Running Title: Contract Duration in Coal Industry

Determinants of Contract Duration: Further Evidence from Coal-Fired Power Plants

Maria Kozhevnikova
Queens College
300A Powdermaker Hall
65-30 Kissena Blvd.,
Flushing, New York 11367
mkozhevn@qc.cuny.edu
Phone: (718) 997-5440
Fax: (718) 997-5466

Ian Lange
Department of Economics
University of Stirling
Stirling UK FK9 4LA
i.a.lange@stir.ac.uk
Phone: +44 (0) 1786 467276
Fax: +44 (0) 1786 467469
Corresponding Author

Abstract
Transactions cost theory predicts that the availability of alternatives is one of the determinants of contract duration. Over the last 20 years, the coal market has seen many regulatory changes that have generally increased the number of alternatives in the process of procuring coal. In this paper data from long-term coal contracts for electricity generation signed before 1999 are used to estimate the effect of increasing alternatives on contract duration. Empirical results tend to match transactions cost theory that increased alternatives reduces contract duration.

KEYWORDS: coal, contract duration, regulation, transaction costs

JEL Classification: K12, L14, L15, L94

The procurement of coal for electricity generation has many characteristics that fit well with the transactions cost theory originated with Coase (1937) and expanded upon by Williamson (1985) and Klein et al. (1978). Plants and mines are fixed in location and may have a degree of asset specificity. Coal attributes are easily measured once mined. Transactions cost theory predicts that contracts are written in a way that allows for the minimization of contracting costs.

One manner in which participants to a contract can minimize these costs is to alter the duration of the contract. This prediction is based on the argument that repeated bargaining between firms is expensive and leaves them open to ex-post capture of quasi-rents or 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.

Joskow (1987) and Kervilet and Shogren (2001) have empirically tested predictions of the transaction cost theory in the context of coal contract duration and generally found that they hold. However, their data precede the large changes in the regulation of the coal market that have resulted in an increase of alternatives available to both plants and mines. In this paper we investigate how this increased flexibility and a wider array of transactions cost variables have affected contract duration. Our results generally match theoretical expectations. Market-based regulation and the opening of spot markets have decreased contract duration, while larger quantities contracted and plants' located at a mine mouth increase the duration.

1. Background

Coal is a product with a number of attributes. The most common attributes of coal transactions for which data are available are quantity, British Thermal Units (BTUs), sulfur, ash, and moisture content.[1] Higher BTUs are a good attribute to have, while higher sulfur, ash, and moisture are not. Coal attributes can vary substantially by region. There are three major U.S. coal basins that U.S. power plants use to meet their demand. The first one is the Western Basin, which includes Wyoming and Montana. The second one is the Interior Basin, which includes Illinois and Indiana. The Appalachian Basin, which includes West Virginia and Pennsylvania, is the third.

Government policy greatly influences a plant's incentive to choose the type of coal burned. Over the last 25 years, there have been three large policy changes that may have had an impact on the contracting decisions of plants. The first one, the Staggers Act of 1980, reformed the regulation of rail transport, which accounts for the largest volume of coal shipments.[2] Prior to 1981, rail firms were unlikely to be allowed to abandon unprofitable lines, enter profitable lines, and alter prices (Keeler, 1983). The Staggers Act largely freed rail firms to alter the lines serviced and set prices. The Staggers Act made it easier for plants and mines located farther apart to transact and increased the options for entities to transact in the coal market.

The second policy change was the Clean Air Act Amendments (CAAA) of 1990. It established market-based incentives for the control of sulfur dioxide through a cap-and-trade permit system. Previously, regulation was a mix of emissions standards,

[1] There are other coal attributes that plants may value (grindability, for example) for which data are not available. However, these are likely to be similar within contract deliveries.

technological mandates, or non-binding state level regulation. One effect of the tradable permit market, in concert with the increased ease of acquiring coal from the Western region, was that plants began experimenting with the sulfur design specifications for their boilers. Many plants started blending different types of coal or switched to different coal types to lower their sulfur dioxide emissions (Ellerman et al., 2000). This innovation lessened the importance of procuring coal that matched the boiler specifications, lowering asset specificity.

Restructuring of electricity markets was the third policy change that may be relevant for contracting decisions. Access to transmission systems in the Northeast and parts of the Midwest was altered in the late 1990s; plants were required to bid for the right to sell electricity into a transmission system. Plants operating elsewhere in the U.S. and those in restructured states previous to the late 1990s were expected to meet the electricity demand of a given area in exchange for assurance that the state public utility commission would compensate the plant under a rate-of-return or similar type pricing system.

Contracts have been investigated in empirical studies that deal with the energy commodities, such as coal (Joskow 1985, 1987, 1988, 1990) and natural gas (Crocker and Masten 1988, 1991 and Neumann and von Hirschhausen 2008). The Energy Information Administration (EIA), and the coal contract papers discussed below, define a contract as an agreement of one year or longer, while a spot market transaction is for an agreement that is less than one year in duration. Joskow (1985) provides a detailed overview of contracts in the coal industry, noting that they usually rely on long-term contracts that are incomplete but quite complex. Such contracts contain both price and non-price provisions

[2] A detailed history of railroad regulation can be found in Keeler (1983).

that serve to prevent both parties from breach. Joskow (1988 and 1990) uses the fall in coal prices in the mid-1980s to conclude that mines and plants preferred abiding by the contractual obligations to renegotiation, breach of contract, or costly litigation.

Contract duration in the coal industry has been discussed in Joskow (1987) and Kervilet and Shogren (2001). Joskow looks at contract duration for a sample of 277 coal contracts negotiated before 1979. He finds that contracts for plants likely to have high transaction-specific investments (plants located at the mine's 'mouth') and with coal regions with less spot market activity (a substitute for the contract market) have longer contracts. It is argued that there exist systematic differences between coal producing regions, resulting in less spot market activity for the Western region than the Appalachian region. Kerkvilet and Shogren (2001) study a larger set of transactions cost variables for 89 coal contracts signed between 1972 and 1984 for the Powder River Basin in Wyoming. Their transactions cost variables include previous relationship and the ratio of contracts quantity to total quantity supplied/demanded. Their results indicate that a history of previous relationship shortens the duration of contract while evidence of transaction specific investments increase with contract duration.

While the analysis put forward here is similar to Joskow (1987) and Kerkvilet and Shogren (2001), there are a number of differences. First, the data that are used span all three coal regions for a longer time period (contracts signed before 1999). Second, the price adjustment mechanism used in the contract is controlled for using an instrumental variable estimation due to the simultaneity of the price adjustment mechanism and the duration decision. Finally, these papers use data no more recent than the early 1980s, and there have been significant changes in the structure of the coal market since then.

Largely due to regulatory reform in railroad and environmental policy, plants have greater flexibility in dealing with mines compared to the past. Rail rates for the transportation of coal have fallen (Dennis, 1999). Plants undertook investments to become more flexible in the coal attributes that can be burned in their boiler (Ellerman et al., 2000). The systematic difference in coal regions discussed by Joskow (1987) changed in the 1990s, as can be seen in Figure 1. It graphs the ratio of spot to contract quantities transacted by year. Western region spot-to-contract ratios have been above 10% for the entire 1990s, and occasionally above 20%. In combination, these facts suggest that there should exist more alternatives for mines and plants in the 1990s as the systematic difference between coal regions was reduced.

2. Data

The data were obtained from the Coal Transportation Rate Database (CTRB), which is maintained by the EIA. The CTRB is a survey of investor-owned, interstate electric utilities with steam-electric generating stations of more than 50 Megawatts. The dataset can be thought of as two separate data sources merged. The first set of information is on the contracts, and the second set contains information on deliveries for each contract. The dataset contains information on coal transactions for the years 1979-1999, regardless of when the contract was signed. Information included are the cost, quality, and origin of coal purchases as well as the lower and upper bounds for a number of coal attributes. There are 1914 contracts in our dataset. Summary statistics for the data can be found in Table 1.

The dependent variable -- contract duration -- is defined as the year of contract

expiration minus the year when the contract was signed. The rest of the variables fall into two categories: transactions cost variables and regulation variables. The price adjustment mechanism in the contract is converted to an ordinal variable where a higher number implies a less complete contract. We observe the following pricing provisions in contracts for coal: base price plus escalation, price renegotiation, price tied to market, cost-plus contract with a fixed fee provision, cost-plus contract with an incentive fee, and fixed-price contract.[3] We rank these six provisions by their completeness, creating an ordinal variable from one to four with one being the most and four the least complete. In this we follow the approach by Crocker and Reynolds (1993). They use the price adjustment mechanism as a basis for classifying the contracts according to their completeness in engine procurement.

Table 2 provides a detailed description of the categories and shows the ranking. We consider a contract complete if it provides *ex ante* a price for every possible state of the world that can occur after the contract goes into effect. By this definition, a fixed-price contract is the most complete, since it provides a single price for any state of the world. It is given a ranking of one. A base-price-plus-escalation contract is the second most complete and is given a ranking of two. Such a contract has a price that varies up or down as economic conditions change. The nature of escalation is usually described in a contract as a function of some economic indices: e.g., changes in labor costs. The majority of contracts in our data are of the base-price-plus-escalation type.

Next are the cost-plus contracts, which are given a rank of three. Cost-plus contracts with a fixed fee provision and cost-plus contracts with an incentive fee are

[3] The data also list an 'Other' category, which is dropped here. The other category was listed for less than 1% of the data.

pooled. Both of these contracts promise to pay all suppliers' costs. The cost-plus contract with the incentive fee should give the supplier an incentive to curb his costs; however both the fixed fee and the incentive fee arrangement are presumably determined before the contract goes into effect. The price-tied-to-market contracts seem the most difficult to place. We rank it a three with the cost-plus contracts because they will both depend on the relevant economic conditions in similar ways. All of these contract categories have prices that change as market conditions emerge. The fourth, and highest rank, is the price renegotiation at specified intervals.

The other transactions cost variables include plant location relative to the mine (whether a plant is located next to the mine, 'mine mouth'). A mine mouth plant dummy variable is created, which equals one if the plant is located at the mine mouth and is zero otherwise. Distance is the average distance that the coal travels in a delivery from mine to plant. A history of interaction variable was created to indicate whether a plant and a mine had written a contract previously. It takes the value of one if the plant and mine had previously entered into a contract; otherwise it is zero.[4]

Two variables are created to proxy for the dedicated assets of the plant and mine, following Kerkvilet and Shogren (2001). A plant's dedicated assets are defined as the ratio of an individual contract quantity to the sum of the plant's contract quantity. Similarly, a mine's dedicated assets is the ratio of an individual contract quantity to the sum of the mine's contract quantity. A dummy variable indicating whether the plant has the option to take deliveries via a form of transportation other than rail is created. This multiple delivery option dummy is set to one if the mode of transportation for the route

[4] Unfortunately, the data do not contain a mine identification code; consequently, a county of coal origin code is used as a substitute

into the plant is something other than rail for any delivery to that plant (regardless of how a given delivery is otherwise transported); otherwise it is zero. A measure of spot market use is developed by calculating the ratio of spot to contract quantity ratio for each region (from Figure 1). This ratio is then matched to the contract vintage and to the region in which the mine is located.

Three regulatory dummy variables are constructed to control for the railroad reform of the Staggers Act, the 1990 CAAA, and the electricity market restructuring in certain states. The railroad regulatory reform dummy has the value of one for all contracts signed in 1981 or after, it is zero otherwise. A dummy variable is created surrounding the passage of the 1990 CAAA, which takes the value of one for contracts signed in 1991 or after; it is zero otherwise. The electricity market restructuring dummy has the value of one for contracts signed at least one year after restructuring legislation passed in states according to the EIA (2003); it is zero otherwise.

The uncertainty in the contracting environment is important for the choice of contract duration. Figure 2 shows the average spot and contract coal prices and the spot price of West Texas Intermediate petroleum from 1979-1999. Coal prices are stable (relative to petroleum) due to the consumption being almost entirely domestic (about 97%); the demonstrated reserve base is 4000 times yearly consumption; and electricity generation accounts for 91% of the coal mined in the U.S. (EIA, 1997, 2006).[5] There is relatively little uncertainty in coal prices over the sample period, and the decline in coal prices corresponds to the regulatory reform in the rail industry, as discussed above, and increased economies of scale at mines (EIA, 1999). As a result we do not create a

[5] The coefficient of variation for contract coal, spot coal, and spot petroleum prices are 0.106, 0.105, and 0.311 respectively. Bachmeier and Griffin (2006) confirm that these markets are not integrated.

variable to control explicitly for uncertainty in the contracting environment.

3. Estimation

3.1 Model

Using the transaction cost theory we estimate the following model:

$$D_i = \alpha + \beta_1 \bar{C}_i + \beta_2 Z_i + \beta_3 T_i + \varepsilon_i \quad , \qquad [1]$$

where (D_i) stands for contract duration, ($\bar{C}_i$) reflects the predicted price adjustment mechanism, estimated with instrumental variables as discussed below, (Z_i) reflects regulation variables, and (T_i) represents transaction-cost variables. 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. Results given in Table 3 reveal that the coefficients are jointly statistically significantly different than zero; thus we run our model separately for the three regions. We estimate the above model in levels, in natural logs, and correcting for the potential truncation of contract duration at one year given the EIA's definitions with a Tobit model. Results from the levels estimation are shown and discussed here.[6] The simultaneity of the contract completeness and duration decision in writing a contract calls for the use of instrumental variables to identify contract completeness in our analysis.[7]

[6] Results from the other specifications are available from the authors by request; they generally match the sign and significance of the results reported.

[7] Results from a Durbin-Wu-Hausman test confirm that completeness is endogenous in our estimation; they are available from the authors by request.

3.2 Instrumenting for Completeness

Contract completeness and contract duration are thought to be chosen simultaneously, thus the completeness variable is endogenous in the duration equation (Crocker and Matsen, 1991). The argument is that there are multiple methods to reduce contracting costs, including a more complete contract or reducing the duration of a contract. To control for this potential bias, instruments for the completeness are devised following Saussier (2000) (similar to the discussion in Crocker and Reynolds (1993)). Here it is argued that the marginal benefit of a more complete contract increases with the appropriable quasi-rent at stake in a transaction. In the case of coal, we posit that the amount of quasi-rents at stake is determined by the ability to alter the attributes (quality) of the coal delivered in the contract.

We calculate allowable attribute z-scores for BTU, sulfur, moisture, and ash content of the coal to approximate the likelihood that a mine is able to alter the attributes of the coal it promised to deliver. Each contract lists an allowable level for each attribute. Using data from the Federal Energy Regulatory Commission (FERC) Form 423 on coal supplied from 1972-1999, we calculated the mean and standard deviation of each attribute for each Bureau of Mines coal producing district.[8] Then the allowable level specified in the contract was used to calculate a z-score ((allowable level – mean)/standard deviation). As the z-score increases, there is a larger probability that coal

[8] Since the FERC 423 does not collect information on moisture content, means and standard deviations are taken from the CTRB coal transactions by Bureau of the Mines coal-producing district.

acceptable to the contract specifications is in the coal district.[9] This larger probability allows for more *ex-post* rent-seeking behavior. To counter this, it is expected that more complete contracts will be written when a high z-score attribute is specified (i.e., a negative coefficient) (Goldberg, 1985).

3.3 Expected Signs

Our expectations of the effects of the independent variables are summarized in Table 4. The completeness of the contract has an ambiguous affect on contract duration. A less complete contract may signal trust between the plant and mine, which would lead to a longer contract as a means of minimizing transactions cost. On the other hand, a more complete contract may signal transaction-specific investment, which would lead to a longer contract to protect against *ex-post* rent seeking.

Railroad reform has increased the number of options available for both the plants and the mines. We expect that with a larger number of potential buyers/suppliers, contract duration would decrease.

Sulfur reform reduced plants' asset specificities by allowing them to burn coal with different attributes than were originally designed for the boiler. It is expected that this reduction in asset specificity will lead to a reduction in contract duration.

Electricity reform removes the requirement that a plant meet the demand of a specific population. This provides the plant with more output options (the option to not produce electricity), and this increased flexibility would imply a shorter contract. On the other hand, the higher output (electricity) price uncertanty may encourage the plant to

[9] Public data on a mine's coal reserves attributes are scarce; in their place past coal attributes are used under the assumption that past attributes are good predictors of future attributes.

sign a longer contract to ensure quantity certanty. Therefore, the effect of electricity reform on contract duration, is ambiguous.

The history of interaction variable measures the extent to which the mine and the plant are familiar with each other. We expect that a history of previous interaction to be ambiguous with respect to duration, as the two parties can rely on reputation in their transactions to increase or decrease duration. Minimum quantity may indicate the amount of relationship-specific investments between a plant and a mine. We expect higher minimum quantities to be associated with longer contracts. The ratio of a mine's (plant's) contract coal quantity under a given contract relative to all contracts may indicate the amount of dedicated investment between the mine and plant. The larger is the level of investment, the greater are the costs that the mine/plant will face from the failure to execute the contract. We expect that the coefficient on mine and plant contract ratio variables will be positive. A similar argument follows for mine mouth plants: We expect these plants to have longer contracts with the mines. Distance traveled may indicate the likelihood that a plant and a mine have some relationship-specific assets. Therefore, longer distances would be associated with shorter contracts. Multiple delivery options for the plant are expected to decrease contract duration as more delivery alternatives are available.

4. Results

The results are given in Table 5. The estimates of the instruments for contract completeness, the coal attribute z-scores, for each region are given below the dashed line. The results for all regions show that at least one of the instruments is statistically

significant and of the correct sign. Moisture content is statistically significant in all regressions, but it has the sign opposite to what was expected in two of them.

The regression results in Table 5 are generally consistent with the transactions cost theory. Contract completeness does not appear to be statistically significant for the duration of the contract in any of the regions once we control for endogeneity. In the Appalachian region, a previous relationship leads to a statistically significant reduction in duration of about 9 months. However, this effect is not found in the Interior or Western region. The ability to have coal delivered by multiple transportation forms does not statistically alter the duration, implying that this does not alter the availability of supply.

Deregulating electricity markets is not statistically associated with contract duration. It is interesting to note that deregulated electricity markets are statistically associated with more complete contracts (not shown in Table 5). This empirical observation presents an avenue for potential future research. Larger quantity contracts and contracts for mine mouth plants, both of which imply a higher level of asset specificity, are statistically associated with longer contracts in all regions.

Railroad reform (through the Staggers Act), which increased the availability of alternatives through decreased costs of transportation, had a negative and a significant effect on the duration of contracts across all regions. Sulfur reform (through the passage of the 1990 CAAA), which reduced plants' asset specificities, statistically decreased the duration of contracts in the Appalachian region only. A higher spot market ratio statistically significantly decreases duration in the Appalachian and Western regions:

about 3 months for every one percentage point increase.[10]

5. Conclusions

Previous analyses of the coal contracts duration have used data prior to regulatory reforms in rail, environmental, and electricity policy. Transactions cost theory predicts that these reforms, which increased the availability of alternative suppliers, would reduce the duration of contracts as the threat of ex-post opportunistic behavior or the 'hold up' problem is reduced. An empirical analysis of coal contract duration using contracts signed before 1999 is performed here. The effect of the completeness of the contract, as measured by the form of the price adjustment mechanism, on the duration are estimated using instrumental variables due to the simultaneity of the choice of the two. Results confirm that market-based regulation and the availability of alternatives suppliers through the opening of spot markets have decreased contract duration considerably. Larger quantities contracted and plants located at a mine mouth are also predicted to increase contract duration.

Acknowledgements

Part of this work was done while Dr. Lange was at the U.S. Environmental Protection Agency (EPA). The opinions expressed in this paper are those of the authors and do not necessarily reflect that of the U.S. EPA. We are thankful to the editor, two anonymous referees, Kisa Watanabe, Evren Damar, Arif Mamun, Judy Boggess, Sumeet Gulati, Charles Griffiths, and seminar participants at the University of British Columbia

[10] To better compare with the results in Joskow (1987), we also use a post-1990 dummy to proxy for the increased spot market activity. It reveals a pattern of decreasing contract duration in the 1990s relative to

Food & Resource Economics Department & University of Washington Economics Department for insightful comments.

the 1980s, with the largest decrease in the Western region. This pattern is consistent with the results in Joskow (1987) and predictions of transaction cost theory.

REFERENCES

Bachmeier, L. & Griffin, J. (2006). Testing for Market Integration: Crude Oil, Coal, and Natural Gas. The Energy Journal, 27(2), 55-71.

Coase, R. (1937). The Nature of the Firm. Economica, 4(16), 386-405.

Crocker, K. & Masten, S. (1988). Mitigating Contractual Hazards: Unilateral Options and Contract Length. RAND Journal of Economics, 19(3), 327-343.

Crocker, K. & Masten, S. (1991). Pretia ex Machina? Prices and Process in Long-Term Contracts. Journal of Law and Economics, 34(1), 69-99.

Crocker, K. & Reynolds, K. (1993). The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement. RAND Journal of Economics, 24(1), 126-146.

Dennis, S. (1999). Using Spatial Equilibrium Models to Analyze Transportation Rates: an Application to Steam Coal in the United States. Transportation Research Part E, 35(3), 145-154.

Ellerman A. D., Joskow P., Schmalensee R., Montero, J.P, & Bailey, E. (2000). Markets for Clean Air: The U.S. Acid Rain Program. (New York, New York: Cambridge University Press)

Goldberg, V. (1985). Price Adjustment in Long-Term Contracts. Wisconsin Law Review, 527-543

International Energy Agency. (Various Years). West Texas Intermediate Crude Oil Prices.

Joskow, P. (1985). Vertical Integration and Long-Term Contracts: The Case of Coal-Burning Electric Generating Plants. Journal of Law, Economics, & Organization, 1(1), 33-80.

Joskow, P. (1987). Contract Duration and Relationship Specific Investments: Empirical Evidence from Coal Markets. American Economic Review, 77(1), 168-185.

Joskow, P. (1988). Price Adjustment in Long-Term Contracts: The Case of Coal. Journal of Law & Economics. 31(1), 47-83.

Joskow, P. (1990). The Performance of Long-Term Contracts: Further Evidence from Coal Markets. RAND Journal of Economics, 21(2), 251-274.

Keeler, T. (1983). Railroads, Freight, and Public Policy. (Washington, D.C.: The Brookings Institution)

Kerkvilet, J. & Shogren, J. (2001). The Determinants of Coal Contract Duration for the Powder River Basin. Journal of Institutional and Theoretical Economics, 157, 608-622.

Klein, B., Crawford, R. & Alchian, A. (1978). Vertical Integration, Appropriable Rents, and the Competitive Contracting Process. Journal of Law and Economics, 21(2), 297-326

Neumann, A. & von Hirschhausen, C. (2008). Long Term Contracts and Asset Specificity Revisited - An Empirical Analysis of Producer-Importer Relations in the Natural Gas Industry. Review of Industrial Organization, 32(2), 131-143.

Saussier, S. (2000). Transaction Costs and Contractual Incompleteness: the Case of Electricite de France. Journal of Economic Behavior & Organization, 42(2), 189-206.

U.S. Energy Information Administration. (2003). Status of State Electric Industry Restructuring Activity.

U.S. Energy Information Administration. (1999). The U.S. Coal Industry in the 1990s: Low Prices and Record Production.

U.S. Energy Information Administration. (2006). Electric Power Annual Coal Report.

U.S. Energy Information Administration. (Various Years). Coal Transportation Rate Database.

U.S. Federal Energy Regulatory Commission. (Various Years). Form 423: Monthly Report of Cost and Quality of Fuels for Electric Plants

Williamson, O. (1985). The Economic Institutions of Capitalism. (New York, New York: The Free Press)

Table 1: Summary Statistics

Variable	Mean	Std. Dev.
Duration (years)	4.40	7.09
Contract Completeness	1.89	0.73
Railroad Reform Dummy	0.60	0.48
Sulfur Reform	0.32	0.46
Electricity Reform Dummy	0.09	0.28
Previous Interaction	0.51	0.49
Plant Dedicated Assets	0.23	0.28
Mine Dedicated Assets	0.14	0.25
Distance Apart (1000 Miles)	0.42	0.58
Minemouth Dummy	0.01	0.09
Appalachian Coal Mine	0.62	0.48
Interior Coal Mine	0.17	0.37
Western Coal Mine	0.20	0.40
Spot Ratio	0.19	0.10
Ash (z-score)	-0.56	1.50
Sulfur (z-score)	-0.24	1.35
Moisture (z-score)	0.12	1.18
Btu (z-score)	0.10	0.67
Quantity (1000 tons)	0.55	2.02

Table 2: Contract Completeness Descriptions

Question 3 (m) Contract Type Descriptions[11]:

Ordinal Designation	Description
1, Most Complete	Fixed-Price Contract . Price is fixed over the life of the contract.
2	Base Price Plus Escalation. Different components of the price escalate (or de-escal as a function of changing economic conditions (indices).
3	Price Tied to Market. Price tied to the price of coal being sold in a particular mark Product and market area are defined in the contract. Contract may contain a "Most Favored Nations" clause; i.e., supplier will not sell to any utility at a price lower th yours is paying.
3	Cost-Plus Contract with a Fixed Fee Provision. Purchaser agrees to pay all produc costs plus a management fee. Some contracts provide for payment of both a management fee and a profit. This contract has a Fixed Fee provision.
3	Cost-Plus Contract with an Incentive Fee. Provision Purchaser agrees to pay all producer's costs plus a management fee. Some contracts provide for payment of bo management fee and a profit. This contract has an Incentive Fee provision; i.e., a variable fee that is tied to various productivity and cost reduction incentives.
4, Least Complete	Price Renegotiation. The price is renegotiated at predetermined intervals, usually o year. This type of contract, frequently known as an EVERGREEN CONTRACT, n also contain provisions for price adjustments between renegotiations.

[11]Obtained from the FERC website http://www.ferc.gov/docs-filing/hard-filing/form-580/blank-form.pdf

Table 3: Pooled vs Split Sample Test

Chi-squared Test			
Appalachian Variables=Interior Variables			
Chi-Sq	17.26	P-Value	0.07
Appalachian Variables=West Variables			
Chi-Sq	71.97	P-Value	0.00
Interior Variables=Western Variables			
Chi-Sq	2.66	P-Value	0.04

Variables: Railroad Reform, Electricity Reform, Multiple Delivery Options, Previous Relationship, Plant and Mine Dedicated Assets, Total Distance, Spot Ratio, Minemouth Plant

Table 4: Expected Signs

Variable	Expected Sign
Regulation	
Railroad Reform	-
Sulfur Reform	-
Electricity Reform	?
Transaction Costs	
Contract Completeness	?
Previous Relationship	?
Plant Dedicated Assets	+
Mine Dedicated Assets	+
Multiple Delivery Options	-
Total Distance	-
Minemouth Plant	+
Spot Ratio	-
Product Characteristics	
Z-Ash	ID
Z-Sulfur	ID
Z-Moisture	ID
Z-Btu	ID
Quantity	+

ID indicates variables that are used to instrument for contract completeness

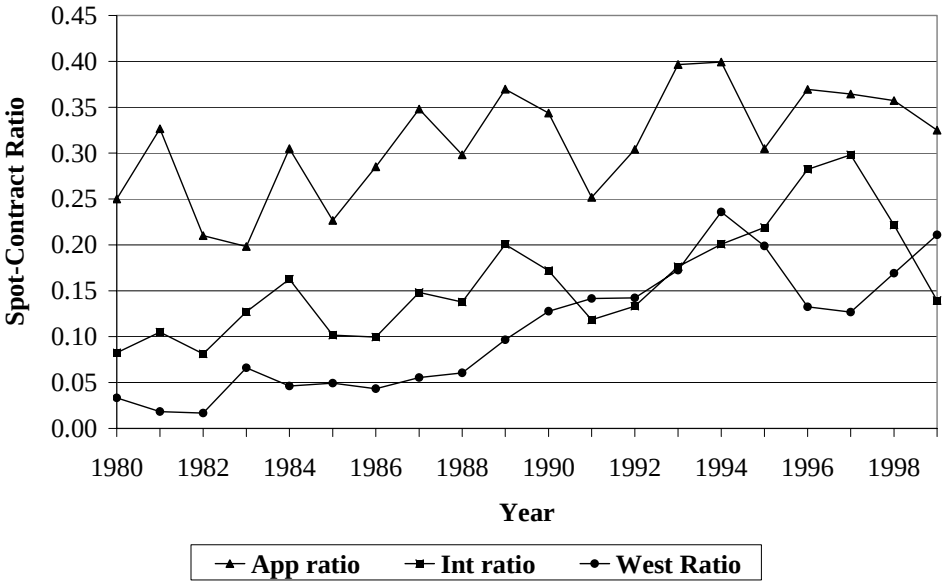
Table 5: Duration Regression Results

Column	1	2	3
Sample	Appalachian	Interior	West
Predicted Completeness	-0.10	-4.79	5.32
	(2.26)	(5.90)	(5.81)
Railroad Reform	-3.22***	-4.77***	-6.15***
	(0.63)	(1.70)	(2.15)
Sulfur Reform	-1.48**	-0.38	0.37
	(0.49)	(2.80)	(1.07)
Electricity Reform	-0.93	-2.12	-1.17
	(1.16)	(2.30)	(1.50)
Multiple Delivery	-0.61	0.98	1.18
Options	(0.63)	(1.25)	(1.16)
Previous Relationship	-0.61*	-0.11	1.25
	(0.38)	(1.14)	(1.10)
Quantity	5.70***	4.90***	1.94***
	(0.72)	(1.12)	(0.68)
Spot Ratio	-0.07	-0.30**	-0.30**
	(0.04)	(0.15)	(0.15)
Plant Dedicated Assets	-2.08**	2.17	0.03
	(0.80)	(1.64)	(2.53)
Mine Dedicated Assets	0.19	-0.53	-0.53
	(0.94)	(1.27)	(1.86)
Total Distance	-0.09	0.05	-0.03
	(0.08)	(0.10)	(0.09)
Minemouth Plant	8.48*	18.43***	15.57*
	(4.59)	(3.32)	(8.24)
Z-Btu	0.02	-0.03	-0.10*
	(0.04)	(0.05)	(0.06)
Z-Ash	-0.05**	-0.01	-0.02
	(0.02)	(0.04)	(0.02)
Z-Moisture	0.07**	-0.10*	0.06*
	(0.02)	(0.05)	(0.03)
Z-Sulfur	-0.07**	0.02	-0.03
	(0.02)	(0.03)	(0.02)
Observations	1207	339	368
R-squared	0.35	0.22	0.52

Standard Errors Clustered on Utility-Mine Pair in Parentheses

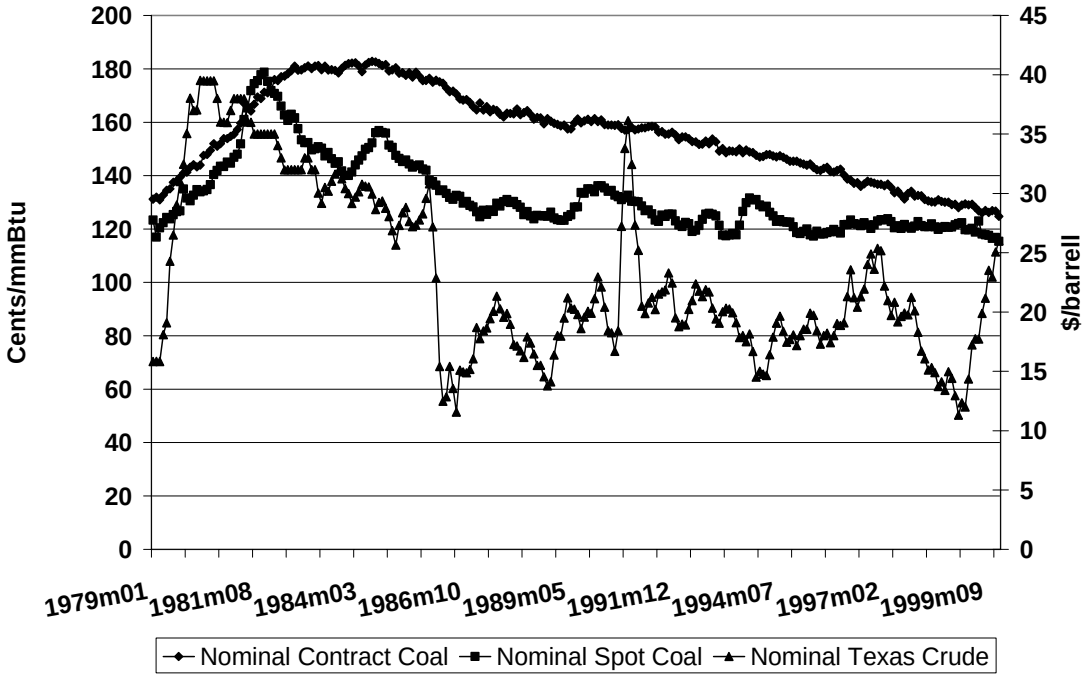
*, **, *** indicates 10%, 5%, and 1% significance respectively

Figure 1: Spot-Contract Quantity Ratios over Time



Source FERC 423

Figure 2: Average Nominal Monthly Prices



Source: FERC 423 and IEA