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Contract Renegotiation and Rent Re-Redistribution: Who Gets Raked Over the Coals?*

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Abstract
Policy shocks affect the rent distribution in long-term contracts, which can lead to such contracts being renegotiated. We seek an understanding of what aspects of contract design, in the face of a substantial policy shock, affect the propensity to renegotiate. We test our hypotheses using data on U.S. coal contracts after the policy shock of the 1990 Clean Air Act Amendments. This law altered the regulation of emissions of sulfur dioxide from coal-fired electric power plants, initiating a tradable permit system for a subset of coal-fired power plants which had previously been unregulated at the federal level. Contracts are divided into two categories, those that were renegotiated following the shock and those that were not and their characteristics are used to determine how they influence whether or not a contract was ultimately renegotiated. The number of years until the contract expires, a larger allowable sulfur content upper bound for plants regulated immediately by the tradable permit scheme, and the minimum quantity are all associated with a contract being renegotiated.

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Introduction

New policy initiatives have the ability to substantially shift rents within an economy. As a result, entities which previously made investments tied to the initial state of affairs (for example capital developments, or long-term purchasing contracts) will be affected by any proposed changes in regulatory policy. To date, there is a lack of empirical evidence concerning how these stakeholders contractually respond to the imposition of a change in regulatory policy. This leaves policymakers without an objective evaluation of the impact of their proposals on stakeholders' rents, compared to the claims put forward. This paper attempts to address this void by investigating how long-term contracts for coal delivery in the electricity generation industry responded to passage of the 1990 Clean Air Act Amendments (CAAA).

The implementation of the 1990 CAAA increased the demand for low-sulfur coal, and greatly reduced the demand for high-sulfur coal. The coal contracts then in existence allowed a range of coal quality to be delivered in satisfaction of the contract terms. If a plant had allowed the mine a large degree of flexibility in the sulfur content of coal delivered, passage of the 1990 CAAA would therefore induce the plant owner to attempt to renegotiate the contract, to avoid the possible delivery of high-sulfur coal.

Contracts were flexible in other ways as well, such as through the pricing mechanism or the delivery mechanism of the coal. Such flexibility was not uniform, however, and many contracts ended up having to be renegotiated. Our ultimate empirical question is to seek an understanding of what factors in the initial contract design led to (or avoided) this renegotiation decision. More broadly, within the contextual example of coal contracts, we seek an understanding of what aspects of contract design affect the propensity to renegotiate when a policy shock (such as new Congressional legislation) occurs in the midst of a long-term contracting environment.

We ground our empirical model in the theory of long-term contracts as first postulated by Coase (1937). In *The Nature of the Firm* Coase effectively argued that long-term contracts emerge in a world of transaction costs. Later authors (Williamson 1985, Klein et al 1978, Goldberg 1976) operationalized these ideas by identifying important categories of transaction costs, including uncertainty and asset specificity. How these transaction-cost based issues are dealt with in any given contract determines the degree of flexibility a contract essentially embodies. Our hypothesis is that when an outside shock occurs in the midst of a contracting environment, the more flexible the initial terms of the contract, the less the probability of explicit contract renegotiation in response to the outside shock.

In our empirical context, we measure the degree of flexibility embodied in a contract with certain contract characteristics, such as the price adjustment mechanism and the number of years until the contract expires. Results generally match expectations. Contracts with a more rigid price adjustment mechanism and more years till expiration are more likely to be renegotiated. A higher allowable sulfur content upper bound also leads to a higher probability of renegotiation for plants that will be affected by the strictures of the 1990 CAAA sooner.

From a policy perspective, this paper contributes to the literature in at least two ways. First, many governments have or are debating the adoption of greenhouse gas policy which will have a similar effect on the coal market as the 1990 CAAA. This historical look back at the effect of the 1990 CAAA on long-term fuel contracts will help in looking forward to the future effects of carbon emissions legislation today. Second, this research speaks to the question of whether the efficiency of the 1990 CAAA was restricted by long-term contracting in the coal market. Swinton (2004), Carlson et al (2000), and Sotkiewicz and Holt (2005) have all suggested that the full cost savings potential of the tradable permit system in the 1990 CAAA was not achieved because inflexible, long-term contracts inhibited adjustment to the new state of affairs. This paper, the first in the literature to do so, provides empirical evidence somewhat disputing this claim.

Background & Literature Review

Coal for use in the U.S. electricity industry is primarily procured through long-term contract. Spot markets account for only around 15% of total sales. The average duration of contracts, however, has been declining from around 14 years in the early 1980s to an average of 8 years in the 1990s (Lange and Bellas, 2007). Contracts are generally between a mine, a coal-fired power plant, and a transportation firm (often a railroad). Joskow (1985) provides a detailed overview of contracts in the coal industry and notes that a mine and a power plant usually rely on long-term contracts that are incomplete but quite complex. Such contracts will contain both price and non-price provisions, such as a specified price adjustment mechanism over time and minimum quantity and coal attribute provisions. Joskow (1988; 1990) finds that when the price of coal dipped after 1982, coal contracts were still largely adhered to, despite the downturn in prices. This illustrates the resilience of these contract commitments. He concludes that mine and plant owners generally prefer to abide by contractual obligations, than to terminate, breach, or litigate a contract. When contracts are renegotiated, compromises are often made; prices fall but minimum quantity provisions at the same time increase.

The early literature on contract design was spearheaded by Coase (1937), Klein et al. (1978), and Williamson (1985). These papers laid out the theory that it is the existence of transaction costs which leads to vertical integration between exchange parties. The degree of vertical integration can range from simple contracts, to complex mergers, all the way up to regulation and/or government takeover of the transacting environment (Goldberg 1976), but ultimately all forms of integration exist as a response to the hold-up problem.

The hold-up problem occurs when one firm makes an investment whose value is largely determined through the use of another firm's product and subsequently finds that the other firm tries to expropriate the rents generated by a relationship specific investment. Three important categories of transaction costs have been identified in the literature: the uncertainty/complexity of the contracting environment, the time duration of the exchange relationship, and the degree of investment by either party in relationship-specific assets, be they physical assets, human capital assets, or assets of some other form. [1]

Predictions of transaction cost theory are that as uncertainty, duration of an exchange relationship, or degree of relationship-specific investments increase, vertical integration of some form should increase as well. The problem with vertical integration as embodied in contracts, however, is that contracts can never be completely specified. This inability to write complete contracts leads to other testable hypotheses of transaction cost theory, such as that as uncertainty or duration increase, contracts should become more relational or flexible in character, and that as investments increase, contracts should become less flexible, or, longer in duration.

Over the years a number of empirical tests have been conducted which confirm these broad predictions of transaction cost theory. Crocker and Masten (1988, 1991), Neumann and von Hirschhausen (2008) and Mulherin (1986) all investigated natural gas contract terms in the

[1] Williamson (1999) later identified a fourth type of transaction cost, probity, but it is primarily related to governmental (not private-sector) contracts.

context of transaction cost theory and found, for example, that the longer the duration of the exchange relationship the more flexible the pricing arrangements, and that with higher degrees of asset specificity, contracts embody longer durations. Other empirical confirmations of transaction cost theory include Crocker and Reynolds (1993), using U.S. Air Force engine procurement contracts, and Gil (2007), using movie industry contracts in Spain.

More recently, a theoretical literature has developed arguing that the inefficiencies inherent in the hold-up problem of long-term contract design can be eliminated through optimal contract provisions including, for example, renegotiation provisions (Aghion et al. 1994, Hart and Moore 1988) or options clauses (Rogerson 1992, Noldeke and Schmidt 1995). It is an interesting discussion which, to date, sorely lacks empirical tests. The only empirical model of the renegotiation decision in the literature can be found in Guasch et al. (2008), and it is a test of the determinants of renegotiation provisions, not so much whether or not they lead to optimality of contract design. As such, however, it is a research effort similar in spirit to our own. It is an empirical analysis of concession contracts in Latin America in the transport and water sectors and it finds that contract clauses do significantly matter to the renegotiation decision. Specifically, they find that more flexible pricing schemes lead to a lower probability of later renegotiation. Overall, there is a need for more empirical testing of these ideas in the literature.

This analysis uses the 1990 CAAA as the policy shock which leads parties to consider contract renegotiation.[2] Regulation of coal-fired power plants is critical to controlling emissions of sulfur dioxide (SO2), as approximately 66% of all emissions come from coal-fired power plants. Sulfur dioxide is formed when the sulfur inherent in the coal combines with oxygen in

[2] Empirical work by Keohane and Busse (2007) and Lange and Bellas (2007) has already shown that initial rent distributions were affected by the 1990 CAAA.

the combustion process. The concern at the time was over the acidification of water sources (acid rain) from the sulfur dioxide emissions.[3] U.S. federal regulation of sulfur dioxide emissions from coal-fired boilers began with the 1970 Clean Air Act, under which a vintage differentiated emission standard was employed. Existing boilers were regulated by the states while new boilers were federally regulated. States generally had much more generous standards than the federal government, which led to increased use of existing boilers and as a result a slower reduction in sulfur dioxide emissions than policymakers had hoped for.

During the 1980s various sulfur dioxide control bills appeared before Congress, but with little success. The politics of the problem made it difficult for most potential policies to proceed (Ellerman et al, 2000). It wasn't until a new administration came to power in 1989 that the political landscape changed to make another attempt at sulfur dioxide legislation successful. The 1990 CAAA, through Title IV, initiated a system of tradable permits for SO_2 emissions that would eventually apply to most coal-burning power plants in the U.S. The permit system was implemented in two phases. Phase I began in 1995 with the inclusion of approximately 263 boilers which were granted permits at a rate of 2.5 lbs of SO_2 emitted per million Btu. Phase II began in 2000 and applied to essentially the entire population of coal-fired power plants in the U.S., which were granted permits at a rate of 1.2 lbs of SO_2 emitted per million Btu. All of the Phase I boilers affected had previously been unregulated, at least at the federal level, and generally burned high sulfur coal and emitted large amounts of SO_2.

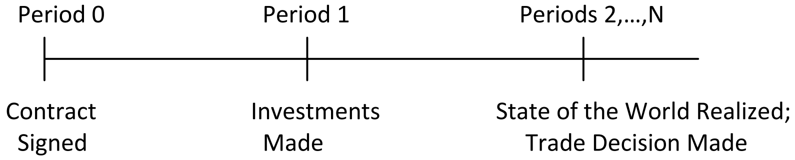
By almost every measure, Title IV has been a success. Carlson et al (2000) estimates a savings of around $250 million annually from Phase I and Ellerman et al (2000) estimates a $360

[3] The acid rain debate (from sulfur emissions) is very similar to the current climate change debate (from carbon emissions).

million annual savings. However, some studies suggest that there may be more savings available. Swinton (2004), Carlson et al (2000) and Sotkiewicz and Holt (2005) use three different applied methods to determine that the potential cost savings of Title IV is larger than the actual cost savings. All three papers speculate that the divergence between actual savings and potential savings could be due to the inability to alter long-term coal contracts. This work can shed light on the speculation that coal contracts prohibited the tradable permit scheme from reaching its cost savings potential. More broadly, this paper investigates the effect of the 1990 CAAA policy shock on the decision to renegotiate long-term coal contracts.

Theoretical Model

We formulate our test of the renegotiation decision in long-term U.S. coal contracts around the following model.[4] We begin with a buyer and a seller, both of which are risk neutral. They enter into a relationship at some initial date, (Period 0 in Figure X) through a written contract, to trade over a period of time a particular good, *q*. The characteristics of *q* at delivery are not fully specified when the contract is signed in period 0. Either due to technological constraints or environmental constraints, it is assumed that it is not possible to completely specify at date 0 the type of *q* to be delivered. *q* is therefore dependent upon a number of characteristics, as represented by the vector *l*, including quality of the good and geographical location of the good, such that *q(l)*.



[4] Notation follows that used in Hart and Moore (1988) and Noldeke and Schmidt

After the contract is signed, both the buyer and the seller make irreversible investments, $\beta(l)$ and $\sigma(l)$ respectively, that allow them to carry out the contract. Because the choices of β and σ are dependent upon expectations of the characteristics l, it is apparent that β and σ are sufficiently complex that they too cannot be contracted on in period 0. β and σ are, however, determined early, in period 1, and so they entail a degree of commitment between the buyer and the seller that cannot be reversed in later periods if either party changes their mind about delivery of q. After period 1, because of these committed investments whose resale value is assumed to be less than their value in their intended usages, the buyer and seller are now locked-in to each other. This, in essence, models the hold-up problem inherent in long-term contract design.

In the next period, after the contract is signed and production investments are made, the state of the world, ω, is realized. ω is allowed to change in any period based on exogenous factors such as new demand preferences, weather effects, or, of most relevance to this paper, policy shocks. The realization of ω allows ultimate valuations over execution of the initial contract to be determined. The buyer's valuation is given by the random variable v, and the seller's valuation by the random variable c, whose distributions are affected by l, and the ultimate state of the world such that

$$v = v[\omega; \beta(l); q(l)]$$

$$c = c[\omega; \sigma(l); q(l)]$$

where $\omega \in \Omega$, the set of all states of the world, $l \in \Pi$; $\beta, \sigma,$ and q are functions mapping $\Pi \rightarrow \Psi$, and v and c are functions mapping $(\Omega; \Psi) \rightarrow R$. We assume that there are no externalities, that Ω is finite, and that ω is publicly observable in each period 2,…,N though sufficiently unknowable that it cannot be contracted on in period 0. We also assume that though the joint distribution of v

and c is common knowledge in period 0, the ultimate realization of v and c are not publicly observable.

In periods 2,…,N if $v \geq c$, it is efficient for the parties to execute the trade agreement (i.e. $q > 0$). Note that even if $v \geq c$, due to the realization of ω, the sizes of v and c may themselves have changed and with them the original rent distribution from the trade agreement. The model has moved away from whatever equilibrium it may have been in the previous period, and because of this, it is likely that one party to the contract is no longer happy with their share of the trade surplus, v-c. Either the buyer or the seller in this instance, may, therefore, seek an (implicit or explicit) renegotiation of the contract. We model the probability that explicit renegotiation occurs as π, and we assume, based on transaction cost theory, that it is dependent on the flexibility of the characteristics of the delivered good, l, to make up for the changes in v and c that occur due to the new realization of ω.

Our testable hypothesis, therefore, is that as policy shocks occur and ω changes, the realization of π (from $0 \rightarrow 1$) is dependent upon $\varphi(l)$, the distribution of the characteristics l. Formally: A wider range of l, as measured by the distribution $\varphi(l)$, implies $\pi \rightarrow 0$, it is easier to implicitly renegotiate. Alternatively, inflexible contract terms (i.e. a limited $\varphi(l)$ range) implies $\pi \rightarrow 1$, it is easier to explicitly renegotiate. We test this hypothesis in the analysis below.

Data

Our empirical context is long term U.S. coal (q) contracts. Data (l) on these contracts were obtained from the Coal Transportation Rate Database (CTRB) which is maintained by the Energy Information Administration. The CTRB is a survey of investor-owned, interstate electric utilities with steam-electric generating stations of more than 50 megawatts.[5] The dataset can be thought of as two separate data sources merged. The first set of information is on the contracts and the second is information on deliveries for each contract. The complete dataset contains information on coal transactions for the years 1979-1999, regardless of when the contract was signed. Information included are the type of contract, cost, quality, and origin of coal purchases as well as the lower and upper bounds for a number of coal attributes.

The dataset codes each contract with a unique identification number. Each contract appears many times in the dataset as deliveries occur over time. With each delivery in the data, the year signed and year of last modification are given. Modifications are evidence of explicit renegotiations in the contract (π=1). The number of renegotiations and percentage of contract renegotiated throughout the sample can be seen in Figure 1. There are two spikes in the figure, one between 1988 and 1989 and another between 1992-1994. These spikes straddle the passage of the CAAAs in 1990 suggesting that preparation for, and response to, this legislation may have been an impetus for large numbers of contract renegotiations. The information in the CTRB is used to determine the vintage of each delivery, either the year signed if no modifications are specified, or the year of last modification. Contracts signed in 1991 or later are excluded from the analysis. Contracts with a vintage of 1990 or earlier but expiration before 1994 are excluded from the analysis since they would not need to be renegotiated given they expire before the 1990 CAAA are put into effect. This leave contracts with a vintage of 1990 or earlier that were still in effect in 1995. There are 273 contracts in the dataset that fit these restrictions. If any of these contracts had a vintage change to 1991 or later, they were considered renegotiated (π=1). The

[5] Our final empirical analysis includes data from 146 distinct electricity plants from approximately 80 utilities.

dependent variable for this analysis, *Renegotiated Contracts*, is binary and set to one if a contract is indeed renegotiated and zero (π=0) otherwise.

The explanatory variables (l) detail the parameters of the contract and the plant and mine involved. Perhaps the most important variables included relating to our policy shock of passage of the 1990 CAAA (ω) are *Allowable Sulfur Upper Bound* and *Phase I Plant*. *Allowable Sulfur Upper Bound* is a measure of the contracted coal's allowable sulfur content upper bound, in percent by weight. After passage of the 1990 CAAA, higher sulfur-content coal was suddenly markedly less valuable than lower sulfur-content coal. Contracts that allowed for delivery of higher sulfur-content coal, then, became less valuable to the plant owner, although at the same time more valuable to the mine owner. It is difficult to predict a priori which direction the sign on this coefficient will go, as it will depend on the relative bargaining strength of the mine and plant owner, but according to transaction cost theory, greater contract flexibility should imply reduced contract renegotiation and since a higher sulfur upper bound implies a wider distributional range, we predict that in the aggregate, the coefficient on this variable should be negative.[6]

Phase I Plant is a dummy variable that takes a one if any of the boilers at a plant are subject to Phase I of Title IV of the 1990 CAAA. Plants that are affected by the regulatory shock of the 1990 CAAA are expected to be more likely to renegotiate their contracts. To distinguish between the effect of the allowable sulfur content upper bound on plants with Phase I boilers, and plants without, an interaction term is created, *Phase I*Allowable Sulfur*, which is the product of the allowable sulfur content upper bound and the Phase I dummy. It is expected that the

[6] A specification where contracts with an allowable sulfur content upper bound above the rate of permits granted in Phase I (2.5 lbs of SO_2 emitted per million Btu) is set to one and below set to zero was also run with the same results in sign and significance as *Allowable Sulfur Upper Bound*.

interaction term will be positive as Phase I plants with a high allowable sulfur content upper bound will have the contract rent distribution (*v-c*) most affected by Title IV.

A number of variables are used to proxy for the level of transaction costs between the parties. The first relates to the physical distance between the parties. *Distance Apart* measures the total distance in hundreds of miles that the coal travels from mine to plant, and is used to proxy for the closeness of the relationship of the contracting parties. We hypothesize that contracting parties that are geographically closer may have developed a stronger trade relationship, making the contract more flexible, leading to less need to explicitly renegotiate ($\pi \rightarrow 0$).

Four variables are created to proxy for the level of dedicated assets (β, σ) the contract implies for the plant and mine.[7] *Plant Dedicated Assets* are defined as the ratio of an individual contract quantity to the sum of the plant's contract quantity. Similarly, *Mine Dedicated Assets* is the ratio of an individual contract quantity to the sum of the mine's contract quantity. Larger levels of dedicated assets imply more appropriable quasi-rent at stake in the transaction, which will lead to a less flexible contract (Saussier 2000). Thus, larger levels of dedicated assets are expected to lead to increases in the probability of explicit renegotiation when faced with a policy shock. A small percentage of plants are located at the "mine's mouth." Minemouth plants, integrated as they are directly at the mining site, have less alternative suppliers than non-minemouth plants, implying more dedicated assets between the parties. A *Minemouth* dummy is created which equals one if the plant is located directly next to a mine. Because of the relatively large amount of dedicated assets, these contracts should be inflexible and the probability that they are renegotiated due to external policy shocks, higher. *Quantity* is the minimum quantity to

[7] This method follows Kerkvilet and Shogren (2001).

be delivered by the contract during each transaction. Larger quantity contracts are associated with longer contracts, making them less flexible and more likely to be renegotiated.

All contracts have a mechanism that adjusts prices over time. The sample here contains four of them: fixed price, base price plus escalation for economic conditions, cost-plus, and price renegotiation at specific intervals. Base price plus escalation contracts have an escalation that is usually a function of some economic indices (i.e., union wages or Consumer Price Index). Cost-plus contracts promise to pay all suppliers' costs plus a fee presumably determined before the contract goes into effect. The first two mechanisms are more rigid than the last two, in that they pre-arrange how the price can adjust, instead of allowing flexibility into the adjustment. A dummy variable, *Rigid Price Adjustment*, was created equal to one for contracts that are in the first category, fixed price or base price plus escalation. A more rigid price adjustment mechanism makes it more difficult to implicitly negotiate the contract, thus it is expected that a more rigid price adjustment mechanism is associated positively with renegotiation ($\pi \rightarrow 1$).

The *Relative Price* of the coal is calculated using data from the Federal Energy Regulatory Commission (FERC) Form 423 on coal supplied for the year 1990. The mean and standard deviation of the price for each Bureau of Mine's coal producing district is calcualted and the contract price in 1990 was used to calculate a z-score ((price–mean)/standard deviation). Bureau of Mine Districts were created to help classify coal types, thus the coal within each area is quite similar in quality. A positive relative price implies the contract price is above the mean price in the District. The effect that a relatively high or low price has on the probability of renegotiation (π) depends upon the relative bargaining powers of the two parties, thus the expected sign is ambiguous.

A *Years Till Expiration* variable is created by subtracting 1991 from the contract expiration year. This variable relates to the varying lengths of contracts; contracts in our sample have an expiration year that ranges from 1995 to 2027. We would expect that, according to transaction cost theory, longer contracts (i.e. those with a higher value for *Years Till Expiration*) would have a higher probability of renegotiation ($\pi \rightarrow 1$), because the more years till expiration, the longer the parties are subject to the new rent distribution.

Another set of explanatory variables groups the contracts either by their vintage or the year signed: *pre-1985*, *1985-1987*, and *1988-1990*. The vintage of the contract is calculated using either the year the contract was signed if it has not been renegotiated, or the year of the last renegotiation before 1991. There are no expectations as to how the different years signed or vintages of a contract will be associated with the probability of renegotiation; these variables (as with the geographical dummies described below) are used to control for factors that may lead to renegotiation regardless of the policy shock.

Finally, dummy variables are created for each of the three coal-producing regions: the *Appalachian*, *Interior*, and *Western* coal mine regions. The Western coal region has on average the lowest sulfur contents, followed by the Appalachian region and the Interior region. However, it is difficult to predict a priori which direction the sign on these region coefficients will go, as it will depend on the relative bargaining strength of the mine and plant owner. For example, plants with a contract with a Western region coal mine are likely to not want to renegotiate while the mine would want to renegotiate given the change in the value of sulfur after Title IV. Summary statistics for all of the variables are given in Table 1, and Table 2 lists the expected effects of our explanatory variables on the probability of contract renegotiation.

Empirical Model

The theoretical model discussed above argues that π, the probability of explicit renegotiation, increases in the face of a policy shock when $\varphi(l)$ is narrow. Narrow ranges of $\varphi(l)$ occur when the contracting parties have little flexibility inherent in the contract to implicitly renegotiate. We do not observe the actual probability of renegotiation, only whether the contract was actually renegotiated. Thus we use an indicator variable, R_i, to proxy for π such that there exists a π^* where any π equal to or above that leads to renegotiation and any below leads to the continuation of the contract. We parameterize our theoretical model using a probit estimation of the following equation:

$$R_i = \alpha + \beta_1 L_i + \varepsilon_i \qquad [1]$$

where R_i is an indicator variable taking the value of one if the contract was renegotiated and zero if it was not, L_i is a vector of variables relating to the coal contract characteristics, and ε_i is an error term. To determine whether the sample should be pooled or split by regions, each explanatory variable was interacted with the region dummy variables, and a Chi Squared-test was undertaken to discover if the explanatory variables are statistically equal across the three regions. The results (available by request) fail to reject the null that the interacted coefficients are jointly equal to zero. Thus the sample is pooled for the empirical model given in [1]. Grouping the error terms by utility (i.e. the firms that owns the power plants) or using the Sandwich estimator of variance does not change the statistical significance of the results. Two estimations are shown in Table 3. The first uses the entire sample and the second restricts the sample to those contract signed before 1988, to ensure exogeneity of the policy shock.

Results

Table 3 provides the results of the probit estimation with the marginal effects reported instead of the estimation coefficients. Two regressions are presented, the first on the full sample, the second on a restricted sample without the contracts that were signed between 1988 and 1990. This was done to ensure the exogeneity of the policy shock of passage of the 1990 CAAA. It may have been that by 1988, three years prior to passage of the amendments, the writing was on the wall and coal mines and generation companies could tell that high sulfur coal was soon to be regulated. The results between the two regressions are indeed remarkably similar. The only coefficient whose significance changes is on the *Rigid Price Adjustment* variable and its increasing significance only adds to the story of the importance of particular variables to the likelihood of renegotiation.

These results are in contrast to our counterfactual policy environment test, presented in Table 4. In this regression only contracts in existence before 1984, which continued past 1987, are used in the analysis. The dependent variable is now equal to one if the contract was renegotiated between 1984 and 1986, and zero otherwise. The years 1984 to 1986 correspond to no changes in the regulation of sulfur dioxide and thus provide a counterfactual policy environment to test our model. In the results presented in Table 4, only one variable has the same sign and significance as the policy shock analysis, the *Allowable Sulfur Content Upper Bound*, and three variables that were not statistically significant in the policy shock analysis suddenly are in the counterfactual analysis.[8] The counterfactual policy environment results are

[8] One of these is the variable *Phase I Plant*. In 1987 there was no such thing as a Phase I plant (it came about from passage of the 1990 CAAA), however, as stated above Phase I plants were generally older and higher emitting plants than average.

quite different than the policy shock results, implying that the policy shock results are reasonably attributable to the 1990 CAAA.

Back to Table 3, in both samples, the *Allowable Sulfur Content Upper Bound* variable is, as predicted, associated with a lower probability of contract renegotiation. However, interaction of the *Allowable Sulfur Content Upper Bound* variable with plants that were part of *Phase I* led to a greater likelihood of contract renegotiation. This implies that Phase I plants whose contracts specified a wide range of allowable sulfur content in the coal are more likely to renegotiate then those that did not. This is an interesting result on the heterogeneous effects of the 1990 CAAA on plant types.[9]

Some of the transaction costs variables drawn from the literature and discussed in the data section have the expected sign, and a few are statistically significant. Larger *Distance Apart* and *Quantity* variables are statistically associated with a higher probability to renegotiate, as predicted by transaction cost theory. These variables lead to more appropriable quasi-rents, which lead to less flexible contracts and the need to renegotiate when a policy shock occurs. Surprisingly, the dedicated asset variables are insignificant across the two samples. One would assume that coal mines and generating plants both have large fixed costs and therefore substantial dedicated assets in their respective businesses, yet the coefficients on these variables are insignificant. It could be that these proxies are not very good,[10] or, it could be that the large fixed costs involved in coal mining and use – both industries with long histories – have by now and for the most part been recovered. There is less that is "dedicated" and more that has already been paid off and sunk.

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[9] The exact same pattern is found when the discrete sulfur variable is used as compared to the continuous one. Results available from the author by request.

[10] Although other authors use similar measures such as Kerkvilet and Shogren (2001).

A more *Rigid Price Adjustment* mechanism is associated with a statistically larger probability to renegotiate only when the 1988-1990 contracts are excluded. It has the correct sign in the full sample, but it is not statistically significant. The *Years Till Expiration* variable is positive and significant across the regressions indicating an increased probability of renegotiation the longer the duration of the contract. This is expected given that the parties would be subject to the new rent distribution for a longer period of time.

Finally, the *Western Coal Mine* variable is negatively and statistically significant implying that contracts with Western coal mines were less likely to be renegotiated compared to those with Appalachian coal mines. Given that the 1990 CAAA increased the value of the coal in the West, as it was low-sulfur, this result implies that the plants had more bargaining power than the mines. At the same time, the *Relative Price* variable is also negative and statistically significant, implying that contracts with high relative prices were also less likely to be renegotiated. This result favors the mine owner. These two results together, on *Western Coal Mine* and *Relative Price*, may be indicating the kind of deal that was struck between plant and mine owners to avoid explicit renegotiation. High quality, low-sulfur coal continued to be delivered, but only where the relative price was high.

In order to further explore the possible validity of this kind of a pact, we decided to look for evidence of it also in the explicitly renegotiated contracts. We did this by empirically exploring how the price of coal changed for those contracts that were renegotiated. This is important as it also speaks to the ultimate rent re-distribution winners and losers from the policy shock.[11]

[11] In current climate change legislation, schemes that involve a cap-and-trade proposal and emissions permits for electric utilities are sometimes seen as acting as a windfall to utility companies. If, however, due to the legislation, the utility companies are having to renegotiate their contracts for fossil fuel inputs, this windfall may actually be

A difference-in-difference hedonic price analysis was undertaken to determine how the price of coal changed after renegotiation.[12] This was done first on all renegotiation delivery data, but it was also done on subsets of the data, including: 1) for plants that contain at least one Phase I boiler, 2) for plants that contain at least one Phase I boiler and the Western (low-sulfur) coal mines, and 3) for plants that contain at least one Phase I boiler and the Interior (high-sulfur) coal mines.

Results of the difference-in-difference hedonic price analysis are given in Table 5. None of the estimations reveal a statistically significant difference-in-difference parameter estimate; however the signs do match expectations. When looking at contracts with Western coal mines, the estimate is positive while the opposite is true for contracts with the Interior coal mines. This pattern follows from the expectations stated above and suggests that the outcome of any renegotiation, whether implicit or explicit, may be some sort of a low-sulfur/high price pact. Further research investigating the strategic bargaining behind these renegotiation deals would be enlightening.

Conclusions

New policy initiatives have the ability to substantially shift rents within an economy, especially with respect to long-term investments. This paper investigates how long-term contracts for coal delivery in the electricity generation industry responded to passage of the 1990 CAAA. The topic is contemporary as many countries are debating policies to reduce greenhouse gas emissions and their resulting impact on the distribution of income. The findings reveal little

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falling to other players in the industry down the line. Such an argument, in fact, is frequently made *by* the utility companies in support of the financial need for initial permit allocations to be free, rather than auctioned off.

[12] For more information about the hedonic price model, see Lange and Bellas (2007).

evidence that either party was "stuck" with the contract previously signed, as those we expect likely to want to renegotiate seem to be able to. Further, many studies speculate that cost savings for Title IV could have been larger if long-term coal contracts were able to adjust to the new regulation. We find that many contracts were flexible enough to be renegotiated so failure to achieve cost-savings potentials can not obviously be blamed on the contracting environment.

The hypothesis tested here is that when an outside shock occurs in the midst of a contracting environment, the more flexible the initial terms of the contract, the lower the probability of contract renegotiation in response to the outside shock. A model is devised which reveals that a contracts' degree of flexibility affects the probability of renegotiation. Empirically, the degree of flexibility is measured with contract price adjustment mechanism, number of years until expiration, quantity contracted, and distance between the parties. A probit model is estimated which finds an association between contracts with a more years till expiration, large quantity, larger total distance apart, and the probability of renegotiation. Plants that were part of Phase I and have a higher allowable sulfur content upper bound are statistically more likely to renegotiate their contract. These results suggest that long-term coal contracts are not a major reason that Phase I has not achieved its full potential cost savings. More thoughtful research should be done investigating why this earlier permit trading scheme was not as cost-effective as it could have been, especially since similar permit trading schemes are actively being considered for use in carbon regulation today. The contracts that are most likely to benefit from renegotiating, Phase I plants with high allowable sulfur content upper bound, are also the ones that are statistically more likely to be renegotiated.

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Figure 1: Coal Contract Renegotiation over Time

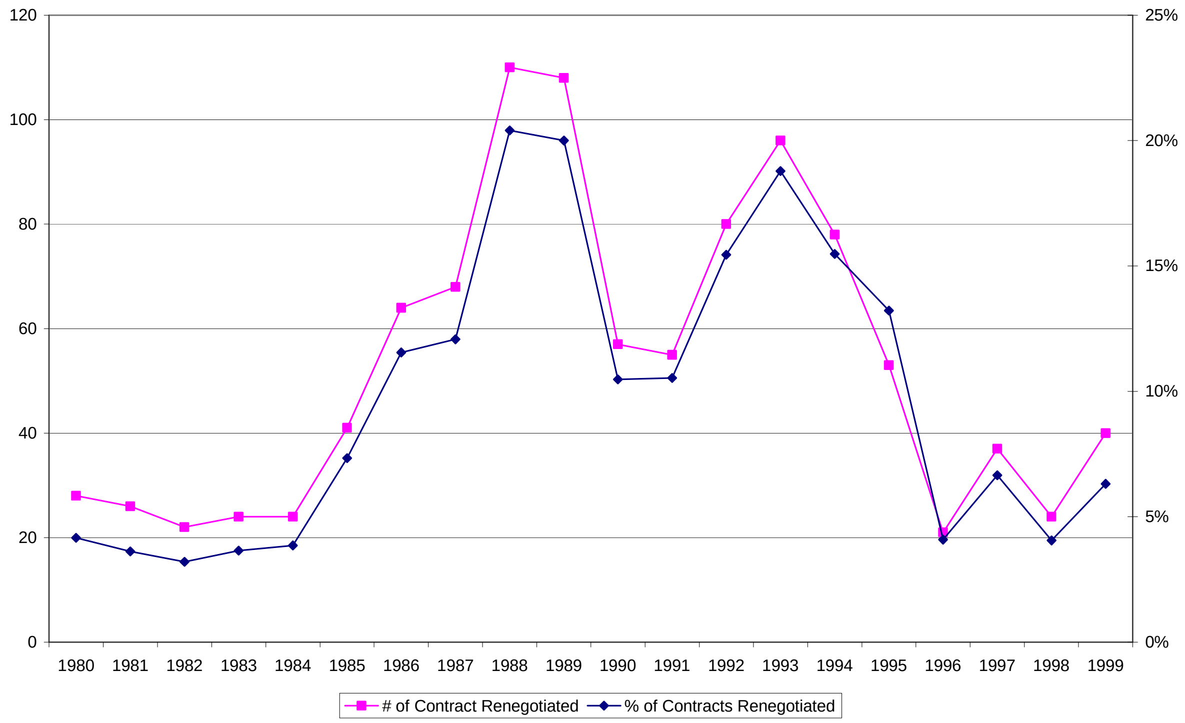

Table 1: Summary Statistics

Variable	Full Sample N=273 Mean	Std. Dev.	Renegotiated Contracts N=99 Mean	Std. Dev.	Unchanged Contracts N=174 Mean	Std. Dev.
Renegotiated Contracts	0.36	0.48				
Duration	21.90	10.67				
Allowable Sulfur Upper Bound	1.39	1.26	1.22	0.97	1.48	1.40
Phase I Plant	0.24	0.43	0.29	0.45	0.20	0.40
Distance Apart (100 Miles)	4.15	4.39	5.25	4.84	3.56	4.20
Plant Dedicated Assets	0.37	0.34	0.35	0.30	0.38	0.36
Mine Dedicated Assets	0.19	0.27	0.16	0.21	0.21	0.30
Quantity (1000 tons)	1.15	1.30	1.41	1.47	1.00	1.20
Minemouth Plant	0.05	0.21	0.02	0.15	0.06	0.24
Rigid Price Adjustment	0.81	0.40	0.87	0.35	0.77	0.47
Relative Price	0.29	1.53	0.17	1.43	0.36	1.57
Years Till Expiration from 1994	7.03	5.92	8.04	6.50	6.45	5.50
88-90 Yr Signed	0.14	0.35	0.16	0.37	0.12	0.34
85-87 Year Signed	0.14	0.34	0.11	0.31	0.15	0.36
Appalachian Coal Mine	0.49	0.50	0.48	0.50	0.50	0.50
Interior Coal Mine	0.18	0.36	0.20	0.40	0.18	0.40
Western Coal Mine	0.31	0.48	0.31	0.46	0.31	0.46

Table 2: Expected Signs

Dependent Variable: Renegotiated 1991-1994 or Not Independent Variable	Expected Sign
Allowable Sulfur Upper Bound	-
Phase I Plant	+
Phase I * Allowable Sulfur	+
Distance Apart (100 Miles)	+
Plant Dedicated Assets	+
Mine Dedicated Assets	+
Minemouth Plant	+
Quantity (1000 tons)	+
Rigid Price Adjustment	+
Relative Price	?
Years Till Expiration	+
88-90 Year Signed	?
85-87 Year Signed	?
Interior Coal Mine	?
Western Coal Mine	?

?= Ambiguous

Table 3: Determinants of Contract Renegotiation

Probit Estimation-Marginal Effects	Full Sample		Contracts Signed Pre-1988	
Dependent Variable: Renegotiated between 1991-1994 or Not				
Variable	Estimate	Std. Error	Estimate	Std. Error
Allowable Sulfur Upper Bound	-0.11***	0.04	-0.11**	0.05
Phase I Plant	-0.07	0.13	0.06	0.16
Phase I * Allowable Sulfur	0.12*	0.07	0.15*	0.08
Distance Apart (100 Miles)	0.03***	0.00	0.03***	0.00
Plant Dedicated Assets	-0.12	0.12	-0.08	0.12
Mine Dedicated Assets	-0.15	0.15	-0.06	0.15
Minemouth Plant	-0.20	0.13	-0.23	0.13
Quantity (1000 tons)	0.05**	0.02	0.05*	0.02
Rigid Price Adjustment	0.11	0.08	0.19**	0.08
Relative Price	-0.03*	0.02	-0.03*	0.02
Years Till Expiration from 1994	0.01**	0.00	0.02**	0.00
88-90 Year Signed	-0.02	0.08		
85-87 Year Signed	-0.06	0.09	-0.06	0.09
Interior Coal Mine	0.09	0.1	0.07	0.1
Western Coal Mine	-0.25**	0.08	-0.25**	0.08
N	273		229	
R-Squared	0.16		0.21	

*, **, *** indicate 10%, 5% and 1% statistical significance

Table 4: Counterfactual Policy Shock Test

Probit Estimation-Marginal Effects	Full Sample	
Dependent Variable: Renegotiated between 1984-1986 or Not		
Variable	Estimate	Std. Error
Allowable Sulfur Upper Bound	-0.06**	0.03
Phase I Plant	0.33***	0.06
Distance Apart (100 Miles)	0.00	0.00
Plant Dedicated Assets	-0.43***	0.13
Mine Dedicated Assets	0.20*	0.11
Minemouth Plant	-0.10	0.14
Rigid Price Adjustment	-0.04	0.07
Quantity (1000 tons)	0.03	0.03
Relative Price	-0.01	0.02
Years Till Expiration from 1986	0.01	0.01
83-84 Year Signed	0.12	0.11
Interior Coal Mine	0.01	0.09
Western Coal Mine	-0.10	0.10
N	281	
R-Squared	0.12	

*, **, *** indicate 10%, 5% and 1% statistical significance

Table 5: Renegotiation Effect on Price

Dependent Variable: Real Price of Coal

Estimation: Hedonic Price Difference-in Difference Model Sample	Difference-in-Difference Parameter Estimate	Std. Error
All Plants (N=3409)	-1.32	1.31
All Phase I Plants (N=2992)	-1.77	1.17
Phase I Plants with Western Mine Contracts (N=348)	3.38	1.99
Phase I Plants with Interior Mine Contracts (N=813)	-2.03	1.28

Other Explanatory Variables: Btu, Sulfur, Ash, & Moisture Content; Total Distance; Contract, Year & Mine District Dummies

Errors Clustered by Utility