Imports and New Technology:

Sources of Injury in the Traditional Steel Industry

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Abstract - This paper explores whether imports or new technology has played a greater role in the recent restructuring of the American steel industry. A modified version of an injury index model developed by Pindyck and Rotemberg (1987) is used to analyze the comparative impact of steel imports and thin-slab minimills on capacity utilization rates in the flat-rolled steel industry. The analysis finds that, while rising import levels may have aggravated the decline of traditional steel production, the emergence of minimill production methods are a more fundamental cause of declining capacity utilization rates in the traditional steel sector.

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I. Introduction

The U.S. steel industry, long considered an integral part of the foundation of American manufacturing, is currently in turmoil. Entrepreneurial growth, advanced technological developments, and intense global competition in the steel industry have combined to usher in an era of dramatic restructuring during the 1980's and 1990's. This restructuring process has encompassed changes in the workforce, raw materials, capital equipment, production scale, geographic location, and ownership of steel mills.

Much of the change in steel industry organization has been spurred by technological developments that have enabled steel production at relatively small mills—or minimills—that recycle scrap into steel. These mills have increased their share of domestic steel capacity from approximately one-fifth to nearly one-half between 1980 and 2000.[1] The resulting U.S. steel industry is now characterized by two distinct production segments: a traditional steel industry that consists of aging, large, ore-based integrated mills and an emerging steel industry that consists of relatively new, smaller, scrap-based minimills. On July 28, 1999, Alan Greenspan made the following comment in testimony before the Senate Banking Committee:

[1] All U.S. steel capacity data in this paper is derived from the Steel Plant Database of the Center for Industry Studies at the University of Pittsburgh. This database, created as part of a Sloan Foundation study of competitiveness in the steel industry, provides detailed information about equipment-level capacity, product shape, and mill type at each steel-making plant in the United States.

> As you know, we really have increasingly two steel industries in this country. One is based on the older technologies…and the other is the mini-mills, which are evolving at a very dramatic pace…[2]

The competitive pressures faced by the traditional segment of the industry from the growth of minimill production have been seriously compounded by global overcapacity and rising import levels. Although world excess steel capacity has hovered around one-quarter of total capacity since the mid-1980s, the gap between capacity and consumption in some of the major U.S. trading partners have given the domestic industry cause for alarm. During the 1990s, the United States was consuming about the same amount of steel as it had capacity to produce, while Europe and Japan were only consuming about 40 percent, on average, of their steel-making capacity during the 1990s.[3] At the same time, annual U.S. imports of steel mill products rose 140 percent, from about 16 million tons in 1990 to a peak of more than 38 million tons in 1998.[4]

By the end of 2001, integrated steel companies had declared bankruptcy in record numbers and closed several mills. The financial failure of these companies followed both the sharp rise in import levels and the expansion of minimill production into the high-quality flat-rolled market during the 1990s. Representatives of the steel industry have claimed that the current crisis experienced by the integrated mills is *not* the result of internal, domestic competition between the integrated and minimill industry segments, but rather is the result of

[2] As quoted by the Steel Manufacturers Association in their Public Policy Statement on Minimill Growth.

[3] Statistisches Jahrbuch der Stahlindustrie 2000/2001 Herausgeber: Wirtschaftsvereingung Stahl Verein Deutscher Eisenhuttenieute (Statistical Yearbook of the Steel Industry)

[4] International Trade Administration, U.S. Department of Commerce

rising imports during the late 1990s. An investigation of steel import levels conducted by the U.S. International Trade Commission (USITC), under Section 201 of the Trade Act, supported the industry's claim, resulting in a positive determination of import-caused injury to the steel industry and a subsequent schedule of tariffs for many steel products. A positive determination by the USITC is only reached if imports have been a "substantial cause" of injury, meaning "a cause which is important and not less than any other cause."

This paper will explore whether domestic or foreign competition played a greater role in the restructuring of the American steel industry. In order to evaluate the sources of injury in the steel industry, I have modified an injury index model developed by Pindyck and Rotemberg (1987) to analyze a Section 201 investigation of the copper industry. In applying this model to the steel industry, injury will be quantified by the percent of unused steel-making capacity, or the idle capacity ratio. Furthermore, Pindyck and Rotemberg's model will be modified to assess the impact of domestic competition resulting from technological change and industry segmentation. The results of the modified model will provide some quantitative insight as to which competitive forces, domestic or foreign, had the greatest impact on the flat-rolled steel industry over the last ten years.

In order to more clearly define market forces and market participants, the injury index model will be applied to the flat-rolled steel market only. Not only is flat-rolled steel a particularly dynamic part of the steel industry, it has also been disproportionately impacted by import levels and by technological change in recent years. Approximately 75 percent of the capacity in bankruptcy is in plants that produce flat-rolled products.[5] Between 1998 and the end of 2001, ten flat-rolled steel mills, with a combined capacity of 31 million tons, declared

[5] United Steelworkers of America (December 2001).

bankruptcy and over 20 million tons of capacity had shutdown.[6] These plants, along with their bankruptcy and shutdown dates, are listed in Table 1. Annual imports of flat-rolled products have risen from 7.8 million tons in 1990 to a peak of 19 million tons in 1998.[7] Although flat-rolled products represented about 60 percent of imports during the period of the USITC investigation (1996-2000), they represented over 70 percent of the products found to be causing injury.[8]

Despite these indicators of decline, the domestic flat-rolled steel industry also includes significant signs of vitality. Several technological advances in the 1990s, most notably the development of thin-slab casting, have improved efficiency and have reduced the scale and cost of producing flat-rolled steel. These advances have spurred the installation of 12 new flat-rolled minimills, listed in Table 2, with more than 18 million tons of cumulative capacity during the 1990s. With the exception of one minimill, Trico Steel, which was a subsidiary of a bankrupt integrated steel-maker, the new thin-slab minimills have been profitable and are even expanding in some cases.[9]

The technological and trade developments in the flat-rolled steel industry are described in greater detail in Section II. With that information in hand, the injury index model for the flat-rolled steel industry can be developed in Sections III and IV. In Section III, the general version of the model is developed to assess the impact of imports on the flat-rolled steel industry as a

[6] In March 2002, National Steel, which has two flat-rolled plants with a combined capacity of almost 6 million tons, also declared bankruptcy.

[7] U.S. International Trade Administration

[8] USITC press release, “ITC Details Determinations Concerning Impact of Imports of Steel on U.S. Industry,” October 23, 2001. Data is from USITC, dataweb.usitc.gov, “U.S. Imports of Steel Products: Overall Trends by Product.”

[9] Trico Steel was co-owned by LTV (50%), Corus (25%) and Sumitomo (25%).

whole. Section IV includes the development of segmented version of the model, which allows for the assessment of both the impact of imports and the impact of new thin-slab capacity on the integrated segment of the flat-rolled steel industry. Section V presents the data that will be used in estimating both versions of the model, and Section VI presents the estimation results.

Although the general injury index model finds that imports have been a cause of injury for the flat-rolled steel industry, this finding is not sustainable when the emerging steel segment, or thin-slab minimill sector, is included as a source of competition. That is, the segmented injury index model finds that domestic competition is the most significant cause of injury for traditional flat-rolled steel producers. The analysis in this paper supports the conclusion that the U.S. steel industry is undergoing a transition between production methods in a process of "creative destruction," which Joseph Schumpeter called "an essential fact about capitalism."[10] Minimills, which form the emerging steel segment, are rapidly replacing integrated mills, the traditional steel segment, as the primary method of production in the steel industry. While rising import levels may have aggravated the decline of the traditional segment, it does not appear to be the primary or most significant cause of its decline.

II. The U.S. Flat-Rolled Steel Industry

A. Technological Change and Thin-Slab Minimills

In order to understand how the steel industry became segmented into two production sectors, it is important to understand how steel is made. The traditional method is to convert iron

[10] "…the same process of industrial mutation–if I may use that biological term–that incessantly revolutionizes the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism." Shumpeter (1975), 82.

ore into pig iron in large iron-making, or blast furnaces, and then to convert that pig iron into steel in a steel-making furnace, such as a basic oxygen furnace (BOF). The operational requirements of the blast furnace have made this method of steel producing a large-scale endeavor. The average capacity of an integrated mill is over 3 million tons, with the largest mill (U.S. Steel in Gary, IN) producing nearly 8 million tons annually.[11] Steel mills using this traditional method of production are referred to as "integrated mills."

The second method is scrap-based production in "minimills" that produce steel at a much smaller scale. The average capacity of a minimill is 875,000 tons, although minimill capacity ranges from 250,000 to 2.5 million tons.[12] Minimills produce steel by melting scrap metal in an electric arc furnace (EAF) and then casting it directly into either a long or flat shape using a continuous caster.[13] Long products, such as rails and bars, have less stringent technical, quality, and scale requirements than flat products, such as sheet and plate. The impurities of scrap metal and the casting process had made flat-rolled production at all but a few specialty steel minimills infeasible until several technological developments in the 1990s. The large integrated mills remained in control of the flat-rolled market during the 1980s, even as minimills gained control over the long product market. By 2000, over 90 percent of capacity for making long products was in minimills, with only a few integrated mills still casting long products.[14]

In the early 1990s, technological advances in thin-slab casting, ladle metallurgy, and rolling mills, however, opened the door to the flat-rolled steel market for minimills. The most

[11] Steel Plant Database and the U.S. Steel 2000 Annual Report.

[12] Steel Plant Database

[13] EAFs can also produce steel with alternative irons, such as direct reduced iron, but the price of scrap has made this option economically unattractive thus far.

[14] Steel Plant Database

significant of these advances was the commercial availability of a new casting technology in 1989.[15] Traditionally, flat-rolled steel had been made by casting 8-10 inch thick slabs and then using a variety of rolling methods to reduce the thickness of the slab. Thin-slab casting, however, enabled scrap steel to be cast into much thinner slabs, approximately 2-inches thick, ready for rolling into sheet and plate. The first thin-slab minimill was installed by Nucor in Crawfordsville, Indiana, in 1989. Eleven other minimills using the same technology have been built since then with a cumulative annual capacity of more than 18 million tons. These mills, along with their start up dates and capacities, are listed in Table 2.

Minimill production enjoys several cost advantages over integrated mills. Their smaller scale translates into lower start-up costs, a smaller installed base, and fewer labor requirements than the large integrated mills. Minimills use less than one-half of a labor hour to produce a ton

[15] Two additional technological developments assisted the market entry of minimills: the Steckel mill and thin-gauge hot-rolled steel. The Steckel mill enables the production of plate steel at a lower cost and smaller scale than a reversing mill. The minimum scale for a Steckel mill is around 1 million rather than 3 million tons per year, and it has a smaller yield loss and lower labor requirements than a reversing mill. Steckel mills have been installed in Ipsco's plant in Iowa, Tuscaloosa's plant in Alabama, Oregon Steel's plant in Portland, and in Bethlehem's Coatesville plant. Thin-gauge hot-rolled steel is a new product that has been made possible by the development of thin-slab casters. Because the slab produced by these new casters is significantly thinner than traditionally produced slabs, it is possible to use hot-rolling facilities to produce sheet as thin as 1 mm, a dimension that was previously only available through cold-rolling mills. Furthermore, thin-gauge steel is available at prices comparable to, or less than, cold-rolled steel (see Barringer and Pierce (2001)).

of steel, in comparison to nearly 3 labor hours per ton of steel at an integrated mill.[16] Moreover, the minimills do not have the burden of long-standing union contracts and outstanding benefits owed to retired workers ("legacy costs") of the older, integrated mills.[17] Only one of the thin-slab minimills, Trico Steel, has declared bankruptcy. Trico was 50 percent owned by LTV (an integrated steel firm that declared bankruptcy in 2001), but was quickly purchased and reopened by Nucor (the largest minimill firm) in 2002.

Furthermore, the thin-slab minimills opened in period of economic opportunity that included rising demand, falling input prices, and tariff protection. During the 1990s, total industrial production rose by 50 percent, and automotive production rose by 85 percent.[18] The largest single industrial consumer of flat-rolled steel is the auto industry, which purchases nearly one-third of flat-rolled steel shipments that are sold directly to the end-user.[19] Not surprisingly, during this period of economic growth, consumption of flat-rolled steel products has risen an

[16] Barringer and Pierce (2001), p. 256, using estimates from 6 thin-slab minimills (Trico, Ipsco Iowa, North Star BHP, Nucor Berkeley, and Nucor Crawfordsville) and from 4 integrated mills (Geneva, Gulf States, Weirton, and Wheeling-Pitt).

[17] According to a June 2001 press release from United Steel Workers of American (USWA), legacy costs at the integrated mills are currently estimated at close to $1 billion per year. Bethlehem Steel, a flat-rolled steel producer that declared bankruptcy near the end of 2001, reported a net present value for legacy costs of $3 billion, close to Bethlehem's total revenue of $3.3 billion for 2001 (press release, March 14, 2001).

[18] Federal Reserve Statistical Release, Industrial Production and Capacity Utilization: Market and Industry Groups.

[19] American Iron and Steel Institute, *Annual Statistical Report,* 2000.

estimated 46%.[20] At the same time, prices for their main raw material, scrap metal, were falling to record lows. Scrap prices fell sharply in the late 1990s, largely due to a financial crisis in Asia, which decreased world demand for scrap. During 1998 alone, the BLS composite price index for carbon scrap steel fell from 189 in January to 114 in December, dropping well below the previous 1990's low point of 124 in October 1992. In contrast, as Figure 1 illustrates, the price of the main raw material used by integrated mills—iron ore—has changed little in the last ten years.

Further assistance to the launch of the thin-slab minimills was provided by anti-dumping duties imposed in 1993 on cold-rolled sheet, cut-to-length carbon plate, and corrosion-resistant steel sheet. Tariffs ranging from 4 to 109 percent were imposed on approximately one-third of imported sheet and plate.[21] These tariffs were in place as most of the new thin-slab capacity became operational, further enhancing the economic environment for the new mills.[22]

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[20] Consumption is based on import, export, and shipment data for flat-rolled steel as reported in AISI *Annual Statistical Report*, 2000. See Table 4 for more detail.

[21] Blonigen (2000).

[22] Interestingly, several of the new mills are owned by steel corporations whose exports to the U.S. were negatively affected by the 1993 tariff schedule. Those mills include North Star BHP, which opened in 1996 and is 50% owned by Australian BHP Steel; Ipsco, which opened plants in 1997 and 2001 and is a Canadian steel company; Gallatin Steel, which opened in 1995 and is a joint venture between two Canadian firms; and Tuscaloosa steel, which is owned by the British firm Corus, PLC. Flat-rolled imports from Australia, Canada, and the United Kingdom were all subject to the 1993 anti-dumping duties, and each of the plants listed above is identified by Blonigen (2000) as a possible case of "tariff-jumping."

B. Import Competition

Quantifying the imports of flat-rolled steel is often made controversial by variations in the treatment of slab imports. As described above, slabs are semi-finished products that serve as an intermediate production step between molten steel and steel that has been rolled into finished flat steel products—such as sheet, strip, and plate. Integrated plants often import slabs to supplement or replace internal steel-making capacity, and several former integrated plants have been transformed into full-time slab processors.[23] Of the slabs produced domestically, over 99 percent are used by the firm that produces them.[24] In making their case before the USITC, the steel industry was successful in having slab imports treated as "flat products" that compete with sheet and plate.[25] However, all of these slab imports were made into other flat products, such as sheet and plate, by U.S. mills, creating a double-counting problem. This distinction impacts the quantity of flat-rolled imports significantly as illustrated by Table 3, where the ratio of slab imports to finished flat product imports exceeds 50 percent in some years.

For this analysis, we will define flat-rolled products as those steel products that have been processed *from* steel slabs and *then* rolled into steel sheet, plate, or coils. In accordance with this definition, the quantity of flat-rolled steel imports, along with their share of U.S. consumption, are detailed in Table 4 During the 1990s, import competition in the steel industry grew steadily,

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[23] In 1999, five integrated producers reported importing over one million tons of slab in the first half of the year. In addition, California Steel, a full-time slab processor, imports approximately 1.8 million tons of slab each year. Reported by Bagsarian (June 1999).

[24] USITC, Publication 3479, *Vol II: Information Obtained in the Investigation*, Steel Investigation No. TA-201-73, December 2001, page Flat-1.

[25] Although slabs were included in the analysis and received a positive determination of injury from the Commission, President Bush excluded them from the imposition of tariffs.

with imports of flat-rolled steel climbing 153 percent between 1990 and 1998. Although this is a steep increase, it should be noted that imports of all goods climbed 133 percent over the same period, and imports of non-automotive capital goods climbed 323 percent during the economic expansion of the 1990s.[26] Nevertheless, by the end of 1998, imports of flat-rolled steel had captured 26 percent of the domestic market, up from about 15 percent in 1990. Imports nearly doubled between 1995 and 1998, rising from 10.6 million tons to over 20.4 million tons.

Between 1998 and 2001, imports declined just as rapidly, dropping by nearly one-third in 1999 and again in 2001. By 2001, imports of flat-rolled steel were just 9.4 million tons, similar to their early 1990's level. Import share in the flat product market fell back to 14 percent in 2001, slightly lower than the 1990 market share. However, the steel industry felt that irreversible damage had been done to steel profits, as evidenced by the bankruptcies that were declared in 2000 and 2001 and by falling prices. Figure 2 shows the decline in the price of hot-rolled sheet, cold-rolled sheet, galvanized sheet, and plate in real terms during the 1990s. Over this period, prices for hot-rolled sheet and cold-rolled sheet fell approximately 50 percent in real terms. The domestic steel industry has pointed to this decline as a major indicator of the injury caused by imports.

III. The General Injury Index Model

The injury index model developed by Pindyck and Rotemberg uses a reduced form equation to evaluate the impact of imports on the economic health of a domestic industry. Their model begins with a partial equilibrium framework that establishes the relationship between import levels and market conditions (i.e., industry supply and demand conditions). They assume

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[26] Bureau of Economic Analysis, National Income and Products Accounts Table, chain-type quantity index.

that there exits a measure of industry economic health—and thus, injury—that can be tested using this partial equilibrium framework. The injury index model further assumes that the domestic industry is competitive and faces an upward sloping supply curve, dependent on price and a supply shift parameter, S(P, a); a domestic demand curve, dependent on price and demand shift parameter, D(P, b); and an upward sloping supply of imports, M(P, c). The shift parameter c responds to changes in foreign supply and demand conditions. In equilibrium, price enables domestic demand to equal domestic supply plus imports.

$$D(P^*, b) = S(P^*, a) + M(P^*, c) \quad (1)$$

Since changes in *a* and *b* affect the equilibrium price, the level of imports responds to changes in domestic as well as foreign economic conditions. This is an important model criteria for evaluating the claims made in a Section 201 investigation. Unlike antidumping and countervailing duty investigations, a 201 investigation is not concerned with unfair trade practices. Rather, it attempts to determine whether the level of imports has itself been a "substantial cause" of injury to the domestic industry, regardless of what caused a rise in import levels. Thus, it is not necessary in a 201 investigation to distinguish between a rise in imports that develop from changes in domestic conditions (i.e., changes in *a* or *b*) or from changes in foreign conditions (i.e., a change in *c*). Consequently, it is also not necessary in the injury index model to specify the import schedule or quantify its shift parameter.

Furthermore, a 201 investigation considers injury only as far as the supply side of the market is affected. Injury to domestic consumers is not considered. Pindyck and Rotemberg create an injury index (equation (2)) that depends on changes in the supply schedule as well as on changes in the shift parameter of the supply schedule directly. Examples of useful indicators of injury include industry employment, idle capacity, and profit. Each of these is discussed in the Trade Act as appropriate indicators of industry welfare.[27]

(2) $$I = g[S(P^*, a), a]$$

A decline in demand or an increase in the import schedule affects the injury index through a decrease in price. Changes in supply conditions affect the index in two ways: indirectly through shifts in the supply curve and directly through the parameter *a*. For example, if employment were the indicator of injury, then an increase in national wage levels would decrease employment directly through the demand for labor as well as indirectly through a shift in supply.

Since equation (1) is not valid in logarithms, Pindyck and Rotemberg assume that the demand, supply, and injury equations are locally linear and write them as follows:

(3) $$S_t = s_o + s_1 a_t + s_2 P_t + \varepsilon_{st}$$

(4) $$D_t = d_o + d_1 b_t + d_2 P_t + \varepsilon_{dt}$$

(5) $$I_t = i_o + i_1 a_t + i_2 S_t(P_t, a_t) + \varepsilon_{it}$$

The coefficients s_2, d_1 and i_1 are assumed to be positive, and the coefficients s_1 d_2, and i_2 are assumed to be negative. This implies that an increase in the supply shift parameter *a* will decrease supply and increase the level of injury, and an increase in the demand shift parameter *b* will increase demand and decrease the level of injury. As discussed previously, the import schedule is not specified, because the level of imports rather than the import schedule is of interest in a 201 investigation. The *ε's* represent error terms that are normally distributed.

An equation for the equilibrium price can be determined by substituting equation (3) and (4) into equation (1). The result is as follows:

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[27] Trade Act of 1974, 19 USC 2522 (8)(b)(3)(c).

(6) $$P_t = \frac{d_0 - s_0 + d_1 b_t - s_1 a_t + \varepsilon_{dt} - \varepsilon_{st} - M_t}{s_2 - d_2}$$

Since s_2 is constrained to be positive and d_2 is constrained to be negative, the denominator (s_2–d_2) will be positive and nonzero by definition. By substituting this equation for P_t into equation (5), we can obtain a reduced form equation for the injury index:

(7) $$I_t = \psi + \alpha a_t + \beta b_t + \delta M_t + \varepsilon_t$$

where $\psi = i_0 + [i_2 (s_2 d_0 - s_0 d_2)/(s_2 - d_2)]$

$\alpha = i_1 - [i_2 d_2 s_1/(s_2 - d_2)] > 0$

$\beta = i_2 s_2 d_1/(s_2 - d_2) < 0$

$\delta = -i_2 s_2/(s_2 - d_2) > 0$

$\varepsilon_t = \varepsilon_{it} + [(i_2 s_2 \varepsilon_{dt} - i_2 d_2 \varepsilon_{st})/(s_2 - d_2)]$

In this equation, injury will be increased by increases in imports and decreased by positive shifts in demand (i.e., rising auto production) and supply (i.e., falling input prices). Performing OLS on equation (7) should produce consistent estimates of the reduced form coefficients (α, β, and δ) as long as the independent variables are uncorrelated with ε_t. Whether consistent estimates of the structural equation coefficients can be obtained depends on assumptions about the cross-correlation of error terms and equation identification. For the purposes of this analysis, however, only the coefficients of the reduced form equation are of interest.

The only estimation concern that Pindyck and Rotemberg raise about equation (7) is that imports may be correlated with ε_t. They point out that imports are likely to be correlated with supply and demand error terms through the price relationship in equation (6), unless imports are price inelastic. In the event that imports are price elastic, which is the most reasonable assumption for the steel industry, Pindyck and Rotemberg suggest using an instrumental variable for imports. One potential variable is lagged values of imports, which could serve as an instrument for M_t as long as the error terms were serially uncorrelated. Also, lagged values of imports would better match the industry's claims that the impact of imports has a time-delayed effect on the domestic industry. Imports peaked in 1998, but most bankruptcies were declared in 2001. Lagged import values will thus be included in the econometric analysis in order to improve the estimation and to better evaluate the industry's claims.

Unfortunately, as Pindyck and Rotemberg also mention, the model does not allow for a direct treatment of the dynamic adjustment to imports that may occur over several periods in the steel industry. Their alternative to redefining the model to include adjustment over time is to perform a test of Granger causality. This test uses lagged values of the injury index and current and lagged values of imports to test for statistical causality. This test will be performed for the flat-rolled steel industry in this paper as well.

IV. The Segmented Injury Index Model: Integrated Mills and Minimills

Although the general injury index model captures many of the factors involved in the recent 201 investigation of the steel industry, it neglects a key change in the flat-rolled industry during the 1990s. That key change is technological change, which enabled a new production process to emerge in direct competition with the traditional production process. During the 1990s, 18 million tons of capacity was installed in thin-slab minimills (the emerging sector) while roughly 31 million tons of capacity in flat-rolled integrated mills (the traditional sector) was placed in bankruptcy, with over 20 million tons of that capacity shutting down (see Tables 1 and 2).

Assessing the impact of imports on the flat-rolled steel industry without accounting for an 18 million ton transfer of capacity between two distinct technological segments of the industry would only offer an incomplete assessment at best. At worst, the assessment may mistakenly attribute causality to the wrong factor. In the first place, new minimill capacity may have benefited from economic advantages unavailable to the integrated mills—such as lower wages, annuity costs, interest rates, and input prices—that shielded the minimills from the full impact of rising imports and falling steel prices in the flat product market. In that case, mixing the minimill industry segment with the integrated industry segment may weaken the assessment of the full impact of imports on the integrated producers of flat-rolled steel. Moreover, the new thin-slab minimills may have served as a source of competition with the integrated mills that had as much or more impact than imports on the ability of the integrated mills to survive.

In order to modify the general injury index model to consider the integrated mills and new thin-slab minimills as separate industry segments in competition with each other, we will treat the products of the thin-slab minimills as substitutes for the products of the integrated mills. Thus, minimill production will enter the market equilibrium equation as a negative parameter in the demand schedule and will be represented by the total capacity at new thin-slab minimills (*N*). With this modification, the steel market equilibrium equation (repeated below as equation (8)) is redefined for the integrated flat-rolled steel industry segment alone, as shown in equation (9):

$$D(P^*, b) = S(P^*, a) + M \tag{8}$$

$$D^I(P^*, b, N) = S^I(P^*, a) + M \tag{9}$$

In the segmented version of the model, the domestic flat-rolled steel industry is now defined as the traditional steel industry segment composed of the integrated firms that were operational in 1989.[28] Capacity at the thin-slab minimills will be used to calculate new capacity, N_t, which is now a parameter in the structural equation for demand. The structural equations for supply and injury are similar to their counterparts in the general model.

[28] Small traditional and specialty steel mills, which accounted for about 6 percent of production on average during the 1990s, are not included in this version of the injury index model.

(10) $S_t^I = s_o + s_1 a_t + s_2 P_t + \varepsilon_{st}$

(11) $D_t^I = d_o + d_1 b_t + d_2 P_t + d_3 N_t + \varepsilon_{\mathrm{dt}}$

(12) $I_t^I = i_o + i_1 a_t + i_2 S_t^I(P_t, a_t) + \varepsilon_{it}$

By solving for P_t using equations (10) and (11) and substituting the result into equation (12), as in the general model, we can obtain the reduced form equation for the segmented model, as follows:

(13) $I_t^I = \psi + \alpha\, a_t + \beta\, b_t + \delta\, M_t + \gamma N_t + \varepsilon_t$

where $\psi = i_0 + [i_2 (s_2 d_0 \text{-} s_0 d_2)/(s_2 - d_2)]$

$\alpha = i_1 - [i_2 d_2 s_1/(s_2 - d_2)]$

$\beta = i_2 s_2 d_1/(s_2 - d_2)$

$\delta = -i_2 s_2/(s_2 - d_2)$

$\gamma = i_2 s_2 d_3/(s_2 - d_2)]$

$\varepsilon_t = \varepsilon_{it} + [(i_2 s_2 \varepsilon_{dt} - i_2 d_2 \varepsilon_{st})/(s_2 - d_2)]$

The demand and supply shift parameters, b_t and a_t, will continue to be based on the industrial production indices and scrap prices. The variable used for new mill capacity (N_t) is the cumulative rated capacity of each thin-slab mill as it opens or is transformed from a processing plant to a minimill.

V. Data for the Injury Index Model

Table 5 identifies the data that will represent each variable in the reduced form equation for both the general and segmented versions of the injury index model. The dependent variable, or measure of injury, in both models will be the idle capacity rate. The general model will use the idle capacity rate for all flat-rolled steel mills, whereas the segmented model will use the idle capacity rate for integrated steel mills only. In order to measure injury, the capacity utilization rate will be reported as idle capacity rate, as follows:

$$IdleCapacityRate = 1 - CapacityUtilizationRate = 1 - (Shipments/Capacity)$$

The independent variables for the general model include the price of scrap as the supply shift parameter, an index of both total industrial and automotive production as the demand shift parameter, and the import tonnage of flat-rolled steel. The segmented model includes the same independent variables, along with new mill capacity. Data for all of the variables have been collected in monthly series, with the exception of capacity, which is only available annually. The Steel Plant database as well as industry reports of the month that each mill opened have been used to estimate a monthly series for new capacity.

A. Dependent Variable: Capacity Utilization

Estimates of U.S. capacity for producing flat-rolled steel products are derived from the Steel Plant Database of the Center for Industry Studies at the University of Pittsburgh. This database, created as part of a Sloan Foundation study of competitiveness in the steel industry, provides detailed information about equipment-level capacity, product shape, and mill type at each steel-making plant in the United States.

Using this information, we can define a sample set of 44 plants that are able to produce flat-rolled steel (see Appendix A). The only plants identified as "flat-rolled steel-making plants" are those plants that use steel-making furnace capacity to process either iron ore or scrap into molten steel, which is then processed into flat shapes (such as plate, sheet, or strips) within the plant. Plants that purchase slabs or coils and then roll those inputs into finished shapes are not included in this list. Of the 44 sample plants, 22 are integrated mills, 12 are thin-slab minimills, and 10 are specialty steel producers that use either traditional minimill technology or pour steel into ingots.[29] In order to calculate the dependant variable, the general model will include data from all 44 plants, while the segmented model will include data from only the 22 integrated mills.

Capacity is defined as all capacity that has not been *permanently* shutdown—that is, both operating capacity and idled, but available, capacity is included. This definition of capacity is used to provide the strongest case possible for the industry position that the steel industry was experiencing serious injury from imports during the later part of the 1990s. If idled or bankrupt capacity were excluded from the definition of "flat-rolled steel-making capacity," then the idle capacity rate would be biased downwards as the value of total capacity declined. Capacity estimates for mills that opened during the sample period have been adjusted for the reported month of opening, on the basis of industry reports.

For the general model, shipments of flat-rolled capacity have been estimated using data from the American Iron and Steel Institute for monthly shipments of all steel products in combination with annual shipments of flat-rolled products. The share of annual shipments of flat-rolled products, listed in Table 6, has been applied to the monthly shipments of total steel products to obtain an estimate of monthly flat-rolled products. The annual averages of the resulting capacity utilization estimates are shown in the last two columns of Table 6. Although capacity utilization has varied over the sample period, flat-rolled capacity has been climbing steadily since 1992.

Since neither production nor shipments are published for integrated mills as a group, calculating the idle capacity rate for the segmented model required several steps. World Steel Dynamics and the U.S. International Trade Commission generously provided plant-level

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[29] Two mills were converted from slab processors into thin-slab minimills and one integrated mill has become a slab processor. These mills are only included in the sample during the months that they are using steel-making furnaces.

production data for the 1990s.[30] Production data for 2000 and 2001 for the integrated steel plants was gathered from published financial statements and SEC filings (e.g., 10K reports) of the individual integrated steel companies. Annual shipments of flat-rolled steel as reported by the American Iron and Steel Institute (AISI) were used for the 2000 and 2001 estimate of production for all flat-rolled mills. The ratio of annual production at the integrated mills to total flat-rolled steel production was then multiplied by the monthly estimate of flat-rolled steel shipments to obtain a monthly estimate of integrated production. This monthly series of integrated production was then compared to the annual capacity at the integrated mills using the Steel Plant Database to obtain a monthly estimate of the idle capacity rate for integrated flat-rolled steel mills. The annual data for this calculation is provided in Table 7. Figure 3 maps the changes in capacity for integrated mills (both operating and idled) and new thin-slab minimills. Clearly, integrated capacity was falling as both new capacity and imports climbed.

<u>B. Independent Variables: Supply, Demand, and Imports</u>

Because many of the major input costs are fixed by industry conditions, it is difficult to quantify the factors that cause significant shifts in the supply of steel. The reported price of iron ore has changed very little over the sample period as illustrated previously by Figure 1. Wages are determined by long-term union contracts that usually apply to multiple plants. Similarly, electricity costs are usually set by fixed-price contracts for each plant, rather than by local market prices. The main supply factor that has experienced significant variation over the sample period is the price of scrap steel. Scrap is the major raw material for electric arc furnaces, but is also an

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[30] I am grateful to Mark Paulson, Chief of the Steel Division at the USITC, who obtained permission for me to use production data published by World Steel Dynamics. Since the data provided by World Steel Dynamics is confidential, plant-level production and capacity utilization data will not be reported.

important input for basic oxygen furnaces, providing about 30% of the charge for the furnace.[31] Scrap is thus the most useful shift parameter for an estimation of the injury index equation. Scrap represents an estimated 14 percent of the cost of producing a ton of steel in an integrated mill and 44 percent at a minimill.[32] Although the price of scrap varies by U.S. region and by scrap quality, the Bureau of Labor Statistics publishes a monthly index of the national composite price of scrap, which provides an overall trend for scrap prices.

The selection of a shift parameter for the demand schedule is more straightforward than the selection of the supply shift parameter. As the largest single consumer of flat-rolled steel, the auto industry has a significant impact on the demand schedule facing flat-rolled producers. The Federal Reserve Board publishes a monthly index of production for the auto industry (SIC 371) that can be used as the demand shift parameter. In order to avoid capturing variation that is purely cyclical, as illustrated in Figure 4, a 6-month moving average of the index of automotive production was used in the estimation of the injury index equation. The monthly index for industrial production, which exhibits far less cyclical variation, was also used for comparison.

Monthly data on the quantity of flat-rolled steel imports has been provided by request from the International Trade Administration of the U.S. Department of Commerce. The definition of flat-rolled steel products used by the ITA conforms to the definition used in this analysis to calculate flat-rolled shipments and capacity. That is, the definition includes sheet, plate, and coils, but not slabs.

[31] Information from American Iron and Steel Institute’s Learning Center at www.steel.org/learning/glssary.

[32] See the estimated costs of steel production by Richard Fruehan in tables 3.1 and 3.2 of Ahlbrandt, Fruehan, and Giarratani (1996).

VI. Estimation Results

To test the impact of imports on the flat-rolled steel industry using the Industry injury index model, I used two sets of equations. The first set estimates the general model in which capacity utilization for all flat-rolled plants is regressed on flat-rolled imports, as described in equation (7). The second set estimates the segmented model in which capacity utilization for integrated plants is regressed on flat-rolled imports and on new thin-slab capacity, as described in equation (13). Although the capacity utilization rate has a lower and upper bound of 0 and 100, a tobit regression analysis was not necessary. None of the observations are at, or near, the limit values, and trial tobit regressions produced almost the exact same results as linear regression.

A. General Model

The results for the general model are reported in Table 10. The injury index equation was estimated first with ordinary least squares. A Durbin-Watson test for serial autocorrelation, however, did not result in the rejection of the hypothesis of autocorrelation for any of the regression estimates (see regressions A and B). Thus, the regressions were estimated with first-order autoregressive feasible generalized least squares rather than with OLS.[33]

Both the index of auto production and the general industrial production index were used for the demand shift variable, b_t. Each produced consistent coefficients across various estimation techniques, with a similar level of statistical significance. For a one percent increase in the level of auto production, the idle capacity rate for the flat-rolled steel industry is expected to drop roughly 0.2 percent (regressions A, C, and E). For a one percent increase in industrial

[33] The reported results were calculated using the Prais-Winston iterative procedure. Tests were also performed using the Cochrane-Orcutt procedure, but the results were not significantly different.

production, the idle capacity rate is expected to drop between 0.3 and 0.4 percent (regressions B, D, F, and G).

Although the results for the demand shift parameter conform to expectations, the results for the supply shift parameter—scrap price—seem counter-intuitive. The coefficient on scrap price is consistently negative and statistically significant, indicating that a percentage increase in the scrap price index will actually *reduce* the ratio of idle capacity by 0.1 to 0.2 percent. This result is surprising since an increase in an input price should have increased the degree of injury, rather than lowered it. However, all scrap price coefficients are statistically significant at the 1% level and their values are consistent across multiple equations. We can thus dismiss the possibility that the price of scrap is has been inappropriately included in the regression. However, while scrap is the largest single variable input, it only represents 14 percent of the total cost of production for integrated mills, which were still responsible for about 80 percent of flat-rolled production in 2000.[34]

Of greater concern is the negative coefficient on the imports of flat-rolled steel reported in some of the results of Table 10. The negative coefficient on current month imports in regressions (A) through (D) indicates that imports are actually *decreasing* the industry injury level, but the result is not a statistically significant for either the OLS regression or the AR(1) correction. Lagged values of flat-rolled imports for several different periods were also included in the estimation of the injury index equation in regressions (E) through (G). Most lagged values of imports lead to the same type of result—a statistically insignificant, negative coefficient—with the exception of a one-month and 36-month lagged values. In those estimations, flat-rolled imports do have a positive effect on the idle capacity rate, as expected, although the inclusion of lagged import values reduces the R-squared estimate (from 0.496 with current values to 0.479 with a one-month lag to 0.393 with a 36-month lag). According to the results of the estimation

[34] See Table 3-1in Chapter 3 of Ahlbrandt, Fruehan, and Giarratani (1996).

with lagged import values, for every one million ton increase in the quantity of imports in the previous month, the domestic idle capacity rate will increase by 3-5 points. A similar increase of 3.7 points is associated with a one million ton increase in imports in the previous 3 years.

In each equation with a statistically significant result for the import coefficient (regressions E-G), the coefficients on domestic demand and on supply shifts are much lower than the coefficient on imports. Therefore, these econometric results support the contention of the U.S. steel industry during the USITC 201 investigation that imports were a "substantial cause" of injury, meaning not less than any other cause, to the U.S. steel industry. In the next section, we will explore whether that result is maintained with the separation of the industry into a traditional, integrated segment, where essentially all of the bankruptcies occurred, and an emerging minimill segment, which represents direct competition with the integrated segment.

B. Segmented Model

As the results in Table 11 demonstrate, the claim of "substantial cause" of injury cannot be maintained when the flat-rolled steel industry is limited to the integrated production segment and the new thin-slab minimills are treated as a substitute product. Segmenting flat-rolled production in this way clarifies the extent of the impact that thin-slab minimills have had on integrated production. In each regression reported in Table 11, the coefficient for new capacity is relatively large, positive, and statistically significant. In contrast, the effect of imports on integrated idle capacity is negative or insignificant or both in regressions (H) through (K), when current values of imports are used. The regressions that included a one-month lagged value for imports (regressions L and M) do report statistically significant, positive coefficients for imports. Regressions with lags of other lengths, including 36 months, resulted in coefficients on imports that were not significant at the 90 percent level. In the segmented model, the impact of three-year lagged import values disappears.

However, as in the general model, the segmented model also found that increases in industrial and automotive production and in the price of scrap all decreased the idle capacity rate for the flat-rolled steel industry. A one percent increase in auto production decreased the integrated idle capacity rate by about 0.3 percent, and a similar increase in industrial production decreased the integrated idle capacity rate by 0.9 percent. These coefficients represent a stronger impact for increased demand in the segmented model than in the general model. Not surprisingly, the coefficient on scrap price was smaller in the segmented model, reducing integrated idle capacity by slightly less than in the general regression equations.

The coefficient on new capacity was significant in each estimation, but was larger when industrial production data was used, rather than auto production data. When auto production is used as the demand shift parameter (regressions H and J), the effect of an additional 1 million tons of new capacity is to increase the integrated idle capacity rate by 7-8 points. When industrial production values are used instead (regressions I, K, L, and M), the effect of new capacity is even larger, increasing the idle capacity rate by about 18 points, with smaller standard errors and an improved R-squared estimate.

In each regression, however, the effect of new capacity on injury is estimated to be much larger for new capacity than for imports. In fact, in the estimations in which imports have their strongest positive impact on the injury index (regressions L and M in Table 11), the effect of new capacity is noticeably larger than the effect of imports. The coefficient on new capacity in these regressions is <u>six times larger</u> than the coefficient on imports, and it is over three times larger than the biggest impact that imports are estimated to have had in the general model (regression F in Table 10). When these coefficients are applied to average monthly changes for imports and new capacity over the period of interest, the total effect of new capacity on injury to the integrated segment of the flat-rolled steel industry remains noticeably larger than the total effect of imports as shown in Table 8.

Thus, when the estimation of the injury index equation for the integrated mills is corrected for serial correlation and uses a one-month lagged value for imports, the results do indicate that imports increased the level of injury at the integrated mills. However, that impact is only a fraction of the estimated impact of the installation of new thin-slab minimills on the idle capacity rate of the integrated production sector. These results make it difficult to support the USITC determination that imports were "a cause which is important and not less than any other cause" in the wave of bankruptcies at integrated mills that occurred between 1998 and 2001.

Granger Test of Causality

In their original analysis of the copper industry, Pindyck and Rotemberg suggested using the Granger test of causality to provide a stricter test of whether or not imports affected the measure of injury for the industry. Their Granger test regressed the injury index on lagged values of itself as the restricted regression equation for comparison with an unrestricted equation which included lagged values of the injury index as well as current and lagged values of imports.

$$(14)\quad I_t = a_o + a_1 I_{t-1} + a_2 I_{t-2} + \varepsilon_t$$

$$(15)\quad I_t = a_o + a_1 I_{t-1} + a_2 I_{t-2} + b_0 M_t + b_1 M_{t-1} + b_2 M_{t-2} + \varepsilon_t$$

An F-test comparing the two equations is used to test the null hypothesis that changes in imports have *not* caused changes in the injury index. If the null hypothesis is rejected, we can assume that imports have caused injury. Table 9 presents the results of these equations for the dependent variables used in both the general and segmented models. Several time lags were tried for each independent variable: lags of one and two months, lags of six months and one year, and lags of one and two years. In each case, the null hypothesis of no causality can be rejected, leading us to the conclusion that imports have a causal link with the idle capacity rate, and thus with the level of injury in the flat-rolled steel industry. What the Granger test does not indicate, however, is the direction of that link. Many of the coefficients on the current and lagged import values in estimating equation (15) were once again negative, indicating that the lagged import values were lowering the idle capacity rate, rather than raising it.

VII. Conclusions

The analytical results of the injury index model clearly suggest that while imports can, under some conditions, be shown to have caused injury to the traditional flat-rolled steel producers, their impact is significantly less than the injury resulting from competition with the new thin-slab minimills. Although imports increased considerably during the latter half of the 1990s, they did not increase much more than goods imports in general. Furthermore, imports increased as steel consumption rose, decreasing the potential market share loss.

In contrast, the impact of domestic competition on the traditional steel industry has been both quantifiable and powerful. Rather than the victim of a “flood of cheap imports,” the steel industry appears to in the midst of Schumpeter’s process of “creative destruction.”[35] The lost capacity in older, integrated mills is being replaced almost ton-for-ton with more efficient, less expensive forms of producing steel. If the United States’ steel industry is to remain globally competitive in the long run, it is important that the transition from out-dated to modern production technology take place. Government policies that restrict imports, thereby raising prices for domestic consumers and angering trading partners, are counterproductive—slowing the transition rather than easing it. Instead, public policy should be focused on easing the transition for the workers and firms that will lose in the transition, while simultaneously maintaining the kind of open economy that will benefit the domestic industry and its consumers in the long run.

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[35]Shumpeter (1975).

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References

Ahlbrandt, Roger S., Richard J. Fruehan, and Frank Giarratani, *The Renaissance of American Steel: Lessons for Managers in Competitive Industries,* (New York: Oxford University Press, 1996).

Bagsarian, Tom, "Mills Bring in the Slabs," *New Steel* (June 1999), http://www.newsteel.com, visited on March 25, 2002.

Barringer, William and Kenneth Pierce, *Paying the Price for Big Steel* (Washington, D.C.: American Institute for International Steel, 2001).

Beeson, Patricia and Frank Giarratani, "Spatial Aspects of Capacity Change by U.S. Integrated Steel Producers," *Journal of Regional Science* 38 (1998), 425-444.

Bethlehem Steel Press Release, "Bethlehem Steel CEO Calls for Government Action on The Steel Legacy Problem," (March 14, 2002).

Blonigen, Bruce, "U.S. Antidumping Database." National Bureau of Economic Research, Research study performed by Bruce Blonigen, Department of Economics, University of Oregon, Grant #9810706 (2000), http://www.nber.org/antidump.

Burnham, James, *American Steel and International Trade: The Challenge of Globalization*, Center for the Study of American Business, Washington University in St. Louis, Contemporary Issue Series 95 (September 1999).

Crandall, Robert W., "From Competitiveness to Competition: The Threat of Minimills to Large National Steel Companies," *Resources Policy* 22(1/2) (1996), 107-118.

Grossman, Gene M., "Imports as a Cause of Injury: The Case of the U.S. Steel Industry," *Journal of International Economics* 20 (1986), 201-223.

International Trade Administration, U.S. Department of Commerce, *Global Steel Trade: Structural Problems and Future Solutions.* (Washington, D.C.: USDOC, 2000).

Pindyck Robert S., and Julio J. Rotemberg, "Are Imports to Blame? Attribution of Injury Under the 1974 Trade Act," *Journal of Law and Economic*, 30 (1987), 101-122.

Shumpeter, Joseph A., *Capitalism, Socialism, and Democracy* (New York: Harper, 1975).

U.S. International Trade Commission, *Vol II: Information Obtained in the Investigation,* Steel Investigation No. TA-201-73, Publication 3479 (Washington D.C.: USTIC, 2001).

U.S. International Trade Commission, "Assessment of Econometric Submissions on Flat Rolled Steel." Submitted by Catherine B. DeFilippo, Chief of the Applied Economics Division, to Commissioner Bragg for Investigation No. TA-201-73, *Steel*, October 22, 2001.

U.S. International Trade Commission, Press Release, "ITC Details Determinations Concerning Impact of Imports of Steel on U.S. Industry," (October 23, 2001).

United Steelworkers of America, Press Release, "Health Care Benefits for Steel Industry Retirees: Domestic Costs vs. Foreign Subsidies," (June 5, 2001).

Table 1: Flat-Rolled Plants Declaring Bankruptcy

Firm	Plant Location	State	Declaration Date	Shutdown Date	Capacity (000 tons)
Acme Steel	Riverdale	IL	9/98	10/01	1200
Gulf States Steel	Gadsden	AL	7/99	9/00	1400
Wheeling Pittsburgh	Steubenville	OH	11/00	11/01	2400
LTV Steel	Cleveland	OH	12/00	12/01	6892
LTV Steel	East Chicago	IN	12/00	12/01	4100
Trico Steel (LTV)	Decatur	AL	3/01	3/01	2200
Bethlehem Steel	Burns Harbor	IN	10/01		5480
Bethlehem Steel	Coatesville	PA	10/01		880
Bethlehem Steel	Sparrows Point	MD	10/01		3800
Geneva Steel	Vineyard	UT	11/01	11/01	2700
Total Bankrupt Capacity					31,052
Total Closed Capacity					20,892

Source: Steel Plant Database and industry reports

Table 2: Thin-Slab Minimills

Firm	Plant Location	State	Start Year	Capacity (000 tons)	Cumulative Capacity
Nucor	Crawfordsville	IN	1989	1500	1500
Nucor	Hickman	AR	1993	2400	4400
Gallatin	Ghent	KY	1995	1200	5600
Nucor	Berkeley	SC	1996	1800	7400
North Star BHP	Delta	OH	1996	1500	8900
Steel Dynamics	Butler	IN	1996	2800	11700
Beta Steel	Portage	IN	1997	500	12200
Ipsco Steel	Montpelier	IA	1997	1250	13450
Trico Steel	Decatur	AL	1997	2200	15650
Tuscaloosa Steel	Tuscaloosa	AL	1999	870	16520
Ipsco Steel	Mobile	AL	2001	1250	17770
Nucor	Hertford	NC	2001	1000	18770

Source: Steel Plant Database and industry reports.

Table 3: U.S. Imports of Finished and Semi-finished Flat Steel

('000 net tons)

Product	1996	1997	1998	1999	2000	1996-2000
Finished Flat Products						
Plate	1,938	1,378	2,114	895	951	-51%
Hot-rolled sheet and strip	5,265	6,517	11,497	6,518	7,460	42%
Cold-rolled sheet and strip	2,626	3,613	4,082	3,406	2,802	7%
Coated sheet and strip	2,280	2,381	2,296	2,659	2,459	8%
Total Flat Products	**12,109**	**13,889**	**19,989**	**13,478**	**13,670**	**14%**
Semi-finished Flat Products						
Slabs	6,297	5,416	5,352	7,368	7,260	15%
Ratio to Finished Imports	52%	39%	27%	55%	53%	
Semi-finished & Finished	**18,406**	**19,305**	**25,341**	**20,846**	**20,930**	**14%**

Source: Compiled by the U.S. International Trade Commission from official statistics of the U.S. Department of Commerce and posted on the USITC DataWeb.

Table 4: Flat-Rolled Imports and Import Share of Consumption, 1990-2001

('000 net tons)

Year	Exports	Imports	Shipments	Estimated Consumption	Import Share
1990	1,964	8,056	47,729	53,822	15%
1991	3,407	7,338	43,536	47,467	15%
1992	1,825	9,131	46,910	54,216	17%
1993	1,429	7,807	51,671	58,049	13%
1994	1,459	13,581	55,695	67,817	20%
1995	3,933	10,613	56,891	63,571	17%
1996	2,016	12,497	59,128	69,608	18%
1997	2,434	14,233	61,030	72,829	20%
1998	2,293	20,405	60,414	78,526	26%
1999	2,641	13,801	65,213	76,373	18%
2000	3,559	14,001	67,697	78,140	18%
2001	3,256	9,389	61,549	67,681	14%
1990-1998	17%	153%	27%	46%	74%
1998-2001	42%	-54%	2%	-14%	-47%
1990-2001	66%	17%	29%	26%	-7%

Source: AISI, *Annual Statistical Report*

Table 5: Data Description and Source for Injury Index Estimation

Variable Description	Data	Data Description	Source
I_t Injury Index	Idle Capacity Rate	Monthly shipments of flat rolled steel compared to monthly estimates of capacity using annual data.	AISI shipments and Steel Plant Database capacity data
a_t Supply Shift	Scrap Price	Monthly composite scrap price index	BLS Commodity Index
b_t Demand Shift	Industrial Production	Monthly index of industrial production (all industry and autos)	Federal Reserve
M_t Import Level	Import Quantity	Monthly imports by ton for flat-rolled steel	International Trade Administration
N_t New Capacity	Thin-slab Minimill Capacity	Annual capacity data prorated by mill startup month	Steel Plant Database and industry reports

Table 6: Flat-Rolled Shipments and Capacity
('000 net tons)

Year	Total Steel Mill Products	Flat-Rolled Shipments	Ratio of Flat to Total Shipments	Flat-Rolled Capacity	Unused Capacity	Idle Capacity Rate
1989	84,649	49,186	58%	81,632	32,446	40%
1990	84,981	47,729	56%	80,963	33,234	41%
1991	78,846	43,536	55%	80,294	36,758	46%
1992	82,241	46,910	57%	76,669	29,759	39%
1993	89,022	51,671	58%	78,894	27,223	35%
1994	95,084	55,695	59%	79,974	24,279	30%
1995	97,494	56,891	58%	81,584	24,693	30%
1996	100,878	59,128	59%	85,119	25,991	31%
1997	105,858	61,030	58%	87,425	26,395	30%
1998	102,420	60,414	59%	88,755	28,341	32%
1999	106,201	65,213	61%	89,885	24,672	27%
2000	109,050	67,697	62%	91,103	23,406	26%
2001	98,940	61,549	62%	92,243	30,694	33%

Source: AISI, *Annual Statistical Report,* 2000 and 2001, and the Steel Plant Database.

Table 7: Integrated Flat-rolled Steel Production and Capacity

	All Plants	Integrated Plants			
Year	Annual Production	Annual Capacity	Annual Production	Production Share of Shipments	Annual Average Idle Capacity Rate
1990	52,305	73,374	48,925	94%	39%
1991	47,655	72,412	43,480	91%	45%
1992	50,165	69,487	45,620	91%	39%
1993	55,114	70,997	49,974	91%	35%
1994	59,798	69,777	53,118	89%	29%
1995	60,413	69,227	52,243	86%	29%
1996	61,674	69,402	54,569	88%	25%
1997	66,808	68,052	54,056	81%	28%
1998	64,270	67,552	50,611	79%	30%
1999	68,139	67,812	52,091	76%	28%
2000	67,697	67,882	52,558	78%	23%
2001	61,549	66,782	46,439	75%	34%

Source: Production for 1990-99 is from World Steel Dynamics. Production for 2000-01 is taken from SEC filings for integrated steel firms and is based on shipments from AISI for production at all plants. Capacity for 1990-01 is from the Steel Plant Database.

Table 8: Total Estimated Change in the Industry Idle Capacity Rate from Imports and New Capacity

	General Model (Regression F)	Segmented Model (Regressions L and M)	
	Imports	Imports	New Capacity
Expected Change in Idle Capacity Rate (per million net tons)	5.1	3.0	18.0
Average Monthly Change 1989-2001 (m net tons)	0.9	0.9	0.6
Expected Total Change in Idle Capacity Rate	4.6	2.7	11.5

Table 9: Granger Test of Causality

Dependent Variable	**Lag Times**	**SSR-r**	**SSR-u**	**N_2 (N_1=3)**	**$F(N_1, N_2, .05)$ Critical Value=2.67**
Idle Capacity Rate					
For All Mills	t = 1, 2	2555	2382	154	3.59
	t = 6, 12	4091	3610	144	6.12
	t = 12, 24	4357	3685	132	7.66
For Integrated Mills	t = 1, 2	2745	2573	154	3.30
	t = 6, 12	4679	4146	144	5.91
	t = 12, 24	5031	4486	132	5.11

Result: Can Reject Null Hypothesis
(H_o = Imports have *not* caused changes in capacity utilization)

Table 10: Estimation Results for the General Injury Index Model

Dependent Variable: Idle Capacity Rate	OLS Regression Results:				AR(1) Regression Results:									
	(A)		(B)		(C)		(D)		(E)		(F)		(G)	
	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t
_cons	-24.308	-9.90**	-9.391	-2.60**	-23.761	-7.18**	-7.692	-1.44	-23.311	-6.94**	-1.813	-0.31	-15.867	-2.37**
Scrap Price	-0.113	-9.27**	-0.139	-10.35**	-0.114	-7.00**	-0.140	-6.98**	-0.118	-7.18**	-0.152	-7.04**	-0.116	-5.55**
Auto Production	-0.170	-12.89**			-0.170	-9.76**			-0.191	-10.92**				
Industrial Production			-0.285	-11.40**			-0.292	-8.19**			-0.371	-9.65**	-0.293	-6.60**
Imports	-0.303	-0.26	-0.065	-0.05	-0.718	-0.50	-0.845	-0.53						
Lag 1 month									2.583	1.82*	5.111	3.10**		
Lag 36 months													3.742	2.18**
N	151		156		151		156		151		155		120	
R-squared	0.682		0.643		0.570		0.496		0.568		0.479		0.393	
DW statistic	1.388		1.174		2.145		2.279		2.155		2.335		2.250	
rho					0.303		0.422		0.324		0.492		0.414	

*Indicates significance at the 90% level

**Indicates significance at the 95% level

Table 11: Estimation Results for the Segmented Injury Index Model

Dependent Variable: Integrated Idle Capacity Rate	OLS Regression Results				AR(1) Regression Results							
	(H)		(I)		(J)		(K)		(L)		(M)	
	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t
_cons	84.128	30.48**	146.880	21.39**	84.904	24.74**	144.699	19.12**	146.992	19.68**	148.020	19.37**
Scrap Price	-0.095	-6.75**	-0.129	-10.98**	-0.093	-5.38**	-0.128	-9.32**	-0.135	-10.05**	-0.131	-9.32**
Auto Production	-0.305	-10.32**			-0.314	-8.68**						
Industrial Production			-0.906	-12.44**			-0.881	-11.05**	-0.914	-11.59**	-0.932	-11.44**
Imports	-1.306	-1.16	0.171	0.17	-1.532	-1.15	-0.239	-0.20				
Lag 1 month									2.950	2.54**	3.104	2.63**
New Capacity	7.109	4.26**	18.816	8.23**	7.667	3.77**	18.206	7.24**	18.000	7.24**		
Lag 1 month											18.648	7.203**
N	151		156		151		156		155		155	
R-squared	0.763		0.744		0.680		0.740		0.752		0.744	
DW statistic	1.534		1.670		2.090		2.076		2.065		2.080	
rho					0.232		0.173		0.183		0.211	

*Indicates significance at the 90% level
**Indicates significance at the 95% level

Appendix A: List of Flat-Rolled Steel Making Plants With 2001 Capacity and Status

Firm Name	Plant Name	County	State	Flat-rolled Capacity	Steel-making Status	Plant Notes
Integrated Mills						
Acme Steel Co.	Riverdale	Cook	IL	1200	Operating	Declared Bankruptcy in September 1998.
AK Steel Corp.	Ashland	Boyd	KY	1700	Operating	
AK Steel Corp.	Middletown	Butler	OH	2800	Operating	
Bethlehem Steel	Burns Harbor	Lake	IN	5480	Operating	Declared Bankruptcy in October 2001
Bethlehem Steel	Sparrows Point	Baltimore	MD	3800	Operating	Declared Bankruptcy in October 2002
Defurco Farrell	Farrell	Mercer	PA	0	Not Operating	Operating as a slab processor since 1999
Geneva Steel	Provo	Utah	UT	2600	Not Operating	Declared Bankruptcy May 1999 and again in January 2001. Closed in November 2001
Gulf States Steel	Gadsden	Jefferson	AL	1400	Not Operating	Declared Bankruptcy in July 1999 and closed in September 2000.
Ispat Inland Inc.	Indiana Harbor	Lake	IN	6000	Operating	Also makes long products
LTV	East Chicago	Lake	IN	3700	Not Operating	Declared Bankruptcy and Closed in December 2001
LTV Steel Co.	Cleveland Works	Cuyahoga	OH	6892	Not Operating	Declared Bankruptcy and Closed in December 2001
McClouth Steel	Trenton	Wayne	MI	560	Not Operating	Steel-making closed in 1996. Now a steel processor, DSC Ltd.
National Steel	Ecorse	Wayne	MI	3500	Operating	Declared Bankruptcy in 2002
National Steel	Granite City	Madison	IL	2400	Operating	Declared Bankruptcy in 2002
Rouge Steel	Dearborn	Wayne	MI	4450	Operating	
USX	Braddock	Allegheny	PA	2900	Operating	
USX	Fairfield	Jefferson	AL	1600	Operating	Also makes long products
USX	Fairless	Bucks	PA	0	Not Operating	Steel-making closed in 1991
USX	Gary	Lake	IN	8700	Operating	
WCI	Warren	Trumbull	OH	1900	Operating	
Weirton Steel	Weirton	Hancock	WV	3000	Operating	
Wheeling Pittsburgh	Steubenville	Jefferson	OH	2200	Not Operating	Declared Bankruptcy in November 2000. Closed in November 2001.

Traditional Minimills and Specialty Mills						
AK Steel	Mansfield	Richland	OH	700	Operating	Specialty steel mill
AK Steel Co.	Butler	Butler	PA	960	Operating	Specialty steel mill
Allegheny Technologies Inc.	Brackenridge	Allegheny	PA	500	Operating	Specialty steel mill
Allegheny Teledyne Inc.	Houston	Washington	PA	279	Operating	Specialty steel mill
Bethlehem Steel Corp.	Coatesville	Chester	PA	880	Operating	Declared Bankruptcy in October 2001
Citisteel	Claymont	New Castle	DE	400	Operating	
J&L Specialty	Midland	Beaver	PA	800	Operating	Specialty steel mill
LeTourneau Co.	Longview	Gregg	TX	124	Operating	Specialty steel mill, no caster
NS Group Inc.	Newport	Campbell	KY	1258	Operating	Brownfield minimill in 1990 from small traditional mill
Oregon Steel	Portland	Multnomah	OR	800	Operating	Brownfield minimill in 1998 from small traditional mill
Thin-Slab Minimills						
Beta Steel Corp.	Portage	Porter	IN	500	Operating	Brownfield minimill in 1997 from slab processor
Gallatin	Ghent	Kenton	KY	1200	Operating	
Ipsco Steel Inc.	Mobile	Mobile	AL	1240	Operating	
Ipsco Steel Inc.	Montpelier	Montpelier	IA	1250	Operating	
North Star BHP Steel	Delta	Fulton	OH	1500	Operating	
Nucor	Crawfordsville	Montgomery	IN	2000	Operating	
Nucor	Hertford	Hertford	NC	1000	Operating	
Nucor	Hickman	Mississippi	AR	2400	Operating	
Nucor Corp.	Berkeley	Berkeley	SC	1800	Operating	Also makes long products
Steel Dynamics	Butler	De Kalb	IN	2800	Operating	
Trico Steel Company	Decatur	Morgan	AL	2200	Not Operating	Declared Bankruptcy and Closed in March 2001
Tuscaloosa Steel Corp.	Tuscaloosa	Tuscaloosa	AL	870	Operating	Brownfield minimill in 1999 from slab processor