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Foreign subsidization and excess capacity

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ABSTRACT

The U.S. steel industry has long held 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 to estimate these excess capacity effects. While the full sample results provide evidence of both cyclical and structural excess capacity effects for exports to the U.S. market, these effects 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.

"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 long held 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 cause 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 reaction of the U.S. government has been to erect antidumping and countervailing duty laws, safeguard actions, etc., to protect the U.S. industry from such behavior (Mastel, 1999).

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.[2] Crandall (1996), Moore (1996), and Tornell (1997) 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 (1997) 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 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, we consider excess capacity effects and examine whether the data support that such effects occur and, if so, whether they have 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 is developed by Staiger and Wolak (1992) in which a foreign monopolist supplies its own protected

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[2] 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.

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home market, but may also export to a competitive market. The foreign monopolist is assumed to have two costs — production and capacity. The export price lies above the (short-run) production costs, but below the total (long-run) production plus capacity costs. Capacity decisions are made before the production decision, and the foreign firm's domestic market experiences random demand shocks. This can lead to short-run (or cyclical) excess capacity in low demand periods in the foreign country's home market that is then sold at market-clearing prices in the competitive export market and provides an explanation for rational cyclical dumping by the foreign firm.

Foreign subsidization is not modeled in the Staiger and Wolak framework and, thus, obviously not a necessary element for cyclical excess capacity effects. We modify the model to consider the effects of subsidization by a foreign government and demonstrate that foreign subsidization leads foreign firms to invest in more capacity than without subsidization. This increases the likelihood and/or increases the volume of their exports to the U.S. market. We term this the structural excess capacity effect. We also demonstrate that such foreign subsidization can exacerbate cyclical excess capacity effects.

To our knowledge, there are only a few studies that have empirically tested for positive export supply responses to negative domestic demand shocks (i.e., cyclical excess capacity effects)[3], and none that have formally tested for the effects of foreign subsidization (structural excess capacity effects).[4] 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 volumes to the U.S. Importantly, however, we explore various subsamples and find that these excess capacity effects are driven by less-developed countries. In particular, the Latin American countries of Argentina, Brazil, and Venezuela, which account for a small share of U. S. steel consumption, are the only countries for which excess capacity effects are statistically important. Further, given their small market shares in the U.S., it is unlikely that their behavior is 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. 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 statistical approach we use to examine our excess capacity hypotheses and present our 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 own domestic market (which we refer to as the "foreign market") can lead to cyclical dumping of excess capacity into the export market (which we refer to as the "U.S. 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.

We frame our model in the spirit of Staiger and Wolak (1992). That is, there is a foreign firm which is a monopolist in the foreign market, but which may also export its products to the U.S. market. The demand function in the foreign market is a simple linear function of price, wherein the intercept (α) 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.[5] Short-run marginal costs (c) are constant until capacity is reached, at which point marginal costs are infinite.[6] Capacity costs are assumed to be increasing in capacity and represented by a simple quadratic function, $\eta_0 K+\eta_1 K^2$, where η_0, $\eta_1>0$.[7]

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

2.1. Capacity choice

Capacity decisions are made prior to the realization of the foreign demand level. Modeling of the capacity decision is then based on expected profits, with an expected value of the demand level defined by α^e. Expected profits are maximized with choices of the capacity level (K), the foreign market sales level (Q^F) and the export level (Q^E). That is, the firm solves the following expected profit maximization problem:

$$\underset{K,Q^F,Q^{US}}{Max}\; E\pi=(\alpha^e-Q^F)Q^F-cQ^F+(P^{US}-c)Q^{US}-\eta_0 K-\eta_1 K^2 \quad (1)$$
$$\text{subject to } K\geq Q^F+Q^{US}.$$

The optimal foreign sales and export levels chosen at this stage are planned levels that can be changed after demand is realized in the foreign market. In contrast, we assume that the optimal capacity

[3] 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, Dunlevy (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 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.

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

[5] 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., any one 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.

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

[7] This is a second modification of the Staiger and Wolak set-up, which assumed linear capacity costs. This treatment allows for closed-form solutions.

choice chosen in this stage cannot be changed after foreign demand is realized.

We initially focus on the case where the U.S. price is high enough to warrant sales given capacity, i.e., $P^{US}-c>0$, but not so large as to warrant capacity investment in its own right; i.e., $P^{US}-c-\eta_0<0$.[8] This assumption means that the foreign firm will not build capacity intended for production and sales to the U.S. market given expected foreign demand. This follows assumptions in Staiger and Wolak (1992) and the steel industry's arguments that these foreign suppliers would not export to the U.S. under normal circumstances. The optimal capacity decision in this case, K^*, equates marginal revenue with (long-run) marginal costs defined by production costs and marginal capacity costs, yielding the following condition:

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

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

Fig. 1 depicts the optimal capacity decision under these assumptions, where the price is below long-run marginal costs (production plus capacity costs $= c+\eta_0$), but above marginal production costs (c). Long-run marginal costs intersect with expected marginal revenue at point A, yielding an optimal capacity of K^*.

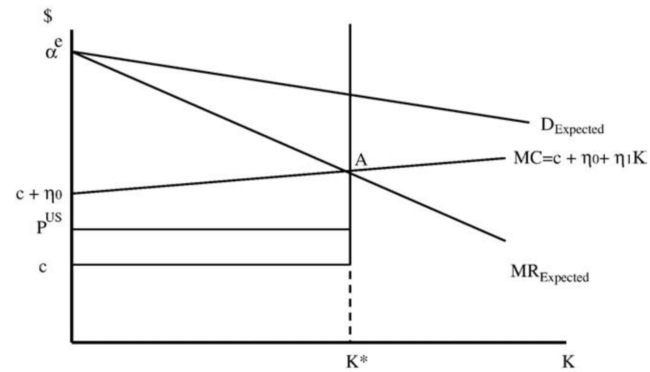

Fig. 1. Capacity decisions by a foreign monopolist.

2.2. Production and export decision

In the second period, the foreign demand parameter is realized (which we note as $\bar{\alpha}$), and the foreign firm maximizes current profits by choosing the level of output and sales in the foreign market (Q^F) and exports to the U.S. market (Q^{US}), given its optimal capacity choice in the first period (denoted as K^*). In this case, the capacity decision is made and the demand shock is realized. Profits are defined by:

$$\underset{Q^F,Q^{US}}{Max}\ \pi = (\bar{\alpha}-Q^F)Q^F - cQ^F + (P^{US}-c)Q^{US} \text{ subject to } Q^F + Q^{US} \le K^*, \qquad (3)$$

Solving Eq. (3), 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 foreign market (i.e., $Q^{F^*}=K^*$) or by allocating capacity between the foreign market and the U.S. market (i.e., $Q^{F^*} = \frac{\bar{\alpha}-P^{US}}{2}$ and $Q^{US^*} = K^* - Q^{F^*} = K^* - \frac{\bar{\alpha}-P^{US}}{2}$). For realizations of the foreign demand parameter greater or equal to the expected foreign demand ($\alpha^e \le \bar{\alpha}$) it is clear that all production will be sold in the foreign market with no export sales. However, for low enough realizations of foreign demand below the expected level, the foreign firm may divert export sales to the U.S. market. Such export sales would be considered dumping under a cost-based definition as the U.S. price is below the firm's long-run marginal costs, and this is then what we call cyclical excess capacity (or cyclical dumping) effects.[9]

Fig. 2 depicts outcomes for various foreign demand realizations. $MR_{Expected}$ in Fig. 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 foreign firm must also cover per-unit capacity costs which are not shown explicitly in the Fig. 2. Given our assumptions on the foreign firm's marginal costs relative to the U.S. price, the firm sells all its production to its own foreign market in this case and none to the U.S. market.

Now consider other possible foreign demand realizations. For any foreign demand realizations where the associated foreign marginal revenue schedule is above marginal revenue in the export market (pUS) out to the given capacity (K^*), it is clear that the foreign firm sells all production into the foreign market. This is true for both MR_{High} and $MR_{Expected}$ in the figure. For a low enough foreign demand realization, represented by MR_{Low}, the marginal revenue in the foreign market is below the marginal revenue from sales in the U.S. market after point D, and the firm optimally ships dumped exports (represented by the distance between points C and D) to the U.S. market, while selling the remaining production (distance between the vertical axis and point D) to the foreign market. Thus, while the U.S. price cannot cover both production and long-run capacity costs on its own, the firm will rationally choose to sell into the U.S. market in the short-run for unexpectedly low foreign demand realizations.

2.3. Government subsidies

We now consider how foreign government subsidization affects the foreign firm's choices and market outcomes in this model. We assume foreign 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: $(\eta_0-s)K+\eta_1K^2$.[10] This simple set-up illustrates that subsidies directly reduce capacity costs. The resulting objective functions and equilibrium solutions are the same as above after substituting η_0-s for η_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 Fig. 3, where the subsidization drives the capacity choice out to K_s^* (from a non-subsidized capacity of K_{NS}^*), such that exports to the U.S. will occur even when realized foreign demand equals expected demand. In this case, the firm would export the production represented by the distance between E and F for a realized foreign demand equal to the expected demand ($MR_{Expected}$ schedule). This is what we term a structural excess capacity effect on U.S. exports from this foreign market.

Interestingly, in this model foreign subsidization (the source of structural excess capacity) can also exacerbate the cyclical excess

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

[9] We note that such export behavior would also be considered dumping under a price-based definition in this model, provided the equilibrium foreign price is above the U.S. price.

[10] Many of the foreign subsidization programs found in CVD investigations are connected with capacity costs, such as equity infusions to rescue failing firms. However, export and production subsidies are also considered as well in CVD investigations. Fortunately, for our purposes, hypotheses about the effects of subsidization on exports are qualitatively unaffected by modeling capacity subsidization, as we do here, or by modeling foreign subsidization as a per-unit subsidy on sales to the export market that would effectively increase the price the foreign firm receives in the export market ($P^{US}+s$) or as a production subsidy that effectively lowers production costs (c-s).

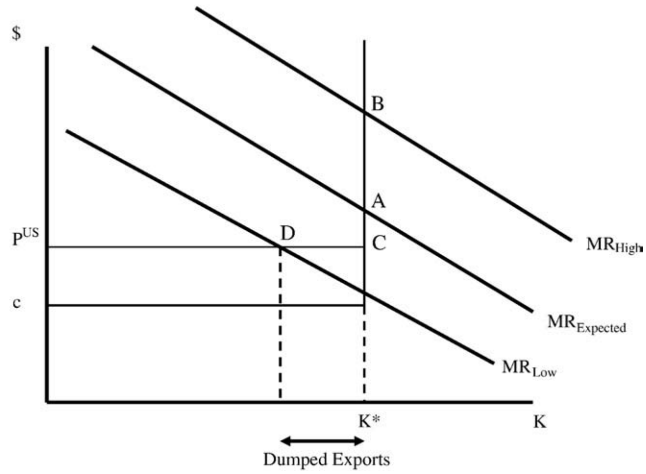

Fig. 2. Optimal foreign firm output and dumping.

capacity effects. Specifically, a comparison of demand shocks around K_{NS}* (no subsidization) to K_S* (subsidization) in Fig. 3, the range of foreign demand realizations where the firm would be serving only the foreign firm's own market is much smaller in the case of subsidization. Thus, there is a greater range of foreign demand shocks that affect export supply in the model and, hence, a higher probability of cyclical excess capacity effects for the U.S. market. This is another excess capacity hypothesis explored below in our empirical analysis — that foreign government subsidization can exacerbate cyclical excess capacity effects.

An important assumption in our analysis to this point 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 U.S. 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 term this the inefficient foreign firm assumption. If one relaxes this assumption so that the foreign firm is efficient enough to initially build capacity for the export market given expected foreign demand, the model still predicts that exports are negatively related to foreign demand shocks. However, excess capacity effects on exports only apply to the additional amount of exports from a negative foreign demand shock beyond the "normal" supply of exports for an expected foreign demand realization. Whether foreign subsidization continues to exacerbate cyclical excess capacity effects depends on the efficiency of the foreign firm. If the unsubsidized foreign firm is inefficient enough that it stops exporting to the U.S. market for high foreign demand realizations, then this effect still remains. Finally, structural excess capacity effects are unaffected by relaxing the inefficient foreign firm assumption.

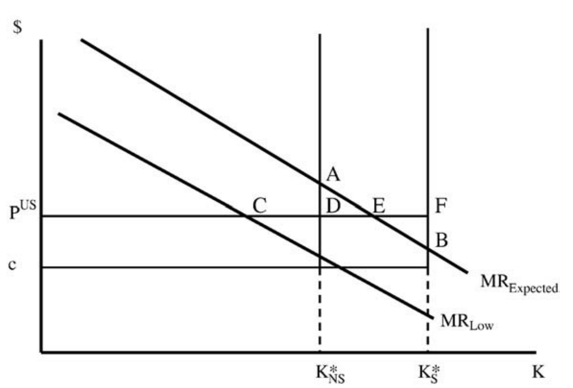

Fig. 3. Optimal firm output, dumping, and subsidies.

In summary, the model in this section provides three excess capacity effects that we explore in our empirical analysis. First, if foreign markets are protected, negative foreign demand shocks 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 government subsidization leads to greater exports to the U.S. market — the structural excess capacity hypothesis. Finally, under certain conditions, foreign government subsidization leads 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 due to subsidization by their 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 ITA determinations provide us with a wealth of information on foreign subsidization, including histories of foreign subsidization programs with starting and ending dates for various programs. These investigations consider an exhaustive list of programs and report information on many programs listed by the U.S. petitioners, including those for which no subsidization benefit was found. As documented 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 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. This is important for our statistical analysis to rule out sample selection bias.[11]

While we have excellent information on the occurrence of foreign subsidization of steel imports in the U.S., there is an obvious measurement error in the ITA's calculation of the *degree* of foreign subsidization. Specifically, 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 et al. (1991) discuss many of the economic problems with this

[11] The significant percent of unsuccessful cases is also important for ruling out an alternative scenario described by a referee where subsidization is occurring, but our estimates will not uncover it because foreign firms alter their export behavior to fully mitigate the subsidization effects for fear of CVD investigations. In such a scenario, we would expect a CVD investigation to be successful whenever it occurs.

methodology.[12] Another significant issue is the treatment of "non-recurring" subsidies, such as one-time equity infusions by a foreign government to stop a 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. The Appendix A describes these ITA procedures in more detail, as well as the construction of a subsidy rate measure over time from information in ITA CVD determinations.

As mentioned above, the U.S. steel industry has a substantial history of filing CVD cases, with 289 cases filed on steel products from 1980 through 2002.[13] The most active periods were in the early 1980s leading up to the significant Voluntary Restraint Agreements (VRAs) 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 formal suspension agreement.[14] 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.[15]

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 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 structural 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 1990 trade volumes, the estimate is 2.61% of the total U.S. steel market affected by foreign government subsidization, as revealed by the CVD investigations. As a percent of imports only, not the total U.S. steel market, almost 13% of imports are affected using the 1990 trade volumes.

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 product-level import volumes reported in the American Iron and Steel Institute (AISI) Annual Statistical Reports. We calculate a trade-weighted 2002 CVD rate for imported U.S. steel mill products of 0.35% when using 2002 trade volumes, and 0.84% when using 1990 trade volumes.[16]

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 with an average trade-weighted CVD on imports of 0.84%. We next turn from a 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.

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 is 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.[17] This assumption of fringe competition simplifies the empirical analysis through the notion that each country acts as a price-taker in the U.S.

[12] 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).

[13] 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.

[14] 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. There were 43 withdrawn cases, most involving European countries prior to VRA agreements in the early 1980s. We also note that the ITA finds subsidization in virtually all cases with negative decisions coming from either the subsidization not meeting *de minimus* standards or from failing the injury test by the U.S. International Trade Commission.

[15] 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.

[16] The product categories reported in the AISI Annual Statistical Reports are sometimes larger than that covered by the U.S. CVD order. In this sense, the trade-weighted CVD we calculate will be an overestimate. We also tried using trade volume weights from even earlier years in our sample than 1990, including import volumes in 1984, which were historically at their highest level prior to the imposition of VRAs. This yields almost identical results as when we use 1990 trade volumes.

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

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 exports 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	8	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	4	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
Taiwan	4	0	0	na	0	0.3	0.0
United Kingdom	15	3	0	8.97	1.79	0.4	0.6
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 compiled by Chad Bown at Brandeis University, 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.

market and acts independently of import decisions by other foreign suppliers to the U.S. market.[18]

An important feature of the data available is fairly disaggregated product-level detail by country. As discussed more below and in the Appendix A, we have U.S. import data by country source for 37 different, but consistently-defined, steel product categories. Identification of our coefficients of interest comes from substantial variation in the data across country–product combinations.

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

$$\ln EX_{ijt} = \alpha + \beta_1 \ln \mathrm{USP}_{ijt} + \beta_2 \ln ER_{it} + \beta_3 \ln \mathrm{FDem}_{it} + \beta_4 \ln \mathrm{Subsidy}_{ijt} + \beta_5 \ln \mathrm{TProt}_{ijt} + \varepsilon_{ijt}. \quad (4)$$

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 Eq. (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, $\ln \mathrm{USP}_{ijt}$ is a measure of the logged real price for product j available to the foreign firms from country i on the U.S. market in year t.[19] 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. 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 for exports to the U.S. and/or divert current production to the U.S. market for a given realization of foreign demand. The second regressor, $\ln ER_{it}$, is the exchange rate of the foreign currency per U.S. dollar, which translates the US price into the foreign producer's currency. For the same reasons as with the USP_{ijt} term, we expect our exchange rate variable to have a positive coefficient.

The variable $\ln \mathrm{FDem}_{it}$ is a primary focus variable and is constructed as a 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 steel is an intermediate input into most industrial activities.[20] 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 $\ln \mathrm{Subsidy}_{ijt}$ 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 structural 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 $\ln \mathrm{TProt}_{ijt}$ 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, special tariff-rate quotas applied to wire rod and line pipe in 2000, and safeguard tariffs applied in 2001 to a wide array of products and countries. 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 1980s VRA and 2000 safeguard remedies on wire rod and line pipe are proxied by dummy variables as they include quota limits. We expect the coefficients on these trade protection variables to be negative.

[18] The empirical evidence also strongly suggests that there are not significant endogeneity issues with our price variable. In unreported results, we instrument for the U.S. price with lagged values and proxy variables for downstream demand with insignificant effects on the U.S. price coefficient or other coefficients in the regression. Throughout our results, we cannot reject the hypothesis that the coefficients on the U.S. price term and the exchange rate term (an exogenous component of the effect U.S. steel price for foreign producers) are identical which also suggests that the U.S. price is exogenous. We also dropped the U.S. price from the equation with no differences in qualitative results.

[19] This variable varies by foreign country as we use a foreign country deflator to convert the US price variable into the foreign firm's own real terms.

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

It is important to highlight that, while the foreign subsidization variable is constructed from information in CVD investigations, it varies quite differently from the CVD duty variable. The foreign subsidization variable reflects the information gained in CVD investigations about all the foreign government subsidization *prior* to the CVD case. Thus, it can vary significantly as foreign subsidy programs began or ended during this prior period. As a representative example, Table 2 shows the data on foreign subsidization rates and countervailing duties on hot-rolled steel strip from Italy from our sample. Ad valorem subsidy rates for the foreign subsidization variable come from two CVD investigations against hot-rolled strip from Italy during our sample — one in 1982 and the other in 1999. While the foreign subsidization variable varies significantly during our sample, the CVD variable only becomes non-zero after the 1999 case is ruled affirmative and leads to a CVD. Hot-rolled strip from Italy is not an unusual product in our sample — less than 10% of changes in subsidization rates uncovered by CVD investigations occur around the time of the CVD case. This feature of the data clearly suggests there is little endogeneity concern with our subsidization variable.

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.[21] 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.[22] A few categories were combined to provide consistency throughout and the Appendix A provides a list of the product categories covered.

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. In unreported results, we alternatively used steel price data obtained from Purchasing Magazine which yielded qualitatively identical results throughout all our regressions. The Appendix A provides a concordance we construct between our price series and the 37 steel product categories in our sample. We convert U.S. into real terms using the country's GDP deflator as provided by the International Monetary Fund's publication, *International Financial Statistics*. Our historical exchange rate came from a variety of sources, detailed in the Appendix A.

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

[21] 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. While we include China in our sample, the U.S. does not conduct CVD investigations for non-market economies. However, we note that we get qualitatively identical statistical results whether we include China in the sample or not.

[22] 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.

Table 2
Sample data on ad valorem foreign government subsidy rates and countervailing duty rates for hot-rolled steel strip from Italy.

Year	Ad valorem subsidy rates (in percent)	Ad valorem countervailing duty rate (in percent)	
1979	8.56	0.00	
1980	8.61	0.00	
1981	8.73	0.00	
1982	8.73	0.00	◄ ITA case C-475-020
1983	0.19	0.00	(ultimately withdrawn)
1984	0.19	0.00	
1985	0.19	0.00	
1986	1.18	0.00	
1987	1.18	0.00	
1988	3.89	0.00	
1989	3.89	0.00	
1990	3.89	0.00	
1991	3.89	0.00	
1992	4.01	0.00	
1993	10.8	0.00	
1994	11.53	0.00	
1995	11.53	0.00	
1996	11.53	0.00	
1997	11.53	0.00	
1998	11.53	0.00	
1999	12.09	12.09	◄ ITA case C-475-825
2000	12.09	12.09	(ruled affirmative)
2001	12.09	12.09	
2002	12.09	12.09	

5. Empirical results

In this section, we present our empirical results that first show significant excess capacity effects that are robust to a variety of empirical specifications. We then show, however, that there is significant heterogeneity in the excess capacity effects across countries in our sample, such that these effects appear to be limited to a small group of less-developed countries exporting steel to the U.S. market.

Table 3 provides regression results based on estimating Eq. (4) for our sample of 22 countries and 37 products from 1979 through 2002. The *F*-test of joint significance of the regressor matrix passes easily at the 1% confidence level across the various specifications in Table 3, 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 3 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 −1.332 and statistically significant at the 1% level, indicating that a 10% decline in the foreign demand variable is associated with a 13.33% increase in exports to the U.S. market. This provides strong 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 32%.

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. Likewise, the exchange rate term has a positive coefficient, similar in magnitude to the U.S. price variable. 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 −1.667 and

Table 3
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)	0.567***	0.567***	0.567***
	(0.129)	(0.129)	(0.129)
Ln (exchange rate)	0.699***	0.699***	0.699***
	(0.129)	(0.129)	(0.129)
Ln (foreign demand)	−1.332***	−1.282***	−1.393***
	(0.465)	(0.488)	(0.557)
Ln (1 + subsidy rate)	3.207**	3.200**	3.200**
	(1.311)	(1.310)	(1.311)
Subsidy dummy* Ln (foreign demand)		−0.353	
		(0.873)	
Ln (foreign demand)* dummy for demand above trend			0.136
			(0.626)
Ln (1 + AD duty)	−1.667***	−1.667***	−1.665***
	(0.516)	(0.516)	(0.517)
Ln (1 + CV duty)	−1.082	−1.077	−1.078
	(0.900)	(0.899)	(0.900)
VRA dummy variable	−0.425***	−0.425***	−0.425***
	(0.091)	(0.091)	(0.091)
Ln (1 + safeguard tariff rate)	−1.544**	−1.551**	−1.539**
	(0.758)	(0.758)	(0.757)
Line pipe and wire rod safeguard dummy variable	−0.091	−0.092	−0.091
	(0.368)	(0.368)	(0.368)
Constant	0.198	0.197	0.198
	(0.141)	(0.141)	(0.141)
Year fixed effects	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes
F-statistic	4.79***	4.74***	4.73***
(*p*-value)	(0.00)	(0.00)	(0.00)
R-squared	0.03	0.03	0.03
Number of observations	17,120	17,120	17,120

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.

−1.544, respectively. CVDs are not estimated to have a significant impact on exports though the associated coefficient is negative in sign as expected and an *F*-test cannot reject that its coefficient is identical to that on the AD variable. The coefficient on the VRA dummy variable is also negative as expected and statistically significant, indicating that exports fall about 53% when subject to a VRA with the U.S. during our sample. The coefficient on the line pipe and wire rod safeguard remedies variable is negative as expected, though insignificant.

In column 2 of Table 3 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 3 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 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 between the foreign demand variable and an indicator variable for whether foreign demand is above its trend. The estimated coefficient is statistically insignificant, suggesting no asymmetric responses, consistent with the notion of foreign subsidized firms and/or ones with an inherent comparative advantage.

5.1. Specification issues and robustness checks

The results point to evidence of steel market claims that subsidation leads to an inherent advantage that has a deleterious effect on the U.S. industry. In this subsection, we examine a variety of alternative specifications to examine the robustness of the result. One possible omitted variable is the lack of 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, while 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.

Another potential concern is with respect to 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.

There are also potential measurement issues with our subsidy variable, particularly the measured magnitude of the subsidies. This is described in considerable detail in the Appendix A. 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. Besides unintended measurement issues one could also worry that the size of the subsidy rates may be biased by political, rather than economic, considerations.[23] Thus, 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 and "0" otherwise. We are the most confident about the information on when a foreign subsidy program begins and it seems much more difficult to fabricate such information for political reasons on the part of the ITA. In unreported results, we find that the coefficient estimated on this subsidy dummy 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 qualitatively identical regardless of which subsidy variable we use throughout our analysis.

Finally, we found our base estimates to be quite robust to modeling possible dynamic effects. We tried a specification where we included a lagged dependent variable and employed the common Arellano–Bond GMM estimator to our benchmark specification. While the lagged dependent variable was significant (coefficient of −0.30), our other coefficients were qualitatively identical to our benchmark results. To examine whether export responses lagged foreign demand shocks, we included a lagged foreign demand variable in our regression which

[23] For four countries in our sample, there is at least some years where the U.S. could apply CVDs without performing an injury test because the country had not signed onto the GATT Subsidies Codes. Our estimates are not qualitatively affected if we drop these countries (Argentina, China, Mexico, and South Africa) from our sample.

Table 4
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
High CVD activity vs. low-activity CVD products				
High-activity CVD products	**−1.08**		**3.23****	
	(p val = 0.214)	**0.14**	(p val = 0.041)	**0.00**
Low-activity CVD products	**−1.41*****	(p val = 0.707)	**3.09***	(p val = 0.953)
	(p val = 0.003)		(p val = 0.091)	
Non-OECD vs OECD countries				
Non-OECD countries	**−1.38****		**4.41*****	
	(p val = 0.020)	**0.00**	(p val = 0.010)	**5.49****
OECD countries	**−1.38****	(p val = 0.999)	**−0.54**	(p val = 0.019)
	(p val = 0.040)		(p val = 0.663)	
South American countries vs. rest of the sample				
South American countries	**−2.24*****		**4.63****	
	(p val = 0.006)	**4.21****	(pval = 0.019)	**3.24***
Rest of the sample	**−0.27**	(p val = 0.040)	**0.42**	(p val = 0.072)
	(p val = 0.618)		(p val = 0.737)	

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.

was estimated to be insignificant. We also find that our estimates are qualitatively very similar when we split our sample before and after the midpoint year of 1990.[24]

5.2. Heterogeneity of excess capacity effects across products and countries

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 4 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 expect excess capacity effects to be 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 for the coefficient estimates on 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 4, 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 only the non-OECD countries in our sample.

We then explored a variety of various subsamples of countries and uncovered significant differences in excess capacity effects. The most striking results are shown as the last set of results in Table 4, where 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.

Thus, while we have estimated statistically significant excess capacity effects for our entire sample, these effects 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 1 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.

There are a few remaining issues that may affect interpretation of our results. First, our subsidy variable is constructed from information stemming from all CVD cases, regardless of the outcome of the case. Interestingly, we do not find any statistical differences in the subsidy effect whether the outcome of the related CVD case is an affirmative decision, negative decision, withdrawal of petition, or suspension due to an agreement amongst the various firms and the ITA. 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 U.S. steel industry has been the largest user of special U.S. trade protection laws by a wide margin. Their justification is that such laws are necessary to protect them from foreign producers that enjoy protected markets with significant government subsidization, leading to substantial dumping of excess capacity into the relatively open U.S. market. This paper takes these claims seriously and confronts them with the data. We use a unique database on U.S. imports of 37 different steel products across 22 different foreign country sources from 1979 through 2002 to examine the evidence 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

[24] The US steel industry contends that foreign markets are largely protected from import competition and this is an important assumption for the theoretical existence of excess capacity effects in our model and that of Staiger and Wolak (1992). It would be interesting to examine how much the degree of import protection in the foreign market matters for our estimation of excess capacity effects. Unfortunately, historical data on import protection by industry and country is often unavailable. Using the TRAINS tariff database, we were able to obtain such data for less than a third of our observations and the coefficient on this foreign import protection measure was statistically insignificant.

for both effects. However, examination of subsamples of our data reveals that these effects are limited to a small set of foreign export sources that account for a small share of the U.S. steel market. Thus, we conclude 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.

A principle finding of the paper is that there are heterogeneous excess capacity effects across import sources. The source of this heterogeneity is an important area of future research. One possibility is that the steel industry files across a wide array of country sources and institutional bias leads to uncovering of subsidization even for country sources where it is insignificant. Alternatively, countries have different ways to subsidize steel production and exports, and subsidy programs may differ in how they affect exports. Such effects are clearly an important area of future research.

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Appendix A

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

A.1. Foreign exports to the U.S. (dependent variable)

These data are 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 into an “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. We are also missing observations for most of the pipe and tubing categories before 1982. 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.

A.2. Real U.S. steel price (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.	[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/[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	[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. shape-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/[2]	Average price series
33 — Wire-nonmet. coated	PCU3311113311119	Average price series
34 — Wire rods	[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.

We derive a real price variable by multiplying these U.S. price series by deflatinge using the foreign country's GDP deflator to convert the US price into real terms for the foreign producer. 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.

A.3. Exchange rate (independent variable)

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 2000–2002 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–early 80s) 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/.

A.4. 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 for Taiwan. Thus, we turn to 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.

A.5. 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 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. The final subsidy rate for a product and country source then totals the subsidy rates across the programs found to provide subsidization.

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: $Ak = \{y/n + [y - y/n(k-1)d]\}/(1+d)$, where Ak 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. We create a subsidization rate measure by 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. We update when there is a subsequent CVD investigation of the same product and country combination. 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. We assume all subsidization is discontinued when a CVD is revoked by a sunset review. In some cases, the ITA calculates subsidy rates for various foreign firms (not a simple country-wide rate). In these cases, we create a weighted sum of the subsidy rates assuming the firms have equal market share of the U.S. imports of the investigated product.

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.

A.6. 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 an order is 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 rules governed how we recorded data on AD/CVD decisions (as well as subsidy rates described above) 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.

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

Variable (first-differenced by country–product combination)	Mean	Standard deviation	Minimum	Maximum
Ln (exports to U.S.)	0.07	1.93	− 11.68	11.67
Ln (U.S. price)	− 0.16	0.44	− 3.47	0.13
Ln (exchange rate)	0.14	0.44	− 0.35	3.88
Ln (foreign demand)	0.03	0.05	− 0.15	0.19
Ln (1 + subsidy rate)	0.00	0.02	− 0.57	0.29
Ln (1 + antidumping duty)	0.02	0.04	− 0.98	1.04
Ln (1 + countervailing duty)	0.00	0.01	− 0.32	0.67
VRA dummy variable	0.00	0.28	− 1.00	1.00
Ln (1 + safeguard tariff)	0.00	0.02	0.00	0.26
Line pipe and wire rod safeguard Dummy variable	0.00	0.05	0.00	1.00

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.

A.8. 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.

A.9. Safeguards on line pipe and wire rod (independent variable)

Safeguards remedies on line pipe and wire rod were put into place in the U.S. on all import sources (except Mexico and Canada) from March 2000 to March 2003. Because these trade remedies were in the form of tariff-rate quotas (not simple ad valorem tariffs), we proxy for their effects with a dummy variable.

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