Dynamic Pricing in the Presence of Antidumping Policy: Theory and Evidence

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Antidumping (AD) trade protection policies allow government agencies to recalculate AD duties based on foreign firms' most recent pricing behavior. We examine the resulting dynamic pricing problem of a foreign firm facing such policy. We show that the expected pattern of AD duty recalculations over time crucially depends on the foreign firm's ex ante expectations of possible outcomes of AD policy enforcement. Our empirical analysis then confirms the role of ex ante expectations in explaining observed patterns of AD recalculations. Many of our model's results are applicable to other situations where enforcement of policy is tied to the subject's behavior. (*JEL* F13, L11)

Dumping occurs when foreign firms price in their export market below what is considered "normal" or "fair" value for the product, often the price charged for the same product in the foreign firm's own market. If such dumping is found to be "injuring" the domestic industry, the government agencies then impose an antidumping (AD) duty that is equal to the calculated dumping margin; i.e., the difference between fair value and the export price.

On the surface, AD duties are simple ad valorem tariffs designed to offset foreign firms' dumping margins, thus protecting domestic industries against dumping behavior. However, recent research on AD protection policies has revealed that the institutional structure surrounding the determination and administration of AD duties make analysis of this form of trade policy quite interesting and complicated. James E. Anderson (1992, 1993) and Blonigen and Yuka Ohno (1998) discuss ways in which AD policy may perversely lead to greater dumping behavior on the part of foreign firms. Robert W. Staiger and Frank A. Wolak (1994) and Corinne M. Krupp and Patricia S. Pollard (1996) focus on how investigation "events" such as the filing of the petition, preliminary decisions by government agencies, terminations, etc., affect import and pricing behavior by foreign firms. Thomas J. Prusa (1992) shows that even the initiation of a petition, with a subsequent withdrawal, may allow domestic and foreign firms to price more cooperatively (collusively).

Blonigen and Stephen E. Haynes (2002) focus on another feature of AD policy that can lead to surprising effects on foreign firms' pricing behavior. AD duties are potentially recalculated each year using the most recent period's pricing data in what are called "administrative reviews." Using a one-period (static) model of pricing for a firm subject to an AD duty, Blonigen and Haynes show that these reviews may lead to more than complete pass-through of the AD duty and may substantially alter exchange rate pass-through after an AD case. They verify these hypotheses using a sample of

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Canadian steel products subject to U.S. AD investigations beginning in 1992.

The administrative review process presumably discourages dumping by foreign firms subject to AD duties. However, changes in AD duties due to the administrative review process reveal diverse reactions from foreign firms after the initial imposition of AD duties. Of the AD duties stemming from U.S. AD cases filed from 1980 through 1995, approximately 45 percent were reduced through the review process, while the remaining AD duties did not decrease, including 6.4 percent that actually increased.

This paper provides a theory that explains the dynamic evolution of U.S. AD duty patterns. The dynamic pricing model we develop not only leads to predictions that bear out in the data, but also has implications for more general situations that involve uncertainty and a feedback loop between policy enforcement and the behavior of those subject to the policy. In this paper, we examine a foreign firm's dynamic optimization problem in an infinite horizon model, where the foreign firm has a static incentive to dump its product (i.e., the export price that maximizes its current profit is less than fair value) but also has a dynamic concern about possible AD duties to follow. We first examine a benchmark model where AD enforcement is certain; specifically, the foreign firm's current AD duty is always equal to the amount of its dumping in the previous period.[1] In such a model, we find that two types of firms emerge. The first type of firm cares enough about future profitability to not dump, despite its preference to dump in the absence of any AD policy. The second type of firm discounts the future enough to dump in the first period. Interestingly, once such a firm dumps, we find the firm dumps even more in future periods with certain AD enforcement. This is because standard demand conditions imply that the static incentive to dump becomes even greater once a positive AD duty is in place. As the AD duties continue to rise in response to lower export prices, this strengthens the firm's static incentive to dump; hence, over time there is a rise in AD duties through the administrative review process. Thus, the certain enforcement model predicts that AD policy can perversely contribute to more aggressive dumping behavior for a particular type of firm.

While the benchmark case of certain AD enforcement is important for establishing basic features of our model, it is unlikely that enforcement of AD policy is certain.[2] In addition, the benchmark case predicts rising AD duties over time after the initial AD duty is imposed, yet our data show that a large percentage of AD duties decline during the administrative review process, as previously mentioned. Therefore, we extend the model to show that uncertain enforcement provides an explanation for why firms choose prices to lead to decreases in AD duties through the administrative review process. In particular, we modify the model so that foreign firms have *ex ante* expected probabilities of possible AD case outcomes. We then show that as the probability that a dumping firm will actually get an AD duty declines, it becomes more likely that the firm will dump, including some firms that would not dump under certain AD enforcement. However, if these firms unexpectedly receive an AD duty, they now face more certain enforcement through the administrative review process. Given their weight on future profitability, these firms will set higher export prices over time, leading to a reduction of AD duties through the review process. Thus, firms with lower *ex ante* probabilities of receiving AD duties, which then actually receive an AD duty, should be the ones we observe lowering their AD duties over time in the administrative review process. We also

[1] Note that this (one-period) lag in adjusting the AD duty is crucial in raising the "dynamic" pricing issue. This is because instantaneous adjustment in the AD duty will simply set the consumer price as fixed at the fair value, regardless of the foreign firm's export pricing decisions, thus eliminating the dynamic pricing issue for the foreign firm. As discussed in Section I, it is reasonable to assume that there exist significant lags in adjusting AD duties.

[2] One important exception, suggested by Robert Feenstra, is the Trigger Price Mechanism (TPM) adopted by the United States with respect to steel products in the late 1970's. Under the TPM, a foreign firm automatically faced duties whenever its price fell below a trigger level, a policy which neatly fits our model of certain enforcement. The program was unsuccessful due to the problems of calculating trigger price adjustments in the face of exchange rate volatility (Barry J. Eichengreen and Hans van der Ven, 1984), making it difficult to compare pricing behavior by firms under the TPM with our model's predictions.

show that when firms believe greater dumping will lead to larger rents from a negotiated Voluntary Export Restraint (VER) in lieu of AD duties (as in Anderson, 1992, 1993), a high *ex ante* expectation of such a VER agreement will lead to AD duty reductions in the event that the firm instead receives only AD duties, not a VER.

The latter half of the paper tests hypotheses derived from our model of dynamic pricing under uncertain AD enforcement. The empirical analysis adopts a two-step estimation method. We first estimate determinants of the probabilities of AD case outcomes. We then use the parameter estimates to form *ex ante* outcome probabilities and estimate the effect of these *ex ante* probabilities on changes in AD duties in the administrative review process. Using a sample of all firm-product combinations subject to U.S. affirmative AD decisions and AD duties for cases filed between 1980 and 1995, the empirical results support the hypotheses. Consistent with our theory, we find evidence that a lower *ex ante* probability of an AD duty leads to significant *ex post* reductions of the AD duty through the administrative review process once an AD duty is imposed. We also find that a higher *ex ante* probability of a VER outcome leads to significant *ex post* reductions in AD duties, which is consistent with Anderson's (1992, 1993) domino dumping hypothesis.

The basic insights in our model are not particular to AD trade protection, but are applicable to other situations where enforcement of policy is tied to the subject's behavior. Our benchmark model of certain enforcement underscores the notion that punishment may not lead to more-preferred behavior of those punished in future periods if the policy enforcement makes good behavior even more costly to the offenders. For example, the stigma attached to committing a felony in terms of future employment opportunities may make felons even more likely to commit future crimes. Our model shows that *uncertain* enforcement can add to the pool of offenders, but these additional offenders are the ones most likely to modify their behavior once caught. Finally, as shown by Anderson (1992, 1993), the potential for unintended side benefits (e.g., quota rents from resulting VERs) can lead to additional offenders. However, as we show, these additional offenders are also the ones most likely to reform if those side benefits are not forthcoming.

The rest of the paper proceeds as follows. Section I provides some relevant details of U.S. AD trade protection and the administrative review process. Section II provides a formal dynamic pricing model for exporting firms in the presence of AD policy and our main propositions. Sections III–V describe our empirical analysis, and the final section concludes.

I. Salient Features of U.S. AD Law and Administration

This section provides a brief overview of the relevant details connected with U.S. AD investigations and administrative reviews. The U.S. AD laws are administered by the U.S. Department of Commerce (USDOC) and the U.S. International Trade Commission (USITC), each with distinct roles in the process. When an AD petition is filed, the USDOC determines whether the subject product is being sold at less than "fair value" in the United States. In contrast, the USITC determines whether the relevant U.S. domestic industry has been materially injured, or is threatened with material injury, by the imports subject to its investigation.

The calculation of the dumping margin by the USDOC is usually not straightforward and revolves around how the USDOC measures what should be the fair value of the product sold in the United States. Selling a product in the United States at less than fair value is the definition of dumping and the difference between the U.S. price and fair value is the dumping margin. In theory, the USDOC defines fair value as the exporting firm's price for the same product in its own home market. However, if the firm's home market sales are deemed inadequate, then the USDOC may base fair value on the exporting firm's prices in third country markets or on a constructed value for the product using manufacturing costs, selling, general and administrative costs, profits, and packaging costs. These calculations obviously involve highly detailed and confidential data on the transactions of the investigated firm, which are requested by the USDOC from the investigated firm. If the firm under investigation does not comply sufficiently, the USDOC will turn to using "facts available," which is often information supplied by the U.S. firms that filed the petition.

If an affirmative preliminary determination is made by both the USDOC and the USITC (which may take up to 160 days), then the importer must post a cash deposit, a bond, or other security for each entry equal to the preliminary margin determined by the USDOC. This requirement stays in effect until either the USDOC or the USITC makes a negative final determination, which may take another 120 days. If an affirmative final determination is made by both the USITC and the USDOC, then the USDOC issues an AD order to levy a duty equal to the estimated dumping margin on the subject product.

When a subject foreign product enters the United States, the importer must pay Customs a cash deposit equal to the margin times the value of the subject product. However, these cash deposits do not necessarily represent the final amount of duties to be assessed on the subject imports. Rather, the margin determined in the USDOC's final investigation is only used as a basis for *estimating* the duty liability of the importer. The actual liability of the importer may be determined in subsequent years by the USDOC. Before 1984, this was accomplished by automatic yearly administrative reviews by the USDOC. However, since 1984, such reviews have become voluntary; that is, unless an interested party requests a review, the duties assessed are those found in the USDOC's final determination (or most recent administrative review). An administrative review serves two purposes. First, it adjusts the margin on subject imports to reflect changes in the difference between the foreign firm's U.S. price and the fair value so that the importer pays an adjusted cash deposit based on the reviewed margin until the next administrative review. Second, it makes AD duties retroactive: if a review determines that the margin during the review period is different from the previous margin used as a basis for the importer's cash deposit, a bill (or refund) in the amount of the difference with interest is assessed (or rebated).

II. Model of Dynamic Pricing in the Presence of AD Policy

This section develops a model of dynamic pricing for a foreign firm in the presence of AD policy. We first construct and analyze a benchmark case where the AD policy is enforced with certainty. We then modify the model to allow uncertain AD enforcement, which leads to implications we can examine empirically. Our discussion of the model highlights the main assumptions and results. Greater detail is provided in Blonigen and Park (2001).

A. *Benchmark Model: Certain AD Enforcement*

Assume that a foreign firm may sell its products in both the foreign and domestic markets and that these markets are segmented so that price discrimination is possible across the markets. We denote the price charged by the foreign firm in its own market as p^f and its export price to the domestic market as p^x. Under certain AD enforcement, the foreign firm faces an AD duty at the border that raises the price to domestic consumers whenever the firm's export price (p^x) is lower than its price in its own foreign market (p^f). τ (≥ 1) denotes the AD duty to offset the dumping margin, such that $p^x\tau = p^f$.[3] The foreign firm's AD duty changes in subsequent periods through the administrative review process in response to changes in p^x or p^f.

Because the initial AD duty determination and the following administrative review(s) are far from instantaneous to changes in prices, the foreign firm faces a dynamic pricing problem. To analyze this problem, we use an infinite horizon model where the change in the AD duty lags one period to changes in the price. Thus, each period's AD duty can be denoted as $\tau_t = p^f_{t-1}/p^x_{t-1}$, with the subscript ($t$) denoting the period. We further assume that p^f_{t-1} equals a fixed value, p^f_1, for all $t \geq 1$. We make this assumption because there are compelling reasons and empirical evidence that the majority of the price change affecting the AD duties in the review process occurs with the domestic (U.S.) price, not the foreign price.[4] Given this

[3] Once a product is subject to an AD duty, the domestic importing firm is obligated to pay the AD duty, not the exporter. This creates a potential conflict of interest between the exporter and the importer. We do not model this issue in the following analysis. This is equivalent to assuming perfectly competitive domestic importers or, alternatively, joint profit maximization between the foreign exporter and the domestic importer.

[4] As Michael P. Gallaway et al. (1999, pp. 219–220) discuss, the USDOC has wide discretion to disallow a foreign

assumption, the current-period AD duty can be expressed as the following function of the previous-period export price to the domestic market: $\tau_t = \tau(p^x_{t-1}) = p^f_1/p^x_{t-1}$ if $0 < p^x_{t-1} \leq p^f_1$ and $\tau_t = \tau(p^x_{t-1}) = 1$ if $p^x_{t-1} > p^f_1$.[5]

To focus on the pricing issue raised by the dynamic structure of AD policy described above, we add further structure. First, assume that the consumers' preferences and the production technology are the same in each period. Let c be the foreign firm's constant marginal production cost and $q(p_t)$ be its per-period domestic market demand function where $p_t \equiv p^x_t \tau_t$ represents the consumer price.[6] In addition to having $q(\cdot)$ twice differentiable everywhere, for analytical simplicity, we assume that the foreign firm has an incentive to dump in the absence of AD policy: arg $\max_{p^x_t}[(p^x_t - c)q(p^x_t)] < p^f_1$ with $\tau_t = 1$.

Denote $\delta \in (0, 1]$ as the discount factor and $\pi(p^x_t; \tau(p^x_{t-1})) \equiv (p^x_t - c)q(p^x_t \tau(p^x_{t-1}))$ as the firm's per-period profit function. Then the foreign firm's optimal pricing sequence solves

$$(1) \qquad \max_{\{p^x_t\}_{t=1}^{\infty}} \sum_{t=1}^{\infty} \delta^{t-1} \pi(p^x_t; \tau(p^x_{t-1})),$$

where $p^x_0 = p^f_1$, so that there is no initial AD duty.[7,8] Alternatively, we can write equation (1) as

$$(2) \qquad \max_{p^x_1}[\pi(p^x_1; \tau(p^x_0)) + \delta V(p^x_1)], \text{ where}$$

$$(3) \qquad V(p^x_1) \equiv \max_{\{p^x_t\}_{t=2}^{\infty}} \sum_{t=2}^{\infty} \delta^{t-2} \pi(p^x_t; \tau(p^x_{t-1}))$$

represents the maximized discounted profit in period 2 as a function of p^x_1.

Equation (2) clearly shows that the foreign firm's initial export price decision, p^x_1, affects not only its current profit, but also its future discounted profit through the resulting AD duty in period 2, $\tau(p^x_1)$. While the foreign firm has the static incentive to price below the fair value (dump) in the initial period, the AD policy makes dumping a costly choice by imposing an AD duty in the next period.[9] For the foreign firm that cares about its future ($\delta > 0$), the optimal initial export pricing involves balancing between the static incentive to dump and the dynamic incentive to avoid a future AD duty.

In subsequent periods, the foreign firm faces a balancing problem of the same kind for its optimal choice over the "current" export price. For any arbitrary period t (≥ 1), p^x_t and p^x_{t-1} denote the current-period and previous-period export price, respectively. The optimal export price in period t can then be mapped from the previous-period export price by the following correspondence:

$$(4) \qquad G(p^x_{t-1}) = \arg\max_{p^x_t} [\pi(p^x_t; \tau(p^x_{t-1})) + \delta V(p^x_t)],$$

where $V(\cdot)$ is the same discounted profit function as in (3).[10] The dynamic incentive to avoid a future AD duty, represented by $\delta V(\cdot)$ in (4), is

firm's prices in its own market when determining "normal" value, either deeming them as "below cost," or by finding insufficient sales and turning to a constructed cost measure or prices to a third market. This makes the strategy of reducing the AD duty by lowering the price in the foreign market tenuous at best, and limited empirical evidence shows that foreign firms reduce AD duties primarily through increases in the price to the domestic market, not decreases in the foreign price.

[5] If $p_{t-1} = 0$, then $\tau_t = \tau(p_{t-1}) = \infty$, which practically prohibits imports of the product from period t and on. The foreign firm can still sell its product by setting $p_t = 0$, but its profit will be negative with any positive production cost.

[6] We do not analyze the possibility of strategic interactions between firms in setting prices. Thus, the simple demand function we use can be considered an individual firm's demand in a monopolistically competitive industry.

[7] In characterizing the optimal sequence for the domestic prices, we can focus on the problem of maximizing the discounted profit from the domestic market for a given p^f_1. This is because only the initial foreign price will matter in determining all subsequent AD duties for the domestic market.

[8] As discussed earlier, the United States applies AD duties retroactively so that foreign firms pay estimated AD duties at the beginning of the period and then pay additional duties or receive a refund at the end of the period, depending on whether the AD duty increased or decreased over the period. However, it can be shown that a model with this retroactive feature will generate qualitatively identical results with respect to the dynamic pricing behavior as the model without retroactiveness. The European Union employs its administrative review process without retroactiveness.

[9] $V(p^x_1)$ in (2) increases in p^x_1 for $p^x_1 < p^f_1$, revealing the dynamic incentive to avoid a future AD duty: a higher current-period export price means a lower AD duty in the following period, creating a more favorable environment for maximizing profits.

[10] $G(\cdot)$ and $V(\cdot)$ are not time-subscripted, indicating that they do not vary over time.

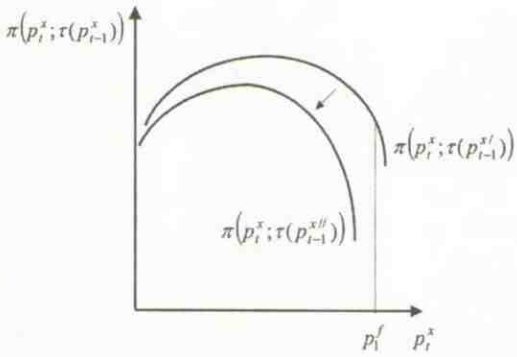

FIGURE 1. PREVIOUS-PERIOD PRICING EFFECTS ON CURRENT-PERIOD PROFIT

the same in each period because the maximum discounted profit that the foreign firm can attain will be identical for any period given the same AD duty. Any change in the optimal export pricing, therefore, must come from changes in the previous-period export price, p_{t-1}^x, which in turn affects the static incentive to dump, $\pi(p_t^x; \tau(p_{t-1}^x))$. The following assumption on the profit function ensures that $G(p_{t-1}^x)$ increases in p_{t-1}^x:

ASSUMPTION 1: $\partial^2\pi(p_t^x;\ \tau_t)/\partial p_t^x \partial \tau_t < 0$ *for* $p_t^x > c$, $\tau_t \leq p_1^f/c$, *and* $q(p_t) > 0$.[11]

This assumption is satisfied as long as $q(\cdot)$ is not too convex in price and is also a sufficient condition for satisfying the second-order condition for profit maximization.

Figure 1 shows the ramifications of Assumption 1 for the firm's profit maximization decisions. The figure displays two current-period profit functions for the firm given two alternative previous-period prices, $p_{t-1}^x{}' > p_{t-1}^x{}''$. If the value of the previous-period price falls from $p_{t-1}^x{}'$ to $p_{t-1}^x{}''$, then the current-period AD duty increases, shifting the current-period profit curve down from $\pi(p_t^x;\ \tau(p_{t-1}^x{}'))$ to $\pi(p_t^x; \tau(p_{-1}^x{}''))$. Given Assumption 1, the difference in the two profit functions is such that the static incentive to dump is greater for the case of $p_{t-1}^x{}''$, as reflected by a greater loss (gain) in profit for a given price increase (decrease) over the relevant range. Because the dynamic incentive to avoid a future AD duty stays the same in any period, this guarantees that $G(p_{t-1}^x)$ is increasing in p_{t-1}^x and leads to the following proposition.

PROPOSITION 1: *When demand satisfies Assumption 1, there exists a critical discount factor,* δ^c, *such that (i) foreign firms with discount factors above* δ^c *will set the export price at fair value for all periods; (ii) foreign firms with discount factors below* δ^c *will set an initial export price below fair value and future export pricing decisions are characterized by* $p_1^x \geq p_2^x \geq p_3^x \ldots$, *leading to nondecreasing AD duties,* $\tau_1 \leq \tau_2 \leq \tau_3 \leq \ldots$.

(See Blonigen and Park, 2001, for proof.)

Proposition 1 tells us that there will be two types of foreign firms: those that care enough about the future to never dump (despite their preference to dump in the absence of any AD policy), and those that weigh the present strongly enough to dump. The latter group of foreign firms that initially dump, rather surprisingly, never try to reduce their AD duty through the administrative review process.

Figure 2 depicts these two cases using the optimal export price correspondences. $G(p_{t-1}^x; \delta < \delta^c)$ represents a possible optimal export price correspondence for a foreign firm that cares relatively little about future periods. For this firm, suppose we begin with no AD duty, thus having p_0^x equal p_1^f. The firm's first period optimal price is then given by the point on the optimal export price correspondence, $G(p_1^f; \delta < \delta^c)$, associated with p_1^f as the previous-period price. This is represented by the vertical height at point A and clearly maps into an optimal price that is less than p_1^f because it is below the 45° line. In fact, by translating it to the 45° line we can see it corresponds to p_1^x. The optimal export price correspondence $G(p_1^x; \delta < \delta^c)$ then gives us the optimal export price in the second period, which is represented by point B and translates to an export price of p_2^x. This process converges asymptotically to the steady-state export price of p_S^x. Thus, for foreign firms that do

[11] $\partial^2\pi(p_t^x;\ \tau_t)/\partial p_t^x\partial\tau_t = p_t^x[\partial q(p_t)/\partial p_t] + (p_t^x - c)\{[\partial q(p_t)/\partial p_t] + p_t[\partial^2 q(p_t)/\partial p_t^2]\}$, which is negative if $q(\cdot)$ is not too convex [i.e., $\partial^2 q(p_t)/\partial p_t^2$ is not too large and positive]. The alternative condition, $\partial^2\pi(p_t^x;\ \tau_t)/\partial p_t^x\partial\tau_t \geq 0$ implies different pricing dynamics under AD policy that are not consistent with the data.

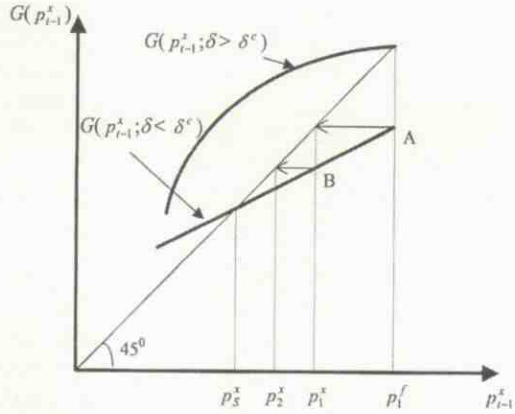

FIGURE 2. OPTIMAL DYNAMIC PRICE DECISIONS FOR FIRMS WITH DIFFERENT DISCOUNT FACTORS

not value future period's profits very highly, $\delta < \delta^c$, optimal export prices fall over time in the administrative review process and, hence, AD duties rise over time until reaching a steady-state equilibrium. In contrast, the optimal export price correspondence for firms that value the future relatively highly, $G(p^x_{t-1};\ \delta > \delta^c)$, crosses the 45° line at p^f_1, indicating that this price is the steady-state equilibrium export price.

This result of increasing AD duties through the administrative review process is driven by the strengthened static incentive to dump in response to a higher current-period AD duty, while the dynamic incentive to avoid a future AD duty remains constant for each period in the infinite horizon model. For a model with finite periods, we can still show that AD duties will only increase through the review process under certain enforcement of AD policy. In fact, the tendency for rising AD duties will be stronger because the dynamic incentive to avoid a future AD duty gets weaker as the remaining number of periods decreases, while a higher current-period AD duty continues to raise the static incentive to dump.[12]

Proposition 1 generates a specific empirical prediction: foreign firms will never try to reduce their AD duties through the administrative review process. However, this result may not have empirical relevance for most cases. As discussed in the introduction, approximately 45 percent of the initial AD duties have been reduced through the review process during the 1980–1995 period, with only 6 percent of initial AD duties seeing a subsequent increase. In order to explain why foreign firms may reduce their AD duties after the imposition of duties, we next introduce uncertain enforcement of AD policy into the model.

B. *Model with Uncertain Enforcement of AD Policy*

Many U.S. AD cases are not ruled affirmative and, hence, do not lead to AD duties. About half the cases are ruled negative, almost exclusively because they do not meet the injury criteria of the USITC, and a significant number of U.S. AD cases lead to terminations, suspensions, or withdrawn cases based on agreements between domestic and foreign firms, often VERs. In addition, the AD investigation starts only after the domestic firms or the USDOC file an AD petition against potential dumping activities. Thus, it is obvious that there exist uncertainties in the outcomes and enforcement of AD policy, especially in the initial AD investigation.

In the presence of uncertainties in the enforcement of AD policy, a foreign firm's expectation on probabilities of different contingencies plays an important role in its initial pricing (dumping) decision and the subsequent pricing decisions once it is subject to an AD duty. To model the dynamic pricing problem in the presence of uncertain enforcement, we classify different contingencies of AD enforcement into three categories: cases with final affirmative dumping determinations (*ADD*), cases ending with negative determinations (*NEG*) including the case of no AD petition filing, and cases being terminated, suspended, or withdrawn in lieu of some settlement, such as a VER (*VER*).[13] Given that a foreign firm dumps ($p^x_t < p^f_1$) in the absence of any current AD duty ($\tau_t = 1$) at period t, let Pr(*ADD*), Pr(*NEG*), and Pr(*VER*) $\in$

[12] A formal proof for this result from the finite horizon model is available upon request.

[13] Note that a *VER* case not only denotes cases leading to a VER settlement but also covers the possibility of other types of settlements or terminations.

[0, 1] denote the *ex ante* probabilities of getting an *ADD*, *NEG*, or *VER* case in the next $(t + 1)$ period, respectively. By definition, $\Pr(ADD) + \Pr(NEG) + \Pr(VER) = 1$. Note that these are *ex ante* probabilities. For example, a firm having a very low value for $\Pr(ADD)$ may find itself subject to an AD duty in the next period despite its low expectation of such a duty.

For analytical simplicity, we introduce the following assumptions on the nature of uncertainties surrounding the AD investigation. First, once an AD duty is imposed, the initial AD duty and the following administrative reviews will be perfectly enforced with $\tau_t = p_1^f/p_{t-1}^x$. This fits with the observation that no injury determination by the USITC occurs during administrative reviews, which is a main source of uncertainty in the initial AD investigation. Second, once a *VER* case arises due to an agreement among interested parties, we assume such an agreement will be perfectly enforced, eliminating possibilities for any future AD investigation. In contrast, a realization of a *NEG* case in any period does not alter the *ex ante* probabilities for the subsequent period. Finally, we assume that these *ex ante* probabilities, $\Pr(\cdot)$s, are not functions of the price chosen in the absence an AD duty or an agreement, even though $\Pr(\cdot)$s may vary across different foreign firms belonging to different industries. At the end of this section we briefly discuss the effects of relaxing some of these assumptions.

Given the uncertain enforcement of AD policy described above, the dynamic pricing problem for a foreign firm is then to find an export price, p_E^x, that satisfies:

$$(5)\quad \max_{p_E^x}\{(p_E^x - c)q(p_E^x) + \delta[\Pr(ADD)V(p_E^x) + \Pr(VER)V^T(p_E^x)]\}/[1 - \Pr(NEG)],$$

where p_E^x is the initial optimal export price the firm will continue to choose each period with uncertain enforcement until it faces an AD duty or a VER settlement, and $V^T(\cdot)$ is the discounted profit function the firm faces in the case of a termination leading to a VER.[14]

[14] See Blonigen and Park (2001) for derivation of (5).

$V(\cdot)$ is the same discounted profit function as in (3) because we assume perfect enforcement of the administrative reviews. Thus, $V(\cdot)$ is increasing in p_E^x. However, $V^T(\cdot)$ may increase or decrease in p_E^x, depending on the nature of a VER agreement. Anderson (1992, 1993) notes that many VERs are structured so that export licenses are given to foreign firms according to their pre-VER market share. It is precisely this feature of VER agreements that leads firms to lower export price (i.e., dump) in order to increase market share in anticipation of such a VER agreement. In our model, this would imply that $V^T(\cdot)$ is decreasing in p_E^x, since the value of the discounted profit that the foreign firm can obtain is higher for firms with lower pre-VER prices. The firms with lower export prices will have higher market shares and a greater share of the export licenses and the resulting VER rents. Alternatively, suppose terminations lead to a VER agreement that is reached through a bargaining process between foreign and domestic firms, where imposition of AD duties is a threat point for the domestic firms in this process (i.e., if an agreement does not yield enough VER rents for the domestic firms, they opt out and the foreign firms face AD duties). Then, it is possible that a lower initial export price reduces the foreign firm's rent obtainable in the VER bargaining process. This is because the domestic firms' decision to opt out would result in a more severe penalty (AD duties) if the foreign firm had priced lower. In this case, $V^T(\cdot)$ is increasing in p_E^x, since the discounted profit that the foreign firm can obtain, once a VER is reached, is increasing in the export price before the *VER* case occurs, p_E^x.

Given this setup, we now provide two sets of results from the model that lead to implications we can explore with available data. First, foreign firms' optimal initial export price under this uncertain environment, p_E^x, will potentially differ from the price chosen in the AD certainty case. Second, when a foreign firm becomes subject to an AD investigation and duties, the $\Pr(ADD)$ is now one rather than something less than one, hence the firm will adjust its price over time to the price it would have chosen in the AD certainty case. Proposition 2 details how changes in $\Pr(ADD)$ and $\Pr(VER)$ affect the initial export price chosen under uncertainty, p_E^x.

PROPOSITION 2: *The initial optimal export price chosen by a foreign firm facing uncertain AD enforcement, p_E^x, is*

(*i*) *increasing in* Pr(*ADD*) *for a given* Pr(*VER*),
(*ii*) *decreasing in* Pr(*VER*) *for a given* Pr(*ADD*) *if $V^T(\cdot)$ is strictly decreasing in p_E^x, and*
(*iii*) *increasing in* Pr(*VER*) *for a given* Pr(*ADD*) *if $V^T(\cdot)$ is strictly increasing in p_E^x.*

(See Blonigen and Park, 2001, for proof.)

Part (i) of Proposition 2 implies that as Pr(*ADD*) falls, foreign firms will lower their initial export price, thus dumping more than if they knew AD enforcement would be a certain outcome of any dumping behavior.[15] Part (ii) of Proposition 2 characterizes how foreign firms would price under conditions consistent with Anderson's (1992, 1993) domino dumping environment. In this case, a higher Pr(*VER*) will give foreign firms incentive to lower their export price (i.e., dump more) because VER rents are positively correlated with pre-VER market share. Part (iii) of Proposition 2 characterizes how foreign firms would price under conditions consistent with an environment where the foreign firm's share of the VER rents depends inversely on how high AD duties would be if the VER negotiations broke down. In this case, an increase in the Pr(*VER*) would induce foreign firms to raise prices (i.e., reduce dumping) in order to improve their bargaining position in a VER negotiation.

Given Proposition 2, we can now discuss how firms that are initially uncertain about eventual outcomes, change their pricing behavior once they are investigated and face AD duties with certainty in the administrative review process. In contrast to the certain AD enforcement case, we may now observe some firms reducing their AD duties through the review process. Corollary 1 demonstrates this for the case of an *ex ante* Pr(*ADD*) less than one:

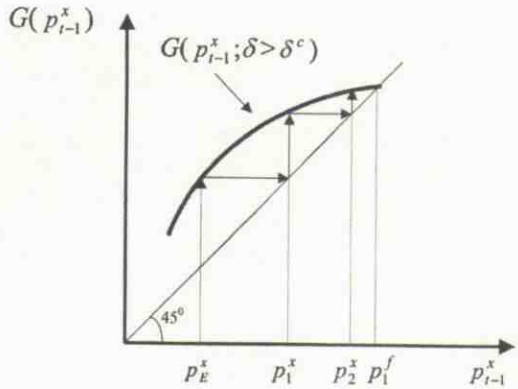

FIGURE 3. DYNAMIC PRICING DECISION FOR A FIRM WITH A LOW *EX ANTE* PROBABILITY OF AD ENFORCEMENT THAT IS THEN SUBJECT TO AD DUTIES

COROLLARY 1: *Denote the stationary equilibrium export price under certain AD enforcement as p_S^x.*[16] *Given $p_S^x >$ arg $\max_{p^x}[(p^x - c)q(p^x)]$, there exists a critical probability of an ADD case,* $\Pr^c(ADD)$, *such that the foreign firm sets its initial optimal export price below p_S^x for* $\Pr(ADD) < \Pr^c(ADD)$. *If an AD duty is enforced, then the foreign firm will choose its pricing path so that its export price converges to p_S^x, decreasing the AD duty toward $\tau_S \equiv p_1^f/p_S^x$ (if $p_S^x = p_1^f$, no AD duty) through the subsequent administrative review process.*

(See Blonigen and Park, 2001, for proof.)

Corollary 1 tells us that, for a low enough Pr(*ADD*), all firms will "shade" or lower their export price below the price they would choose if they were certain to get caught dumping. Thus, when they are caught dumping and face certain AD duty calculations through the administrative review process, they will gradually raise export price to the stationary equilibrium price chosen under certain AD enforcement. Figure 3 shows a representative optimal policy correspondence function, $G(p_{t-1}^x)$, for a foreign firm that cares enough about the future that it would not dump if AD enforcement was certain. If the probability of getting caught and facing

[15] Because Pr(*ADD*) + Pr(*VER*) + Pr(*NEG*) = 1, a decrease in Pr(*ADD*) with Pr(*VER*) constant, implies an increase in Pr(*NEG*). This (induced) change in Pr(*NEG*) does not influence the optimal choice of p_E^x because it simply changes the total magnitude of the discounted profit to be maximized: $(p_E^x - c)q(p_E^x) + \delta[\Pr(ADD)V(p_E^x) + \Pr(VER)V^T(p_E^x)]$ is multiplied by $1/[1 - \Pr(NEG)]$, as shown in (5).

[16] Kevin D. Cotter and Park (2002) show that a unique stationary equilibrium exists under certain AD enforcement.

AD duties is low enough though, the firm will price below the fair value (p_E^x in Figure 3). Then, if it is caught and faces duties, it will raise its price (reducing dumping) over time in the administrative review process as shown by the arrows converging back to where $G(p_{t-1}^x)$ intersects with the 45° line at p_1^f.

We can derive similar results to those in Corollary 1 for the dynamic path of AD duties for Pr(*VER*), which follow directly from Proposition 2, parts (ii) and (iii). In particular, dumping behavior may lead to better settlement terms for the foreign firm due to competition for export licenses under the settlement, as discussed by Anderson (1992, 1993). In this case, a *high* enough Pr(*VER*) exists such that the firm would price lower than it would under certain enforcement. Once it becomes subject to AD duties, this effect from the *ex ante* Pr(*VER*) would work toward reducing AD duties over time. Alternatively, a firm anticipating a VER may want to dump less initially because this strengthens its VER bargaining position. In this case, imposition of AD duties could lead to increases (or lower decreases) in AD duties over time for those firms that held a high *ex ante* Pr(*VER*). These alternative behaviors, which are tied to VER expectations, are an empirical question that we address in the next section.

On a final note, our analysis above was simplified by two seemingly strong assumptions. The first such assumption was that the foreign firm's pricing behavior does not affect the likelihood of an AD petition and/or the probability of AD duties. For many cases this may be reasonable, as a firm is just one of many firms investigated and the crucial injury determination by the USITC considers the cumulative effect of dumping by all investigated firms. However, we can show that our theoretical predictions are qualitatively identical if the probability of an AD petition is positively correlated with dumping by a foreign firm. We also assumed certainty in enforcement of outcomes after an affirmative AD case has occurred. We considered an alternative (not reported here) where a foreign firm is uncertain whether it will face a "strong" petitioner that may make it difficult for the firm to reduce the AD duty after the case, even if it raises its export price. While this extension can lead to a richer set of outcomes, it does not change our basic hypotheses about how *ex ante* probabilities may affect AD duty changes after the case.

III. Empirical Methodology

The previous theoretical section develops a dynamic pricing model for firms facing U.S. AD duties. In this section, we use detailed data from U.S. AD investigations filed during the 1980–1995 period to empirically examine the implications that emerge from the model with uncertain enforcement relating *ex ante* expectations to patterns of AD recalculations over time. Corollary 1 predicts that a higher *ex ante* likelihood of an affirmative decision should make it less likely that we observe a firm raise its price (lower its dumping) once an AD case leads to AD duties. Similarly, our model shows that a higher *ex ante* likelihood of a termination/VER outcome could cause an increase or a decrease in dumping when AD duties occur, depending on how VERs are negotiated and export licenses are distributed.

A direct examination of these implications would use price data. However, data on prices set by foreign firms are unobservable. Instead, data on AD duties and recalculations of these duties from administrative reviews allow us to track pricing decisions by the foreign firms over time. To the extent that these changes in AD duties over time reflect changes in the U.S. price only, they give a good measure of dynamic changes in U.S. prices from which we can test implications of the previous theoretical section. As discussed earlier, Gallaway et al. (1999) provides evidence that the majority of dumping margin changes stem from changes in the U.S. price, not measures of fair value.

To examine our hypotheses, we need to relate these foreign firms' price changes (reflected in AD duty changes) to foreign firms' *ex ante* expectations of an AD case outcome. To accomplish this we employ a two-step estimation procedure. In the first step, we estimate *ex ante* probabilities of case outcomes using data on U.S. AD petition filings and outcomes prior to the firm's own case. In the second step, we test whether these estimated *ex ante* probabilities affect the change in the AD duty after an affirmative AD case, controlling for other factors. The following subsections provide more detail on each of these estimation steps.

A. *First-Stage Estimation of Ex Ante Probabilities*

In the first stage, we estimate the *ex ante* probabilities of various AD case contingencies. These probabilities can be broken into two separate components: the probability that an industry will file an AD petition and the probabilities of various case outcomes conditional on an AD case petition. For example, the probability that a foreign firm will be subject to an AD case that leads to AD duties in a given year is the probability that the U.S. domestic industry will file a petition multiplied by the probability that the U.S. government will rule affirmative and assess AD duties.

To estimate the probability of an AD *petition filing,* we sample all 4-digit SIC manufacturing industries and use a logit estimation procedure where the dependent variable is "1" if a petition is filed in an industry in a given year, and "0" otherwise. Then, to estimate the probabilities of AD *case outcomes* conditional on a petition being filed, we sample the data from the AD cases we observe and use a multinomial logit specification where our dependent variable indicates three possible outcomes for an AD case: (1) an affirmative decision with AD duties, (2) a negative decision with no duties imposed, and (3) a termination, withdrawal, or suspension of the case due to a negotiated (VER) agreement between the domestic and foreign firms. Below we discuss sensitivity of results to alternative categorizations of AD case outcomes.

To estimate *ex ante* probabilities, we use only the previous years in the sample for both sets of probability estimations (petition probability and case outcome probabilities). For example, to estimate probabilities for 1986 U.S. AD cases in our sample, we use data for only the years from 1980 to 1985. This assumes that firms do not use information prior to the beginning of our sample in 1980 to form expectations. This is a reasonable assumption since a substantial U.S. AD law change occurred in 1979 that led to a drastic increase in U.S. AD petitions and success rates. It also assumes that firms do not have better information than we do to form expectations.

For each set of probabilities, we rely on previous literature to specify our explanatory variables. A number of studies have estimated petition probabilities for U.S. manufacturing industries, including J. Michael Finger (1981), Mark G. Herander and J. Brad Schwartz (1984), Robert M. Feinberg and Barry T. Hirsch (1989), Wendy L. Hansen (1990), Krupp (1994), Frank Lichtenberg and Hong Tan (1994), Staiger and Wolak (1994), and Taiji Furusawa and Prusa (1996). From these studies, import penetration and industry employment (or size) are consistently the variables that best explain cross-sectional petition probabilities. The import penetration variables capture how the domestic industry is faring relative to import competitors, which should affect their incentives to file a petition and are criteria used by the USITC in determining injury. The size variable indicates the importance of the industry to the U.S. economy, which may affect the USITC's willingness to grant trade protection. Thus, we include the share of imports to domestic consumption and the square of this variable to control for import penetration, and employment for the 4-digit SIC industry. We lag these variables one year, as it may take some time for the industry to organize a petition.[17] We expect import penetration to positively affect the probability of an AD petition, with the quadratic term potentially negative in sign, and employment to be positively related to petition probability. Unlike previous studies, we also include a variable that indicates whether the industry has filed an AD petition previously. We expect a positive relationship between this variable and petition probability, since familiarity with the AD petitioning process would presumably lower costs of future petitions. There may be a number of time-invariant industry characteristics that would affect petition filings, such as those that would influence the ability of the industry to organize and jointly support an AD petition. To control for these characteristics, we estimate a random-effects specification of our

[17] In addition, the USITC may look at economic conditions up to three years prior to the petition in determining the eventual outcome of the case. However, Michael M. Knetter and Prusa (2000) also lag these variables one year in their estimation of country-level AD petition filings and find no qualitative difference when they use three-year lags.

logit model. Finally, to control for macroeconomic shocks that may affect petition filing, we follow Knetter and Prusa (2000) and include GDP growth and the exchange rate (a multilateral index of the U.S. exchange rate in terms of foreign currency per dollar). We also include year dummies.

A number of empirical papers have examined the factors that determine the injury determination by the USITC which in turn, largely determines whether a U.S. AD case will be ruled affirmative or negative. These studies include Finger et al. (1982), Robert E. Baldwin (1985), Michael O. Moore (1992), James M. DeVault (1993), and Hansen and Prusa (1996, 1997). Determinants of withdrawn/suspended cases are estimated by Maurizio Zanardi (2000). We draw on these studies for specifying our matrix of explanatory variables.

First, there are a number of economic criteria that the USITC uses in considering whether to rule affirmative with respect to the injury decision. Import penetration and significance of the domestic industry are main factors. Thus, as with petition filing probability estimation, we include the share of imports to domestic consumption and the square of this variable to control for import penetration, and industry employment for the 4-digit SIC industry. We expect greater import penetration and higher industry employment to increase the likelihood of affirmative and terminated/suspended outcomes. Zanardi (2000) points out that settlements may be most likely for cases involving large, high-profile industries. This suggests that the effect of import and employment levels on the probability of a terminated/suspended outcome can be larger than that for an affirmative outcome.

One problem with using 4-digit SIC industry data is that it may not match very well the more narrowly defined products involved in AD cases. From the specific AD cases, we are able to gather information on import volumes of the investigated product. Thus, we include these product-specific import volumes and import volumes squared, expecting positive and negative coefficients, respectively.[18]

Noneconomic factors have been found to affect AD case outcomes in the previous studies as well. Many studies have found that certain regions are more likely to receive certain outcomes than others. Studies on the USITC decisions find that cases against EU countries are more likely to receive a negative outcome, while cases against Japan and nonmarket economies are more likely to receive affirmative outcomes. Zanardi (2000) finds that EU and nonmarket countries are more likely to have settled cases. We include region dummies for the EU, nonmarket countries, Japan, Asian NICs, and less developed countries.

Another common focus is whether steel and steel-related industries receive different outcomes, everything else equal, because so many U.S. AD cases cover these products and they were often high profile trade disputes. Previous studies on the USITC decisions often find these industries more likely to receive affirmative decisions. Also, a disproportionate number of steel-related AD cases appear to end with settlements/VERs as well, though Zanardi (2000) does not find a statistically significant steel effect. We include variables to capture industry effects for steel (SIC 3312, 3313, and 3315) and steel pipes and tubes (SIC 3317).[19,20] Another industry control we include is the 4-firm concentration ratio.

As with petition filing, past outcomes may correlate with current outcomes. One explanation for this correlation is learning effects on the part of the petitioners and government agencies. Thus, we include three separate dummy variables indicating whether a product has been involved in a previous affirmative U.S. AD outcome, a negative U.S. AD outcome, or a terminated/suspended U.S. AD outcome. Finally, we include GDP growth and exchange rates to control for macroeconomic conditions.

[18] Import penetration for the investigated product, rather than simply import volumes, would obviously be a preferred variable. However, domestic shipment data of the investigated product is often suppressed from the USITC reports accompanying the AD case.

[19] There may be reasons to include year dummies in this estimation stage, but in a number of years there are only one or zero instances of a particular case outcome (particularly terminated/suspended) which leads to collinearity problems with including year dummies.

[20] With the exception of steel products, AD cases cover a wide variety of industries with often only a few cases in a particular industry, making it difficult to include systematic industry dummies.

B. *Second-Stage Estimation of AD Duty Changes*

In the second stage, the focus of our empirical analysis, we sample all firm and product combinations that were subject to an affirmative U.S. AD decision during our sample period, and examine whether changes in the AD duties subsequent to the affirmative case are related to the *ex ante* unconditional AD case outcome probabilities estimated in the first stage. As discussed in Section I, AD duty changes through administrative reviews can be initiated every year at the anniversary date of the initial AD orders. Since these reviews may take a number of years to be completed in practice, we examine changes in the AD duty in the four years subsequent to the case. This time period is long enough so that foreign firms that initiated administrative reviews had experienced at least one change in the AD duty. Corollary 1 implies only the direction of the change we should observe; i.e., whether we should be more likely to see an increase or decrease in the AD duty. Thus, we begin with a probit specification, where the dependent variable takes the value of "1" if we see the AD duty stay the same or increase after the case and "0" otherwise (i.e., a decrease). Alternatively, Corollary 2 of Blonigen and Park (2001) shows that these *ex ante* probabilities should also relate to the percentage change we observe in the AD duty. This is a more specific implication that we examine using a continuous dependent variable defined as the percentage change in the AD duty (in decimal form) in the four years subsequent to the case. Since a significant number of margins (83 or 16 percent) were reduced to zero during this time period, we use a tobit specification truncated at -1.

Our main regressors are the estimated *unconditional* probabilities of an affirmative and terminated/suspended probabilities estimated in the first stage. These are the conditional probabilities of affirmative and terminated/suspended probabilities multiplied by the probability of petition. We exclude the unconditional probability of a negative decision to avoid perfect collinearity, as the three unconditional probabilities necessarily sum to one for each observation. In part B of Section V, we also discuss further controls in this regression which we add after first presenting results for this most basic regressor matrix.

One significant concern with this specification is that the regressors are generated from previous regressions. This can lead to biased standard errors, as shown by Adrian Pagan (1984). Since there is no available formula for the covariance matrix when one introduces probabilities from logit and multinomial logit estimations into a probit or tobit equation, we generate bootstrapped standard errors in this second-stage estimation.

IV. Data

Our sample for the first-stage estimates of the AD *petition* probabilities consists of data for all 4-digit SIC (1972, revision 2) U.S. manufacturing industries from 1980 to 1994. Data on U.S. AD petitions and investigated tariff-line codes were collected from *Federal Register* notices and concorded to 4-digit SIC using the NBER Trade Database developed by Robert C. Feenstra. Imports from the NBER Trade Database were combined with 4-digit SIC-level shipment data from the NBER Manufacturing Industry Productivity Database developed by Eric J. Bartelsman, Randy A. Becker, and Wayne B. Gray, to construct the import penetration variables. Industry employment data were also obtained from this latter NBER database. GDP growth and a trade-weighted multilateral index of the dollar (in terms of foreign currency per U.S. dollar) came from the *Economic Report of the President.*

Our sample for the first-stage estimates of AD *case outcome* probabilities consists of all U.S. AD manufacturing cases filed between 1980 and 1994. Data on AD cases were collected from *Federal Register* notices. We define terminated/VER cases as only those where a VER or other formal settlement is publicly announced, and classify other withdrawn or terminated cases as negative outcomes. Below, we discuss how results vary when we categorize these cases in an alternative manner. Thus, of the 715 case determinations for which we have observable data, 296 (41 percent) are categorized as affirmative, 338 (48 percent) are categorized as negative, and the remaining 81 (11 percent) are categorized as terminated/VER. Industry data on import pene-

TABLE 1—DESCRIPTIVE STATISTICS FOR ENTIRE FIRST-STAGE SAMPLE OF VARIABLES, 1980–1994

Variables	Mean	Standard deviation	Minimum	Maximum
Random-effects logit estimates of petition probabilities				
Dependent variable: "1" = petition; "0" = no petition	0.038	0.190	0.000	1.000
Independent variables:				
Import penetration share lagged	13.484	15.669	0.000	95.801
Import penetration share lagged and squared	427.29	1,017.78	0.000	9,177.87
Industry employment lagged (in 000s)	40.105	61.544	0.000	694.000
Real GDP growth rate	2.747	2.198	−2.023	7.263
Exchange rate index (1981 = 100)	94.822	13.076	81.500	121.100
Previous AD petitions	0.150	0.357	0.000	1.000
Multinomial logit estimates of case outcomes				
Dependent variable: "1" = affirmative; "2" = negative; "3" = terminated/VER	1.706	0.659	1.000	3.000
Independent variables:				
Import penetration share lagged	14.014	9.010	0.217	57.698
Import penetration share lagged and squared	277.47	463.40	0.047	3,329.07
Industry employment lagged (in 000s)	117.71	128.69	1.300	632.40
Real GDP growth rate	2.683	2.310	−2.023	7.263
Exchange rate index (1981 = 100)	96.271	14.606	81.500	121.10
Import value of investigated product	33,826	83,351	0.000	859,800
Import value of investigated product squared	8.08E+09	4.82E+10	0.000	7.39E+11
Previous affirmative decision	0.551	0.498	0.000	1.000
Previous negative decision	0.592	0.492	0.000	1.000
Previous terminated/VER decision	0.452	0.498	0.000	1.000
Four-firm concentration ratio	37.538	16.212	9.000	100.00
Iron and steel products	0.263	0.441	0.000	1.000
Steel pipe products	0.084	0.277	0.000	1.000
Nonmarket economy	0.115	0.319	0.000	1.000
Less developed country	0.488	0.500	0.000	1.000
European Union	0.298	0.458	0.000	1.000
Japan	0.122	0.327	0.000	1.000
Asian NICs	0.158	0.365	0.000	1.000

tration and employment come from the same sources as indicated above. Import volumes for the particular products involved in the case were taken from the USITC reports and estimated when not available by collecting trade volumes of the subject tariff line codes from the NBER Trade Database. Concentration ratio data at the 4-digit SIC level are for the year 1987 and are obtained from the Census of Manufactures. Table 1 gives the descriptive statistics for the variables we use in our first-stage estimations for the entire sample from 1980 through 1994 for both the logit estimates of petition probabilities and the multinomial regressions of AD case outcomes.[21]

[21] Many of the U.S. AD data used for this study can be found at the following Web page developed by Blonigen: http://darkwing.uoregon.edu/~bruceb/adpage.html.

Our sample for the second-stage estimates consists of all manufacturing firm-product combinations subject to U.S. affirmative AD decisions and AD duties for U.S. AD investigations filed between 1980 and 1995. Much of the data were initially collected by James C. DeVault from *Federal Register* notices and the USITC reports (See DeVault, 1996, for more details on data collection). Information available from these data sources includes firm-specific AD duties both at the time of the initial case, and in subsequent administrative reviews. As discussed, these AD duties are estimated dumping margins and reflect differences in the firm's U.S. price and a definition of "normal" value, which is often the foreign firm's price in its own market. The evidence from our sample is that there is substantial variation in AD duty changes from administrative review. Out of the 518 firm-specific initial AD duties in our

TABLE 2—RANDOM-EFFECTS LOGIT ESTIMATION OF FIRST-STAGE DETERMINANTS OF U.S. AD PETITION PROBABILITY

	Dependent variable: "1" if petition; "0" otherwise		
Explanatory variables	Estimation for 1985 (using 1980–1984 data)	Estimation for 1990 (using 1980–1989 data)	Estimation for 1995 (using 1980–1994 data)
Import penetration share lagged	0.050*	0.063***	0.072***
	(0.030)	(0.019)	(0.016)
Import penetration lagged and squared	−0.001	−0.001***	−0.001***
	(0.001)	(0.0004)	(0.0003)
Industry employment lagged	0.005***	0.004***	0.003***
	(0.001)	(0.001)	(0.001)
Real GDP growth rate	−0.014	−0.011	−0.011
	(0.050)	(0.048)	(0.048)
Exchange rate index (1981 = 100)	−0.028	−0.023	−0.022
	(0.018)	(0.017)	(0.017)
Previous AD petitions	2.532***	2.160***	2.076***
	(0.289)	(0.185)	(0.154)
Chi-squared statistic	125.88***	225.25***	312.87***
Pseudo-R^2	0.19	0.16	0.15
Number of observations	2,159	4,323	6,463

Note: Standard errors are in parentheses, with ***, **, and * denoting statistical significance (two-tailed test) at the 1-, 5-, and 10-percent levels, respectively.

sample, 243 (46.9 percent) were subsequently reviewed at least once.[22] On average, AD duties fall almost 25 percent in the first four years after the AD case. However, there were 33 cases (6.4 percent) where the AD duty increased after the first administrative review.

V. Empirical Results

A. *First-Stage Estimates of Ex Ante Probabilities*

In the first stage we perform both random-effect logit estimations of the petition probability and multinomial logit estimates of the AD case outcomes. For both sets of estimations, we estimate separate regressions for each year from 1982 through 1995 using the data from previous years back to 1980 in order to construct *ex ante* probabilities of AD case outcomes for our second stage.[23] For the sake of space, Tables 2 and 3 present coefficient estimates from only three of the 13 subsamples in the estimations for petition and AD case outcome probabilities, respectively. In other words, we present estimates used to construct *ex ante* probabilities for years 1985, 1990, and 1995, using subsamples 1980–1984, 1980–1989, and 1980–1994, respectively. For the multinomial logit estimations of AD case outcomes, we normalize the coefficient estimates for a negative AD outcome to be zero, in order to identify and, hence, estimate the parameters of the model. Thus, Table 3 gives coefficient estimates for affirmative and terminated/VER outcomes, which are interpreted as effects relative to the negative outcome.

Both sets of regressions in Tables 2 and 3 show decent fit of the data even for the earlier 1985 subsample we report, though a greater number of variables are expected sign and statistically significant for later samples. We do not discuss the coefficient estimates to save space, except to note that they lead to the estimated probabilities seem quite reasonable. For example, the average estimated *ex ante* proba-

[22] We eliminated six outliers that involved very small initial AD margins, for which modest percentage point increases in AD margins translated into percentage increases over 500 percent. Elimination of these outliers does not affect our results qualitatively, but led to more reasonable coefficient magnitudes and increased the pseudo-R^2 measures substantially.

[23] Reasonably estimated *ex ante* probabilities for 1981 were not possible because of insufficient sample size.

bilities of case outcomes almost exactly match the actual sample average probabilities.

B. *Second-Stage Estimates*

Using the coefficient estimates from the first stage, we construct predicted *ex ante* probabilities of affirmative and terminated/VER AD outcomes to be used as regressors to test the implications from our theory regarding the *ex ante* probabilities and AD duty changes. Obviously, the constructed probabilities are only for the 518 firm-product combinations that became subject to affirmative AD decisions and, hence, AD duties. Column 1 of Table 4 provides probit estimates of whether we observe the AD duty stays the same or increases after an affirmative AD case. Here we only include the *ex ante* probabilities of affirmative and termination/VER and a constant as regressors. Column 3 of Table 4 provides tobit estimates of the percentage change in the AD duty after the case, using this same regressor matrix.

For both specifications, the coefficients on the *ex ante* probability of termination/VER are negative and statistically significant at the 1-percent level. In other words, firms anticipating a termination/VER outcome, but receiving AD duties instead, are *less* likely to keep their AD duties the same or increase them after the case. This empirical result provides significant support for Anderson's domino dumping view of VER negotiation incentives and firms' optimal responses to these incentives. The magnitude of the termination/VER probability coefficient is quite substantial. Whereas the probability of an average firm dropping their AD duty is 38.2 percent in the probit specification, a firm with an *ex ante* termination/VER probability one standard deviation (11.0 percentage points) higher than the average has a 58.7-percent probability of reducing its AD duty. Similarly, the tobit estimates suggest that a one-standard-deviation increase in the *ex ante* termination/VER probability means a 41.0-percentage-point decrease in the firm's AD duty beyond the average 24.8-percent decrease.

In contrast to the results on the termination/VER coefficient, the probit and tobit results reported in columns 1 and 3 of Table 4 fail to confirm our hypothesis with respect to the effect of the *ex ante* probability of an affirmative outcome. The coefficients are positive, as hypothesized, since firms placing a high probability of receiving AD duties should be the ones to not reduce their AD duties as much in the administrative reviews. However, the coefficients are not statistically significant. As we next show, this statistical insignificance can be attributed to omitted variable bias.

In particular, a potential concern with these estimates is that the USDOC changes its methods of AD duty calculations over time due to a variety of regulatory changes, appeals court decisions, and staff turnover.[24] In addition, from 1980 to 1984, administrative reviews occurred automatically each year at the anniversary of the affirmative AD decision, whereas after 1984 these reviews occurred only if an interested party (a foreign or domestic firm involved in the case) requested a review. This structural change in the law may also alter the dumping margin changes that we observe. Because it is difficult to observe these numerous changes, we control for potential changes in AD duty calculation practices in a general way by including year dummies as controls. A related concern is the USDOC's handling of nonmarket economies where price data may not exist. This allows the USDOC to use a variety of methods to estimate dumping margins. In addition, firms from nonmarket economies may not be profit-maximizing, which violates the profit-maximizing assumption of our theory. Thus, we include a dummy variable that indicates observations that involve nonmarket economies. A final concern is that a number of cases were revoked within the four-year window on which we focus. We record these as cases where the AD duty decreased 100 percent under the rationale that revocations occur because the foreign firm completely reduced its AD duty. However, revocations may occur for a variety of alternative reasons which may not be due to any change on the part of the foreign firm. Thus, we include a

[24] Parties involved in U.S. AD cases have recourse to appeals with the U.S. Court of International Trade, which then often rules on various practices used by the USDOC to calculate AD duties. Parties also have recourse to dispute panels connected with the WTO, if they are a WTO member, or with NAFTA, if they are from a NAFTA country. These panels likewise can make decisions that lead to changes in the USDOC practices.

TABLE 3—MULTINOMIAL LOGIT ESTIMATION OF FIRST-STAGE DETERMINANTS OF U.S. AD CASE OUTCOME PROBABILITIES

	Dependent variable: "1" if affirmative; "2" if negative; "3" if terminated/VER		
Explanatory variables	Estimation for 1985 (using 1980–1984 data)	Estimation for 1990 (using 1980–1989 data)	Estimation for 1995 (using 1980–1994 data)
Determinants of affirmative outcomes			
Industry import penetration share lagged	−0.108	−0.056	−0.113***
	(0.069)	(0.042)	(0.030)
Industry import penetration lagged and squared	0.002*	0.001	0.002***
	(0.001)	(0.001)	(0.001)
Industry employment lagged	0.003	0.0003	0.0003
	(0.002)	(0.001)	(0.001)
Real GDP growth rate	−0.088	−0.063	0.032
	(0.076)	(0.055)	(0.045)
Exchange rate index (1981 = 100)	−0.004	−0.006	−0.007
	(0.030)	(0.010)	(0.007)
Import value of investigated product	−1.13e−06	3.87e−06	5.15e−06*
	(1.10e−05)	(3.99e−06)	(2.71e−06)
Import value of investigated product squared	1.51e−11	−3.67e−12	−5.25e−12
	(5.57e−11)	(7.19e−12)	(4.35e−12)
Previous affirmative decision in investigated product	0.987*	1.161***	0.597**
	(0.598)	(0.307)	(0.249)
Previous negative decision in investigated product	1.615***	0.367	0.074
	(0.570)	(0.307)	(0.247)
Previous terminated/suspended decision in investigated product	−0.929	−0.644	−0.464
	(0.923)	(0.433)	(0.285)
Industry four-firm concentration ratio	−0.022	−0.009	−0.010*
	(0.014)	(0.007)	(0.006)
Iron and steel products	−0.555	−0.429	0.268
	(1.166)	(0.554)	(0.341)
Steel pipe products	0.276	0.015	1.103***
	(1.013)	(0.519)	(0.386)
Nonmarket economy	0.250	0.491	0.804**
	(0.821)	(0.494)	(0.324)
Less developed country	0.195	0.402	0.398
	(0.816)	(0.444)	(0.340)
European Union	−0.067	−0.202	0.022
	(0.711)	(0.411)	(0.328)
Japan	1.205	0.943**	1.102***
	(0.789)	(0.471)	(0.382)
Asian NICs	−0.333	0.020	0.001
	(0.791)	(0.385)	(0.275)
Determinants of terminated outcomes			
Industry import penetration share lagged	1.410*	0.218	0.008
	(0.750)	(0.233)	(0.098)
Industry import penetration lagged and squared	−0.063**	−0.008	0.0002
	(0.030)	(0.007)	(0.002)
Industry employment lagged	0.001	0.003	0.005**
	(0.005)	(0.003)	(0.002)
Real GDP growth rate	0.042	0.036	0.001
	(0.120)	(0.088)	(0.077)
Exchange rate index (1981 = 100)	0.033	0.081***	0.083***
	(0.059)	(0.029)	(0.016)
Import value of investigated product	3.03e−05**	1.93e−05***	1.59e−05***
	(1.29e−05)	(6.84e−06)	(4.78e−06)
Import value of investigated product squared	−3.19e−11	−1.99e−11	−1.76e−11**
	(5.40e−11)	(1.30e−11)	(8.15e−12)
Previous affirmative decision in investigated product	0.628	0.830	0.291
	(1.038)	(0.739)	(0.596)

TABLE 3—*Continued.*

Explanatory variables	Dependent variable: "1" if affirmative; "2" if negative; "3" if terminated/VER		
	Estimation for 1985 (using 1980–1984 data)	Estimation for 1990 (using 1980–1989 data)	Estimation for 1995 (using 1980–1994 data)
Previous negative decision in investigated product	−0.212	−0.695	0.082
	(0.896)	(0.740)	(0.572)
Previous terminated/suspended decision in investigated product	−0.221	−0.044	−0.784
	(1.114)	(0.772)	(0.648)
Industry four-firm concentration ratio	−0.054	−0.024	0.009
	(0.044)	(0.029)	(0.018)
Iron and steel products	2.703*	2.102**	1.675**
	(1.424)	(1.014)	(0.736)
Steel pipe products	3.611***	2.583***	3.204***
	(1.406)	(0.880)	(0.785)
Nonmarket economy	2.868**	1.820***	1.538***
	(1.151)	(0.642)	(0.563)
Less developed country	−2.062	−0.063	0.323
	(1.270)	(0.652)	(0.594)
European Union	−0.939	0.365	0.416
	(1.159)	(0.669)	(0.591)
Japan	−1.857	0.565	0.034
	(1.579)	(1.010)	(0.870)
Asian NICs	−1.607	−2.009*	−1.741**
	(1.447)	(1.136)	(0.848)
Chi-squared statistic	142.33***	230.08***	284.85***
Pseudo-R^2	0.31	0.25	0.21
Number of observations	214	448	715

Note: Standard errors are in parentheses, with ***, **, and * denoting statistical significance (two-tailed test) at the 1-, 5-, and 10-percent levels, respectively.

dummy variable that indicates cases which were revocations of the AD duties, not changes due to standard administrative reviews.

Columns 2 and 4 of Table 4 present our results from our two specifications when we include these additional controls. Both the nonmarket economy and revocation variables have expected signs and are statistically significant. Our estimates suggest that nonmarket economies are less likely to have AD duties fall, while revocations lead to substantially larger decreases in the AD duty, as expected. In addition, chi-squared tests strongly support the inclusion of year dummies. The inclusion of these controls also increases the pseudo-R^2 substantially for both specifications.

Importantly, controlling for these additional variables leads to a statistically significant positive coefficient on the *ex ante* probability of an affirmative outcome in both specifications, confirming our hypothesis with respect to this variable. The coefficient estimate is also economically significant. In the probit results, the coefficient estimate suggests that a standard deviation increase in the *ex ante* probability of an affirmative outcome (6.2 percentage points) will increase the likelihood (from 61.8 percent to 67.5 percent) that the AD duty will not decrease. The tobit estimates imply that a standard deviation increase in the *ex ante* probability of an affirmative outcome will mean that the AD duty will drop only 17.6 percent, rather than the average 24.8-percent decline.

The *ex ante* probability of a terminated/VER outcome continues to be statistically and economically significant in both specifications. The magnitude of the coefficient falls by approximately 50 percent in both specifications, but this still means substantial effects on the dependent variable. For example, in the tobit specification a standard deviation increase in the *ex ante* termination/VER probability results in a further 21.9-percentage-point decrease in the AD duty from the average 24.8-percent decrease in the sample.

We also tried a number of alternative

TABLE 4—ESTIMATION OF SECOND-STAGE DETERMINANTS OF AD MARGIN CHANGES AFTER AFFIRMATIVE AD OUTCOMES

	Probit estimation		Tobit estimation	
Regressors	No controls	Controls	No controls	Controls
Focus variables				
Ex ante probability of	0.882	2.385**	0.642	1.167**
AFFIRMATIVE outcome	(0.958)	(1.109)	(0.529)	(0.557)
Ex ante probability of	−4.848***	−2.379*	−3.725***	−1.990***
TERMINATION/VER outcome	(0.762)	(1.351)	(0.681)	(0.653)
Control variables				
Nonmarket economy		0.648***		0.133*
		(0.249)		(0.071)
Revocation of AD duty		−1.530***		−1.218**
		(0.391)		(0.480)
Year dummies		Yes		Yes
Chi-squared statistic	47.51***	157.60***	82.55***	194.73***
Pseudo-R^2	0.07	0.23	0.07	0.17
Number of observations	518	518	518	518

Note: Dependent variable for tobit estimation is the four-year percentage change in the AD duty, while the dependent variable for the probit estimation is a dummy variable that takes the value of "1" if AD duty does not decrease and "0" otherwise. Bootstrapped standard errors are in parentheses, with ***, **, and * denoting statistical significance (two-tailed test) at the 1-, 5-, and 10-percent levels, respectively.

specifications to check the sensitivity of our results. First, in the initial specifications, we took a strict definition of terminated/VER cases, in the sense that we included only those cases where VERs or settlements were publicly announced. Any other withdrawn or terminated cases were treated as negative outcomes for our estimation of the *ex ante* probabilities. However, as indicated by Prusa (1992), many withdrawn cases may be due to private settlements that yield similar outcomes for the involved firms. Thus, as an alternative we categorized all such cases as terminated/VER cases, rather than negative outcomes. When we do this, our results are qualitatively similar to those reported in Table 4. However, the coefficient on the terminated/VER probability falls by about a third in both specifications. This may suggest that it is improper to include these withdrawn cases with no publicly announced settlements as ones where a public settlement was reached. Alternatively, private settlements may not elicit the same pricing behavior induced by "domino dumping" that our results suggest is occurring with public settlements.[25]

[25] Christopher T. Taylor (2001) and Staiger and Wolak (1994) find little evidence that withdrawn cases lead to market outcomes that are consistent with private collusive settlements.

A second set of robustness checks were done on our estimated first-stage probabilities. For our reported results, we estimated using only sample data prior to the year of the observation. Our results yield qualitatively identical results when we estimate these "*ex ante*" probabilities using the full sample for every observation or, alternatively, when we estimate with data from only the five years prior to the observation. This may be surprising until one recalls the fairly stable coefficient estimates for our estimated probabilities across the varying samples reported in Tables 2 and 3.

VI. Conclusion

Our theoretical model under certain enforcement of AD policy can explain what is seemingly unreasonable behavior by foreign firms subject to AD duties: not all the foreign firms try to take advantage of the administrative review process by raising their export prices to lower AD duties. Some may discount the future enough so that dumping is optimal. This may be particularly true for firms with products that quickly become obsolete. We show that for those firms, the presence of AD duties will make the intertemporal trade-off between the current and

the future discounted profits more favorable to dumping behavior in the next period, yielding constant or higher AD duties through the review process. Introducing uncertain enforcement of AD policy into our model reveals incentives for the foreign firms to reduce their AD duties through the review process. Once a foreign firm is subject to AD duties, the firm may adjust its prices so that AD duties fall over time in subsequent reviews, depending on its *ex ante* expectations and discount rate.

The empirical results support the theoretical model with uncertain enforcement by showing that a lower *ex ante* probability of AD duties correlates with a greater reduction in AD duties in the administrative review after controlling for the USDOC procedural idiosyncrasies. The empirical results also provide systematic empirical evidence of behavior consistent with Anderson's (1992, 1993) well-known domino dumping model.[26] In Anderson's model, firms with *ex ante* expectations that an antidumping investigation will likely lead to a settlement dump more in anticipation of VER rents based on export market share. Our model, in turn, shows that when such firms then receive AD duties instead of a settlement, their increase in prices in subsequent periods to reduce those AD duties will be more substantial. Our empirical results support this scenario by finding that a higher *ex ante* expectation of terminated/VER outcome substantially lowers AD duties in subsequent periods, all else equal.

There are various ways to extend the current theoretical model, which could also lead to further empirical analysis. We can study how different types of uncertainties, such as fluctuations in exchange rates or in product demands, affect firms' dynamic pricing under AD policy. We can also analyze how the vertical relationship between a foreign exporter and a domestic importer may affect the foreign firm's dynamic pricing path. In addition, there may be additional reasons for falling AD duties that we have not explored. For example, as one referee suggests, the demand structure may be such that firms find it optimal to dump when entering markets to establish market share and then lower their dumping over time. It is also possible that cyclical dumping occurs in markets with fixed capacity (e.g., see Staiger and Wolak, 1992), leading to falling AD duties after the initial case. These theoretical extensions may generate a new set of testable predictions on dynamic pricing of firms subject to AD duties.

[26] Judith M. Dean (1996) is the only other related empirical study on this issue. She examines exports from Bangladesh to the United States in textiles and apparel and finds evidence that a greater threat of VERs is correlated with export growth.

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