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Long-term contracts in resource goods trade: Three essays

Tang, Chuanlong, Ph.D.

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LONG-TERM CONTRACTS IN RESOURCE GOODS TRADE:
THREE ESSAYS

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF
THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

ECONOMICS

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BY

CHUANLONG TANG

Dissertation Committee

Sumner J. La Croix, Chairman
David C.H. Yang
Marcellus S. Snow
James P. Dorian
Gerard Russo

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ABSTRACT

Much of the trade in resource goods takes place within a framework of long-term contracts. There are many studies on long-term contracts in the U.S. energy industry. The main purpose of this study is to provide analyses of long-term contracts in the international resources trade. The sample of long-term contracts examined in this study consists of selected overseas coking coal procurement contracts negotiated by Japanese importers. This study is composed of three essays.

In the first essay, we specify the determinants of price in a long-term contract and use an econometric model to investigate the effect of transaction-specific capital and market structure on contract price. The key finding is that both buyer concentration and transaction-specific capital have a significant impact on coking coal prices. Japanese steel firms also paid a price premium for contracts with larger dedicated quantities and longer duration. In contrast to previous studies, the empirical analysis shows that coking coal prices are significantly affected by major coal quality properties.

The second essay examines in more detail the structure of long-term contracts and the price adjustment process. We find that there has been quite a strong move since the mid-1980s towards shorter term deals and that long-term contracts have

become simply a means of structuring renegotiations over the terms of trade. The empirical analysis shows that the import prices paid by Japanese firms for coking coal were more stable than the domestic coking coal prices in its supplier countries.

The third essay presents a model to explore a downstream firm's problem of procurement contract choice, i.e., procuring an input by itself or through trading companies. The model proposes that while the downstream firm is more effective in monitoring activity, the trading company is more effective in input searching activity - the trade-off between these two effects determining the downstream firm's choice of contracts. Comparative results of the model are presented and are applied to explain the presence of Japanese trading companies in Japan's overseas resource goods procurement.

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Chapter 1. INTRODUCTION

1.1 Background

Much of the trade in resource goods takes place within a framework of long-term contracts. The benefits of using long-term contracts are multi-fold. First, a long-term contract that specifies the terms and conditions for some set of future transactions *ex ante*, provides a vehicle for guarding against *ex post* opportunism incentives when relationship-specific investments are important. Second, when a market is characterized by small-numbers bargaining, trade organized through spot exchange is prone to frequent and costly renegotiation. Third, if asymmetries of information arise during the course of the relationship, letting the parties negotiate as they go along may lead to *ex post* bargaining inefficiencies, which can be avoided by a long-term contract.

The importance of a long-term contract when there are relationship-specific investments can be seen from the following example. Let U and D be the upstream firm (seller) and downstream firm (buyer), respectively. Suppose that in order to realize benefits, D must make an investment d which is specific to U and U supplies an input u at costs of $c(u)$ to D . Consider a two-period model where the investment is made

at date 0, while the input is supplied and the benefits, $b(d,u)$, are received at date 1.

If there is no long-term contract between U and D reached at date 0 and neither party has alternative trading partners at date 1, then there is, given D 's sunk investment cost d , a surplus of $b(d,u) - c(u)$ to be divided up. Following the Nash bargaining solution, the input price p will satisfy $b(d,u) - p = p - c(u)$. This solution is inefficient and will lead to underinvestment because D will choose d to maximize its net payoff

$$b(d,u) - p - d = [b(d,u) - c(u)]/2 - d \quad (1.1)$$

The efficient outcome is where d is chosen to maximize total surplus $b(d,u) - c(u) - d$. Inefficiency arises because the downstream firm does not receive the full return from its investment - some of this return is appropriated by the upstream firm in the date 1 bargaining, and this distorts the downstream firm's choice.

If there is a long-term contract reached at date 0 specifying the input price p^* , D will maximize $b(d,u) - p^* - d$, and efficiency can be achieved. Therefore, long-term contracts can promote efficiency by securing the distribution of the surplus in advance.

A growing body of literature has provided a theoretical and empirical analysis of long-term contracts in U.S. resource goods market, where long-term contracts have been widely used.

This analysis of long-term contracts has, however, rarely been extended to international trade in resource goods. The main purpose of this study is to fill this gap by providing an analysis of Japan's overseas coking coal procurement contracts.

1.2 Theoretical Research on Long-Term Contracts: A Selected Literature Survey

Theoretical research on contracts has progressed along several different lines, each with its particular interests (Hart and Holmstrom, 1987). One line of research has focused on the relationship between long-term contracts and the internal organization of the firm. The exploration of long-term contracts in labor market is another prominent line of research. Other areas of research include contract theoretical and empirical studies in financial markets. While the works on labor market and financial market are fruitful and can shed light on the study of long-term contracts on resource goods trade, a review of these related literature is, however, beyond the scope of this study. As a result, the literature reviewed in this section focuses on the following two issues: first, the comparative advantages of long-term contracts and firms; second, the cause and effects of incomplete contracting on the form of organization.

Wiggins (1990) examines explicitly the comparative advantage of long-term contracts and firms. Long-term contracts in Wiggins' analysis are defined as arrangements where parties (upstream stage firm and downstream stage firm) prespecify a nonlinear (transfer) pricing schedule before investment in specific assets. One firm is then designated to set output, and each manager is compensated out of the residual earnings of the portion of production they manage. Under an integrated firm allocation, one of these stages is owned by the other, and the manager of the "owned" stage is then compensated through a fixed wage.

According to Wiggins's model, the comparative advantage of long-term contracts and firm is as follows. Contract leads to efficient managerial effort in both stages, and efficient adjustment to either cost or revenue uncertainty. However, when there is both cost and revenue uncertainty, contracting results in inefficiency and fails. Integrated firm allocation generates efficient adjustment to both cost and revenue uncertainty. The disadvantage of firms, however, is that the manager who is paid a fixed wage will shirk.

The fact that the central difference between long-term contracts and firms is how the managers are compensated in Wiggins' model overwhelms other important differences between these institutions, and probably reduces the soundness of his conclusions. Another major unanswered question in Wiggins'

analysis is that financial resources of the purchaser in the case of vertical integration are ignored.

Hart and Holmstrom (1987) analyzed the economic significance of incomplete contracts. The existence of incomplete contracts is the consequence of transaction costs. Because of the presence of such costs, parties to a relationship will not write a contract that anticipates all the events that may occur and the various actions that are appropriate in these events. Rather they will write an incomplete contract, in the sense that it contains gaps or missing provisions. This is because some events may have been unanticipated by the parties, or they may have been anticipated, but the parties may have been unable to provide for them in advance in a clear and enforceable manner. In other words, the incompleteness arises because states of the world, quality, and actions are observable to the contractual parties, but are too complicated to be specified in a contract. This has proved to be important in the determination of economic organization.

Grossman and Hart (1986) examined the costs and benefits of ownership. They divided contractual rights into two types: specific rights and residual rights. They contended that contracting is almost always costly and incomplete. When it is costly to enumerate all specific rights over assets in the contract, it may be optimal to let one party purchase all residual rights except those specifically mentioned in the

contract. Ownership is the purchase of these residual rights of control. Vertical integration is the purchase of the assets of a supplier (or of a purchaser) for the purpose of acquiring residual rights of control. However, when residual rights are purchased by one party, they are lost by a second party. Their model showed that firm 1 purchases firm 2 only when firm 1's control increases the productivity of its management more than the loss of control decreases the productivity of firm 2's management.

While Grossman and Hart's view on incomplete contracts and residual rights of control provides a useful organizing framework for thinking about the comparative advantage of firm and contracts, it was based on some ambiguous assumptions and leaves some questions unanswered. A key assumption of their approach is that integration (the residual right to control assets) alters neither equilibrium information flows nor auditing capabilities. This position stands in contrast to Williamson (1975, p29-30), who argued that internal audits would be less formal and likely to yield better information. Grossman and Hart also ignored the question of financial resources in integration.

Grossman and Hart have focused exclusively on bilateral trading relations where a single supplier produce an input for use by a single buyer. Bolton and Whinston (1993) extend their analysis of transaction cost models of vertical integration to multilateral settings. Bolton and Whinston

argued that supply and purchasing relationships in reality are almost always multilateral; for example, a manufacturer supplies inputs to a number of firms or a retailer handles numerous manufacturers' products. Their main focus is on supply assurance concerns which arise when several downstream firms are competing for inputs in limited supply. Their model shows that the presence of a multilateral supply setting has important implications for the effect and welfare properties of various ownership structures. Transaction costs savings are often a two-edged sword, with the alleviation of supply assurance concerns for merging parties often exacerbating supply assurance concerns for other downstream firms and leading to a form of market foreclosure.

Masten (1984) applied the theory of transaction costs to analyze the organization of production. A producer, having selected an end-product line, must decide which intermediate products he will make within the organization and which he will delegate to outside suppliers (sometimes referred to as a make-or-buy decision). He asserted that this decision is closely related to the transaction costs associated with specific investments although it also involves a large number of other considerations. The more idiosyncratic are the investments associated with a particular transaction, the greater are the incentives to incur the costs of writing more detailed and longer term contracts. Therefore, if an item is

highly complex or specialized, it is more likely to be internally supplied.

1.3 Literature Review of Empirical Studies of Long-Term Contracts in the U.S. Energy Industry

There is a growing body of empirical studies which examines the structure of contractual relationships from a transaction cost perspective. Transaction cost economics adopts a contractual approach to the study of economic organization. It departs sharply from neoclassical tradition in its shift of emphasis from the market to the individual transaction. Most of the empirical literature on long-term contracts focuses on the role of asset specificity and contracting hazard in explaining variations in the use and structure of long-term contracts.

The consummation of a long-term contract between a supplier and consumer involves agreement on numerous contractual terms and conditions. Among the most important are the price, the quantity, the duration of the contractual commitment, the quality characteristics of the commodity, and provisions for adjusting one or more of these contractual provisions over time. Most of the studies focused on the coal industry, the natural gas industry, and the petroleum industry, because these industries are characterized by significant sunk investments and small-numbers bargaining.

1.3.1 Previous Research on Contracts in the Coal Markets

Paul L. Joskow conducted a series of research projects on long-term coal supply contracts by using data from the U.S. steam coal market. Joskow (1987) analyzed the duration of contracts between electric utilities and coal suppliers specified at the contract execution stage. Contract duration was used to measure the extent to which the parties to the contract are willing to precommit to the terms of future trade ex ante rather than relying on repeated negotiation. The author argued that when relationship-specific investments were more important the parties would be more likely to tie down the terms of future trade ex ante by specifying contracts with longer durations. The empirical work relies on a sample of about 300 coal contracts written between 1960 and 1979. Several variables were designed to capture variations in the importance of relationship-specific investments associated with each contract. Mine mouth plants, coal-producing regions and quantity supplied were used to serve as proxies for site specificity, physical asset specificity, and dedicated assets, respectively, on a contract-by-contract basis. The empirical results support the view that buyers and sellers rely on longer-term contracts when relationship-specific assets are more important.

Joskow (1988) examined the behavior of coal prices specified in long-term contracts and investigated the

relationship between the spot market price and the contract price of coal in the United States. Using regression analysis, he found that the major determinants of initial contract prices and subsequent transaction prices were coal quality, the origin of coal, and the time at which a contract was signed. Since contract duration was found to have no effect on initial contract price and the subsequent transaction price, Joskow concluded that these coal prices generally reflected prevailing market conditions and did not embody a significant financial hostage component. Joskow also noted that contract quantity did not appear to affect contract price either. In addition, Joskow found that the price-adjustment mechanisms in long-term contracts appeared to have been reasonably successful in responding to the challenge during the 1970s and early 1980s. Between 1970 and 1981, nominal coal prices increased by a factor of about four. Real coal prices doubled. Yet transactions prices pursuant to long-term contracts tracked prevailing market conditions during the 1970s quite closely. While there were some significant rigidities in contract prices, the price disparity between contracts of different vintages resulting from these rigidities was on average only about 10-15 percent on average during the 1979-81 period. Therefore, he concluded that at least during this time period, the contractual provisions in long-term coal contracts did a fairly good, but far from perfect, job of adapting to changing market conditions.

Joskow (1990) analyzed the price adjustment in long-term coal contracts. His analysis covered a period in which the nominal market prices for coal were below the prices specified in the preexisting long-term contracts, and he explored two sets of issues. First, did actual transaction prices for coal delivered pursuant to old contracts follow contractual pricing formulas, leading to higher rather than lower prices, or did they adapt quickly to changing conditions? Second, what were the relative roles of formal contractual provisions, voluntary renegotiation, and breach of contractual promises in determining actual transaction prices, quantities, and the durability of contractual relations? It appears that actual transaction prices were rigid downward, following written contractual provisions rather than changes in current market values. Changing economic conditions led to an increase in renegotiation, breach, and litigation, but the vast majority of existing long-term contracts endured through the market downturn without major changes in prices or quantities from those previously agreed to by contract.

1.3.2 Previous Research on Contracts in the Natural Gas Markets

While Joskow's finding of the correlation between contract prices and market prices in U.S. coal markets was convincing, it was questioned whether market prices are the

appropriate standard against which to evaluate contract prices. Goldberg (1985, p539-540) argued:

The relevant price to each party is its opportunity cost - the net price it could get from the next best trading partner. In a market for a standardized commodity, the list price and these two opportunity costs are roughly the same. However, in a long-term contract in which the parties deliberately isolate themselves from the external market, these three prices are more likely to diverge.

Crocker and Masten seemed to be influenced by Goldberg's argument and they (Crocker and Masten, 1991) turned to the question of how parties adjust prices - a question different from what Joskow did in coal markets. By using samples of long-term contracts in the U.S. natural gas markets, they classified price adjustment processes into two basic categories: redetermination processes and renegotiation processes. Redetermination provisions establish prices by formula, while renegotiation provisions allow the parties to renegotiate a new price, often within a process or structure specified in the contract. Crocker and Masten observed that the choice between redetermination and renegotiation provisions reflected the relative costs of governing relationships under the respective arrangements. Specifically, they argued that the choice of price adjustment process is likely to be influenced by the degree of uncertainty, the scale of transaction-specific investments, and the flexibility of non-price dimensions of the contract such as quantity, timing, and product specification. Their

empirical results suggested that (1) the greater uncertainty associated with contracts of longer duration, for instance, appears to favor more flexible pricing: the adoption of renegotiation provisions increased with the duration of natural gas contracts; (2) renegotiation provisions are more likely to be adopted where quantity flexibility is limited: the use of renegotiation provisions decreased with the size of take-or-pay percentages.

Hubbard and Weiner (1991) explored the determinants of initial contract prices in the U.S. natural gas industry. Their empirical work entailed testing for the effects of transaction-specific and market-specific factors on the outcomes of contract negotiations. Their price determination model included three groups of variables: (1) variables associated with market concentration; (2) variables associated with transaction and information costs; and (3) variables associated with production costs. The model was tested against a large detailed data set on contracts between U.S. natural gas producers and pipelines signed during the 1950s. The empirical results revealed two major findings. First, static market-power influences were not the only factors in contract price determination. While there was some evidence of pipeline monopsony power, there was no evidence for positive effects of producer market power (as measured by concentration) on contract prices. Second, transaction-specific and firm-specific variables are important, including

measures of buyer and seller market share and size indicated by total volume or total number of contracts.

There are a few other studies on U.S. energy industry, for example, Mulherin (1986), and Goldberg and Erickson (1987). However, little empirical work based on long-term contracts in the context of international trade has been done.¹ Because of the different legal environments in different countries, the performance and specification of international contracts should differ from domestic contracts.

1.4 Purpose of the Study

This study applies the theory of contracts to examine the choice and performance of international long-term contracts. International long-term contracts refer to long-term contracts signed by firms located in different countries. The sample of long-term contracts examined in this study are overseas coking coal procurement contracts negotiated by Japanese importers.

Japan is the world's largest importer of coking coal. It imports coal from suppliers in more than eight countries around the world. Long-term contracts have been extensively used in the coking coal import transactions. The practice of using long-term contracts in their coking coal procurement has

¹D'Cruz (1979) might be an exception. Economic analysis of long-term contracts in trade also included Smith (1979, 1981), and Rodgers and Robertson (1987) though they were not empirical studies.

long been associated with intense political and economic controversy. A much debated allegation is that Japan's steel mills exercise monopsony power in their coking coal procurement. Rigorous empirical work has, however, never been conducted to investigate these long-term contracts.

The main purpose of this study is multi-fold:

- (1) To examine how transaction-specific capital is involved in the coal-mining industry and steel-manufacturing industry and how it facilitates the use of long-term contracts.
- (2) To describe the market structure of the coking coal trade and analyze the role of transaction-specific capital and market structure in contract price determination.
- (3) To explore the evolution and changes in the contract's provisions and the role of long-term contracts in market stabilization.
- (4) To develop a mathematical model of contractual choice to explain why Japanese steel firms procure coking coal through their trading companies, instead of directly from coal producers abroad.

1.5 Organization of the Study

This study is composed of three essays. The first essay (Chapter 2) examines the importance of transaction-specific capital in the coal-mining industry and steel-manufacturing

industry and how it facilitates the use of long-term contracts in the coking coal trade between Japanese steel firms and their foreign suppliers. The empirical analysis explores, by using data from contracts in force during 1986 and 1989, the role of transaction-specific capital and market structure in contract price determination.

Having reviewed the role of long-term contracts in the coal industry, the second essay (Chapter 3) analyzes the evolution of contract types and changes in the contract's provisions, and examines price adjustments in long-term contracts. By using a primary time series analysis, the role of long-term contracts in market stabilization is examined.

Finally, in the third essay (Chapter 4) a mathematical model is presented to model the choice of procurement contracts. The model incorporates the theories of transaction costs and incomplete contracts to examine different contractual structures. The model sheds light on why Japanese steel firms procure coking coal through their trading companies, instead of directly from coal producers abroad.

Chapter 2. ESSAY ONE

The Role of Specific Capital and Market Power in Contracting: Evidence from Japan's Overseas Coking Coal Procurement

2.1 Introduction

The purchase and supply of resource goods are frequently governed by long-term contractual agreements. Though there is a growing body of empirical studies of long-term contracts in the U.S. coal industry, petroleum industry and natural gas industry,¹ little empirical work based on long-term contracts in the context of international trade has been done. This essay seeks to investigate the factors determining the use of long-term contracts in the coking coal trade between Japanese importers and their foreign suppliers and to examine empirically the determinants of transaction prices in coking coal contracts. The empirical analysis makes use of information from samples of Japan's coking coal procurement contracts in force during 1986 and 1989.

Coking coal contracts for Japan are of particular interest for a number of reasons. First, Japan is the world's

¹Joskow conducted a series of research projects on long-term coal supply contracts by using data from the U.S. steam coal market, see Joskow (1985, 1987, 1988, 1990). Several authors analyzed long-term contracts in the U.S. petroleum industry and natural gas industry; see, for example, Crocker and Masten (1991), Goldberg and Erickson (1987), Hubbard and Weiner (1991), and Mulherin (1986).

largest importer of coking coal, and Japan's imports for coking coal have made extensive use of long-term contracts. Second, though there have been intense political debates and economic analyses associated with Japan's coking coal procurement, few empirical studies based on contract-specific data have been undertaken. Third, while information on long-term contracts are, in general, commercial secrets, publishers in Japan have published fairly detailed information on its coking coal procurement contracts. Finally, this data set provides an opportunity to investigate whether the determinants of price in long-term **international** contracts differ from the determinants of price in long-term **domestic** contracts because of their different legal environment.

The rest of this essay proceeds as follows. Section 2.2 describes the background of Japan's coking coal procurement and reviews the existing economic literature. Section 2.3 examines various types of asset specificity in the coal industry and steel industry. Section 2.4 analyzes the factors affecting renegotiated prices in long-term contracts. An empirical model is provided in Section 2.5 to investigate the determinants of contract prices. Conclusions are summarized and discussed in Section 2.6.

2.2 Background of Japan's Coking Coal Procurement and Existing Economic Literature

2.2.1 Japan's Coking Coal Imports

Coal can be roughly divided into coking coal and steaming coal; coking coal is used to produce steel while steaming coal is used to generate electric power. Japan is the world's largest importer of coking coal as well as of steaming coal; its total imports account for, respectively, 35 percent and 17 percent of total world trade in 1989 (DOE/EIA, 1991).² Steaming coal was excluded from this study as published information on Japan's steaming coal procurement contracts is unavailable. The distinguishing characteristics of coking coal are its caking abilities that will allow the coal to be converted into a coke suitable for use in modern large blast furnaces; the coke, in turn, is used to support the blast furnace charge and to generate the heat and gases necessary to produce pig iron. To work well, the coke should resist abrasion, be uniform in size and permeability, be strong at high temperatures, and be chemically pure to provide the necessary carbon combustion.

²Coking coal consumption in Japan totaled 74.4 million tons in 1989, of which 99 percent was imported; the corresponding figures for steaming coal were 38.6 million tons and 76 percent respectively (International Energy Agency, *Coal Information*, 1991; *Energy Prices & Taxes*, 1991).

The world's leading coal producers are China, the United States, and the (former) U.S.S.R.; they are followed at a considerable distance by Poland, South Africa, India, Australia, and Canada. Because coal is a product characterized with a low value-to-weight ratio and is infrequently exported by some leading producing countries, the relative rankings associated with coal export are quite different. Based on 1989 data, Australia is the largest exporter in the world; followed by the United States, South Africa, the former U.S.S.R, Canada, and Poland.

The world's significant coal-importing countries are located in East Asia and Western Europe. Apart from Japan, South Korea and Taiwan are important importers in Asia. They have three major coal suppliers: Australia, Canada, and the United States. Table 2.1 shows coking coal trade flows to Asia in 1989. Japan's coking coal imports in 1989 accounted for 74 percent of total Asian imports, while the combined imports of South Korea and Taiwan accounted for only 18 percent.³ On the supply side, the combined exports of Australia, Canada, and the United States accounted for about 82 percent of the total coking coal supplied to Asia.

Japan's coal imports have expanded since 1960, and until the second round of OPEC oil price increases in 1979, imports were almost exclusively coking coal. Coking coal is primarily

³In contrast, the coking coal imported by Europe is much more evenly shared among importing countries.

Table 2.1
Asian Coking Coal Trade flows in 1989 (10⁶ ton)

Exporters	Importers				Total
	Japan	Korea	Taiwan	Others	
Australia	30.0	4.0	3.3	5.0	42.3
Canada	18.8	3.8	1.0	0.4	24.0
U.S.A.	11.6	3.0	0.7	0.1	15.4
Former USSR	5.5	0.0	0.0	0.9	6.4
China	1.4	0.0	0.0	0.0	1.4
S. Africa	3.5	0.9	0.0	0.5	4.9
Others	2.7	0.9	0.0	1.8	5.4
Total	73.5	12.6	5.0	8.7	99.8

Sources: Derived from DOE/EIA (1991), *Annual Prospects for World Coal Trade*; International Energy Agency (1991), *Energy Prices & Taxes*; The Tex Report (1990), *Coal Manual*. Statistical discrepancies have been adjusted.

used for steel production and about 94 percent of Japan's imports is taken by its steel mills.⁴ Therefore, the demand for coking coal is closely related to the performance of the steel industry. Japan is the second-largest producer of crude steel in the world after the former U.S.S.R. Beginning in 1978, Japan's crude steel production varied between 97 million tons and 112 million tons (DOE/EIA, 1991). Since the mid-1980s, because of the sharp appreciation of the yen in world financial markets and the competition from steel companies in developing countries, conditions in Japan's steel industry have been depressed. As a result, Japan's coking coal imports fluctuated between 60 and 75 million tons during 1980s. Table 2.2 shows Japan's coking coal imports from 1981 to 1990 and the shares of suppliers. As can be seen, while the share of the USA continued to fall, the share of Canada and other suppliers almost doubled in the 1980s.

There are six major steel firms in Japan, of which Nippon Steel Corporation alone accounts for about 40 percent of production. The Japanese steel mills' coking coal imports are handled by importers who act on behalf of the steel mills to coordinate their purchases. There are over 40 Japanese importers involved in the coking coal trade; most have been involved in the trade for many years. A substantial majority of these importers have dealings with all supplying countries

⁴The remaining portion is used for chemical and other industries.

Table 2.2

Japan's Total Coking Coal Imports and Shares of Its Suppliers

Year	Total Imports	Share(%)			
	(10 ⁶ ton)	Austr.	Canada	USA	Others
1981	65.76	44.30	14.57	32.80	8.37
1982	64.87	39.17	14.70	36.86	9.27
1983	59.83	47.07	17.15	24.60	11.16
1984	69.34	43.02	22.24	22.09	12.49
1985	70.14	43.27	23.98	18.24	14.51
1986	69.69	41.95	23.35	16.73	17.97
1987	67.08	45.42	23.08	13.68	17.82
1988	75.00	41.12	25.32	17.32	16.24
1989	73.45	44.63	24.58	14.87	15.92
1990	74.24	45.59	24.12	14.50	15.79

Sources: Derived from International Energy Agency, *Energy Prices and Taxes*, various issues.

except a few very new suppliers. Two importers, Mitsui & Co. and Mitsubishi Corp., were responsible for about 50 percent of the total imports.

Because Japan's domestic coal resources are almost exhausted, its steel mills rely heavily on coking coal imported from foreign suppliers; imported coking coal accounts for more than 90 percent of total consumption. On the other hand, those foreign suppliers have also been highly dependent on the Japanese market, as their exports to Japan account for significant proportions of their production and total exports. Table 2.3 reports the supplying countries' coking coal production, total exports, and exports to Japan in 1989. Table 2.3 shows that in 1989 Australia exported 88 percent of its coking coal production, and 54 percent of its exports went to Japan; comparable figures for Canada were 94 percent and 70 percent, respectively. South Africa, the former U.S.S.R., and China exported only a small fraction of their coking coal production; most of their exports, however, went to Japan. The United States might be an exception, for the comparable figures were considerably smaller.⁵

⁵The U.S. producers have access to a large, though declining, domestic market, and their remaining sales can go to Europe and other places of the world.

Table 2.3

Supplying Countries' Coking Coal Output, Exports and Exports to Japan (10⁶ ton)

Countries	Output	Total Exports	Exports to Japan
Australia	63.2	55.6	30.0
Canada	28.3	26.7	18.8
U.S.A.	96.3	59.1	11.6
Former USSR	121.5	27.3	5.5
China	84.6	1.4	1.4
S. Africa	- ^a	4.9	3.5
Others	- ^a	- ^a	2.7

Sources: Derived from International Energy Agency (1990), *Coal Information*; The Tex Report (1990), *Coal Manual*.

Note: ^aData unavailable.

2.2.2 Previous Economic Research on Japan's Overseas Coking Coal Procurement

The coking coal trade between Japan and its suppliers has been associated with intense political and economic debates. Media coverage, government statements, and academic research reports have all been involved in this controversy. The fundamental issue is the balance of market power between importers and producers. A common perception is that Japan's steel mills exercise monopsony power in their coking coal procurement by collective purchasing. There is even an allegation that there was a conspiracy among Japan's government departments, steel mills and importers. Economic research mainly concentrated on the issues of pricing and the monopsony power of the Japanese steel industry. The work of D'Cruz (1979) and Anderson (1987) directly focused on these issues.⁶

D'Cruz (1979) looked at the determinants of coking coal prices. He defined the concept of "quasi-integration" as long-term contracts, logistical linkages, equity participation, and technological changes and examined the relationship between coking coal price and the existence of quasi-integration. Then he hypothesized in his model that

⁶Smith wrote a series of articles on long-term contracts between firms in Japan and Australia; see Smith (1976, 1980, 1981). His work, though not directly targeted on long-term contracts in the coking coal trade, is also important and very stimulating.

quasi-integration would attenuate the impact of market power. In periods when the market power balance lies with sellers, such as during the growth phase of the buyer's industry life cycle or during business cycle upturns, quasi-integrated sellers are expected to receive lower prices than independents, and in return achieve superior quantity stability and growth. On the other hand, during life cycle maturity or business downturns, as the balance of market power shifts to buyers, prices of quasi-integrated sellers are expected to be higher than independents, while they continue to achieve better quantity performance.

In the empirical research, D'Cruz used various forms of the following model to test the hypothesis:

$$P = F(Q, C, I)$$

where:

P = a dependent variable, measuring either price or quantity performance

Q = a group of dummy variables describing product quality

C = a group of dummy variables describing the effect of the "country-of-origin"

I = a group of dummy variables describing the quasi-integration linkages between buyers and sellers.

With this specification, the benchmark model was the case in which the supplier was not linked to the Japanese steel mills by any one of the four quasi-integration linkages. The model was tested against data on seven countries' coking coal suppliers to the Japanese steel industry from 1970 to 1977.

The empirical analysis showed that coking coal prices were largely determined by product quality and the country of origin of the supply source. Quasi-integration linkages were shown to have a small, but statistically significant impact on prices. D'Cruz's analysis anticipated more recent literature (Williamson, 1975, 1983, 1985) which specifies the more fundamental conditions including D'Cruz's "logistical linkages." D'Cruz's study did not, however, distinguish long-term contracts from other forms of quasi-integration and is limited by the use of average aggregate data rather than contract-specific data in its empirical analysis.

Anderson (1987) conducted a more recent comprehensive study. He synthesized two rather polarized views on the coking coal procurement policy of Japanese steel mills: the conspiratorial view and the anti-conspiratorial view. The conspiratorial view contends that Japanese steel firms deliberately created an oversupply situation which they are now exploiting in an aggressive manner. According to this view, Japanese steel firms enticed suppliers to build more capacity than necessary through a variety of vehicles and with the aid of some rather devious practices. The proponents of

anti-conspiratorial theory do not argue against the fact that over-capacity existed in the coking coal industry during the 1980s but suggest that most of the problems were caused by an anticipated decline in the long-term demand for steel. By extensively reviewing existing literature and analyzing Japan's coking coal procurement policy towards Australia and Canada, Anderson seemed to be in favor of the conspiratorial theory and concluded that the Japanese steel mills appear to exercise oligopsonistic power over the Asian-Pacific coking coal trade. While Anderson's analysis was stimulating, long-term contracts, which are the main form of exchanges in coking coal trade, should be examined in more detail, and empirical work based on firm-level data (contract-specific data) should be undertaken to investigate these issues.

2.3 Asset Specificity & Long-Term Coal Procurement Contracts

Long-term contracts are usually defined as contracts for sales and purchases with duration over five years. A contract for as short as a one- to five year-period is still regarded as a long-term contract, if the contract has been "rolled over" on a routine basis and therefore can be regarded as "evergreen".⁷ Although evergreen contracts have no commitment

⁷A similar definition is used by Rogers and Robertson (1987), who examined long-term contracts in the world's iron ore markets. Not surprisingly, this definition is not unambiguous. Japanese steel mills define a long-term contract as a contract with a duration of more than one year.

as to contract length, continuation of these contracts is very common.

The primary reason for using long-term contracts between firms is transaction-specific investments.⁸ The notion of transaction-specific investments describes situations where exchange involves significant investments in relationship-specific capital, and parties have an incentive to engage in opportunistic behavior to influence the distribution of the resulting quasi rents.

Williamson (1983, p.526) identified four distinct types of transaction-specific investments. Joskow (1987, p.170) elaborated the first three types as follows:

(a) Site Specificity: The buyer and seller are in a "cheek-by-jowl" relationship with one another, reflecting ex ante decisions to minimize inventory and transportation expenses. Once sited the assets in question are highly immobile.

(b) Physical Asset Specificity: When one or both parties to the transaction make investments in equipment and machinery that involves design characteristics specific to the transaction and which have lower values in alternative uses.

(c) Dedicated Assets: General investments by a supplier that would not otherwise be made but for the prospect of selling a significant amount of product to a particular consumer. If the contract is terminated prematurely, it would leave the supplier with significant excess capacity.

Williamson's fourth asset specificity is human asset specificity; it arises in a learning-by-doing fashion (Williamson, 1983). Masten, Meehan and Snyder (1991) expanded

⁸Other reasons for the use of long-term contracts have also been suggested, such as risk aversion, information lags and income effects; see, for example, Hart and Holmstrom (1987).

Williamson's original four-way classification by identifying a fifth transaction-specific asset: temporal specificity.

They argued (Masten, et.al., p.9):

Where timely performance is critical, delay becomes a potentially effective strategy for exacting price concession. Knowing that interruptions at one stage can reverberate throughout the rest of the project, an opportunistic supplier may be tempted to seek a larger share of the gains from trade by threatening to suspend performance at the last minute.

The transactions of coking coal between Japanese steel mills and producers around the world are well characterized by the features of transaction-specific investments.

Although a "cheek-by-jowl" relationship does not exist as Japan is geographically separated from its suppliers, "site specificity" still seems to be involved in Japan's coking coal trade with its suppliers; there have been investments "to minimize inventory and transportation expenses". Five major coal shipping ports have been developed to supply coal to the Japanese steel industry: Roberts Bank and Neptune Terminals in British Columbia, Canada; the Hay Point port in Queensland, Australia; the Richards Bay port in South Africa; and the McDuffie Terminals in Alabama (D'Cruz, 1979). All these ports can accommodate vessels of the 100,000 DWT class and have special purpose bulk loading equipment capable of loading these ships in less than two days. These ports and equipment are apparently highly immobile. On the other hand, Japanese steel mills have built carriers of the 100,000 DWT class originally for the import of iron ore and later extended for

importing coking coal. Each ship was built to carry specific cargo along specific routes. Specification reportedly resulted in substantial freight cost savings.

Physical asset specificity is important in the coking coal trade because coking coal is a product with different properties. It varies in terms of its caking characteristics, content of carbon, ash, sulphur and so on. Steel mills are designed to produce a particular mix of products; with different processes requiring a particular mix of the coking coal. In order to find an optimal mix, steel mills usually have to spend years experimenting before full capacity operation. Once the facilities are commissioned, substitution between alternative sources may be limited and may involve substantial cost penalties, i.e., such investments have higher value in their intended than in their next best use.

The notion of "dedicated assets" essentially captures the cases where a supplier is heavily relying on some particular buyers. If the contract between them is terminated prematurely, it would leave the supplier with significant excess capacity. As discussed above, because coking coal is a bulky product, its value is limited by long distant transportation; therefore, suppliers located at the Pacific Rim are highly dependent on Japan's imports as Japan is the dominant importer in Asia.

Joskow (1987, p.170) argued that there is a buyer-side analogy to the dedicated asset as well. He noted:

A buyer that relies on a single supplier for a large volume of an input may find it difficult and costly to quickly replace these supplies if they are terminated suddenly and effectively withdrawn from the market and, as a result, a large unanticipated demand is suddenly thrown on the market.

This argument is clearly applicable to Japanese steel mills because over 80 percent of their coking coal is from three big suppliers: Australia, Canada, and the United States.

The notion of "temporal specificity" developed by Masten, Meehan and Snyder (1991) is also relevant to Japan's coking coal trade. On one hand, because coking coal is a large volume input in steel production, it is very costly for steel mills to arrange enough storage to guarantee supply for a considerably long period of time; therefore, buyers may be frequently under the threat of delivery delay. On the other hand, because of the long lead time for construction of coal mining projects, buyers' delay in accepting delivery would cause larger losses for producers.

In summary, coal trade between Japanese steel mills and their suppliers involved significant transaction-specific investments and both buyers and sellers were locked into an isolated relationship. In the presence of transaction-specific investment, trade organized through spot exchange is prone to frequent and costly renegotiation and parties have incentives to evade performance in order to seek the resulting quasi

rent. Long-term contracts can guard against such opportunistic behavior and promote efficiency by ex ante specification of contractual choice variables. Table 2.4 displays Japan's coking coal import volume by contract type.⁹

Table 2.4
Import Volume by Contract Type (10⁶ tons)

Year	Long-Term	Evergreen	Annual	Spot	Total
1986	35.52	10.25	20.99	2.93	69.69
1989	33.06	16.11	19.00	5.28	73.45

Sources: Derived from Tex Report (1987, 90), *Coal Manual*.

Another option which the two parties can choose to protect quasi-rent streams from appropriation is to fully or partially vertically integrate (Williamson, 1985, p85-130; Pisano, 1989). A steel firm would then have less incentive to appropriate quasi-rents from a supplier as its incentives are more closely aligned with the incentives of its coal supplier.

⁹While evergreen contracts are conceptually considered to be long-term contracts in this study, they are separated into an individual group for expository reasons. In calculations for Table 3 and the following empirical analysis, an evergreen contract is defined as a contract with a duration from two to five years and annual contracts which follow the expiration of contracts with a duration over 5 years.

Opportunistic threats by a steel firm generate fewer potential benefits, as such threats reduce the value of the firm's equity position in the coal supplier. A direct equity position in a coal firm does not, however, eliminate opportunistic behavior, as the majority share holder in the coal firm still bears most of the costs stemming from opportunistic behavior.

Because the capital requirements of Japan's postwar reconstruction period placed heavy demands on domestic savings, it was difficult for Japanese steel mills to own foreign-based captive mines or even engage in substantial equity participation until the early 1970s (Johnson, 1982). However, Japanese steel firms have made extensive equity investments in their foreign coking coal trading partners since the early 1970s. Such equity participation gives Japanese steel firms representation on the management board, assuring better information for contract negotiations and more closely aligned incentives to find the market price of coal. Japanese steel firms have, however, normally restricted themselves to an equity position between 10 percent and 35 percent so as to minimize the impact of foreign direct investment on the political and economic environment of the host countries (Anderson, 1987).

Partial vertical integration between the steel and coal industries serves as a substitute for a fully-specified long-term contract specifying all elements of future transactions.

The fully-specified long-term contract is replaced by a more flexible long-term relational contract which is characterized by an ongoing process of negotiation over the terms of trade. Consequently, as can be seen below, long-term contracts in the coking coal industry can be structured to approximate spot market conditions more closely.

2.4. Factors Affecting Prices in Long-Term Contracts

Long-term contracts can increase the overall value of both parties by specifying ex ante the terms of trade over future years. Prespecified contract prices can cause problems when market conditions change dramatically. Since the early 1970s, the world coking coal market has experienced considerable fluctuation because of fluctuating world oil prices and the competition of steel industry from steel plants built in developing countries. Coking coal prices increased more than three times from the early 1970s to the early 1980s, and then decreased over 50 percent by 1987. As a result, prespecified price escalation provisions were abandoned for a majority of long-term contracts. Instead, the Japanese steel mills, importers, and coking coal producers of supplying countries hold annual conferences to examine the prices and other contractual terms according to current market condition. Virtually all long-term contracts are open for adjustments. Therefore, it seems that long-term contracts only serve as a

starting point for renegotiation. While these annual renegotiations have, in general, been tough but successful,¹⁰ an interesting question concerns the determinants of the renegotiated prices.

Renegotiated prices in a relational contract can be affected by a number of factors.¹¹ First, market structure has a significant role in determining prices if transactions are in "arm's-length" form. For example, if the buyer has monopsony power in a market it can depress the market price. Second, transaction-specific investments can affect prices. A coal firm's investment in additional coal-mining capacity represents a dedicated asset that allows a steel firm to earn rents by contracting for a secure supply of coal. The steel firm can reduce the probability that the coal firm will not supply coal by sharing a portion of the security rents with the coal firm. Such sharing takes the form of a higher

¹⁰Perhaps the only exception is the 15-year contract of Quintette coking coal of Canada. Because of unfavorable financial conditions, the Canadian mine refused a price reduction requested by the Japanese steel mills. As a result, on November 16, 1987, the contract dispute finally developed into such an unprecedented case that the Japanese steel mills appealed to a court of arbitration in British Columbia province (*Coal Manual*, 1990, p311).

¹¹Several empirical studies have looked at the issue of pricing in long-term contracts. For example, Joskow (1988) analyzed price adjustments in long-term contracts in the U.S. steam coal market; Hubbard and Weiner (1991) examined the determinants of contract prices in the U.S. natural gas industry.

contract price.¹² Finally, because coking coal is a product with a wide range of quality specifications, its price should reflect changes in quality indexes. Therefore, it is expected that the following relationship holds:

$$P = f(M, T, Q) \quad (2.1)$$

where P is contract price, M represents market power factors, and Q is quality factors. Based on (2.1), a reduced-form model is constructed in the following empirical analysis to test the impacts of different factors on contract prices.

The market structure is of particular interest because there have long been allegations of consumer monopsony in Japan's coking coal procurement.¹³ A typical outcome of monopsony power, a transaction situation in which a single buyer faces a large number of independent sellers, is the mark-down of prices.

Japanese steel mills' coking coal procurement takes place in the following eight areas: the United States, Canada, New South Wales and Queensland of Australia, China, the former

¹²This analysis does not require that either firm be risk averse. In addition, investment in a specific asset does not imply a lower marginal cost of reproduction. The rents are generated by reducing the uncertainty encountered by both buyer and seller. Hashimoto (1978) discussed how a cooperative buyer and seller can set rental shares to maximize joint wealth.

¹³While Anderson (1987) concluded that Japanese steel mills exercised monopsony power in their coking coal procurement, D'Cruz (1979) just assumed that Japanese steel mills completely colluded, i.e., "operated as a single customer unit."

USSR, and a few other small coal-exporting countries. The geographic market boundaries are defined asymmetrically for buyers and sellers. While Japanese firms are able to procure coal from firms in a variety of countries, exporters are heavily constrained by the very large size of the Japanese markets. Transportation costs also separate producers into geographic market; coking coal prices are specified in all contracts as FOBT prices.¹⁴

The outcome of individual transactions is significant in the coking coal trade because of the way transactions are organized. As discussed above, a majority of coking coal is traded under the framework of long-term contracts. There is no well developed spot market, therefore no widely quoted market price. Price and non-price provisions specified in each contract are the outcomes of bilateral negotiations. Because of the high dependance between the buyers and sellers, they have little choice but to deal with each other over an extended period. Therefore, transaction-specific investments would play a significant role in determining contract prices. However, the Williamson types of transaction-specific assets

¹⁴Areeda and Turner (1978, p.347) defined a market's boundaries by the following criterion: "a firm or group of firms, which if unified by agreement or merger, would have market power in dealing with any group of buyers." Presumably there would be a similar definition with respect to buyer market power. Landes and Posner (1981, p.937) defined market power as "the ability of a firm (or a group of firms, acting jointly) to raise prices above the competitive level without losing so many sales so rapidly that the price increase is unprofitable and must be rescinded."

have not been well quantified; and the available information on Japanese overseas coking coal procurement transactions does not make it possible to capture all relevant transaction-specific investments. In the absence of direct measures, contract quantity and contract duration are used as proxies for transaction-specific capital to examine their effects on contract prices.

Contractual quantity is closely related to the concept of "dedicated assets".¹⁵ If a buyer and a seller signed a long-term contract which requires a large quantity of coal to be delivered, a breach by either party would make it difficult for the other party to quickly dispose of unanticipated surplus at a compensatory price (if the buyer breaches) or to replace supplies at a comparable price (if the seller breaches). The two parties have an incentive to share the security rents such that the wealth of the two parties is maximized (Hashimoto, 1979).

If the buyer of large quantities reneges, the suppliers are left with excess capacity. Therefore, suppliers of large quantities would demand a higher price to compensate for costs incurred from the delay in finding a new buyer. On the other hand, buyers of large quantities also would incur significant losses if a seller reneges, as the steel plant must cut back

¹⁵In his pioneering work, Joskow (1987) employed contract quantity as a proxy for dedicated assets in his empirical analysis of the relationship between transaction-specific assets and contract duration.

on its output until it arranges for new deliveries. Buyers demand a lower price to compensate for the interruption in operations. Thus specification of the rental shares depends on which party is most likely to renege on the contract and their ability to find a new buyer or seller. Neither argument presupposes a risk premium; risk-neutral suppliers and buyers who have made specific capital investments have incentives to incorporate a price premium in their contracts to maximize their joint wealth.

The duration of a contract is also related to the extent of investment in transaction-specific assets. Presumably, suppliers with longer-term contracts often have larger specific capital investments, such as exploration activities to guarantee proper reserve/output ratios, investments in improved delivery facilities, etc. From the buyers' point of view, a long-term contract also secures a supply of inputs for facilities that are specific to the input. Joskow (1988, pp.66-67) analyzed the potential effect of contract duration on the initial base price as a "financial hostage"; rather than relying on variations in the term of the agreement to amortize relationship-specific investments, the base price could vary systematically with the negotiated term of the agreement. Joskow also included a duration variable in his renegotiated price regressions and found that it was always insignificant. Two duration variables are included in the following

renegotiated price regressions, as they represent additional, albeit imperfect, measures of investment in specific capital.

Coking coal prices should presumably vary directly with product quality. The estimated coefficients are of interest because of the allegation that the Japanese steel mills offer a wide range of prices for coking coals of similar quality.¹⁶ There are two important quality criteria for coking coal used in the steel industry: "caking properties" which allow the coal to be converted into a coke suitable for use in modern large blast furnaces and "carbon content" which facilitates the conversion to carbon monoxide gas so as to reduce iron ore to pure iron.

2.5. Empirical Tests of the Determinants of Contract Prices

The primary interest of the empirical analysis is in estimating the effects on contract prices of market structure factors, transaction-specific factors, and coal quality. If only one group of factors matter, the estimated coefficients on all other variables are expected to be zero. However, the three groups of variables are not necessarily exclusive; and

¹⁶For example, Anderson (1987, p.72) asserted that there is Japanese monopsony power in the coking coal trade. He noted that "perhaps the strongest evidence to support the allegations that the Japanese steel mills exercise significant market power is their current practice of paying widely varying prices for coal of similar quality".

their effects on coking coal prices are reflected in the magnitude and significance of their estimated coefficients.

2.5.1 Data and Variable Definitions

A. The Data

The contract data used in this study are from the *Coal Manual*.¹⁷ The manual covers all long-term contracts (including annual contracts) between Japanese coking coal importers and producers in supplying countries. There is a brief abstract for each contract, which includes: importer, producer, date, duration, price, quantity, quality specifications, price escalation clause, penalty, loading port, delivery schedule, etc. The data used in the empirical analysis include contract samples from 1986 (65 contracts) and 1989 (70 contracts), yielding a pooled sample with 135 observations.¹⁸

B. Variables associated with market structure

One proxy for market power is a concentration index, a summary statistic reflecting the distribution of firms in an

¹⁷The *Coal Manual* is published regularly by The Tex Report, Ltd. (a publishing firm in Japan).

¹⁸Contracts in force in 1986 and 1989 are interesting because during this period the average coking coal price turned the declining trend and rebounded.

industry.¹⁹ An industrial concentration index usually incorporates the two relevant aspects of industry structure, i.e., firm numbers (N) and size inequalities (I). It is assumed that the smaller the number of firms and the more unequally sized they are, the more market power they can exert as a group. Thus, a concentration index C can be expressed as:

$$C = f(N, I); \quad f_N < 0, f_I > 0 \quad (2.2)$$

Numerous concentration indexes have been constructed based on (2.2). The two simplest indexes are the n -firm concentration ratio and the Herfindahl index. The n -firm concentration ratio is defined as the sum of the shares of the largest n firms in the market, that is:

$$C_n = \sum_{i=1}^n (q_i/Q) \quad (2.3)$$

where q_i is firm i 's output and Q is aggregate industry output; and $n < N$. It can be shown that the n -firms concentration ratio is a good measure of market power if the largest n firms jointly maximize profit while the rest act as price takers. If all firms act as Cournot followers, the "correct" measure is the Herfindahl index. The Herfindahl index is defined as

¹⁹See any standard textbook of industrial organization for detail, for example, Waterson (1984) and Carlton and Perloff (1990), from which the following related discussion is drawn.

the sum of the squares of the shares of all firms in the market, that is:

$$H = \sum_{i=1}^N (q_i/Q)^2 \quad (2.4)$$

By applying (2.3) and (2.4), the Herfindahl index, 2-firm and 4-firm concentration ratios, are employed to measure the market power of Japanese importers (reported in Table 2.5). Variables associated with industrial concentration indexes of producers are not incorporated in the empirical analysis owing to the following two reasons. First, calculation of concentration indexes for producers in some partially planed economies (such as China or the former Soviet Union) may involve conceptual problems. Second, there is an implicit assumption in the previous literature that there exists no monopoly power in the producer market. The lack of price-setting power for producers is not surprising. Since the early 1980s, a massive over-capacity has been created in some major exporting countries (such as Australia and Canada).²⁰ Producers in other markets who took action to increase prices by limiting supply would find the supply reduction offset by

²⁰There are two views on how this over-capacity situation was created. The conspiratorial view contends that the situation was deliberately created by Japanese government and Japanese steel mills. The proponents of anti-conspiratorial theory do not argue against the fact that over-capacity existed during 1980s but suggest that most of the problems were caused by an unanticipated decline in the long-term demand for steel. For details, see Anderson (1987).

Table 2.5
Buyers Market Concentration Indexes

Market	1986			1989		
	BHI	BC2	BC4	BHI	BC2	BC4
U.S.A.	0.149	0.489	0.651	0.192	0.578	0.738
Canada	0.177	0.471	0.768	0.164	0.438	0.741
NSW	0.188	0.331	0.585	0.113	0.353	0.559
QLD	0.280	0.726	0.858	0.247	0.674	0.831
China	0.072	0.245	0.419	0.073	0.267	0.441
Former USSR	0.136	0.437	0.634	0.150	0.458	0.674
S.Africa	0.438	0.752	1.000	0.480	0.823	1.000
Others	0.292	0.750	0.882	0.327	0.786	1.000

Note: Computation of the concentration indexes is based on data from The Tex Report, *Coal Manual* (1987, 1990).

additional output from Canada and Australia of from new facilities in the former Soviet Union and China aggressively pursuing opportunities to earn hard currency.

C. Variables associated with transaction-specific capital

Contractual quantity (*QNT*) and contract duration (*LTD*, *EGD*) serve as proxies for the presence of transaction-specific capital. Hubbard and Weiner in their study of contracting in the U.S. natural gas industry considered contract quantity to be a measure of cost, as they assert the presence of economies of scale in transmission of natural gas. In this study *QNT* could also be picking up economies of scale in coal transportation as well as the presence of specific capital. In addition, Hubbard and Weiner (p.43) consider contractual quantity to be an exogenous variable as "gas wells, once sunk, produce at maximum sustainable yield because of transmission-cost considerations and the common-pool problem." Coal quantity is, however, more likely to be an endogenous choice variable, as coal mining has neither a common-pool problem nor the transmission cost economies peculiar to natural gas; most importantly, mine owners can adjust quantity in response to renegotiated prices. Thus, in addition to an OLS specification of the price equation, an instrumental specification for the quantity variable is introduced, and 2SLS is applied in the empirical analysis.

Contracts are divided into three groups based on the length of the buyer-seller relationship: long-term contracts, evergreen contracts, and annual contracts. Two dummy variables are constructed to capture these differences: dummy *LTD* with a value of 1 if the duration of the contract is longer than 5 years; dummy *EGD* with a value of 1 if evergreen contract. Thus the base case is the annual contract. While the initial contract price and contract duration are set simultaneously, contract duration is exogenous to the renegotiated price.

D. Quality-related variables

There are five quality specifications in the two contract samples: total moisture (*MST*), ash content (*ASH*), volatile matters (*VLM*), total sulfur (*SLP*) and crucible swelling number (*CSN*). The first three are actually indirect measure of the carbon content in a particular coal, because, in general, carbon content is calculated as a residual by subtracting the percentages of moisture, ash, and volatile matter from one hundred. Moisture consists of free water and is lost when the coal is heated in the coke oven. Coals with high moisture content yield less fixed carbon in the coke than other coals. Ash consists of all inert substances that remain behind when the coal is completely burned. Thus the higher is the percentage of ash, the lower is the amount of available fixed carbon. Volatile matter consists of the organic chemical

compounds that escape as gases when the coal is heated in the absence of air. Coals with high volatile matter lose more mass when heated in the coke oven; thus the coke yield of fixed carbon is low for such coal. Therefore, it is expected that the price of coking coal is negatively related to the presence of moisture, ash, and volatile matter. Total sulphur is also related to carbon content; but since its magnitude is rather small compared with the first three quality measures, it is more an indicator for environmental concern. Crucible swelling number is one of the most common, simple caking tests. Its value ranges from 0 (no caking characteristics at all) to 9 (superior caking properties). Thus it is expected that the higher the value, the higher the price.

E. Additional dummy variables

Finally, two dummy variables are introduced. Dummy variable *EPC* is used to distinguish the transaction prices of fixed-price contracts and those of escalating price contracts. While this variable is endogenously determined with the initial price when the contract is executed, it is exogenous to determination of renegotiated prices. Dummy variable *YRD* is used to distinguish the contracts in force in 1986 and 1989. The definitions of all variables and summary statistics for the variables are reported in Table 2.6.

Table 2.6
Variable Definitions and Summary Statistics

Variables	Descriptions	Mean	STD	MIN	MAX
P	Nominal transaction price in dollar/ton	47.31	8.48	32.00	74.50
BHI	Buyers' Herfinahl index	0.19	0.09	0.07	0.48
BC2	Buyers' 2-firm concentration ratio	0.50	0.17	0.25	0.82
QNT	Quantity dedicated in a contract (10 ⁶ ton)	0.88	0.95	0.01	5.10
LTD	Dummy that equals 1 if long-term contract				47 Observations
EGD	Dummy that equals 1 if evergreen contract				51 Observations
MST	Total moisture (%)	8.07	1.33	2.40	10.00
ASH	Ash content (%)	8.62	2.19	2.00	25.00
VLM	Volatile matter (%)	28.96	6.19	17.00	42.00
SLP	Total sulphur (%)	0.65	0.25	0.30	1.60
CSN	Crucible swelling number	5.66	2.30	0.50	9.00
EPC	Dummy that equals 1 if escalating price contract				14 Observations
YRD	Dummy equals 1 if contract in force in 1986				65 Observations

2.5.2 Regression Specifications and Estimated Results

The reduced-form price equation is specified as follows:

$$P_{ijk} = \alpha + \beta M + \gamma T + \eta Q + \theta D + \epsilon \quad (2.5)$$

where:

i, j, k : presents buyers, sellers, markets respectively;

P : the transaction price in a contract signed between the i th buyer and j th seller in the k th market;

M : $M \in \{BC2, BC4, BHI\}$, variables associated with market structure;

T : $T = (QNT, LTD, EGD)$, variables related to transaction-specific variables;

Q : $Q = (MST, ASH, VLM, SLP, CSN)$, quality variables;

D : $D = (EPC, YRD)$, dummy variables used for contract types and transaction time.

The three market structure variables yield three specifications. Specifications of equation (2.5) passed Ramsey's test for residual non-linearities and the Park-Glejser test for heteroscedasticity in contractual quantity (QNT)²¹. In Ramsey's test, the dependent variable is regressed on the model's prediction and the squared prediction. If there are no residual nonlinearities, then the coefficient on the

²¹All tests and estimates were obtained using *Econometrics Computer Program -SHAZAM* (Version 6.2 as of 1990) primarily developed by Kenneth J. White.

prediction should be insignificantly different from 1.0, while the coefficient on the squared prediction should be insignificantly different from zero (see Ramsey, 1974). In Park-Glejser test, the squared logged residual is regressed on the logged contractual quantity ($\log QNT$). If the slope coefficient is insignificantly different from 0, it is assumed that the residual is homoscedastic (see Pindyck and Rubinfeld, 1981).

Equation (2.5) is estimated by using OLS and the estimated results are reported in Table 2.7. The three regression specifications are very similar in terms of the signs and significance of the estimated coefficients, and in terms of the magnitude of R^2 , indicating that the two measurements of market structure (the concentration ratios and the Herfindahl index) produce the same effects on contract prices.

The estimated coefficients on Japanese importers concentration ratios ($BC2$ and $BC4$) and Herfindahl index (BHI) are negative and statistically significant, implying that the more concentrated are the Japanese importers, the lower are the transaction prices of coking coal, other things being equal. These results are consistent with the popular, yet much debated view that the Japanese importers exercise monopsony power in their coking coal procurement.

The estimated coefficients on the group of transaction-specific variables (QNT , LTD , EGD) have the expected positive

Table 2.7

OLS Estimates of the Contract Price Determination Equation

Variable	P	<i>t</i> -value	P	<i>t</i> -value	P	<i>t</i> -value
BHI	-15.718	(-3.03) [†]
BC2	..	..	-7.517	(-2.53) [†]
BC4	..	..	..	..	-9.237	(-2.74) [†]
QNT	2.010	(3.82) [†]	1.926	(3.64) [†]	2.012	(3.79) [†]
LTD	3.024	(2.52) [†]	3.266	(2.70) [†]	3.405	(2.82) [†]
EGD	2.522	(2.34) [†]	2.725	(2.51) [†]	2.889	(2.68) [†]
MST	-0.085	(-0.26)	0.007	(0.02)	-0.073	(-0.22)
ASH	-1.040	(-4.53) [†]	-1.042	(-4.40) [†]	-1.055	(-4.48) [†]
VLM	-0.333	(-3.44) [†]	-0.331	(-3.33) [†]	-0.348	(-3.47) [†]
SLP	2.720	(1.29)	2.581	(1.20)	2.497	(1.18)
EPC	12.867	(8.27) [†]	12.758	(8.11) [†]	12.726	(8.15) [†]
YRD	0.447	(0.54)	0.348	(0.42)	0.392	(0.47)
Constant	58.836	(10.01) [†]	58.173	(9.66) [†]	62.470	(9.29) [†]
N	135		135		135	
Adjusted R ²	0.7044		0.6980		0.7005	

Note: [†]Significant at 0.05 level.

signs and are statistically significant, indicating that the prices of larger-quantity contracts, long-term contracts and evergreen contracts are significantly higher than those of annual contracts. These estimates suggest that coal producers who sign larger quantity supply contracts or longer-term contracts succeed in seeking higher prices. In both cases, the producers are expected to make more specific investments, while Japanese steel mills are provided with more insurance via a stable supply. The small difference between the estimates of *LTD* and *EGD* reveals that prices of long-term contracts are similar to those of evergreen contracts.²²

The estimated coefficient of the dummy variable *EPC* is positive and significant, indicating the average price of escalating price contracts is 12 - 13 dollars per ton more than in fixed-price contracts. This result stems from the imperfect nature of most price adjustment clauses: they usually do not replicate the market price of the goods. Significant differentials between the spot price of the good and the specified "adjusted" price may arise; the party which is most susceptible to breach when the contract and prices diverge will be willing to pay a premium to prevent the breach.²³

²²The null hypothesis that the estimated coefficients on *LTD* and *EGD* are equal can not be rejected by a *t*-test at the five percent significant level.

²³Escalating price contracts were mostly used with Canadian suppliers.

The estimated coefficient of dummy variable *YRD* is very small and insignificant, suggesting that average price levels in 1986 and 1989 were equal.

The five variables measuring coking coal quality produce interesting results. While three of them (*ASH*, *VLM*, *CSN*) have the expected signs and are statistically significant for three equations, the other two (*MST*, *SLP*) have the wrong signs (but are insignificant). The estimated coefficients of *ASH*, *VLM* and *CSN* indicate, as expected, that the higher the content of ash and volatile matters, the lower the coking coal price and that the higher the crucible swelling number, the higher price for the coking coal.

As noted above, *MST*, *ASH*, and *VLM* together reflect one of the two important quality indicators of coking coal - carbon content. It is interesting to examine its relationship with contract price. Carbon content as a percentage is calculated as follows:

$$CBN = 100 - MST - ASH - VLM \quad (2.6)$$

Equation (2.5) was re-estimated with the replacement of *CBN* for *MST*, *ASH*, and *VLM*, and the estimated results are reported in Table 2.8.

As can be seen from Table 2.8, while the estimated coefficients on other variables do not vary appreciably across the two models, both of the estimated coefficients on *CBN* and *CSN*, which are the most important two quality properties, are

Table 2.8

Re-estimates of the Contract Price Determination Equation

Variable	P	t-value	P	t-value	P	t-value
BHI	-12.119	(-2.31) [†]
BC2	..	..	-4.832	(-1.65) [‡]
BC4	..	..	..	..	-6.636	(-1.96) [†]
QNT	2.117	(3.91) [†]	2.026	(3.73) [†]	2.103	(3.85) [†]
LTD	2.861	(2.07) [†]	2.748	(2.21) [†]	2.849	(2.30) [†]
EGD	2.861	(2.80) [†]	3.023	(2.71) [†]	3.138	(2.82) [†]
CBN	0.343	(3.54) [†]	0.327	(3.32) [†]	0.347	(3.48) [†]
SLP	5.002	(2.48) [†]	4.603	(2.25) [†]	4.713	(2.33) [†]
CSN	0.703	(2.88) [†]	0.821	(3.48) [†]	0.758	(3.14) [†]
EPC	12.999	(8.56) [†]	12.902	(8.33) [†]	12.880	(8.44) [†]
YRD	0.238	(0.28)	0.158	(0.18)	0.194	(0.23)
Constant	18.416	(3.75) [†]	19.043	(3.86) [†]	20.321	(4.16) [†]
N	135		135		135	
Adjusted R ²	0.6829		0.6764		0.6972	

Note: [†] Significant at 0.05 level; [‡] Significant at 0.10 level.

significant and have the expected signs. It is interesting that the estimated coefficient on *SLP* has the wrong sign and is statistically significant. As noted before, sulphur content is only one of the minor properties of coking coal. Since Japanese steel mills typically use sixteen or more coals in a particular blend, they are able to adjust these minor properties and expansion qualities by choosing from a large variety of available coals. Therefore, the steel mills are relatively insensitive to these properties in their quality valuation and are willing to purchase coals within a wide range of specifications for minor properties. They concentrate instead on the two major properties of coal - the fixed carbon content and the caking property. Therefore, these estimated results show that, in general, quality properties are important determinants of coking coal price.²⁴

During the 1980s, the average coking coal price decreased until 1987 due to expanded coking coal supplies and lower demand resulting from the contraction of the steel industry in Japan and other industrial countries. The price has rebounded since 1987 largely because of increased demand from a buoyant steel industry. It is assumed that the balance of bargaining power rests with the Japanese importers during the price-decreasing period, and with the coal producers during the price-increasing period. Thus, an interesting question is

²⁴For a more detailed discussion on Japanese steel mills' preferences on coking coal quality, see Matsuoka (1975).

whether these estimated relationships are stable across the two different periods. To examine this issue, the model was run separately for the contract data in 1986 and for the contract data in 1989; the estimated results are reported in Table 2.9 and Table 2.10 respectively.

As can be seen from Table 2.9 and 2.10, the estimated results are similar in several respects to the estimated results of the pooled model.²⁵ The signs of all significant coefficients are identical in the pooled model and the separate models. Both separate models indicate that the basic determinants of coking coal price are consistent. Yet an interesting difference is that the estimated coefficients on *BHI*, *BC2* and *BC4* are less significant in 1986 than in 1989. This result shows that buyer's market structure is less important in price determination in a period when the average price is declining (the balance of bargaining power rests with the buyer).

In model (2.5), the contract price and contract quantity might be simultaneously determined.²⁶ To tack this potential problem, an instrumental variable is introduced and two-stage

²⁵By using Chow test, the null hypothesis that the regression for 1986 data and for 1989 data are identical can not be rejected at the 5 percent level. This conclusion is suggested by the estimates in *YRD* in Table 2.7, since dummy variable test and Chow test are equivalent (see Snow and Im (1991) for a formal demonstration).

²⁶Variables of contract duration (*LTD*, *EGD*) and contract type (*EPC*) are also important contractual variables. Since data used in the model is the transaction data of a particular year, these variables are predetermined.

Table 2.9

OLS Estimates of the Contract Price Determination Equation, 1986

Variable	P	t-value	P	t-value	P	t-value
BHI	-15.330	(-1.56)	..	..	..	..
BC2	..	..	-7.248	(-1.27)	..	..
BC4	..	..	..	..	-7.518	(1.18)
QNT	2.600	(2.84) [†]	2.499	(2.73) [†]	2.550	(2.74) [†]
LTD	3.423	(1.63)	3.490	(1.65)	3.818	(1.81) [‡]
EGD	4.063	(2.00) [†]	4.129	(2.02) [†]	4.430	(2.05) [†]
MST	-0.034	(-0.05)	0.073	(0.12)	0.070	(0.11)
ASH	-1.059	(-3.13) [†]	-1.064	(-3.05) [†]	-1.053	(-3.01) [†]
VLM	-0.564	(-3.17) [†]	-0.574	(-3.16) [†]	-0.577	(-3.15) [†]
SLP	2.737	(0.71)	2.735	(0.70)	2.412	(0.62)
CSN	0.421	(0.87)	0.574	(1.24)	0.489	(1.00)
EPC	12.971	(4.21) [†]	12.748	(3.99) [†]	12.150	(4.04) [†]
Constant	65.665	(6.27) [†]	65.042	(5.97) [†]	67.309	(5.45) [†]
N	65		65		65	
Adjusted R ²	0.7110		0.7068		0.7056	

Note: [†] Significant at 0.05 level; [‡] Significant at 0.10 level.

Table 2.10

OLS Estimates of the Contract Price Determination Equation, 1989

Variable	P	t-value	P	t-value	P	t-value
BHI	-17.870	(-3.28) [†]
BC2	..	..	-9.656	(-3.00) [†]
BC4	..	..	..	..	10.898	(-3.10) [†]
QNT	1.708	(3.17) [†]	1.672	(3.07) [†]	1.657	(3.06) [†]
LTD	2.631	(2.16) [†]	3.204	(2.58) [†]	3.046	(2.47) [†]
EGD	1.513	(1.47)	1.874	(2.82) [†]	1.921	(1.88) [‡]
MST	-0.096	(-0.28)	0.023	(0.07)	-0.081	(-0.24)
ASH	-1.278	(-4.04) [†]	-1.297	(-3.99) [†]	-1.323	(-4.06) [†]
VLM	-0.189	(-1.93) [‡]	-0.185	(-1.85) [‡]	-0.210	(-2.05) [†]
SLP	1.988	(0.95)	1.945	(0.92)	1.885	(0.90)
CSN	0.574	(2.62) [†]	0.679	(3.18) [†]	0.670	(3.15) [†]
EPC	10.948	(5.69) [†]	10.534	(5.31) [†]	11.558	(6.03) [†]
Constant	58.914	(9.27) [†]	58.691	(9.02) [†]	63.449	(8.73) [†]
N	70		70		70	
Adjusted R ²	0.7249		0.7178		0.7204	

Note: [†] Significant at 0.05 level; [‡] Significant at 0.10 level.

least square (2SLS) estimation is used. The introduction of an instrumental variable involves the search for a new variable X (or a vector of variables) which is highly correlated with the independent variable QNT and at the same time uncorrelated with ϵ , the error term (Pindyck and Rubinfeld, 1981). Sellers' market share (SMS), which is defined as follows, is used as an instrument in this study.

$$SMS = STQ/JTM \quad (2.7)$$

where STQ is seller's total contract quantity with Japanese importers and JTM is Japan's total imports.

The two-stage least square procedure works as follows: In the first stage, QNT is estimated using ordinary least square by regressing QNT on all variables in the right-hand side of equation 2.5 (except QNT) and instrumental variable SMS . From the first-stage regression, the fitted values of QNT are determined. In the second stage regression, equation (2.5) is estimated by replacing the variable QNT with the first stage fitted variable \hat{QNT} . The two-stage least square (2SLS) estimates for the pooled data, 1986 data and 1989 data are reported in Table 2.11. The estimates do not change in any important way from those obtained using ordinary least squares.

Table 2.11
2SLS Estimates of the Contract Price Determination Equation

Variable	Pooled		1986		1989	
	P	<i>t</i> -value	P	<i>t</i> -value	P	<i>t</i> -value
BC2	-8.335	(-2.79) [†]	-7.631	(-1.31)	-9.668	(-2.94) [†]
QNT	2.335	(3.66) [†]	2.710	(2.52) [†]	1.605	(2.49) [†]
LTD	2.845	(2.36) [†]	3.448	(1.60)	2.600	(2.03) [†]
EGD	2.545	(2.39) [†]	4.400	(2.11) [†]	1.243	(1.21)
MST	0.056	(0.17)	0.069	(0.11)	0.089	(0.24)
ASH	-1.027	(-4.31) [†]	-1.028	(-2.90) [†]	-1.321	(-3.94) [†]
VLM	-0.331	(-3.32) [†]	-0.526	(-2.82) [†]	-0.216	(-2.14) [†]
SLP	3.115	(1.43)	2.940	(0.74)	2.225	(1.00)
CSN	0.757	(3.27) [†]	0.552	(1.17)	0.729	(3.34) [†]
EPC	12.710	(8.05) [†]	12.264	(3.82) [†]	11.635	(5.85) [†]
YRD	0.475	(0.56)	..	..	..	..
Constant	57.547	(9.45) [†]	63.193	(5.70) [†]	59.218	(8.72) [†]
N	135		65		70	

Note: [†]Significant at 0.05 level.

2.6 Conclusions and Discussions

A majority of coking coal trade between Japanese steel mills and coal producers around the world primarily takes place within a framework of long-term contracts. Transaction-specific assets, which are the primary factors determining the use of long-term contracts, have some unique characteristics in the case of international trade. For example, though the Williamson's "cheek-by-jowl" type of site specificity does not exist (as Japan is geographically separated from its suppliers), relationship-specific assets still seem to be involved in Japan's coking coal trade with its suppliers. There are many special purpose ports, carriers, bulk loading equipment built to minimize inventory and transportation expenses.

The major findings of the empirical analysis can be summarized as follows. First, Japanese steel mills seem to have exercised monopsony power in the coking coal trade; coking coal prices tend to be lower in markets where the concentration of Japanese steel mills is high. Second, transaction-specific investments (as indicated by contract quantity and contract duration) have significant impacts on coking coal price determination; Japanese steel mills paid a price premium for contracts with larger quantity or with longer duration. Third, while the relationships between coking coal prices and some minor quality specifications are

insignificant and ambiguous, the prices are found to be highly correlated with two major quality properties, i.e., carbon content and caking properties.

The results for the contract duration and quantity variables contrast sharply with the Joskow's (1988) estimates. He used contract duration as one of the independent variables in his regression analyses of base prices and transaction prices in long-term coal supply contracts between coal mines and power plants in the United States. His empirical results showed that duration has no effect on base prices or transaction prices. He also noted that "there does not appear to be a contract-quality effect either" (p.66, footnote 45).

The contrasting results are not particularly unexpected considering the different legal environments in which the respective firms are imbedded. A coal mine in the U.S. selling to a steel firm in the U.S. can appeal to the U.S. federal and state court system to enforce the provisions of a long-term contract. By contrast when the coal firm and the steel firm are located in two different countries, both firms may encounter higher costs of settling a dispute in the other country's court system and a lower probability of prevailing in the dispute. Two substitutes for court adjudication of disputes are to construct contracts such that they are more adaptable to circumstances and to make them self-enforcing (Telser, 1981; Klein and Leffler, 1981). The contracts between Japanese steel mills and foreign coal mines appear to

embody both features. The yearly conference to renegotiate prices ensures a secure supply/demand for both parties without allowing transaction price to deviate substantially from the spot price. And the price premium, as reflected in the positive coefficients on the duration and quantity variables, binds the two parties to the contract by reducing the probability that either party will terminate the contract if there is a temporary price change (Hashimoto, 1979). In lieu of access to low-cost enforcement in the courts, the two parties have structured their long-term contract to ensure maximization of joint wealth.

Chapter 3. ESSAY TWO

Long-Term Contracts in Coking Coal Trade:

Contract Structure and Price Adjustments

3.1 The Role of Long-Term Contracts in the Coking Coal Trade

Long-term contract in resource good trade can be regarded as an institutional arrangement that specifies rules, and incentives, to encourage parties to conform to a particular sequence of resource trade, and to provide limited opportunity for adjustments to be made to the structure of an economic relationship over time. In this essay, we examine the contractual structure and price adjustments in Japan's overseas coking coal procurement contracts. In the hope of facilitating our follow-up discussions, we first review the role of long-term contracts in the coking coal trade and then examine how long-term contracts are structured to conform both parties to prespecified exchange while allowing adjustments when market conditions change.

First, long-term contracts can protect against the hazards inherent in exchange where one or both parties have transaction-specific investments. The exploitation of coal and production of steel are extremely capital intensive, both in the actual extraction (or production) and in the development of infrastructure and port facilities. The

economic value of each party's investments is dependent on other's. For example, the value of coking coal production facilities is dependent on the performance of steel firms that use coking coal as an input. Those who finance investment in coking coal facilities want some assurance that the steel firms will not take advantage of the fact that once the facilities are built the producers may have, at least in the short run, few alternative markets for the coal to be produced. Likewise, those who finance steel mills want assurance that coal producers will not threaten to withdraw coal supply unless a higher price for coal is paid. This threat could materialize if a steel mill, once built, had few alternative sources of supply. Thus, long-term contracts, by prespecifying price and quantity to be traded and other conditions, provide protection for those who invest in these facilities. In addition, long-term contracts provide producers with protection of their market shares in a relatively limited market, while permitting consumers assured supplies in the coking coal trade.¹

Second, long-term contracts can increase market stabilization. Once a coal mine is under full-capacity operation, its output would be highly stable if there were no prolonged industrial disputes. There is, therefore, a strong incentive for the coal producer to use long-term contracts to

¹In contrast, long-term contracts are rarely used in sales and purchases of standardized parts or equipment, where no transaction-specific investments have been made.

protect itself against any fluctuation in coal demand.² The demand for coking coal is derived from the demand for steel, and therefore is primarily determined by the following two factors: the demand for steel and its requirement as an input in steel production. If a steel firm enjoys a relatively stable demand for its products and expects no remarkable technical renovation in steel production regarding coking coal consumption, then it has incentive to use long-term contracts for the supply of coking coal, so as to avoid potential supply instability associated with spot markets and short-term deals.

Thirdly, long-term contracts may reduce transaction costs in trade. The coal market is characterized by small-numbers bargaining. Trade organized through spot exchange is prone to frequent and costly renegotiation, while long-term contracts reduce the need for frequent search for markets (or supplies). Long-term contract arrangements are also likely to result in large quantities being traded between individual sellers and individual buyers, therefore the number of transactions is likely to decrease. The experience gained from continuous dealing with particular suppliers or buyers may promote a mutual understanding which, once initial contracts have been negotiated, allows additional contracts or contract renewals

²If the output is subject to considerable fluctuation, the seller's benefit from using long-term contracts would decrease because he has to use buffer stocks to meet his commitments. A farmer, whose output is subject to weather conditions, probably would not sell all his normal output by using long-term contracts.

to be negotiated relatively quickly and efficiently. All these factors can reduce the transaction costs involved in trade.

3.2 The Structure of Long-Term Contracts and Trends

Because of the transaction-specific assets associated with the coking coal trade, both buyer and seller have a mutual interest in developing a contract that maximizes its value to both parties. However, either party could behave noncooperatively and seek its own interest disregarding the overall value. The structure of contracts, which is reflected by a long list of provisions, is designed to incorporate the attempts of both parties to constrain their noncooperative behavior in order to increase the overall value. The most important provisions are clauses related to contract price, duration, quantity, quality, delivery schedule, conditions of termination or renegotiation, etc. The provisions of duration, price, quantity, and quality are discussed below.

3.2.1. Contract Price Specifications

Because the Japanese importers desire to arrange their own shipping, prices specified in the long-term contracts are in the form of *FOBT*, that is, free on board and trimmed. According to the price provisions, long-term coking coal

supply contracts for Japan can be divided into the following three groups: (1) fixed-price contracts; (2) escalating price contracts; (3) reference price contracts.³

● *Fixed-price contracts (FPC)* Fixed-price contracts are the simplest, most explicit of the various types of price provisions. The price fixed in the contract represents an average price of the initial and final prices over the contract period. The advantages of fixed-price contracts are exactly the motivations for long-term contracting. For example, fixed-price contracts provide producers with protection of their market share in a relatively limited market, while permitting consumers assured supplies at known prices. The primary problem with a fixed-price contract is that the fixed contract price could deviate from the prevailing market price substantially over the term of the contract.

● *Escalating price contracts (EPC)* Over the long term the costs of coal production will change. It is natural to allow the price of coal to vary with changes in the costs of coal production. In an escalating price contract, pricing schemes are often specified as two part prices. The first part is fixed, which is based on the seller's current costs of

³Joskow divided the coal supply contracts in the U.S. coal market into three groups: fixed-price contracts, market price contracts and escalating price contracts. For more detail, see Joskow (1988).

coal production (production cost and scarcity rent). The second part is escalated by a formula linking the increases in the costs of mining labor and materials used in production.

● *Reference price contracts (RPC)* Reference price contracts can tie contract prices paid to a coal producer to prices paid in other contracts covering coal sales in the same "area". The "area" can be a political boundary, like a country or a state, or a geological boundary, such as coal mines in a nearby region. A reference price contract can also tie its contract price to the spot market price of the same product.

A breakdown of long-term contracts in force in 1983, 1986, and 1989 is reported in Table 3.1. A majority of contracts are fixed-price contracts. However, among the contracts which have a duration of two years or longer, the number of fixed-price contracts and escalating price contracts are almost the same. Because of the heterogeneity of coking coal, it would be difficult to use a unified "reference price" for transactions. Therefore, it is unsurprising that reference price contracts have not been widely used in the coking coal trade.⁴ However, identical prices appeared in

⁴However, reference-price contracts are widely used in petroleum markets and natural gas markets. Razavi and Fesharaki (1991, p.5) estimated that oil transactions which link the contract price to the spot market price comprised 50 - 55 percent of total trade in the late 1980s. Most-favored-nation contracts, which tie contract prices paid to a producer to prices paid in other contracts covering sales in the same area, are widely used by small producers in the U.S. natural gas markets. See Hubbard and Weiner (1991).

some groups of contracts (especially annual contracts), though reference pricing provisions were not formally specified in contracts. This might be due to transaction-cost considerations: if the coals are similar (origin, quality, etc.), why should people bother to spend resources determining a tiny difference in prices?

Table 3.1
Breakdown of Contracts by Types^a

Types	FPC	EPC	RPC	Total
1983	- ^b (15) ^c	14	2	- ^b
1986	49(17)	14	2	65
1989	63(5)	5	2	70

Notes: ^aData are drawn from samples of contracts prepared for this study. A few contracts were dropped from the sample because of partially missing information. ^bThe number can not be identified. ^cNumbers in parentheses are contracts with a duration over two years.

3.2.2. Trends in Contract Duration

Duration of a contract is the length of time to which the parties agree *ex ante* to abide by the terms of the contracts. The longest duration in our sample is 17.5 years, a contract for Witbank coking coal in South Africa. A breakdown of

contracts by duration is shown in Table 3.2. Most contracts with a duration over 10 years were signed before 1982 when the prices for coking coal peaked, and many of these contracts turned into evergreen contracts after the initial contract period expired. The contract duration agreed upon in recent years has frequently been shorter than the original contracts. In general, there has been quite a strong move since the mid-1980s towards shorter-term deals – typically annual deals.⁵ As a result, the number of long-term contracts in force has fallen.

Table 3.2
Breakdown of Contracts by Duration

	1 year	2-5 years	> 5 years	Total
1983	-	2	29	-
1986	32	11	21	65
1989	48	6	16	70

⁵A similar trend towards annual deal or even spot deals in other resource markets was also observed. For example, Razavi and Fesharaki (1991, p.4) show that spot exchange in petroleum markets increased from 15 percent in the early 1980s to 35 percent at the turn of the decade.

Several factors can explain this tendency. First, because of the stagnation of the steel industry and the depressed state of the coking coal market, no substantial new specific capital was involved for both buyers and seller since the early 1980s. To the extent that specific investments are one of the primary determinants of long-term contracts, the shorter length of recent agreements is not surprising. Second, market prices of coking coal have decreased dramatically since the early 1980s, a consequence of over-capacity of coal mines in Australia and Canada and stagnation of the world steel industry. As a result, Japanese importers had an incentive to purchase annually so as to take advantage of flexible (declining) market prices over rigid contract prices. Third, the shortening of contract duration might also be a response to the increased uncertainty associated with the coal market and technology of steel industry. Apart from the price fluctuations of the 1980s, it was expected that the iron and steel industry would use lower quality coking coal in a blend with high-quality coking coal or employ new technologies, such as pulverized coal injection.⁶ Either course reduces the consumption of high-quality coking coal.

⁶Pulverized coal injection (PCI) is a relatively new technology used in pig iron manufacturing. It is the process of partially substituting coke in the blast furnace with pulverized coal which is generally made of low quality semisoft or soft coking coal. The International Coal Report (1991) reported that Japan consumed 6 million tons of PCI coal. For an analysis of the impact of pulverized coal injection on Japan coal demand, see Dwyer and Muir (1992).

Faced with these uncertainties, Japanese steel mills and importers would not have incentives to enter into long-term contracts.

The coking coal procurement of the Japanese steel mills takes place in the United States, Canada, Australia, Russia, China, South Africa, and some Latin American countries. There are significant differences in the use of procurement contracts across these countries. Table 3.3 reports the numbers of long-term contracts used in different countries in 1986. It shows that most of Japan's long-term coking coal procurement contracts were employed between Japanese steel firms and coal producers in Australia and Canada. This can be explained by the interdependence of Japanese steel firms and coal producers in Australia and Canada. On the one hand, Japanese steel firms import about 70 percent of their coking coal requirements from coal producers in Australia and Canada. On the other hand, Australia and Canada, respectively, exported 54 percent and 70 percent of their coking coal production to the Japanese steel firms in 1986; the comparable figure for the United States and other countries was much lower. This explanation is consistent with the notion of asset specificity, which is frequently advanced as an important factor determining the use of long-term contracts. According to the argument of asset specificity, contracts are of longer duration where both buyers and sellers have made

sunk investments, or where buyers have few alternative supply sources, or where sellers have no other potential purchasers.⁷

Table 3.3

Breakdown of Contracts by Duration and by Countries

Regions	1 year	2-5 years	> 5 years	Total
Canada	1	2	6	9
Australia	25	4	10	39
U.S.A.	1	1	3	5
Others	11	0	1	12

3.2.3. Quantity and Tonnage Options

Normally the tonnage delivered under a contract is only a portion of the total production of a mine or the total consumption of a steel mill. Coal suppliers and steel mills seem to have a policy of diversification which generally limits any one contract to below about 20 percent of the total production or input requirements. The quantity of particular contracts may vary between 10,000 and 5,000,000 tons per

⁷Joskow tested the hypothesis that the more important are the transaction-specific investments, the longer will be the contract duration. His empirical results provided fairly strong support for the hypothesis. For more detail, see Joskow (1987).

annum, but are normally about 200,000 to 1,000,000 tons per annum. If a Japanese steel firm has equity participation in a coal mine, its contractual tonnage is usually larger and one contract may supply more than 20 percent of the firm's imports. This is revealed in the contracts between Japanese importers and coal producers in Canada and Queensland, Australia, with whom the Japanese steel firms have considerable equity participation.

In most cases, there is a tonnage reduction at the buyers' option of plus or minus 10 percent, though a 20 percent or even 50 percent option is not uncommon in some annual contracts signed in the late 1980s. In some contracts a recession clause is provided under which buyers may make an extra cut in their import tonnages in the case of an unusual overall economic recession, provided such a cut is not discriminatory with respect to other suppliers.⁸ Tonnage reduction at buyers' option might also be due to transaction-cost considerations and be an efficient solution. Coking coal is a large volume input in steel production; it is very costly for steel mills to store large stocks of coal given fluctuations in steel demand. On the other hand, coal producers are likely to vary production levels to some extent; therefore, it is less costly for coal producers to "store" the

⁸While labor strikes and accidents at coal mines have been sometimes advanced by coal producers as reasons for renegotiation on the quantity to be delivered, no formal clauses on these matters were stipulated in the contracts of our sample.

coal in coalfields and arrange output according to predetermined delivery schedules. In addition, because of differential land rents, the cost of holding stocks is substantially lower for coal producers in Australia and other exporting countries than for steel firms in Japan.

3.2.4. Quality Specifications

Since coal is a heterogeneous product, there is a wide range of quality parameters to specify in a contract. Quality parameters vary between contracts due to different technical requirements. In Japanese coking coal import contracts, there are five basic specifications: total moisture (%); ash content (%); volatile matters (%); total sulfur (%), and the crucible swelling number. The first three are indirect measures of the carbon content in a particular coal, because carbon content is calculated as a residual by subtracting the percentages of moisture, ash and volatile matter from one hundred. The content of sulfur is an environmental indicator; and crucible swelling number represents the caking ability of coking coal. Some of the quality parameters are specified in ranges between minimum or/and maximum levels with tolerance to cover minor variations.

Quality is normally monitored by an independent authority with a recognized level of competence. The two parties mutually agree to this authority, and his activities are

mostly carried out at the loading port; the seller pays for these services. Although loading port analyses are final and binding on both parties, many Japanese importers regularly conduct their own analyses on receipt of the coal at the discharge port. These are mostly carried out by the buyer's staff, rather than independently, and generally have no contractual recognition. However, in the event that there is a continuing significant discrepancy between loading port and discharge port results, it is quite reasonable for the seller to investigate such discrepancies. In some contracts, it is explicitly specified to be the seller's obligation if the quality is not within the tolerance range. For example, in a 15-year contract between Japanese steel firms and the Fording Coal Ltd. (Canada), there is a clause on maintenance of coking coal property, which stipulates that should there be arrivals of coal with CSN (crucible swelling number) below 4.5, the Japanese side should give notice to the seller of the fact; the seller and the buyer are to discuss and study the problem; then if shipment of coal with such quality is received twice in succession, buyers may suspend receipt of future shipments and seek compensation.

3.3 Price Adjustments in Long-Term Contracts

Long-term contracts promote efficiency by avoiding costly repetitive bargaining over the terms of trade and reducing the risk to each party of relying on the performance of the other. However, in reality contracts are not necessarily precise, mechanically enforced documents. Long-term contracts often provide price-adjustment provisions.

Price-adjustment provisions have become more important and been used more frequently since the mid-1970s. On the one hand, continuous inflation in the world economy has led producers to seek price escalation to cover the rapidly rising costs of production. On the other hand, the unexpected stagnation of the steel industry caused purchasers to seek renegotiation for reduction in tonnage delivery as well as a markdown in real prices.

Generally, economists have identified three motives for price adjustments: risk sharing, incentive alignment, and transaction-cost based arguments.⁹ Risk-sharing arguments see the goal of price adjustments as stabilizing the surplus of the more risk-averse party. In the incentive explanation, prices in variable quantity contracts are adjusted to provide appropriate price signals to the transactor having discretion over quantity. The third rationale seems to be more apposite in the case of coking coal supply contracts. According to

⁹See, for example, Crocker and Masten (1991).

this explanation, the goal of price adjustments is to reduce relational frictions. Changes in market conditions during execution of a fixed-price contract may leave one or the other party in an unfavorable position relative to outside opportunities. That party then becomes more likely to engage in rent-seeking activities designed to evade performance or force a redistribution of contractual surpluses. If the probability of wasteful behavior increases as the divergence between contract price and opportunity costs of the aggrieved party widens, price-adjustment rules which narrow the gap become increasingly attractive.

Price-adjustment provisions are usually provided in contracts with a duration of more than three years. Price adjustments in fixed-price contracts are achieved by "price review" and "price in equity review" on a regular basis. The intent of the "price review" is to allow an adjustment in the initial price to a level more closely related to the prevailing market and/or to allow a catch-up of costs. Price reviews usually take place every year between the Japanese importers and their coal suppliers, but this does not necessarily mean that prices change annually. Under a "price in equity review," the coal price may be revised whenever the coal becomes less or more expensive than other coal to an unequitable extent, as in the case of the first oil shock which resulted in skyrocketing prices on the spot coal market.

Typically, there are two types of price adjustment provisions in escalating price contracts apart from regular base price reviews. One is the "cost-plus" provision, by which the price is adjusted according to the actual costs of coal production. This type of provision does not provide adequate incentives for the suppliers to produce efficiently (Joskow, 1988). Another type of provision uses exogenous indexes on cost change as the basis for price adjustments. These indexes include changes in wage levels, the prices of raw materials and equipment, and so forth. In some cases, a combination of these two provisions are used in the escalating clauses. The components for escalation in those contracts include wages, materials and equipment costs, royalties, port dues, railway freights, diesel oil price, and so on. Changes in wages, materials and equipment costs, and railway freights are calculated from a pre-determined share of escalating components multiplied by the rate of increase in the government's indexes of those items announced every three months. Royalties, port dues, and other components are directly adjusted. With an escalation clause, transaction prices generally track the actual costs of suppliers, but they do not necessary reflect market conditions.

The price of a reference price contract can be very simple and can be tied to several exogenous prices. For example, in the 5-year contract of Dombarton hard coking coal (New South Wales, Australia), the price is simply stated as to

be determined at US\$3.85 less than that of Coal Cliff (New South Wales, Australia). But in another reference price contract, the 15-year contract between Japanese steel mills and the Jim Walter Resource Co. of the United States, price indexes were specified as follows after renegotiation:

a) Export prices of both Pittson MV Blend and Mettiki coals (the United States) to Japan.

b) Export price of U.S. metallurgical coal to markets other than Japan.

c) Prices of thermal coal produced from underground mines in the U.S. for power utilities, which are the long-term price indexes reported by U.S. power companies to the U.S. Energy Department.

d) Export prices of three brands of coking coal (Moura, South Blackwater, German Creek) from Queensland, Australia to the Japanese markets.

Apart from the price adjustment provisions, renegotiation plays an important role in the process of adjusting prices in all long-term contracts. While most contracts did specify price for long-term periods in the future, and some included complicated formulae for determining price increases (labor escalation clauses, inflation clauses, royalty clauses, etc.), these terms and conditions were adhered to only in those rare instances where it suited the interests of both parties to do so. In most cases, one or the other party felt the need to

renegotiate terms each year to account for changes in circumstances not fully specified in the contract.

Renegotiation can not only change the base price specified in a contract, it can also change the price review intervals, the escalation method, and the reference prices of a reference price contract. Renegotiation can take into account the full range of relevant new information before settling on price and therefore gives the transaction a considerable degree of flexibility. In some of the contracts, renegotiation provisions are provided which specify the time or the conditions for renegotiation. But renegotiation could take place at the request of any party even if there are no such provisions in a contract. There are many circumstances in which this would happen. A buyer can succeed in a mark down of the contract price if it is above the seller's marginal costs and the seller has difficulty finding alternative buyers. Another case is that the seller would accept a price reduction if the buyer increases quantity or takes all optional tonnage.

Such renegotiations took place annually, between January and March, when Japanese steel-makers negotiated with each supplier the prices and quantities for the next fiscal year. Most of the contracts are no longer mechanically implemented documents, but are characterized by an ongoing process of negotiation over the terms of trade. These renegotiations have, in general, been tough but successful; very few cases

were filed, and fewer went to trial. The only exception in 1980s was the 15-year contract of Quintette coking coal of Canada. A brief discussion of the dispute over this contract may be interesting.¹⁰ The Quintette Coal Mine is located in the eastern Rocky Mountain foothills in northeastern British Columbia. It was built to be a dedicated coking coal exporter to Japanese steel firms. The contract was signed in 1981. The duration of the contract is 14.5 years; and the total tonnage intended to be 69.55 million tons over this 14.5 year period. The base price was set at C\$75 per ton, of which C\$35 was fixed and C\$40 was escapable by a formula linking the increases in the costs of diesel fuel, mining labor and materials used in manufacturing. Because of the escalation clause, the price of Quintette coking coal had risen to C\$97.24 by April 1, 1984 and by April 1985 would have been C\$101.28 per ton, which was 44 percent higher than the price of very similar coal produced in the south east of BC. Through renegotiation, the Japanese importers won a C\$8.5 per ton reduction in the fixed part of the pricing scheme from April 1985. However, by April 1988 the contract price of Quintette escalated to C\$106.97 per ton, while price of coal produced in south eastern BC decreased to C\$58 per ton. The Japanese side requested to reduce the contract price significantly and to eliminate the escalation clause. Because

¹⁰The following discussion is primarily based on Barnett (1991).

of unfavorable financial conditions, the Canadian mine refused any further price reduction. The contract dispute finally developed into such an unprecedented case that the Japanese side appealed to a court of arbitration in British Columbia province. After a lapse of nearly two years, the Arbitration Court of British Columbia ruled that the price of Quintette coal be progressively reduced to C\$82.40 per ton by January 1991, neglecting escalation, and that Quintette must reimburse the Japanese importers C\$46 million it had received by way of over payment given the new prices.

3.4 Long-Term Contracts and Market Stability

While questions relating to the issue of market instability for raw materials have occupied a position in development economics since the 1970s,¹¹ scant attention has been paid to the role of long-term contracts as one particular vehicle for achieving market stability (or limiting market instability). One exception is Rogers and Robertson (1987), who examined the relationship between the use of long-term contracts and market stability in the international iron ore market. In this section, a simple empirical analysis is conducted to examine the relationship between the use of long-term contracts and market stability in the coking coal markets.

¹¹See, for example, Tilton (1978).

Stable coking coal supply has been, as noted above, a major concern for the Japanese steel mills and importers. The use of long-term contracts in the coking trade may have contributed to stabilization of the international coking coal markets. The effect of long-term contracts on import market stability can be observed by comparing the movements of Japanese coking coal *CIF* prices and the average domestic coking coal prices of the three major exporting countries: Australia, Canada, and the United States. Table 3.4 reports these price series from 1981 to 1991.

The commonly followed procedure to measure market instability is to use indexes which define some mean or trend in the data series and measure deviations from the mean or trend. There are a number of ways in which this may be done. The frequently used index is the Moving Average Trend Index (*MATI*); it can be defined as in the following way:¹²

$$MATI = \frac{100}{n} \sum_{t=1}^{t=n} \frac{|p_t - p_t^*|}{p_t^*} \quad (3.1)$$

where n is the number of years covered, p_t is the value of price in year t , and p_t^* is the five-year moving average price

¹²For definitions and a brief and useful review of other indexes, such as the Linear Trend Index and the Logarithmic Trend Index, see Rogers and Robertson (1987).

Table 3.4

The Average Japanese Coking Coal *CIF* Prices and Domestic
Prices of Australia, Canada and the USA

Year	<i>CIF</i> Prices from			Domestic Prices of		
	USA	Canada	Austr.	USA	Canada	Austr. ^a
1981	80.12	66.98	71.24	69.29	82.97	28.14
1982	83.95	70.77	74.42	71.62	87.47	35.82
1983	78.82	70.16	63.36	65.37	88.05	33.55
1984	70.94	69.52	59.03	62.37	77.90	31.76
1985	68.66	67.51	54.36	59.86	75.50	34.59
1986	64.70	66.65	52.82	56.03	75.06	35.24
1987	64.03	65.42	48.26	51.53	76.88	33.08
1988	60.34	67.36	48.30	52.58	73.39	29.29
1989	63.34	69.73	52.58	52.36	67.35	28.04
1990	66.90	71.27	55.27	52.68	66.65	29.25
1991	66.16	71.85	56.64	53.82	67.56	29.46

Notes: ^aThe domestic prices of Canada and Australia are in Canadian dollar and Australia dollar respectively.

Sources: Derived from International Energy Agency, *Energy Prices and Taxes*, various issues.

centered on year t . The advantage of *MATI* is that it indicates the average absolute percentage by which annual values for prices deviated from their five-year moving average. The values of this index (*MATI*) for Japanese coking coal *CIF* prices and the corresponding domestic prices of these exporting countries are reported in Table 3.5.

Table 3.5
Moving Average Trend Index for Prices over 1981-91

Exporters	Australia	Canada	USA
Japan's <i>CIF</i> prices	3.64	1.76	2.75
Exporter's Domestic Prices	7.07	3.40	3.22

If other things are equal, it can be expected that the Japanese *CIF* prices will be less stable because they are vulnerable to exchange rates and transport cost changes. However, it is revealed from Table 3.5 that the opposite is true for all three countries, especially for Australia and Canada, as their domestic prices for coking coal fluctuated with magnitudes almost twice as much as Japan's import prices for coking coal from the two countries respectively. This is very likely to be due to the extensive use of long-term contracts. As noted above, Japan's coking coal imports

primarily take place within the framework of long-term contracts. For example, in 1986, only 4 percent of coking coal procured by Japanese steel firms involved spot market transactions; about 66 percent involved long-term contracts or evergreen contracts; the remaining 30 percent involved annual contracts. In contrast, considerably more spot transactions are used in the domestic sales and purchases in these exporting countries. The U.S. producers have access to a large domestic market and European markets; they have been swing suppliers and engaged in considerable spot transactions historically.¹³ Although long-term contracts have been frequently renegotiated, they were likely to have attenuated the fluctuations in Japan's coking coal import prices. Many long-term coking coal contracts resulted in large quantities being traded between coal producers and Japanese importers, while domestic transactions in Australia and Canada are likely to be scattered and small because their domestic coking coal consumption is only a small fraction of their production (12 percent and 6 percent respectively). The large quantity of coking coal traded under long-term contracts may also contributed to the stability of Japanese import prices.

The relative magnitudes of the three indexes for Japanese coking coal *CIF* prices are also consistent with the argument

¹³Joskow's research on steaming coal in United States showed that roughly 15 percent of coal purchased by electric utilities involves spot market transactions. See Joskow (1988).

that long-term contracts contributed to market stability. Almost all the coking coal imports from Canada were through long-term contracts and the contracts between Canada and Japan have the longest duration on average,¹⁴ while many contracts between Australia and Japan were annual contracts. On the whole, the results provide support for the argument that long-term contracts have contributed to market stability, and particularly to price of coking coal in Japan's steel industry.

3.5 Summary and Conclusions

Coking coal trade between Japanese steel firms and their foreign coking coal suppliers primarily takes place within a framework of long-term contracts. Though the primary motives of long-term coking coal contracts are to protect against opportunism and guarantee sellers' access to markets and buyers' access to supply because of the presence of transaction-specific investment, they are not, in practice, precise, mechanically enforced documents. Because of the stagnation of the world steel industry and increased uncertainty of coal market (such as the employment of new technology used in steel industry), the contract durations stipulated in recent years have frequently been shorter than the original contracts. In addition, price adjustment

¹⁴See Table 3.3 in Section 3.2.2.

provisions, tonnage options and quality tolerances are frequently provided in many long-term contracts.

Long-term coal contracts can be classified into three categories based on price adjustment provisions: fixed-price contracts, escalating price contracts and reference price contracts. Price adjustment provisions are usually provided in contracts with a duration of more than three years. Price adjustments in fixed-price contracts are achieved by regular price reviews and price in equity reviews. Price adjustments in escalating price contracts are realized either by "cost-plus" provisions or by escalation formulae based on wage levels, inflation, royalty, etc. The price of a reference price contract is tied to and adjusted with prices of other contracts or spot market prices. While most contracts did specify price adjustment provisions for long periods, the Japanese steel firms and their suppliers were more willing to engage in annual renegotiations on contractual prices and quantities. Long-term contracts in coking coal trade have simply become an ongoing processes of negotiations over the terms of future trade. This may be due to lack of effective enforcement of international long-term contracts; parties are willing to structure contracts such that they are more adaptable to circumstances.

While long-term contracts were regarded as little more than statements of intention to do business over a substantial period in the future, they have provided a framework for

negotiations which can significantly enhance the stability of the trading relationship. There is evidence that they might have contributed to market stability of Japanese steel firms' coking coal imports. The market stability index used in this study shows that due to the extensive use of long-term contracts, Japanese import prices for coking coal were more stable than domestic prices in those exporting countries.

Chapter 4. ESSAY THREE

A Theory of Procurement Contract Choice

4.1 Introduction

The procurement of an input by a downstream firm from an upstream firm in spot markets frequently involves substantial transaction costs and tends to fail if one or both parties have made transaction-specific investments. The transaction costs can be reduced by substituting internal organization (vertical integration) for market exchange. Another alternative is to employ long-term contracts. If the downstream firm chooses contracting as its vehicle for procurement, then it has two alternative channels of access to an input: direct contracting with producers (direct contracting), or delegating the procurement task to a trading company which then contracts with producers (indirect contracting). For example, Japanese steel firms' coking coal is procured through a group of trading companies. The trading companies are not subsidiaries of the steel firms but independent firms. They act as the "go-between" to facilitate trade between Japanese steel firms and their foreign coking coal suppliers.

The purpose of this essay is to examine the downstream firm's choice of procurement contracts: direct contracting or indirect contracting. While several authors have attempted to

explain the choice of different production organizations, such as ownership or contractual relationship (Grossman and Hart, 1986), vertical integration or long-term contracts (Wiggins, 1990), and make-or-buy decision in production (Masten, 1984; Masten, Meehan and Snyder, 1991), no attempt has been made to examine contractual choice in input procurement.¹ Perhaps the only study related to the question posed in this essay is Chu (1989). Chu provided a model of a manufacturing firm's marketing channel choice: to use a trading firm or to market the product itself. He argued that while the trading firm enjoys low marketing costs due to static scale and scope economies, the manufacturing firm benefits from dynamic learning-by-doing when it does the marketing itself and learns about the market. The trade-off between these two effects determines the manufacturing firm's choice of marketing channels. In our case of input procurement, the trading firm also enjoys low procurement costs because of its scale and scope economies and its special knowledge of the input market. Moreover, the downstream firm's learning-by-doing advantage is

¹This deficiency could be due to institutional differences between the U.S. and Japan. The importance of independent trading companies in the U.S. declined as large manufacturing firms emerged on the scene and took over their own product marketing and input procurement (Chu, 1989). The situation in Japan is believed to be quite different, as product marketing and input procurement has generally been handled by independent trading companies. For a general discussion of the historical evolution and the role of Japanese trading companies in the Japanese economy, see Yoshihara (1982) and Young (1979).

limited. This is because the input material is a product of the upstream firm and varies with the upstream firm's operational conditions and resource endowments; the downstream firm does not necessarily enjoy an advantage through learning-by-doing over the trading firm in input procurement.²

What, then, is the relative advantage of a downstream firm over a trading company in the case of input procurement? We posit that the downstream firm has an advantage in the ability to monitor quality because of its greater knowledge of its own production process and input requirements. Thus, in our model, while the trading company is more effective in input searching activities, the downstream firm is more effective in monitoring activities. It is the trade-off between these two effects which determines the downstream firm's choice of contract type: direct contracting or indirect contracting.

The downstream firm's choice of procurement contracts involves several critical transaction parameters. The theory of transaction-cost economics can be used to shed light on this issue. According to this theory, the choice among alternative organizational arrangements is part of an agent's

²Even the manufacturing firm's advantage in learning-by-doing is subject to controversy. Yamamura (1975) argued that it is the trading companies which have a learning-by-doing advantage because a worker in a trading company does the same task many times within a given period; learning-by-doing is typified by the increased command of foreign languages attained by veteran employees of trading companies.

overall optimization problem, and the net value of a transaction organized in a particular manner depends not only on the losses due to potential misallocations of resources but also on the costs of conducting the transaction itself.³ We view "the costs of conducting the transaction itself" as unmarketed inputs. The two specific unmarketed inputs are, as we discussed above, the monitoring ability and the searching ability. We believe that these are important factors in contract choice determination.

The rest of this essay proceeds as follows. In Section 4.2 a general model of contractual choice is introduced. In Section 4.3 the model is solved for a Cobb-Douglas specification. The results of comparative static analyses are presented in Section 4.4. Some implications of the model for Japanese trading companies are discussed in Section 4.5. Conclusions are summarized in Section 4.6.

³The theory of transaction costs is frequently applied to explain contractual structures in agriculture; see, for example, Eswaran and Kotwal (1985), Roumasset and Uy (1987), and Vandeman and Sadoulet (1991). Although the procurement contracts examined here are quite different from agricultural contracts, many of the same analytical constructs can be applied to procurement contracts.

4.2 The Model

We model a downstream firm that needs to procure an input material X to produce a product (with other inputs). The firm can either procure X by direct contracting with a supplier or through a trading company which contracts with a supplier. We denote the former type of contract as contract type f (direct contract), the latter as contract type t (indirect contract).⁴

The production process of the downstream firm is crucially dependent on the attributes of input X . The input may be heterogenous, may be inconsistent in quality, and may even be subject to supply interruption. The downstream firm or the trading company can influence the "quality" of these attributes.⁵ They have two means of assuring quality from producers of input materials to boost the "effective material input." One is by direct monitoring; the other is to search for reliable suppliers and to apply pressure on the suppliers to perform the contractual obligations by the threat of contract termination.

⁴In the case of an indirect contract, the downstream firm and the trading company have an implicit contract. They have a long-term relationship and have established good reputations. Their implicit contract is assumed to be enforced by the power of reputations (Holmstrom, 1981).

⁵"Quality" here can be understood in a broad sense; it may include the physical quality of the input material as well as the timing of its delivery.

We have argued above that the downstream firm has a comparative advantage in monitoring activity over a trading company because of its greater knowledge of its specific requirements for the input material. This would be especially true for some heterogeneous materials (such as mineral products). In this case, producers of the input have much better information than the downstream firm or the trading company. This asymmetric information frequently leads to incomplete contracts since it can be extremely costly to write a contract that specifies unambiguously all possible actions of all parties in every observable state of nature. Parties would rather write an incomplete contract, i.e., the contract will specify some attributes of the input material X but not others; it will mention what should happen in some states of the world, but not in others although both specified and unspecified attributes of the input have important effect on the downstream firm's efficiency and output. An example may be useful. Suppose the downstream firm is a steel mill and X is one of its inputs: coking coal. Suppose that the steel mill which uses coking coal for producing steel does not function well if the coal supplied is impure. Ex ante there can be many potential impurities, and it may be too costly to include clauses for each of these in the contract. Ex post, however, it may be clear what the relevant impurity is. In the case of incomplete contracts, monitoring activity by the downstream firm is likely to be more effective in ensuring the

quality of the procured input compared with the trading company, because the effectiveness of the trading company's monitoring activity may be quite limited with respect to unspecified attributes of the input.

Therefore, monitoring effort M under different contracts has different effects on the downstream firm's production. Let β_i be a parameter representing the efficiency of monitoring under contract i ($i = f, t$). Since the downstream firm (indexed as f ; f stands for firm) is relatively more efficient in monitoring than the trading company (indexed as t ; t stands for trading company), we specify $\beta_f > \beta_t$.

The purpose of search activity is to find the most reliable supply sources and secure supply. There are two means to increase the reliability and security of supply. The first is to make transaction-specific investments, which link the buyer and seller together and secure supply from a buyer's perspective. The second is to apply pressure on the supplier to perform the contractual obligations by the threat of contract termination. The effectiveness of this strategy depends on the difference between the contract price and the opportunity cost of the supplier. Klein and Leffler (1981) demonstrated that a necessary and sufficient condition for performance is the existence of price sufficiently above salvageable production costs so that the nonperforming firm loses a discounted stream of rents on future sales which is greater than the increase in wealth from nonperformance.

Assume that there is a prevailing price for X in the market. Then the effectiveness of the threat of contract termination under the two types of contracts is determined by the ability to search for input producers with low opportunity costs, i.e., input producers with transaction-specific investments. Trading companies specialize in foreign trade and many of them have dealt with a considerable number of producers for many years. Therefore, they have a learning-by-doing advantage (human asset specificity). In addition, they have a comparative advantage over the downstream firm in searching for producers who are reliable and have low opportunity costs. Let S be the search activity for X and δ_i a parameter representing the efficiency of search under contract i . Therefore, $\delta_f < \delta_i$.

We posit that the production of the downstream firm entails the use of two factors: (1) the input X ; (2) and a second input K . The quality of X is raised by the monitoring effect, βM ; and search effect, δS . X is transformed by these activities to an effective material input, Z , and can be expressed as

$$Z = Z(X, \beta M, \delta S) \tag{4.1}$$

$$Z_1 > 0, Z_2 > 0, Z_3 > 0$$

where Z_1 , Z_2 , and Z_3 are first derivatives of Z respect to the first, second and third argument, respectively.

The output of the downstream firm is

$$\begin{aligned}
 Q &= F(Z, K) \\
 &= F[Z(X, \beta M, \delta S), K]
 \end{aligned}
 \tag{4.2}$$

$$F_Z > 0, F_K > 0; F_{ZZ} \leq 0, F_{KK} \leq 0.$$

Let w be contractual price for X , and u the cost of capital K . If the downstream firm has a direct contract with a supplier to procure the input, its procurement decision solves the following optimization problem:

$$\begin{aligned}
 \text{Max}_{X, M, S, K} \Pi_f &= pQ_f - wX_f - uK_f - v_f M - v_f S \\
 &= pF[Z(X_f, \beta_f M_f, \delta_f S_f), K_f] - wX_f - \\
 &\quad - uK_f - v_f M - v_f S
 \end{aligned}
 \tag{4.3}$$

where p is the competitive price of output Q , assuming p to be constant; v_f is the marginal costs of the downstream firm's monitoring activity and search activity.

Under an indirect contract, trading companies procure the input for the downstream firm. Competition among trading companies ensures that they will conduct the monitoring and search activities assigned by the downstream firm and receive

the commission fee for their services.⁶ The downstream firm's maximization problem is:

$$\begin{aligned}
 \text{Max}_{X_t, M_t, S_t, K_t} \Pi_t &= pQ_t - wX_t - uK_t - rX_t - v_t M - v_t S \\
 &= PF[Z(X_t, \beta_t M_t, \delta_t S_t), K_t] - (w + r)X_t \\
 &\quad - uK_t - v_t M - v_t S \qquad (4.4)
 \end{aligned}$$

where rX_t is the commission fee paid by the downstream firm to the trading company for the procurement contracts and r is fixed commission rate;⁷ and v_t is the marginal cost of the trading company's monitoring and search activity, which is reimbursed by the downstream firm.

Function (4.3) and (4.4) are standard form of a profit-maximizing firm's profit function. Profit function (4.3) distinguishes from profit function (4.4) only in the magnitude of exogenous parameters. It might be more interesting to examine the indirect function $\pi(\beta, \delta, w, v)$, that is, an objective function that represents the maximum value of Π_t (or Π_t) for any specified β, δ, w , and v .⁸ It is expressed as follows:

⁶The notion of competition among Japanese trading companies has been defended by several authors; see, for example, Yamamuru (1975).

⁷The downstream firm may pay a commission rate higher than market rate to attenuate the problem of moral hazard possibly associated with trading companies.

⁸Exogenous parameter p and u are omitted because they do not vary across contracts.

$$\begin{aligned} \pi(\beta, \delta, w, v) = & pF[Z(X^*, \beta M^*, \delta S^*), K^*] - wX^* - \\ & - uK^* - vM^* - vS^* \end{aligned} \quad (4.5)$$

The first partial derivatives of the indirect profit function with respect to w , v , β , and δ are:

$$\partial\pi/\partial w = -X^* < 0 \quad (4.6)$$

$$\partial\pi/\partial v = -(M^* + S^*) < 0 \quad (4.7)$$

$$\partial\pi/\partial\beta = pF_Z Z_2 M^* > 0 \quad (4.8)$$

$$\partial\pi/\partial\delta = pF_Z Z_3 S^* > 0 \quad (4.9)$$

Therefore, the isoprofit curve, defined as the locus of combination of β and δ that yields the same profit level, must be negatively sloped, as drawn in Figure 4.1. This can be derived from $\partial\pi/\partial\beta > 0$ and $\partial\pi/\partial\delta < 0$. Which contract type will be chosen depends on the relative magnitude of β_i and δ_i . Suppose the profit under direct contract is equal to the profit under indirect contract at point A on isoprofit curve π_A (both the downstream firm and the trading company have the same combination of β' and δ'). Because $\partial\pi/\partial\beta > 0$ and $\beta'' > \beta'$ (while δ remains the same), direct contract would be chosen at point B on isoprofit curve π_B . Likewise, indirect contract would be chosen at point C on isoprofit curve π_C . The relative position of π_B and π_C is dependant on the relative magnitude of β_i , δ_i , v_i ($i = f, t$) and r . If an indirect contract is

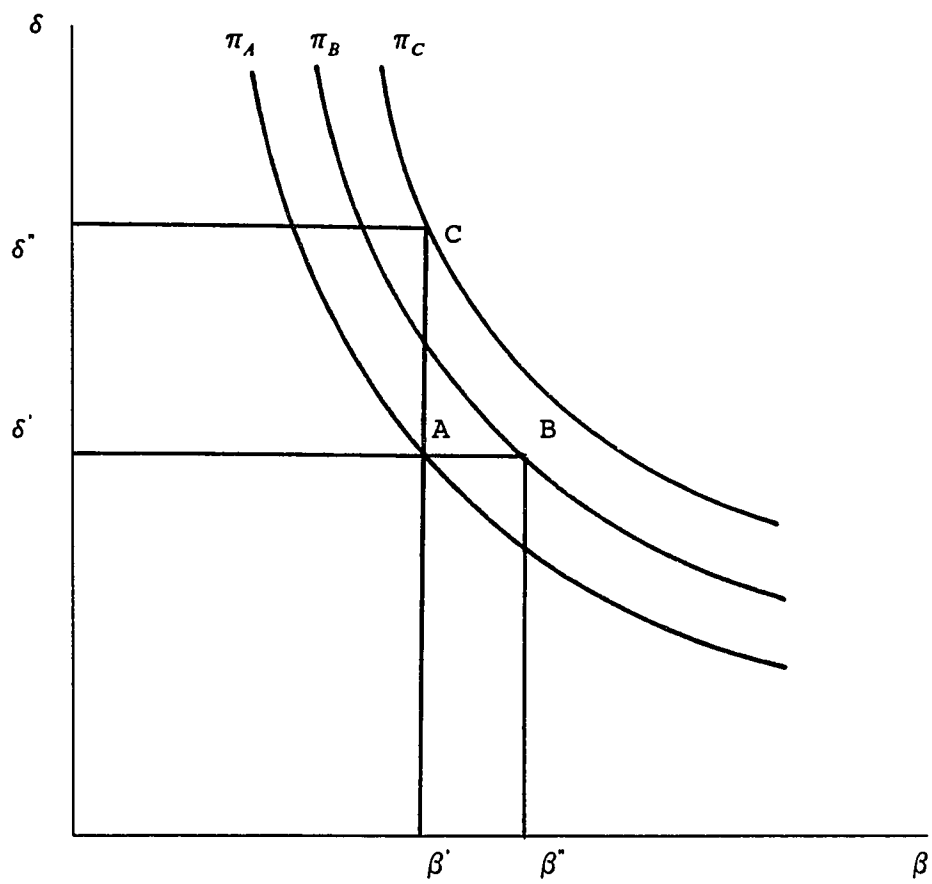


Fig 4.1. Isoprofit Curves

chosen, the profit differential between the indirect contract and a direct contract must be greater than zero, that is:

$$\Delta\pi \approx \frac{\partial\pi}{\partial\beta} \Delta\beta + \frac{\partial\pi}{\partial\delta} \Delta\delta + \frac{\partial\pi}{\partial w} \Delta w + \frac{\partial\pi}{\partial v} \Delta v > 0 \quad (4.10)$$

That is,

$$pF_Z Z_2 S^* (\delta_i - \delta_f) - (M^* + S^*) (v_i - v_f) > \\ pF_Z Z_2 M^* (\beta_i - \beta_f) + X^* r \quad (4.11)$$

Equation (4.11) implies that if the downstream firm is to use a trading company to procure inputs, the benefits stemmed from the trading company's relative advantage in search activity and relatively low payments for its monitoring and search activities must be greater than the sum of the foregone benefits from the downstream firm's relative advantage in monitoring activity and the payment of commission fee. In what follows, we explicitly solve the model for a Cobb-Douglas specification and present the comparative static results.

4.3 Results of Cobb-Douglas Specification of the Model

The effective input Z is assumed to be given by the following expression:

$$Z = Z(X, \beta M, \delta S) \\ = X^{(a1/b)} (\beta M)^{(a2/b)} (\delta S)^{(a3/b)} \quad (4.12)$$

where $b = a_1 + a_2 + a_3$. The production function of the downstream firm is assumed to be given by the following Cobb-Douglas specification:⁹

$$Q = AZ^b K^{a_4}, \quad b + a_4 = 1. \quad (4.13)$$

Then

$$Q = AX^{a_1} (\beta M)^{a_2} (\delta S)^{a_3} K^{a_4} \quad (4.14)$$

where A , a_j , $j = 1, 2, 3, 4$ are positive constants and

$$\sum_{j=1}^{j=4} a_j = 1 \quad (4.15)$$

In this entire section, we normalize the price and the stock of capital K to unity. The optimization problem for contract type f can be written as follows (for simplicity, subscript f is omitted when possible):

$$\text{Max}_{X,M,S} \{PAX^{a_1} (\beta_f M)^{a_2} (\delta_f S)^{a_3} K^{a_4} - wX - uK - v_f M - v_f S\} \quad (4.16)$$

The first order conditions for (4.16) are:

$$FOC(X) : a_1 PAX^{a_1-1} (\beta_f M)^{a_2} (\delta_f S)^{a_3} K^{a_4} - w = 0 \quad (4.17)$$

$$FOC(M) : \beta_f a_2 PAX^{a_1} (\beta_f M)^{a_2-1} (\delta_f S)^{a_3} K^{a_4} - v_f = 0 \quad (4.18)$$

$$FOC(S) : \delta_f a_3 PAX^{a_1} (\beta_f M)^{a_2} (\delta_f S)^{a_3-1} K^{a_4} - v_f = 0 \quad (4.19)$$

⁹The Cobb-Douglas specification is chosen simply for its attractive operational property.

Solving (4.17), (4.18) and (4.19), we obtain the solution to the optimum problem of direct contracting as follows:

$$X_f^* = [pA(a_1/w) (\beta_f w a_2 / v_f a_1)^{a_2} (\delta_f w a_3 / v_f a_1)^{a_1}]^{(1/e)} \quad (4.20)$$

$$M_f^* = [pA(a_2/v_f) \beta_f^{a_2} (v_f a_1 / w a_2)^{a_1} (\delta_f a_3 / a_2)^{a_3}]^{(1/e)} \quad (4.21)$$

$$S_f^* = [pA(a_3/v_f) \delta_f^{a_2} (v_f a_1 / w a_3)^{a_1} (\beta_f a_2 / a_3)^{a_2}]^{(1/e)} \quad (4.22)$$

where $e = 1 - a_1 - a_2 - a_3$.

The optimization problem of contract type t is:

$$\begin{aligned} \text{Max}_{X,M,S} \{ & pAX^{a_1} (\beta_t M)^{a_2} (\delta_t S)^{a_3} K^{a_4} - (w + r)X - uK \\ & - v_t M - v_t S \} \end{aligned} \quad (4.23)$$

Likewise, the first order conditions and the solution to the optimization problem for indirect contracting is:

$$FOC(X) : a_1 pAX^{a_1-1} (\beta_t M)^{a_2} (\delta_t S)^{a_3} K^{a_4} - w' = 0 \quad (4.24)$$

$$FOC(M) : \beta_t a_2 pAX^{a_1} (\beta_t M)^{a_2-1} (\delta_t S)^{a_3} K^{a_4} - v_t = 0 \quad (4.25)$$

$$FOC(S) : \delta_t a_3 pAX^{a_1} (\beta_t M)^{a_2} (\delta_t S)^{a_3-1} K^{a_4} - v_t = 0 \quad (4.26)$$

$$X_t^* = [pA(a_1/w') (\beta_t w' a_2 / v_t a_1)^{a_2} (\delta_t w' a_3 / v_t a_1)^{a_1}]^{(1/e)} \quad (4.27)$$

$$M_t^* = [pA(a_2/v_t) \beta_t^{a_2} (v_t a_1 / w' a_2)^{a_1} (\delta_t a_3 / a_2)^{a_3}]^{(1/e)} \quad (4.28)$$

$$S_t^* = [pA(a_3/v_t) \delta_t^{a_2} (v_t a_1 / w' a_3)^{a_1} (\beta_t a_2 / a_3)^{a_2}]^{(1/e)} \quad (4.29)$$

where $w' = w + r$.

4.4 Results of Comparative Statics

Comparative statics is concerned with the comparison of different optimized states that are associated with different sets of values of parameters and exogenous variables. The exogenous parameters of the model are those pertaining to the production function (i.e., A ; a_j , $j = 1, \dots, 4$); efficiency parameters of monitoring and searching activities (i.e., β_i , δ_i , $i = f, t$); output and factor prices (i.e., w , w , u , v_i); and the commission rate to trading companies (i.e., r). Because the optimum solution of the problem (with a Cobb-Douglas specification) is rather complicated, comparative statics are not straightforward and are difficult to obtain. Thus in this essay, only numerical results of comparative statics are presented.

Our first comparative statics results are concerned with the choice of contract and the relative efficiency of monitoring and searching activities. We first define the relative efficiency parameters. We have argued above that the downstream firm has superior abilities in monitoring activity and the trading company in search activity. The idea of differential abilities can be quantified by means of two parameters γ_1 , γ_2 . Here, γ_1 is defined as the relative efficiency of trading company's monitoring activity compared to downstream firm's, quantitatively, $\gamma_1 = \beta_t/\beta_f$ ($0 < \gamma_1 < 1$); while γ_2 is defined as the relative efficiency of downstream

firm's searching activity compared to trading company's, $\gamma_2 = \delta_f/\delta_t$, ($0 < \gamma_2 < 1$).

Figure 4.2 illustrates the classification of relative efficiency parameter space (γ_1, γ_2) according to dominant contract types over a certain range of commission rates (r). For a low value of γ_1 and a high value of γ_2 contractual type f (direct contracting) will be chosen. This is because in this case the downstream firm's searching ability is comparable with trading company's (high γ_2), while the trading company's monitoring ability is significantly low (low γ_1). The downstream firm can take advantage of its high abilities both in monitoring and searching to directly contract with an input material producer. Conversely, for a high value of γ_1 and a low value of γ_2 , contract type t (indirect contracting) will be chosen; so that the downstream firm can take advantage of the trading company's compelling efficiency in both monitoring and searching activities. Figure 4.2 also shows that the boundary of the two types of contracts shifts with the value of commission rate r . The lower the commission rate prevailing in a competitive market of trading companies, the more likely the downstream firm will delegate the task of input procurement to a trading company. In Figure 4.2, this means that the area covered by contract type t (indirect contract) increases, while that covered by contract type f (direct contract) shrinks.

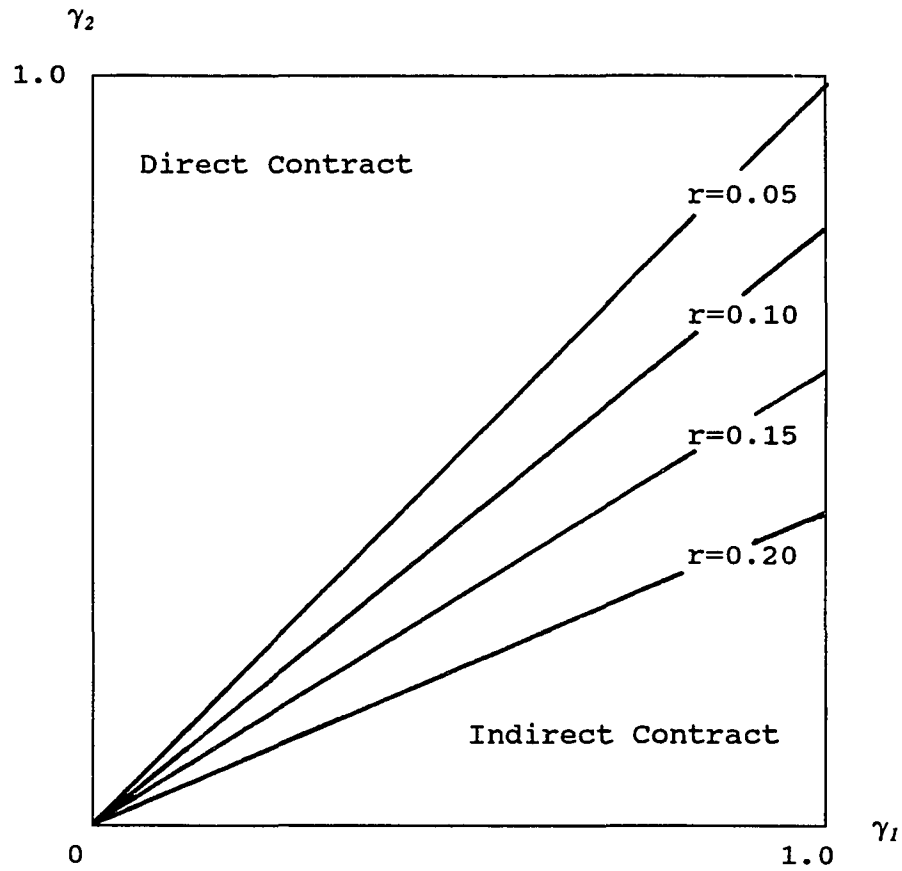


Figure 4.2. Classification of Contractual Types in Relative Efficiency Parameter Space With Varying r

Parameter Values:

$$\begin{aligned}
 v_f &= v_l = 1 \\
 a_1 &= a_2 = 0.35 \\
 a_3 &= a_4 = 0.15 \\
 p &= w = u = 1 \\
 A &= 4
 \end{aligned}$$

The boundary of the contract types will also change with the relative importance of monitoring and search activities on the improvement of production (i.e., the relative magnitude of a_2 and a_3). We define $\epsilon = a_2/a_3$ to reflect the relative importance of monitoring and search activities on production. An increase of ϵ means an increase in the importance of monitoring relative to search activity. Figure 4.3 illustrates the results of the second comparative analysis. As ϵ increases, the downstream firm will be more likely to choose a direct contract for its input procurement. Conversely, the firm will tend to choose an indirect contract if ϵ falls (the importance of search activity increases relative to monitoring activity).

If the downstream firm, which is assumed to have superior ability in monitoring activity, has the same ability in search activity as a trading company, then it has no choice but to procure the input through direct contracting. The converse statement is, however, not necessary true. That is, even if the trading company has the same ability in monitoring activity as the downstream firm, the firm still has two choices: direct or indirect contracting. Our third comparative static analysis (Figure 4.4) examines how the relative efficiency parameter of search activity (γ_2) changes with the commission rate (r) under the assumption of $\beta_f = \delta$, (i.e., $\gamma_1 = 1$), and how the boundary of the two contract types changes with ϵ (the relative importance of monitoring and

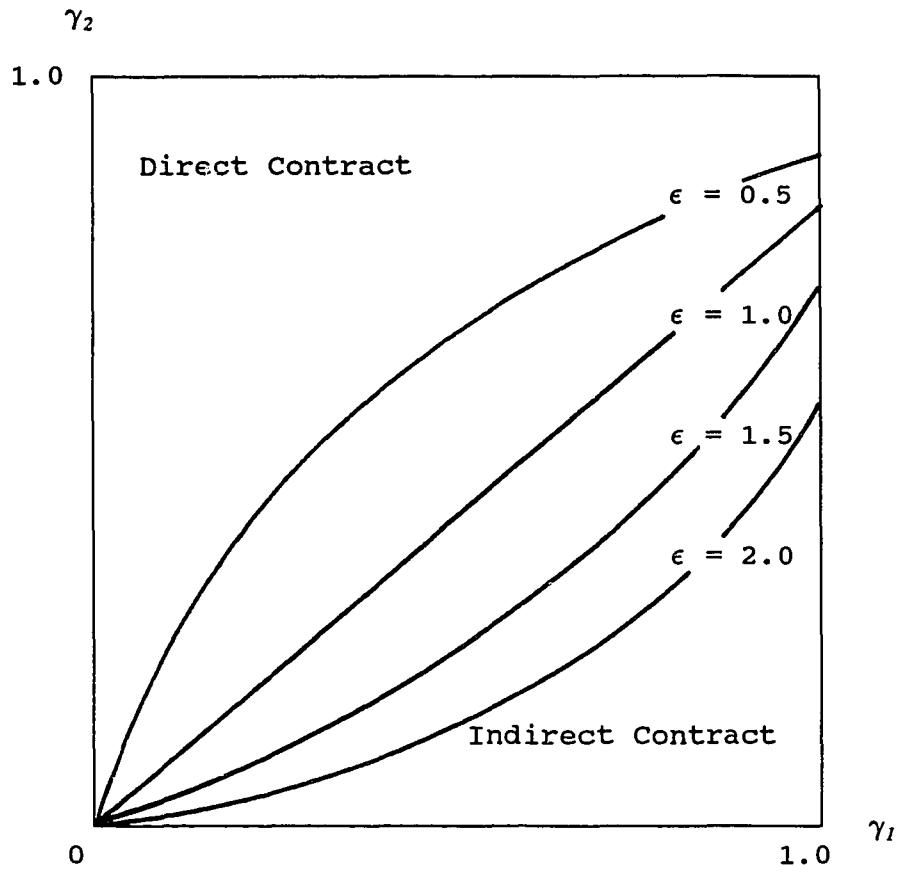


Figure 4.3. Classification of Contractual Types in Relative Efficiency Parameter Space With Varying ϵ

Parameter Values:

$$\begin{aligned}
 v_f &= v_t = 1 \\
 a_1 &= a_2 = 0.35 \\
 p &= w = u = 1 \\
 r &= 0.1 \\
 A &= 4
 \end{aligned}$$

search activities on output). The motivation for conducting this comparative static analysis is as follows. We believe that the effectiveness of monitoring activity depends on two factors: technical monitoring ability and contractual enforcement. If deviations are detected by monitoring activity but can not be substantiated in court, the effectiveness of the monitoring activity would be limited.¹⁰ Therefore, in the case of imperfect enforcement (such as international contracts), the downstream firm's relative advantage over the trading company in technical monitoring activity is not necessarily translated into more efficient production. As a result, the value of β_f may be still higher than β_t , but the two would be close enough. As Figure 4.4 indicates, the critical γ_2 increases with a decrease in r . With a reasonable range of r (for example, $0 < r \leq 0.2$), the area covered by contract type t (indirect contract) is considerably larger than the area covered by contract type f (direct contract). This implies that if the commission rate and the value of δ_2 are not too high, the downstream firm would prefer to procure the input through indirect contracting. The area covered by contract f further shrinks with a decrease in the relative importance of monitoring and search activities.

¹⁰For an insightful analysis of contractual enforcement and its implication in the courts, see Schwartz (1992).

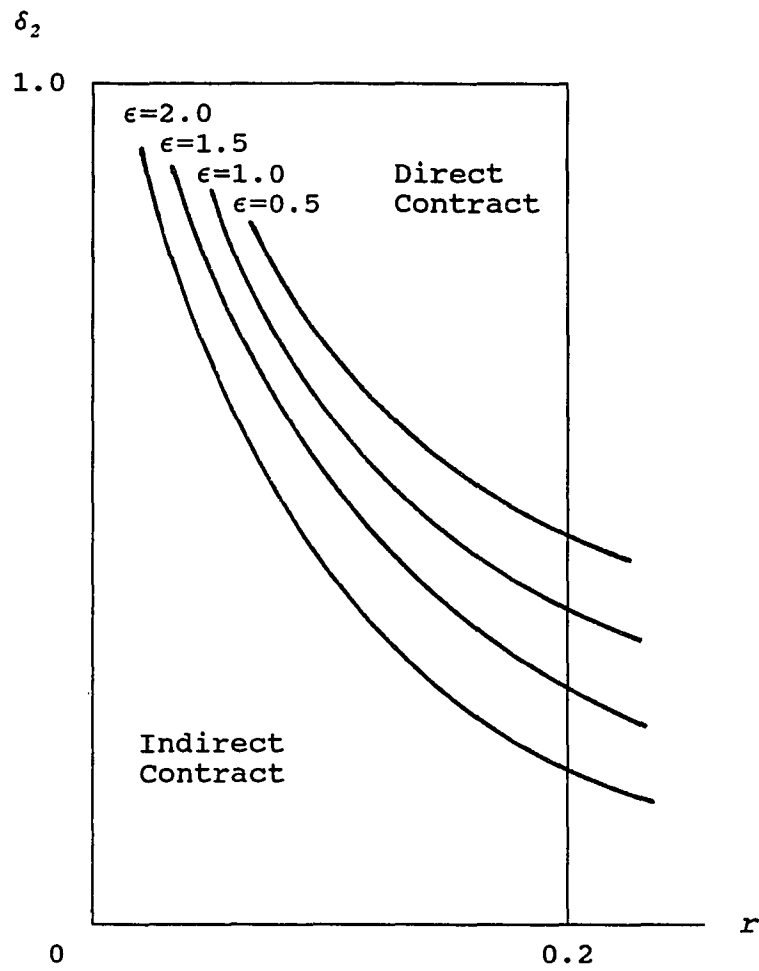


Figure 4.4 Classification of Contractual Types
Under Assumption of $\beta_f = \beta_i$ ($\gamma_i = 1$)

Parameter Values:

$$\begin{aligned}
 v_f &= v_i = 1 \\
 a_1 &= a_2 = 0.35 \\
 a_3 + a_4 &= 0.30 \\
 p &= w = u = 1 \\
 A &= 4
 \end{aligned}$$

4.5 Interpretation and Implications

Independent trading companies are also found in other countries besides Japan. For example, in the grain trade, American companies such as Continental Grain, Cargill, etc. cannot be considered merely as intermediaries. The Japanese trading company is, however, believed to be a unique organization (Yoshihara, 1982). A Japanese trading company has a world-wide network, handles numerous commodities, and accounts for a large share of the foreign trade of the country. In this section, we will try to use the results of comparative static analysis to explain why a Japanese downstream firm prefers to procure input through trading companies.¹¹ To begin with, a brief review of Japanese trading companies is in order.

Trading companies discussed in this essay refer to Japanese general trading companies (*Sogo Shosha*). They differ from wholesalers, retailers, department stores, manufacturers, and others by their overwhelming weight in Japan's foreign trade (Young, 1979). Although there are many such trading companies in Japan, they are portrayed by the largest ten companies ("the big ten"); because the big ten handles over 50 percent of Japan's imports and exports. The giant Japanese

¹¹Chu (1989) modeled a manufacturing firm's choice of marketing channels, but he did not elaborate why a Japanese manufacturing firm prefers to using a trading firm for its product marketing.

manufacturing industries (steel, automobile, computers, shipbuilding, rubber, and others), refining, and power industries prefer using these trading companies to procure industrial raw materials for use or to market their products.

A trading company's profits are generally based on trade volumes with a small commission earned on each unit traded. In the case of raw materials for steel mill, commissions are generally in the range of 0.5 - 2.0 percent of value (Parker, 1992). Given this small level of commission, it is not surprising that a trading company's priority is placed on trade volumes. In addition, trading companies have the following distinguished features. First, they have a highly diversified business. Each trading company handles from 10,000 to 20,000 products. They have been primarily large-volume, first-stage wholesale traders of industrial raw materials and grains and of such standardized intermediate products as steel, synthetic fiber, and fertilizer. Second, their operations have a global scope; they trade with all geographic regions and have extensive business dealings with both the industrialized economies and developing countries. Their global networks typically include 200 offices distributed among 80 countries. Third, they engage in multiple types of trade. For example, some trading companies exert considerable effort to develop two-way trade: to buy a huge quantity of iron ore and coal from an Australia mining company and sell it mining and transportation equipment; or to

import grains from the U.S. and sell fertilizer to U.S. farmers.

The trading companies' basic business has always been and still is trading. They are, however, more than mere traders. They can create demand and supply by organizing huge joint ventures, such as overseas development of industrial raw materials (e.g. iron ore, coal, bauxite), with giant producers. They are also involved in long-term contracts to ensure the supply of natural resources to various industries.

Why does an American manufacturing firm prefer to assume its own direct supply and marketing responsibilities while a Japanese firm prefers to use trading companies? Several authors have explored this question by examining how Japanese trading companies have developed and why they are so unique (Yamamura, 1975; Yoshihara, 1982; Young, 1979). A common accepted notion is that Japanese trading companies can reduce transaction costs substantially because of their economies of scale and world-wide information networks. Yamamura (1975) attributed the emergence of Japanese trading companies to Japan's unique culture and geographical isolation. He argued (Yamamura, 1976, p190) that "linguistic and cultural barriers and geographical isolation in a period of limited communication facilities (the late 19th century) made the cost of information and contract negotiations nearly prohibitive." This contrasts sharply with the Western nations. Yamamura (1976, p194) continues, "because of the linguistic and

cultural similarities and geographical proximity among the Western trading partners (and they traded among themselves more than with non-Westerners), the absolute costs of information, of negotiation, and of enforcement of contracts were significantly lower than they were for Japan." Therefore, it is not surprising that trading companies emerged in Japan as a unique vehicle to reduce transaction costs, and that Japanese manufacturing firms would prefer to use them for raw material procurement and product marketing so as to take advantage of their economics of scale.

Although Yamamura's arguments are pervasive in explaining the creation of Japan's trading companies, they are less compelling in explaining their prevalence in Japan's current industrialized economy. Besides, Yamamura's arguments are not based on a well-defined model. In what follows, we will examine how our model can shed some light on the question why Japanese manufacturing firms prefer to use trading companies for raw material procurement and product marketing. We offer three reasons. First, many of those trading companies have been involved in the business for many years (Yoshihara, 1982), they have superior advantages over a particular downstream firm in market information, and they are much more effective in search activity. This means that γ_2 is rather small in Figure 4.2 ($\gamma_2 = \delta_j/\delta_i$). If the trading company is not too inferior to the downstream firm in terms of the effectiveness of its monitoring activity, then the low value

of γ_2 renders direct contracting less likely. Szabo (1985) enumerated a trading company's three advantages in input procurement. The first advantage is that trading companies have world-wide intelligence networks. The networks are responsible for gathering and verifying information from all suppliers. In the case of coal, Japanese trading companies and coal suppliers have a Mutual Technical Exchange of Information Program. This exchange gives the trading company the opportunity to visit the coal producer's mines and gain valuable information regarding seams, mine plans, and productivity. The second advantage is the trading company's exceptional training of traders. The third advantage is these traders' foreign language skills and shrewd contract negotiation practices.

Second, since a substantial majority of these input procurement contracts are signed with foreign suppliers, the enforcement of these contracts may be rather complicated because of the different legal environments in which the respective firms are imbedded. As we argued above, the effectiveness of monitoring activity depends on the ability to monitor as well as to enforce. While a downstream firm has a relative advantage in technical monitoring activity over a trading company, it does not necessarily have a relative advantage over the trading company in terms of contractual enforcement. In the language of our model, β_f is not considerably larger than β_i ; in other words, γ_i is close to

one. For a high value of γ_1 , if the value of γ_2 is not too high, the resulting contract would be an indirect contract (Figure 4.2). If the trading company enjoys the same effectiveness of monitoring activity as the downstream firm, Figure 4.4 shows that the downstream firm is likely to use indirect contracting even if it has considerable search ability.

Finally, Japan's downstream firms heavily depend on foreign sources for raw materials.¹² Table 4.1 displays Japan's import dependence on some mineral and energy products. It shows that almost all of these input requirements are imported from foreign countries. Reliable supply would make a real difference in the production process. As a result, Japanese firms have placed considerable emphasis on the security of supply.¹³

Given Japan's lack of domestic supplies, its substantial distance from suppliers, and its historical experience with supply interruption,¹⁴ it is likely that a reliable input supply is more important than input quality in a firm's production. This would imply that a_2 is smaller than a_3 .

¹²Similarly, Japanese manufacturing firms are heavily dependent on foreign markets.

¹³In the case of coking coal supply, Japanese steel firms' emphasis on the security of supply is obvious in the Japanese papers presented to the Australia-Japan Coal Conference.

¹⁴For details of analysis of Japanese firm's supply interruptions, see Johnson (1982).

Table 4.1
 Japan's Import Dependence on Selected Raw Materials
 (Import as % of requirements, 1960 - 1990)

	1960	1970	1980	1990
Bauxite	100	100	100	100
Copper	74	85	96	100
Iron Ore	92	99	100	100
Crude Oil	100	100	100	100
Coal	- ^a	58	79	88
Of which				
Coking Coal	- ^a	77	88	99

Sources: Derived from United Nations, *UN Commodity Yearbook*, various issues; *UN Yearbook of World Energy Statistics*, various issues; The Tex Report, *Coal Manual*, various issues; International Energy Agency, *Coal Information*, various issues.

Note: ^aData unavailable.

Figure 4.3 indicates that when ϵ ($\epsilon = a_2/a_3$) falls, the area covered by contract type f (direct contract) shrinks, and therefore, the downstream firm is more likely to procure the input via indirect contracting. Figure 4.4 demonstrates the same pattern.

4.6 Summary and Conclusions

When exchange is governed by contractual agreements, a downstream firm has two alternative channels for access to inputs: direct contracting with producers (direct contracting), or delegating the procurement task to a trading company which then contracts with producers (indirect contracting). Production is crucially dependent on the quality of the procured input. The downstream firm and the trading company have two means to boost the quality of the input. One is by monitoring the input material, and the other is to search for reliable suppliers and to assure reliable input supply. In general, the downstream firm has a relative advantage over the trading company in monitoring activity, while the trading company had a relative advantage in searching activity. The trade-off between these two effects determines the downstream's choice of procurement contracts. In this essay, these ideas are incorporated in a model, and the model is solved using a Cobb-Douglas specification.

The comparative static analyses show that the choice of contractual form is primarily determined by the relative efficiency parameters of monitoring and searching activity (i.e., γ_1 and γ_2). If the downstream firm has a significant advantage over the trading company in monitoring activity, while the trading company has only a slightly advantage in searching activity, then the direct contract prevails. Conversely, if the trading company has a significant advantage in search activity, while the downstream firm has only a slight advantage in monitoring activity, then the resulting contract is an indirect contract. Many other factors also affect the trade-off between the two choices. For example, with an increase in the commission rate, the downstream firm leans towards a direct contract. If search activity is more important than monitoring activity to improve production, the downstream firm is more likely to use an indirect contract.

The model is then applied to explain the unique presence of trading companies in Japanese firms' procurement of input materials. There are three primary reasons. First, many of those trading companies have been involved in the business for many years; they are highly efficient in market searching activities. Second, while the downstream firms have a relative advantage over trading companies in technical monitoring activities, the relative effectiveness of these activities may not be apparent because of the complicated legal environment associated with international contracts.

Finally, since Japan's downstream firms heavily depends on foreign sources for raw materials, the reliable input supplies are more important than the quality of supplies in Japanese firms' production.

Chapter 5. SUMMARY

Japan is the largest coking coal importer in the world and a majority of coking coal trade between Japanese steel firms and coal producers around the world takes place within a framework of long-term contracts. We documented that transaction-specific assets are important factors determining the use of long-term contracts in the coking coal trade. For example, many coal mines and shipping facilities in supplying countries are dedicated to the Japanese coking coal trade. There are many special purpose ports, carriers, and bulk loading equipment built to minimize inventory and transportation expenses.

In Chapter 2 (the first essay), we examine the role of transaction-specific capital (as indicated by contract quantity and contract duration) and market structure (as measured by the Herfindahl index and concentration ratios) in contract price determination. The empirical findings are as follows. First, Japanese importers appear to exercise monopsony power in their coking coal procurement, as coking coal prices tended to be lower in markets where Japanese importers have higher concentration indexes. Second, transaction-specific capital has a significant impact on coking coal price determination; Japanese steel mills paid a price premium for contracts with large quantity or with longer

duration. Third, though we find empirical evidence that Japanese steel firms are insensitive to some minor coal properties, the price of coking coal is strongly related to coking coal's two major quality attributes - fixed carbon content and caking ability.

The estimates of transaction-specific variables contrast sharply with previous studies on the U.S. coal market. The major difference is that our estimates suggest that Japanese buyers paid a price premium to ensure contract performance. We attribute this difference to the different legal environments associated with a domestic contract, which is signed by two firms located in the same country, and an international contract, which is signed by two firms in different countries. In the case of the international contract, both firms may encounter higher costs of settling a dispute in the other country's court system and a lower probability of prevailing in the dispute. Japanese steel firms paid a price premium for the purpose of reducing the probability of contract termination and assuring a secure supply.

Chapter 3 (the second) essay examines in more detail the contractual structure and price adjustments in the coking coal trade. We find that the contract duration specified in the late 1980s has frequently been shorter than in the original contracts. Long-term contracts have simply become a framework for an ongoing process of negotiations over the terms of

future trade. The main reasons for this tendency are stagnation in the steel industry and uncertainty about the coking coal demand. Because of stagnation in the Japanese steel industry and the depressed state of the coking coal market, specific capital, which is frequently advanced as an important factor behind the use of long-term contracts, has not substantially been involved for both buyers and sellers since the early 1980s. Because of the uncertainty associated with coking coal demand and new technology in steel production, buyers and sellers are more willing to conduct annual negotiations to make contracts more adaptable to circumstances and therefore self-enforcing.

While long-term contracts have simply become an ongoing processes of negotiations over the terms of trade, there is evidence that they have contributed to the market stability for Japanese steel firms' coking coal imports. The market stability index used in this essay shows that due to the extensive use of long-term contracts, Japanese import prices for coking coal were more stable than domestic prices in the coal exporting countries.

Japanese steel firms have two basic alternative channels of procurement of coking coal: direct contracting with coal producers (direct contracting), or delegating the procurement task to a trading company which then contracts with producers (indirect contracting). Chapter 4 (the third essay) presents a model examining a downstream firm's problem of contract

choice. Besides the conventional input factors, we posit that the production of the downstream firm entails two additional inputs: monitoring and searching activities for the quality and reliability of raw material being procured. The downstream firm has a relative advantage over the trading company in monitoring activity because of its greater knowledge of its own production process and its specific requirements for the input material, while the trading company is more effective in searching activity because of its special knowledge of the input market. The trade-off between these two effects determines the downstream firm's choice of contract.

The model is explicitly solved for a Cobb-Douglas specification. The comparative static analysis is presented and is applied to explain the unique presence of trading companies in Japanese firms' procurement of input materials. We offered three reasons. First, Japanese trading companies are highly efficient in market searching activity. Second, the effectiveness of the downstream firms' monitoring activity is limited by the complicated legal environment associated with international contracts. Finally, the reliability of supply may be more important than the quality of supply for Japanese downstream' production because they are highly dependent on foreign raw materials.

REFERENCES

- Anderson, David L. (1987), *An Analysis of Japanese Coking Coal Procurement Policies: The Canadian and Australian Experience*, Center for Resource Studies, Queen's University, Ontario, Canada.
- Areeda, Phillip and Donald Turner (1978), *Antitrust Law III*, Boston: Little, Brown.
- Barnett, Donald (1991), "Quintette - Mistake or Malevolence," in Fereidun Fesharaki and James P. Dorian ed. *Energy Development in 1990s: Challenges Facing Global/Pacific Markets*, East-West Center, Honolulu.
- Bolton, Patrick and Michael Whinston (1993), "Incomplete contracts, vertical integration, and supply assurance," *Review of Economic Studies*, 60(1), 121-48.
- Carlton, Dennis W. and Jeffrey M. Perloff (1990), *Modern Industrial Organization*, New York: Harpe Collins.
- Chu, Wan-wen (1989), "Determinants of marketing channels choice: extent of demand, differential costs and entry threats," *Southern Economic Journal* xx(4), 349-62.

Crocker, Keith and Scott Masten (1991), "Pretia ex machina? Prices and process in long-term contracts," *Journal of Law & Economics*, 34(2), 69-99.

D'Cruz, Joseph R. (1979), *Quasi Integration in Raw Material Markets: The Overseas Procurement of Coking Coal by the Japanese Steel Industry*, Unpublished D.B.A. Dissertation, Harvard University.

DOE/EIA (1991), *Annual Prospects for World Coal Trade*.

Eswaran, Mukesh, and Ashok Kotwal (1985), "A theory of contractual structure in agriculture," *American Economic Review*, 75(1), 352-67.

Goldberg, Victor and John Erickson (1987), "Quantity and price adjustment in long-term contracts: a case study of petroleum coke," *Journal of Law & Economics*, 30(2), 369-98.

Grossman, Sanford and Oliver Hart (1986), "The costs and benefits of ownership: a theory of vertical and lateral integration," *Journal of Political Economy*, 94(4), 691-719.

Harris, Stuart and Toyoaki Ikuta (1982), ed., *Australia, Japan and the Energy Coal Trade*, Canberra: Australia-Japan Research Center.

Hart, Oliver and Bengt Holmstrom (1987), "The theory of contracts", in T. Bewly, ed., *Advances in Economics Theory*, Cambridge University Press.

Hashimoto, Masanori (1978), "Bonus payments, on-the-job training, and lifetime employment in Japan," *Journal of Political Economy*, 87(5), 1086-1104.

Holmstrom, Bengt (1981), "Contractual models of the labor market," *American Economic Review*, 71(2), 308-13.

Hubbard, Glenn and Robert Weiner (1991), "Efficient contracting and market power: Evidence from the U.S. natural gas industry," *Journal of Law & Economics*, 34(2), 25-67.

International Energy Agency (1991), *Energy Prices & Taxes*.

International Energy Agency, *Coal Information*, various issues.

Johnson, Chalmers (1982), *MITI and the Japanese Miracle*, Stanford University Press, Stanford, California.

Joskow, Paul (1985), "Vertical integration and long-term contracts: the case of coal burning electric generating plants," *Journal of Law, Economics and Organization*, 1(1), 33-80.

Joskow, Paul (1987), "Contract duration and relationship investments: empirical evidence from coal markets," *American Economic Review*, 77(1), 168-85.

Joskow, Paul (1988), "Price adjustment in long-term contracts: the case of coal," *Journal of Law & Economics*, 31(1), 48-83.

Joskow, Paul (1990), "The performance of long-term contracts: further evidence from coal markets," *Rand Journal of Economics*, 21(2), 251-75.

Klein, Benjamin, Robert G. Crawford, and Armen A. Alchian (1978), "Vertical integration, appropriable rents, and competitive contracting process," *The Journal of Law & Economics*, 21(2), 297-326.

Klein, Benjamin and B. Leffler (1981), "The role of market forces in assuring contractual performance," *Journal of Political Economy*, 89(4), 615-41.

- Landes, William M. and Richard A. Posner (1981), "Market power in antitrust cases," *Harvard Law Review*, 94(5), 937-96.
- Masten, Scott (1984), "The organization of production: evidence from the aerospace industry," *Journal of Law & Economics*, 27(2), 403-17.
- Masten, Scott, James W. Meehan, Jr. and Edward A. Snyder (1991), "The cost of organization," *Journal of Law, Economics, & Organization*, 7(1), 1-25.
- Matsuoka H. (1975), "Requirements for coals in Japanese coking blends," in Proceedings of Australian International Mining & Metallurgy Illawarra Branch Symposium.
- Mulherin, J. Harold (1986), "Complexity in long-term contracts: an analysis of natural gas contract provisions," *Journal of Law, Economics and Organization*, 2(1), 105-17.
- Parker, Paul (1992), "Information specialization and trade: trading companies and the coal trade of Europe and Japan," Pacific Economic Papers, No. 207, Australia-Japan Research Center.

Pisano, Gary P. (1989), "Using equity participation to support exchange: evidence from the biotechnology industry," *Journal of Law, Economics, & Organization*, 5(1), 109-126.

Ramsey, James B. (1974), "Classical model selection through specification tests," in P. Zarembka ed. *Frontiers in Econometrics*, New York: Academic Press.

Rogers, Christopher D. and Kirsty Robertson (1987), "Long term contracts and market stability: the case of iron ore," *Resources Policy*, 13(1), 3-18.

Roumasset, James and Marilou Uy (1987), "Agency costs and the agricultural firm," *Land Economics*, 63(3) 290-302

Schwartz, Alan (1992), "Relational contracts in the courts: an analysis of incomplete agreements and judicial strategies," *Journal of Legal Studies*, 21(2), 271-318.

Smith, Ben (1976), Long term contracts in resource goods trade, Center for Resource and Environmental Studies, The Australian National University.

Smith, Ben (1980), Long-term contracts and financial arrangements for mineral development, Center for Resource and Environmental Studies, The Australian National University.

Smith, Ben (1982), "Bilateral commercial arrangements in energy coal trade," in Harris, Stuart and Toyooki Ikuta (1982), ed., *Australia, Japan and the Energy Coal Trade*, Canberra: Australia-Japan Research Center.

Snow, Marcellus and Eric Im (1991), "The equivalence of two test statistics for testing constancy of regression coefficients," *Econometric Theory*, 7(3), 418-20.

Szabo, Peter (1985), "Role of Japanese trading company setting world coal price," *Mining Engineering*, 23(1), 31-33.

Tilton, J.E. (1978), "Impact of market instability for mineral materials," *The World Economy*, 1(4), 369-83.

White, Kenneth and Donna Wang (1990), *SHAZAM - Econometrics Computer Program*, New York: McGraw-Hill Company.

Waterson, Michael (1984), *Economic Theory of the Industry*, Cambridge University Press, Cambridge.

Wiggins, Steven (1990), "The comparative advantage of long-term contracts and firms," *Journal of Law, Economics, & Organization*, 6(1), 155-70.

Williamson, Oliver (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*, New York: Free Press.

Williamson, Oliver (1983), "Credible commitments: using hostages to support exchange," *American Economic Review*, 73(3), 519-40.

Williamson, Oliver (1985), *The Economic Institutions of Capitalism: firms, Markets, and Relational Contracting*, New York: Free Press.

Vandeman, Ann and Elisabeth Sadoulet (1991), "Labor contracting and a theory of contract choice in California agriculture," *American Journal of Agricultural Economics*, 73(3), 681-92.

Yamamura, Kozo (1976), "General trading companies in Japan: their origins and growth," in Hugh Patrick ed. *Japanese Industrialization and Its Social Consequences*, University of California Press, Berkeley, 1976.

Yoshihara, Kunio (1982), *Sogo Shosha: The Vanguard of the Japanese Economy*, Oxford: Oxford University Press.

Young, Alexander (1979), *The Sogo Shosha: Japan's Multinational Trading Companies*, Boulder, Colorado: West View Press.