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The Price Differential between Domestic and Imported Steel*

Domestic and imported steel do not sell at the same price. In this paper we explain why. We first show that the price differential is real. We then document characteristics that differ between domestic and imported steel. Finally, for two of the most important characteristics, variability of supply and delivery time, we estimate the price differential that would compensate users of imported steel.

I. Introduction

Since the late 1950s, the quoted price of imported steel has generally been below the domestic price. This fact has been a recurrent source of worry for steelworkers and producers who fear that imports will force many domestic mills out of business. Congress seems to share this concern, as indicated by its acquiescence to a series of barriers to steel imports, such as the "voluntary" quotas of 1969–72 and the recent trigger prices. Little help is expected from buyer loyalty to American steel: Steel is steel, and the buyer need only find the cheapest source.

The concerns of the steel producers and workers seem, at first, well founded in economic theory: Identical products cannot sell at different prices; either the higher price will fall to meet the competition, or production of the higher priced one will stop.

But the production of domestic steel has not stopped, even though domestic producers have lost some ground to imports. Since the late 1950s, when imports first became low priced, the demand for imports has grown steadily—and

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sometimes suddenly, as in 1968. Still, the amazing story is not that imports have increased but that they have increased slowly. In 1962, imports accounted for 6% of the U.S. market. Fourteen years later, they accounted for 14%. Each year, on average, imports have increased their share of the market by less than 1 percentage point.

Why have imports grown so gradually? That is the central question of this paper. We explore two answers, one briefly, the other in more detail. The first possible answer is that imports only seem to be lower in price but actually are not. This is not a trivial possibility. Quoted prices of domestic products are often said to differ from actual transaction prices. Import-price quotes are at least as suspect. The second possible answer is that buyers do not consider imported steel to be a perfect substitute for domestic steel—to them, steel is not steel.

It turns out that one major difference between imported and domestic steel is in lead time. To find out why the longer lead time for imported steel is an important detriment, we apply a standard model of optimal inventory levels.

The inventory problem and its relation to price differentials have been the subjects of several recent studies. A theoretical study by DeVany (1976) argues that a monopolist can raise his price by expanding capacity and shortening waiting times for his customers. Gould (1978) considers the case of a competitive equilibrium in which some suppliers offer high prices and short waiting times and others offer low prices and long waiting times. This offers an explanation of the observed multiplicity of prices, an alternative to the usual explanation that buyers have imperfect information about prices. A number of other empirical implications are also noted. A study by Carlton (1978) examines the social welfare implications of a competitive equilibrium in which both consumers and producers trade off waiting time against price (for consumers) or cost (for producers). Our work can be viewed as an empirical counterpart of these studies.

The possibility that buyers distinguish between imported and domestic products, even when their physical characteristics seem to be the same, has implications for both policy and research.

The implication for policy is that imports will not dominate the market suddenly; the gains derived from removing trade barriers need not come at the cost of sudden, massive layoffs in domestic industries. The adjustment of employment comes only after substantial warning.

The implication for research is that the demand for imports should be specified as a function of (at least) two distinct prices—the import price and the domestic price. For examples of empirical work using this assumption, see Kreinin (1967); Houthakker and Magee (1969); Magee (1971); Price and Thornblade (1972); Burgess (1974); Richardson (1974); Murray and Ginman (1976); Jondrow, Chase, and Gamble (1977); Crandall (1981). (Some of the theory of functional form under imperfect substitution has been worked out by Armington [1969].) These demand curves, by incorporating imperfect substitution, make possible a model of the import market that includes the assumption of extremely elastic supply curves for both domestic and imported steel. Indeed, estimated supply curves for manufactured products do tend to be quite elastic. Empirical supply curves regarding imports are almost entirely absent from the economic literature, but the limited share of U.S. imports in world consumption of most manufactured goods suggests that the "small country" assumption of elastic supply is applicable.

The distinction between imported and domestic products also has implications for the theoretical analysis of international trade. It argues that imports and domestic products are often imperfect substitutes, a thought that runs counter to the perfect-substitution assumption of much theoretical work.

II. Is the Price Differential Illusory?

Economic data are widely regarded as imperfect. This is especially true of price data and even more of import price data. Import prices are typically estimated by prices quoted in trade journals (such as prices of steel in *Metal Bulletin*) or by unit values (the ratio of value to tonnage). Accordingly, it would not be at all surprising to find that the price differential between imported and domestic steel is a statistical artifact.

Instead, we found evidence of a genuine price differential. Documentation comes from a number of sources, including formal studies, informal accounts in the press, congressional hearings, a survey conducted for the U.S. International Trade Commission (1976), and our interviews with steel purchasers and producers.

In one study, for instance, Rosenberg (1973) compares price lists on "U.S. base price and extras" with cost plus insurance and freight (CIF) prices of four popular types of Japanese and European steel. Some of the quoted differentials are small: For example, the 1970 U.S. price of hot-rolled sheet was 4% above the import price. Other differentials were large: 16.2% in March 1971 for hot-rolled sheet and 13.3% in mid-1972.

In another study, Kravis and Lipsey (1971) use interviews with purchasers to compare export prices for various countries in selected years between 1953 and 1964. If the U.S. export price was the same as the internal price, domestic steel sold for about 30% more than Japanese steel in 1964.

Reports in the press also indicate that at times there has been a substantial difference between the prices of domestic and imported steel. The *Wall Street Journal,* for example, reported in 1975 that "the era of cheap foreign steel has gone the way of cheap foreign oil"

("Drop in Imports Make Steelmen Wonder If Days of Cheap Foreign Steel Are Over" [December 30, 1975], p. 22). An earlier article in the *Wall Street Journal* described the beginning of a price war among major steel companies, precipitated by price shading meant to bring domestic prices closer to foreign prices ("U.S. Steel Cuts Prices to Fight Import Boom, Dismaying Other Mills" [May 19, 1968], p. 1).

In 1968, the staff of the Senate Committee on Finance reported the results of a survey of domestic steel producers; the survey included detailed information on delivered prices for domestic and imported steel (see U.S. Congress, Senate 1968). For hot- and cold-rolled carbon sheets, about which the most replies were received, the reported differential ranged from 4% to 35%. As an example, one price comparison in Michigan showed domestic hot-rolled sheets delivered at $149 per ton and imported at $107, a 28% differential.

The price comparisons further indicate that the differential was not purely a function of inland transportation costs. In some cases, differentials were clearly inland and substantial. For example, hot-rolled carbon sheets sold at an 18% differential in Kentucky, a 12% differential in Tennessee, and a 16% differential in Missouri.

During congressional hearings in 1968 (see U.S. Congress, House 1968), a major importer reported delivered prices for imported and domestic steel covering the period 1965–68. The quoted differentials were usually smaller than those quoted by U.S. producers, but there were still differentials. For example, in the period 1965–68, imported hot-rolled coils sold at 7.0%–22.3% less than equivalent domestic steel. More recently (1976), a mail survey by the U.S. International Trade Commission (1976) found differentials in stainless-steel plate ranging from 0% to 30% at various times between 1971 and 1975.

III. Is the Price Differential between Imported and Domestic Steel Accounted for by Differences in Characteristics?

We tested in several ways the hypothesis that imports differed from domestic steel. First, we checked to find out whether imported steel was described as different from domestic steel in the technical literature. Second, we asked buyers and sellers of steel. Third, for two characteristics, security of supply and lead time between order and delivery, we made illustrative calculations of the added costs to users of imported steel. Fourth, we estimated a hedonic price regression to see how well the prices of steel from alternative sources of supply, including sources other than imports and domestic mills, could be explained by these same two characteristics.

Before reviewing this evidence, it is useful to list the characteristics that may distinguish imported and domestic steel: (1) quality of products, (2) delivery lead time, (3) certainty of delivery lead time, (4) credit conditions, (5) required size of purchase, (6) availability and cost of nonbase extras, (7) familiarity with domestic product, (8) transactions cost, and (9) security of supply.[1]

Evidence of Differing Characteristics in the Literature

The literature cites several respects in which domestic and imported steel differ. Hogan (1971), in his history of the steel industry, cites as disadvantages of imported steel (in the mid-1960s): long lead time, the need to buy in large quantities, the cost of unloading and unwrapping, and, in some cases, unknown quality. Miller (1968) says that purchasers regard the availability of foreign steel as "at best a cyclical phenomenon" and that imports cannot match the day-to-day continuity of supply provided by domestic sources, continuity that purchasers consider crucial. An importer testified at 1968 congressional hearings that imports must sell below domestic products because of slower delivery, problems of communication, transport hazards, and the necessity for users to carry large inventories to compensate for inflexible delivery schedules (see U.S. Congress, House 1968). Kravis and Lipsey (1971), though they do not cite evidence about steel, do note that, with aluminum, one large consumer switched to domestic suppliers despite a 5%–10% price differential, because relying on imports meant that he had to maintain costly stocks to provide a margin of safety.

Finally, Crandall, in his recent book on the steel industry (1981, p. 69), explains his finding of less than perfect substitution between domestic and imported steel as an indication "that the U.S. steel market consists of two types of buyers: those desiring long-term arrangements with secure domestic suppliers and those more interested in minimizing their short-term cost of steel."

Evidence from Interviews

For additional information about the relative importance of various characteristics, we spoke with a number of buyers, sellers, and others close to the steel market[2]—not to generate data for statistical analysis but to elicit comments from people close to the steel market.

The reasons most often given for buying or not buying imports are listed in table 1. These reasons reinforced the impression that, except for the shortage period, imports have usually been priced well below domestic steel. One respondent noted that "in most instances, foreign

1. "Security of supply," as used here, means that the consumer is assured of a specified price in the future and that he can obtain his normal supply.

2. Among buyers, we interviewed fabricators and wholesalers (10), warehouses (5), and manufacturers using steel (4). Among sellers, we talked to domestic mills (9) and foreign mills (2). In addition, we talked to representatives of trade associations (2) and a government official. The total of those interviewed was 28.

TABLE 1 Interview Responses to Questions about Factors Influencing Choice between Imports and Domestic Steel

Characteristic of Imports	Most Important Positive	Positive for Imports	Negative for Imports	Most Important Negative	Not Important
Security of supply		2	4	8	2
Delivery lead time			15	1	1
Certainty of lead time			15		1
Required size of purchase			10		4
Inventory requirements			10		3
"Buy American" clause			8		3
Availability and cost of nonbase extras			7		4
Familiarity with domestic products			3		7
Relative transaction cost			3		11
Credit conditions		2	3		9
Quality		8	3	1	7
Price	15	1			1

NOTE.—The columns do not sum to the number of interviews (28) because different interviews concentrated on different questions. A single interview typically covered about half the questions.

steel has to be sold at lower than domestic prices, or there is no reason for purchase." Most respondents felt that import quality was higher (i.e., less was unusable because of such defects as cracks and blemishes) and speculated that this higher quality was a result of the higher cost of reshipping imports, if defects caused them to be returned. A number of interviewees said that foreign steel shipments has longer lead times—3 months rather than 1 month or less—and were less reliable. Security of supply, the requirement to make large purchases, "buy American" clauses, and the need for large inventories also worked against imports. (We interpret the larger inventories as a consequence of longer lead time; details are discussed later.) Credit conditions, information, and transaction costs were not considered important differences between imported and domestic steel.

The Costs of Some Characteristics of Imports

In the following sections, we analyze two of the competitive disadvantages of imports: supply insecurity and long lead time. Our purpose is to provide rough estimates of the cost that purchasers might plausibly impute to these disadvantages. The estimates require strong assumptions and will therefore be of interest primarily for their orders of magnitude.

The Cost of Insecurity of Import Supply

Our interviews indicated that insecurity of import supply is a major selling point for domestic steel. In this section, we limit the analysis to one aspect of "supply insecurity": the situation in which import prices rise sharply and domestic producers do not accept new customers. The assumption is that the relative prices of domestic and foreign steel do not vary enough over the cycle to eliminate excess demands or supplies. Instead, domestic suppliers provide implicit insurance against shortages by charging higher prices than foreign producers when demand is slack and allowing steady customers to buy at the (then) lower prices when demand is temporarily heavy. Indeed, during the steel shortage of 1973–74, domestic mills allocated supplies on the basis of 1972 purchases.[3] The premium paid for this "insurance" may explain part of the price discount on imports during periods of slack demand.

To estimate the appropriate discount for imported steel when demand is slack and import prices are low, we make use of a strong assumption: When import prices are high, users cannot switch to domestic steel.[4] Given this assumption, a first approximation to the appropriate discount in slack periods is one that equates the average price of imports over the cycle to the average price of domestic steel.

But this first approximation omits several facts about the steel market. First, when steel prices are particularly high (during boom periods), some users can substitute other factors of production. Hence, their loss of profits is not so great as would first appear.[5] Second, import prices tend to be high during boom times, when, presumably, output prices are higher. Some allowance must, therefore, be made for the fact that imports become expensive at exactly the time when output demand is heaviest. Therefore, instead of calculating the price differential that equalizes the import and domestic *price* averages over the business cycle, we calculate the differential that equalizes *profits*.

Our method for estimating the equal-profit differential is shown in figure 1. Line *D1* represents the demand for imports under boom conditions, and line *D2* represents slack demand. Both curves are drawn holding the domestic price constant at p. The demand curves reflect our assumption that steel users do not switch back and forth between

3. For a more complete description of this shortage and how import users and domestic users fared, see the longer version of this paper (Jondrow et al. 1977).

4. We also assume that imports are not bought when cheap and then stored. As will be seen later, the cost of storing steel for several years would be prohibitive. Hence, storing is limited to short periods.

5. This would suggest that, ceteris paribus, buyers with close substitutes for steel would be more willing to buy imported steel than those with no good alternatives. Crandall (1981) found that imports of hot- and cold-rolled sheet steel—for which aluminum and other materials may be substituted—are more price sensitive than are imports of structural steel, steel plate, and steel bars.

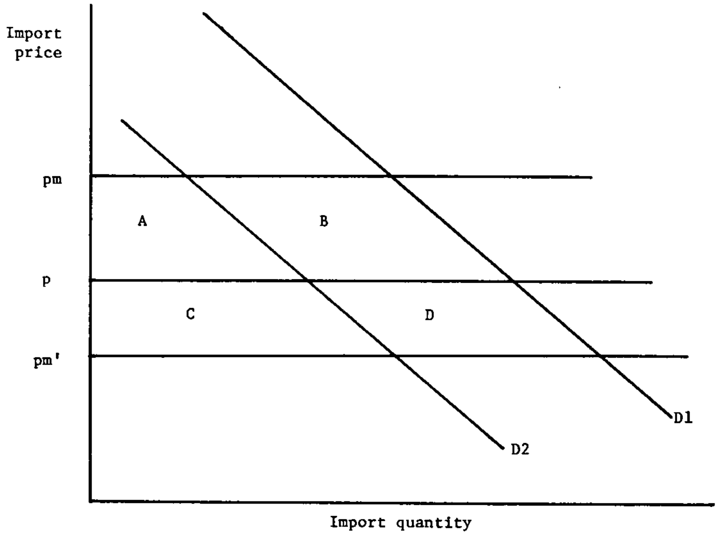

FIG. 1.—The difference in profit from using imported and domestic steel

domestic and imported steel, that they act instead as though bound to one source of supply by an implicit contract, and that they rarely negotiate new contracts. The demand curves, accordingly, do not represent substitutions between imported and domestic steel.

Suppose that during a shortage, the import price is *pm*. If the user has specialized in domestic steel, he can purchase domestic steel at price *p*. A consumer-surplus-type measure of the lost profits of import users relative to domestic users is equal to area $A + B$. To make up for this loss, the import purchaser requires some discount during nonshortage times (*pm'*). This discount yields the purchaser a gain in profits measured by the area to the left of the nonshortage demand curve (*D2*) between prices *p* and *pm'*. Ignoring present value considerations, the appropriate nonshortage import price is the one that equates area $A + B$ with area C, where each area is weighted by the frequency with which it is expected to occur.

Though this graphical analysis describes two periods, the actual calculations of the discount are made for each quarter of a typical cycle. We calculated the discount by simulating a simplified quarterly model of the market for imported and domestic steel. By successive simulations of the model, we find the discount that foreign producers must offer during slack periods to provide purchasers with the same present value of profits they would enjoy if they bought domestic steel.

The Model. The model includes six equations: one expressing the demand for imported steel, two describing domestic and foreign steel production, one for world steelmaking capacity, and two describing the prices of domestic and foreign steel.

The units of measurement for the variables can be chosen for convenience, provided only that the prices of imported and domestic steel are based on the same quantity units. Hence, the equations are so written that several of the variables are indices with value 1 in the first period of simulation: world capacity (k), the domestic steel price (p), and the U.S. price of steel-using commodities (py). The time trend (t) begins at 0 and increases by 1 each quarter. For the other variables, units are determined by the equations:

import demand:

$$m = \left(\frac{pm}{py}\right)^{-.345} y; \tag{1}$$

output of steel-using commodities in the United States:

$$Y = e^{.006t}\{1 + .054 \text{ sine } [.449(t + 7)]\}; \tag{2}$$

world steel output:

$$s = e^{.006t}\{1 + .050 \text{ sine } [.449(t + 7)]\}; \tag{3}$$

world steelmaking capacity:

$$k = e^{.006t}; \tag{4}$$

domestic prices:

$$p = ae^{.026t}; \tag{5}$$

import prices:

$$pm = Ae^{.026t}\left(\frac{s}{k}\right)^{1.84}. \tag{6}$$

Equation (1) says that import demand (m) depends on the price of imports relative to the price of output (pm/py) and on the level of output (y) in the steel-using industries. The form of the equation can be derived from the assumption of a constant elasticity of substitution (CES) production function for output (y). That demand is proportional to output results from an assumption of constant returns to scale. The elasticity of substitution (.345) was estimated empirically by Jondrow (1978).

Equations (2) and (3) describe trends and cycles in the output of steel-using commodities in the United States (y) and in world steel output(s). Both are assumed to grow exponentially at 0.602% per quarter, the rate of growth of nonresidential investment in the United

States, used here as a proxy for the rate of growth of steel-using activity, domestic and foreign. The growth rate is calculated as a least-squares trend in the log of investment, 1966:III–1973:III, peak to peak over two cycles. Cycles about the trend are introduced by a sine wave. The length of the wave is 14 quarters, since the two investment cycles cover 28 quarters.

The cycle in world steel output was assumed to coincide with the cycle in U.S. output of steel-using commodities but with differing amplitudes. The amplitude of the U.S. cycle was estimated from the two cycles discussed earlier; the amplitude of the world cycle was estimated from the amplitude of cycles in world utilization over the period from 1956 to 1976. Accordingly, the parameters determining amplitude of the foreign and domestic cycles are different, 0.050 and 0.054, respectively. Each cycle is shifted 7 quarters by use of $t + 7$ as an argument in the sine functions of equations (2) and (3). This simply begins the cycle at the beginning of the trough, when the import price drops below its trend. World steelmaking capacity is assumed to be a simple exponential trend (eq. [4]), with the rate of growth equal to that for world steel output. It is measured as an index, set equal to 1 in the first period of the simulation.

U.S. prices of steel (p) and steelmaking output (y) are both assumed to grow by 2.6% per quarter. This was calculated as the least-squares trend in the logarithm of wholesale price index from the first quarter of 1972—when recent inflation began to exceed 5%—to the second quarter of 1977. Historically, any price response of domestic steel to demand fluctuations has been mild (see, e.g., Crandall 1981); therefore, no influence of demand on price is built into the basic model. We do consider a variation with mild price response.

The price of imported steel (eq. [6] in the model) has the same rate of growth as the price of domestic steel. In addition, the import price shows a strong response to world market conditions, as measured by the ratio of world steel production to world capacity. The coefficient in this ratio, 1.84, is taken from Jondrow (1978).

The remaining parameter (α) is so adjusted that the lower prices of imports during troughs offset the premium during booms, in the sense that the present value of profits is the same whether imported or domestic steel is used. To discount, we first deflate by the price of steel-using output, then use a real rate of return of 7%, a rate consistent with long-term, real returns on securities listed on the New York Stock Exchange (see Hayes 1977).

For individual quarters, the added profit from using imports is the area to the left of the demand for imports and between the import price and the domestic price, illustrated earlier as area $A + B$ in figure 1. To make numerical estimates of this area, we integrate the demand for imports (eq. [1]) between the import and domestic price. This integral is

$$\frac{y\ py^{.345}}{(1 - .345)py}(p^{1-.345} - pm^{1-.345}).$$

Parameter α is adjusted until the present value of this integral sums to 0 over the cycle. Once this has been done, there are a number of outputs of the simulation over the cycle. We report only the one of major interest, the price differential in the trough of the cycle, 9%. Suppliers of imports must offer a 9% discount during the trough of the cycle to compensate purchasers for the insecurity of import supply. This result assumes that the U.S. price does not respond to demand. An alternative assumption of mild responsiveness in price[6] lowers the discount from 9% to 8%.

The Costs of Long Lead Times to Importers

That larger inventories will be needed is suggested by several characteristics of imports, including longer waiting times, less certainty about waiting time, and larger order requirements. In this section, we focus on longer lead time, and we use a standard inventory model to estimate the higher inventory cost. (We do not make corresponding estimates for larger order requirements or uncertainty about waiting time.)

One basic question is this: Why do longer lead times increase costs at all? If the lead time is longer, why not just plan earlier? The answer is that planning far in advance is costly. One important cost is the risk that predictions will be inaccurate and that too much or too little will be ordered. This risk can plausibly be expected to be higher for predictions that reach farther into the future.

Application of inventory model. The inventory model used is a standard one, based on trade-offs among three costs: the costs of ordering, the costs of storing inventories (including carrying charges), and the costs of running out of the material (outage costs). If inventories are large, the storage costs are high and the outage costs low; if inventories are small, storage costs are low, but outages are more frequent and costly. The inventory model tells how to minimize the expected sum of these costs by selecting an appropriate average level of inventory, size of order, and rule for when to reorder.

The model used is described in detail in Hadley and Whitin (1963). These inputs are required: (1) *Expected lead-time demand:* This is the expected demand for the product between placement of the order and receipt of the material. (2) *The standard deviation of lead-time demand:* The variation in lead-time demand comes from two sources—

6. The specific responsiveness was that a change in capacity utilization from .9 to .95 leads to a 1% change in price (Crandall 1981, p. 65).

variation in demand per period and variation in the lead time around its mean. (3) *The form of lead-time demand:* We use a normal distribution. When substantial probability is associated with negative demand, the distribution is truncated at 0. (4) *Unit inventory cost:* This is the cost of holding one unit of inventory for 1 year, expressed as a percentage of purchase price. (5) *The cost of ordering:* This is the transaction cost. (6) *The cost of outage:* This is the cost of not having material when it is needed.

In applying the model, we had data on only some of the parameters. To derive values for the unknown parameters, we used the observed levels of inventory held by steel purchasers, 1.82 months. (This is the ratio of end-of-quarter inventories to consumption, each averaged over the period from 1970 to 1975.) This observed level allowed us to solve the model backward to determine permissible values of the unknown parameters. Though any number of sets of parameters can be derived in this way, the overall results of this section are not greatly affected by the specific combinations of parameters we chose. The parameters we used to estimate inventory costs are shown in table 2.

Using these inputs, the model projects an average inventory level of 1.82 months (the parameters were so chosen as to ensure this), an order size of 103 tons, and, most important, an annual inventory cost of 3.2% of the purchase price. It is this last cost that must be compared with the corresponding cost of imports.

To estimate the corresponding costs for users of imported steel, we assume that the expected lead time increases from 1 to 3 months while the variance of lead time remains unchanged. Because lead time is longer, predictions must be made farther into the future, and errors in prediction increase. Hence, the variance of lead-time demand grows, even though the variance of lead time itself does not.

TABLE 2 **Parameters for Inventory Model: Manufacturers Using Domestic Steel**

Parameter	Value
Expected lead-time demand (tons)*	100
Standard deviation of lead-time demand (tons)†	50
Unit inventory cost (%)‡	16.5
Observed level of inventories (months)§	1.82
Cost of outage ($)†	550
Cost of ordering ($)†	200

*Arbitrary. The absolute figure is unimportant. What matters is the relation to the standard deviation of lead-time demand.

†These parameters were chosen as a set to generate the observed level of inventories (see text).

‡The sum of interest cost (7%), housing cost (6.8%), obsolescence (1.5%), and inventory taxes and insurance (1.2%). All except the interest cost are drawn from "How the Steel Center Institute Figures Carrying Charges," *Purchasing World* 16 (July 1972): 82.

§The ratio of end-of-quarter inventories to monthly consumption, both averaged from 1970 to 1975. Raw data are from *Survey of Current Business*.

The question now becomes, By how much will this variance increase? To derive the increase in variance, we assumed that the errors of prediction increase proportionately with the length of projections. Clearly, this assumption cannot hold for predictions far into the future without implying massive errors. Yet the assumption is reasonable for a period of 1–3 months, the range of interest in this paper. The assumption about the dependence of errors on the length of projection is important. We checked it by examining recent projections of total steel production in the United States made by a large econometric model and found that the assumption predicted well relative to the assumption that the size of the error is uncorrelated with the length of time to be projected. (The proportional increase in error can also be generated by the assumption that future demand is a random walk. For details see Jondrow et al. [1977].)

These assumptions allowed us to adjust the parameters of the inventory model so they describe importers. The expected lead time was lengthened from 1 month to 3 months, expected lead-time demand was increased from 100 tons to 300, and the standard deviation of lead-time demand was increased from 50 tons to 248 tons. (For a detailed derivation of the change in the standard deviation, see the appendix to Jondrow et al. [1977].)

With the new parameters for import users, the inventory model predicts an optimal inventory level of 7.47 months, an optimal order size of 228 tons, and, most important, an inventory cost of 11.9% of price. Because inventory costs are 11.9% of purchase price for import users and 3.2% for domestic users, inventory costs associated with lead-time differences can explain a price differential of about 8.7%.

An Interpretation of the Estimates

We have suggested that for imports the combined costs of supply insecurity and long lead times are about 18% of price, each type of cost accounting for about 9%. But imports are not necessarily priced 18% below domestic steel. Different prospective purchasers have different costs of using imports. For example, a purchaser whose output experiences large cyclical fluctuations in demand will, everything being equal, find it costlier to use imports because the cost of supply insecurity is higher. Similarly, a manufacturer who produces steel-using articles to order rather than for stock may be able to predict his demand several months ahead and hence will experience a lower inventory cost from using imports. Because the costs of imports vary among users, the differential is not fixed; it takes different values for different purchasers. At a small differential, there are few purchasers; at a larger differential, there are more.

Our estimates refer to a "typical" user of imported steel. Suppose, for illustration, that this user is the median in terms of the differential he requires before switching to imports, then the 18% differential we have calculated gains imports a 50% market share. Because the current share is much smaller, generating it requires a smaller price differential.

Evidence from Hedonic Regressions

If imported steel must cost less than domestic steel because of lead time and supply insecurity, other forms of steel with these same disadvantages would also sell at discounts, and sources of supply with favorable characteristics would sell at a premium above domestic steel. We considered five sources of supply: major mills, small mills, importers, warehouses, and brokers.

To see how well these prices can be explained by lead time and insecurity of supply, we made use of a regression with pooled data covering all five sources of supply and every quarter of the period 1973:I–1975:IV but omitting the shortage quarters, 1973:III–1974:IV. (Not reported are the coefficients on a set of dummy variables, one for each time period except the first.) The estimated equation is as follows:

$$P = \underset{(17.0)}{11.9} - \underset{(-1.7)}{.206S} - \underset{(3.1)}{.49T}, \; R^2 = .54,$$

where P is the price per hundred pounds. An attempt was made to incorporate discounts and premiums from list price (for details, see the Appendix). The source of the adjustment for discounts was the same as for lead time, and the two measures, therefore, refer to the same "typical" transaction. Security of supply, S, is stated as the difference (in 1967 dollars) between the highest price and the lowest price in the period 1973:I–1975:IV. The lead time in months is T. Lead time was assumed to be 0 for brokers and warehouses. Times for domestic mills were obtained from articles in *American Metal Market*. It was assumed that times for small mills were the same as for large mills. The articles in *American Metal Market* were quite descriptive, and we think we have good information on major mills and imports. Though information about small mills was much less firm, the assumption of equality with major mills seems reasonable.

The serious problems of identification with hedonic regressions are well known (see Rosen 1974).[7] Still, to the extent that the regression represents the preferences of purchasers, the hypothesized effect of lead time receives strong support, and the hypothesized effect for supply insecurity receives some support. Here is a rough idea of the orders of magnitude involved: For 1973:I, the regression predicts that imports had to be priced 8.3% below the domestic mill price because of

7. We would also have liked more detailed data to investigate more detailed hypotheses (e.g., that the coefficient of lead time differs between imports and domestic mills).

insecurity of supply, and that an additional 10.6% discount was needed because of longer lead time; both figures are close to our earlier estimates.

IV. Summary

In this paper, we have considered two attempts to explain why domestic steel retains most of the market, even though imports usually cost less. One hypothesis is that the price differential is entirely a consequence of difficulties in measurement. The evidence, drawn from the literature and interviews, does not support this hypothesis; there usually is a real difference in price. A second hypothesis is that imports must be priced below domestic steel because of unfavorable service characteristics, such as long lead times and insecurity of supply. This hypothesis is supported by evidence from a variety of sources: discussions in the literature, interviews with buyers and sellers of steel, illustrative calculations of the cost (to import users) of two characteristics, and a hedonic regression involving alternative sources of steel supply.

Appendix

TABLE A1 **Estimated Price by Quarter and Source of Supply (Dollars per Pound)**

	Price					
	Iron-Age Composite*	Major-Mill Price†	Small-Mill Price‡	Import§	Warehouse‖	Broker#
1973:						
I	9.36	9.36	9.36	8.18	12.64	9.74
II	9.36	9.36	9.36	9.36	12.64	10.77
III	9.36	9.36	9.55	11.14	12.54	13.48
IV	9.43	9.43	10.75	11.98	12.54	17.07
1974:						
I	9.48	9.48	11.76	13.56	12.32	19.15
II	10.03	10.03	11.44	14.45	13.90	18.96
III	12.35	12.35	14.32	14.56	16.91	20.37
IV	12.43	12.43	13.93	12.81	17.41	13.43
1975:						
I	12.93	12.93	11.90	10.67	14.67	12.37
II	12.93	11.44	10.80	10.98	11.94	7.99
III	12.91	11.17	11.43	11.43	11.63	8.65
IV	13.69	12.94	11.32	11.32	12.64	10.30

*The *Iron Age* composite is listed in a number of sources, including *Iron Age* magazine and *Business Week*.

†To construct this series, we assumed that list prices were charged throughout the period of very firm demand, 1973:–1974:IV, because we did not find reports of discounting in the trade press. Data for 1975:II–1975:IV were constructed by adjustment of the *Iron Age* composite price by the degree of discounting reported in various articles in the press, notably *American Metal Market* and the *Wall Street Journal*.

‡The small-mill price for 1973:I–1973:II was assumed to be the same as the major-mill price. For the period 1973:III–1974:IV, the price was based on a weighted average of the major-mill price and

the price of scrap, where the latter was weighted by its input-output coefficient in electric furnaces. We derived 1975 prices by adjusting the *Iron Age* composite by the degree of discounting, reported in the trade press. "Small mills" were defined as those smaller than Sharon.

§Import prices for 1973:I–1974:IV were constructed on the basis of the European export price composite, along with the fact that domestic mill and import prices were reported as equal in 1973:II. The European export composite is reported in *A Study of Steel Prices* (Executive Office of the President 1975). The export price composite is compiled from price quotations in *Metal Bulletin*. For the period 1975:I–1975:IV, the import price is formed from the *Iron Age* composite price along with reports in the trade press about the degree to which imports were selling below domestic quotes.

‖Data on warehouse prices are quoted in *A Study of Steel Prices* through 1974:IV. We constructed the price for this period by adjusting the *Iron Age* composite by the warehouse premium over mill for hot-rolled sheets. For 1975:I, we formed the price by adjusting the warehouse quote by the degree of discounting reported by Ryerson in *American Metal Market*. To adjust the *Iron Age* composite for 1975:II–1975:IV, we used reports of discounting relative to the mill price.

#Broker prices through 1975:I are quoted in *A Study of Steel Prices*. We adjusted the *Iron Age* composite price on the basis of the premiums or discounts relative to the mill price for hot-rolled sheets. For other quarters, we used reports in the trade press of discounting, relative to quoted mill prices, to adjust the *Iron Age* composite. When reports were unavailable, we relied on advertisements in *American Metal Market*, some for broker and some for warehouse surplus, which we assumed to be part of the same market.

TABLE A2 Percentage Discount from (−) or Premium over (+) Major-Mill Quote

	Iron-Age Composite*	Major-Mill Price†	Small-Mill Price‡	Import§	Warehouse‖	Broker#
1973:						
I	0	0	0	−13	+35	+4
II	0	0	0	0	+35	+15
III	0	0	+2	+19	+35	+44
IV	0	0	+14	+27	+33	+80
1974:						
I	0	0	+24	+42	+30	+102
II	0	0	+14	+44	+38	+89
III	0	0	+16	+18	+37	+65
IV	0	0	+12	+3	+40	+8
1975:						
I	0	0	−8	−17	+13	−4
II	0	−12	−16	−15	−8	−38
III	0	−13	−11	−11	−10	−33
IV	0	−5	−17	−17	−8	−24

NOTE.—See notes to table A1.

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