NBER WORKING PAPER SERIES

FOREIGN SUBSIDIZATION AND THE EXCESS CAPACITY HYPOTHESIS

Bruce A. Blonigen
Wesley W. Wilson

Working Paper 11798
http://www.nber.org/papers/w11798

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2005

This research was supported by NSF grant 0416854. We thank Joshua Aizenmann, Ronald Davies, Robert Feenstra, Aris Protopapadakis, Andrew Rose, Kathryn Russ, and seminar participants at the Santa Cruz Center for International Studies conference for helpful comments. We also thank Anson Soderbery and Paul Thoma for excellent research assistance. Any remaining errors are our own. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

Foreign Subsidization and the Excess Capacity Hypothesis
Bruce A. Blonigen and Wesley W. Wilson
NBER Working Paper No. 11798
November 2005
JEL No. F13, L11

ABSTRACT

The U.S. steel industry contends foreign-subsidized 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 demonstrate that foreign export supply responses to foreign demand shocks depend critically on whether foreign firms have subsidized excess capacity. We then test the excess capacity hypothesis using detailed product and country data on steel exports to the U.S. market from 1979 through 2002, and find strong statistical evidence that rejects the U.S. steel industry's foreign excess capacity claims. Our empirical methodology may be applicable to many other products, including agricultural markets that have been the subject of intense discussions within the WTO.

Bruce A. Blonigen
Department of Economics
University of Oregon
Eugene, OR 97403
and NBER
bruceb@uoregon.edu

Wesley W. Wilson
Department of Economics
University of Oregon
Eugene, OR 97403
wwilson@uoregon.edu

"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. We call this the excess capacity hypothesis. 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 excess capacity hypothesis 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 firms have rationally disinvested over time. Finally, economists have

[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.

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.

Surprisingly, there have not been any attempts to examine the steel industry's claim for its decline – the excess capacity hypothesis.[2] While Howell et al. (1988) and U.S. countervailing duty investigations provide figures on purported foreign subsidies, no one has examined how such subsidies affect market outcomes, particularly the supply of steel to the U.S. market.

This paper considers the excess capacity hypothesis and examines whether the data support such a hypothesis for the U.S. steel industry. To do this, we begin with the model of cyclical dumping by Staiger and Wolak (1992) and extend it to allow for capacity subsidization by the foreign government. In the Staiger and Wolak model, foreign monopolists supply their own protected industry, but also export to a competitive market. The foreign firm's own foreign market experiences random demand shocks which can lead to "excess capacity" in low demand periods that is sold at market-clearing prices in the competitive domestic market. This provides an explanation for rational cyclical dumping by the foreign firm. It also creates an asymmetric export supply response that depends on whether the foreign market is in a high or low demand state; i.e., relatively elastic supply responses to foreign demand changes in low demand states and (perfectly) inelastic in high foreign-demand states. We then introduce the possibility of foreign

[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, with an elasticity around -0.30 that is statistically significant at the 1% level. Unlike the focus of this paper, neither of these tests for the presence of foreign subsidization affecting capacity choices of the foreign firms.

subsidization and show that under reasonable assumptions, this leads foreign firms to invest in more capacity than without subsidization. This likely eliminates any asymmetric supply response, as firms are less likely to ever hit capacity constraints.

The difference in predicted foreign export supply response depending on foreign subsidization gives us a hypothesis which we can then test using data on exports of steel by product and country to the U.S. market from 1979 through 2002. Our statistical estimates provide substantial evidence of asymmetric export supply responses to foreign demand changes that depends on whether foreign demand is in a high or a low state. In fact, we cannot reject the null hypothesis that export supply responses are perfectly inelastic whenever foreign demand growth is above average. This is consistent with foreign firms setting capacities free of foreign subsidization effects and is, thus, inconsistent with the excess capacity hypothesis.

To our knowledge, this represents the first empirical examination of the Staiger and Wolak (1992) model of cyclical dumping, as well as the excess capacity hypothesis. In addition, this methodology can be applied generally to other situations beyond the U.S. steel industry as a test of market distortions of capacity choices. In particular, foreign subsidization of agricultural products by the U.S. and the European Union has been a substantial issue of contention within the World Trade Organization. Lumber, airplanes, semiconductors, and automobiles are other notable sectors where government subsidization is alleged, but little analysis has been done to *quantify their impacts on world markets. Our* approach *may also be helpful in a reconsideration of how governments determine countervailing duties that are intended to counteract the impact of foreign subsidies on import prices.*

The paper proceeds as follows. In the next section, we provide a description of data from U.S. steel countervailing duty (CVD) cases that purportedly measure the degree of foreign subsidization. We examine these data and also explain why they are poor measures of the market effect of any subsidization that may be taking place. In section 3, a model that follows Staiger and Wolak (1992) is presented to frame the empirical application reported in sections 4 and 5.

2. A first look – U.S. countervailing duty investigations

Due to the effects on domestic industry from foreign subsidies, the U.S. and World Trade Organization statutes allow domestic industries to obtain relief from imports that are subsidized by foreign governments in what are termed countervailing duty (CVD) laws. In theory, a CVD is calculated that, once applied, exactly offsets the advantage gained in the domestic market by the exporting foreign firms from subsidization by the foreign government. In this section, we examine data that come from U.S. steel CVD cases, particularly the duty calculated by the International Trade Administration (ITA) of the U.S. Department of Commerce, for preliminary evidence on the extent of foreign subsidization connected with U.S. imports of steel.

We consider the evidence of foreign subsidization from the CVD investigations as suggestive at best. A primary reason for this is that the CVD calculations in the U.S. are not well-grounded in economic theory. The ITA's methodology for calculating an *ad valorem* CVD is to add up the monetary benefits from all production and export subsidies afforded to the foreign firm and divide this by the foreign firm's total sales of the product (across all markets) to come up with an *ad valorem* CVD.[3] Francois, Palmeter and Anspacher (1991) discuss many of the economic problems with this methodology.[4] The main issue is the implicit assumption that a 10% overall subsidy translates into a 10% price drop for the firm's

[3] See ITA's notice of final rules for CVD cases (after Uruguay Round changes) in the *Federal Register*, Wednesday, November 25, 1998.

[4] 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).

product in all markets it serves. First, if the firm has any degree of market power, it is unlikely to fully pass-through a subsidy. Second, to the extent that a firm has various degrees of market power, the pass-through will vary across markets. Third, a domestic subsidy will not have the same impact on export prices and volumes as an equivalent-sized export subsidy provided that supply curves (or marginal cost schedules) are not flat. These points all suggest that ITA's calculated CVDs are overestimating the effect of foreign subsidization on import prices, though it is possible to think of other factors that could lead these calculated CVDs to be an overestimate. For example, a small subsidy may be critical in preventing firms from shutting down, thus preserving a substantial amount of production and exports in the marketplace.

Due to these issues, the information on U.S. CVDs is only suggestive of the degree to which import sources are subsidized by their foreign governments. For this reason, we rely on an econometric approach to provide more definitive evidence of foreign subsidization effects. Nonetheless, the following discussion provides an overview of the history of the U.S. steel market for the period of our sample used in the statistical analysis.

As shown in Figure 1, the U.S. steel industry has a substantial history of filing CVD cases and is characterized by a few episodes of substantial activity. The year with the most U.S. steel CVD filings was 1982 when 115 cases were filed on various steel products.[5] Most point to the steel industry's dissatisfaction with the Trigger Price Mechanism's ability to prevent import penetration as leading to this massive filing of CVD cases in conjunction with a similar number of AD cases. The U.S. economy was also in the midst of a severe recession,

[5] 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. Figure 1 starts with the year 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 the steel industry losing almost 50% of its workforce during the first half of the 1980s.[6] The majority of these cases were filed against countries from the European Community (EC) and led to negotiated voluntary restraint agreements (VRAs) that began in the early part of 1983.

Despite the negotiated VRAs with the EC, import penetration continued to rise substantially from non-EC sources from 1983 through 1985. As a result, the steel industry filed an additional 55 CVD cases during this period against non-EC countries. These filings ultimately led to a comprehensive set of negotiated bilateral VRAs with virtually all significant import sources in 1985 that continued on until the spring of 1992. Within weeks of the expiration of steel VRAs in 1992, the U.S. steel industry filed a large number of AD and CVD cases against four significant classes of steel products: plate, hot-rolled flat products, cold-rolled flat products, and corrosion-resistant flat-rolled products. The ultimate outcome was affirmative decisions for only a subset of the products investigated and no movement to renew the VRAs. The negative decisions came primarily from the USITC finding of no material injury to the domestic industry. However, the ITA calculated substantial CVDs even though many of them were not implemented because of final negative USITC injury rulings.

There was little AD or CVD activity in steel for most of the mid-1990s and a common explanation for this was the strength of the U.S. economy during this period. Beginning in the late 1990s and early 2000s, there was a final increase in U.S. steel filing activity for CVDs. Often-cited contributing factors to this episode are the increase of imports

[6] Employment in the steel industry fell from 395,700 workers in 1980 to 208,700 by 1986. (American Iron and Steel Institute, various issues)

[8] 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.

from Asian countries after the Asian financial crisis and the recession of the U.S. economy. Whether due to import competition or not, the early 2000s saw an unprecedented number of bankruptcy filings and consolidation activity in the U.S. steel industry. The period from 1998 through 2001, there were 34 CVD cases filed against a wide variety of countries and steel products. A greater percentage of these cases were ruled affirmative than in previous episodes of steel filings with 21 of 34 (62%) ruled affirmative. The average CVD calculated for the affirmative steel cases during this period was 10.03%, whereas the average CVD factoring in the negative cases was 6.19%. The Safeguard tariffs imposed by President Bush in early 2002 likely led to little activity in the final years of our sample.

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.[8] 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.[9]

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

---

[9] 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 do not make sense for non-market economies.

greatest. By these calculated, subsidization is more extensive in Argentina, Brazil, Canada (though only for the few cases investigated), Italy, South Africa, and Spain. We use this information in our analysis below to examine whether our statistical analysis suggests a greater presence of foreign subsidization in these countries as well.

Of course, higher 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 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.[10]

A final important piece of information stemming from U.S. CVD investigations is the type of subsidies provided by foreign governments, as this will guide our modeling assumptions below. Our reading of U.S. CVD investigations suggests that the primary types of subsidies found by the ITA are equity infusions, assumption of debt, or other methods to help existing firms avoid bankruptcy (i.e., loss of capacity) or to build new capacity. Production, input, or export subsidies that vary with production (or exports) are rare. For example, we gathered data on all CVD rates calculated in the 1992 U.S. CVD filings against over 20 countries and 4 major classes of steel products for which the ITA provided details on the percent of the CVD attributable to each type of subsidy.[11] Of these CVDs, the ITA attributed over 85% of the average CVD to outright grants or equity infusions to the foreign firm for debt reduction or financing of new plants. Another 6.4% on average was subsidization through preferential loan rates, which obviously target the cost of capital. This leaves less than 10% for subsidization of inputs (such as electricity), exchange rate transactions, or other subsidies that vary with production or export volume.

---

[10] 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.

[11] This sample is composed of 56 unique observations over firms from 12 different countries and all four major products named in the case.

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%.[12] Foreign subsidization found by the ITA in steel cases is also primarily connected with one-time grants or equity infusions tied to capacity and shut-down decisions, not per-unit production or export subsidies.

While the magnitudes of foreign subsidization by the ITA seem relatively small, such changes can have dramatic impacts on the margin. For example, as noted above, a small subsidy could prevent exit of a firm and a loss of substantial amount of capacity and production. Thus, 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.

3. Conceptual Framework

This section outlines a version of the cyclical-dumping model in Staiger and Wolak (1992). We then adapt the model to illustrate how foreign subsidization of capacity leads to testable implications about 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 exported products to the foreign (hereinafter, the

[12] 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.

U.S.) market. The demand function in the foreign firm's domestic market is a simple linear function of price, wherein the intercept (α^F) is an i.i.d. random variable. That is, demand is given by $Q^F = \alpha^F - P^F$, where Q^F and P^F are quantity and price for the foreign market, respectively. In the export 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 at all levels of capacity.[13] Following Staiger and Wolak, short-run marginal costs are constant until capacity is reached, at which point marginal costs are infinite.[14] Capacity costs are assumed to be increasing in capacity and represented by a simple quadratic function, ηK^2, where $\eta>0$. [15]

The timing of decisions is as follows. The foreign firm first makes its capacity decision each period 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. As usual, we solve the game backwards and first discuss the output and export decisions of the foreign firm for a capacity chosen in the first stage.

3.1. Production and Export Decision

Given capacity choice, the firm maximizes profits by choosing output for the foreign and export markets:

[13] 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.

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

[15] This is a second modification of the Staiger and Wolak set-up, which assumed linear capacity costs. While increasing capacity costs seems quite reasonable for any firm (or sector) competing for capital in an economy, this assumption is necessary to get well-defined continuous capacity choices in the model once we assume that the foreign firm is a price-taker in the U.S. market.

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

where π is the firm's profit function, 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 exports fall for a given level of capacity, the higher the realized value of the foreign market demand intercept. The relative marginal benefit of serving the foreign market goes up and, with the presence of a fixed capacity constraint, exports to the U.S. market are a residual that must fall (assuming that the export market price will cover marginal costs so that exports are initially non-zero). Likewise, exports increase for lower foreign market demand realizations. This is then a model that generates cyclical dumping in the spirit of Staiger and Wolak.

3.2. Capacity Choices

We now turn the first-stage capacity choice of the foreign firm. For our purposes, it is useful to distinguish the capacity choice as composed of separate decisions on capacity for the foreign market (K^F) and on any additional capacity the firm may choose to serve the export market to the U.S. (K^{US}). Thus, the firm solves the following problem to determine first-stage capacity:

$$\underset{K^F, K^{US}}{\text{Max}} \;\; \text{E}\pi = (\alpha^F - K^F)K^F - cK^F + (P^{US} - c)K^{US} - \eta(K^F + K^{US})^2 \text{ subject to } K^F, K^{US} \ge 0,$$

where E is an expectations operator and all other variables are defined as above. In addition, to the conditions for non-negative capacity choices, the first-order conditions are the following assuming risk-neutrality of the firm:

$$\frac{\partial \pi}{\partial K^F} = E\alpha^F - 2K^F - c - 2\eta(K^F + K^{US}) = 0,$$

$$\frac{\partial \pi}{\partial K^{US}} = P^{US} - c - 2\eta(K^F + K^{US}) = 0,$$

which yield the following optimal capacity choices:

$$K^{F*} = \frac{E\alpha - P^{US}}{2}; \;\; K^{US*} = \frac{(P^{US} - c)(1+\eta)}{2\eta} - \frac{E\alpha - c}{2}. \qquad \textbf{(2)}$$

The optimal K^F capacity is exactly equal to the optimal production in the second stage should the realized foreign-market demand parameter exactly equal the expected value. The amount of additional K^{US} capacity increases as the differential between the export price (P^{US}) and marginal cost (c) increases, the cost of capital parameter (η) decreases, and the foreign-market demand parameter decreases. The solutions in (2) assume interior solutions for K^F and K^{US}. Assuming that the expected foreign-market demand parameter is above marginal production and capacity costs (as well as the export price), there is an interior solution for K^F. Another relevant case is where there is no interior solution for K^{US}, so that no additional capacity is built for export. In this case, it is easy to show that $K^{F*} = (E\alpha^F - c)/(2 + 2\eta)$.

Given this model, we use a simple graph (Figure 2) to illustrate the asymmetric response of exports by the foreign firm depending on how the realized foreign-market demand parameter differs from the expected value. For this example, we assume that the export price is just low enough so that the foreign firm does not build any capacity in the first-stage to serve the export market. MR_1 in Figure 2 represents the marginal revenue schedule when the realized foreign market demand exactly equals the expected value ($\alpha = E\alpha^F$), MR_2 represents the marginal revenue schedule for a negative demand shock ($\alpha < E\alpha^F$), and MR_3 represents the marginal revenue schedule for a positive demand shock ($\alpha > E\alpha^F$). When realized demand is identical to expected demand, we get an equilibrium point at 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 graph. At equilibrium point A, the firm sells all its production to the domestic market and none to the export market.

Now consider a negative demand shock leading to MR_2. In this case, the effective marginal revenue schedule is MR_2 until point B, after which the firm receives greater marginal revenue from the export market along the export price line, P^{US}. Thus, the firm sells exports equal to the length AB and sells the rest of its capacity to its own foreign market. In contrast, if there is a positive demand shock switching the marginal revenue schedule out to MR_3, the foreign firm continues to sell all of its capacity to the foreign market, albeit at a higher price, with no exports. This illustrates an important asymmetry due to capacity constraints. Positive demand shocks for a firm already at or near capacity, do not lead to any changes in exports, since there were little exports to begin with.

3.3. Government Subsidies

We now consider how government subsidization affects the firm's choices and market outcomes. Given the findings in section 2 about the types of subsidies uncovered by the ITA's CVD calculations, we assume government subsidization comes in the form of a capacity subsidization and specifically model such a subsidy (s>0) as entering the capacity cost term in the following manner, $(\eta\text{-}s)K^2$. The resulting objective functions and equilibrium solutions are the same as above after substituting $\eta\text{-}s$ for η. It is straightforward then to show that capacity is increasing in the subsidy regardless of whether the initial situation is one where the foreign firm builds some (additional) capacity for the export market or not. And, of course, the subsidy makes it more likely that the foreign firm will build capacity for the export market in the first place.

The effect we focus on is how (unexpected) demand shocks then affect export decisions in the presence of this additional capacity. The main result is that symmetric responsiveness of exports to demand shocks is more likely given the additional capacity. To see this, begin with the same situation as in Figure 2, but now have a significant subsidization by the foreign government. As shown in Figure 3, this will now lead the firm to have capacity built for the export market for a total subsidized capacity of K_s* (versus a non-subsidized capacity, as in figure 2, of K_{ns}*). If the realized demand is equal to the expected demand, we have the marginal revenue curve represented by MR_1 and an equilibrium where the firm exports are equal to length AB and sales in the foreign market are capacity minus the export levels. Now, regardless of whether there is a high-demand state (MR_2) or a low-demand state in the foreign market (MR_3), the export change (length AC and length DA, respectively) are similarly proportional to the change in foreign market demand.

The analysis points to a difference in the response of export supply to foreign demand shocks that depends on whether firms capacity choices are subsidized or not. This forms the foundation for our empirical work below. In particular, subsidized foreign firms are likely to have excess capacity in all possible states. This leads to symmetric export supply responses to positive or negative foreign demand shocks. In contrast, non-subsidized foreign firms are capacity-constrained when foreign demand is high. In this case, we should expect little (or no) export response to foreign demand shocks when foreign demand is generally high, while low demand states would see export supply responsiveness to demand shocks.

4. Empirical Specification and Data Description

In this section, we describe the statistical analysis of the hypotheses derived above. . Namely, we hypothesize a negative elasticity of export supply by foreign firms to demand shocks in their own countries. We further hypothesize that this elasticity significantly falls in magnitude (or even becomes zero) in the presence of capacity constraints when demand in the foreign market is high. The presence of excess capacity would suggest little change in the elasticity of supply regardless of demand shocks to the foreign market.

Following the model in section 3, the empirical specification takes 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%. 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.[16] 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 act 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.

Given these considerations, we estimate the following base empirical specification, pooling observations over import source countries, products and years (1979-2002):

$$EX_{ijt} = \alpha + \beta_1 USP_{ijt} + \beta_2 TProt_{ijt} + \beta_3 FDem_{it} + \beta_4 FDem_{ijt} \times HighFDem_{it} + \varepsilon_{ijt} . \qquad (1)$$

EX_{ijt} denotes exports to the U.S. measured as the log of net tons, where (i) indexes foreign country, (j) indexes products, and (t) indexes years. USP_{ijt} is a measure of the real foreign currency price available on the U.S. market in logged form. Thus, it is the U.S. price in U.S. dollars, translated into the appropriate foreign currency and adjusted into real terms. We expect a positive sign on this variable's coefficient since a higher U.S. price would make the foreign firm (modeled in section 3 above) more likely to build capacity to serve for exporting.

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

$TProt_{ijt}$ is a matrix of variables measuring special U.S. trade protection programs that occurred during our sample, including CVDs, antidumping duties, VRA coverage, 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 VRA coverage is a binary variable. We expect the coefficients on these variables to be negative. $FDem_{it}$ 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. $FDem_{it} \times HighFDem_i$ is an interaction term between the $FDem_{it}$ variable described above and a measure of high demand in the foreign market. We construct the latter as an indicator variable that takes the value of "1" whenever the $FDem_{it}$ is above the country's mean over all the years in the sample. Given this construction, the sum of the coefficient on $FDem_{it}$ and the interaction variable (β_1 and β_4) will give us an estimate of foreign demand elasticity with respect to foreign demand when foreign demand is above its mean. We expect a positive coefficient on this variable (β_4) if foreign firms' are hitting capacity constraints i.e., when foreign demand is above average, whereas in the presence of excess capacity, we expect β_4 to be zero. This is the key hypothesis of our empirical experiment. Finally, ε_{ijt} is our error term. We also first-difference our variables by country-product pairs to control for unobserved country-product heterogeneity and include separate product, country, and year dummies.

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

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.

[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.

[19] We thank Benjamin Liebman at St. Joseph's University for sharing these data.

Finally, we gathered data on real industrial production indices to measure foreign demand (shocks) for steel. These come primarily from the International Monetary Fund's *International Financial Statistics* (IFS), though we rely on other sources discussed in the appendix for China and Taiwan, which do not have such data reported in the IFS. We also examine the robustness of our results to using real GDP data from the IFS to proxy for foreign demand. To construct the interaction term we create a dummy variable for when foreign demand is above average for the country over the sample and interact this with the level of foreign demand.

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 (1) from 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 without an interaction term for the foreign demand variable, while Column 2 provides results with an interaction term between foreign demand and an indicator variable for when foreign demand is above its mean (i.e., "high"). Without the interaction term, of the effect of foreign demand on exports to the U.S. market is not statistically significant at conventional levels. This argues against cyclical dumping of steel products by foreign firms onto the U.S. steel market. However, when the interaction term is included, the elasticity of exports to the U.S. market is statistically significant and dependent on whether foreign markets are in high or low demand states. Specifically, in the set of results reported in Column 2, the foreign-demand elasticity of exports is statistically significant and has an estimated value of -2.530 when foreign demand is below its mean. However, when foreign demand is above its mean, the foreign demand-elasticity is 0.347 (-2.530+2.877) and not statistically different from zero. This is precisely what the model of cyclical dumping presented in section 3 suggests. That is when capacity constraints bind and foreign demand is high, there is no effect. If foreign subsidization meant foreign excess capacity even when the foreign economy is doing well, we would expect to see a zero coefficient on our interaction term. Thus, to the extent there is foreign subsidization, these results provide strong evidence that it does not lead foreign firms to build capacity beyond what they expect will be necessary to serve their own markets.

The effects of antidumping duties and safeguard tariffs on foreign exports to the U.S. are negative as expected, though the elasticities are relatively low in the -0.10 to -0.20 range. CVDs are not estimated to have a significant impact on exports, although this may be due to multicollinearity, since most CVDs are only filed when AD cases are filed, but not vice versa. The coefficient on the VRA variable indicates that exports fall about 30% when subject to a VRA with the U.S. during our sample. The final focus regressor in our specification is the U.S. price variable. As one would expect, we find a positive coefficient, indicating that steel exports increase to the U.S. when the foreign firms receive a higher price for those exports in their own currency.

Since the effect of foreign demand on steel exports to the U.S. is our main focus, columns 3 and 4 of Table 2 explore the robustness of these results to alternative measures of foreign demand. Column 3 uses real GDP to proxy for foreign demand, rather than an industrial production index.[20] Real GDP is likely to be a cruder proxy for demand for the steel sector because it includes other non-industrial sectors. However, the ready availability of real GDP data allows us to increase our observations by almost 2000 (about 12%). As Column 3 of Table 2 shows, this alternative measure yields qualitatively similar results. The foreign-demand elasticity of exports is negative and significant for low foreign demand, but much lower in absolute magnitude for high foreign demand (-5.067+3.468 = -1.599 with p-value=0.02).[21] Likewise, Column 4 of Table 2 shows qualitatively identical results when we use data on industrial production value added (in constant 1995 U.S. dollars) obtained from the World Bank's *World Development Indicators* database. In this case, as with our industrial production index, we cannot reject the hypothesis that the foreign-demand elasticity of export supply is perfectly inelastic for high foreign demand states.

5.1. Examining subsets of countries and products

As section 2 documents, U.S. CVD investigations brought by the steel industry have targeted certain products and countries more heavily. While our general results do not find evidence of excess foreign steel capacity, it could well be the case that products and countries targeted by CVD investigations may be of more significance. Columns 1 and 2 of Table 3 provide alternative specifications that examine this hypothesis. In column 1 we include terms that interact our Foreign Demand and Foreign Demand interaction term with an indicator of whether a particular steel product is covered by a CVD for more than 5% of its

[20] Real GDP data were collected from the International Monetary Fund's *International Financial Statistics*.
[21] We also get qualitatively identical results when using real GDP data on the same sample as that using the industrial production index.

observations in our sample. This criterion is satisfied for 7 of our 37 products: "Bars – hot rolled", "Oil country goods", "Plates", "Sheets – cold rolled", "Sheets and strip – other", "Strip – cold-rolled", and "Wire rod". If there is evidence of foreign subsidization, this is where we should find it. However, as the estimates in column 1 of Table 3 show, there is no statistical difference between these products and the rest of the sample in how foreign demand shocks affect foreign exports to the U.S. market. Column 2 of Table 3 instead examines whether there is a differential impact for country-product combinations that had a CVD at some point during the sample years. Again, we find no statistical difference between these country-product combinations and other observations in our sample.

5.2. Examining the U.S. price effect further

To this point, our focus has been on the effect of subsidization on the responsiveness of U.S. exports from foreign markets to foreign market demand shocks. Evidence of asymmetric responses is consistent with foreign firms making optimal capacity choices that are not significantly affected by foreign subsidization.

A related test is to look at whether the price elasticity of export supply has a similar asymmetric response for positive versus negative foreign demand shocks. Our hypothesis, following the model described in section 3, is that the price elasticity of export supply is more likely to be inelastic in high foreign demand states. An easy way to think of this in the context of our model is the following. Suppose that for an initial export price the foreign firm does not build any (additional) capacity for the export market. Regardless of whether an expected or high demand state is realized subsequently, the foreign country does not export. Now consider an increase in the export price that causes the foreign firm to build additional capacity given an expected foreign demand, but then realizes a high enough foreign demand state that it does not export. The price elasticity of export supply in this situation is perfectly inelastic for a high demand state. The price elasticity of export supply for low demand states would not display this possible truncation; i.e., exports would increase proportionally to increases in the U.S. price.

In contrast, subsidization of capacity makes it more likely that the firm would still have capacity to send to the foreign market for an export price increase even if a high demand state is realized. Thus, the presence of capacity subsidization would suggest again that there would be less likelihood to see an asymmetric price elasticity of export supply for high foreign demand states.

Column 3 of Table 3 examines this hypothesis by interacting the U.S. price variable with the indicator variable of high foreign demand. As predicted, the price elasticity of export supply is much more inelastic when foreign demand is above average. In above-average foreign-demand states it is 0.648 (1.381-0.733), whereas it is 1.381 when foreign demand is below-average. Both elasticities are statistically significant at the 1% level, but clearly there is a significant drop (more than 50%) when foreign demand is high. To the extent that marginal cost rises much more steeply as it approaches capacity, this is further evidence that foreign firms are at or near full capacity when foreign demand is above average.

5.3. The potential role of cost shocks

A final issue is the role of cost shocks. Our hypotheses arise from consideration of foreign demand shocks, but suppose that a firm must make capacity decisions before experiencing both demand and cost shocks. Using our model in section 3, one can construct examples where such cost shocks may confound our ability to identify excess capacity from foreign demand shocks depending on the initial parameters and the correlation between cost and demand shocks. To address this we collected indexes of hourly compensation costs in national currency for production workers in manufacturing for firms and years in our sample, available from the U.S. Bureau of Labor Statistics website: ftp://ftp.bls.gov/pub/special.requests/ForeignLabor/ichccsuppt05.txt.[22] We deflated these measures and then used them as foreign cost controls in our regressions after logging and differencing them identically to our other controls. This led to no significant change in any of our results. For example, its inclusion in the specification reported in Column 2 of Table 2 led to a coefficient on the wage cost measure of -0.09 with a p-value of 0.444 and virtually no quantitative change in the other coefficients.

5.4. 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 is that our results for our high foreign demand interaction variable, particularly its opposite sign from the independent effect of foreign demand on exports, may be driven by multicollinearity. However, if we instead run separate samples for when foreign demand is high versus when it is low, we get qualitatively similar estimates. In particular, the coefficient on the foreign demand variable for the only a sample of low demand observations is significantly negative at the 1% level, while the coefficient on this variable in the high foreign demand sample is generally statistically insignificant from zero. Finally, one may be concerned with 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

[22] The other important variable input in steel production, at least for integrated mills, is iron ore. However, to the extent there is a world market for this commodity, our year dummies should be capturing any cost shocks from this source.

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 develops a model and related empirical specification to judge such claims using data on observable market data. In particular, we extend a model by Staiger and Wolak (1992) to generate predictions of foreign export supply behavior with and without foreign subsidization and resulting excess capacity. Our key hypothesis is that excess capacity would suggest similar export supply responses to foreign market demand conditions regardless of whether the country was experiencing a high or low demand state, whereas capacity in line with expected demand in foreign markets would suggest very inelastic export supply in high demand states as foreign firms hit capacity constraints.

We test this excess capacity hypothesis using detailed product and country data on steel exports to the U.S. market from 1979 through 2002, carefully controlling for other factors affecting export supply such as U.S. trade protection programs. We find strong statistical evidence that foreign export supply responses to foreign demand shocks are negative and significant in low-foreign-demand states, but statistically zero in high-foreign-demand states. This suggests that foreign firms reach capacity in periods of high foreign demand and this is consistent with optimal capacity decisions by foreign firms that are not distorted by foreign government subsidization.

References

Crandall, Robert W. (1996). "From Competitiveness to Competition: The Threat of Minimills to National Steel Companies," *Resources Policy*, Vol. 22(1-2), 107-18.

Diamond, Richard D. (1990). "A Search for Economic and Financial Principles in the Administration of U.S. Countervailing Duty Law," *Law and Policy in International Business*, Vol. 21: 507-607.

Dunlevy, James A. (1980). "A Test of the Capacity Pressure Hypothesis Within a Simultaneous Equations Model of Export Performance," *Review of Economics and Statistics*, Vol. 62(1): 131-5.

Francois, Joseph F., N. David Palmeter, and Jeffrey C. Anspacher. (1991). "Conceptual and Procedural Biases in the Administration of the Countervailing Duty Law," in Richard Boltuck and Robert E. Litan (Eds.), *Down in the Dumps: Administration of the Unfair Trade Laws*. Washington, DC: The Brookings Institution, 95-136.

Howell, Thomas R., William A. Noellert, Jesse G. Krier, and Alan W. Wolf. (1988). *Steel and the State: Government Intervention and Steel's Structural Crisis.* London and Boulder, CO: Westview Press.

Lenway, Stefanie, Randall Morck and Bernhard Yeung. (1996). "Rent Seeking, Protectionism and Innovation in the American Steel Industry," *Economic Journal*, Vol. 106(435): 410-21.

Mastel, Greg. (1999). "The U.S. Steel Industry and Antidumping Law," *Challenge*, Vol. 42(3): 84-94.

Moore, Michael O. (1996). "The Rise and Fall of Big Steel's Influence on U.S. Trade Policy," in Anne O. Krueger (Ed.), *The Political Economy of Trade Protection*. Chicago: University of Chicago Press for National Bureau of Economic Research, 15-34.

Morck, Randall, Jungsywan Sepanski and Bernhard Yeung. (2001). "Habitual and Occasional Lobbyers in the US Steel Industry: An EM Algorithm Pooling Approach," *Economic Inquiry*, Vol. 39(3): 365-78.

Oster, Sharon. (1982). "The Diffusion of Innovation Among Steel Firms: The Basic Oxygen Furnace," *Bell Journal of Economics*, Vol. 13(1): 45-56.

Staiger, Robert W., and Frank A. Wolak. (1992). "The Effect of Domestic Antidumping Law in the Presence of Foreign Monopoly," *Journal of International Economics*, vol. 32: 265-87.

Tornell, Aaron. (1997). "Rational Atrophy: The U.S. Steel Industry," NBER Working Paper No. 6084.

Yamawaki, Hideki. (1984). “Market Structure, Capacity Expansion, and Pricing: A Model Applied to the Japanese Iron and Steel Industry,” *International Journal of Industrial Organization*, Vol. 2(1): 29-62.

Data Appendix

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

Import Data

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.

Antidumping and Countervailing Duty (AD//CVD) Rates

AD/CVD rates come from my and Chad Bown's data files on U.S. AD/CVD activity. (http://www.brandeis.edu/~cbown/global_ad/) The products were 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

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

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 VRA or not. This variable is a pure indicator variable and is therefore not logged.

Steel Price

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/.

Industrial Production Indexes

Our primary source for these three variables is the International Monetary Fund's *International Financial Statistics*, CD-ROM, June 2005. The IFS does not provides these data for any years for the countries of Taiwan and China. For these three countries, we generate industrial production indexes by calculating an index of real GDP for industry. 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. Our Chinese data source is statistic available at the Economic Research Service of the U.S. Department of Agriculture: http://www.ers.usda.gov/data/china/. This variable is logged for use in our analysis.

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

Table A.2: Summary Statistics of Key Variables in Base Specification Reported in Columns 1 and 2 of Table 2 in the Text.

Variable	Mean	Standard Deviation	Minimum	Maximum
Imports	0.09	1.90	-11.68	14.59
U.S. Price	-0.01	0.13	-0.44	0.94
Foreign Demand (Industrial Production Index)	0.02	0.05	-0.30	0.22
Foreign Demand*High Foreign Demand	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

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 Share of Total U.S. Consumption of Steel Mill Products, 2002	Share 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		Using Alternative Measures of Foreign Demand	
Regressors	Without Interaction	With Interaction	Real GDP	Real Industrial Value Added
U.S. Price	1.149**	1.125**	0.607**	0.598**
	(0.166)	(0.167)	(0.130)	(0.128)
Foreign Demand	- 0.633	- 2.530**	- 5.067**	- 3.070**
	(0.462)	(0.771)	(1.051)	(0.785)
Foreign Demand × High Demand		2.877**	3.468**	2.217**
		(0.894)	(0.938)	(0.862)
AD Duty	- 0.161**	- 0.159**	- 0.190**	- 0.205**
	(0.052)	(0.052)	(0.055)	(0.057)
CV Duty	0.018	0.015	- 0.020	- 0.015
	(0.061)	(0.061)	(0.060)	(0.060)
Voluntary Restraints	- 0.288**	- 0.270**	- 0.428**	- 0.425**
	(0.094)	(0.093)	(0.092)	(0.096)
Safeguard Tariffs	- 0.111*	- 0.110*	- 0.121*	- 0.105
	(0.054)	(0.054)	(0.055)	(0.067)
Country Fixed Effects	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.04	0.04	0.04	0.04
F-statistic	5.33	5.36	5.64	5.19
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	15,754	15,754	17,599	16,600

*Notes: Dependent variable is U.S. imports of steel product from foreign country. All variables are logged and first-differenced by country-product combination. Robust standard errors are in parentheses. ** indicates significance at the 1% level, * indicates significance at the 5% level. An intercept term was included, but is not reported.*

Table 3: OLS Estimates of Foreign Export Steel Supply, 1979-2002: Alternative Specifications.

	Different Response for High CVD Products?	Different Response for CVD Countries and Products?	Price Responses Affected by Foreign Demand?
U.S. Price	1.124**	1.130**	1.381**
	(0.167)	(0.167)	(0.201)
U.S. Price × High Demand			- 0.733**
			(0.255)
Foreign Demand	- 2.729**	- 2.345**	- 2.501**
	(0.814)	(0.814)	(0.772)
Foreign Demand × High Demand	2.988**	2.416*	2.640**
	(0.959)	(0.955)	(0.891)
AD Duty	- 0.160**	- 0.161**	- 0.159**
	(0.052)	(0.052)	(0.052)
CV Duty	0.016	0.011	0.023
	(0.061)	(0.061)	(0.061)
Voluntary Restraints	- 0.270**	- 0.263**	- 0.263**
	(0.093)	(0.092)	(0.093)
Safeguard Tariffs	- 0.110*	- 0.106*	- 0.109*
	(0.054)	(0.054)	(0.054)
Foreign Demand × High CVD Product	1.043		
	(1.826)		
Foreign Demand × High Demand ×High CVD Product	- 0.585		
	(2.201)		
Foreign Demand × CVD Country-Product		- 1.407	
		(1.713)	
Foreign Demand × High Demand × CVD Country-Product		3.386	
		(2.003)	
Country Fixed Effects	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
R^2	0.04	0.04	0.04
F-statistic	5.29	5.29	5.32
(p-value)	(0.000)	(0.000)	(0.000)
Observations	15,754	15,754	15,754

*Notes: Dependent variable is U.S. imports of steel product from foreign country. All variables are logged and first-differenced by country-product combination. Robust standard errors are in parentheses. ** indicates significance at the 1% level, * indicates significance at the 5% level. An intercept term was included, but is not reported.*

Figure 1: U.S. Countervailing Duty Steel Cases and Decisions, 1980-2003

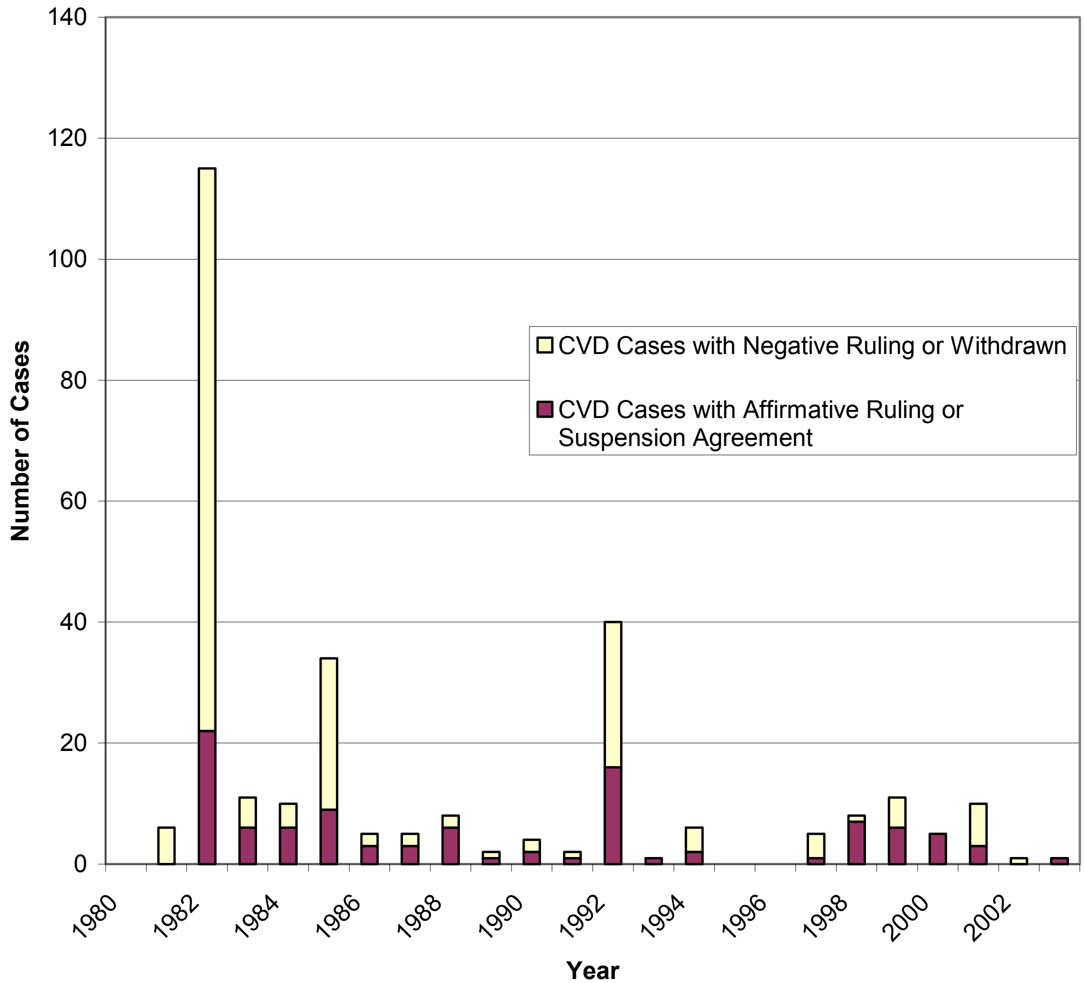

Figure 2: Effects of Foreign Demand Shocks on Foreign Monopolist's Production and Export Decisions

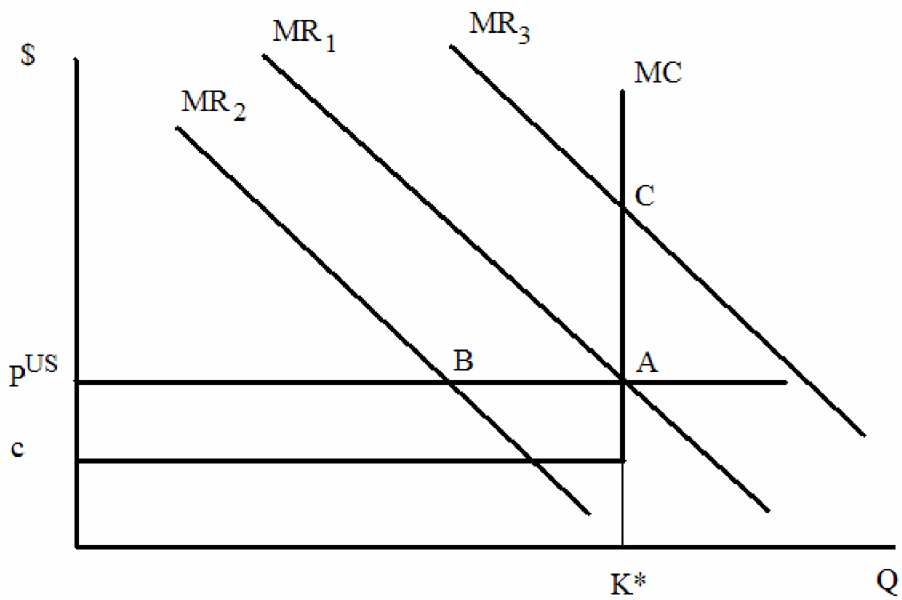

Figure 3: Effects of Foreign Demand Shocks on Foreign Monopolist's Production and Export Decisions with Subsidized Capacity