Competitive pricing behavior in the U.S. steel industry

Distinguishing two steel markets—the spot market, where price varies with demand, and the contract market, where both price and lead time are negotiated—explains the seeming price rigidity of the big integrated steel producers

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Few economic studies of pricing behavior have had results as predictable as those of the U.S. steel industry. Despite intense competition from mini-mills and foreign producers, the large integrated producers have consistently been accused of having inflexible prices.[1] This apparent lack of price competitiveness among integrated producers is often blamed for the decline of the domestic steel industry. Their prices have been viewed as higher and capacity larger than should exist in a competitive market. Integrated producers have been seen as either ignorant of or insensitive to structural changes sweeping their industry.

Equally inexplicable has been the willingness of some steel consumers to continue buying the high-priced steel of integrated producers. But, the inability of past studies to explain seemingly irrational behavior toward pricing signals may simply mean that relevant features of the interaction between integrated steel producers and their customers have been ignored.

One source of confusion can be easily traced to the pattern of two sets of observed prices in the steel industry. One price is the spot-market price, measured by the transactions price of steel sold on the Antwerp spot market. The other price is the contract price, measured by the transactions price of steel sold on forward contract. At face value, inflexible pricing behavior is consistent with the observed price pattern of contract prices, when compared to the spot market (see Figure 1).

Past studies, as well as public perceptions, have erroneously treated the steel sold in the two markets as identical, however, and concluded that the divergence of the two price series is evidence of noncompetitive behavior in the contract market.

Theories developed to explain the seemingly inflexible contract prices have been taken from traditional industrial organization models that do not differentiate between the products that different producers sell. For example, a common model of price behavior would distinguish between two types of firms—the 'competitive' firm and 'corporate' firm—which have parallels in the steel industry.[2] The competitive firm, most closely identified with mini-mill producers and importers, is a price-taker and, therefore, very sensitive to demand conditions. However, the corporate firm, most closely associated with integrated steel producers, can influence the price of its product. The corporate firm is generally viewed as setting its price based on production costs that include the long-run cost of capital.

In the short run, changes in demand in the spot market will be met with changes in price in order to equilibrate supply and demand. The corporate firm, however, can continue to base its price on a markup over input costs. The price does not depend on demand directly,

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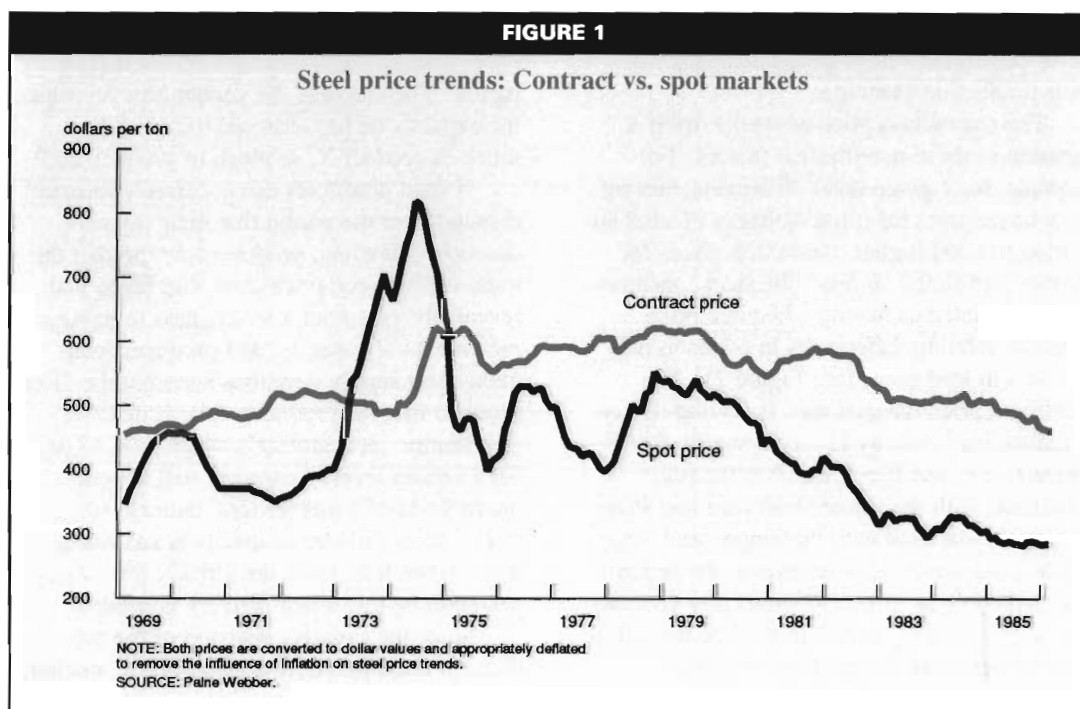
as it would if the producer's price were set in a competitive market. Instead, the price depends on demand only insofar as long-run projections of demand affect input costs (e.g., wage settlements may be affected by expected long-run profits). Since competitive firms' prices can drop more quickly than corporate firms' prices in the face of weakening demand, competitive firms might be able to gain market share at the corporate firms' expense. While this description of price and firm behavior is simplistic, it is in essence how economists have explained the effect of industrial organization on the steel industry's performance.

Treating the product of the two types of firms as identical may be a basic flaw in the description of the steel industry's pricing behavior. While the two firms do produce identical *physical* goods, they may be selling different *economic* goods with distinct non-physical attributes. If so, the theories based on past empirical evidence of steel pricing behavior are erroneous, and the explanations of the price inflexibility of integrated producers are called into question. This article presents a more plausible explanation for many of the observed features of integrated steel producers' pricing behavior, including price rigidity, buyer loyalty, and excess capacity.

Product differentiation by lead time

Steel purchasers have long argued that three factors govern their decisions about choosing a supplier: quality, lead time, and price (usually in that order).[3] Quality for a specific firm's product is unlikely to change in the short run, however, although the relative quality of its steel may change over the long run. Thus, while quality may be important in explaining price trends, quality's importance in explaining short-term price variation is limited. However, lead times (or the amount of time between placing an order and receiving delivery at the plant) do vary considerably with price in the short run, so that the relative lead-time variation may be responsible for the observed variation in the relative prices of different producers.

In the spot market, i.e., the competitive sector of the steel industry, lead times are technically fixed by the amount of time necessary to load and ship the steel to the customer's plant. Since spot steel is purchased essentially out of inventory, production time and the possibility of delays are not included in the lead time. Of course, the customer must pay whatever price the market sets at the time of purchase, which will change quickly and dramatically with demand as customers in

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FIGURE 1

Steel price trends: Contract vs. spot markets

NOTE: Both prices are converted to dollar values and appropriately deflated to remove the influence of inflation on steel price trends.
SOURCE: Paine Webber.

effect bid for the amount of steel available on the spot market.

The spot market does not have a queue of customers per se; the market is cleared by the competitive price. However, an alternative view of the spot market would be that some customers, who are essentially priced out of the market by the current level of spot prices, are waiting for that price to drop to a fixed price that they are willing to pay. Their expected lead time for spot market steel in this sense will depend on the expectation of the level of demand for steel in the near future—higher demand will mean longer lead times.

Lead time in the contract market, however, is subject to negotiation between the customer and (integrated) producer. Steel consumers who require guaranteed deliveries at set prices for their production planning can reduce the risk of late deliveries through the terms of the contract, regardless of the level of demand. Given projected shortages that were expected to occur in the 1980s (especially after the steel shortage of 1973–74), steel consumers felt that they had good reason to cultivate domestic supply channels in order to insure an adequate supply of steel in the future, even if purchasing steel by long-term contract meant paying a premium over spot market prices.[4] If so, nonphysical attributes of steel (i.e., lead times) attained an overriding importance to those customers who required certainty for their production planning.

The transaction price of steel is itself a function of these nonphysical factors. For example, for a given level of demand, customers who contract for future delivery of steel are willing to trade higher transaction prices for shorter lead times. Indeed, the steel consumer can be depicted as having a hedonic price schedule relating differences in prices to differences in lead times (see Figure 2). The additional price the customer is willing to pay to reduce lead time by $L_i < L_j$ is simply $P_i > P_j$, where $L_i < L_j$ and $P_i > P_j$ (or, P_j is the price associated with the shorter lead time and P_i is the price associated with the longer lead time). While its exact shape is unknown, the hedonic price schedule must be monotonically decreasing, so that shorter lead-time steel commands higher prices than longer lead-time steel.

FIGURE 2

Hedonic price schedule
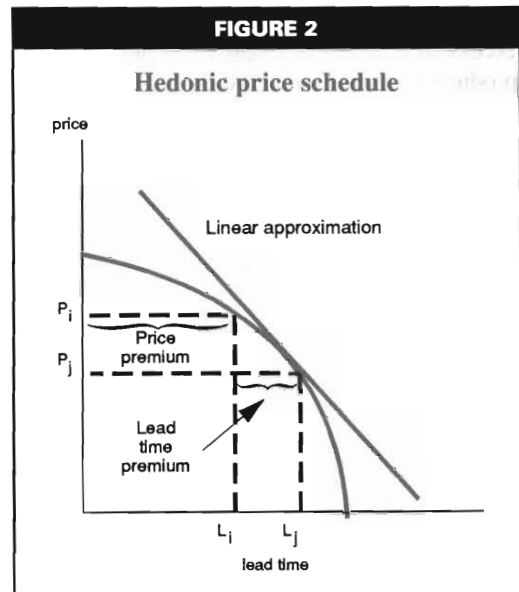
The role of capacity

The customers' demand for lead time is implicitly a demand for capacity—larger capacity means shorter lead time. The purchasing literature contains frequent references to implicit contracts between producers and consumers to reserve a producer's capacity on a regular basis. For example, in a recent *Purchasing Magazine* article, the relationship was described as following:

"The buyer, in effect, reserves production line capacity and holds off placing a specific order until he has a clean fix on his requirements. Then he tells the vender how he wants the capacity he has reserved to be used, so much of product X, so much of product Y."[5]

If steel producers can accurately forecast demand over the period that their capacity decision is binding, producers can predict the trade-off between prices and lead times that reveals the customer's willingness to pay for increments of capacity, and producers can make their supply decisions accordingly. The problem that the producers face is demand uncertainty. A customer's willingness to pay for a certain level of capacity will depend on the level of expected total demand for steel—access to extra capacity is not worth much when lead times are already low or expected to be low when delivery is needed.

Since the capacity decision of the producer is fixed before it is priced in the market,

producers are vulnerable to low returns to excess capacity if steel demand is low. If producers are risk averse, they would be unwilling to provide extra capacity desired by the customer, who is afraid of being cut off when demand is high. Given such a situation, risk-sharing agreements logically can emerge, where customers guarantee to pay a certain price for the producer's steel regardless of the current level of demand for steel. The producer will then be able to cover the cost of his capacity decision when demand is considerably weaker than expected. The contract guarantees the customer will have a place in the queue even when demand is high. In addition, the contract guarantees the producer that the customer will continue to purchase steel even though the customer could find lower prices on the spot market, when demand is relatively low.

Competition between spot and contract markets

Thus, rather than the two types of producers selling in the same market, they are actually selling in different markets, but the two markets are in competition with one another. In the spot market, only price varies. Alternatively, one can imagine price held constant and only lead time varying for the customers who wait for the spot market to drop to a desired level. In the contract market, both price and lead time are subject to negotiation and can vary in some inverse relationship. Expected increases in demand for steel in the contract market will allow the producer to negotiate either longer delivery times, higher prices, or both.

If the negotiated lead time in the contract market is very high for a given price, some steel customers may switch to the spot market—paying possibly higher prices but getting quicker delivery. For the customer, the decision to switch will be based on a trade-off between anticipated spot prices in the future versus the combination of delivery time and price that can be negotiated currently in the contract market. However, an additional cost to switching will also be the risk of not being able to return to the contract market as a loyal customer with a reserved spot in the queue when demand is high.

Prices of contract steel, therefore, are more stable than spot prices because contract prices are based on long-run expectations rather than short-term demand and supply factors. Contrary to past speculations, integrated producers can be shown to be pricing competitively, but they are competing in a different market than the spot market. In order to make a fair comparison, the price difference between the two markets must be analyzed with the same lead time in both markets. In the next two sections, it is shown that even under these conditions the contract price fluctuates less than the spot price. The remaining difference in fluctuation is due to the long-term agreement between producers and consumers, as will be explained in the latter section. This agreement constitutes an insurance that the producer will provide enough capacity to provide guaranteed delivery times.

Empirical evidence of two price mechanisms

The search for evidence of competitive pricing behavior in the steel industry centers around identifying the shape of the hedonic price schedule. Although its exact shape is unknown, it is possible to derive a linear approximation of the schedule and empirically test for it. Assume two types of steel, type C (contract steel) with lead time (w_C) and type S (spot steel) with lead time (w_S). Using a first-order Taylor expansion of the price of C (P_C) around the price of S (P_S), the formula for the linear approximation of the hedonic price schedule is:[6]

1) $\quad P_C - P_S = \{dP/dw\}*(w_C - w_S)$
or 1') $\quad P_C - P_S = -(dP/dw)w_S + (dP/dw)w_C$

where P_C = the c.i.f. transactions price of composite domestic sold on forward contract.
P_S = the c.i.f. transactions price of steel sold on the Antwerp spot market.
w_C = the lead time on domestic contract steel in months.
w_S = the lead time on spot steel in months.

The linear approximation is the derivative (dP/dw), determined at the point w_S, and should be negative. Equation 1' can now be used to test the following hypotheses:

$H1$) the observed gaps between contract prices and spot prices can largely be explained by the effect of underlying material character-

istics (including lead time) on the two markets.

H2) the observed gaps are attributable to differences in the nature of the buyer-seller relationship in the two markets.

With waiting time for spot steel (w_s) assumed constant, Equation 1' was tested over the period 1969–84, which was a period free of trade restraints in the steel industry. The results are:

$$2) \quad (P_c - P_s) - 415.1 - 132.7\ w_c$$
$$\quad\quad\quad\quad (14.6) \quad (-11.4) \text{ (t statistics)}$$

$$DW = .210 \quad FOA = .891 \quad R^2 = .39$$
$$n = 203 \quad DM = 97.1$$

(where *DW* are Durbin-Watson statistics, *FOA* is first-order autocorrelation in the residuals of the equation, R^2 is the coefficient of determination, *n* is sample size, and *DM* is the mean of the dependent variable).

These results show that the regression model has statistical power. Differences in lead times explain about 40 percent of the relative price differences. The coefficient of w_c is negative and significant, which is consistent with the negative slope of the hedonic price schedule, as depicted in Figure 2.

The interpretation of the estimated Equation 2 is that if expected lead time for the contract market decreases relative to lead time for the spot market, the contract price will increase relative to the spot price. However, in times of extreme shortage of capacity, the contract market may fall behind its normal lead time schedule and significantly exceed its average lead time when demand is normal.[7] In that case, the price difference may reverse itself, as it did in the 1973–74 period (see the negative values shown in Figure 3).

The evidence of Equation 2 does not make a strong statement about whether lead time largely accounts for relative price variation, in part because of high autocorrelation. Efforts to correct for autocorrelation reduce variation in the model.[8] Therefore, rather than employ such corrections, the regression results will be tentatively accepted as lending support to *H1*, that lead time variation has power to explain price changes, with the understanding that the statistical inference is biased in favor of accepting the hypothesis.

The 1973–74 period was particularly unusual, since steel was in severe short supply and contract lead times rose markedly. If the 1973–74 period is deleted, a large amount of the variation in the dependent variable is lost, and much poorer regression results are obtained. The range of the independent variable w_c is about 2.5 months over the entire sample period of 1973–74, while it drops to 1.5 if that period is omitted (i.e., a 40 percent reduction in the variation in the range). Running Equation 2, but excluding the 1973–74 period, yields the following results:

$$3) \quad (P_c - P_s) = 127.1 - 1.3\ w_c$$
$$\quad\quad\quad\quad (4.6) \quad (-0.1) \text{ (t statistics)}$$

$$DW = .05 \quad FOA = .968 \quad R^2 = .0001$$
$$n = 167 \quad DM = 124.0$$

As expected, regression 3 has no power to explain the effect of lead time on the price premium. The normal variation for the w_c range is within 1.5 months for lead time. In other words, lead times are being drawn for the same underlying distribution of aggregate demand, so that the spread largely represents random variation around a constant mean. This random variation would not be expected to explain the price premium. Only when the 'abnormal' variation of the 1973–74 period is included in the sample can the regression capture the price premium effect, because the switching between normal and abnormal demand situations is captured.

While the price premium is expected to change as the *ex ante* lead-time difference changes, the premium does not necessarily have to respond to changes in *ex post* realizations of lead-time differences. Thus, a contract producer may deliver a product at a price that is higher and a lead time that is on average shorter than the price and lead time that the consumer expected to obtain on the spot market. During normal times, the producer's actual lead time may vary considerably around this average value without affecting the previously contracted price for the steel (although one would expect that variance in lead time would affect the price that is set *ex ante*). This behavior leads to the results of Equation 3.

Empirical evidence of price premiums under normal demand

To be sure, even when the 1973–74 period is excluded, the price differential shows substantial variation. Over this subsample, the contract premium ranges from a low of six

Scatter plot of price premium vs. lead time: 1969–84

$P_C - P_S$

SOURCE: Paine Webber and Department of Commerce.
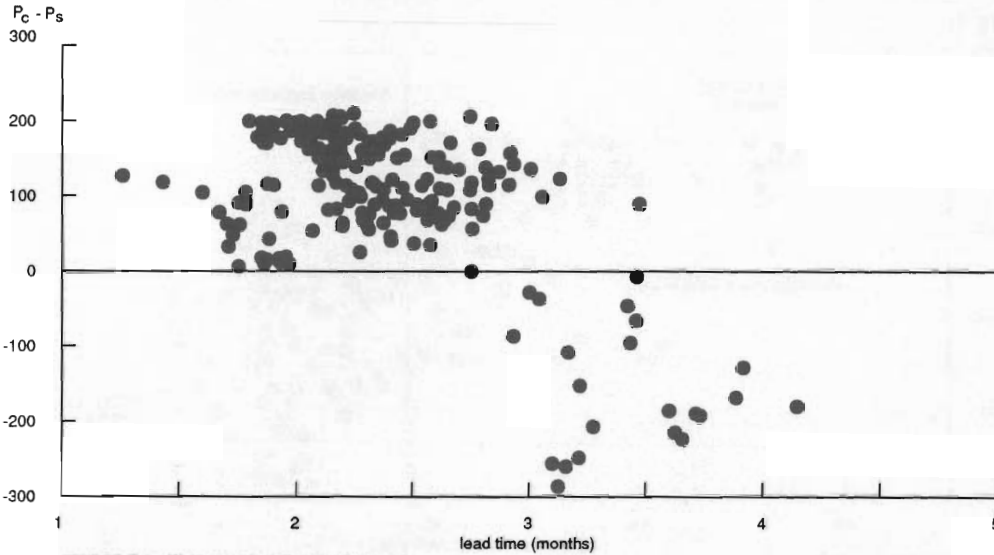
dollars to a high of two hundred and seven dollars per ton, or roughly between 1 percent and 35 percent of its average value over the entire sample. This is interesting because it gives some idea of the amount of the premium not explained by the lead-time differences.

While Equation 2 could not entirely explain the price premium, Equation 3 shows that there are large price swings that remain even after the effect of the variation in lead time is removed. This is supportive evidence for *H2*—there seems to be large variation in the price premium that cannot be rationalized by variation in a material characteristic.

The contract premium, $P_C - P_S$, exhibits substantial covariation with the business cycle even when the premium does not systematically vary with lead time. Figure 4 plots $P_C - P_S$ against capacity utilization for steel over the subsample (i.e., excluding 1973–74). When business activity is relatively strong (proxied by capacity utilization), the spot price rises relative to the contract price. When business activity is relatively weak, the spot price falls relative to the contract price. Contract price seems to be 'overpriced' when demand is low and 'underpriced' when demand is high.[9]
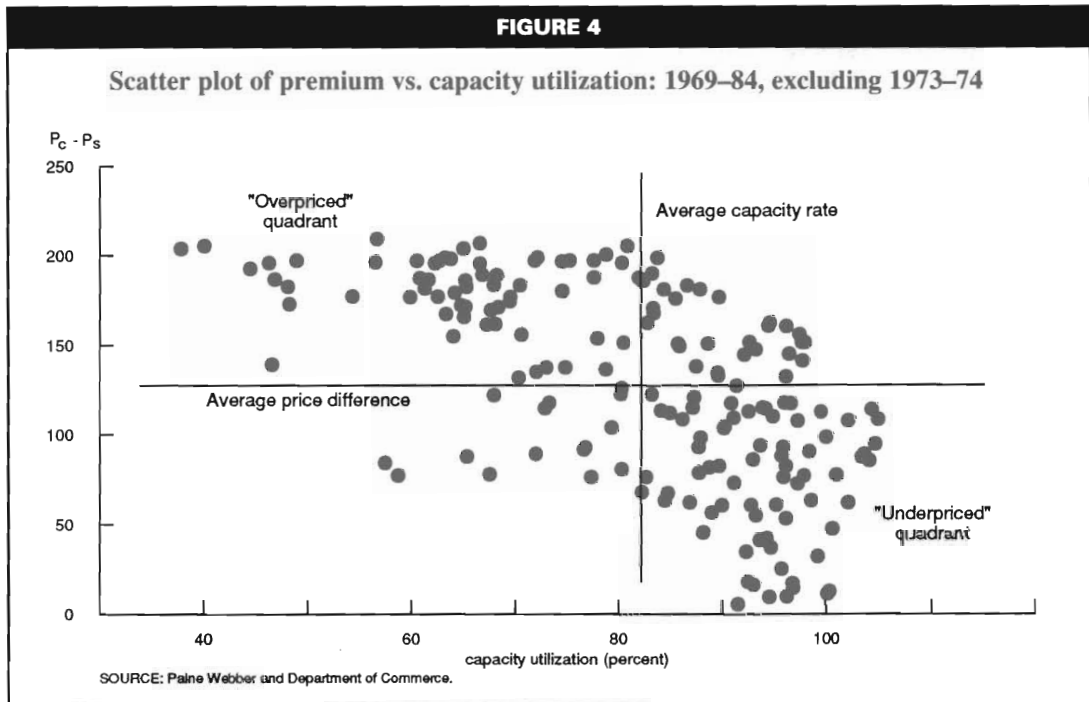
As observed in the introduction, rigid prices may be rationalized as the outcome of long-term arrangements between buyers and

sellers, rather than reflecting anticompetitive practices. The basic model can be reformulated to show how the opportunities of some consumers appear to worsen as aggregate demand for steel increases, while other customers experience little or no increase in price and/or lead time. Specifically, in the range of low-to-moderate demand pressure (i.e., over the subsample excluding the 1973–74 period), neither the contract price nor the lead time rises with increasing capacity utilization (CAPU). In fact, both variables appear to be close to constant, as the regressions below indicate:

4) $P_C = 525.6 + 22.7$ CAPU
   $\quad\quad$ (27.3) $\quad$ (.9) $\quad$ (t statistics)

   DW = .04 FOA = .968 R^2 = .005
   n = 167 DM = 558.6

5) $w_c = 2.2 + .12$ CAPU
   $\quad\quad$ (14.6) $\quad$ (.7) $\quad$ (t statistics)

   DW = .582 FOA = .703 R^2 = .003
   n = 167 DM = 2.3

The regression of P_S on capacity utilization, however, does yield significant correlation with capacity over the subsample, representing the short-run supply and demand characteristics of that market:

FIGURE 4

Scatter plot of premium vs. capacity utilization: 1969–84, excluding 1973–74

SOURCE: Paine Webber and Department of Commerce.

6) $P_s = 225.6 + 236.4\ CAPU$
$\qquad$ (14.6) $\quad$ (8.0) $\quad$ (t statistics)

$DW = .09\ FOA = .943\ R^2 = .279$
$n = 167\ DM = 420.3$

Equations 4 and 6 are obviously poor models for forecasting the levels of prices. However, these equations in combination afford further insight into the behavior of the contract price premium. Namely, one component of the premium, the spot price, exhibits substantial covariation with demand (as proxied by capacity utilization). On the other hand, neither the contract price nor the lead time appear related to demand conditions (over the subsample covering moderate levels of demand). While Equation 3 implies that the premium is not related to 'normal' lead variation, Equations 4 through 6 reveal that the premium depends on demand conditions. This is important, because relative price variation should only depend on variation in underlying material characteristics in equal access markets. If all customers were quoted a constant lead time and price for contract steel as capacity utilization rates increased within this range, no customer would be willing to pay increasing premiums for spot steel as demand pressures increase. Yet, although spot steel is not more appealing relative to contract steel as

demand increases in this range (since the lead-time difference is roughly constant), the amount by which the spot price increases with demand pressure is substantial.

These equations (4 through 6) indicate that as demand increases over moderate levels, consumers purchasing in the contract market do not incur any significant price increases or longer lead times. On the other hand, the monotonic rise of the spot price with capacity utilization means that consumers buying in the spot market experience progressively poorer prices and/or lead times as demand rises. Taken together, this evidence strongly suggests that some consumers receive preferential treatment from contract producers, and those who do not get the preferential treatment are forced to pay substantial premiums on the spot market, especially when demand is high.

Finally, when Equation 5 is rerun over the entire sample, lead time in the contract market does tend to increase with capacity utilization:

7) $w_c = 1.5 + 1.0\ CAPU$
$\qquad$ (8.5) $\ $ (4.8) $\quad$ (t statistics)

$DW = .369\ FOA = .810\ R^2 = .105$
$n = 203\ DM = 2.4$

This result is expected. When demand increases well above moderate levels, producers act to minimize the potentially adverse

effects of such demand increases on the opportunity sets of their most loyal customers, i.e., they quote longer lead times to transients in order to be able to reserve space in the production queue for loyal customers. However, when aggregate demand becomes sufficiently high, firms must use lead time and/or price increases to allocate production capacity even among their loyal customers.

The major findings of the empirical part of this study are the establishment of the significant relationship between the price premium and the lead time premium between the two markets (evidence from Equation 3). However, this relationship cannot be observed when demand is moderate because of: 1) the expected and realized differences in both price and lead time between the two markets and 2) small systematic variations in the price premium relative to changes in lead-time differences (evidence from Equation 2). The premium, however, does seem to be related to the business cycle (proxied by capacity utilization). Therefore, variation is not the result of material characteristics (i.e., lead time) when demand is moderate, but does seem to be systematically related to the business cycle, which implies some underlying long-run arrangement of risk sharing.

Benefits of the contract market: a theory of long-run behavior

Conceptually, rigid pricing agreements between consumers and producers emerge as a consequence of a particular type of vertical arrangement between buyers and sellers. For producers, a capital outlay is akin to a gamble. If producers are risk averse, they will choose 'too small' a gamble (i.e., too little capital in the aggregate) which implies that the distribution of market prices will be higher than if producers were risk-neutral. The object of the vertical arrangement is to induce risk-averse producers to behave as if they were closer to being risk-neutral, thus reducing the expected expenditures of consumers of steel by reducing prices over the long run.

The capital decision is a gamble because the outlay must be made long before the return from it becomes known (in this analysis, the capital outlay once made is fixed). For example, rolling mills can require an up-front capital investment of over six hundred million

dollars and typically remain operative for fifteen or more years. The magnitude of the capital outlay is important because it determines the location of a producer's variable cost curve over the horizon during which he produces. At any point in time, a producer in a competitive market will choose a quantity to equate the exogenous market price to his marginal cost. However, since a producer's marginal cost depends on his prior choice of capital, the producer's profits at any time are solely a function of initial choice of capital.

In the absence of demand uncertainty, a producer's discounted profit stream is a deterministic function of his initial capital outlay. Thus, the producer realizes that if he chooses a given capital outlay, K', and the price is p' each period, he will make a profit of $p'*q' - C(q';K')$ each period gross of his initial cost of capital, where q' is the optimal choice of quantity given p' and his variable cost curve $C(q';K')$, which is determined by his choice of K.

Demand uncertainty, however, implies that the future prices are random. The producer associates a different *distribution* of discounted expected profits with each possible initial choice of K. The initial capital outlay is a fixed sum that can be regarded as equivalent to a bet. The discounted expected return to the bet increases as the producer places larger bets, but so does the spread in the return distribution to the bet (i.e., the spread increases as a consequence of the spread in the distribution of market prices). How large a bet is the producer willing to take?

Risk-averse producers, like risk-averse consumers, undertake smaller bets than if they were risk-neutral. In particular, an economy of risk-averse agents chooses a smaller capital outlay than an economy of risk-neutral agents. Since the aggregate supply curve (the economy's variable marginal cost curve) depends directly on the aggregate choice of K (assume all producers are identical), the supply curve in a risk-averse economy will lie to the left of that in a risk-neutral economy. This means that, for a given demand, prices in a risk-averse economy are always higher than would be the case in a risk-neutral economy.

Risk-averse producers could be induced to behave as if they were closer to risk neutral if they could somehow reduce the spread in the

distribution of the return to their capital gamble. The reason for such a spread is that when market prices are high the return to any given choice of K is high, while conversely, when market prices are low the return to the same choice of K is low. If there were a market offering fair (constant expected value) insurance to producers, so that producers could enact *ex ante* trades offering real value when demand is high (the insurance premium) in exchange for receiving value when demand is low (the insurance payoff), risk-averse firms could be induced to behave as if they were risk neutral. This is because producers would simply choose capital to maximize expected profits, and then use the fair-insurance market to obtain these expected profits with certainty.

In the absence of such insurance markets, however, consumers can provide at least partial insurance through vertical arrangements with firms. They do so by making transfer payments to firms when demand is low and producers experience low returns, while customers receive rebates when demand is high. This form of insurance involves paying higher than spot prices when demand is low and receiving lower than spot prices when demand is high.

Coalitions of consumers and producers who engage in this type of risk sharing benefit because this insurance enables firms to expand their capital and, thus, achieve lower marginal costs. Firms can induce consumers to enter the arrangement by offering them lower expected expenditures, although over certain periods consumers will pay higher prices. Not all consumers would benefit by such an arrangement, since the producer could only promise to reduce expected expenditures over the long haul. Transient consumers of steel would be remiss to pay higher than market prices for the promise of lower than market prices when demand is high if they did not expect to consume a sufficient supply of steel in the future to justify paying the current premium.

A problem with this arrangement is that though not all consumers could actually benefit by it, all consumers would have an incentive to say that they would support the insurance scheme during periods of high demand when they receive the price rebate. For this reason, producers distinguish loyal from tran-

sient customers. Only those consumers who have paid premiums when demand was low obtain preferential treatment when demand is high. Thus, firms employ a self-selection mechanism by basing insurance payouts on a consumer's past purchasing history. Only those consumers who can potentially benefit from such long-term arrangements pay the premiums and obtain the benefits.

Favorable treatment may assume the form of price and/or lead-time reductions when demand is high (since reductions in lead time are equivalent to cutting the price). Within this context, it is possible to rationalize the earlier finding of this study that the spot price rose during periods of moderate but increasing demand pressure, but the domestic price and lead time remained constant. As demand rose, domestic producers quoted progressively higher prices and/or longer lead times to transient customers, who proceeded to turn to the spot market and bid up the price. At the same time, loyal customers began to enjoy the benefits of their coverage.[10]

Implications for the 1990s

The evidence presented in this study shows that: 1) it is important to analyze some economic goods with the same physical attributes as differentiated products and 2) an appropriately defined price comparison can provide evidence that argues against the prevailing view that the rigid pricing by integrated producers is incompatible with competitive pricing. Instead, rigid prices are the outcome of long-term arrangements between producers and consumers, which establish a contract market that is distinct from the spot market. The contract market establishes the dependence between the prices consumers face at any given time and past commitments to particular producers. Rigid prices emerge as the outcome of an insurance arrangement between consumers and firms in which consumers agree to bear part of the risk of a firm's capital outlay. Such an arrangement induces risk-averse producers to choose larger initial capital outlays and, thus, enables them to achieve lower marginal costs than if they bore the total risk of the capital gamble themselves. However, this insurance scheme requires the consumer to pay premiums over the spot market price during recessions, while they receive

rebates during booms. This description of pricing behavior is valuable in clarifying vague and often misleading explanations in past studies of why consumers will buy steel that seems overpriced during normal periods of economic activity.

An essential feature of these specialized arrangements is a mechanism to insure that both producer and customer keep their end of the bargain when they both may have short-run incentives to break the arrangement. This study has presented a theory to explain how such a mechanism can be implemented and how it can be mutually beneficial to both parties to remain loyal to the special arrangement.

The modeling of two competing steel markets may shed new light on the decline of the steel industry, as well as the future prospects for integrated producers. Once consumers were convinced in the early 1980s that world capacity was more than adequate to meet their needs even if demand were high,

they were increasingly unwilling to pay price premiums to integrated producers during normal periods. The integrated producers' commitment to a shrinking contract market could have contributed to the whole industry's decline, because they were not positioned to compete aggressively on price alone in the growing spot market.

To be sure, the integrated producers are gradually adjusting to the new market reality, but adjustment takes time. The integrated producers' capital stock may have been uniquely designed to meet the needs of their customers most efficiently when demand was high. The most appropriate technology under the new conditions may be quite different. Today, integrated producers are investing heavily in new technologies. As the adjustment process is completed, integrated producers may be able to compete more aggressively with mini-mills and foreign producers than they have in the past.

FOOTNOTES

[1] For example, studies of integrated steel producers, who generally control all stages of the steel-making process from ore to finished steel product (or 'Big Steel', currently defined as USX Corp., Bethlehem Steel Corp., Inland Steel Industries Corp., LTV Corp., and Armco Inc.), have long depicted steel producers as textbook examples of oligopolists, following administered pricing policies. See De Vany and Frey (1982) and Gardner Means (1957).

[2] See, for example, Acs (1984) for a more detailed description.

[3] See, for example, Raia (1988), p. 39.

[4] See, for example, Hogan (1972), p. 3.

[5] See *Purchasing Magazine* (1974), p. 26.

[6] The contract price of steel is a weighted average of contract prices of all domestic steel products, where the weights on each product are the value of the product as a proportion of total U.S. shipments in 1977. The spot price is the price quoted on the Antwerp spot market, adjusted to include cost, insurance, and freight (c.i.f) paid by a 'typical' domestic steel purchaser. These data were supplied by Paine Webber. The price data are adjusted by the producer price index for finished goods to remove the influence of inflation. Average lead time on domestic steel is constructed by dividing unfilled orders at the end of each month by shipments of the following month. A similar measure of lead time was used in earlier studies. See, for example, Gregory (1971). These data were taken from the *Survey of Current Business*, various issues.

[7] Interestingly, Equation 2 determines the average lead time for the spot market as roughly 3 months (i.e., 415/133 = 3.1), which is reasonable, given past studies such as Jondrow, et al, 1982), which found foreign steel delivery times to be about 3 months.

[8] The high positive correlation in the residuals of Equation 2 will lead to downward bias in the standard errors, and this bias will be further exacerbated by significant low-order positive autocorrelation in w_c. Most of the autocorrelation in the residuals can be corrected by taking first differences (or, applying more sophisticated versions of generalized least squares models). Such procedures tend to eliminate most of the variation in both the independent and dependent variables, however, since they also exhibit strong positive low-order serial correlation. This leads to poor parameter estimates.

[9] Figure 1 also shows that the premium varies countercyclically. However, the objection to using this as support for price rigidity is that such variation could possibly reflect covariation with an underlying nonphysical characteristic, such as lead time that varies with the business cycle. If so, the premium's observed correlation with the business cycle might be incidental. However, Figure 4 depicts variation in the premium not explained by lead time variation, and it is clear that this 'residual' variation still exhibits strong comovement with the business cycle. Thus, Figure 4 provides considerably stronger support for the hypothesis of rigid pricing.

[10] For a more formal analysis of the long-run benefits of the insurance agreement, see Erceg, et al, (1989).

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