I report the estimates of the interactive models in Table 6. The odd columns report the models interacting the post-merger treatment dummies with the state restructuring programs and the even columns report interactive analysis on retail choice programs. The coefficients are negative and statistically significant in all but one model, suggesting that plants operating in a more competitive product market realize higher input price savings following mergers. The magnitudes of the additional savings for these plants are about 3 to 5% larger than the cost savings for plants in rate-based regulation regimes. These findings indicate that competitions in the output market provide incentives to reduce input costs and capture market share.

4.4 Input prices and merger wealth gains

Having documented that input price decline is more substantial in deals with higher synergistic gains, I now directly analyze the association between merger wealth creations and observed input prices. The estimates in the panel analysis uncover the relative changes in input prices between treatment plants and the control plants around the mergers. In this section, I focus on the treatment plants and conduct cross-sectional analysis on the time-series changes in their input prices. I calculate the changes in the prices from one-year prior to the merger to three years after the merger and define a dummy variable that equals to one if the average coal price in year 1 to 3 is lower than the year -1 relative to the merger. Specifically, I estimate the following logit regression:

$$Prob(Price\ Decline)_i = \beta_0 + \beta_1 Wealth\ Gain_i + \beta\gamma_i + \varepsilon_i$$

In this model, a positive β_1 indicates that the plants in mergers with higher synergistic gains are more likely to have subsequent input price deductions.

I also directly analyze the relative changes in coal prices using the following specification.

$$\frac{Avg\ Price_{t=1,2,3} - Price_{t=-1}}{Price_{t=-1}}_i = \beta_0 + \beta_1 Wealth\ Gain_i + \beta\gamma_i + \varepsilon_i$$

The variable $Avg\ Price_{t=1,2,3}$ is the average input prices in the three years after merger completion. In the above model, a negative β_1 indicates that the higher merger gains are associated with a larger time-series price reduction for the treatment plants. I use the total wealth gain in (-1, +1), (-2, +2), and (-5, +5) window as the main independent variables. I also include variables on coal quality and plant characteristics in year -1 to control for other determinants of coal prices.

Table 7 reports the estimates of four models relating market reactions to coal prices. The logit regressions on the likelihood of price reduction are reported in the first three columns, and the OLS regressions on the level of price reductions are reported in the next three columns. These models suggest that the wealth gain in mergers is positively associated with a higher likelihood of input price reduction and greater cost savings. In the logit models, an interquartile change in the total wealth gain in (-1, +1) window is associated with 5% more increase in the probability of post-merger input price reduction. Similarly, a merger with 25 percentile total wealth gain in (-1, +1) window on average experiences 4.5% in post-merger input price but a merger with 75 percentile total wealth gain in (-1, +1) window experiences 7.2% in post-merger input price. Combining with the subsample analysis in the previous section, I conclude that shareholder wealth gains in the horizontal mergers are strongly correlated with the input price reduction.

5. Supply chain changes

In previous sections, I document that input prices decline significantly after horizontal mergers, and this effect is stronger for target plants, the plants in deals with higher synergistic gains, and plants in deregulated electricity markets. In this section, I analyze changes in supply contracts and choices of suppliers to understand the sources of post-merger supply chain efficiency.

The research design I adopt is similar to the econometric models in the input price analysis. To identify whether and how merging plants change the existing procurement contract, I estimate a model with contract and year fixed effects. Since a single plant can have multiple supply contracts, including contract fixed effects allows me to capture the time-series variation in contact enforcement for a given plant-coal mine pair. The findings in the paper are similar if I include plant fixed effects instead. To understand whether changes in a contract can explain the input price changes, I estimate year dummy variables to examine the timing of the contract revisions since the contract changes can predate realized procurement cost savings. My empirical specification is:

$$Contract\ Information_{i,t} = \beta_0 + \sum_k \beta_k Year[k]_{i,t} + \beta\gamma_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$

where $Year[k]_{i,t}$, k=-2,…,+3 following the definition of the input price regressions. α_i and α_t are contract fixed effects and year fixed effects, respectively. $Contract\ Information_{i,t}$ represents information in a contract. The model becomes a linear probability specification when $Contract\ Information_{i,t}$ is a dummy variable. $\gamma_{i,t}$ represents the control variables in the input price regressions and a variable capturing the length of the contract.

5.1 Contract revision

I start with an analysis of the likelihood of supply chain contract revisions to examine whether changes in input contract can be an attributing factor to efficiency gains in mergers. Both bargaining power and purchasing efficiency argument predict that merging firms will actively seek to rewrite supply chain contracts to utilize higher bargaining power or identify more efficient procurement practice. I use the years of contract revisions in the coal transportation data set to identify events involving major overhaul in bilateral supply contracts. To this end, I define a dummy variable that takes the value of 1 in years when supply contracts are renegotiated. It is worth noting that the coal-fired plants report the contract revision events as a part of the mandatory disclosure filing to regulators. As such, studying these events avoids researchers' subjective judgment on the contents of coal supply contracts.

Table 8 reports the estimation of contract revisions following mergers. I estimate linear probability models for three matched samples separately. I find that treatment dummies for year 0 are positive and statistically significant in the two larger samples, suggesting that the merging plants are more likely to start supply contract renegotiation immediately in the year of merger completion. Given that the merging plants' input prices start to decline one year after the merger completion, the contract revision process potentially contributes to the lower input prices observed in the post-merger period. The likelihood of contract renegotiation is not significantly different between the treatment and control plants before the merger completion. Interestingly, I find that the treatment plants are less likely to revise supply contracts three years after the merger. If repeated contract renegotiation is costly (Williamson 1985), it is possible that the merging plants tend to avoid frequent contract revisions when the new owners reach a long-term agreement with the existing suppliers. Additionally, I also find that longer-term contracts are more likely to be negotiated probably because the procurement practice laid out at the time of contract initiation no longer adapts to the recent needs of production.

5.2 Input quality

Given that contractual revisions are more frequent for coal plants of the merging firms, a natural next step is to understand the exact changes in the supply chain contracts. In this part, I focus on the quality of the delivered products. For coal-fired plants, inferior coal supply leads to lower production efficiency and potentially higher production costs if the plants violate emission standards imposed by the environment protection agency (Kacker 2016). The bargaining power argument predicts that suppliers are more likely to cater to the quality requirements of the merging plants since the threat of switching suppliers is more credible for a large buyer.

I now estimate the changes in input quality following the mergers. I use the contractual standards in the coal transportation data set to define two variables capturing the quality of the delivered goods and the standard required by the coal plant. I focus on significant variations in important coal attributes: sulfur, moisture, and ash. High sulfur coal increases the amount of pollution emission in the electricity generation process, adding to the related environmental cost. High moisture and ash content reduce efficiency in combustion and power generation. The coal contract I obtained from the coal transportation data set contains information on the contractual standards for these coal attributes and the information on the delivered coal. To capture significant changes in coal quality, I define a dummy *Inferior Input* that equals to one if any of the three quality attributes in the delivered coal is more than 5% higher than the contractual standards in the supply contract. To examine whether coal plants change the quality standards, I identify significant changes in the standards for sulfur, moisture, and ash in the supply contract. Since coal products with lower sulfur, ash, and moisture are more desirable, the dummy *Raise Standard* equals to one in years that the delivery standard for at least one of the major attributes is 5% lower than the previous year.

The first three columns of Table 9 report estimates on changes in the contractual requirement of coal input and the next three columns report estimates on the delivered coal input. The estimates on the input quality regressions suggest that merging plants are more likely to impose more stringent input quality standards in the year when the ownership changes hands. Given the findings on merging firms' intention to revise supply contracts, it is possible that the higher input standard is a part of the new contractual changes made by the owner. All other year dummies are not statistically significant from zero, and hence treatment plants are not more likely to renegotiate supply contracts before or after the completion of mergers.

Having documented that merging plants are more likely to impose stricter quality standards after the mergers, I estimate the enforcement of quality standards in the next three columns of Table 9. Overall, the coefficients for year dummies after the merger are negative and significantly different from zero in the third year after merger completion. A plausible explanation is that the availability of existing coal stocks and the stricter quality standards stipulated by the merging plants prevent the coal mines from improving the input quality right after merger completion. Hence the input quality improvement is only observable in longer horizons following the merger. Additionally, there is no discernible pattern in input quality changes prior to the mergers, suggesting that the input quality changes are unlikely to be caused by unobservable shocks in the local area or supplier county in years leading up to the horizontal mergers. Given the findings in the previous section, the observed change in input quality is possibly an outcome of the merging firms' effort to renegotiate supply contracts following mergers. The merging firms can also use their buyer power to bargain for higher quality inputs at possibly even lower prices. Moreover, suppliers are more careful in handling products of merging firms that account for a large portion of the sales.

5.3 Shipping costs

Shipping cost is a significant component of coal prices (Preonas 2018). Merging firms can save on shipping costs in several ways such as renegotiating a lower price with the transportation service providers or redesigning the logistics for a larger amount of inputs. In this section, I study whether pooled purchasing efficiency reduces shipping costs after two utility firms merge.

Table 10 reports the changes in supply chain shipping after mergers. I use two variables to capture the changes in shipping processes: the total distance of shipping route (*Shipping Distance*) and the number of transportation links in the shipping route (*Num Transportation Links*). The results in the first three columns indicate that the merging firms significantly shorten the coal shipping distance. For example, the point estimate in the first model suggests that merging firms reduce the shipping distance by about 94 miles upon merger completion, about 20% of the average shipping distances. I use the number of transportation links as dependent variables in the next three columns and find consistent results with the analysis of shipping distances. Similarly, in the year of merger completion, the number of coal shipping nodes for the merging firms decrease by about 16% relative to the mean of the sample. Similarly, I find that the changes in coal shipping process mostly occur in the year of the merger and the first two years of merger completion. This finding accords with the timing of contract revision: the combined company rearranges the shipping route at the same time as the contract renegotiation and executes the contract with the redesigned shipping route for the next few years. In summary, the findings on coal shipping contracts suggest that reduction in shipping prices can be a factor that accounts for the post-merger input price decline.

5.4 Supply chain relation

In addition to renegotiating supply contracts with existing partners, the merging firms also achieve input cost savings by searching for more cost-efficient business partners in the factor market. The ex ante threat to terminate suppliers is also a bargaining chip to negotiate for favorable terms in supply chain contracts if merging plants possess higher bargaining power. To test these hypotheses, I analyze the choices of coal mining counties using the detailed county classification of coal suppliers from the EIA-423 from 1990. I do not use the coal contract data set for this analysis since the dataset on coal contract only contains procurement information large coal plants. In this test, I analyze new supply relation by the plant-county pairs and then aggregate the changes to a plant since a single coal plant can purchase generation coal from multiple counties. I treat the first and the last year of each plant-county pair's presence in the data set as the start and the end year of a supply chain relationship. I then define variables *New Supplier (Change Supplier)* that equal to one if a plant establishes (terminates) any procurement relation with a county. The estimated econometric model is also a difference-in-differences regression in the years before and after a merger completes.

Table 11 reports estimates on the plants' likelihood to start or end supply chain relations. The dependent variable in the first three models is *New Supplier*. The point estimates on the post-merger dummies are all positive and significantly different from zero, indicating that merging plants are more likely to establish new supply relations. In the next three columns, I analyze whether merging plants tend to terminate existing suppliers. The point estimates on all estimates are negative but insignificantly different than zero. The analysis suggests that merging plants actively seek new suppliers for coal procurement but do not systematically end existing supply partnerships. The findings in this section support the purchasing efficiency argument but do not contradict the bargaining power explanation since the merging plants can merely use relation termination as an ex ante threat when negotiating with suppliers.

6. Conclusion

In this paper, I use the electric utility industry as an experimental setting to study horizontal merger's influence on merging firm's factor prices and supply chain contracts. Following horizontal mergers, I find that input prices decline significantly, especially for subsidiaries originally owned by target firms, deals with higher wealth creation in the equity market, and firms in deregulated regimes. These findings suggest that savings in input prices can be an important determinant for shareholder wealth creation in mergers. I examine supply chain contracts to identify potential channels that explain for input price savings. I find that the savings in procurement cost are more likely due to the merging firms' buyer power.

My findings highlight the importance of product market effects in mergers. Firms and their supply chain partners have strong economic linkages: downstream business combinations have nontrivial impacts on the suppliers. To the extent that efficient capital market reflects mergers' real effects, shareholders' wealth creation in mergers should incorporate the expected gains in factor markets. I find support for this argument. My results on the supply contracts indicate that contract renegotiation is likely an important channel that induces supply chain synergies. In other words, ownership changes can lead to an active contract renegotiation process with relevant stakeholders of the firm.

A natural extension of this paper is to examine whether the observed supply chain effects are efficiency-increasing for all stakeholders in a firm. Supply chain integration can generate synergies for suppliers and customers since suppliers can become more operationally efficient by selling to a common downstream firm. Existing customers can realize gains if the combined firms pass on the procurement cost savings to the end-users by charging a lower output price.

However, not all attempts to renegotiate supply contracts are efficient from a societal perspective. If merging firms exercise their monopsony power to reduce input purchases and production below the socially optimal level, horizontal mergers can be beneficial to shareholders yet inefficient for all other stakeholders in the firm. As such, the economic forces that drive procurement cost savings can be anti-competitive. In a review article, Carlton and Israel (2011) call for a more detailed analysis of supply chain contracts and merger outcomes to advance our understanding of whether increased buyer power is efficiency-enhancing. Future works are needed to shed light on this critical issue.

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Appendix: Definitions of Variables

Variables	Description
Mergers	
Num Acquirer Coal Plants	Number of coal plants owned by the acquirer
Num Target Coal Plants	Number of coal plants owned by the target
Cash Deal	An indicator that equals one if the acquiring firm pays more than 50% of the transaction value in cash
Challenged	An indicator that equals one if the deal is challenged by the regulatory agency
Acquirer CAR(-1,+1)	Acquirer's cumulative abnormal returns in (-1,+1) window calculated based on estimated Fama-French three-factor model over days -200 to -60 relative to the merger announcement
Target CAR(-1,+1)	Target's cumulative abnormal returns in (-1,+1) window calculated based on estimated Fama-French three-factor model over days -200 to -60 relative to the merger announcement
Acquirer CAR(-2,+2)	Acquirer's cumulative abnormal returns in (-2,+2) window calculated based on estimated Fama-French three-factor model over days -200 to -60 relative to the merger announcement
Target CAR(-2,+2)	Target's cumulative abnormal returns in (-2,+2) window calculated based on estimated Fama-French three-factor model over days -200 to -60 relative to the merger announcement
Wealth Gain(-1,+1)	The combined abnormal wealth gain of the acquirer and the target in (-1, +1) window based on the market value on the day -3. Unit: $Millions
Wealth Gain(-2,+2)	The combined abnormal wealth gain of the acquirer and the target in (-2, +2) window based on the market value on the day -3. Unit: $Millions
Wealth Gain(-5,+5)	The combined abnormal wealth gain of the acquirer and the target in (-5, +5) window based on the market value on the day -6. Unit: $Millions
Plants	
Coal Price	Dollar coal price per Million British Thermal Units (Unit: MMBTU). The dollar coal price is deflated to 2000 dollars using the U.S. GDP deflator from the Bureau of Economic Analysis.
Sulfur	Pounds of sulfur per MMBTU
Ash	Pounds of ash per MMBTU
Heat Purchased	Total coal heat purchased in a year (Unit: Million MMBTU)
Scrubber	A dummy variable that equals to one if the coal plant has installed a scrubber (flue-gas desulfurization unit)
Capacity	Total capacity of all generation units in a plant (Unit: MW)
Restructured	A dummy variable that equals to one if the state administrator has deregulated the state electricity market
Retail Choice	A dummy variable that equals one if the retail customers in the state can freely switch to alternative electricity providers
Contracts	
Contract Age (Years)	The age of the coal supply contract
Revision	An indicator variable that equals one if a given supply contract is modified
Inferior Input	An indicator that equals to one if the shipped coal is 5% or more inferior to the contractual standards for ash, moisture or sulfur
Raise Standard	An indicator variable that equals one if the contractual standards for ash, moisture or sulfur is raised by 5% or more.
Shipping Distance (Miles)	The total distance of coal shipping
Num Transportation Links	The number of transportation links in a coal-shipping route
Suppliers	
New Supplier	An indicator that equals one if a plant initiates procurement transactions in a county
Change Supplier	An indicator that equals one if a plant stops procurement transactions in a county

Figure 1 Major Energy Sources and Percent Shares of U.S. Electricity Generation
This figure presents the percentages of U.S. electricity generation produced by coal, natural gas, and other energy sources in the sample period from 1985 to 2015. The generation of utility plants is obtained from EIA-923 forms maintained by the Energy Information Agency.

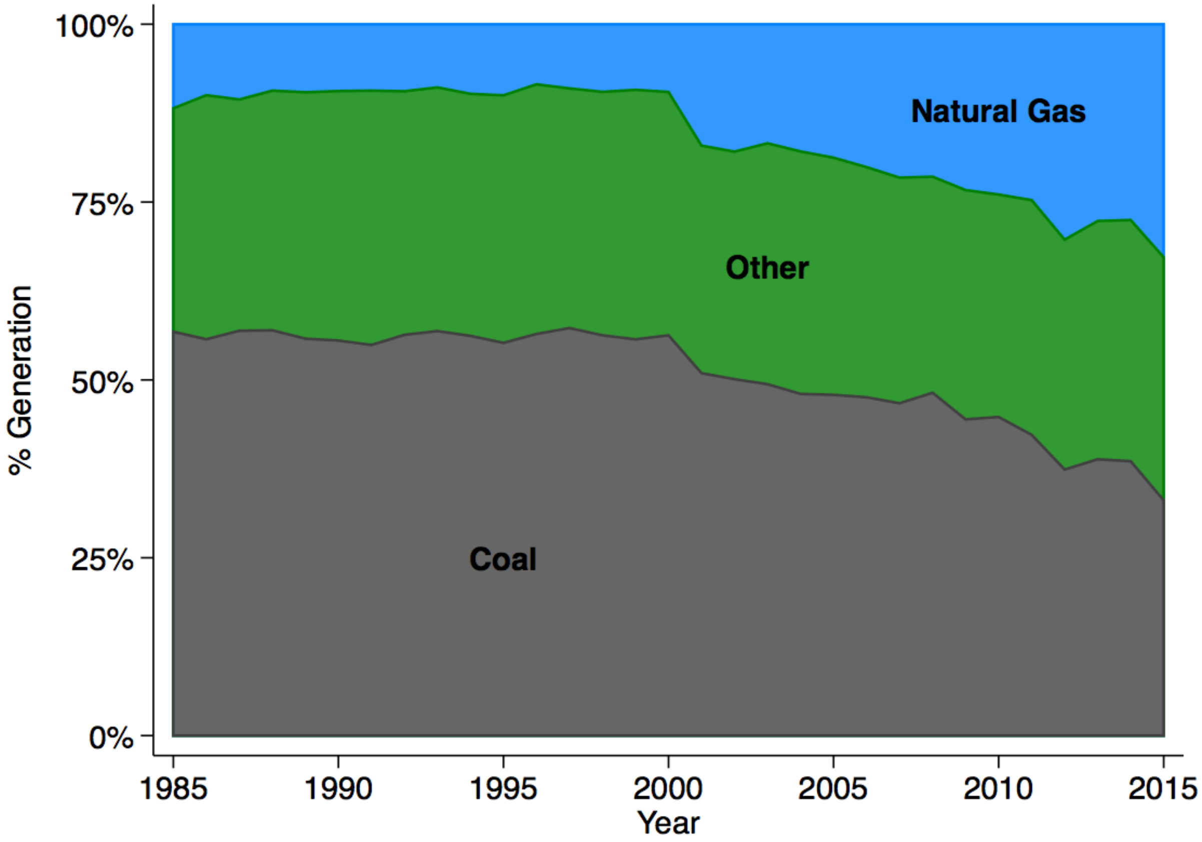

Figure 2 Distribution of Utility Mergers

This figure presents the distribution of 43 utility mergers studied in this paper.

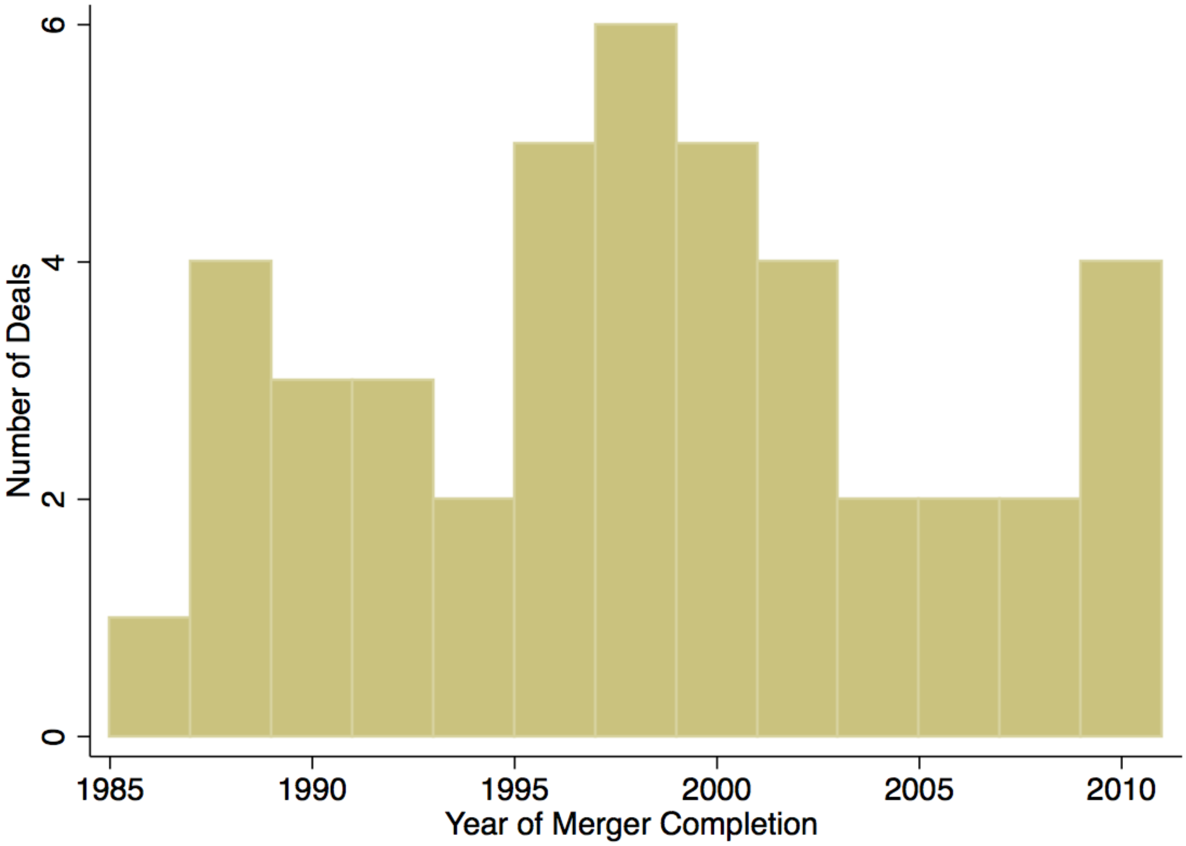

Figure 3 Coal-Fired Plants in the Sample

This figure presents the spatial distributions of the merging plants and the matched plants within 200 miles. The red circle indicates the location of the merging plants, and the blue cross indicates the location of the matched plants. The picture is produced using Google Maps.

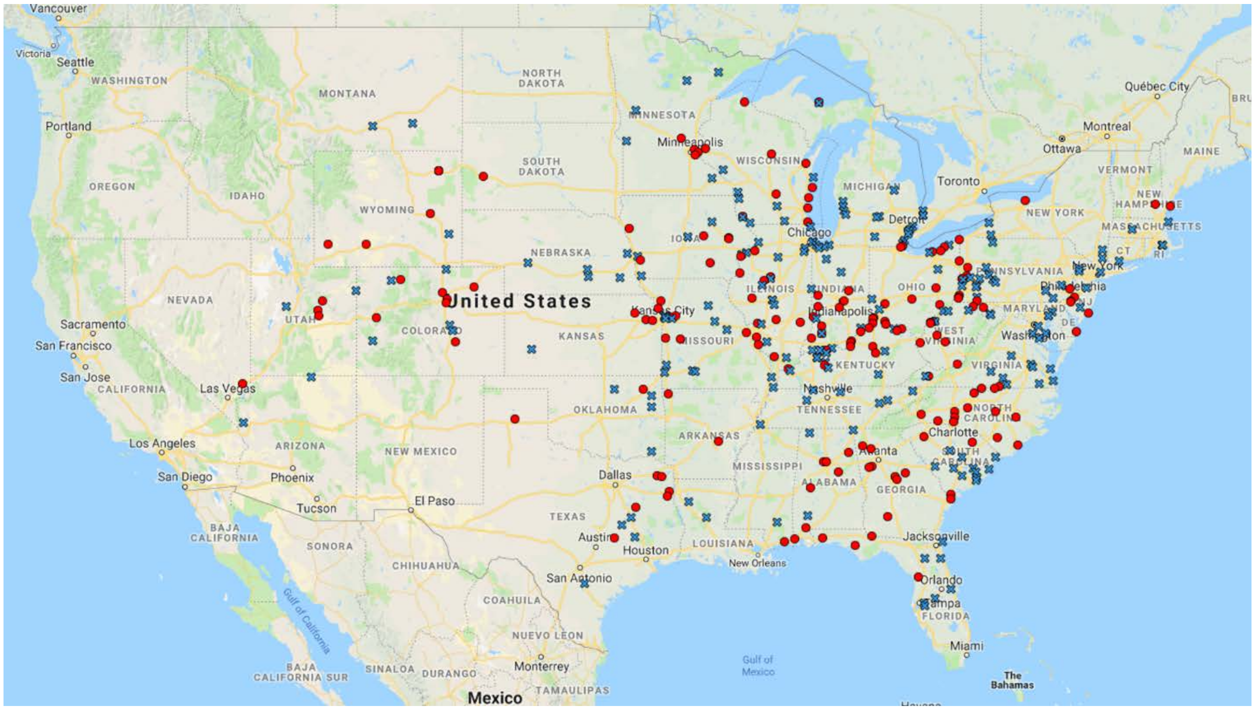

Figure 4 Changes in Coal Prices Following the Mergers

This figure presents the coefficient estimates (β_k) and the 90% confidence intervals from the equation below. $Year[k]_{i,t}$ k= (-2,…,+3) equals one if a plant belongs to the acquirer or the target in year k. The regression is estimated based on all merging plants and the nearest 5 matched plants within 200 miles. The point estimates β_k represent the percent differences between the treated and the matched plants in year k. i denotes the coal plants, and t denotes the calendar year.

$$Log(Coal\ Price)_{i,t} = \beta_0 + \sum_k \beta_k Year[k]_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$

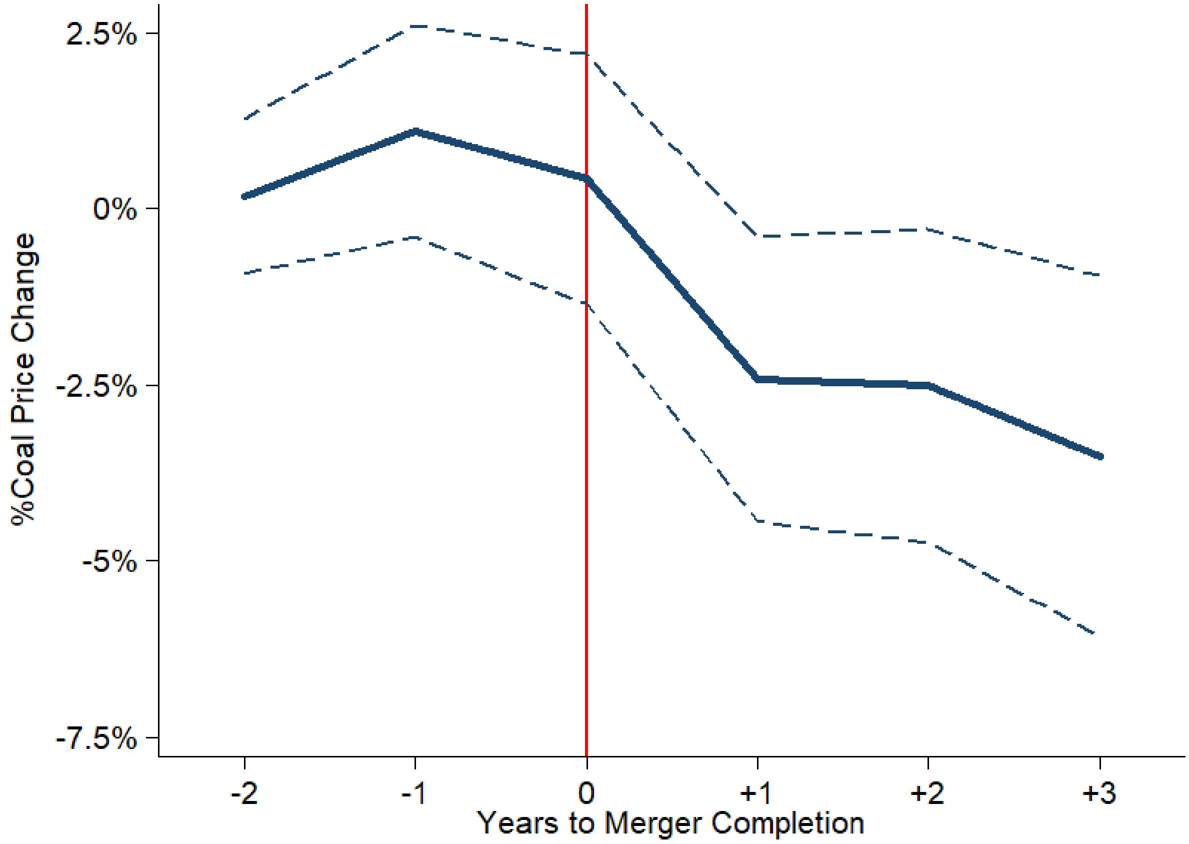

Table 1: Utility Mergers in the Sample

This table presents all the mergers in the sample. The deals are sorted by the year of merger completion.

Announcement	Completion	Acquirer	Target
1985	1986	Toledo Edison Co	Cleveland Elec Illuminating
1987	1988	Duke Power Co	Nantahala Power & Light(Alcoa)
1987	1988	Southern Co	Savannah Electric and Power Co
1987	1989	PacifiCorp	Utah Power & Light Co
1990	1990	Midwest Resources Inc	Iowa Resources
1990	1991	UtiliCorp United Inc	Centel Corp-Electric Ops
1991	1991	IES Industries Inc	Iowa Southern Inc
1988	1992	Northeast Utilities	Public Service Co of NH
1990	1992	Kansas Power & Light Co	Kansas Gas & Electric Co
1992	1993	Entergy Corp	Gulf States Utilities Co
1993	1993	Texas Utilities Co	Southwestern Electric Service
1992	1994	Cincinnati Gas & Electric Co	PSI Resources Inc
1994	1995	Midwest Resources Inc	Iowa-Illinois Gas & Electric
1995	1997	Public Service Co of Colorado	Southwestern Public Service Co
1995	1997	Union Electric Co	CIPSCO Inc
1996	1997	Ohio Edison Co	Centerior Energy Corp
1995	1998	WPL Holdings Inc	IES Industries Inc
1996	1998	Delmarva Power & Light	Atlantic Energy(AmeriGas)
1997	1998	Wisconsin Energy Corp	ESELCO Inc
1997	1998	WPS Resources Corp	Upper Peninsula Energy Corp
1997	1998	LG&E Energy Corp	KU Energy Corp
1998	1999	Nevada Power Co	Sierra Pacific Resources Corp
1998	1999	AES Corp	CILCORP Inc
1997	2000	American Electric Power Co Inc	Central & South West Corp
1999	2000	PECO Energy Co	Unicom Corp
1999	2000	UtiliCorp United Inc	St Joseph Light & Power Co
1999	2000	Carolina Power & Light Co	Florida Progress Corp
1999	2000	Northern States Power Co	New Century Energies Inc
2000	2001	AES Corp	IPALCO Enterprises Inc
2001	2002	Potomac Electric Power Company	Conectiv Inc
2001	2002	Energy East Corp	RGS Energy Group
2002	2003	Ameren Corp	CILCORP Inc
2002	2004	Public Service Co of NH	Connecticut Valley Electric
2003	2004	Ameren Corp	Illinois Power Co
2004	2005	Black Hills Power Inc	Cheyenne Light Fuel & Power Co
2005	2006	Duke Energy Corp	Cinergy Corp
2005	2006	MidAmerican Energy Holdings Co	PacifiCorp
2007	2008	Great Plains Energy Inc	Aquila Inc
2007	2008	Black Hills Power Inc	Aquila Inc-Utility Properties
2010	2011	FirstEnergy Corp	Allegheny Energy Inc
2011	2011	AES Corp	DPL Inc
2010	2012	Northeast Utilities	NSTAR Inc
2011	2012	Duke Energy Corp	Progress Energy Inc

Table 2 Summary Statistics

This table provides descriptive statistics for variables in the study from 1985 to 2015. Panel A reports the characteristics of the utility mergers analyzed in the paper. Panel B reports plant procurement and operating measures. The coal price is deflated to 2000 dollars using the U.S. GDP deflator from the Bureau of Economic Analysis. The sample contains all treatment plants and the 5 closest neighbors (control plants) for each treatment plant. Each observation is a plant-year. Panel C reports information in the coal shipment contracts. Each observation contains the annual contract execution information in the Coal Transportation Rate Database from 1985 to 2001. A plant can have multiple contracts in a year. Panel D reports information on a utility firm's supply relation based on EIA-423 forms from 1990 to 2015. Variables in Panel B are winsorized at 1% and 99% levels. All variables are defined in the Appendix.

Panel A: Mergers

	Obs	Mean	SD	P25	Median	P75
Num Acquirer Coal Plants	43	4.116	4.531	2.000	3.000	5.000
Num Target Coal Plants	43	2.372	2.371	0.000	2.000	4.000
Cash Deal	43	0.116	0.324	0.000	0.000	0.000
Challenged	43	0.093	0.294	0.000	0.000	0.000
Acquirer CAR(-1,+1)	43	-0.007	0.033	-0.024	-0.004	0.013
Target CAR(-1,+1)	43	0.065	0.129	0.003	0.041	0.087
Acquirer CAR(-2,+2)	43	-0.007	0.032	-0.023	-0.000	0.013
Target CAR(-2,+2)	43	0.071	0.127	0.018	0.046	0.103
Wealth Gain (-1,+1)($Billions)	43	0.024	0.352	-0.054	0.017	0.100
Wealth Gain (-2,+2)($Billions)	43	0.040	0.330	-0.003	0.031	0.142
Wealth Gain (-5,+5)($Billions)	43	0.080	0.417	-0.047	0.028	0.177

Panel B: Plants

	Obs	Mean	SD	P25	Median	P75
Coal Price($/MMBTU)	9,166	1.627	0.636	1.136	1.488	2.040
Sulfur(lbs/MMBTU)	9,166	1.301	0.995	0.501	1.000	1.699
Ash(lbs/MMBTU)	9,166	8.838	2.936	6.424	8.987	10.520
Heat Purchased(Million MMBTU)	9,166	39.507	36.957	12.483	25.420	60.515
Scrubber	9,166	0.370	0.483	0.000	0.000	1.000
Capacity(MW)	9,166	766.487	631.096	257.000	565.000	1135.000
Restructured	9,166	0.192	0.394	0.000	0.000	0.000
Retail Choice	9,166	0.112	0.315	0.000	0.000	0.000

Panel C: Contracts

	Obs	Mean	SD	P25	Median	P75
Contract Age (Years)	9,111	6.055	8.626	1.000	3.000	7.000
Revision	9,111	0.125	0.331	0.000	0.000	0.000
Inferior Input	9,111	0.257	0.437	0.000	0.000	1.000
Raise Standard	9,111	0.063	0.243	0.000	0.000	0.000
Shipping Distance (Miles)	9,111	480.880	416.055	150.000	425.000	594.000
Num Transportation Links	9,111	1.292	0.576	1.000	1.000	2.000

Panel D: Suppliers

	Obs	Mean	SD	P25	Median	P75
New Supplier	7,783	0.333	0.471	0.000	0.000	1.000
Change Supplier	7,783	0.371	0.483	0.000	0.000	1.000

Table 3: Input Prices

This table reports the estimates of difference-in-differences specifications on post-merger coal prices from 1985 to 2015. The dependent variable is the natural logarithm of the dollar coal price per MMBTU. In odd columns, the main independent variable is *Post-Merger*, an indicator variable equals to one for all treatment plants from year 1 to year 3 after merger completion. In even columns, *Year [k]* (k = −2,…,+3) are dummy variables equal to one if a plant belongs to the acquirer or the target in year k. Year 0 is the year of merger completion. I estimate difference-in-differences specifications based on three matched samples: treatment plants and their closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. All independent variables are defined in the Appendix.

Dependent Variables	*Log(Coal Price)*		*Log(Coal Price)*		*Log(Coal Price)*	
Closest m Neighbor(s)	m=1	m=1	m=3	m=3	m=5	m=5
Post-Merger	-0.032***		-0.031***		-0.031***	
	(-3.31)		(-2.98)		(-3.13)	
Year[-2]		0.004		0.001		-0.002
		(0.54)		(0.12)		(-0.37)
Year[-1]		0.009		0.011		0.008
		(1.02)		(1.18)		(0.90)
Year[0]		0.006		0.007		0.005
		(0.55)		(0.59)		(0.42)
Year[+1]		-0.027**		-0.023*		-0.025**
		(-2.18)		(-1.73)		(-2.00)
Year[+2]		-0.022*		-0.020		-0.021
		(-1.66)		(-1.39)		(-1.55)
Year[+3]		-0.030*		-0.035**		-0.038**
		(-1.96)		(-2.08)		(-2.40)
Log(Heat Purchased)	-0.041***	-0.041***	-0.034**	-0.034**	-0.039**	-0.039**
	(-2.61)	(-2.62)	(-2.55)	(-2.55)	(-2.37)	(-2.38)
Sulfur	0.018	0.018	-0.025	-0.025	-0.015	-0.015
	(0.43)	(0.43)	(-0.71)	(-0.71)	(-0.46)	(-0.46)
Ash	0.014*	0.014*	0.023**	0.023**	0.029***	0.029***
	(1.70)	(1.70)	(2.30)	(2.30)	(3.21)	(3.22)
Scrubber	0.052	0.052	0.039	0.038	0.078*	0.078*
	(1.58)	(1.57)	(0.84)	(0.84)	(1.90)	(1.89)
Log(Capacity)	0.076	0.076	0.021	0.021	0.023	0.023
	(1.43)	(1.43)	(0.28)	(0.28)	(0.39)	(0.39)
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.898	0.901	0.885	0.888	0.880	0.887
Observations	3,468	3,468	6,510	6,510	9,166	9,166

Table 4: Input Prices: Falsification Test

This table reports falsification tests using the year of merger announcements as the event year. The sample contains mergers that take two or more years to complete due to regulatory oversight. The dependent variable is the natural logarithm of the dollar coal price per MMBTU. The main independent variable, *Pseudo-Post-Merger*, is set to one for all merging plants from year 1 to year 3 after the merger announcements. *Pseudo-Year [k]* (k = −2,…,+3) are dummy variables equal to one if a plant belongs to the acquirer or the target k years relative to the year of the merger announcement. I estimate difference-in-differences specifications based on three matched samples: merging plants and their closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. All models include year and plant fixed effects. Control variables are the same as those in Table 3 and are omitted for brevity. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

Dependent Variables	*Log(Coal Price)*		*Log(Coal Price)*		*Log(Coal Price)*	
Closest m Neighbor(s)	m=1	m=1	m=3	m=3	m=5	m=5
Pseudo-Post-Merger	-0.008		-0.012		-0.011	
	(-0.42)		(-0.69)		(-0.62)	
Pseudo-Year[-2]		0.000		-0.007		0.001
		(0.02)		(-0.41)		(0.07)
Pseudo-Year[-1]		-0.004		-0.006		-0.001
		(-0.18)		(-0.29)		(-0.06)
Pseudo-Year[0]		-0.012		-0.008		-0.004
		(-0.53)		(-0.35)		(-0.20)
Pseudo-Year[+1]		0.006		0.006		0.016
		(0.20)		(0.25)		(0.66)
Pseudo-Year[+2]		-0.010		-0.008		-0.008
		(-0.30)		(-0.30)		(-0.28)
Pseudo-Year[+3]		-0.044		-0.053		-0.046
		(-1.18)		(-1.62)		(-1.43)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.899	0.900	0.917	0.917	0.902	0.902
Observations	905	905	1,709	1,709	2,370	2,370

Table 5: Input Prices: Subsample Test

This table reports the estimates of post-merger coal prices in two subsamples. The dependent variable is the natural logarithm of the standardized coal prices. The main independent variables are the interactions between *Wealth Gain*, *Target Plant,* and *Post-Merger. Wealth Gain* represents the combined wealth gains of the merging firms in the event window (-1, +1). *Target Plant* is an indicator set to one if a plant is owned by the target prior to the merger. I estimate difference-in-differences specifications based on three matched samples: treatment plants and the closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

Dependent Variables	*Log(Coal Price)*		*Log(Coal Price)*		*Log(Coal Price)*	
Closest m Neighbor(s)	m=1	m=1	m=3	m=3	m=5	m=5
Post-Merger	-0.035***	-0.018	-0.033***	-0.014	-0.033***	-0.012
	(-3.81)	(-1.57)	(-3.43)	(-1.17)	(-3.53)	(-1.08)
Wealth Gain	-0.049**		-0.048**		-0.046***	
	(-2.24)		(-2.30)		(-2.62)	
Post-Merger X Wealth Gain	-0.042**		-0.043**		-0.038**	
	(-2.18)		(-2.17)		(-1.97)	
Target Plant		-0.029		-0.011		-0.005
		(-1.63)		(-0.73)		(-0.42)
Post-Merger X Target Plant		-0.038**		-0.047***		-0.050***
		(-2.18)		(-2.76)		(-3.00)
Log(Heat Purchased)	-0.044***	-0.041***	-0.035***	-0.034**	-0.040**	-0.039**
	(-2.82)	(-2.63)	(-2.71)	(-2.56)	(-2.49)	(-2.38)
Sulfur	0.023	0.018	-0.024	-0.025	-0.016	-0.015
	(0.54)	(0.42)	(-0.67)	(-0.71)	(-0.48)	(-0.45)
Ash	0.013*	0.014*	0.023**	0.023**	0.029***	0.029***
	(1.67)	(1.76)	(2.30)	(2.28)	(3.26)	(3.21)
Scrubber	0.039	0.058*	0.030	0.041	0.077*	0.079*
	(1.25)	(1.76)	(0.65)	(0.92)	(1.84)	(1.93)
Log(Capacity)	0.069	0.082	0.027	0.022	0.023	0.023
	(1.35)	(1.47)	(0.37)	(0.30)	(0.40)	(0.39)
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.904	0.902	0.891	0.889	0.889	0.887
Observations	3,468	3,468	6,510	6,510	9,166	9,166

Table 6: Input Prices: Deregulation

This table reports the estimates of post-merger coal prices in states which deregulated the electricity market. The dependent variable is the natural logarithm of the standardized coal prices. The main independent variables are the interactions between *Restructured, Retail Choice,* and *Post-Merger. Restructured* is a dummy variable that equals to one if the state administrator has deregulated the state electricity market. *Retail Choice* is a dummy variable that equals to one if the retail customers in the state can freely switch to alternative electricity providers I estimate difference-in-differences specifications based on three matched samples: treatment plants and the closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

Dependent Variables	*Log(Coal Price)*		*Log(Coal Price)*		*Log(Coal Price)*	
Closest m Neighbor(s)	m=1	m=1	m=3	m=3	m=5	m=5
Post-Merger	-0.020**	-0.022**	-0.022**	-0.022**	-0.022**	-0.023**
	(-2.03)	(-2.22)	(-2.10)	(-2.16)	(-2.24)	(-2.34)
Restructured	0.025		0.001		-0.009	
	(1.36)		(0.03)		(-0.49)	
Post-Merger X Restructured	-0.053***		-0.040*		-0.036*	
	(-2.62)		(-1.89)		(-1.71)	
Retail Choice		0.023		0.001		-0.013
		(0.72)		(0.03)		(-0.47)
Post-Merger X Retail Choice		-0.063**		-0.049*		-0.041
		(-2.42)		(-1.80)		(-1.50)
Log(Heat Purchased)	-0.042***	-0.043***	-0.035***	-0.035***	-0.039**	-0.040**
	(-2.65)	(-2.70)	(-2.60)	(-2.68)	(-2.37)	(-2.48)
Sulfur	0.017	0.018	-0.025	-0.025	-0.015	-0.015
	(0.40)	(0.42)	(-0.72)	(-0.71)	(-0.45)	(-0.46)
Ash	0.014*	0.013	0.023**	0.023**	0.029***	0.029***
	(1.68)	(1.60)	(2.30)	(2.28)	(3.21)	(3.21)
Scrubber	0.051	0.052	0.038	0.038	0.079*	0.079*
	(1.54)	(1.58)	(0.84)	(0.84)	(1.92)	(1.91)
Log(Capacity)	0.078	0.076	0.021	0.020	0.021	0.022
	(1.47)	(1.43)	(0.28)	(0.27)	(0.37)	(0.38)
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.902	0.902	0.889	0.889	0.887	0.887
Observations	3,468	3,468	6,510	6,510	9,166	9,166

Table 7: Input Prices and Shareholder Wealth Gains

This table reports the cross-sectional analysis of coal price changes in merging plants following the merger completion. Models (1) to (3) the estimates of logit model in which the dependent variables *Price Decrease* equals to one if the average input prices in the three years following the merger is lower than the input price in the year prior to merger completion. Models (4) to (6) reports the estimates of OLS models in which the dependent variables *%Price Change* is defined as$\frac{P_{1,2,3}-P_{-1}}{P_{-1}}$, where $P_{1,2,3}$ is the average annual coal prices in years 1, 2, and 3 relative to the merger and P_{-1} is the annual input price one year prior to merger completion. The main independent variables are the dollar wealth gains of the mergers based on windows (-1, +1), (-2, +2), and (-5, +5). ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. All independent variables are defined in the Appendix.

Dependent Variables	*Price Decrease*			*% Price Change*		
	(1)	(2)	(3)	(4)	(5)	(6)
Wealth Gain (-1,+1)	1.897^{***}			-0.177^{***}		
	(4.50)			(-6.05)		
Wealth Gain (-2,+2)		1.897^{***}			-0.166^{***}	
		(5.37)			(-6.29)	
Wealth Gain (-5,+5)			0.938^{**}			-0.095^{***}
			(2.03)			(-3.38)
Cash Deal	-4.591^{***}	-4.036^{***}	-2.979^{***}	0.348^{***}	0.303^{***}	0.249^{***}
	(-3.01)	(-3.31)	(-3.34)	(5.00)	(4.93)	(4.46)
Challenged	1.920^{*}	2.011^{*}	2.169^{**}	-0.103^{***}	-0.117^{***}	-0.129^{***}
	(1.82)	(1.92)	(2.08)	(-3.05)	(-3.63)	(-4.00)
Target Plant	0.424	0.491	0.395	-0.036	-0.043^{*}	-0.042
	(1.15)	(1.33)	(1.15)	(-1.49)	(-1.74)	(-1.59)
Quantity	0.259	0.225	0.324^{*}	-0.019	-0.017	-0.025^{*}
	(1.36)	(1.20)	(1.66)	(-1.39)	(-1.26)	(-1.67)
Sulfur	0.264	0.223	0.245	-0.027^{**}	-0.025^{*}	-0.025^{*}
	(1.30)	(1.12)	(1.41)	(-2.10)	(-1.97)	(-1.91)
Ash	0.040	0.030	-0.011	-0.004	-0.003	-0.000
	(0.76)	(0.58)	(-0.24)	(-1.01)	(-0.78)	(-0.02)
Scrubber	-0.355	-0.248	-0.247	0.023	0.015	0.015
	(-1.02)	(-0.73)	(-0.72)	(0.92)	(0.61)	(0.56)
Log(Capacity)	-0.206	-0.213	-0.302^{*}	0.018^{**}	0.020^{**}	0.024^{***}
	(-1.53)	(-1.58)	(-1.89)	(2.11)	(2.26)	(2.66)
Adj. R-squared	0.194	0.204	0.132	0.294	0.286	0.199
Observations	265	265	265	265	265	265

Table 8: Contract Revision

This table reports the estimates of difference-in-differences specifications on post-merger contract revision from 1985 to 2001. *Revision* is an indicator that equals one if a given supply contract is modified. *Year [k]* (k = −2,…,+3) are dummy variables equal one if a plant belongs to the acquirer or the target in year k. Year 0 is the year of merger completion. I estimate difference-in-differences specifications based on three matched samples: treatment plants and the closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. All independent variables are defined in the Appendix.

Dependent Variables		*Revision*	
Closest m Neighbor(s)	m=1	m=3	m=5
Year[-2]	0.041	0.049	0.045
	(1.11)	(1.49)	(1.40)
Year[-1]	0.005	0.044	0.048
	(0.09)	(0.87)	(1.03)
Year[0]	0.071	0.097^{**}	0.099^{**}
	(1.55)	(2.38)	(2.47)
Year[+1]	-0.004	0.021	0.022
	(-0.07)	(0.46)	(0.50)
Year[+2]	-0.061	-0.024	-0.021
	(-1.01)	(-0.44)	(-0.41)
Year[+3]	-0.110^{**}	-0.110^{**}	-0.127^{***}
	(-2.23)	(-2.46)	(-2.78)
Contract Age	0.010^{**}	0.014^{***}	0.016^{***}
	(2.37)	(3.26)	(3.21)
Log(Heat Purchased)	0.000	-0.004	-0.006
	(0.03)	(-0.64)	(-0.88)
Sulfur	-0.001	0.005	0.002
	(-0.06)	(0.34)	(0.16)
Ash	0.004	0.004	0.005
	(0.40)	(0.62)	(0.85)
Scrubber	0.005	-0.011	-0.014
	(0.20)	(-0.86)	(-1.39)
Log(Capacity)	0.003	0.006	0.003
	(0.31)	(0.67)	(0.33)
Contract Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adj. R-squared	0.364	0.353	0.361
Observations	3,751	6,960	9,111

Table 9: Input Quality

This table reports the estimates of difference-in-differences specifications on delivered coal quality from 1985 to 2001. In the first three columns, the dependent variable *Raise Standard* is an indicator that equals to one if the shipped coal is 5% or more inferior to the contractual delivery standards for ash, moisture or sulfur. In the next three columns, the dependent variable *Inferior Input* is an indicator that equals to one if the contractual standard for ash, moisture or sulfur is raised by 5% or more. *Year [k]* (k = −2,…,+3) are dummy variables equal to one if a plant belongs to the acquirer or the target in year *k*. Year 0 is the year of merger completion. I estimate difference-in-differences specifications based on three matched samples: treatment plants and the closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. All independent variables are defined in the Appendix.

Dependent Variables	*Raise Standard*			*Inferior Input*		
Closest m Neighbor(s)	m=1	m=3	m=5	m=1	m=3	m=5
Year[-2]	0.020	0.027	0.022	-0.007	-0.020	-0.014
	(0.68)	(1.00)	(0.83)	(-0.20)	(-0.57)	(-0.41)
Year[-1]	0.019	0.024	0.026	0.004	-0.004	-0.017
	(0.83)	(1.08)	(1.14)	(0.11)	(-0.11)	(-0.42)
Year[0]	0.085**	0.083**	0.073*	0.014	0.029	0.013
	(2.19)	(2.03)	(1.74)	(0.29)	(0.62)	(0.30)
Year[+1]	0.013	0.013	0.009	-0.021	-0.026	-0.039
	(0.54)	(0.54)	(0.38)	(-0.41)	(-0.58)	(-0.84)
Year[+2]	-0.019	-0.011	-0.019	-0.075	-0.072	-0.088*
	(-0.50)	(-0.26)	(-0.45)	(-1.42)	(-1.41)	(-1.85)
Year[+3]	0.003	0.002	0.001	-0.127**	-0.110**	-0.122***
	(0.11)	(0.09)	(0.02)	(-2.31)	(-2.37)	(-2.71)
Contract Age	0.003	0.002	0.003	-0.003	-0.002	-0.002
	(0.57)	(0.45)	(0.61)	(-0.48)	(-0.51)	(-0.58)
Log(Heat Purchased)	0.009**	0.010***	0.012***	-0.018**	-0.018***	-0.016***
	(1.98)	(2.75)	(3.26)	(-2.47)	(-2.74)	(-2.72)
Sulfur	-0.036	-0.029	-0.024	-0.001	0.053	0.062
	(-1.20)	(-1.39)	(-1.27)	(-0.01)	(0.79)	(1.22)
Ash	-0.004	-0.004	-0.003	0.066***	0.057***	0.054***
	(-0.59)	(-0.77)	(-0.64)	(4.96)	(5.16)	(5.73)
Scrubber	-0.012	-0.005	-0.001	-0.016	-0.038	-0.050*
	(-0.63)	(-0.45)	(-0.07)	(-0.39)	(-1.12)	(-1.92)
Log(Capacity)	0.012*	0.002	-0.001	-0.005	-0.007	-0.011
	(1.87)	(0.46)	(-0.14)	(-0.32)	(-0.60)	(-1.28)
Contract Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.387	0.366	0.376	0.623	0.600	0.597
Observations	3,751	6,960	9,111	3,751	6,960	9,111

Table 10: Shipping

This table reports the estimates of difference-in-differences specifications based on post-merger coal shipment from 1985 to 2001. In the first three columns, the dependent variable, *Shipping Distance*, represents the total distance of coal shipping. In the next three columns, the dependent variable, *Num Transportation Links*, represents the number of stops in a coal-shipping route. *Year [k]* (k = −2,…,+3) are dummy variables equal to one if a plant belongs to the acquirer or the target in year *k*. Year 0 is the year of merger completion. I estimate difference-in-differences specifications based on three matched samples: treatment plants and the closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. All independent variables are defined in the Appendix.

Dependent Variables	*Shipping Distance*			*Num Transportation Links*		
Closest m Neighbor(s)	m=1	m=3	m=5	m=1	m=3	m=5
Year[-2]	-2.478	-13.336	-17.323	0.016	-0.004	-0.005
	(-0.18)	(-1.10)	(-1.51)	(0.33)	(-0.10)	(-0.10)
Year[-1]	-12.538	-21.366	-26.456*	-0.019	-0.042	-0.045
	(-0.63)	(-1.33)	(-1.78)	(-0.34)	(-0.88)	(-0.93)
Year[0]	-94.947***	-107.142***	-104.595***	-0.213***	-0.228***	-0.214***
	(-3.02)	(-3.84)	(-3.97)	(-3.24)	(-3.55)	(-3.30)
Year[+1]	-121.303***	-141.301***	-143.652***	-0.198***	-0.218***	-0.217***
	(-3.19)	(-4.30)	(-4.66)	(-2.72)	(-3.31)	(-3.22)
Year[+2]	-107.562**	-116.238***	-111.334***	-0.205**	-0.195**	-0.180**
	(-2.20)	(-2.65)	(-2.66)	(-2.26)	(-2.33)	(-2.21)
Year[+3]	-83.409	-92.346*	-89.073*	-0.134	-0.138	-0.132
	(-1.50)	(-1.76)	(-1.79)	(-1.43)	(-1.53)	(-1.50)
Contract Age	2.542	6.248**	6.470***	-0.005	-0.005	-0.006
	(0.82)	(2.25)	(2.80)	(-0.86)	(-1.07)	(-1.26)
Log(Heat Purchased)	-10.289	-3.824	-1.551	-0.013	-0.012	-0.006
	(-1.65)	(-0.70)	(-0.35)	(-1.31)	(-1.62)	(-1.00)
Sulfur	-23.618	-8.617	-6.199	-0.017	0.002	0.000
	(-1.46)	(-0.88)	(-0.76)	(-0.88)	(0.18)	(0.04)
Ash	-12.884*	-8.813	-6.512	-0.014	-0.008	-0.012
	(-1.92)	(-1.43)	(-1.29)	(-1.48)	(-0.83)	(-1.27)
Scrubber	26.699	-19.763	-25.542*	0.075	0.053*	0.031
	(1.30)	(-1.28)	(-1.78)	(1.47)	(1.81)	(1.31)
Log(Capacity)	-12.057	-1.599	2.067	-0.020	-0.017	-0.027
	(-0.64)	(-0.10)	(0.15)	(-0.51)	(-0.64)	(-0.94)
Contract Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.907	0.887	0.891	0.747	0.735	0.728
Observations	3,751	6,960	9,111	3,751	6,960	9,111

Table 11: Supply Chain Relation
This table reports changes in supply chain relations following mergers from 1990 to 2015. The dependent variables *New Supplier (Change Supplier)* are dummy variables equal to one if a plant initiates (terminates) procurement transactions in a county. *Post-Merger* is an indicator variable equals to one for all treatment plants from Year 1 to Year 3 after a merger. I estimate difference-in-differences specifications based on three matched samples: treatment plants and the closest *m* neighboring plants (m=1, 3, and 5) burning the same rank of coal within 200 miles. I report robust standard errors clustered by plant. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. All independent variables are defined in the Appendix.

Dependent Variables	*New Supplier*			*Change Supplier*		
Closest m Neighbor(s)	m=1	m=3	m=5	m=1	m=3	m=5
Post-Merger	0.057^{**}	0.064^{***}	0.060^{**}	-0.013	-0.013	-0.019
	(2.43)	(2.66)	(2.49)	(-0.49)	(-0.49)	(-0.70)
Log(Heat Purchased)	0.070	0.092^{*}	0.089^{*}	0.094	0.082	0.070
	(1.51)	(1.93)	(1.88)	(1.63)	(1.58)	(1.51)
Sulfur	-0.040	-0.015	-0.023	-0.033	0.023	0.037
	(-1.19)	(-0.44)	(-0.69)	(-0.85)	(0.62)	(1.13)
Ash	0.025^{*}	0.025^{*}	0.026^{**}	0.038^{***}	0.008	0.008
	(1.89)	(1.87)	(2.11)	(3.02)	(0.48)	(0.58)
Scrubber	0.150^{**}	0.095	0.074	0.124^{**}	0.150^{***}	0.161^{***}
	(1.99)	(1.34)	(1.22)	(2.15)	(3.23)	(3.08)
Log(Capacity)	0.347^{**}	0.226^{*}	0.165	-0.065	-0.074	-0.046
	(2.41)	(1.72)	(1.33)	(-0.44)	(-0.59)	(-0.39)
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.348	0.327	0.315	0.369	0.347	0.340
Observations	2,897	5,493	7,783	2,897	5,493	7,783