Antidumping Policy under Imperfect Competition: Theory and Evidence

Meredith A. Crowley*
Federal Reserve Bank of Chicago
mcrowley@frbchi.org

First version: December 30, 2001
This version:

January 30, 2004

Abstract

In this paper, I develop and test a model of dumping among imperfectly competitive firms in different countries that face stochastic demand. In the theoretical model, I show that foreign firms dump when they face weak demand in their own markets. I then show that an antidumping duty can improve an importing country's welfare by shifting some of the dumping firm's rents to the home country. I test this model using data on US antidumping cases from 1979 to 1996. Empirically, I find strong evidence that the US government is more likely to impose protection when demand in foreign countries is weak. After controlling for injury to the domestic industry and the strength of US aggregate demand, I find that reducing foreign aggregate demand two standard deviations below its trend increases the probability of protection by 2.8-3.4%.

JEL Codes: F12, F13

*I thank Bob Staiger, Scott Taylor and Yuichi Kitamura for detailed comments and encouragement. I also thank Bob Baldwin, Chad Bown, Eric French, Limor Golan and seminar participants at the University of Wisconsin-Madison, the Federal Reserve Bank of Chicago, Purdue University, the Federal Reserve Board of Governors, the Bureau of Labor Statistics, and the Midwest International Economics Group Spring 2002 Meetings. The views expressed here are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Chicago or the Federal Reserve System.

1 Introduction

Over the last twenty years, antidumping policy has emerged as a significant trade impediment in the developed world. Between 1980 and 2002, US industries filed 1005 requests for antidumping protection. European industries filed 632 petitions for antidumping protection between 1980 and 1997. While not all petitions result in antidumping duties, their success rate is generally high. In June 2002, the US had 256 antidumping duties in place while the EU had 171. Less transparent outcomes of antidumping investigations, like price undertakings and suspension agreements, constitute an additional barrier to trade. The use of antidumping policy is clearly having an effect on trade in the developed world. Moreover, since the establishment of the WTO in 1995, antidumping policy has been growing in popularity among developing countries: South Africa had 98 antidumping duties in place in June 2002, Mexico had 60 and Brazil had 47.

The question that has perplexed economists is: why do governments pursue antidumping policies? Dumping, or pricing below average cost, lowers import prices and, thus, improves an importing country's welfare. In this paper, I offer a new rationale for governments' use of antidumping policy in imperfectly competitive markets. I show that governments can use antidumping policy in imperfectly competitive markets to improve domestic welfare. In this paper, I introduce capacity constraints and demand uncertainty into a model of imperfect competition to explain why firms dump. I then show that an antidumping duty can improve the importing country's welfare by shifting rents from a foreign firm to the home country. Although dumping by foreign firms improves domestic welfare, the domestic government can further improve welfare by instituting an antidumping duty equal to the margin of dumping. Thus, the first contribution of this paper is that it provides a welfare rationale for antidumping law.

The paper's second contribution is that it presents an empirical analysis of the theoretical model. I test the theory by estimating the US government's decision rule of whether or not to impose antidumping protection. Using data on US antidumping cases filed against 18 industrialized countries between 1979 and 1996, I find strong support for the hypothesis that importing countries use antidumping policy to protect against dumping associated with weak foreign demand. After controlling for injury to the domestic industry and the strength of US aggregate demand, I find that reducing foreign aggregate demand growth two standard deviations below its trend increases the probability of protection by 2.8-3.4%.

Economists have tried to explain the phenomenon of dumping and the government's policy response in terms of the different modes of competition in the markets for dumped goods. Several papers (Ethier, 1982; Anderson, 1992; Staiger and Wolak, 1992; and Clarida, 1993) explain dumping in the context of competitive markets. This paper contributes to the theoretical literature that focuses on dumping in imperfectly competitive markets (Dixit, 1988; Gruenspecht, 1988; Prusa, 1992; Reitzes, 1993; and Blonigen and Park, 2001) and the empirical literature that examines the determinants of antidumping protection (Hansen, 1990; Moore, 1992; Baldwin and Steagall, 1994; Staiger and Wolak, 1994; Hansen and Prusa, 1996, 1997; and Knetter and Prusa, 2000).

The theoretical model developed in this paper provides a welfare rationale for antidumping policy[1] that can be tested empirically. Moreover, unlike previous models of dumping under imperfect competition, the model in this paper captures three important features of dumping and antidumping policy. First, the majority of antidumping cases in the US and EU rely on a definition of dumping as pricing below average cost.[2] Second, many foreign firms choose to dump when they face antidumping duties rather than raise their prices in order to eliminate the duty.[3] Third, antidumping duties are applied on a country-specific basis. Although many investigations of dumping involve allegations against several countries, the importing country's government frequently imposes antidumping duties on only a subset of accused countries.

The novel theoretical model developed here introduces Staiger and Wolak's (1992) idea of weak foreign demand as the driving force behind dumping into a model of imperfect quantity competition with segmented markets (Brander and Spencer, 1984). Because antidumping duties are applied on a country-specific basis, the theoretical model must include at least three countries, one importing country and two exporting countries. In this paper, the firms in the three countries play a two-stage game in which they install capacity in the first stage and produce and sell their output in the second stage. When firms must install capacity before they learn the state of demand in exporting countries, a negative demand shock in an exporting country creates a situation in the importing country's market that looks like dumping, i.e. an import surge and pricing below average cost by

[1] This contrasts with Dixit (1988) who was the first to show that antidumping policy is welfare-reducing in a model of oligopolistic competition. Gruenspecht (1988) and Reitzes (1993) find that antidumping policy can be welfare-improving in dynamic models of imperfect competition.

[2] Gruenspecht (1988) utilizes this definition of dumping, but his model can only be applied to industries in which learning-by-doing is important. Reitzes' (1993) model defines dumping as international price discrimination.

[3] Because an exporting firm has the power to reduce or eliminate its own duty by restricting its own exports, many papers (Prusa, 1992; Reitzes, 1993; Blonigen and Park, 2001) conclude that an exporting firm will cease dumping to avoid an antidumping duty.

the firm in the exporting country. In the face of country-specific dumping, the welfare-maximizing tariff policy is a targeted increase in the tariff against the firm that is dumping and a decrease in the tariff against firms that are not dumping. This tariff policy reduces the flow of imports and shifts rents from the dumping firm to the importing country. I then show that the antidumping policy specified in US and GATT law, setting the antidumping duty equal to the margin of dumping, improves an importing country's welfare relative to free trade.

The empirical novelty of this paper is that it examines whether or not country-specific foreign economic shocks are an important determinant of a government's decision to impose an antidumping duty. The empirical literature on antidumping protection largely focuses on the domestic political and economic factors that lead firms to seek protection (Staiger and Wolak, 1994; Knetter and Prusa, 2000) and that the government considers in deciding whether or not to protect and industry (Hansen, 1990; Moore, 1992; Baldwin and Steagall, 1994; and Hansen and Prusa, 1996, 1997). Knetter and Prusa (2000), which estimates a Poisson model of domestic firms' antidumping petitions, is unique in this literature in that it examines the importance of foreign economic factors. However, Knetter and Prusa's approach differs from this paper in two respects. First, their empirical work addresses the question, "what leads domestic firms to seek protection?" whereas this paper addresses the question, "what leads a domestic government to impose protection?" Understanding the answer to my question is a necessary first-step that policy reformers must take before they can attempt to change the WTO's antidumping code. Second, Knetter and Prusa examine how world GDP growth, rather than a specific country's GDP growth, affects filing decisions. Because antidumping duties are country-specific, my paper attempts to discover why certain countries are most likely to be targeted than others.

Section 2 outlines the model. Section 3 analyzes the government's tariff response to dumping. Section 4 presents the empirical model. Section 5 describes the data. Section 6 presents the empirical results and section 7 concludes.

2 The Model

In this section, I describe the two stage game played by three firms in three different countries and show how a negative demand shock in one country causes dumping.[4] In the first stage, all three firms simultaneously install capacity before they know the state of demand in each market. Then, before the second stage begins, the firms learn the state of demand. In the second stage, the firms simultaneously choose the amount of output to sell in each market. Intuitively, because installing capacity is costly, the average cost of production always exceeds the marginal cost. If realized demand in an exporting country is sufficiently weak, the price in the importing country's market will be above marginal cost but below average cost. This satisfies the legal definition of dumping[5] and, empirically, is the most frequently used definition.[6]

2.1 The game with stochastic foreign demand

There are three countries in the world, two foreign countries (denoted a and b) and one domestic country (called home). By assuming there is one firm in each country, markets are segmented, and the goods produced in each country are perfect substitutes, I can tie-down the country-specific volume of trade and simplify analysis of the strategic behavior of firms. To further simplify the analysis, I assume the home market is open to imports, but both foreign markets are closed. Let q denote the home firm's output, q^i denote the output that the firm in foreign country $i = a, b$ sells in its own market, and M^i denote imports from firm i into the home country, i.e. output sold by the firm in country i in the home country's market. See figure 1 for a diagram of trade flows.

Inverse demand in the home country is given by $p(q, M^a, M^b)$ and demand in each foreign country i is given by $p^i(q^i)$. In order to derive a precise analytic relationship between the magnitude

[4]Dumping could occur for a variety of reasons, for example, because of uncertainty or changes in demand, technology, or endowments. Because my interest lies in explaining antidumping policy, which is a response to an unexpected import-surge, I ignore endowment shocks as these are likely to occur gradually and involve predictable changes in import volumes. I ignore domestic demand shocks because, in a segmented markets model, it is unlikely that a foreign firm would dump in the face of either a positive or negative demand shock in an importing country. Finally, uncertainty or changes in technology are addressed in Gruenspecht (1988), Clarida (1993), and Crowley (2002).

[5]Under the Trade Act of 1979 and the GATT of 1994, the legal definition of dumping requires the US DOC to define "fair value" as the price of the good in the firm's home market. If no home market price is available, the DOC is instructed to use the price of the good in third country markets. Finally, if no third country price is available, the DOC must construct "fair value" as the foreign firm's average cost of production.

[6]Because home market and third market prices can be thrown out in favor of a price based on "constructed cost" if it can be shown that the home market and third market prices don't provide a full recovery of costs plus a "reasonable" profit, the majority of antidumping cases in the US and the EU rely on a pricing below average cost definition of dumping (Clarida, 1996; Macrory, 1989; and Messerlin, 1989).

of the foreign demand shock and the antidumping duty, I assume that inverse demand in the home country is linear, $p(q, M^a, M^b) = a - (q + M^a + M^b)$[7] and that inverse demand in each foreign country i is linear, $p^i(q^i) = a^i - q^i$. Because I am interested in analyzing the country-specificity of the government's antidumping policy, I assume demand in one foreign country is stochastic and demand in the other foreign country and in the home country is deterministic. Without loss of generality, suppose demand in country a is stochastic, $p^a(q^a) = a^a - q^a$ where a^a is an iid random variable.

In order to focus on dumping by the firm in country a, I place restrictions on the distribution of a^a such that, in the subgame perfect equilibrium, firm a dumps in the home country's market in response to a negative demand shock in country a. I analyze the game under a symmetric discrete distribution in which a^a takes on three values, low ($\underline{a}^a$), normal (Ea^a), and high ($\bar{a}^a$). I require that the size of a negative demand shock falls within the range $\underline{s} < \underline{a}^a < \bar{s}$.[8] This ensures that every negative demand shock in country a is large enough to lead firm a to sell its output at a price below its long-run-average-cost of production and ensures that the negative demand shock is not so large that firm a holds excess capacity.

Let k denote the home firm's capacity and let k^i denote the capacity of the firm in country i. The cost of installing one unit of capacity is θ where $\theta > 0$. Therefore, the total cost of building a plant with capacity k (k^i) is given by $c(k, \theta) = \theta k$ ($c(k^i, \theta) = \theta k^i$). Each unit of capacity can be used to produce one unit of output. Thus, after installing capacity, the home firm can produce any quantity q up to the capacity level k and the firm in country i can produce any quantity $q^i + M^i$ up to the capacity level k^i. The marginal cost of production is constant and, for simplicity, is normalized to zero.

The timing of the game is as follows.

1. In the first stage, the home firm and the foreign firms simultaneously choose capacities k, k^a and k^b.

   After capacity has been installed, all firms learn the state of demand in foreign country a.

2. In the second stage, the three firms simultaneously choose output. The home firm chooses an amount of output to sell on the home market, q, given its level of installed capacity, k, and

[7] More generally, my results about the desirability of an antidumping policy will depend on the convexity of demand. The critical condition will be that the marginal revenue curve be steeper than the inverse demand curve.

[8] $\underline{s} = Ea^a - \frac{5}{2}\theta$ and $\bar{s} = Ea^a - \frac{5}{4}(a - \theta)$.

the import-sales of the foreign firms. Each foreign firm i chooses the amount of output it will sell in its own market q^i and in the home market M^i given its capacity k^i, the output of the home firm (q), the import-sales of foreign firm $j \neq i$ (M^j), and for firm a the realization of demand in its own market a^a.

2.1.1 The Subgame Perfect Nash Equilibrium

In this section and sections 2.1.2 and 2.1.3, I characterize the subgame perfect Nash equilibrium of the game with foreign demand uncertainty. The subgame perfect equilibrium strategies for sales in the home country's market in the second-stage of the game are as follows.

$$
\begin{aligned}
q^* &= \frac{1}{4}(a-\theta) && (1)\\
M^{a*} &= \frac{1}{4}(a-\theta) + \frac{4}{15}(Ea^a - a^a) && (2)\\
M^{b*} &= \frac{1}{4}(a-\theta) - \frac{1}{15}(Ea^a - a^a) && (3)
\end{aligned}
$$

where * denotes an equilibrium quantity.

The subgame perfect equilibrium capacity choices in the first-stage of the game are:

$$
\begin{aligned}
k^* &= \frac{1}{4}(a-\theta) && (4)\\
k^{i*} &= \frac{1}{4}(a-\theta) + \frac{1}{2}(Ea^i - \theta) \text{ for } i = a, b && (5)
\end{aligned}
$$

In the next two subsections, I show that this is the unique subgame perfect Nash equilibrium of the game. To show that equations (1) through (5) constitute a subgame perfect Nash equilibrium, I proceed first to show that the stage two sales are part of a Nash equilibrium.

2.1.2 Output and sales in stage two

Working backwards, I first consider the home firm's problem in the second stage of the game for arbitrary capacity levels, k and k^i. Under the simplifying normalization that the marginal cost of production is zero, the home firm chooses to produce and sell output q to maximize total revenue subject to the constraint that output cannot exceed the firm's total capacity k. The home firm's total revenue depends on the foreign demand parameters only through the effect foreign demand shocks have on the foreign firms' import-sales functions.

$$\max_q TR = p\big(q, M^a, M^b\big)q \tag{6}$$

subject to $q \leq k$.

Taking first order conditions yields the home firm's second-stage best response to its opponents' import-sales for an arbitrary k.

$$q(M^a, M^b; k) = \min\{k, \frac{a - M^a - M^b}{2}\} \tag{7}$$

The home firm's best-response function is kinked. The first term within the brackets in (7) is the home firm's best response when its capacity constraint binds; the second term is its best response when its capacity constraint does not bind. See the top panel of figure 2 for a graph of the home firm's best-response function. When the home firm's capacity constraint binds, it cannot produce more than its installed capacity k. On the other hand, when the home firm's capacity constraint does not bind, the home firm will produce and sell a quantity equal to one- half of the residual demand in the home market. Intuitively, although the marginal cost of production is zero after the home firm installs its capacity, when the foreign firms sell large quantities in the home country's market, the home firm chooses to produce less than its full capacity because an extra unit of output will drive the home market price down to the extent that an extra unit of output will reduce the home firm's total revenue.

Next, I turn to the maximization problems of the foreign firms. The problems of firm a and firm b are identical with the exception that the total revenue of foreign firm a depends directly on the random foreign demand parameter a^a through its effect on the price in country a's market. Each foreign firm i chooses a level of output to sell in its own market q^i given the state of demand in its own market (a^i). Firm i chooses a quantity to sell in the home country's market M^i to maximize its total revenue in that market given the output of the home firm, the import-sales of foreign firm j, and an arbitrary capacity level k^i. Because the total sales by foreign firm i in the markets of the home country and foreign country i cannot exceed the firm's total capacity k^i, it must allocate its total capacity k^i optimally between the two markets.

$$\max_{q^i, M^i} TR^i = p^i\big(q^i; a^i\big)q^i + p\big(q, M^i, M^j\big)M^i \tag{8}$$

subject to $q^i + M^i \leq k^i$.

Taking first order conditions yields the following best-response functions for foreign firm $i = a, b$, $i \neq j$ for an arbitrary capacity k^i. Each foreign firm maximizes total revenue by equating marginal revenue across its own market and the importing country's market.

$$q^i = \min\left\{ \left[\frac{k^i}{2} + \frac{a^i}{4} - \frac{(a - q - M^j)}{4}\right], \frac{a^i}{2} \right\} \tag{9}$$

$$M^i = \min\left\{ \left[k^i - q^i\right], \frac{a - q - M^j}{2} \right\} \tag{10}$$

The output that firm i produces for sale in its own market is given by (9). This function is kinked. The first term in (9) is the sales of firm i in the country i market when its capacity constraint binds; the second term ($\frac{a^i}{2}$) is the sales of firm i when its capacity constraint does not bind. First, note that when firm i's capacity constraint binds, it has to allocate its total output between its own market and the home country's market. Firm i allocates half of its capacity to producing for its own market. It then adjusts this figure upwards in proportion to the strength of demand in its own market and adjusts this figure downwards in proportion to the strength of the residual demand it faces in the home country's market. When firm i's capacity constraint does not bind, firm i produces the monopoly quantity for sale in its own market. Firm i's import-sales best-response function (10) is also kinked. If firm i's capacity constraint binds, it sets import-sales equal to its residual capacity. If firm i's capacity constraint does not bind, it sets import-sales equal to half of the residual demand it faces in the home country's market.

Firm i's best-response function is displayed in figure 2. The realization of demand in country a affects the residual, or export, capacity of firm a. See the middle panel of figure 2. If demand in country a is weak, firm a will allocate less capacity to producing for its own (country a) market. Weak demand in the country a market causes the capacity- constrained segment of firm a's import-sales best-response function to shift up. The lower panel of figure 3 displays the import-sales best response function of firm b.

Having solved for the second-stage best response functions for each firm as a function of arbitrary capacity levels k and k^i, I now impose the equilibrium capacity choices of all firms (4) and (5). The equilibrium capacity choices are such that capacity constraints bind for all realizations of a^a. Solving the second-stage best-response functions simultaneously, given equilibrium capacity choices, yields the subgame perfect equilibrium sales strategies in terms of the underlying cost and demand parameters (1), (2), and (3).

In the subgame perfect Nash equilibrium, the home firm produces an output equal to its entire capacity (4). This is equal to the home firm's equilibrium sales in a simultaneous Cournot game with three identical players. Firm a sets its import sales equal to sales in a simultaneous Cournot game, then increases its sales into the home country when demand in its own market is weak and decreases its sales into the home country when demand in its own market is strong. The strength of demand in country a's market also affects the equilibrium import-sales of firm b. In the face of weak demand in country a and a surge of imports from firm a, firm b reduces its import-sales to the home country. See figure 3 for a two-dimensional graph of the capacity-constrained Nash equilibrium.

2.1.3 The first-stage capacity choice

Working backwards, having solved for the equilibrium sales strategies of each firm in the second-stage of the game, I now turn to the first-stage capacity choices of the three firms. In the first stage of the game, each firm chooses a capacity to maximize expected profits.

The home firm chooses capacity k to maximize expected profits, given the equilibrium capacity choices of firm a and firm b.

$$\max_k E_{a^a} \left\{ \pi(k, k^a, k^b; a^a) \right\} \tag{11}$$

where

$$\pi(k, k^a, k^b; a^a) = p(q + M^a + M^b)q - \theta k$$

and where $q(\cdot)$ is given by (7) above, $M^i \leq k^i$ for $i = a, b$. Note that if the home firm's second stage capacity constraint were to bind, then the first stage profit function would not be differentiable at $k = a - M^a - M^b$. At this point, two observations simplify the analysis of the home firm's capacity choice problem. First, it is never a best response to install excess capacity in the first stage; the home firm's capacity constraint must bind ($k = q$). Second, for all $k > a - M^a - M^b - \theta$, profits are negative, so a capacity choice in the range of $k \geq a - M^a - M^b$ is never a best response. Thus, I restrict my attention to capacity choices $k < a - M^a - M^b$. See appendix A for proofs of these observations. Taking the derivative of (11) with respect to k over the range $k < a - M^a - M^b$ yields the following.

$$\frac{\partial E\pi}{\partial k} = a - \theta - E(M^a + M^b) - 2k \tag{12}$$

Solving (12) yields the home firm's capacity best response to the import-sales choices of the foreign firms, k^R.

$$k^R = \frac{1}{2}(a - \theta - E(M^a + M^b)) \tag{13}$$

Similarly, the capacity choice of each foreign firm k^i maximizes expected profits given the capacity choices of the home firm and foreign firm $j \neq i$.

$$\max_{k^i} E_{a^a} \left\{ \pi^i(k^i, k, k^j; a^a) \right\} \tag{14}$$

where

$$\pi^i(k^i, k, k^j; a^a) = p^i\big(q^i; a^i\big)q^i + p\big(q + M^i + M^j\big)M^i - \theta k^i$$

and where q^i and M^i are given by (9) and (10) respectively, $q \leq k$ and $M^j \leq k^j$. Again, note that if firm i's second stage capacity constraint were to bind, the first stage expected profit function would not be differentiable at $k^i = Ea^i + a - q - M^j$. As with analysis of the home firm's problem, two observations simplify the analysis of firm i's problem. First, in expectation, installing excess capacity is never a best response, firm i's capacity constraint must bind ($k^i = E(q^i + M^i)$). Second, for all $k^i > Ea^i + a - q - M^j - 2\theta$, expected profits are negative, so a capacity choice in the range of $k^i \geq Ea^i + a - q - M^j$ is never a best response. Thus, analysis of firm i's problem can be restricted to capacity levels $k^i < Ea^i + a - q - M^j$. The proofs of these observations are similar to those in appendix A. Taking the derivative of (14) with respect to k^i for $k^i < Ea^i + a - q - M^j$ yields:

$$\frac{\partial E\pi^i}{\partial k^i} = \frac{1}{2}(Ea^i - \theta) + \frac{1}{2}(a - \theta - E(q + M^j)) - k^i \tag{15}$$

Solving (15) yields foreign firm i's capacity best response as a function of the home firm's and firm j's second-stage sales.

$$k^{iR} = \frac{1}{2}(Ea^i - \theta) + \frac{1}{2}(a - \theta - E(q + M^j)) \tag{16}$$

Because the cost of capacity installation is strictly positive for all firms ($\theta > 0$) and by the restrictions on $\underline{a}^a$, the capacity best response functions (13) and (16) imply that the firms' capacity constraints will bind in the second-stage of the game. Thus, solving (13) and (16) simultaneously yields the subgame perfect Nash equilibrium capacity choices of the home firm and the foreign firms (4) and (5). Firm i's capacity choice (5) consists of two components. The first component is the portion of capacity that the firm installs to produce output for sale in its own market. The second component is the portion of capacity the firm installs to produce output for the home country's market.

The results from this section can be summarized in the following proposition.

Proposition 1 *In the unique subgame perfect equilibrium, players choose capacity levels in the first-stage such that no firm holds excess capacity in the second-stage. The equilibrium strategies in the game are given by* (1) *through* (5).

Having described the equilibrium strategies in the capacity and sales game, I now turn to the effect of a negative foreign demand shock on the home country.

Proposition 2 *Dumping and Injury. A negative demand shock in country a leads firm a to increase its exports to the home country and to sell its exports in the home country's market at a "dumped" price which is below its long run average cost of production. Further, the sale of "dumped" goods causes injury to the home country's firm by reducing its profits and market share.*

Proof: From equilibrium import-sales (2), firm a's exports increase when $a^a = \underline{a}^a$. Recall "dumping" is selling in the home country's market at a price below one's long run average cost of production, i.e., $p(q, M^a, M^b) < LRAC^a$. Substituting in the equilibrium sales functions of all three firms and the per-unit capacity installation cost of θ yields the following condition for dumping, $a^a \leq Ea^a - \frac{5}{4}(a-\theta) = \bar{s}$. Having defined a negative demand shock in section 2.1 as $a^a \leq \bar{s}$, it follows that all negative foreign demand shocks result in dumping. Intuitively, after capacities have been installed, firms sell their output at zero marginal cost. When firm a experiences a negative demand shock, it maximizes its total revenue by equating marginal revenue across all markets. This means it must shift some sales to the importing country. Although this increase in sales causes the price in the importing country to fall below firm a's long run average cost, the price remains above the marginal cost of production.

I define the market share of the home firm as the fraction of its sales in its own market $MS = \frac{q}{q+M^a+M^b}$. Substituting in the equilibrium sales of each firm yields market share as a function of the realized value of foreign demand a^a. Taking the derivative of market share with respect to a^a yields $\frac{\partial MS}{\partial a^a} = \frac{20(a-\theta)}{[15(a-\theta)+4(Ea^a-a^a]^2} > 0$. Thus, a negative demand shock in foreign country a implies a fall in the home firm's market share. Finally, for all $\underline{a}^a$, the home firm's capacity constraint binds in the second-stage of the game so that $q = k$. With no change in output and a fall in the home market price, the profits of the home firm fall. QED.

Proposition 3 *Dumping and welfare. Dumping by the firm in country a improves the welfare of the importing country.*

Proof: Define welfare of the importing country after capacity has been installed as the sum of consumer's surplus and the home firm's profits in the second-stage ($W = CS(q, M^a, M^b; a^a) + TR(q, M^a, M^b; a^a)$). Taking the derivative of welfare with respect to country's a demand parameter a^a yields $\frac{dW}{da^a} = \frac{-1}{5}[\frac{1}{2}(a-\theta) + \frac{1}{5}(Ea^a - a^a)] < 0$ for all negative foreign demand shocks ($a^a < Ea^a$). Thus, as the size of a negative demand shock, and hence, the margin of dumping increases, the home country's welfare improves. QED.

This result is consistent with earlier findings like Dixit (1988). Because dumping is simply a terms of trade improvement from the perspective of the importing country, it improves welfare. However, this paper deviates from the previous literature by showing that although dumping itself improves welfare, an antidumping duty can improve welfare even more. The next two subsections examine tariff policy responses to dumping and the welfare consequences of these tariff policies.

3 Policy Interventions

Having shown in section 2 that a negative foreign demand shock leads to dumping that injures the domestic firm, I now turn to the problem of government intervention. In section 3.1, I solve for the government's welfare-maximizing tariff policy in the face of dumping caused by weak demand in a foreign market. In section 3.2, I analyze the welfare properties of the antidumping duty that is allowed under US and GATT law - a duty equal to the margin of dumping. I show that this policy improves welfare relative to free trade.

3.1 An optimal contingent tariff

Building on the game from the previous section, I now allow the government to announce its tariff policy before firms install capacity. The government chooses a contingent tariff schedule whereby the tariff imposed against each country depends on the realized state of demand in country a, $\tau^i(a^a)$. That is, the tariff is not dependent on the pricing policy of the foreign firm. Rather than define the tariff in terms of the degree of dumping, the government chooses an optimal rent-shifting tariff given the foreign firm's export supply under weak demand. To solve for the government's contingent tariff schedule, I work backwards. I begin by presenting the firms' equilibrium strategies in the presence of a tariff in equations (17) through (21). Then, I work backwards through the firms' problems to show that these strategies constitute an equilibrium. Finally, I turn to the government's problem.

When firms face import tariffs, the subgame perfect Nash equilibrium strategies for sales in the home country's market in the second-stage are:

$$\begin{aligned}
q^* &= \frac{1}{4}(a - \theta + E\tau^a + E\tau^b) && (17)\\
M^{a*} &= \frac{1}{4}(a - \theta) + \frac{4}{15}(Ea^a - a^a) - \frac{4}{15}\tau^a + \frac{1}{15}\tau^b - \frac{3}{10}E\tau^a && (18)\\
M^{b*} &= \frac{1}{4}(a - \theta) - \frac{1}{15}(Ea^a - a^a) - \frac{4}{15}\tau^b + \frac{1}{15}\tau^a - \frac{3}{10}E\tau^b && (19)
\end{aligned}$$

and the subgame perfect Nash equilibrium capacity choices in the first stage are:

$$k^* = \frac{1}{4}(a - \theta + E\tau^a + E\tau^b) \tag{20}$$

$$k^{i*} = \frac{1}{2}(Ea^i - \theta) + \frac{1}{4}(a - \theta + E\tau^j - 3E\tau^i) \tag{21}$$

Recall that in the second stage of the game in which firms choose sales, the home firm's problem is given by (6) in section 2.1.2. However, when faced with a tariff, each foreign firm's problem is now to maximize total revenue less the realized cost of the tariff.

$$\max_{q^i, M^i} TR^i = p^i(q^i; a^i)q^i + p(q, M^i, M^j)M^i - \tau^i(a^a)M^i \tag{22}$$

Taking the first order condition and solving yields foreign firm i's best response import-sales function.

$$M^i = \min\left\{ \left[\frac{k^i}{2} - \frac{a^i}{4} + \frac{(a - q - M^j - \tau^i)}{4}\right], \frac{a - q - M^j - \tau^i}{2} \right\} \tag{23}$$

Comparing firm i's best- response function in the presence of a tariff (23) to its best-response function under free trade (10), we see that the tariff causes firm i's best-response function to shift in.

Having solved for the best response functions of the home firm (7) and the foreign firms (23) for arbitrary capacity levels, I now impose the equilibrium capacity choices of all firms. Solving (7) and (23) simultaneously, given equilibrium capacity choices (20) and (21), yields the Nash equilibrium sales in the second stage of a game under country-specific tariffs (17), (18), and (19). Comparing the Nash equilibrium sales of a foreign firm in the presence of a tariff (18) and (19) to sales under free trade (2) and (3), we see that the foreign firms reduce their sales to the home market as the tariff increases.

In stage one of the game, the home firm and the foreign firms know the government's contingent tariff schedule. However, because the tariff is conditional on the realization of foreign demand, they must install capacity in the presence of tariff as well as demand uncertainty. The home firm's maximization problem is identical to that in the absence of any tariff policy (11), but now the foreign firms' equilibrium capacity choices (21) reflect the cost of the tariff. Solving the home firm's maximization problem given the foreign firms' equilibrium capacities yields the home firm's equilibrium capacity (20). The problem of foreign firm i is to choose a capacity level k^i as in section 2.1.3, but now the distribution of tariffs for country i ($\tau^i(a^a)$) represents an additional cost that the foreign firm must take into account.

$$\max_{k^i} E_{a^A}\left\{\pi^i(k^i, k, k^j; a^a)\right\} \tag{24}$$

where

$$\pi^i[k^i, k, k^j; a^a] = p^i\big(q^i; a^i\big)q^i + p\big(q + M^i + M^j\big)M^i - \tau^i(a^a)M^i - \theta k^i$$

Similar to the case of free trade, it is never a best response for firm i to choose a capacity level $k^i > Ea^i + a - q - M^j - 2\theta - E\tau^i$ because expected profits are negative for capacity choices in this range. Thus, I restrict my analysis to capacity choices in the range $0 \leq k^i \leq Ea^i + a - q - M^j - 2\theta - E\tau^i$. Taking the first order condition of (24) with respect to k^i over this range and solving yields firm i's Nash equilibrium capacity choice (21), given the equilibrium capacity choices of the other firms. The increase in the cost of selling in the home market places the foreign firms at a cost disadvantage relative to the home firm and leads them to reduce their capacities. The home firm takes advantage of the reduction in foreign capacities induced by the tariff and increases its capacity relative to the level under free trade. So, as in Staiger and Wolak (1992), the presence of an antidumping policy reduces the foreign firm's exports to the home market even when an antidumping duty is not imposed.

Continuing to work backwards, I now solve for the government's welfare-maximizing tariff schedules $\tau^a(a^a)$ and $\tau^b(a^a)$. The government's problem is to choose these tariff schedules to maximize social welfare, the sum of consumer's surplus, producer's surplus and tariff revenue.

$$\max_{\tau^a, \tau^b} CS\left[q, M^a, M^b, k\right] + \pi\left[q, M^a, M^b\right] + \tau^a M^a + \tau^b M^b \tag{25}$$

Taking the first order conditions with respect to τ^i for $i = a, b$ and solving simultaneously yields the government's contingent tariff schedule for imports from each country.

$$\tau^a = \frac{3}{14}(a-\theta) + \frac{1}{15}\left(Ea^a - a^a\right) \tag{26}$$

$$\tau^b = \frac{3}{14}(a-\theta) - \frac{1}{15}\left(Ea^a - a^a\right) \tag{27}$$

In the event of a negative demand shock in a foreign market ($a^a = \underline{a}^a$), the welfare-maximizing tariff against country a rises; the government wants to increase the optimal tariff for rent-shifting reasons. As demand in country a weakens (a^a falls), the import-sales capacity of firm a increases. Although the increase in output sold in the home market causes the price to fall, as long as the capacity constraints of all three firms bind, the increase in import-sales by firm a will increase firm a's total revenue. The government can capture some of firm a's increased revenue with an increase in its tariff.

Summarizing the above results yields the following proposition.

Proposition 4 *The home government's welfare-maximizing response to a negative foreign demand shock in one country is a temporary increase in its optimal rent-shifting tariff against imports from that country. This tariff resembles an antidumping duty in that it increases when dumping occurs, it is country-specific, and it persists for the length of the foreign demand shock.*

3.2 An antidumping duty

In this section, I examine the welfare properties of an antidumping duty whose magnitude is equal to the margin of dumping. Having shown in the previous section that a tariff policy will cause foreign firms to install less capacity and will cause the home firm to install more capacity, I simplify my analysis of welfare in this section by assuming that the government announces its antidumping policy after capacity has been installed.

The timing of the game is as follows.

1. In the first stage, the home firm and the foreign firms do not anticipate the government's antidumping policy announcement and simultaneously choose capacities k, k^a, and k^b.

2. The government surprises the firms by announcing its antidumping policy, τ^{ADi}.

After capacity has been installed and firms learn of the government's antidumping policy, the state of demand in country a is realized.

3. In the final stage, the firms simultaneously chooses sales for each market given the government's antidumping policy and the state of demand in country a.

In equilibrium, because the firms do not anticipate that the government will institute an antidumping policy, the problem they face in the first stage of the game is identical to that in section 2.1 and the firms will install the capacities given by (4) and (5).

I define the government's antidumping policy as a country-specific retroactive tariff subject to administrative review.[9] If a firm in country i is found (1) to have increased its imports into the home country, (2) to be selling its imports at a price below long-run-average-cost, and (3) to be causing injury to the import-competing firm, it faces the following antidumping duty.

$$\tau^{ADi} = \max\{0, LRAC^i - p(q + M^a + M^b)\} \tag{28}$$

Because the cost of installing a unit of capacity is θ and the marginal cost of production is normalized to zero, the long-run-average-cost of production is simply θ. Each foreign firm knows that it will have to pay a tariff of this form if it dumps, but under administrative review the actual dumping margin is calculated after its imports have entered the country. Thus, each foreign firm can increase or decrease its own antidumping duty according to its choice of imports, M^i.

In the last stage of the game, the home firm's problem is given by (6) and its best response function is given by (7). The problem of each foreign firm is given by (22) where τ^i is now given by (28) above. The best response functions of the foreign firms are given by (23).

In equilibrium, the capacity constraints of all three firms will bind and the firm in country b will not dump, according to the government's definition of dumping as selling *increased* imports at a price below long run average cost. Thus, the antidumping duty against imports from country

[9] Under US and GATT law, the magnitude of an antidumping duty is equal to the margin of dumping. Most often, this is the difference between the average cost of production and the price in the importing country's market. Further, under the US's administrative review process, antidumping duties are retroactively determined by the behavior of the foreign exporting firm. Specifically, if an antidumping order is in effect, an estimated antidumping duty is paid at the time the goods enter the country. At the end of one year, the government conducts an administrative review in which it assesses the actual dumping margin for the previous twelve months and collects or returns any difference plus interest between the estimated and actual duty.

b will always be set at zero. The equilibrium second-stage sales as a function of the antidumping duty imposed on imports from country a are as follows.

$$q^* = \frac{1}{4}(a-\theta) \tag{29}$$

$$M^{a*} = \frac{1}{4}(a-\theta) + \frac{4}{15}(Ea^a - a^a) - \frac{4}{15}\tau^{AD,a} \tag{30}$$

$$M^{a*} = \frac{1}{4}(a-\theta) - \frac{1}{15}(Ea^a - a^a) + \frac{1}{15}\tau^{AD,a} \tag{31}$$

Substituting the equilibrium second-stage sales (29), (30), and (31) into the definition of the government's antidumping duty (28), yields the following expression for the equilibrium antidumping duty.

$$\tau^{AD,a} = \max\{0, \frac{1}{6}(Ea^a - a^a) - \frac{5}{24}(a-\theta)\} \tag{32}$$

The antidumping duty will be greater than zero whenever the firm in country A faces a sufficiently large negative demand shock ($\underline{a}^a \leq \bar{s}$). Direct calculation shows us that whenever a negative demand shock is large enough to result in dumping (i.e., $\underline{a}^a \leq \bar{s}$), the profit-maximizing strategy of firm a will be to dump. See figure 4 for a graphical explanation of this.

The left graph of figure 4 presents the residual demand curve firm a faces in the importing country's market. The right graph presents the demand firm a faces in its own market. Prices are on the y-axes and quantities are on the x-axes. In the presence of an antidumping duty that increases with the margin of dumping, the firm in country a faces a kinked residual demand curve (the kinked bold line beginning at a in the left graph). Thus, its residual marginal revenue curve is a piecewise function (the thin line in the left graph with a break at $M(ver)$) with a gap at the import-sales quantity at which price is equal to long run average cost. In its own market, firm a faces "normal demand" (the bold line beginning at $E(a^a)$) when realized demand takes its expected value and "weak demand" (the bold line beginning at $\underline{a}^a$) when realized demand is low. The thin horizontal line, LRAC, represents the long run average cost of production, which with zero marginal cost, is equal to the cost of capacity installation, θ. At the time firm a makes its capacity installation decision, it chooses to install capacity $k^a = M^a(Ea^a) + q^a(Ea^a)$. $M^a(Ea^a)$ and $q^a(Ea^a)$ are the quantities that equate the expected marginal revenue in each market to the cost of capacity installation. Recall that the cost of capacity installation is a sunk cost incurred in the first stage of the game and that the marginal cost of production is zero. As a result, when a negative demand shock occurs, in the second-stage of the game the firm chooses a quantity for each market ($M^a(\underline{a}^a)$ and $q^a(\underline{a}^a)$) such that its capacity constraint binds and the marginal revenue across the two markets is equal and is greater than zero. Graphically, this implies that imports rise relative to their "normal" level ($M^a(\underline{a}^a) > M(Ea^a)$) and that the price in the home market falls below the long run average cost of production.

An important question to ask is: if a foreign firm faces an antidumping duty equal to the margin of dumping, would it prefer to dump and to pay the duty or voluntarily restrict its exports in order to avoid the duty? Interestingly, figure 4 also shows us that for negative demand shocks in the range $\underline{s} \leq \underline{a}^a \leq \bar{s}$, firm a will never voluntarily choose to restrict its imports in order to avoid the antidumping duty. When the firm dumps, although it must pay the extra cost of the tariff, it is able to equate its net marginal revenue across the two markets for an optimal allocation of output. If the firm voluntarily restricts its exports to the level which equates price with long run average cost ($M(ver)$), it ceases to equate marginal revenue in the two markets. Increased profits earned in the home country's market are more than offset by the losses in its own market. Thus, the firm can do better by dumping and paying the duty than it can by voluntarily restricting its exports. This suggests that firms that do choose to voluntarily restrict their exports may do so because they are able to find an outlet for their excess capacity in another market.

Turning to the home country's government, I next ask: does a country-specific antidumping duty equal to the dumping margin improve the home country's welfare?

Proposition 5 *An antidumping duty equal to the margin of dumping improves the home country's welfare over a policy of free trade.*

Proof: Let τ^{a*} be the optimal, country-specific, rent-shifting tariff as a function of a^a. Under the assumption that demand in the home country is linear, $W(\cdot)$ is monotonically increasing in τ^a for $0 \leq \tau^a < \tau^{a*}$. Direct calculation shows that with τ^{ADi} given by (32) and $\tau^{a*} = \frac{45}{148}(a - \theta) + \frac{17}{37}(Ea^a - a^a)$, it follows that $0 \leq \tau^{ADi} < \tau^{a*}$ for all negative demand shocks in country a ($\underline{s} \leq \underline{a}^a \leq \bar{s}$). QED.

4 Empirical Model

In the previous sections I showed theoretically that a negative foreign demand shock causes foreign firms to dump in the home country's market and that the optimal government response is to impose a tariff increase. In this section, I test this theory using data on US antidumping petitions filed between 1979 and 1996.

In this section I describe the empirical model of the relationship between the state of demand in an exporting country whose firms have been accused of dumping and the importing country's decision of whether or not to institute an antidumping duty. Following US and GATT law, the importing country's government (the US) imposes protection if it observes evidence of dumping and injury. The government's latent measure of injury and dumping d^*_{ijt} is unobserved, but takes the form $d^*_{ijt} = \beta' x_{ijt} + \varepsilon_{ijt}$ where i denotes the industry in which dumping is alleged to occur, j denotes the foreign country accused of dumping, and t denotes the time period in which the complaint is filed. The variables in x_{ijt} are described in detail in the next section. In brief, this vector includes a measure of the state of aggregate demand in both the accused foreign country and in the importing country and measures of injury to the importing country's industry. The model predicts that the probability of protection decreases as foreign aggregate demand strengthens and increases as the measures of injury increase. While the model makes no formal predictions about the relationship between the probability of protection and the state of domestic demand, I include this measure to avoid the problem of omitted variables bias. Although I do not observe the latent measure of injury and dumping, I observe the importing government's decision of whether $(d_{ijt} = 1)$or not $(d_{ijt} = 0)$ to impose antidumping protection.

$$d_{ijt} = \begin{cases} 1 & \text{if } d_{ijt} \geq d^*_{ijt} \\ 0 & \text{if } d_{ijt} < d^*_{ijt} \end{cases} \tag{33}$$

Assuming $E[\varepsilon_{ijt} | x_{ijt}] = 0$ and $\varepsilon_{ijt} \backsim N(0, \sigma^2)$, I can estimate the government decision model

$$Pr(d_{ijt} = 1) = \Phi(\beta' x_{ijt}) \tag{34}$$

where Φ is the standard normal cdf.

An antidumping case is only considered by the government if a domestic industry chooses to file a petition for protection. Some industries may be more likely to file for protection than others. For example, large industries may be better able to assume the large legal fixed cost of filing a petition. Industries in which the level of imports relative to total domestic consumption is high may be more familiar with trade protection policies and thus, more likely to file. The vertical structure of an industry may matter; industries that are further downstream may file more petitions because they are more sensitive to industry price changes. Thus, industry-specific characteristics that are unrelated to injury could affect the sample of industries that the government considers for protection. Further, industries know their own condition and may choose to file petitions when they are most likely to meet the government's injury criteria. If industry self-selection in filing petitions is important, estimates of β in (34) will be inconsistent. To address this, I take two approaches to estimating (34). First, I assume self-selection is not important and directly estimate (34) using maximum likelihood.

Second, following Heckman(1979) and Van de Ven and Van Praag (1981), I attempt to correct for self-selection by first estimating a selection model of an industry's decision to petition. The latent measure of selection, y^*_{it}, is unobserved, but takes the form $y^*_{it} = \gamma' z_{it} + \nu_{it}$, where z_{it} is a vector of industry characteristics that are predetermined at time t and a measure of injury to the industry. The error, ν_{it}, is assumed to be uncorrelated across time, but may be correlated across industries. Further, the error in the government's decision model, ε_{ijt}, and ν_{it} are assumed to be bivariate normally distributed with correlation coefficient ρ. If $\rho = 0$, then industry self-selection does not lead to inconsistent estimates of β.

The industry's decision to petition ($y_{it} = 1$) can be written

$$y_{it} = \begin{cases} 1 & \text{if } y_{it} \geq y^*_{it} \\ 0 & \text{if } y_{it} < y^*_{it} \end{cases} \tag{35}$$

and the selection model can be estimated using maximum likelihood.

$$Pr(y_{it} = 1) = \Phi(\gamma' z_{it}) \tag{36}$$

The determinants of an industry's decision to petition for protection (z_{it}) and the determinants of the government's decision to grant protection (x_{ijt}) are described in the next section.

5 Data

I estimate the empirical model using a panel dataset constructed from three different data sources: (1) the NBER Trade and Manufacturing Databases, (2) the OECD's Main Economic Indicators, and (3) the US Antidumping Database.

The NBER Trade and Manufacturing Databases provide data on imports, shipments, prices, employment, real capital stock and value added for about 450 manufacturing industries. US manufacturing imports from 1979 to 1994, disaggregated to 1972 4 digit SIC codes, came from the NBER Trade Database, disk 1. This dataset was augmented with manufacturing imports in 1987 4 digit SIC codes for 1995 and 1996 from Schott's "US Multilateral Manufacturing Imports and Exports by SIC4 (1987 revision), 1989 to 2001." All data were concorded to 1987 4 digit SIC codes using the industry concordance provided by the NBER-CES Manufacturing Industry Database. Data on US manufacturing industries from 1979 to 1996 came from the NBER-CES Manufacturing Industry Database. Nominal values of imports and shipments (a measure of domestic output) were deflated to real 1987 dollars using industry specific price indices.

Industry characteristics used to estimate the selection equation (36) include a measure of industry size, the level of employment; the real import penetration ratio (real imports/(real imports + real domestic shipments)); and a proxy for the vertical structure of an industry, the value-added to output ratio. The selection equation also includes the capacity utilization rate (real shipments/real capital stock), which is a measure of injury.[10] Because the current values of these variables and the choice of whether to petition for protection may be endogenous, I use lagged values of these variables because they are predetermined at the time of filing.

The NBER data are also used to construct measures of injury for the government's decision equation. The theoretical model predicts that import penetration should increase when dumping occurs. Because there are long-term trends in the import penetration level over time, I use the percent change in the level of import penetration as the measure of injury caused by imports. Two other measures of injury in x_{ijt} are the change in the level of employment and the level of capacity utilization.

Because the focus of the paper is to determine if foreign demand shocks are a source of dumping,

[10] In one specification, I include two additional measures of injury, the percent change in the import penetration ratio and the change in employment at time t. Inclusion of these variables in the selection equation is problematic because they are not predetermined at time t.

I use data on quarterly GDP growth from the OECD's main economic indicators for 18 industrialized countries accused of dumping to construct a measure of the strength of aggregate demand within the foreign market. The lack of high-quality GDP data for developing and non-market economies means that they must be omitted. To construct a measure of the strength of foreign demand, I use seasonally adjusted real quarterly output data for all accused countries from the OECD's Main Economic Indicators. For each country accused of dumping, I calculate the average or trend quarterly GDP growth rate from 1978 (or earliest year available for the series, if later) to 2000. I then calculate the deviation from trend growth (actual growth - trend growth) in the foreign country in the quarter an antidumping petition was filed against the country. A negative measure of this variable implies GDP growth (and, by assumption, aggregate demand) in the accused country is below its long run trend; a positive value implies GDP growth is above average. To control for the strength of US demand, I calculate the same variable using quarterly US GDP growth. Both the deviation from trend foreign GDP growth and the deviation from trend US GDP growth are included in x_{ijt}.

Data on antidumping cases from 1979 through 1995 (TA-731-001 through TA-731-739) come from the US Antidumping Database compiled by Blonigen at the University of Oregon. The US Antidumping Database provides data on all antidumping petitions filed between 1979 and 1995, the date the petition was initiated, the petitioning industry's 4 digit 1987 SIC code, the products involved and the country accused of dumping. This dataset is augmented to include cases through the end of 1996 (through case TA-731-759).[11] The final outcome in an antidumping case is affirmative (a duty is imposed) or negative (a duty is not imposed) in only about 80% of cases. The remaining 20% of cases are "suspended" or "terminated" before the government renders a decision. Previous research (Prusa, 1992; Staiger and Wolak, 1994) shows that suspensions and terminations have a trade-restricting impact similar to an antidumping duty. However, the government doesn't explicitly decide the outcome in these cases. I take two approaches to classifying suspensions and terminations. First, I assume that they are identical to antidumping duties and estimate (34) where $d_{ijt} = 1$ if the outcome is an antidumping duty, a suspension or a termination. Results under this assumption are reported in Tables 2 and 3. Second, I omit cases that ended in a suspension or termination from the sample used to estimate (34). These results are reported in Tables 4 and 5.

[11] I am indebted to Tom Prusa for providing data on the more recent antidumping cases and to Chad Bown for providing the corresponding 1987 4 digit SIC codes.

6 Empirical Results

Tables 2 and 4 report the estimates of the parameters in the model of the government's decision under industry self-selection, β, γ and ρ under the specification that utilizes all protective outcomes as the dependent variable and under the specification that only utilizes affirmative (antidumping duty) and negative (no duty) decisions. Tables 3 and 5 report the marginal effects of a one-unit increase in a covariate on the probability of protection. Using both specifications of the dependent variable, I find strong support for the hypothesis that the US uses antidumping policy to protect against dumping associated with weak foreign demand. Because the error may be correlated across industries or countries, I report robust standard errors.

Estimates from the full model of the government's decision under industry self-selection are presented in columns 3 and 4 of tables 2 and 4. Likelihood ratio tests of the hypothesis $\rho = 0$, i.e., that the selection and decision equations are independent, cannot reject the hypothesis that $\rho = 0$. Thus, it seems that ignoring industry self-selection does not lead to inconsistent estimates of β in the government's decision model. For both the estimates in table 2 that use the dependent variable of (protection, no protection) and those in table 4 that use the dependent variable of (antidumping duty, no antidumping duty), the critical $\chi^2(1)$ value at the 95% confidence level is 3.84. For all specifications of the model of the government's decision under industry self-selection, the difference in the log likelihoods of the unrestricted and restricted models is less than the critical $\chi^2(1)$ value. Lastly, note that controlling for selection does not substantially change the estimates in the government's decision equation and that all the coefficient estimates in the selection equations have the predicted sign.

Turning to the marginal effects in tables 3 and 5, recall the question of interest: "Does the state of foreign demand affect an importing government's decision to protect?" In table 3, a one unit increase in the deviation from trend GDP growth (i.e., stronger than normal growth) in the accused foreign country is associated with a decrease in the probability of a protective outcome (an antidumping duty, a suspension, or a termination) of roughly 5-7 percentage points. Given that a two standard deviation shock to foreign GDP growth is roughly 1.2%, a two standard deviation decrease in foreign GDP growth increases the probability of protection by about .16 percentage points, or 2.8% of its mean value. In table 5, a one-unit increase in the deviation of foreign GDP growth is associated with a decrease in the probability of an antidumping duty of about 6.5

percentage points. This implies a two standard deviation decrease in foreign GDP growth increases the probability of protection by about 3.4% of its mean value. Thus, having a weak economy seems to increase the probability that imports from that country will face American trade protection.

The theoretical model assumed deterministic demand in the importing country and offered no predictions about the likely sign on the variable that measures the difference between actual and trend GDP growth in the US. The empirical analysis finds a one-unit increase in this variable is associated with a 5-7 percentage point increase in the probability of protection. Therefore, a two standard deviation increase in US GDP growth increases the probability of protection by 1.6-2.4%. Somewhat surprisingly, the US government is more likely to impose protection when the US economy is relatively stronger.

The relationships between the government's decision and the different measures of injury are as expected in the specifications that use the dependent variable of (protection, no protection), but are not statistically significant in the specifications that only use affirmative and negative outcomes. In table 3, an improvement in industry employment is associated with a lower probability of protection. An increase in the percent change in import penetration, which could be interpreted as an import surge, is associated with a higher probability of protection. Surprisingly, the rate of capacity utilization is not statistically significant in any specification.

Lastly, inclusion of a country dummy for Japan improves the fit of the model. It's not clear why this is so, but it is consistent with previous research (Moore, 1992; Hansen and Prusa, 1996, 1997) that looks at the political bias against certain countries in US antidumping cases.

7 Conclusion

This paper has shown that a capacity-constrained foreign firm will sell its exports at a price below average cost in the event of a negative demand shock in its own market. In response to this, an antidumping duty can improve the importing-country's welfare. Interestingly, the antidumping duty does not completely stem the tide of dumped imports, but it improves welfare through shifting some of the dumping firm's rents to the home country. Even when faced with an antidumping duty, a foreign firm that serves more than one market will prefer an antidumping duty over a voluntary export restraint because dumping allows it to earn higher revenues in its own market.

To test the hypothesis that importing countries impose antidumping duties on dumped imports caused by weak foreign demand, I examined US antidumping cases from 1979-1996. I found strong evidence that the US government is more likely to impose antidumping protection when foreign GDP growth is weak.

While this paper demonstrates that antidumping duties could improve the welfare of an importing country, it remains a puzzle why the GATT permits the use of these import restraints. If this model were extended to include three symmetric countries, the use of antidumping policy by all three countries would reduce worldwide welfare.

Appendix A: Proofs

Proofs from section 2.1.3

Observation: $q = k$

Proof: Suppose $k = q + \epsilon$. Then $\pi = (a - (q + M^a + M^b))q - \theta(q + \epsilon)$. Then the firm can earn strictly higher profits by choosing a smaller capacity, $k = q$ and not incurring the additional installation cost, $\theta\epsilon$. Thus, installing excess capacity is never a best response and the firm will always choose a capacity level such that the capacity constraint will bind in the second stage of the game.

Observation: $k > a - M^a - M^b - \theta$ **is never a best response for the home firm**

Proof: Suppose $k > a - M^a - M^b - \theta$. Then, in the second stage, for $q = k$ or $q < k$, profits are negative, $\pi < 0$. So the firm could do better by choosing $k = 0$ or $k = a - M^a - M^b - \theta$ because both choices yield zero profits. So $k > a - M^a - M^b - \theta$ is never a best response.

Figure 1: Trade Flows in the Model

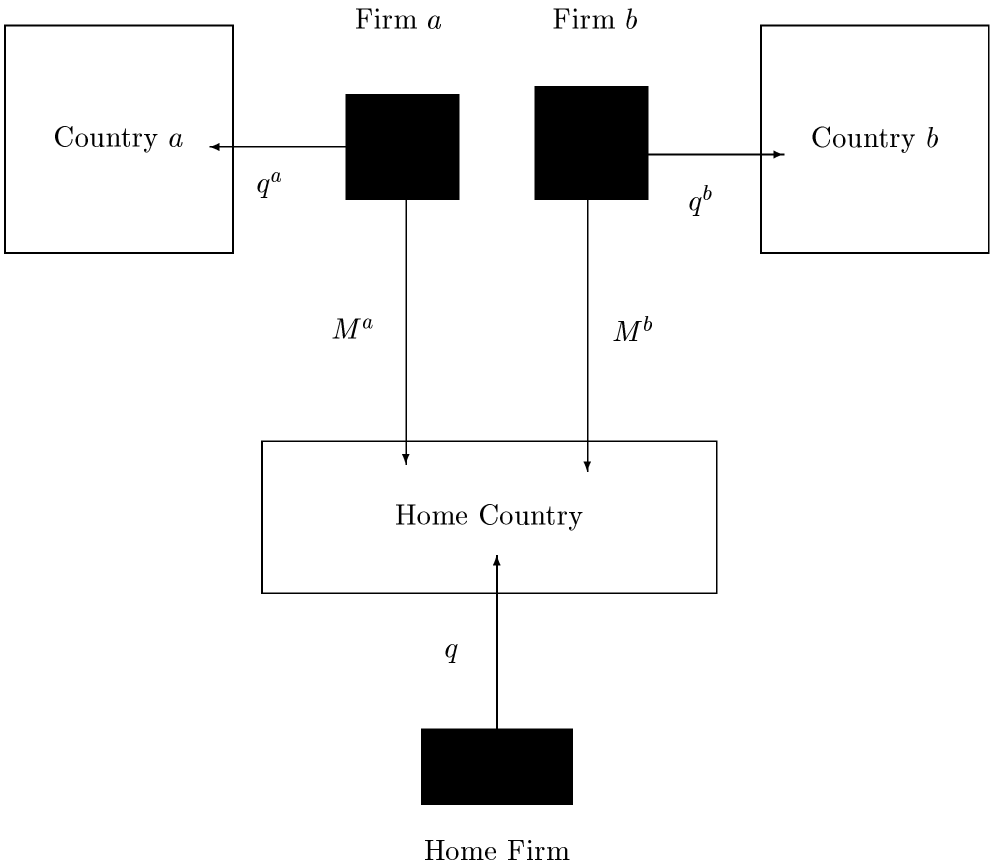


Figure 2: Sales reaction curves in the second-stage of the capacity-sales game

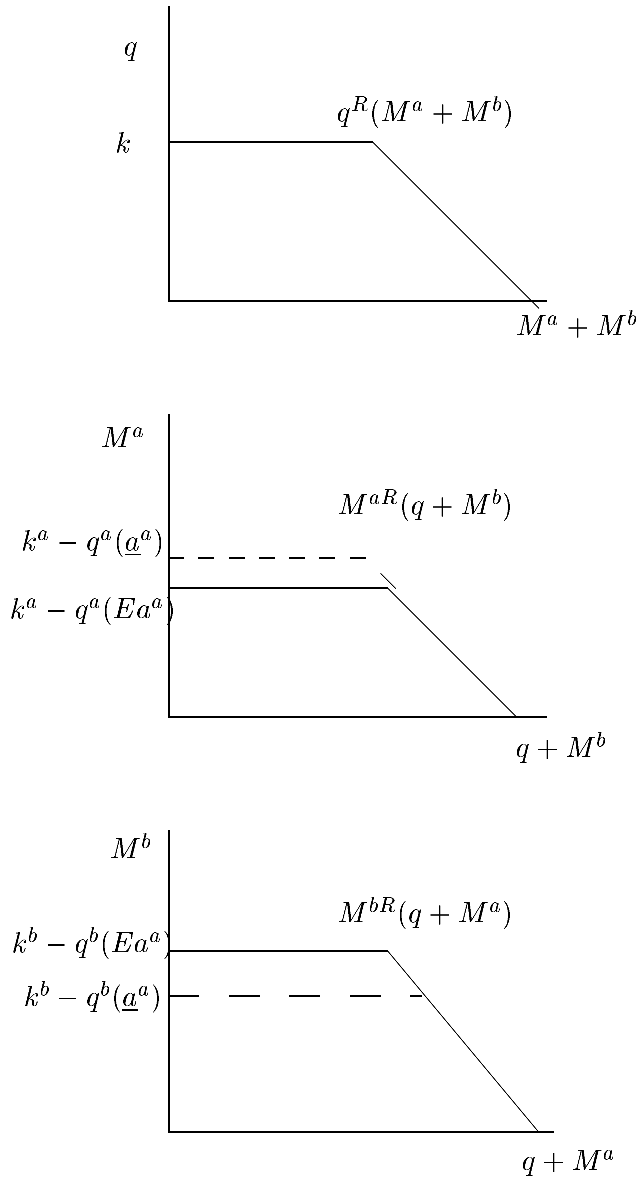
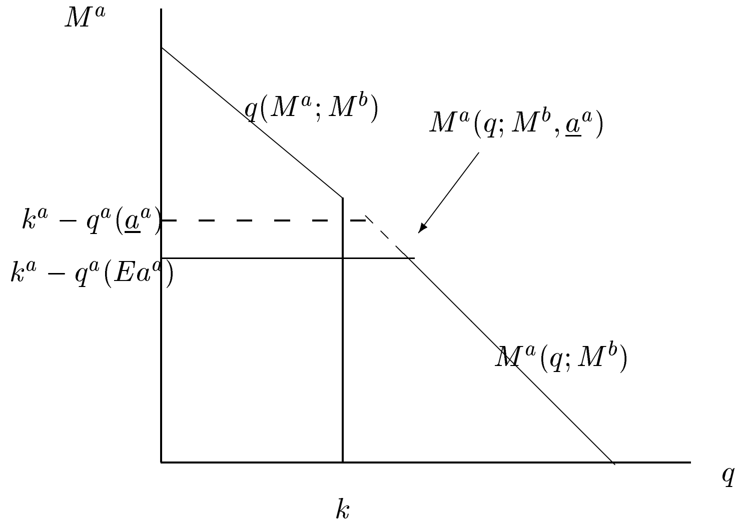


Figure 3: Nash equilibrium sales in the second-stage of the capacity-sales game



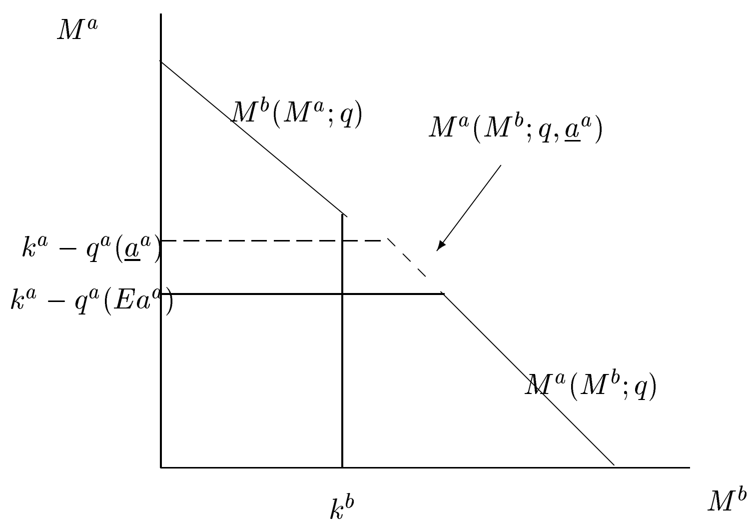
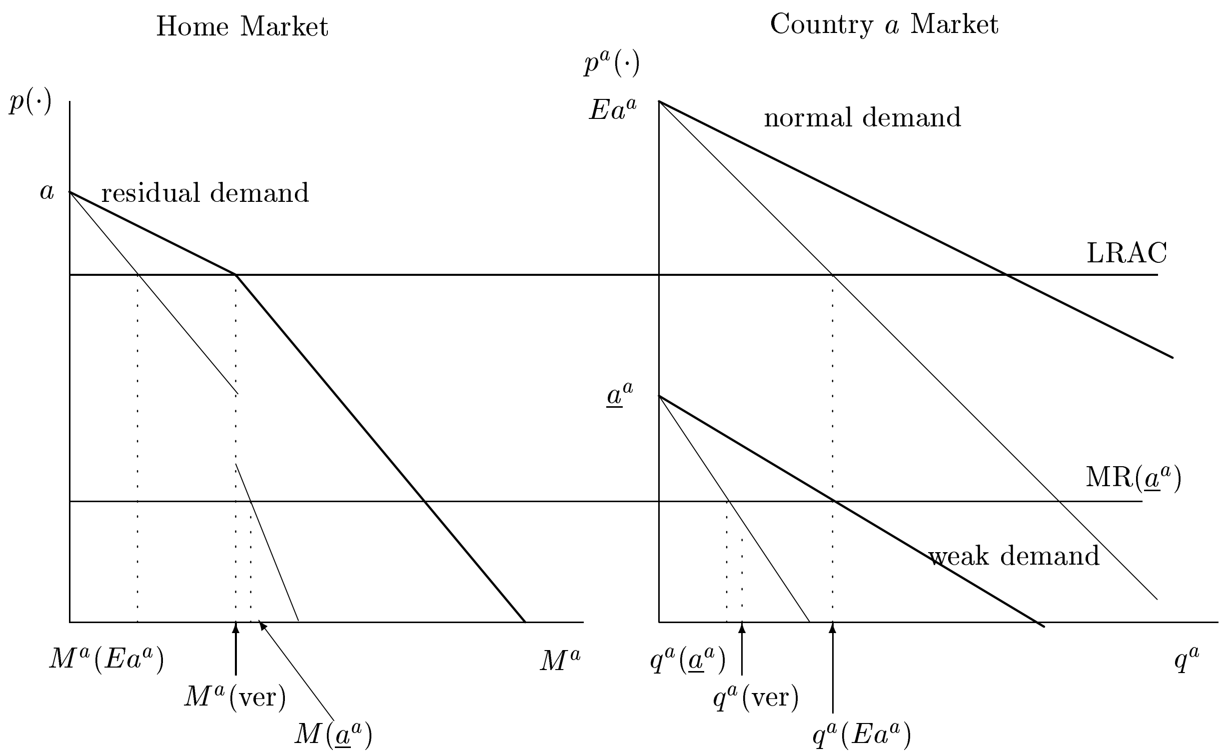


Figure 4: Dumping under antidumping policy



A binding capacity constraint implies:

$k^a = q^a(Ea^a) + M^a(Ea^a)$

$k^a = q^a(\underline{a}^a) + M^a(\underline{a}^a)$

$k^a = q^a(\text{ver}) + M^a(\text{ver})$

where ver=Voluntary Export Restraint

Table 1: Summary Statistics

	OECD MEI	Full Panel	All protective outcomes	AD duty or no duty outcomes
import penetration$_{t-1}$		.123	.140	.137
		(.137)	(.078)	(.082)
capacity utilization$_{t-1}$		2.64	1.48	1.52
		(1.56)	(0.97)	(1.02)
employment$_{t-1}$		44.99	122.23	95.30
		(61.88)	(128.17)	(101.93)
val_add/output$_{t-1}$		.495	.443	.451
		(.127)	(.113)	(.114)
P(decision=1)			.571	.471
			(.120)	(.139)
Dev. Foreign	.00000		-.00088	-.00047
GDP growth$_t$	(.01209)		(.00889)	(.00895)
Dev. US	.00000		-.002434	-.001391
GDP growth$_t$	(.00811)		(.009890)	(.008271)
Δ employment$_t$		-.7096	-12.175	-7.011
		(7.8482)	(28.685)	(21.273)
% Δ import pen$_t$		.197	.097	.078
		(4.345)	(.225)	(.153)
capacity utilization$_t$		2.63	1.47	1.53
		(1.53)	(1.11)	(1.16)
Japan dummy			.208	.235
			(.406)	(.425)
N	106	9239	409	332

Table 2: Maximum Likelihood Coefficient Estimates for All Protective Outcomes

Decision equation: 1=protect, 0=don't protect				N=409
Dev. Foreign GDP growth$_t$	-17.13**	-13.47*	-14.82**	-15.11**
	(7.84)	(7.86)	(7.79)	(7.94)
Dev. US GDP growth$_t$	13.95*	13.14*	12.08	12.08
	(8.16)	(8.19)	(7.94)	(8.09)
Δ employment$_t$	-.00839**	-.00761**	-.00493	-.00400
	(.00309)	(.00307)	(.00352)	(.00475)
% Δ import pen$_t$	.617*	.523	.626*	.641*
	(.345)	(.342)	(.355)	(.357)
capacity utilization$_t$	.083	.114	.197	.180
	(.078)	(.077)	(.113)	(.128)
Japan dummy	.517**		.502**	.503**
	(.169)		(.165)	(.166)
Constant	-.180	-.101	.135	.122
	(.139)	(.138)	(.213)	(.289)
log likelihood				
decision eqn	-266.557	-271.549	-266.557	-266.557
Selection equation: 1=industry petitions, 0= no petition				**N =9239**
import penetration$_{t-1}$			.840**	.764**
			(.129)	(.128)
capacity utilization$_{t-1}$			-.449**	-.420**
			(.054)	(.052)
employment$_{t-1}$			.00473**	.00393**
			(.00018)	(.00022)
val_add / output$_{t-1}$			-1.46**	-1.25**
			(.18)	(.19)
Δ employment$_t$				-.01786**
				(.00174)
% Δ import pen$_t$				-.006
				(.004)
constant			-.483**	-.602**
			(.126)	(.128)
log likelihood				
selection eqn			-1300.389	-1279.434
$\rho = corr(\varepsilon_{ijt}, \nu_{it})$			-.269	-.244
			(.145)	(.215)
log likelihood				
full model			-1565.884	-1545.2878
Robust Standard Errors in Parentheses				

** statistically significant at the 5% level, * statistically significant at the 10% level

Table 3: Marginal Effects for All Protective Outcomes

Decision equation: 1=protect, 0=don't protect				N= 409
Dev. Foreign GDP growth$_t$	-6.71**	-5.28*	-4.84**	-5.08**
	(3.07)	(3.08)	(2.55)	(2.67)
Dev. US GDP growth$_t$	5.47*	5.15*	3.94	4.06
	(3.20)	(3.21)	(2.59)	(2.72)
Δ employment$_t$	-.00329**	-.00298**	-.00161	-.00135
	(.00121)	(.00120)	(.00114)	(.00160)
% Δ import pen$_t$	.242*	.205	.204*	.215*
	(.135)	(.134)	(.116)	(.120)
capacity utilization$_t$	.033	.045	.064	.060
	(.030)	(.030)	(.037)	(.043)
Japan dummy	.203**		.164**	.169**
	(.066)		(.054)	(.056)
Constant	-.070	-.040	.044	.041
	(.054)	(.054)	(.069)	(.097)
Selection equation: 1=industry petitions, 0= no petition				N =9239
import penetration$_{t-1}$			.274**	.257**
			(.042)	(.043)
capacity utilization$_{t-1}$			-.146**	-.141**
			(.018)	(.018)
employment$_{t-1}$			.00154**	.00132**
			(.00006)	(.00008)
val_add / output$_{t-1}$			-.477**	-.419**
			(.060)	(.063)
Δ employment$_t$				-.00602**
				(.00059)
% Δ import pen$_t$				-.002
				(.001)
constant			-.158**	-.202**
			(.041)	(.043)
Robust Standard Errors in Parentheses				

** statistically significant at the 5% level, * statistically significant at the 10% level

Table 4: Maximum Likelihood Coefficient Estimates for Antidumping Duty or no Duty Outcomes

Decision equation: 1=AD duty, 0=don't protect				N=332
Dev. Foreign GDP growth$_t$	-16.90**	-12.03	-17.13**	-17.33**
	(8.49)	(8.50)	(8.54)	(8.50)
Dev. US GDP growth$_t$	17.96**	16.90*	18.10**	18.29**
	(9.17)	(9.34)	(9.18)	(9.18)
Δ employment$_t$	.00184	.00265	.00130	.00019
	(.00390)	(.00387)	(.00509)	(.00635)
% Δ import pen$_t$	.473	.357	.459	.443
	(.507)	(.517)	(.515)	(.514)
capacity utilization$_t$	.077	.119	.060	.045
	(.076)	(.076)	(.121)	(.118)
Japan dummy	.652**		.652**	.652**
	(.177)		(.176)	(.176)
constant	-.350**	-.244*	-.408	-.469
	(.139)	(.138)	(.377)	(.395)
log likelihood				
decision eqn	-216.515	-223.751	-216.515	-216.515
Selection equation: 1=industry petitions, 0= no petition				N=9162
import penetration$_{t-1}$			.728**	.671**
			(.137)	(.136)
capacity utilization$_{t-1}$			-.432**	-.413**
			(.058)	.(057)
employment$_{t-1}$			.00407**	.00347**
			(.00022)	(.00023)
val_add / output$_{t-1}$			-1.35**	-1.19**
			(.20)	(.20)
Δ employment$_t$				-.01780**
				(.00203)
% Δ import pen$_t$				-.015
				(.011)
constant$_{t-1}$			-.572**	-.661**
			(.136)	(.136)
log likelihood				
selection eqn			-1181.222	-1167.167
$\rho = corr(\varepsilon_{ijt}, \nu_{it})$			-.045	.088
			(.261)	(.269)
log likelihood				
full model			-1397.721	-1383.628
Robust Standard Errors in Parentheses				

** statistically significant at the 5% level, * statistically significant at the 10% level

Table 5: Marginal Effects for Antidumping Duty or no Duty Outcomes

Decision equation: 1=AD duty, 0=don't protect				N=332
Dev. Foreign GDP growth$_t$	-6.70**	-4.77	-6.72**	-6.69**
	(3.37)	(3.37)	(3.35)	(3.28)
Dev. US GDP growth$_t$	7.12**	6.71	7.10**	7.06**
	(3.64)	(3.70)	(3.61)	(3.54)
Δ employment$_t$	.00073	.00105	.00051	.00007
	(.00155)	(.00153)	(.00200)	(.00245)
% Δ import pen$_t$	.188	.142	.180	.171
	(.201)	(.205)	(.202)	(.198)
capacity utilization$_t$	.031	.047	.024	.017
	(.030)	(.030)	(.048)	(.046)
Japan dummy	.258**		.256**	.251**
	(.070)		(.069)	(.068)
constant	-.139**	-.097	-.160	-.181
	(.055)	(.055)	(.147)	(.152)
Selection equation: 1=industry petitions, 0= no petition				N=9162
import penetration$_{t-1}$			.286**	.259**
			(.054)	(.053)
capacity utilization$_{t-1}$			-.169**	-.160**
			(.023)	(.022)
employment$_{t-1}$			.00160**	.00134**
			(.00009)	(.00009)
val_add / output$_{t-1}$			-.530**	-.459**
			(.077)	(.076)
Δ employment$_t$				-.00687**
				(.00079)
% Δ import pen$_t$				-.006
				(.004)
constant$_{t-1}$			-.224**	-.255**
			(.053)	(.053)
Robust Standard Errors in Parentheses				

** statistically significant at the 5% level, * statistically significant at the 10% level

References

[1] **Anderson, James E.** 1992. "Domino Dumping, I: Competitive Exporters." *American Economic Review*, 82:65-83.

[2] **Baldwin, Robert and Steagall, Jeffrey W.** 1994. "An Analysis of ITC Decisions in Antidumping, Countervailing Duty and Safeguard Cases." *Weltwirtschaftliches Archiv*, 130:290-307.

[3] **Bartlesman, Eric J.; Becker, Randy A. and Gray, Wayne B.** 2000. "The NBER -CES Manufacturing Industry Database" at http://www.nber.org/nberces/nbprod96.htm.

[4] **Blonigen, Bruce A.** 2000. "US Antidumping Database" at http://darkwing.uoregon.edu/ bruceb/adpage.html.

[5] **Blonigen, Bruce A. and Park, Jee-Hyeong** 2001. "Dynamic Pricing in the Presence of Antidumping Policy: Theory and Evidence." *NBER Working Paper # 8477.*

[6] **Brander, James A. and Spencer, Barbara J.** 1984. "Trade Warfare: Tariffs and Cartels." *Journal of International Economics*, 16:227-242.

[7] **Clarida, Richard** 1996. "Dumping: In Theory, in Policy, and in Practice" in *Fair Trade and Harmonization: Prerequisites for Free Trade? Vol. 1.*, Jagdish Bhagwati and Robert E. Hudec, eds. Cambridge, MA and London: MIT Press.

[8] **Clarida, Richard** 1993. "Entry, Dumping, and Shakeout." *American Economic Review*, 83:180-202.

[9] **Crowley, Meredith A.** 2002. "Do Safeguard Tariffs and Antidumping Duties Open or Close Technology Gaps?" *Federal Reserve Bank of Chicago Working Paper 2002-13.*

[10] **Dixit, Avinash** 1988. "Anti-Dumping and Countervailing Duties Under Oligopoly." *European Economic Review*, 32:55-68.

[11] **Ethier, Wilfred J.** 1982. "Dumping." *Journal of Political Economy*, 90:487-506.

[12] **Feenstra, Robert C.** 1996. "NBER Trade Database, Disk1: U.S. Imports, 1972-1994: Data and Concordances," *NBER Working Paper # 5515.*

[13] **Gruenspecht, Howard K.** 1988. "Dumping and Dynamic Competition." *Journal of International Economics*, 25: 225-248.

[14] **Hansen, Wendy L.** 1990. "The International Trade Commission and the Politics of Protectionism." *American Political Science Review*, 84: 21-46.

[15] **Hansen, Wendy L. and Prusa, Thomas J.** 1996. "Cumulation and ITC Decision Making: The Sum of the Parts is Greater than the Whole." *Economic Inquiry*, 34: 746-69.

[16] **Hansen, Wendy L. and Prusa, Thomas J.** 1997. "The Economics and Politics of Trade Policy: An Empirical Analysis of ITC Decision Making." *Review of International Economics*, 5: 230-45.

[17] **Heckman, James J.** 1979. "Sample Selection Bias as a Specification Error." *Econometrica*, 47: 153-162.

[18] **Knetter, Michael M. and Prusa, Thomas J.** 2000. "Macroeconomic Factors and Antidumping Filings: Evidence from Four Countries." *NBER Working Paper # 8010.*

[19] **Macrory, Patrick F.J.** 1989. "Cost of Production as the Sole Measure of Dumping" in *Antidumping Law and Practice*, John H. Jackson and Edwin A. Vermulst, eds. Ann Arbor: University of Michigan Press.

[20] **Messerlin, Patrick** 1989. "The EC antidumping regulations: A first economic appraisal, 1980-85." *Weltwirtschaftliches Archiv*, 125, 563-87.

[21] **Moore, Michael O.** 1992. "Rules or Politics? An Empirical Analysis of ITC Anti-dumping Decisions." *Economic Inquiry*, 30: 449-66.

[22] **Prusa, Thomas J.** 1992. "Why are so many antidumping petitions withdrawn?" *Journal of International Economics*, 33: 1-20.

[23] **Reitzes, James D.** 1993. "Antidumping Policy." *International Economic Review*, 34: 745-763.

[24] **Schott, Peter.** 2003. "US Multilateral Manufacturing Imports and Exports by SIC4 (1987 revision), 1989 to 2001" at http://www.som.yale.edu/faculty/pks4/subinternational.htm.

[25] **Staiger, Robert W. and Wolak, Frank A.** 1992. "The effect of domestic antidumping law in the presence of foreign monopoly." *Journal of International Economics*, 32:265-287.

[26] **Staiger, Robert W. and Wolak, Frank A.** 1994. "Measuring Industry-Specific Protection: Antidumping in the United States." *Brookings Papers on Economic Activity: Microeconomics*, 51-118.

[27] **Van de Ven, P.M.M. and Van Praag, Bernard M.S.** 1981. "The Demand for Deductibles in Private Health Insurance: A Probit Model with Sample Selection." *Journal of Econometrics*, 17:229-252.

[28] **World Trade Organization, Committee on Antidumping Practices** 2002. *Semi-Annual Report under Article 16.4 of the Agreement: Brazil, European Communities, Mexico, South Africa, United States.* Geneva: WTO.