# FOREIGN SUBSIDIZATION AND EXCESS CAPACITY EFFECTS

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**ABSTRACT**: The U.S. steel industry contends that foreign subsidization and excess capacity has led to its long-run demise, yet no one has formally examined this hypothesis. In this paper, we incorporate foreign subsidization considerations into a model based on Staiger and Wolak's (1992) cyclical-dumping framework and illustrate testable implications of both cyclical excess capacity and structural excess capacity stemming from foreign subsidization. We then use detailed product- and foreign country-level data on steel exports to the U.S. market from 1979 through 2002 to estimate these excess capacity effects. While we find evidence of both cyclical and structural excess capacity effects for exports to the U.S. market, they are confined to such a narrow range of country-product combinations that it is unlikely that such effects were a significant factor in the fortunes of U.S. steel firms over the past decades.

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*"I take this action to give our domestic steel industry an opportunity to adjust to surges in foreign imports, recognizing the harm from 50 years of foreign government intervention in the global steel market, which has resulted in bankruptcies, serious dislocation, and job loss." (President George W. Bush in press statement announcing new Safeguard measures on imported steel, March 5, 2002)*

## 1. Introduction

For decades, the U.S. steel industry has contended that distortionary policies of foreign governments have led to its long-run demise. The main argument, as described and developed by Howell et al. (1988), is that foreign government subsidies lead foreign producers to have excess capacities. High protective trade barriers in foreign countries allow the foreign producers to sell at high prices in their own market and then dump the excess on the U.S. The understandable reaction of the U.S. government is, as described in Mastell (1999), to erect antidumping and countervailing duty laws, safeguard actions, etc., to protect U.S. industry from such behavior.

Most economists have dismissed the effect of foreign subsidization and excess capacity and, instead, point to other factors as responsible for the long-run decline in employment in U.S. steel. For example, Oster (1982) documents the slow adoption of new technologies by the U.S. steel industry. A related trend has been the rise of minimill steel production, which uses scrap metal in a steel production process that is indisputably lower cost than integrated mills, but has historically produced lower quality steel.[1] Crandall (1996), Moore (1996), and Tornell (1996) have argued that minimill production may be more important for explaining the decline of large integrated steel producers in the U.S. than imports. Alternatively, Tornell (1996) provides a model and evidence suggesting that powerful labor unions have been able to appropriate rents to such an extent that U.S. steel

[1] Over time, minimill production has successively innovated into making increasingly higher-quality steel products which likely puts even more pressure on traditional integrated steel mills.

firms have rationally disinvested over time. Finally, economists have suggested a familiar political theme to the steel industry's history of trade protection. Lenway et al. (1996) and Morck et al. (2001) find evidence that the firms that lobby for protection are typically larger, less efficient, less innovative, pay higher wages, and habitually seek protection versus firms that do not lobby. A natural conclusion is that trade protection is not to prevent unfair competition, but rather the result of rent-seeking activities by less-efficient and non-competitive firms.

Rather than simply dismiss the steel industry's arguments, this paper considers excess capacity effects and examines whether the data confirm that such effects are having a significant effect on the U.S. steel industry. In addressing this issue, we find it is important to distinguish between *cyclical* excess capacity and *structural* excess capacity.

A model of cyclical excess capacity has been developed by Staiger and Wolak (1992). In the Staiger and Wolak model, foreign monopolists supply their own protected home market, but may also export to a competitive market. The foreign monopolists are assumed to have long-run marginal costs below the price (i.e., marginal revenue) in the export market. However, the foreign firm's own market experiences random demand shocks which can lead to short-run (or *cyclical*) excess capacity in low demand periods that is then sold at market-clearing prices in the competitive export market. This provides an explanation for rational cyclical dumping by the foreign firm. We note that foreign subsidization is not a necessary element for cyclical dumping to occur. Thus, after presenting a simplified model of cyclical dumping, we next modify the model to consider the effects of subsidization by a foreign government. We first show that foreign subsidization leads foreign firms to invest in more capacity than without subsidization and that this increases the likelihood and/or increases the volume of their exports to the U.S. market. This is what we term *structural* excess capacity effects. We then show that such foreign subsidization can exacerbate cyclical excess capacity effects.

To our knowledge, there are only a few studies that have empirically tested for cyclical export supply responses to negative domestic demand shocks (i.e., cyclical excess capacity)[2], and none that have formally tested for the effects of foreign subsidization (or structural excess capacity).[3] The latter hypothesis is difficult to examine due to data availability on foreign subsidization programs. However, the U.S. steel industry has filed hundreds of countervailing duty (CVD) investigations to identify and quantify the effects of foreign government subsidization against a fairly exhaustive list of relevant steel products and foreign country sources over the past decades. As a part of these CVD investigations, the relevant U.S. agencies publicly document a history of all foreign government subsidization practices in each case. They also provide estimates of the value of each subsidy program as a percent of the firm's export sales and determine which ones are significant enough to cause injury to the domestic industry. These data provide a unique opportunity to directly estimate the effects of purported foreign subsidy programs on foreign exports to the U.S. market.

We test for both cyclical and structural excess-capacity-related effects using data on exports of 37 different steel products from 22 different foreign countries to the U.S. market from 1979 through 2002. Our statistical estimates provide evidence for *cyclical* excess capacity effects on exports to the U.S. markets. We also find statistical evidence of *structural* excess capacity effects -- foreign subsidization significantly increases export

[2] The most closely related empirical literature are papers that examine whether export supply increases when domestic industries have excess capacity during low-domestic-demand periods. For example, Dunleavy (1980) finds that "export sales are inversely related to the pressure on domestic capacity" (p. 131) in an examination of aggregate export behavior for the U.S. and the United Kingdom. Yamawaki (1984) finds evidence in support of the hypothesis that Japanese steel export prices are lower in periods of excess capacity. Crowley (2006) develops a model where firms dump into export into foreign markets when home demand is low and shows that the foreign government improves foreign welfare in such situations with an antidumping duty (AD). Her empirical analysis shows that the U.S. government agencies are more likely to rule affirmatively when foreign demand is weak. She does not test directly for cyclical dumping effects from negative home demand shocks.

[3] Howell et al. (1988) and U.S. countervailing duty (CVD) investigations provide figures on purported foreign subsidies in the steel industry, but does not examine how such subsidies affect market outcomes, particularly the supply of steel to the U.S. market.

volumes to the U.S. Importantly, however, we find these excess capacity effects to be quite isolated in the U.S. steel market. We find such effects only for less-developed country sources in our data, particularly the Latin American countries of Argentina, Brazil, and Venezuela, which account for a small share of U.S. steel consumption. The very narrow scope of these excess capacity effects in the U.S. steel market make it unlikely to be a significant source of the U.S. steelmakers troubles over the past few decades.

The paper proceeds as follows. In the next section, we present a simple version of the Staiger and Wolak (1992) model to illustrate cyclical excess capacity effects on steel exports to the U.S. market. We then extend the model to draw out structural excess capacity implications of foreign subsidization for foreign steel exports to the U.S. market. Section 3 discusses the detailed data on foreign subsidization that has come out of hundreds of U.S. CVD steel cases for the past few decades and whether an initial look at the data suggests that foreign subsidization may significantly impact the U.S. steel market. Sections 4 and 5 describe the empirical approach we use to examine our excess-capacity hypotheses and present our statistical results, respectively.

## 2. Conceptual Framework

This section presents a simple version of the cyclical-dumping model in Staiger and Wolak (1992) and shows how demand shocks in the foreign firm's domestic market (foreign demand) can lead to cyclical dumping of excess capacity into the U.S. (export) market. We then introduce foreign subsidies into the model and illustrate how foreign subsidization leads to testable implications about the probability and magnitude of exports, as well as the responsiveness of foreign export supply to the U.S. market to foreign demand shocks.

Following Staiger and Wolak (1992), there is a foreign firm which is a monopolist in its own domestic market, but which may also sell products to the export (hereinafter, the U.S.) market. The demand function in the foreign firm's domestic market is a simple linear function of price, wherein the intercept ($\alpha$) is an i.i.d. random variable. That is, demand is given by $Q^F = \alpha - P^F$, where $Q^F$ and $P^F$ are quantity and price for the foreign market, respectively. In the U.S. market, the foreign firm is a price-taker (facing an exogenously-given price) that is assumed to be lower than prices in the foreign firm's domestic market price at all levels of capacity.[4] Short-run marginal costs ($c$) are constant until capacity is reached, at which point marginal costs are infinite.[5] Capacity costs are assumed to be increasing in capacity and represented by a simple quadratic function, $\eta_0 K + \eta_1 K^2$, where $\eta_0, \eta_1 > 0$.[6]

The timing of decisions is as follows. The foreign firm first makes its capacity decision before the demand shock is realized. After the demand shock is realized, the foreign firm chooses how much to produce and sell in its own domestic market and export to the U.S. market.

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[4] The assumption of an exogenously-given U.S. price differs from Staiger and Wolak (1992), which assumes that the U.S. price is determined through market competition between the foreign firm and a competitive fringe in the U.S. market. As discussed below, the very small market shares of individual foreign-country import sources in the U.S. steel market (i.e., the foreign firm is a fringe player in the U.S. market) makes the assumption of an exogenously-determined U.S. price from the perspective of the foreign firm a reasonable one. Such an assumption also makes the model much easier to solve and describe.

[5] We make this assumption for simplicity, but would obtain similar implications for increasing marginal costs, provided such costs approach infinity as production nears capacity.

[6] This is a second modification of the Staiger and Wolak set-up, which assumed linear capacity costs. This treatment allows for closed solutions for two different cases when the foreign firm is a price-taker in the US market. These are a case where the US price ($P^{US}$) cannot support capacity costs at any level of capacity, and the case wherein the US price can support capacity choices, at least over a range of capacity decisions.

### *2.1. Production and Export Decision*

We first consider the output choice given capacity. The foreign firm is taken to maximize profit by choosing the level of output in its own domestic market (*F*) and in the U.S. market. In this case, the capacity decision is made and the demand shock is realized. Profits are defined by:

$$\underset{Q^F, Q^{US}}{\text{Max}} \ \pi = (\overline{\alpha} - Q^F)Q^F - cQ^F + (P^{US} - c)Q^{US} \text{ subject to } Q^F + Q^{US} \leq K, \qquad \textbf{(1)}$$

where $\pi$ is the firm's profit, $Q^F$ and $Q^{US}$ are the firm's choices for production and sales to its own foreign market and exports to the U.S. market, respectively, $c$ is constant marginal costs, $K$ is the chosen level of capacity by the firm in the first stage, $P^{US}$ is the exogenously-given price of exports to the U.S. market, in the foreign firm's own currency, and $\overline{\alpha}$ is the *realized* value of the foreign market demand intercept.

Solving the model in (1), it is easy to see (and show) that the foreign firm's output is determined by selling all of the output that can be produced given capacity in its domestic market i.e., $Q^{F^*} = K^*$ or by allocating capacity between its domestic market and the U.S. market i.e., $Q^{F^*} = \frac{\overline{\alpha} - P^{US}}{2}$ and $Q^{US^*} = K^* - Q^{F^*} = K^* - \frac{\overline{\alpha} - P^{US}}{2}$. Selling some of the output to the export market is not dumping *per se* if the U.S. price warranted capacity investments for the export market in the first place. In this case, positive or negative demand shocks simply reflect normal substitution patterns from a firm selling in two markets.

However, if the initial capacity choice was intended only for production to serve the foreign firm's own market, dumping may occur when realized demand is less than planned demand this leads to allocating some production to the U.S. (export) market. That is, the firm did not plan on exporting to the US, but because the realized demand is much lower than planned, they optimally choose to export to the US. Of course, the larger is the difference in the expected and realized demand, the greater is the level of exports. Thus, while the U.S. price cannot cover both production and long-run capacity costs on its own, it can rationally choose to sell into the U.S. market for unexpectedly low demand realizations.

### *2.2. Capacity Choices*

Capacity decisions are made prior to the realization of the foreign firm's domestic demand level. Modeling of the capacity decision is based then on expected profits, with an expected value of the demand level defined with $\alpha^e$. Expected profits are maximized with choices of the capacity level ($K$) and the domestic output level ($Q^F$) and the export level ($Q^E$). That is,

$$\underset{K,\,Q^F,\,Q^{US}}{\text{Max}} \quad \mathrm{E}\pi = (\alpha^e - Q^F)Q^F - cQ^F + (P^{US} - c)Q^{US} - \eta_0 K - \eta_1 K^2 \qquad (2)$$

$$\text{subject to } K \geq Q^F + Q^{US}.$$

We focus on the case where the U.S. price is large enough to warrant sales given capacity i.e., $P^{US} - c > 0$, but not so large to warrant investment in capacity in its own right i.e., $P^{US} - c - \eta_0 < 0$.[7] Thus, given capacity, the foreign firm may choose to sell in the U.S. market, but would not plan to sell in the U.S. market before the capacity decision is made. We illustrate the model graphically in Figure 1. In this model, the expected intercept ($\alpha^e$) is greater than the marginal production ($c$) and capacity costs intercept ($\eta_0$). However, the U.S. price lies below the marginal production and capacity cost intercept so that investments with express intent to produce for the U.S. market do not occur. Nevertheless, since the U.S. price is greater than the production cost, given the capacity decision, the foreign firm *may* supply

[7] As we discuss later, one effect of subsidies can be to affect the capacity from a case in which the firm does not consider the US market in its investment decisions to a case where it does. This is developed and discussed later.

the U.S. market. The optimal capacity decision, $K^*$, equates marginal revenue with marginal costs defined by production costs and marginal capacity costs i.e.,

$$K^* = Q^{F^*} = {(\alpha^e - c - \eta_0)}\Big/{(2(1+\eta_1))}. \qquad (3)$$

As would be expected, capacity and, hence, planned output increase in the expected demand intercept, and falls with increases in production costs and capacity costs.

Given the capacity decision, the marginal condition for sales both in its own country and in the U.S. is different from that of the capacity (planned output) condition. Of course, if the realized demand is equal to or greater than the expected demand, the foreign firm is pre-committed to output levels at the optimal capacity choice i.e., $Q^F = K^*$. If, however, the realized demand intercept is less than the expected demand intercept, there are two possible outcomes. First, the difference between the planned and realized demand may not be large enough to warrant changes in the production plan. Specifically, the optimality condition for output choices is that $\bar{\alpha} - 2Q^F \geq P^{US}$. This means that the foreign firm confronted with a negative demand shock (i.e., the difference of the planned demand and the realized demand is negative) will hold fast with $Q^F = K^*$, until the shock is large enough to satisfy the optimality condition with equality. Let $\bar{\alpha} = \alpha^e - \delta$ where $\delta$ is the demand shock – the difference between the expected and realized values of the demand intercept. Substitution of this definition into the optimality condition, yields $\delta = \alpha^e - P^{US} - 2K^*$. The size of the shock necessary to induce sales to the U.S. (dumping) is increasing in the expected intercept, and falling in both the U.S. price and the level of predetermined capacity.[8]

Given this model, we use Figure 2 to illustrate potential responses of exports by the foreign firm depending on how the realized foreign-market demand parameter differs from

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[8] Note that the result with respect to the intercept is more complicated than it appears since $K^*$ depends on the intercept. However, it is straightforward to show that the result holds without ambiguity.

the expected value. As before, we hold the assumption that the export price is just low enough so that the foreign firm would not build capacity with an expectation of sales to the U.S. Rather, their planned output and foreign sales are identical with no planned output to the U.S.

When demand is realized, however, sales to the U.S. may or may not occur. $MR_1$ in Figure 2 represents the marginal revenue schedule when the realized foreign market demand exactly equals the expected value ($\alpha=\alpha^e$) and the equilibrium production occurs at point A. Note that the equilibrium occurs at an intersection point above the constant marginal costs of production ($c$), since the firm must also cover per-unit capacity costs which are not shown explicitly in the Figure 2. Also, given our assumptions on the firm's marginal costs relative to the U.S. price, the firm sells all its production to the domestic market and none to the export market.

We can then consider scenarios where realized foreign demand differs from expectations. It is clear to see that positive demand shocks will not induce a change in output since the firms is capacity-constrained and, in particular, will not result in exports to the US. For a negative demand shock (realized demand less than actual) two types of outcomes are possible in terms of exports to the U.S. $MR_2$ represents the marginal revenue schedule for a negative demand shock ($\alpha<\alpha^e$) that is still not large enough to induce exports to the US, while $MR_3$ represents the marginal revenue schedule with a large enough negative demand shock to induce exports. With the latter MR schedule (MR3), the relevant marginal revenue for the firm is $P^{US}$ after point C. In other word, the firm gains greater marginal revenue in the export market than its own domestic market for production levels past point C. In this case the firm produces $K^*$ and sells $Q_3$ to its own domestic market and sells the rest of its capacity (the length CB) in the export market. This is, then, a model that generates dumping in the spirit of Staiger and Wolak (1992).

*2.3. Government Subsidies*

We now consider how government subsidization affects the firm's choices and market outcomes. We assume government subsidization comes in the form of capacity subsidization and specifically model such a subsidy (*s*>0) as entering the capacity cost term in the following manner, $(\eta_0 - s)K + \eta_1 K^2$. This simple setup illustrates that subsidies directly reduce capacity costs. The resulting objective functions and equilibrium solutions are the same as above after substituting $\eta_0$-*s* for $\eta_0$. It is straightforward then to show that capacity is increasing in the level of the subsidy. If the subsidy is large enough such that $P^{US} - c - (\eta_0 - s) > 0$ then the original capacity decision results in planned exports (sales to the US). This is depicted in Figure 3, where the subsidization drives the capacity choice out to *K*(S)* (from an non-subsidized capacity of *K*(NS)*), such that exports to the U.S. will occur even when realized foreign demand equals expected demand ($MR_2$ schedule). This is then what we term a structural excess capacity effect on U.S. exports from this foreign market.

Interestingly, the model shows that foreign subsidization (the source of structural excess capacity) can also exacerbate the cyclical excess capacity effects. In comparing Figure 2 (no foreign subsidization) to Figure 3 (subsidization), the range of foreign demand realizations where the firm would be serving only the domestic market is much greater. Thus, there will be greater range of demand shocks that will not affect export supply in the model and, hence, a lower probability of cyclical excess capacity effects for the U.S. market. This is our third excess capacity hypothesis that we explore more below in our empirical analysis.

An important assumption in our analysis is that the foreign firm's costs relative to the U.S. price of steel would not warrant the firm building initial capacity to serve the export market. This follows Staiger and Wolak's assumptions and the contention of the U.S. steel producers that these foreign producers are exporting due to excess capacity issues, not an inherent comparative advantage in producing steel. We'll term this the inefficient foreign firm assumption. If one relaxes this assumption so that the foreign firm is efficient enough to build capacity for the export market, the model would still predict that exports would be negatively related to foreign demand shocks. However, excess capacity effects on exports would only apply to the additional amount of exports from a negative demand shock beyond the "normal" supply of exports for an expected foreign demand realization. Whether foreign subsidization would continue to exacerbate cyclical excess capacity effects depends on how efficient the foreign firm is. If the foreign firm is inefficient enough that it would stop exporting to the U.S. market for high foreign demand realizations, then this effect would still remain in the model as well. Finally, structural excess capacity effects would be unaffected by relaxing the inefficient foreign firm assumption.

In summary, the model in this section provides three primary excess capacity effects that we will explore in our empirical analysis. First, if foreign markets are protected, negative foreign demand shocks will generate greater exports to the U.S. market even without any subsidization by the foreign government. This is the cyclical excess capacity (or dumping) hypothesis. Second, foreign subsidization will lead to greater exports to the U.S. market – the structural excess capacity hypothesis. Finally, under certain conditions, foreign subsidization will lead to larger cyclical excess capacity effects.

The next section provides information on foreign subsidization in the steel industry uncovered by U.S. CVD investigations and a preliminary analysis of the structural excess capacity hypothesis. This is followed by section 4, where we develop an empirical specification based on this section's modeling to examine the statistical evidence for all three hypotheses.

**3. U.S. countervailing duty investigations and information on foreign subsidization**

Due to the potential effects of foreign subsidization on a domestic industry, the U.S. and World Trade Organization statutes allow domestic industries to obtain relief from imports that are subsidized by foreign governments through the use of CVD protection. In these cases, an *ad valorem* subsidy rate is calculated that, once applied as a CVD, is intended to offset the advantage gained in the domestic market by the exporting foreign firms from subsidization by the foreign government. In the U.S., CVD calculations are done by the International Trade Administration (ITA) of the U.S. Department of Commerce with CVD determinations for each case published in the *Federal Register*. These CVD determinations document all foreign subsidization programs related to the products subject to the U.S. CVD investigation and provide an *ad valorem* subsidy rate for each of these programs, as well as a total *ad valorem* subsidy rate which is the CVD if the imports are found to be causing injury to the domestic industry.

The reported ITA determinations provide us with a wealth of information on foreign subsidization, often including histories of foreign subsidization programs with start and end dates for various programs. These investigations consider an exhaustive list of programs and report information on many programs listed by the U.S. petitioners for which no subsidization benefit was found. As we document below, the U.S. steel industry has filed hundreds of CVD cases since 1980, many of which have been found to have insufficient evidence of foreign subsidization or deemed too insignificant to be injurious to the domestic industry. Thus, it is quite unlikely that there are any significant foreign government programs subsidizing steel exports to the U.S. that have not been examined by these CVD investigations.

While we have excellent information on the occurrence of foreign subsidization of steel imports in the U.S., there is obvious measurement error in the ITA's calculation of the *degree* of foreign subsidization. The ITA's methodology for calculating an *ad valorem* subsidy rate is to add up the monetary value of subsidy afforded to the foreign firm and divide this by a corresponding revenue stream. For example, if the subsidy is connected with all of the firms exports (not just to the U.S.), it divides the subsidy benefit by the total value of the firms' exports. If it is a production subsidy, it divides by the firms total sales, both domestic and foreign. Francois, Palmeter and Anspacher (1991) discuss many of the economic problems with this methodology.[9] Another significant issue is the treatment of "non-recurring" subsidies, such as one-time equity infusions by a foreign government to stop a steel firm from going bankrupt. Translating the effect of such an event into an *ad valorem* subsidy that affects the market in subsequent years requires a significant number of assumptions. Our data appendix describes these ITA procedures in some more detail, as well as our construction of subsidy rate over time from information in ITA CVD determinations.

The U.S. steel industry has a substantial history of filing CVD cases, with 289 cases filed on steel products from 1980 through 2002.[10] The most active periods were in the early 1980s leading up to the significant Voluntary Restraint Agreements (VRAs)

[9] A related literature in the trade law area discusses the difference between a competitive-benefits approach that focuses on the market advantage gained by the foreign firm from subsidization (i.e., an economics-based approach) and a "cash-flow approach" that the ITA uses in its calculations. For example, see Diamond (1990).

[10] Throughout the paper, we define "steel products" as those falling under Standard Industrial Classification 331, including steel mill products, pipes and tubes, and wire-related products. Our starting year is 1980, as this was the first year under new AD and CVD rules that are associated with a large increase in subsequent filing activity.

with virtually all significant importers beginning in 1985, a large group of cases when these VRAs were allowed to expire in 1992, and significant activity in the late 1990s and early 2000s prior to the steel safeguard actions imposed by the U.S. in 2002.

Table 1 provides a more detailed look at U.S. CVD activity in steel products over the 1980s and 1990s from a foreign country level. The first three columns report the number of CVD cases by foreign country source and the number of "successful" cases through either an affirmative decision by U.S. authorities or through a private suspension agreement.[11] There is substantial variation in the frequency with which countries are investigated and the frequency with which they end in "successful" outcomes for the U.S. steel industry. The primary activity has been against EC/EU countries, Korea, South Africa, and the Latin American countries of Argentina, Brazil, and Mexico. Success rates are generally much lower with respect to the EC/EU countries.[12]

The next two columns of Table 1 provide average CVDs for affirmative cases and for all non-suspended cases. As above, we assume a zero CVD for the non-affirmative cases. To the extent that the ITA's CVD calculations were a good measure of the effective subsidization rates, these columns provide evidence for where foreign subsidization is greatest. By these calculated rates, subsidization is more extensive in Argentina, Brazil, Canada (though only for the few cases investigated), Italy, South Africa, and Spain. In our statistical analysis below, we use the information on

[11] These "successful" cases do not include ones that were withdrawn in periods before comprehensive VRAs were negotiated since it is not always clear whether the case was withdrawn due to the impending VRA or a decision by the petitioners that the case would not be successful.

[12] Interestingly, Japan was never subject to a CVD investigation in steel products during this period. China likewise experienced no CVD investigation, but this is due to ITA's ruling that such calculations are not appropriate for non-market economies.

government subsidization reported in these CVD cases to “directly” examine whether such foreign subsidization increases exports into the U.S. steel market.

We can more specifically examine the efficacy of the permanent excess capacity hypothesis by looking at the extent of the U.S. steel market affected by the foreign subsidization uncovered in ITA investigations. High subsidization rates may mean little if it is only occurring for a small percentage of products. In the final two columns of Table 1, we provide a snapshot of the percentage of each country’s exports of steel to the U.S. market that are covered by a CVD as of 2002 and then the share of total U.S. consumption accounted for by the foreign country’s exports of steel. Thus, multiplying the two percentages together (in decimal form) provides a measure of the percent of the total U.S. steel market affected by foreign subsidization by the particular foreign country. For example, imports of steel from Canada account for 4.4% of the U.S. steel market in 2002 and 0.3% of these Canadian imports are subject to a CVD. Thus, the CVDs in place as of 2002 indicate that 0.01% ($0.003 \times 0.044 \times 100$) of the U.S. steel market is affected by Canadian subsidization of steel exports to the U.S. France, Germany and Italy have the largest share of their U.S. exports affect by CVD orders and relatively large shares of the U.S. market. But even the biggest impact – Germany – translates into just 0.34% of the U.S. market affected by its subsidization. Totaling up across all these country sources (which represents virtually all of the imports into the U.S.) provides an estimate that 1.32% of the U.S. market is affected by foreign subsidization.

To the extent that 2002 trade volumes are depressed by the presence of the CVD, this 1.32% number may not be representative of the portion of the steel market that was affected by foreign subsidization. As an alternative, we take the 1990 trade volumes of the products with CVD orders in 2002 as a share of total 1990 U.S. steel market. Virtually all the CVDs in place in 2002 became effective after the 1983-1992 VRA period. Using the 1990 figures, the estimate is 2.61% of the total U.S. steel market affected by foreign government subsidization as revealed by the presence of a CVD. While this number is still quite small, it is about double the previous estimate. As a percent of imports only, not the total U.S. steel market, almost 13% of imports are affected using the 1990 trade volumes.[13]

In summary, the data from U.S. CVD cases are not suggestive of large effects on the U.S. steel market from foreign subsidization. The most generous numbers suggest that 13% of imports are affected, translating into 2.6% of the total U.S. steel market, and that the average trade-weighted CVD on imports is 0.84%.[14] We next turn from the descriptive approach of ITA's calculations of CVD rates to a more formal statistical analysis of whether excess capacity is prevalent in the foreign markets.

[13] We can also calculate an approximate trade-weighted CVD rate across all imported U.S. steel mill products for 2002. For trade weights, we use first use product-level import volumes reported in the 2002 American Iron and Steel Institute (AISI) Annual Statistical Report. The product categories reported in the AISI Yearbook are sometimes larger than that covered by the U.S. CVD. So, in this sense, the trade-weighted CVD we calculate will be an overestimate. Keeping this limitation in mind, we calculate a trade-weighted 2002 CVD rate for imported U.S. steel mill products of 0.35%. As above, the trade-depressing effect of the CVD may mean the 2002 trade volumes are inappropriate to use as weights. When we use 1990 trade volumes as weights, we calculate an average CVD rate of 0.84% for all imported U.S. steel mill products.

[14] This conclusion assumes that the U.S. steel industry has petitioned in all the instances where foreign subsidization has occurred and that the ITA and USITC have correctly ruled affirmatively in those cases. These assumptions do not seem too unrealistic. The steel industry has filed literally hundreds of cases in the past couple decades, often obtaining negative decisions, which suggest they are filing even more cases than justified. With respect to application of CVD protection by the U.S. agencies, the analysis of Diamond (1990) and Francois, Palmeter, and Anspacher (1991) suggests that CVD protection may be applied more often than justified by the economic circumstances.

## 4. Empirical Specification and Data Description

In this section we develop an empirical specification based on the model in section 2 to estimate cyclical and structural excess capacity effects, as well as describe the data we use to examine our hypotheses.

### *4.1. Empirical Specification*

Following the model in section 2, the empirical specification assumes each foreign country as a fringe competitor with respect to the U.S. market. The second-to-last column of Table 1 suggests that this is a reasonable assumption. Canada is the foreign country with the largest U.S. market share at 4.4% in 2002. Brazil and Mexico are next with less than 3%. Germany, Korea and Japan have a little more than 1%, and all other countries have around 0.5% or less of the U.S. market.[15] This assumption of fringe competition simplifies the empirical analysis through the notion that each country acts as a price-taker in the U.S. market and acts independently of import decisions by other foreign suppliers to the U.S. market.

An important feature of the data available is a fairly disaggregated product level detail by country. As discussed more below and in the data appendix, we have U.S. import data by country source for 37 different, but consistently-defined, steel product categories. Identification of price and trade protection effects comes from substantial variation in these variables across these various country-product combinations.

[15] While these are 2002 numbers, these market shares change very little over the previous two decades and were, of course, much smaller before 1980.

Given these considerations, we estimate the following base empirical specification, pooling observations over import source countries (i), products (j), and years (t):

$$\ln EX_{ijt} = \alpha + \beta_1 \ln USP_{ijt} + \beta_2 \ln FDem_{it} + \beta_3 \ln Subsidy_{ijt} + \beta_4 \ln TProt_{ijt} + \varepsilon_{ijt} . \quad \textbf{(4)}$$

We estimate this specification using data that is first-differenced by country-product combinations to control for unobserved heterogeneity along these dimensions and as a way to address time series issues with some of our variables. We also include separate product, country, and year dummies in this first-differenced specification.

Our dependent variable in (4), ln $EX_{ijt}$, denotes exports to the U.S. measured as the log of net tons for product j from country i in year t. The first regressor, ln $USP_{ijt}$ is a measure of the logged real foreign currency price for product j available on the U.S. market in year t. Given the small individual market shares of foreign countries in the U.S. steel market noted in Table 1, we assume here (as in our theory) that the U.S. price is taken exogenously by the exporters. However, since the U.S. price must be translated into the appropriate foreign currency and adjusted into real terms, this variable is country-specific, as well as product- and year-specific. We expect a positive sign on this variable's coefficient since a higher realized price for their exports to the U.S. would make the foreign firm (modeled in section 2 above) more likely to build capacity to serve for exporting.

The variable ln $FDem_{it}$ is a primary focus variable for us and is the logged measure of demand for steel products in the foreign market. We expect a negative coefficient on this variable, as theoretically a higher demand in a foreign firm's own market leads to lower exports to the U.S. market. Such a result would be consistent with the cyclical excess capacity (or cyclical dumping) hypothesis of Staiger and Wolak. We use real industrial value added data taken from the World Bank's *World Development Indicators* to proxy for foreign demand for steel products since the steel is an intermediate input into many various industrial activities.[16] We also examine whether foreign subsidization exacerbates any cyclical dumping effects by interacting the foreign demand variable with our measure of foreign subsidization, which we describe next.

The term ln $Subsidy_{ijt}$ is the log of 1 plus the *ad valorem* foreign government subsidization rate that we construct from ITA determinations. A statistically significant positive coefficient on this term would confirm a structrual excess capacity effect of foreign subsidization on U.S. steel markets. Due to concerns with how the ITA calculates the magnitude of these *ad valorem* subsidy rates, we also examine the sensitivity of our results when we instead use a simple dummy variable for the presence of foreign subsidization.

The term ln $TProt_{ijt}$ denotes a matrix of variables measuring special U.S. trade protection programs that occurred during our sample, including CVDs, antidumping duties, VRAs in the latter half of the 1980s, and safeguard tariffs. We assume that standard *ad valorem* tariff rates are controlled for by year dummies included in the regression. We add "1" to the CVD, antidumping duties and safeguard tariffs and log them, whereas the VRA coverage is a binary variable. We expect the coefficients on these trade protection variables to be negative.

[16] The use of industrial production indexes or real GDP data gives qualitatively identical results in our statistical analysis. Real value added was not available for Taiwan and we use an industrial production instead. See our data appendix for further details.

### *4.2. Data*

Our sample consists of 22 countries, 37 steel product categories, and years 1979 through 2002. These data dimensions were largely determined by data availability of steel imports which we draw from yearly volumes of the American Iron and Steel Institute's (AISI's) *Annual Steel Report*. The 22 countries are the historically largest exporters of steel to the U.S. market. They include the countries listed in Table 1, as well as Austria (1979-2000), Finland (1979-1999), and Greece (1979-1987) for which data do not span the entire sample period.[17] The strength of the AISI *Annual Steel Reports* is reporting of data by consistent product categories throughout the sample period, ensuring that virtually all steel products are covered in our sample.[18] A few categories were combined to provide consistency throughout and the data appendix provides a list of the product categories covered. Import data are in net tons of steel.

Data on U.S. prices comes from producer price indexes published by the U.S. Bureau of Labor Statistics and available from their website at: http://www.bls.gov/ppi/home.htm. We also experiment with steel price data obtained from Purchasing Magazine which yielded qualitatively identical results throughout all our regressions. The data appendix provides a concordance we construct between our price series and the 37 steel product categories in our sample. We convert steel prices into the foreign country's currency by multiplying by an appropriate exchange rate and convert

[17] All other countries' observations span all years of the sample with the exception of South Africa, for which the years 1987-1995 are not reported due to the anti-apartheid embargo imposed on that country. We get qualitatively identical statistical results whether we include South Africa in the sample or not.
[18] An alternative would be to collect data by Harmonized Tariff System (HTS) codes down to even the 10-digit level. However, HTS codes, especially for a highly-scrutinized sector such as steel, are changing on a frequent basis, sometimes drastically. One would also have to concord the change from the TSUSA-based system before 1989 in the U.S. to the HTS.

into real terms using the country's GDP deflator as provided by the International Monetary Fund's publication, *International Financial Statistics*.

Our measure of foreign subsidization was constructed from *Federal Register* notices of ITA CVD decisions and is described in detail in our data appendix. Special protection measures, such as CVDs, antidumping duties, VRAs, and safeguard tariffs come from *Federal Register* notices and publications of the USITC. The data appendix has further details on sources and variable construction.

A data appendix provides further details on the construction and sources of our variables, as well as a table of summary statistics for the variables used in our statistical analysis.

## 5. Empirical Results

Table 2 provides regression results based on estimating equation (4) for the sample of 22 countries and 37 products from 1979 through 2002. The F-test of joint significance of our regressor matrix passes easily at the 1 percent confidence level across the various specifications in Table 2, and our main regressors are generally of expected sign and statistically significant at standard confidence levels. The coefficient estimates can be read as elasticities since they are logged (with the exception of the VRA variable).

Column 1 of Table 2 provides results of our benchmark model. Statistical evidence for cyclical, as well as structural, excess capacity effects is strong. The coefficient on the foreign demand variables is -1.62 and statistically significant at the 1-percent level, indicating that a 10% decline in the foreign demand variable is associated with about a 16% increase in exports to the U.S. market. This is confirmatory evidence for cyclical excess capacity effects.

The case for structural excess capacity effects is supported by a positive and statistically significant coefficient on our foreign subsidization variable. The coefficient on this variable suggests that a 10% increase in the foreign subsidization rate of a steel product increases its exports to the U.S. market by over 30%.

The control variables in the regression perform fairly well. As one would expect, we find a positive coefficient on the export price variable, indicating that steel exports increase to the U.S. when the foreign firms receive a higher price (in their own currency) for their U.S. exports. The effects of antidumping duties and safeguard tariffs on foreign exports to the U.S. are negative, as expected, and statistically significant with elasticities of -1.89 and -1.27, respectively. CVDs are not estimated to have a significant impact on exports though the associated coefficient is negative in sign as expected. The coefficient on the VRA indicator variable is also negative as expected and statistically significant, indicating that exports fall about 40% when subject to a VRA with the U.S. during our sample.

In Column 2 of Table 2 we examine whether foreign subsidization exacerbates the cyclical excess capacity effects by including a term that interacts the foreign demand variable with an indicator variable for the presence of positive foreign subsidization. A negative coefficient on this variable would indicate that the elasticity of exports to the U.S. market is even more pronounced for negative demand shocks; i.e., that cyclical dumping is even larger in magnitude. While the estimated coefficient on this interaction term is negative, it is statistically insignificant.

In Column 3 of Table 2 we examine whether the cyclical dumping effect is asymmetric and depends on whether foreign demand is generally in a high or low state.

Our simple model of cyclical dumping in section 2 would suggest that if foreign steel producers are relatively inefficient and/or unsubsidized, we would see little to no response of U.S. exports to foreign demand shocks if foreign demand was already at a high level such that the foreign firm was serving its own domestic market at full capacity. Foreign producers with an inherent or government-induced comparative advantage in producing steel are less likely to see any asymmetric response of exports to demand shocks in their own foreign market. To examine this we include an interaction term that interacts the foreign demand variable with an indicator variable for whether foreign demand is above its trend. The estimated coefficient is negative and statistically insignificant, suggesting no asymmetric responses, consistent with the notion of foreign subsidized firms and/or ones with an inherent comparative advantage.

Before turning to alternative specifications and samples, we comment on a number of data and specification issues. First, our empirical specification does not include any explicit controls for capital costs, which were clearly important in the model we present in section 2. However, differencing our data by country-product combinations controls for any time-invariant cost differences across these cross-sectional units. In addition, we include separate product, country, and year fixed effects. In this first-differenced specification, product fixed effects controls for any unobserved differences in trends common to a particular steel product. Country fixed effects control for unobserved differences in trends common to a country across all its steel products. And year effects control for any macroeconomic shocks. To the extent that changes in capital costs for country-product combinations can be decomposed into these fixed effects in an additively separable way, we have fully accounted for such changes.

One may be concerned with data measurement issues with regard to our key variables. We proxy for foreign demand with real industrial value added, though we get qualitatively identical results when we use industrial production indexes or real GDP measures reported in the International Monetary Fund's *International Financial Statistics*. We prefer the data on real industrial value added since data for industrial production indexes are missing for a significant number of observations in our sample and because real GDP measures include economic activity in many sectors, such as services, that hardly consume any steel at all.

As our data appendix describes in more detail, there are measurement issues with our subsidy variable, particularly the magnitude of the subsidies. In addition, subsidy programs that start before a CVD case in our sample are clearly documented, whereas ending dates for programs that continue past the CVD case are not. As an alternative to our subsidy rate variable we construct a dummy variable that takes the value of "1" when a foreign subsidization program begins for a country-product combination. The coefficient estimated on this variable is significantly positive at the 1% level and indicates a 34% increase in exports to the U.S., ceteris paribus. Coefficient estimates of other regressors are virtually identical regardless of which subsidy variable we use throughout our analysis.

### *5.1. Examining subsets of countries and products*

As section 3 documents, U.S. CVD investigations brought by the steel industry have targeted certain products and countries. In this section, we examine the extent to which there are differences in excess capacity effects across subsamples of our data. For each of these investigations we construct a dummy variable indicating a particular subsample of the data and then interact this dummy variable with all our main control regressors. Table 3 shows the coefficient estimates for our key excess capacity variables for the different subsamples, as well as an F-test of statistical difference between the two subsamples' estimates.

The first sample split we examine is between products which were subject to significant U.S. CVD investigations and those that were rarely, if ever, investigated. Steel products in the "high CVD activity" category include hot-rolled bars, plates, cold-rolled and hot-rolled sheet and strip, and wire rods. We would expect excess capacity effects to larger for high CVD activity products if these are the types of products that are heavily subsidized and protected by all foreign governments. However, as reported in Table 3, there are no statistical differences on the coefficient estimates for our foreign demand or subsidy variables, our respective measures of cyclical and structural excess capacity effects, across high and low CVD activity products.

We next split our sample into non-OECD countries and OECD countries. Inherent efficiencies in steel production and/or the extent of government subsidization may systematically differ across these two sets of countries. Results in Table 3 show that while there are no statistical differences between these two sets of countries with respect to cyclical dumping effects, structural excess capacity effects from foreign subsidization are limited to the non-OECD countries in our sample.

In fact, as shown in the last set of results in Table 3, both cyclical and structural excess capacity effects can be shown to be limited to only three countries in the sample, the South American countries of Argentina, Brazil, and Venezuela. The coefficients on the foreign demand and subsidy variables for these three countries are large in magnitude and statistically significant, while the coefficients on these variables for all other 19 countries in our sample are very close to zero in magnitude and statistically insignificant. As shown in Table 1, these three South American countries accounted for just 3.6% of U.S. consumption of steel in 2002. We have tried a variety of other sample splits with various country groupings, none with these stark results.

Thus, while we have estimated statistically significant excess capacity effects for our entire sample, they are apparently driven by a very narrow group of foreign country sources that are a small part of the U.S. market. This is consistent with our analysis of the CVD activity shown in Table in section 3 earlier. Taken together, it is difficult to imagine that excess capacity effects have had a significant role in the fortune of U.S. steel firms.

### *5.2. Further considerations and sensitivity tests*

There are a few remaining issues that may affect interpretation of our results. First, 22% of our observations on exports to the U.S. for a given country and product combination take the value of zero. However, we get qualitatively identical results for a sample of only non-zero observations. A second concern may be the impact of export markets other than the U.S. Taking the U.S. steel industry defenders at their word, this should not be a concern as the U.S. is the only significant market that is relatively open to steel imports. However, to the extent the rise or fall of other export market availability impacts our countries and products similarly, our inclusion of year dummies should control for these effects.

## 6. Conclusions

The effect of government subsidization on trade patterns has been an issue in the General Agreement on Tariffs and Trade (subsequently the WTO) from its inception. Measures to counteract such subsidization in the WTO, such as countervailing duty cases, often lead to substantial arguments over what constitutes a subsidy and calculations that do not begin to measure the market impacts of such subsidization. Yet, claims of injury from foreign subsidization have been used substantially by sectors to gain trade protection over the past decades, with the U.S. steel industry a primary example of this.

This paper presents a model and related empirical specification to examine such claims by the U.S. steel industry using data on observable data. Using data on 37 different steel products across 22 different foreign country sources, we are able to test for both short-run cyclical excess capacity effects on exports to the U.S. market, as well as long-run structural excess capacity effects stemming from foreign subsidization. We find statistical evidence for both effects. However, examination of subsamples of our data reveal that these effects are limited to a very small set of foreign export sources that account for a small share of the U.S. steel market. Thus, it is unlikely that these excess capacity effects have been a significant factor in the U.S. steel industry's performance over the past decades.

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**Table 1: Statistics on U.S. Steel Countervailing Duty (CVD) Cases, 1980-2003.**

| Country | U.S. Steel CVD Cases, 1980-2003 | CVD Cases Ruled Affirmative | CVD Cases Suspended | Average CVD for Affirmative Case | Average CVD for all non-suspended cases | Country's Percent of Total U.S. Consumption of Steel Mill Products, 2002 | Percent of Country's Steel Mill Imports Affected by CVD Orders, 2002 |
|---|---|---|---|---|---|---|---|
| Argentina | 9 | 7 | 1 | 11.83 | 10.52 | 0.3 | 0.0 |
| Australia | 1 | 0 | 0 | na | 0 | 0.6 | 0.0 |
| Belgium-Luxembourg | 21 | 2 | 0 | 3.93 | 0.37 | 0.5 | 6.0 |
| Brazil | 34 | 8 | 7 | 21.77 | 6.15 | 2.9 | 5.0 |
| Canada | 4 | 3 | 0 | 39.89 | 29.92 | 4.4 | 0.3 |
| China | 0 | 0 | 0 | na | na | 0.6 | 0.0 |
| France | 22 | 4 | 0 | 12.6 | 2.29 | 0.5 | 51.9 |
| Germany | 19 | 4 | 0 | 8.39 | 1.77 | 1.1 | 30.7 |
| Italy | 23 | 8 | 0 | 13.47 | 4.68 | 0.3 | 61.7 |
| Japan | 0 | 0 | 0 | na | na | 1.2 | 0.0 |
| Korea | 21 | 12 | 0 | 2.41 | 1.38 | 1.4 | 17.2 |
| Mexico | 8 | 3 | 0 | 9.37 | 3.52 | 2.8 | 1.2 |
| Netherlands | 5 | 0 | 0 | na | 0 | 0.5 | 0.0 |
| South Africa | 18 | 12 | 1 | 7.73 | 5.15 | 0.3 | 23.6 |
| Spain | 19 | 9 | 0 | 20.58 | 9.75 | 0.3 | 0.4 |
| Sweden | 6 | 2 | 0 | 6.52 | 2.17 | 0.1 | 0.0 |
| United Kingdom | 15 | 3 | 0 | 8.97 | 1.79 | 0.4 | 0.6 |
| Taiwan | 4 | 0 | 0 | na | 0 | 0.3 | 0.0 |
| Venezuela | 12 | 1 | 0 | 0.78 | 0.07 | 0.4 | 0.0 |

*Notes: Data for the first five columns come from Federal Register notices and were complied by Chad Bown at Brandeis University, and which are available online at http://www.brandeis.edu/~cbown/global_ad/. Data for the final two columns come from authors' calculations using the 2002 American Iron and Steel Institute Annual Statistical Report.*

**Table 2: OLS Estimates of Foreign Export Steel Supply, 1979-2002**

| | Base Specification | Subsidy Dummy and Foreign Demand Interaction | High Versus Low Foreign Demand |
|---|---|---|---|
| Ln (U.S. Price) | 0.697*** | 0.697*** | 0.698*** |
| | (0.129) | (0.129) | (0.129) |
| Ln (Foreign Demand) | -1.560*** | -1.459*** | -1.417** |
| | (0.480) | (0.508) | (0.600) |
| Ln (1 + Subsidy Rate) | 3.036** | 3.025** | 3.052** |
| | (1.315) | (1.313) | (1.315) |
| Subsidy Dummy | | | |
| Subsidy Dummy* Ln (Foreign Demand) | | -0.651 | |
| | | (0.898) | |
| Ln (Foreign Demand) * Dummy for Demand Above Trend | | | -0.33 |
| | | | (0.739) |
| Ln (1 +AD Duty) | -1.888*** | -1.889*** | -1.890*** |
| | (0.575) | (0.575) | (0.574) |
| Ln (1 + CV Duty) | -0.843 | -0.834 | -0.853 |
| | (0.953) | (0.952) | (0.953) |
| VRA Dummy Variable | -0.515*** | -0.515*** | -0.517*** |
| | (0.098) | (0.098) | (0.098) |
| Ln (1 + Safeguard Tariff Rate) | -1.272* | -1.286* | -1.284* |
| | (0.759) | (0.759) | (0.758) |
| Constant | 0.348** | 0.346** | 0.349** |
| | (0.138) | (0.138) | (0.138) |
| Year Fixed Effects | Yes | Yes | Yes |
| Country Fixed Effects | Yes | Yes | Yes |
| Product Fixed Effects | Yes | Yes | Yes |
| Observations | 16600 | 16600 | 16600 |
| R-squared | 0.04 | 0.04 | 0.04 |

*Notes: Dependent variable is the natural logarithm of 1+ U.S. imports of steel product from foreign country. All variables are first-differenced by country-product combination. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.*

**Table 3: Exploring Differences in Excess Capacity Effects across Various Subsamples**

| | **Cyclical Excess Capacity** | | **Structural Excess Capacity** | |
|---|---|---|---|---|
| | **Coefficient on Foreign Demand Variable** | **F-Statistic for Difference across Subsamples** | **Coefficient on Subsidy Variable** | **F-Statistic for Difference across Subsamples** |
| **<u>High CVD Activity vs. Low Activity CVD Products</u>** | | | | |
| High-Activity CVD Products | **-1.97**** | | **3.16*** | |
| | (pval=0.040) | **0.28** | (pval=0.081) | **0.01** |
| Low-Activity CVD Products | **-1.44***** | (pval=0.595) | **2.89*** | (pval=0.911) |
| | (pval=0.005) | | (pval=0.069) | |
| **<u>Non-OECD vs OECD Countries</u>** | | | | |
| Non-OECD Countries | **-1.72*** | | **4.39***** | |
| | (pval=0.005) | **0.12** | (pval=0.010) | **6.72***** |
| OECD Countries | **-1.44*** | (pval=0.726) | **-1.22** | (pval=0.010) |
| | (pval=0.052) | | (pval=0.359) | |
| **<u>South American Countries vs. Rest of the Sample</u>** | | | | |
| South American Countries | **-2.34***** | | **4.80**** | |
| | (pval=0.003) | **3.76*** | (pval=0.015) | **4.06**** |
| Rest of the Sample | **-0.45** | (pval=0.053) | **0.04** | (pval=0.044) |
| | (pval=0.433) | | (pval=0.974) | |

*Notes: These are coefficient estimates for selected variables from specifications running the base model in Column 1 of Table 2 with interactions terms for all main regressors to identify subsample differences. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.*

**Figure 1: Capacity decisions by a foreign monopolist**

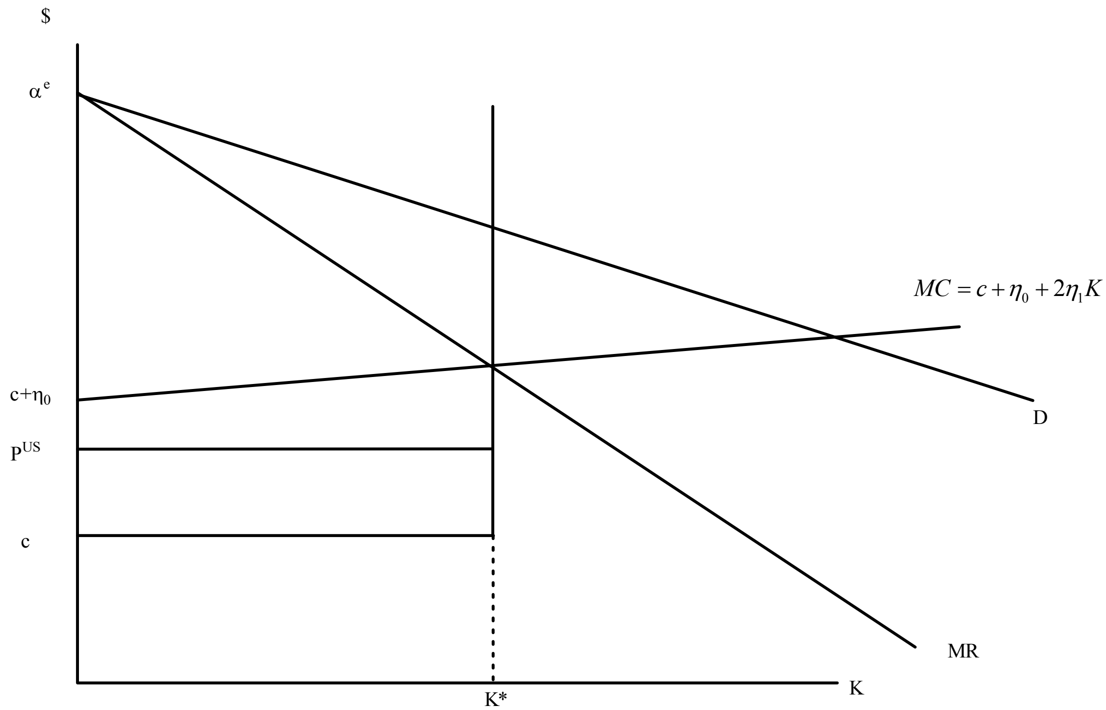


**Figure 2: Optimal Foreign Firm Output and Dumping**

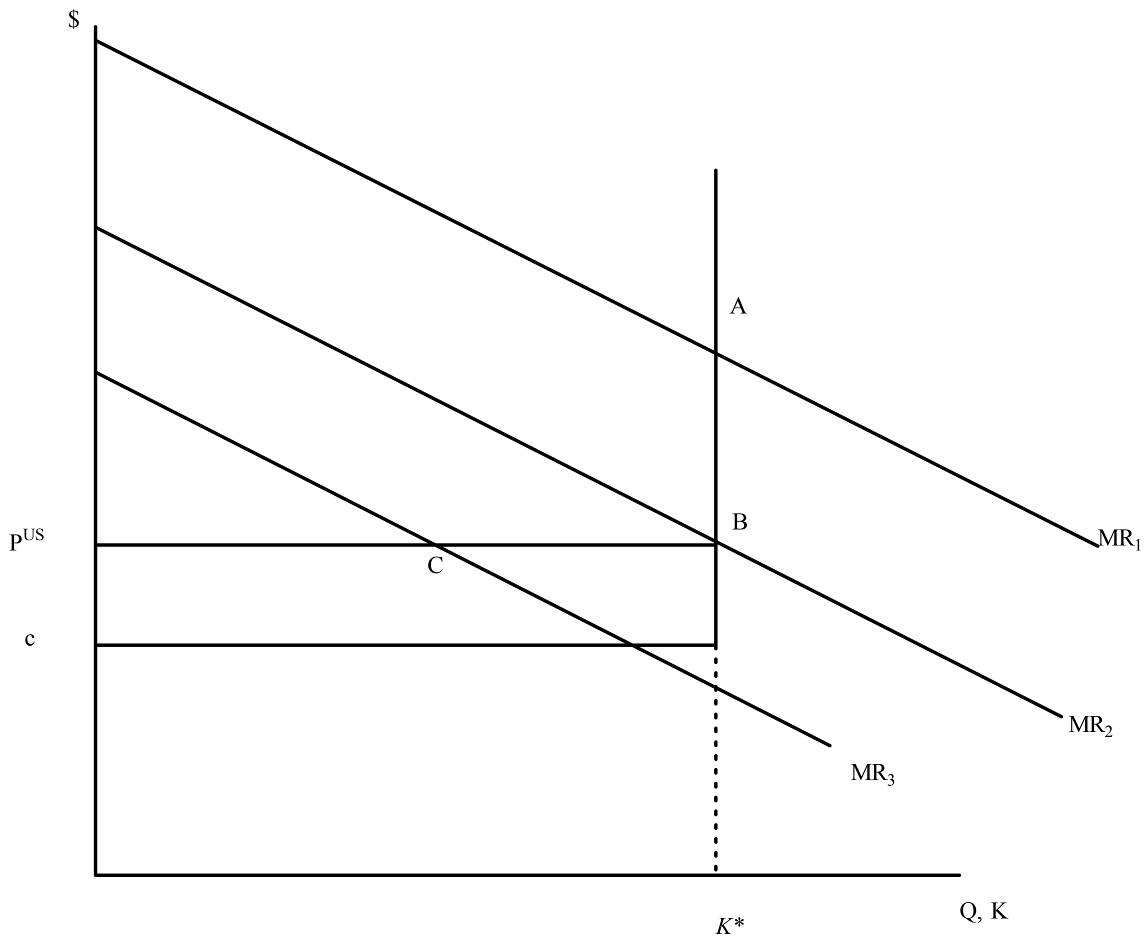
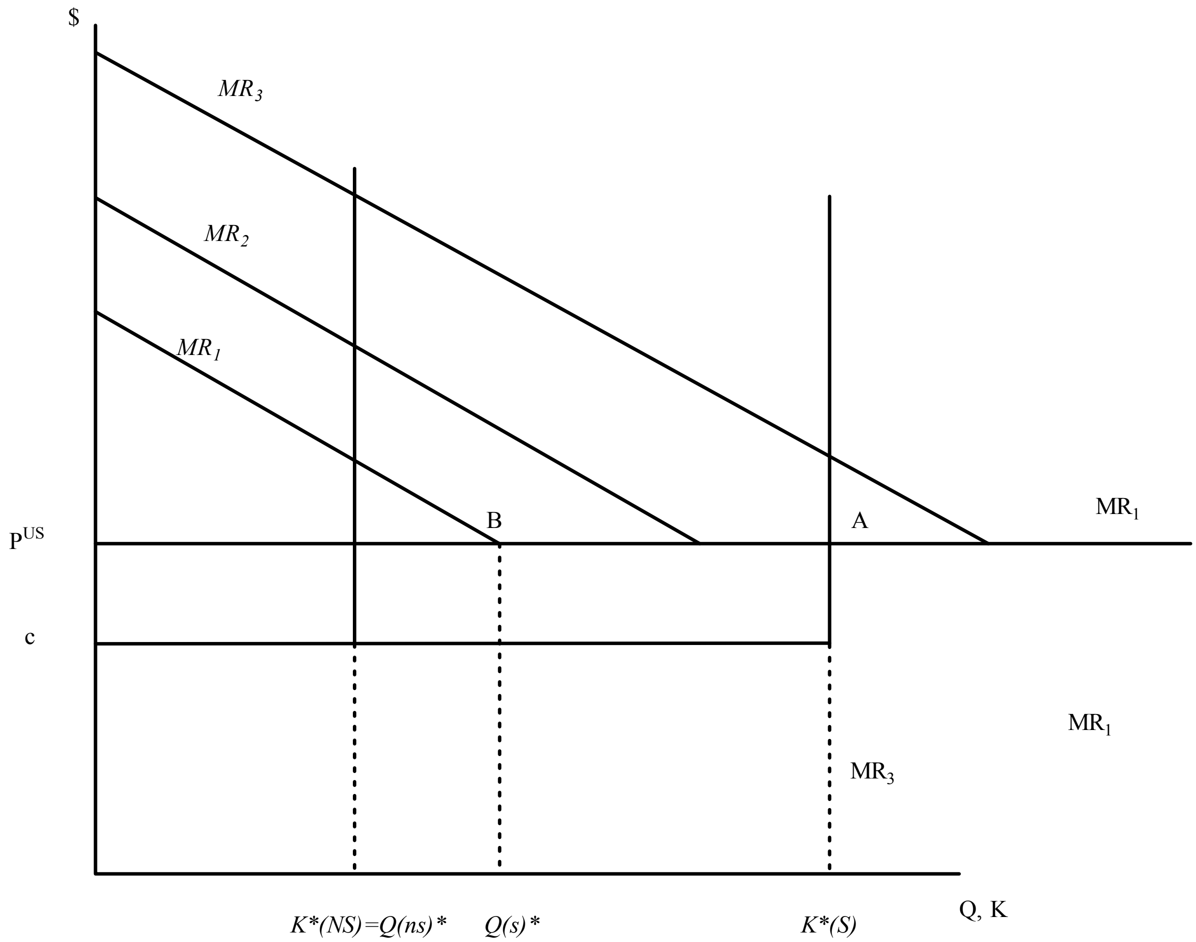


**Figure 3: Optimal Firm Output, Dumping and Subsidies**



**Data Appendix**

The following provides greater detail on our data sources and variable construction.

**Data on Foreign Exports to the U.S. (Dependent Variable)**
Collected from American Iron and Steel Institute's (AISI's) *Annual Statistical Report*, various volumes. We collect these data by the product categories reported in this source. However, for consistency over time, we combined a few product categories. In particular, all "plate" categories were combined, including "Plates – in coils" and "Plates – cut lengths". A number of categories, including "galvanized", "other metallic coated" and "electrical" were combined into a "Sheets & strip – Other" category. Likewise, a number of pipe categories, including "Stainless pipe and tubing", "Nonclassified pipe & tubing", "Structural pipe & tubing", and "Pipe for piling", were combined "Other pipe and tubing" category. See table A.1 below for a list of our 37 product categories. The 22 countries included in our sample are those listed in Table 1 of the paper, as well as Austria (1979-2000), Finland (1979-1999), and Greece (1979-1987) for which data do not span the entire sample period. These steel import data are reported in net tons and we use the log of the sum of the variable + "1" as our dependent variable.

**Real U.S. Steel Price in Exporter's Currency (Independent Variable)**
As mentioned in the text, we primarily rely on Producer Price Indexes from the Bureau of Labor Statistics (BLS) for our data on steel prices. For a robustness check we also use steel price data from *Purchasing Magazine* provided by Benjamin Liebman at St. Joseph's University. The following table concords our steel product categories to the steel price series we have available from these two sources.

**Table A.1: Concordance for our product-level U.S. price data**

| **Product Code (pcode)** | **BLS Price Index** | **Steel Purchasing Price Index** [5] |
|---|---|---|
| 1 – (Rigid) Conduit | PCU331111331111B | Average Price Series |
| 2 – Barbed Wire | PCU3311113311119 | Average Price Series |
| 3 – Bars, Cold-finished | PCU331111331111F | Average Price Series |
| 4 – Bars, Hot-rolled | PCU3311113311117 | Average Price Series |
| 5 – Bars, Shapes Under 3 In. | Footnote 1 | Average Price Series |
| 6 – Black Plate | PCU3311113311117 | Hot-rolled Plate Series |
| 7 – Reinforcing Bar | PDU3312#425 | Rebar Series |
| 8 – Grinding Balls | PCU3311113311113 | Average Price Series |
| 9 – Ingots, Blooms, Billets, Slabs | PCU3311113311113 | Average Price Series |
| 10 – Line Pipe | PCU331111331111B | Average Price Series |
| 11 – Mechanical Tubing | PCU331111331111B | Average Price Series |
| 12 – Nails and Staples | PDU3315#2 | Average Price Series |
| 13 – Oil Country Goods | PCU331111331111B | Average Price Series |
| 14 – Other Pipe and Tubing | PCU331111331111B | Average Price Series |
| 15 – Pipe and Tube Fittings | PDU3498# | Average Price Series |
| 16 – Plates | PCU3311113311117 | Hot-rolled Plate Series |
| 17 – Pressure Tubing | PCU331111331111B | Average Price Series |

| | | |
|---|---|---|
| 18 – Rail and Track Accessories | PDU3312#C/Footnote 2 | Average Price Series |
| 19 – Sashes and Frames | PCU3311113311117 | Average Price Series |
| 20 – Shapes, Cold-Formed | PCU331111331111D | Average Price Series |
| 21 – Sheet Piling | PCU3311113311117 | Average Price Series |
| 22 – Sheet, Cold-rolled | PCU331111331111D | Average Price Series |
| 23 – Sheet, Hot-rolled | PCU3311113311115 | Hot-Rolled Sheet Series |
| 24 – Sheets & Strip, Other | Footnote 3 | Galv. Sheet Series |
| 25 – Standard Pipe | PCU331111331111B | Average Price Series |
| 26 – Strip, Cold-rolled | PCU331111331111D | Average Price Series |
| 27 – Strip, Hot-rolled | PCU3311113311115 | Hot-Rolled Sheet Series |
| 28 – Struc. Shapes – Plain | PCU3311113311117 | Wide Beams Series |
| 29 – Struc. Shapes – Fab. | PCU3311113311117 | Wide Beams Series |
| 30 – Terne Plate (Tin Free) | PCU3311113311117 | Hot-rolled Plate Series |
| 31 – Tin Plate | PCU3311113311117 | Hot-rolled Plate Series |
| 32 – Wheels and Axles | PDU3312#C/Footnote 2 | Average Price Series |
| 33 – Wire – Nonmet. Coated | PCU3311113311119 | Average Price Series |
| 34 – Wire Rods | Footnote 4 | Wire Rod Series |
| 35 – Wire Rope | PCU3311113311119 | Average Price Series |
| 36 – Wire Strand | PCU3311113311119 | Average Price Series |
| 37 – Wire Fabric | PCU3311113311119 | Average Price Series |

[1] Average of PCU3311113311117 and PCU331111331111F.
[2] Used price series for "Blast furnaces and steel mill products – PDU3312#" for the years after 1997 due to data availability.
[3] Average of PCU331111331111D and PCU3311113311115.
[4] PDU3312#219 for years before 1998 and PDU3312#21611 for years after 1997.
[5] "Average price series" is a weighted average of price series for wire rod, hot-rolled sheet, hot-rolled plate, galvanized sheet, rebar, and wide beams. Data for these price series are only available from 1980 through 1999. They are monthly data and were averaged on an annual basis.

In our statistical analysis we derive a price variable by multiplying these U.S. price series by an exchange rate that converts into the foreign currency and then deflate using the country's GDP Deflator to convert into real terms. Finally, we log the variable.

Our primary source for the GDP deflator series for each country is the International Monetary Fund's *International Financial Statistics*, CD-ROM, June 2005.

Our exchange rate data (foreign currency per U.S. dollar) come from a few different sources. For Argentina, Brazil, China, Greece, Korea, Mexico, Netherlands, South Africa, Taiwan**,** we downloaded annual exchange rates through 1999 from the Economic History Services website www.eh.net/hmit/exchangerates, which also gives conversion to new currencies over time. We then added exchange rates from 2000-2004 using data from Werner Antweiler's PACIFIC Exchange Rate Services website: http://fx.sauder.ubc.ca/. Full citation on for the Economic History Services information is:

Lawrence H. Officer, "Exchange rate between the United States dollar and forty other countries, 1913-1999," Economic History Services, EH.Net, 2002. URL: www.eh.net/hmit/exchangerates.

For earlier years for China, Greece and Korea (1970-early80s) we use the IMF's *International Financial Statistics* data. For dates prior to 1984 for Taiwan, we use the website, http://intl.econ.cuhk.edu.hk/exchange_rate_regime/index.php?cid=11, and for years for Taiwan after 1999, we use Werner Antweiler's PACIFIC Exchange Rate Services website.

For Australia, Austria, Belgium (Lux), Canada, Germany, Finland, France, Italy, Japan, Spain, Sweden and U.K., we use historical data from Werner Antweiler's PACIFIC Exchange Rate Services website: http://fx.sauder.ubc.ca/.

**Foreign Demand for Steel as Proxied by Real Industrial Value Added (Independent Variable)**

Our source for this variable is the World Bank's *World Development Indicators* (WDI). The WDI database does not provide these data Taiwan. For Taiwan, our source for these data is official statistics of the Taiwanese Directorate – General of Budget, Accounting and Statistics, available online at: http://eng.dgbas.gov.tw/mp.asp?mp=2. We use an industrial production index for the Taiwanese economy as a proxy for real value added. Our paper's qualitative results are robust to whether Taiwanese observations are included or not.

**Foreign Subsidization Rates (Independent Variable)**

The Import Administration of the International Trade Administration (ITA) of the U.S. Department of Commerce performs all subsidy rate calculations in CVD cases since 1980. Their determinations for each case are published in the *Federal Register* and each list all foreign programs purported to directly or indirectly subsidize a product in a CVD case. There is a wide variety of programs considered by the ITA, including grants, equity infusions, debt forgiveness, loans at below-market interest rates, input subsidies, export subsidies, and duty drawbacks on imported inputs. The most recently revised rules followed for CVD investigations and subsidy rate calculations, as well as the original statutes governing CVD investigations and remedies can be found online at the ITA: http://ia.ita.doc.gov/regs/index.html.

The basic methodology is the following. The ITA determines the cash benefit of the subsidy connected with each program it considers and then divides this by a corresponding revenue stream to determine an *ad valorem* subsidy rate. For example, if the subsidy is connected with all of the firms exports (not just to the U.S.), it divides the subsidy benefit by the total value of the firms' exports. If it is a production subsidy, it divides by the firms total sales, both domestic and foreign.

Determination of the current cash value of continuous, or "recurring", subsidy programs is relatively easy. Determination of the current value of an infrequent, or "non-recurring", subsidy program, such as a one-time equity infusion by the government to allow a firm to

avoid bankruptcy a number of years prior to the current CVD case is obviously more difficult. In these cases, the ITA uses the following formula to "allocate" the cash benefit of such subsidies over time: $A_k = \{y/n + [y – y/n(k-1)d]\} / (1+d)$, where $A_k$ is the amount of the subsidy benefit allocated to year k, y is the face value of the subsidy in the year it occurred,
n is the average useful life of renewable physical capital for an industry (determined to be 15 years for steel plants), and d is the discount rate. The ITA's official regulations do not indicate the basis or rationale for this formula. Notable features of the formula is that it assigns a declining value of the subsidy benefit as years pass and that the benefit assigned to the last year (year n) is larger than y/n, the amount one would assign to each year if the benefit were equally apportioned to each year of average useful life of capital in the industry.

For the purposes of this paper, we use the information in the ITA determinations in the following way to get measures of foreign subsidization over time for the products subject to a CVD investigation. The first measure we create is a subsidization rate measure which we construct using the reported subsidization rates for each program, as well as their starting and ending dates. If no starting date is reported for a recurring subsidy program, we assume it was occurring at the same rate for all prior years back to the beginning year of our sample, 1979. If the program is recurring and still in place at the time of the CVD investigation, we assume it continues on until the end of our sample, unless a subsequent CVD investigation of the same product and country combination does not report it. If a CVD case is suspended *in lieu* of an agreement with the foreign government to suspend subsidization or otherwise mitigate the effect of such subsidization on its exports to the U.S., we assume that all subsidization has stopped. If CVDs are withdrawn or terminated due to the voluntary export agreements that occurred with some countries in 1982 and virtually all countries in 1985, we assume that subsidization continues. Finally, we assume all subsidization is discontinued when a CVD is revoked by a sunset review.

Products are matched to our dataset through reported Harmonized Tariff System (HTS) codes accompanying the cases (Tariff System of the United States Annotated (TSUSA) system prior to 1989). Often the CVD cases are defined narrowly enough that the product is matched to just one product category in our dataset, though sometimes they span multiple product categories. Sometimes a CVD product may be only a limited subset of one of our product categories. We have no obvious way to determine the portion of a product category that is covered by the CVD, so we simply assign the subsidization rates to the entire product category. Finally, there are a small handful of country-product combinations in our dataset where multiple CVD cases apply. In these situations, we cumulate the subsidization rates across these cases for that country-product combination in the years in which there is an overlap.

**Antidumping and Countervailing Duty (AD//CVD) Rates (Independent Variable)**
AD/CVD rate data were obtained from http://www.brandeis.edu/~cbown/global_ad/.
These data were then matched up to AISI product categories using an approximate

concordance in “Appendix D: Definitions of Certain Terms and Descriptions of Products Subject to the Investigation” in Office of Industries, USITC. (April 1995) *Steel Semiannual Monitoring Report: Special Focus: U.S. Industry Conditions*. Washington, DC: USITC Publication 2878.

For AD rates, we assumed that the initial dumping margins remain until order revoked. In other words, we do not adjust margins as administrative reviews occur. The rationale is that dumping margins only change as companies must respond to the initial dumping margin and raise prices. The impact on imports should be similar whether the dumping margin is collected or not collected due to the firm raising prices. With CVD rates, we adjusted these as they changed with administrative reviews.

The following rule governed how we recorded data on AD/CVD decisions into an annual observation: If the decision comes out prior to August 1, it is applied as the rate for the entire year. If the decision comes out on Aug. 1 or later, it gets applied to the following year.

Often AD/CVD rates may only apply to part of the product category. Since we do not have information on composition, we cannot prorate the AD/CVD rate. In a few instances, a product category becomes subject to more than one AD/CVD rate. To account for this, we sum the applicable rates. We add “1” to these variables and log for our statistical analysis

**Safeguard Tariffs (Independent Variable)**

Safeguard tariffs were placed on select steel products (primarily flat-rolled products, plate, bar, rod, and fittings) effective March 20, 2002 by order of President Bush. Most developing countries, as well as Canada and Mexico were exempted from these measures. We use the USITC publication *Steel: Monitoring Developments in the Domestic Industry (Investigation No. TA-204-9) and Steel-Consuming Industries: Competitive Conditions with Respect to Steel Safeguard Measures (Investigation No. 332-452) (Publication 3632, September 2003)*, pp. 1-5 and 1-6, to determine safeguard tariff coverage across our sample of countries and products. We add “1” and log this variable for our statistical analysis

**VRA coverage (product and country combinations) from 1983 through 1993 (Independent Variable)**

We use Table 7 of Michael O. Moore’s National Bureau of Economic Research working paper no. 4760, “Steel Protection in the 1980s: The Waning Influence of Big Steel?”, June 1994, as well as, p. i of preface to *Monthly Report on Selected Steel Industry Data: Report to the Subcommittee on Ways and Means on Investigation Number 332-163 Under Section 332 of the Tariff Act of 1930*, published by the U.S. International Trade Commission, February 1986, to determine whether a product category from a particular foreign country import source was subject to a voluntary restraint agreement or not. This variable is an indicator variable and is therefore not logged.

The following table provides summary statistics of these main variables in the base specification of our statistical analysis.

**Table A.1: Summary statistics of key variables in benchmark specification reported in Column 1 of Table 2 in the text.**

| Variable (in logs and differenced by country-product combination) | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Exports to U.S. | 0.09 | 1.90 | -11.68 | 14.59 |
| U.S. price | -0.01 | 0.13 | -0.44 | 0.94 |
| Foreign demand (Real Industrial Value Added) | 0.02 | 0.05 | -0.30 | 0.22 |
| Subsidy rate | 0.03 | 0.04 | -0.01 | 0.22 |
| Antidumping duty | 0.02 | 0.36 | -5.13 | 5.21 |
| Countervailing duty | 0.003 | 0.19 | -3.67 | 4.56 |
| Voluntary restraint agreement | 0 | 0.27 | -1 | 1 |
| Safeguard tariff | 0.03 | 0.33 | 0 | 3.43 |