SPARE THE ROD, SPOIL THE FIRM?
A PLANT-LEVEL ANALYSIS OF THE EFFECTS OF TEMPORARY PROTECTION[1]

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Abstract

This paper examines whether temporary protection allows firms to make productivity-augmenting investments or promotes inefficiency by limiting international competition. Using a dataset that includes the full population of U.S. manufacturing plants, I show that traditional revenue productivity measures lead to the inaccurate conclusion that antidumping duties increase productivity. The apparent increases in revenue productivity associated with antidumping duties are primarily due to increases in prices and mark-ups, as physical productivity falls among protected plants. Moreover, antidumping duties slow the reallocation of resources from less productive to more productive uses by reducing product-switching behavior at protected plants.

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Section 1: Introduction

For decades, economists and policy-makers have debated whether temporary trade protection gives firms the "breathing room" to make productivity-augmenting investments or leads to inefficiency by limiting international competition. But even as temporary policies like antidumping duties have become a primary form of trade protection worldwide, the empirical evidence needed to evaluate these policies has been lacking. This paper provides the first micro-level evidence on the effects of antidumping duties in the United States with a dataset that includes the full population of U.S. manufacturing plants. Using output data measured in units of quantity, I show that traditional revenue productivity measures lead to the inaccurate conclusion that antidumping duties increase plant-level productivity. In addition, I show that antidumping duties slow the reallocation of resources to their most productive uses by reducing product-switching at protected plants. As a result, antidumping duties prevent the aggregate productivity gains emphasized in recent models of trade with heterogeneous firms.

The ability of antidumping duties to alter or halt trade flows is unparalleled. When aluminum sulfate from Venezuela was assigned a 259 percent antidumping duty in December 1989, annual U.S. imports from Venezuela fell 98 percent. Moreover, the use of antidumping duties is widespread in the U.S. economy. Sixteen of nineteen manufacturing sectors contain products that petitioned for antidumping protection.[3] But despite the importance and ubiquity of antidumping duties, there is disagreement about some of their most fundamental implications, including their effect on firm and plant-level productivity.

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[3] I define sectors at the 2-digit Standard Industrial Classification (SIC) level. SIC Sector 39, "Miscellaneous Manufacturing Industries," is excluded from the analysis.

On one hand, there is a substantial literature that suggests that any increase in tariffs should decrease productivity. In Melitz (2003), an increase in tariffs—or a failure to decrease tariffs—allows for the continued operation of low-productivity firms that would have otherwise exited, resulting in a decrease in mean firm-level productivity relative to free trade. In addition, Bernard, Redding and Schott (2009b), describe a channel for within-plant productivity growth during trade liberalization, which arises when plants drop their least productive products and reallocate resources to their most productive products. Pavcnik (2002) and Fernandes (2007) (for developing countries) and Bernard, Jensen and Schott (2006) (for the U.S.) provide empirical evidence showing that revenue productivity and nominal tariffs are negatively correlated.

In contrast, there is evidence that tariff protection—particularly temporary protection—can increase firm or plant-level productivity by increasing the incentive to invest in new technology. Matsuyama (1990) was among the first to show that temporary protection can speed up the time of technology adoption, while noting that the government's threat to remove protection if the domestic firm fails to invest is not credible. Similarly, Miyagiwa and Ohno (1995) show that protection can induce investment in a fixed-cost technology by increasing the market share of domestic firms. These theoretical models are supported by empirical results in Konings and Vandenbussche (2008) showing that revenue productivity increased among E.U. manufacturers receiving temporary antidumping protection.[4] As noted in that paper, however,

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[4] Konings and Vandenbussche (2008) find that antidumping duties were associated with increases in mean plant-level productivity. An important additional result is that antidumping duties allowed for technological catch-up by the least productive firms, while firms with high ex-ante productivities experience productivity declines.

increases in revenue productivity can be caused not only by increases in physical productivity, but also by increases in prices and mark-ups.

I examine these issues by comparing the behavior of a treatment group of plants that received protection to a control group of plants in similar industries that did not receive protection. As described below, this control group is constructed in a manner that eliminates two potential sources of bias: a self-selection bias that exists if industries that apply for protection differ from those that do not apply and a "government-selection bias" that arises if the government bases its decision of whether to provide protection on variables that are correlated with productivity. I employ a difference-in-difference estimator to estimate the effect of antidumping protection, which nets out time-invariant differences between the treatment and control groups, as well as macro-level shocks affecting the treatment and control groups identically. In addition, I examine whether variation in the effective antidumping duty rate and the duration of protection lead to heterogeneous responses to protection.

I find that the effect of antidumping duties on plant-level productivity depends crucially on whether output is measured in revenue or physical units of quantity. While antidumping protection is associated with increases in revenue productivity, these increases are driven primarily by increases in prices and mark-ups.[5] Antidumping duties actually lower physical productivity among the set of protected plants reporting output data in units of quantity.[6] These

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[5] I examine the effect of antidumping duties on both prices and mark-ups, since mark-ups will be less responsive to antidumping protection if suppliers are able to extract rents from protected plants through higher input prices.

[6] The physical productivity of the treatment group of protected plants will fall relative to the control group if antidumping duties allow low-productivity plants to continue producing low-productivity products. I present evidence showing that antidumping duties do reduce product-dropping behavior by low-productivity plants.

results underscore the importance of differentiating between revenue and physical productivity—a distinction described in Foster, Haltiwanger and Syverson (2008) and Syverson (2004)—that has received relatively little attention in the field of international trade.[7] In fact, this distinction is particularly important when considering the case of antidumping duties, since increases in prices and markups would likely be taking place at the same time as any changes in physical productivity.

Antidumping duties also provide a useful way of examining some of the best-known results from the heterogeneous-firm international trade literature. In particular, while most empirical research on the responses of firms to trade liberalization has focused on developing countries, antidumping protection provides an example of a major trade shock in a large, developed country—in this case, the United States. Moreover, in many heterogeneous-firm models, trade liberalization increases aggregate productivity as resources are shifted from less productive to more productive uses. By studying the imposition of antidumping duties, it is possible to examine whether some of these newly recognized benefits of trade liberalization are eliminated when protection is imposed.

One well-documented way that trade liberalization reallocates resources from low to high-productivity uses is through the exit of the least productive firms. In the theoretical literature, exit of low-productivity firms during trade liberalization is a key result of Melitz (2003), Bernard, Eaton, Jensen and Kortum (2003) and Bernard, Redding and Schott (2009b). These theoretical results are also supported by robust empirical evidence. Pavcnik (2002) and Bernard, Jensen and Schott (2006) have shown that decreases in trade costs bring about the exit

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[7] An important exception is a series of papers by Marcela Eslava, John Haltiwanger, Adriana Kugler and Maurice Kugler using Colombian data. See, for example, Eslava, Haltiwanger, Kugler and Kugler (2004).

of low-productivity firms and plants, yielding substantial increases in aggregate productivity. To examine whether antidumping protection slows this process, I compare the probability of exit among a treatment group of plants that received antidumping protection to that in a control group of unprotected plants.

Bernard, Redding and Schott (BRS) (2009a, 2009b) identify an additional channel for resource reallocation and productivity growth during trade liberalization, through product-switching by multi-product firms. BRS (2009b) provide a model of firms with exporting and production, where overall firm productivity is a combination of firm and firm-product-country components. Trade liberalization yields productivity growth by forcing firms to drop marginally productive products and by forcing the least productive firms to exit.[8] If antidumping protection allows low-productivity plants to continue producing low-productivity products, therefore, it will have negative effects on both plant-level and aggregate productivity. I examine the effect of antidumping duties on plants' product-switching activities by comparing the probability of dropping protected products in the treatment group to the probability of dropping products that did not receive protection in the control group.

I find that antidumping duties allow for continued production by low-productivity plants that otherwise would have stopped producing. Importantly, this effect manifests itself not through decreased plant-level exit—which the literature has focused on as the most important

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[8] There are important differences between the framework in BRS (2009b) and the temporary antidumping protection examined in this paper. First, BRS is based explicitly on a multilateral trade liberalization occurring as two countries move from a closed economy to an open-economy equilibrium. In antidumping duty proceedings, changes in trade policy are unilateral and are targeted against imports from a particular country. Second, BRS focuses on trade liberalization for all products. Antidumping duty investigations, on the other hand, involve a single product or a set of closely related products. Third, the trade liberalization in BRS is permanent, while antidumping duties are temporary.

channel for resource reallocation—but rather through a reduction in product-switching among protected plants. Protected plants are no less likely to exit than those that did not receive protection. But while low-productivity plants that are turned down for antidumping duties by the government react by dropping products, protected plants continue producing the same products. As a result, antidumping duties likely decrease the productivity gains that would otherwise occur as a result of product-switching.

By allowing for continued production by low-productivity plants, antidumping duties may eliminate the benefits of trade liberalization associated with output rationalization, where high-productivity plants increase their market share at the expense of low-productivity plants. I measure this effect by decomposing aggregate productivity into mean plant-level productivity and a term that measures the degree to which higher-productivity plants produce a larger share of output, as in Olley and Pakes (1996). I find that antidumping protection slows the process of output rationalization, decreasing aggregate productivity growth. While the degree of output rationalization is substantially higher among protected plants prior to receiving protection, the control group of unprotected plants increases its level of output rationalization as the antidumping duties set in. By the end of the period of analysis, the control group has overtaken the treatment group and exhibits a higher level of output rationalization.

The remainder of the paper is organized as follows. Section 2 describes the data. Section 3 provides a brief discussion of the antidumping investigation process in the United States, as well as a description of the products typically involved in antidumping investigations. Section 4 defines the treatment and control groups and describes the productivity measures employed in this paper. Section 5 describes the empirical strategy and reports results. Section 6 concludes.

Section 2: Data

This analysis uses data from the U.S. Census Bureau's Census of Manufactures (CM) for the years 1987, 1992 and 1997.[9] The CM is conducted every five years, in years ending in two and seven and all U.S. manufacturers, regardless of size, are required by law to respond.[10] The CM contains plant-level data on the value of shipments, as well as input data including the number of production and non-production employees, raw material usage and book value of capital, which can be used to calculate total factor productivity. In addition, the CM includes plant-product-level output data measured in revenue for every product and in physical units of quantity for some products.

An important benefit of the CM is the availability of output data measured in units of quantity for certain products. The availability of quantity-based output data allows for the calculation of physical productivity—described in detail below—as well as average unit prices and price-cost mark-ups. The ability to examine physical productivity, prices and mark-ups is extremely important when studying antidumping duties, since changes in physical productivity are likely accompanied by increases in prices and mark-ups. These quantity-based output data have been used in recent studies examining the differences between revenue and physical productivity, including Foster, Haltiwanger and Syverson (2008).

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[9] The choice of years is not arbitrary. In particular, this period of time was selected for two specific reasons. First, this is the only period for which a high-quality HS10-SIC5 concordance was available. See the Data Appendix and Pierce and Schott (2009b) for a detailed discussion of this concordance. Second, the years from 1987 to 1997 were a stable period in the SIC, with no major revisions to industry codes and only minor revisions to product-class codes taking place. This stability in the SIC was a major reason that the same Census years of 1987, 1992 and 1997 were used in Bernard, Redding and Schott's (2009a) analysis of the product-switching behavior of U.S. Manufacturers.

[10] The CM collects a limited set of data from small manufacturers, referred to in the data as "administrative records." Since input usage data may be imputed for administrative records, they have been excluded from the analysis. This exclusion of administrative records is standard in research employing the CM. See, e.g. Bernard, Redding and Schott (2009a).

It is important to define a number of terms that will be used throughout this paper. The term plant refers to a manufacturing establishment, which is a production facility located at a single physical location. Products and industries are 5-digit and 4-digit categories of the SIC, respectively.[11] A sub-industry is the set of plants producing a particular product. Lastly, an investigated product is a product that was involved in an antidumping investigation, regardless of the outcome of the investigation.

The use of plant-level data is an important innovation of this paper and provides many advantages over more aggregated data, even including firm-level data. Many firms involved in petitioning for antidumping protection are large multi-product manufacturers. In fact, some firms participated as petitioners in multiple antidumping investigations involving multiple products. Individual plants on the other hand, tend to produce a much narrower set of products than firms as a whole. The use of plant-level data, therefore allows for more accurate matching between the products named in contingent protection investigations and the facilities that actually produce those products.

In addition, I am able to greatly refine the identification of plants that did and did not receive contingent protection through the use of plant-product-level data contained in the CM. These data report the full list of products manufactured at each plant, as well as the value, and sometimes quantity, of shipments attributable to each product. The availability of this plant-product-level data represents an additional level of disaggregation beyond the "major industry" codes generally used to identify plants and firms in micro-level datasets.

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[11] The 1987 SIC contains 459 four-digit industries and 1,446 products.

The list of products involved in antidumping investigations in the United States is from version 3.0 of Chad Bown's Global Antidumping Database.[12] Products subject to antidumping investigations are identified using the Harmonized Tariff System (HTS) and products may be defined from the 4-digit level to the 10-digit level. In addition to a description of the products involved in each investigation, the antidumping database provides the dates and outcomes of each phase of the investigation—e.g. preliminary and final injury and dumping determinations—along with the final remedy. The analysis in this paper considers the effects of antidumping investigations that were completed during the period from 1988 to 1996. This setup ensures that I am able to observe plant-level outcomes both before and after the imposition of protection for every product group.[13] Lastly, because successful antidumping investigations in the United States almost always result in ad-valorem tariffs—rather than price undertakings or suspension agreements—I am able to study the effect of variation in the antidumping duty rate on productivity.

Section 3: Antidumping Duties in the United States

Under GATT Article VI and the WTO's Antidumping Agreement, WTO members are permitted to impose discriminatory tariffs on goods sold by foreign producers at prices that are deemed to be less than fair value (LTFV), if these sales result in material injury to the domestic industry. In the United States, sales are considered to be made at LTFV—i.e. dumped—when a foreign firm sells a good in the United States at a price that is below that offered on comparable sales in its home market, or below a constructed value similar to average total cost (ATC).

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[12] Available online at http://people.brandeis.edu/~cbown/global_ad/.

[13] See the Appendix for a description of how antidumping data were matched to domestic production data.

Antidumping investigations in the United States are initiated by individual firms, trade associations or sometimes labor unions, which are referred to in antidumping investigations as petitioners. The foreign firms selling allegedly dumped merchandise are referred to as respondents. Petitioners apply for antidumping protection by submitting a petition to the Import Administration of the Department of Commerce (DOC) and the International Trade Commission (ITC). The DOC determines whether sales made by foreign firms in the U.S. are being made at LTFV. The ITC determines whether the U.S. industry has been injured as a result of the dumping.

If the DOC finds that sales have been made at LTFV and the ITC concludes that these sales have injured U.S. producers, an ad-valorem tariff is placed on imports of goods from the respondents' home countries.[14] This ad-valorem tariff, which is known as an antidumping duty is equal to the percentage difference between the U.S. price and the home-market price or ATC. I refer to the magnitude of the antidumping duty as the antidumping duty rate. Because the antidumping duty is applied to all dumped goods, it benefits the petitioners, as well-as non-participating producers of the investigated product.

Table 1 reports the types of products involved in antidumping investigations that were completed from 1988 to 1996, showing the number of antidumping duty investigations by 2-digit HTS Chapter. The most frequent seekers of antidumping duties were producers of "Iron and Steel" (Chapter 72) and "Articles of Iron and Steel" (Chapter 73). Other active applicants for

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[14] In some cases, protection may take the form of a suspension agreement, in which foreign producers agree to change their behavior in a way that halts any dumping. Of the 148 antidumping investigations completed between 1988 and 1996, 5 ended with suspension agreements as the only form of protection. For these cases, no ad-valorem antidumping duty rate was available.

antidumping protection included producers of machinery and parts (Chapters 84 and 85) and inorganic and organic chemicals (Chapters 28 and 29).

Figure 1 shows the number of antidumping investigations completed, by outcome for the years 1980 to 2005. The number of antidumping investigations tends to increase during and immediately following periods of recession, and we see that this phenomenon did, in fact, occur following the recession of 1990-1991, when the number of new investigations spiked in 1991 and 1992. Aside from this countercyclical trend in new investigations, the period from 1988 to 1996 was typical in terms of the number of investigations initiated.

Section 4: Pre-Estimation Definitions

A. Definition of Treatment and Control Groups

I conduct this analysis by comparing the behavior of plants in a treatment group receiving antidumping protection to plants in a control group that do not. The treatment group consists of plants in sub-industries that applied for and received antidumping protection. Each plant in the treatment group is assigned a date of treatment and an ad-valorem duty rate, which comes from the results of the antidumping investigation associated with the product it produces. If a plant produces more than one product that receives protection, the treatment date and duty are those associated with the product that accounts for the highest share of its shipments.

In defining an appropriate control group, I will control for two potential sources of bias. The first is a self-selection bias, which arises if the types of sub-industries that apply for antidumping protection are different from those that do not. This is almost certainly the case. For example, antidumping applicants produce goods that are subject to import competition, perceive themselves as being injured by imports and operate in sub-industries capable of cooperating to file a case. Moreover, antidumping petitions are concentrated in particular sectors, especially metals, chemicals and basic mechanical goods.

The second source of bias, which I will refer to as the "government selection bias," arises if the government bases its decision of whether or not to approve protection for petitioners based on variables that are correlated with productivity or other dependent variables I will examine. The variables considered by the ITC when determining the injury portion of an antidumping investigation are publicly disclosed and include, among others, import penetration and employment. Because these variables are likely correlated with productivity, it will be necessary to address this government selection bias.

I control for these potential sources of bias in two steps. First, to control for the self-selection bias, I limit the control group to plants in sub-industries that applied for protection, but whose petitions were rejected by the government. I refer to these sub-industries whose petitions were rejected as "terminated sub-industries." As with the treated (protected) sub-industries, terminated sub-industries face import competition, perceive themselves as being injured by those imports and are able to collaborate to file an antidumping petition. Moreover, as shown in Table 2, both the treated and terminated sub-industries are concentrated in the sectors that are most frequently involved in antidumping investigations, namely primary and fabricated metals, chemical products and industrial equipment.

The government selection bias arises if the treatment and control group differ in terms of the variables considered by the government when deciding whether to provide protection. I control for this bias with a second step that limits the control group to the set of terminated sub-industries that are most similar to the treated sub-industries in terms of variables considered by the ITC in its determinations.

To determine which of the terminated sub-industries are most "similar" to the treated sub-industries, I estimate a probability of protection with the following logistic regression:

(1) $\Pr(Treatment_{it} = 1) = \Phi(\beta_1 IP_{it-1} + \beta_2 TE_{it-1} + \beta_3 GDP_t + \beta_4 P_{it} + \beta_5 LP_{it})$

where the binary dependent variable $Treatment_{it}$ takes a value of 1 if a product in industry *i* received protection[15] and a value of zero if it did not and where IP_{it-1} is lagged import penetration, TE_{it-1} is the log of lagged employment, GDP_t is the GDP growth rate between period $t-1$ and period *t*, P_{it} is the growth rate of industry-level prices from period $t-1$ to period *t* and LP_{it} is the log of labor productivity.[16] After calculating the probability of protection using the fitted values from this regression, the control group is limited to terminated sub-industries that were in the top 75th percentile in terms of their predicted probability of receiving protection.[17]

Results of the logit regression described above are reported in Table 4. Estimated coefficients take the expected sign and are consistent with results in Blonigen and Park (2004) and Konings and Vandenbussche (2008). Specifically, the probability of receiving antidumping protection increases with higher levels of import penetration and labor productivity and increases with negative price growth.

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[15] The treatment is set equal to one in this industry-level regression if the industry received protection either through an ad-valorem tariff or a suspension agreement.

[16] Regressions employ industry-level observations, as data for the independent variables described below are unavailable at the product-level. These variables have been used to explain the probability of receiving antidumping protection in Blonigen and Park (2004) and Konings and Vandenbussche (2008).

[17] While this cutoff is somewhat arbitrary, the results are robust to different cutoff percentiles including the 50th percentile and the inclusion of all plants that applied but were turned down for protection (i.e. the 100th percentile). Moreover, the 75th percentile cutoff is also used by Konings and Vandenbussche (2008) in construction of their matched control group.

Through these two steps, the control group has the attractive property of being composed of plants in industries that applied for protection—thus controlling for potential self-selection bias—while also being highly similar to the treated industries, in terms of the variables considered by the ITC, therefore controlling for the government selection bias. In addition, as described in Table 3, plants in the treatment and control groups are comparable in terms of their mean value of shipments, mean number of employees and mean capital to labor ratios.[18] As discussed below, the results are robust to consideration of two alternate control groups.

B. Calculation of Productivity

1. Revenue Versus Physical Productivity

As discussed above, the observed effects of trade protection on productivity may differ based on whether productivity is calculated as revenue or physical productivity. To examine these differences I calculate TFP and labor productivity using both revenue and physical units of quantity as measures of output. Throughout this paper, the term revenue productivity refers to productivity measures where output is measured as revenue, or price multiplied by quantity. Importantly, the revenue productivity measures used in this paper have been deflated using plant-specific deflators based on industry-level data.[19] The term physical productivity refers to productivity measures that use physical units of quantity as a measure of output.

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[18] Observations where the treatment and control groups overlap have been dropped from the analysis. Overlapping of treatment and control groups can occur for two reasons. First, a single plant could produce multiple products, where one product receives protection and the other is denied protection. 3,629 of 102,180 plants were dropped from the sample because they produced products associated with both successful and failed antidumping investigations. In addition, a single SIC5 product could receive protection from one antidumping investigation but be denied protection in another. This is possible if the HTS10 products defined in two different antidumping investigations both map into the same SIC5. 69 of the 440 SIC5-level products involved in antidumping investigations were excluded from the sample for this reason.

[19] See the Appendix for more details on the deflation strategy used.

2. The Physical Productivity Sample

Manufacturing establishments may produce more than one product, and they may report output data in physical units of quantity for some products, but not others. Following Foster, Haltiwanger and Syverson (2008), I restrict calculation of physical productivity measures to those plants that earn at least 50 percent of the value of their shipments from products for which physical output data are reported. Naturally, in my analysis, these products must also be in the set of products included in the treatment and control groups defined above.[20]

I also make adjustments to the sample to eliminate plants with imputed quantity data. Specifically, I exclude plants from the physical productivity sample if the price associated with a particular product is equal to the average price at the 4-digit, 5-digit or 7-digit SIC level. This eliminates imputations based on industry or product averages.[21] In addition, I exclude products defined by "balancing product codes," which are used by Census to ensure that the sum of a plant's product-level shipments is equal to that plant's total shipments.

Lastly, I exclude certain outlier observations from the baseline quantity sample. Specifically, plants reporting product-level prices that were outside three standard deviations of the mean price at the 5-digit SIC level were excluded from the quantity sample. I note that the main results are robust to a number of alternative outlier restrictions including no dropping of outliers, the exclusion of plants reporting prices that were ten times the product-level median and the exclusion of plants reporting prices that were ten times the plant-level median.

3. Methods of Calculating Productivity

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[20] Because input data are collected at the plant-level, rather than the product-level, input usage must be allocated across products for multi-product plants. I follow the adjustment procedure in Foster et al. (2008), which involves simply dividing the product-level quantity by the share of sales associated with the product in question.

[21] Certain quantities in the CM are imputed based on average unit values of reported data.

I calculate total factor productivity using the superlative TFP index from Caves, Christensen and Diewert (1982). As described in Aw, Chung and Roberts (2000), this TFP expression measures the performance of each plant, relative to a hypothetical plant producing the mean level of output with the mean level of inputs, within an industry, in the base period, 1987.[22] The TFP index therefore incorporates a plant's deviation of output and inputs from the industry mean in any given year, but also from the mean in the base period. This calculation yields a TFP measure that is comparable across plants and years:

$$(2)\ \ln TFP^{i}_{pt} = (\ln Y^{i}_{pt} - \ln \overline{Y}^{i}_{t}) + \sum_{s=2}^{t} (\ln \overline{Y}^{i}_{t} - \ln \overline{Y}^{i}_{t-1})$$

$$-[\sum_{m} \frac{1}{2}(S^{i}_{mpt} + \overline{S}^{i}_{mt})(\ln X^{i}_{mpt} - \ln \overline{X}^{i}_{mt})$$

$$+\sum_{s=2}^{t} \sum_{m} \frac{1}{2}(\overline{S}^{i}_{mt} + \overline{S}^{i}_{mt-1})(\ln \overline{X}^{i}_{mt} - \ln \overline{X}^{i}_{mt-1})]$$

I construct the TFP index expressed in Equation (2) for each plant *p* in year *t* using the set of inputs *m*={Capital, Raw Materials, Production Workers, Non-Production Workers}. The superscript *i* indicates that mean variables are calculated at the SIC4 industry level. Y^{i}_{pt} is the output at plant *p* in time *t* and will be measured as revenue for calculation of revenue productivity and physical units of quantity for physical productivity. X^{i}_{mpt} is the expenditure of plant *p* in time *t* on input *m* and S^{i}_{mpt} is the share of input *m* in total revenue.[23] I calculate

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[22] This measure of total factor productivity is standard in the trade and productivity literature and has been used in other studies including Bernard, Redding and Schott (2009a).

[23] The share for capital is set equal to the difference between 1 and the sum of shares for all other inputs.

average input usage and shares at the industry-year-level. Therefore, $\overline{S}_{mt}^{i}$, $\ln \overline{Y}_{t}^{i}$ and $\overline{X}_{mt}^{i}$ are the arithmetic means of industry-level input shares, revenue and input expenditure, respectively.

The second measure of productivity is a simple, single-factor labor productivity, defined as output per employee:

$$(3)\ LP_{pt} = \frac{Y_{pt}}{TE_{pt}}$$

where Y_{pt} is output, measured in either revenue or physical units of quantity and TE_{pt} is the total number of employees at plant *p* at time *t*. Labor productivity is used primarily as a robustness check for the results based on total factor productivity.

Semi-parametric estimators, including those developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) have been used extensively in recent papers studying the effects of changes in trade policy on TFP.[24] As has been established in this literature, these methods can be useful for correcting the simultaneity bias that arises when plants with high TFP consume more inputs and the selection bias associated with only observing surviving plants. These methods are not well-suited for the economic census data employed in this paper, however, due to their use of lagged input values in the TFP calculation. Nonetheless, I note that Van Biesebroeck (2004) finds that TFP measures derived from various methods tend to be highly correlated.

C. Effective Antidumping Duty Rates

A single antidumping investigation can be filed against imports from multiple countries and if the case ends with a determination by the DOC and ITC to offer protection, each country may be assigned a different ad-valorem antidumping duty. Naturally, imports from certain

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[24] See, for example, Pavcnik (2002), Fernandes (2007) and Konings and Vandenbussche (2008).

countries account for larger shares of U.S. imports of a good than others. In order to account for the true importance of an antidumping duty on U.S. trade, therefore, I calculate an effective antidumping duty rate for each product that is assigned an ad-valorem antidumping duty. The effective antidumping rate is calculated as follows:

$$(4)\quad Rate_{gt} = \sum_{c} SHARE_{c,g,t-1} * AVD_{c,g,t}$$

where $SHARE_{c,g,t-1}$ is country *c*'s share of U.S. imports of product *g* in time *t-1* and $AVD_{c,g,t}$ is the ad-valorem duty applied to imports of product *g* from country *c* in time *t*. A country's share is calculated based on imports in time *t-1*, rather than time *t*, because antidumping duties often lead to significant reductions in imports from pre-protection levels. Using a pre-protection share, therefore, provides a more accurate representation of a country's importance to U.S. trade.

Section 5: Empirical Strategy and Results

A. Do Temporary Tariffs Increase or Decrease Plant-Level Productivity?

As discussed above, some have argued that temporary protection can increase within-plant productivity by increasing the incentive to invest in new technology. On the other hand, temporary protection is also likely to lead to higher prices and mark-ups. Because an increase in revenue productivity that occurs at the time of protection could be caused by either of these phenomena, however, it can be difficult to determine what is driving gains in revenue productivity. Using output data measured in units of quantity, I am able to separate these two effects by calculating both revenue and physical productivity measures. Moreover, I am able to directly measure the effects of antidumping duties on plant-level prices and mark-ups. I find that apparent growth in productivity associated with antidumping protection is driven primarily by higher prices and mark-ups, rather than increases in physical productivity. Physical productivity actually falls among protected plants.

1. Empirical Strategy

I examine the effect of temporary protection on plant-level productivity, prices and mark-ups using a difference-in-difference approach. As discussed above, the treatment group is composed of plants producing products that receive antidumping protection. The control group is composed of plants producing products that applied for protection and are similar to those in the treatment group, but did not receive antidumping protection. The difference-in-difference estimator is attractive because it isolates the effect of the treatment—antidumping protection—by eliminating time-invariant differences between the treatment and control group, as well as time-specific effects common to both treatment and control. The difference-in-difference estimator, therefore, measures not simply the change in the dependent variable that occurs following antidumping protection, but rather the difference between the changes in the treatment group and the changes in the control group.

Let T be the set of plants producing products that receive antidumping protection and let C be the set of plants in the control group. Further, define I_g to be the treatment year for product g.[25] I measure the difference-in-difference effect by estimating Equation (5):

(5) $y_{pgt} = \alpha + \beta_1 Treatment_{pgt} * Post_{pgt} + \gamma_t + \delta_g + \varepsilon_{pt}$, where

$Treatment_{pgt} = 1 \ \forall \ p \in T$ and $Treatment_{pgt} = 0 \ \forall \ p \in C$

$Post_{pgt} = 1 \ \forall \ t > I_g$, 0 otherwise[26]

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[25] The treatment year is defined as the year in which the final affirmative ITC determination was made for protected (treatment) products and as the year in which the investigation was initiated for terminated (control) products.

Here, y_{pgt} is the outcome variable of interest—such as productivity, prices or mark-ups—at plant *p*, which produces product *g* at time *t*. Year fixed effects capture any macro-level shocks affecting plants in *T* and *C* equally. Similarly, product fixed effects, δ_g, capture time-invariant differences between products. Note that Equation (5) contains product-level fixed effects, rather than a more general *Treatment* dummy used in the most basic difference-in-difference expressions. This specification captures time-invariant differences between producers of different products *within T* and *C*. This is likely important when dealing with a diverse set of manufacturers from different sectors and industries. Finally, the coefficient β_1 on the interaction term is the coefficient of interest and measures the difference-in-difference effect of antidumping protection on the plant-level outcomes discussed below.

Equation (5) defines protection with a binary variable—any plant that receives any antidumping protection is considered to be equally protected. It seems reasonable to expect, however, that plants' reactions to protection would depend not only on this simple binary classification, but also on the level of protection they receive. That is, plants producing products that receive high ad-valorem duty rates—such as the 259.17 percent antidumping duty rate on Aluminum Sulfate from Venezuela—may respond differently than those producing products that receive low antidumping duty rates, such as the 4.18 percent rate on Corrosion Resistant Carbon Steel Sheet from Germany. As these two examples indicate, the variation in duty rates among

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[26] Antidumping protection often lasts for ten years or more, meaning that almost every antidumping duty put in place during the sample period considered was still in effect at the end of the period. In 3 of the 148 antidumping investigations considered in this sample, however, antidumping protection began after 1988, but ended prior to 1997. In these cases, the variable $Post_{pgt}$ takes the value zero in years when antidumping protection has already ended.

cases that receive protection is large: the mean duty rate is 51 percent and the standard deviation is 49 percent at the product-country-level.

I measure the effects of heterogeneity in antidumping rates by augmenting Equation (5) with an additional interaction term:

$$(6)\ \ y_{pgt} = \alpha + \beta_1 Treatment_{pgt} * Post_{pgt} + \beta_2 Rate_{pgt} * Post_{pgt} + \gamma_t + \delta_g + \varepsilon_{pt}$$

Here, $Rate_{pgt}$ is the ad-valorem effective antidumping duty rate on product *g*, which is produced by plant *p* at time *t*. By interacting $Rate_{pgt}$ with the $Post_{pgt}$ dummy, I am able to separate the effect of varying rates of protection from the mean response of all plants receiving antidumping protection.

I will employ the difference-in-difference framework in Equations (5) and (6) to examine the effect of antidumping duties on plant-level prices, as well as mark-ups over average variable cost and average total cost. Prices are defined as follows:

$$(7)\ \ P_{pgt} = \frac{TVS_{pgt}}{Q_{pgt}}$$

where *TVS* is a plant's total value of shipments and *Q* is the total quantity of units shipped. Plant-level mark-ups over average variable cost are defined as:

$$(8)\ \ PAVC_{pgt} = \frac{P_{pgt}}{AVC_{pgt}} - 1 \text{ where}$$

$$(9)\ \ AVC_{pgt} = \frac{Wages_{pgt} + MAT_{pgt}}{Q_{pgt}}$$

while plant-level mark-ups over average total cost are defined as:

$$(10)\ \ PATC_{pgt} = \frac{P_{pgt}}{ATC_{pgt}} - 1 \text{ where}$$

$$(11)\ \ ATC_{pgt} = \frac{Wages_{pgt} + MAT_{pgt} + CAP_{pgt} * R_t}{Q_{pgt}}$$

Here, *Wages* are the real wages paid to production workers, *MAT* is the real cost of materials, *CAP* is the real book value of capital and *R* is the rental rate of capital.[27]

2. Results

a. Revenue Productivity

I find that antidumping protection is associated with increases in revenue productivity of 6 to 9 percent, as shown in Table 5.[28] Table 5 reports the results for Equations (5) and (6) with TFP and labor productivity.[29] I continue to find a positive and significant relationship between antidumping protection and revenue productivity when the effective duty rate is included in the specification, although the rate term is not significant.

As discussed below, the increase in revenue productivity associated with antidumping protection—as measured by the binary protection variable—is a robust result in this analysis. It is somewhat surprising, however, that revenue productivity appears to be essentially unaffected by changes in the antidumping duty rate. As will be seen in results below, this lack of responsiveness appears to be due to decreases in physical productivity associated with higher antidumping duty rates being offset by increases in prices and mark-ups.

b. Physical Productivity

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[27] The rental rate is defined as the sum of the U.S. 3 month commercial paper rate and a depreciation rate of 0.1. The depreciation rate of 0.1 is also used in, for example, Konings and Vandenbussche (2005).

[28] Reported results for revenue productivity, physical productivity, prices and mark-ups all include robust standard errors that have been adjusted for clustering at the product-level.

[29] Products from the three investigations that received protection solely through suspension agreements are excluded from results in Tables 5-8 since antidumping duty rate information is unavailable.

As described above, the use of revenue productivity measures can yield misleading results in situations where prices and mark-ups may also be changing concomitantly. In particular, because the imposition of antidumping duties likely allows domestic producers to increase prices and mark-ups, revenue productivity measures will overstate any potential productivity gains associated with antidumping protection. Because the CM contains output data measured in units of quantity for a subset of products, I am able to calculate measures of physical productivity that are unaffected by changes in prices and mark-ups.

The effect of antidumping duties on plant-level productivity is starkly different when output is measured in units of quantity, rather than revenue. As reported in Table 6, antidumping duties are actually associated with a decrease in physical productivity among the set of plants reporting quantity data. In fact, physical productivity actually falls by a greater amount as the effective duty rate protecting the plant increases.

Bernard, Redding and Schott (2009b) provides a plausible reason that plant-level productivity may fall in the treatment group, relative to the control group. In that model, tariff protection allows firms to continue producing low-productivity products that they would have otherwise stopped producing. Indeed—as will be discussed in more detail below—I do find that protected plants are less likely to drop investigated products than unprotected plants. This means that while plants in the control group focus on their “core competencies” and produce their highest-productivity products, plants in the treatment group are able to continue producing low-productivity products.

A word of warning in terms of interpreting these results is necessary here. It would be inappropriate based on these results to claim that antidumping duties, *in general*, decrease plant-level physical productivity. It is true that antidumping duties were associated with a relative decline in productivity among the set of plants reporting output data in units of quantity. However, this group is not necessarily representative of the full set of plants subject to antidumping protection. When I examine the effect of antidumping protection on the revenue productivity of the subset of plants reporting output in units of quantity, I find that, on average, revenue productivity was unaffected by antidumping protection.[30] This contrasts with the increase in revenue productivity associated with antidumping protection in the full sample. Nonetheless the fact that plants in this sub-sample experienced a zero average effect of antidumping protection on revenue productivity and a large and highly significant decrease in physical productivity suggests that increases in prices and mark-ups are affecting results based on revenue productivity.

c. Prices and Mark-Ups

The disparity between results showing the effect of antidumping protection on revenue versus physical productivity suggests that increases in prices and mark-ups are playing a role in the apparent increase in revenue productivity. I use the same difference-in-difference specifications from the productivity analysis to examine the effects of antidumping duties on the measures of prices and mark-ups over average total cost described above.

As reported in Table 9, I find that antidumping duties are associated with price increases of 40 percent, on average. Moreover, these pricing changes are sensitive to the effective duty rate a plant experiences—the higher the effective duty rate, the higher the prices charged by the plant. Similarly, I find that mark-ups over both average variable cost and average marginal cost increase as the effective duty rate increases. Specifically, I find that for each 1 percent increase

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[30] I find a small decrease in revenue labor productivity as the effective duty rate increases, although the magnitude of this effect is ten times smaller than the result found for physical productivity. This result is not present for TFP.

in the effective duty rate, mark-ups over average variable cost and average total cost increase by 0.3 percent and 0.2 percent, respectively.

D. Robustness Checks

The preceding results have shown that apparent increases in revenue productivity associated with antidumping duties are primarily due to increases in prices and mark-ups, with physical productivity falling among protected plants reporting output data in units of quantity. I examine the robustness of these results in several ways.[31]

i. Alternate Control Groups

As an initial robustness check, I considered two alternate control groups employed in Konings and Vandenbussche (2008). The first alternative control group, AC1, consists of all plants in sub-industries that applied for protection, but whose petitions were rejected by the government. The second alternative control group, AC2, consists of industries that did not receive protection, but had a high probability of receiving protection based on a multinomial logit model of antidumping protection described in Blonigen and Park (2004) and Konings and Vandenbussche (2008).[32] The primary conceptual difference between AC2 and the control

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[31] In addition to the robustness checks described in detail below, the result are also robust to consideration of only those products with at least 25 establishment observations per year, subsets of antidumping investigations in the treatment and control group and alternative outlier screens.

[32] Results of the multinomial logit regression are reported in Table 4. As in the logit estimation used to construct the preferred control group, estimated coefficients take the expected signs. In particular, the probability of receiving antidumping protection increases with higher levels of import penetration, total employment and labor productivity. In contrast, higher GDP growth and price growth are associated with a lower probability of receiving protection.

group used in this paper is that AC2 includes industries that never applied for protection, but were similar to those industries that did apply and receive protection.[33]

Table A.1 shows that antidumping duties were associated with an increase in revenue productivity in both alternate control groups, as they were with the primary control group. In addition, Table A.2 confirms that physical productivity falls, the higher the effective duty rate, as was the case in the preferred control group. Lastly, Tables A.3 and A.4 show that both prices and mark-ups increase as the effective duty rate increases, as they did using the preferred control group. In sum, the results presented above are robust to calculation with different control groups, even with substantial differences in the composition of plants in each group.[34]

ii. Examining the Duration of Protection

I have shown that the level of the effective duty rate affects plants' physical productivities, prices and mark-ups. But in addition, it may be possible that another measure of the intensity of protection—namely the duration of protection—could be important to plants' performance. To examine this possibility, I define duration as the number of years that protection has been in place and estimate the following equation:

$$(12)\quad y_{pgt} = \alpha + \beta_1 Treatment_{pgt} * Post_{pgt} + \beta_2 Rate_{pgt} * Post_{pgt}$$
$$+ \beta_3 Dur_{pgt} * Treatment * Post_{pgt} + \gamma_t + \delta_g + \varepsilon_{pt}$$

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[33] Specifically, control group AC2 is the set of plants in industries that had a probability of protection greater than the 75th percentile of that in treated industries, but that did not receive protection.

[34] For example, the AC2 sample has over 100% more revenue productivity observations than the preferred control group sample. The AC1 sample has over 35% more physical productivity observations than the preferred control group.

where y is the set of dependent variables examined above—namely revenue and physical productivity, prices and mark-ups over average variable cost and average total cost—and *DUR* is the duration of protection.

Results are reported in Table A.5. I find that the duration of protection has no effect on physical productivity, prices or mark-ups over average total cost. Instead, the effective duty rate continues to be the most important measure of the intensity of protection, with higher duty rates associated with lower physical productivity and higher prices and mark-ups. I do find that mark-ups over average variable cost fall as the duration of protection rises, perhaps due to entry into the market by domestic firms or firms in countries that are not covered by the antidumping duties.

iii. Within-Plant Estimates

The results discussed thus far provided within-product estimates of the effect of antidumping duties on U.S. manufacturers. It is important to note, however, that these results do not necessarily reflect the within-plant effect of antidumping duties. Because equations (5) and (6) are estimated on an unbalanced panel, coefficient estimates could reflect changes in mean plant-level productivity due to entry in exit. In order to estimate the within-plant effect of antidumping duties, I re-estimate Equations (5) and (6) with plant fixed effects for the balanced subsample of plants that were active in all three census years. These estimates provide both a useful robustness check for the within product-group estimates, as well an explicit estimate of the within-plant effects of antidumping duties.

The within-plant estimates are broadly consistent with the within-product results reported earlier. In Table A.6, I show that antidumping protection is associated with increases in revenue productivity of 3-5 percent. But as before, physical productivity actually falls among protected plants, as shown in Table A.7. While prices increase with protection, antidumping duties do not have a statistically significant effect on within-plant estimates of mark-ups.

B. Do Temporary Tariffs Discourage Product-Dropping?

Bernard, Redding and Schott (2009b) show that reductions in trade barriers can increase firm or plant-level productivity by inducing firms to drop their least productive products, while expanding output of their most productive products. Moreover, product-dropping can yield increases in aggregate productivity—as defined below—as the least productive plants drop products. If antidumping duties prevent the dropping of products by low-productivity plants, they will prevent some of these benefits of trade liberalization from occurring. In fact, I do find that antidumping protection decreases the probability of dropping investigated products.

1. Empirical Strategy

The effect of antidumping duties on the probability of dropping products is investigated using a difference-in-difference specification similar to that employed to study changes in plant-level productivity, prices and mark-ups. By comparing the probability of product-dropping among protected plants to the unprotected plants in the control group, I am able to estimate the effect of antidumping duties on product-dropping.

An important difference between this product-switching analysis and the plant-level productivity regressions described above is that the product-switching data are defined at the plant-product-level. This means that I have dropped the restriction that each plant is assigned to a particular treatment or control product. In doing so, I am able to consider the full set of products that are involved in antidumping investigations. I employ a linear probability model, to allow for the inclusion of fixed effects and clustering of standard errors and estimate the following equation:

$$(13)\ \ Drop_{pgt} = \alpha + \beta_1 Treatment_{pgt} * Post_{pgt} + \beta_2 Post_{pgt} * Rate_{pgt} + \beta_3^{'} X_{pgt} + \gamma_t + \delta_g + \varepsilon_{pgt}$$

Drop is a binary variable that equals 1 if product g is produced by plant p at time *t*, but not time *t+5*. This variable is defined for plants that drop products between 1987 and 1992 and 1992 and 1997. *Drop* is not defined in the year 1997 due to a change in the product classification system that makes it difficult to identify plants that produced products subject to antidumping investigations in 2002. *X* is a matrix of plant-product-level variables found to be determinants of product-dropping in Bernard, Redding and Schott (2009a). In particular, *X* includes product-level shipments in dollars and product tenure, which is defined as the number of years a plant has produced a particular product. To be clear, the variable *Drop* only takes into account product-dropping by continuing plants. Exiting plants are not considered product-droppers.

2. Results

I find that plants are 4 percent less likely to drop protected products than they are to drop unprotected products, as reported in Table 8.[35] Moreover, this product-switching behavior is sensitive to the value of the effective duty rate applied to a product. I find that the probability of dropping a protected product decreases as the effective duty rate assigned to that product increases. In the product-dropping regression, the results are robust to the inclusion of product-level shipments and product tenure, which are both negative and significant, as expected. These results make clear that more plants produce a given protected product than would be the case if the product was unprotected. They are also robust to consideration of the two alternate control groups, as can be seen in Tables A8 and A9.

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[35] Reported results include robust standard errors adjusted for clustering at the product-level.

This reduction in product-switching brought about by antidumping duties has implications for both plant-level and aggregate productivity. At the plant level, Bernard, Redding and Schott (2009b) suggests that a reduction in product-dropping resulting from trade protection will lower productivity, relative to unprotected plants. While unprotected plants drop their least productive products to focus on their highest-productivity product-lines, protected plants continue to produce the protected product, resulting in lower relative productivity. A reduction in product-dropping among protected plants can also decrease aggregate productivity growth. In unprotected product-groups, the least productive producers will either exit completely, or drop the unprotected product. In the protected product groups, however, these low-productivity plants are able to continue producing, resulting in lower aggregate productivity relative to the control group.

C. Do Temporary Tariffs Discourage Plant-Level Exit?

It is a well-known result that trade protection can slow aggregate productivity growth by preventing the exit of low-productivity plants and firms that would otherwise cease to operate. I examine this issue by comparing the probability of plant-level exit in the treatment group of protected plants to that in the control group. I find that antidumping duties do not affect the probability of exit. Plants that are denied protection by the government are no more likely to exit than those that receive antidumping duties.

1. Empirical Strategy

I define a plant as exiting in year *t* if it appears in the CM in year *t*, but not in year *t+5*. To be clear, a plant that halts production of the investigated product between year *t* and year *t+5*, but continues to operate, is not counted as an exit. The exit variable is not defined in 1997 for the same reason discussed in the product-dropping section above.

I estimate the relationship between antidumping protection and the probability of exit using a difference-in-difference framework identical to the specification used to study changes in product-dropping above. As in the analysis of product-dropping, I employ a linear probability model, to allow for the inclusion of fixed effects and clustering of standard errors and estimate the following equation:

$$(14)\ Exit_{pgt} = \alpha + \beta_1 Treatment_{pgt} * Post_{pgt} + \beta_2 Post_{pgt} * Rate_{pgt} + \beta' X_{pgt} + \gamma_t + \delta_g + \varepsilon_{pgt}$$

The binary dependent variable, *Exit* was described above. The coefficient β_1 is the primary parameter of interest and estimates the effect of receiving antidumping protection on the probability of exit. X is a matrix of plant-level variables including log number of employees, plant age, log of capital-labor ratio, log of average wage and indicators for whether the plant is a multi-product plant, or a part of a multi-unit firm.[36] As in Equation (13), year and product fixed effects are included. Estimates with robust standard errors and clustering at the product-level are reported in Table 8.

2. Results

I find that antidumping duties have no effect on the probability of plant-level exit. This result is surprising, given that most theoretical and empirical research examining the effect of changes in tariff rates on output rationalization have focused on exit as the primary channel for the reallocation of output. Combined with the product-dropping result described above, this suggests that U.S. manufacturers are flexible and dynamic in the face of changes in trade policy.

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[36] These variables were found to be important determinants of plant-level exit in Bernard, Jensen and Schott (2006). Plant age is measured in number of years. Capital intensity is a plant's book value of capital divided by the number of employees. Average wage is the average annual wage paid to production workers. Multi-unit and multi-product are binary variables that equal one if the plant is part of a multi-unit firm or a producer of multiple products, respectively.

Rather than exiting, they react to being turned down for antidumping duties by dropping the unprotected product while producing other, potentially higher-productivity products. There is also no effect of antidumping protection on the mean probability of exit when considering the two alternate control groups, as can be seen in Tables A.8 and A.9.

D. Do Temporary Tariffs Decrease Output Rationalization and Aggregate Productivity?

A number of theoretical models including Melitz (2003) and Bernard, Redding and Schott (2009b) suggest that tariff increases allow for the continued operation of low-productivity firms that might otherwise stop production. If antidumping duties create a similar situation, we should expect the level of output rationalization to increase in the control group relative to the treatment group. Indeed, I do find that the level of output rationalization rises in the control group and falls among the protected plants in the treatment group.

1. Empirical Strategy

I have already shown that antidumping duties allow plants that would have otherwise dropped the investigated product to continue producing. If these plants that would have otherwise dropped the product are also low-productivity plants, antidumping duties may have a negative effect on output rationalization and aggregate productivity growth. To compare the productivity of product-dropping plants to non-droppers, I regress plant-level productivity on a binary variable that equals one in time t if plant p dropped an investigated product between time t and time $t+5$:

$$(15)\ Prod_{pgt} = \alpha + \beta_1 Drop_{pgt} + \gamma_t + \delta_g + \varepsilon_{pt}$$

Next, I examine the level of output rationalization directly by decomposing aggregate productivity as in Olley and Pakes (1996) and Pavcnik (2002). This procedure decomposes growth in aggregate productivity into two components, shown below:

$$(16)\ W_{gt} = \sum_{p} s_{pgt} TFP_{pgt} = TFP_{tg}^{mean} + (s_{pgt} - s_{gt}^{mean})(TFP_{pgt} - TFP_{gt}^{mean})$$

The first term of the final expression represents mean plant-level productivity at time *t*. The second term is a covariance-like variable representing the degree to which greater output is produced by higher-productivity plants. s_{pgt} denotes the share of plant *p*'s output in the total output of product-group *g* at time *t*, while s_{gt}^{mean} is the mean output share of plants producing product *g* at time *t*. Similarly, TFP_{pgt} and TFP_{gt}^{mean} represent the revenue total factor productivity of plant *p* and the mean TFP of plants in product-group *g*, respectively. When plants with above-average TFP also capture an above-average market share, the covariance term increases, indicating a higher level of output rationalization.

The covariance term measuring the degree of output rationalization will be the primary variable of interest. Ideally, I would simply examine the effects of antidumping duties on aggregate productivity, W_{gt} directly. A number of data problems would make this comparison unreliable, however. First, as mentioned above, the use of revenue-based aggregate productivity measures would overstate productivity gains among protected products, since I have shown that protected plants respond to temporary protection by increasing prices and mark-ups. Moreover, quantity-based productivity measures are not useful in settings where analysis is taking place at the product-level or higher, since quantity data are only available for producers of a limited set of products.

Revenue-based productivity measures are still useful, however, for analyzing output rationalization. Assuming that prices increase uniformly among all producers of a given product once it receives protection, the covariance term still reflects the degree of output rationalization within a product group. After calculating aggregate productivity, mean plant-level productivity and the output rationalization term at the product-group-level, I report their output-weighted means by year, treatment group and a dummy variable indicating whether the antidumping investigation for product *g* has already taken place.

2. Results

First, I find that plants that drop the investigated product have lower productivities than non-dropping plants, as reported in Table 9. As a result, the reduction in product-dropping by low-productivity plants caused by antidumping duties contributes to a decrease in output rationalization and aggregate productivity growth among protected products.

Moreover, I do find that antidumping protection decreased the level of output rationalization in the treatment group, while output rationalization grew in the control group. As reported in Table 10, the treatment group of plants that ultimately receive protection starts with a level of output rationalization in 1987 that is higher than the control group. As time progresses and protection takes effect, however, output rationalization rises in the control group—likely due to product-dropping by low-productivity plants—while remaining essentially flat in the treatment group. By 1997, the control group has overtaken the treatment group in terms of output rationalization. These results suggest that antidumping duties slow the reallocation of resources from less productive to more productive uses, contributing to a decrease in aggregate productivity, relative to the control group.

Section 6: Conclusions

The question of whether temporary protection allows firms to reorganize and become more productive or simply leads to inefficiency is an old one in international trade. But even as temporary policies like antidumping duties have become one of the primary methods for protecting domestic industries, micro-level evidence on their effects has been lacking. In addition to increasing our understanding of an important trade policy, the study of antidumping duties can also provide new insights into the responses of heterogeneous firms in a developed country to a major tariff shock.

Using a difference-in-difference framework, I compare outcomes at plants in a treatment group that receives protection to a control group that did not. I find that apparent increases in revenue productivity associated with antidumping protection are driven primarily by increases in prices and mark-ups. Physical productivity actually falls among the protected plants reporting output data in units of quantity. Protected plants are also less likely to drop protected products, although they are no less likely exit. Because antidumping protection allows for the continued operation of low-productivity plants that might have otherwise dropped the protected product, antidumping duties decrease the level of output rationalization and aggregate productivity.

The results have several implications. First, for empirical researchers, the results underscore the importance of differentiating between changes in revenue productivity—which may be driven by increases in prices and mark-ups—and changes in physical productivity. Separating these two effects is particularly important in situations where changes in productivity may be taking place concomitantly with changes in prices, as is the case with antidumping duties. Second, for theoretical researchers, the results underscore the importance of thinking of plants and firms as producers of multiple products. While antidumping duties had no effect on the probability of plant exit, they had a clear impact on plants' product mix. And finally, for

policy-makers, the results suggest that antidumping protection is more likely to lead to higher prices than higher productivity.

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Van Biesebroeck, Johannes, “Robustness of Productivity Estimates,” NBER Working Paper 10303, 2004.

Table 1: Completed Antidumping Investigations by HTS Chapter, 1988-1996

HTS2	Description	Investigations
73	Articles of Iron and Steel	27
72	Iron and Steel	18
84	Machinery	15
28	Inorganic Chemicals	12
29	Electrical Machinery	12
85	Organic Chemicals	12
87	Transportation Vehicles and Parts	10
90	Precision Instruments and Apparatus	7
25	Plastering, Lime and Cement	6
39	Plastics and Articles Thereof	6
40	Rubber and Articles Thereof	4
56	Certain Textiles	4
20	Preparations of Vegetables or Fruits	3
81	Other Base Metals	3
83	Misc. Articles of Base Metal	3
Other		37
Total		179

Notes: This table displays the number of antidumping investigations by 2-digit Harmonized Tariff System Category. Investigations involving products in more than one 2-digit HTS category are counted in each of those categories.

Figure 1: Antidumping Investigations, by Outcome

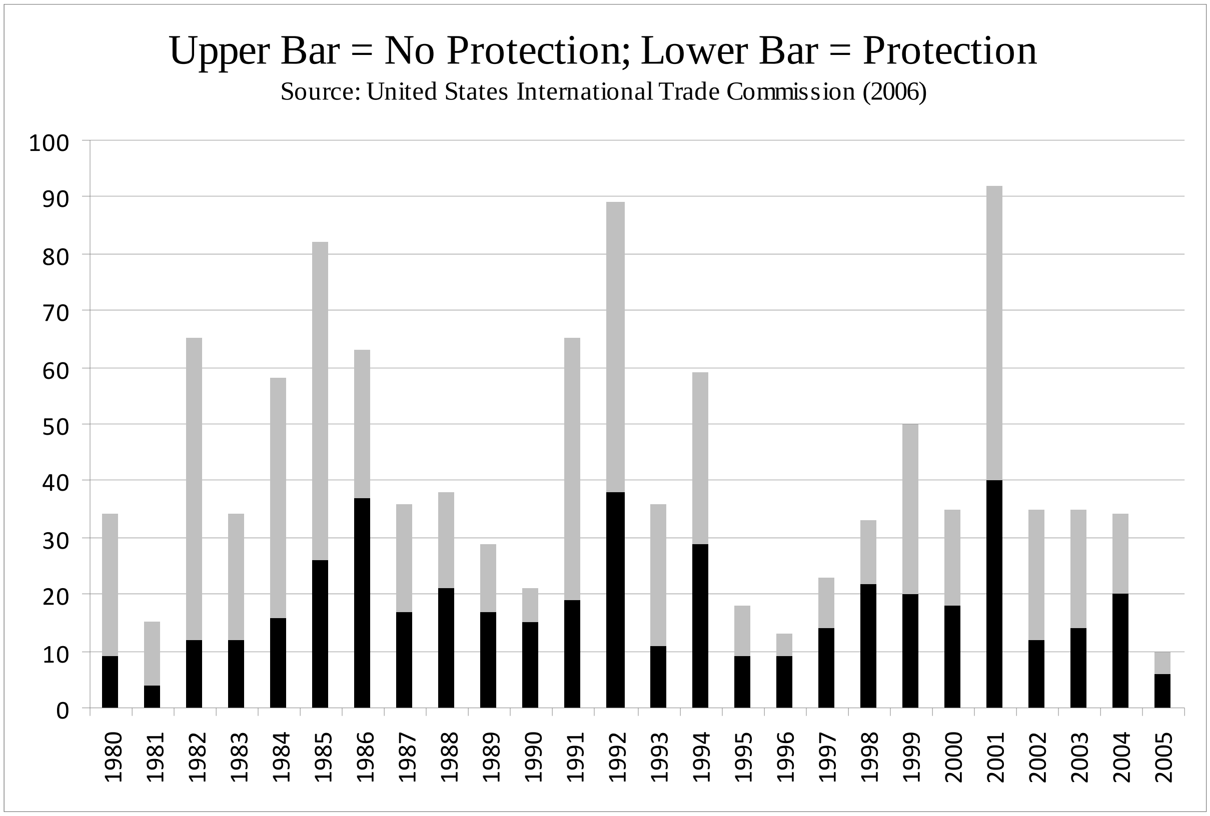

Table 2: Plant-Level Observations, by SIC2

		Total Observations			Observations With Quantity		
SIC2 Description	SIC2	Control	Treatment	Total	Control	Treatment	Total
Food and Kindred Spirits	20	0	1,546	1,546	0	1,099	1,099
Textile Mill Products	22	1,062	969	2,031	762	412	1,174
Apparel and Other Textiles	23	5,355	1,753	7,108	230	534	764
Furniture and Fixtures	25	1,741	0	1,741	55	0	55
Paper and Allied Products	26	2,646	0	2,646	1,075	0	1,075
Chemical Products	28	880	3,703	4,583	73	651	724
Rubber Products	30	12,177	4,009	16,186	154	79	233
Stone, Clay and Concrete	32	2,077	650	2,727	441	405	846
Primary Metals	33	0	3,326	3,326	0	1,964	1,964
Fabricated Metals	34	11,834	4,394	16,228	1,022	505	1,527
Industrial Machinery	35	4,084	16,294	20,378	92	300	392
Electronic Machinery	36	488	7,950	8,438	88	34	122
Transportation Equipment	37	2,469	886	3,355	557	*	*
Measuring Instruments	38	611	7,647	8,258	*	199	*

Notes: This table reports the number of plant-level observations in the treatment and control groups, by 2-digit SIC (1987) category. In addition, the table shows the number of plant-level observations where output data were reported in units of quantity by treatment status and 2-digit SIC. An asterisk (*) denotes a cell that was suppressed to prevent the disclosure of confidential data.

Table 3: Summary Statistics by Treatment Group, Year

Year	Treatment	Mean TVS ('000$)	Mean No. Employees	Mean Capital Intensity	No. Plants	Qty. Share	Treatment Share	Effective AD Rate
1987	0	25,844	151	42	12,934	93%	71%	
1987	1	23,402	165	52	16,372	93%	71%	17%
1992	0	27,783	125	46	15,563	93%	71%	
1992	1	28,267	149	55	17,851	91%	70%	17%
1997	0	34,498	119	52	16,927	94%	73%	
1997	1	36,833	146	70	18,904	92%	70%	16%

Year	Treatment	Mean Revenue TFP	Mean Revenue LP	Mean Physical TFP	Mean Physical LP	Sum TVS (Mil. $)	QTY Sum TVS (Mil. $)
1987	0	0.20	4.70	-0.41	4.85	334,000	113,000
1987	1	0.16	4.64	0.37	5.18	383,000	52,000
1992	0	0.08	4.70	-0.15	4.95	432,000	200,000
1992	1	0.20	4.73	0.24	5.31	505,000	50,400
1997	0	0.09	4.78	0.45	5.49	584,000	57,000
1997	1	0.29	4.89	0.18	5.41	696,000	61,600

Notes: This table reports summary statistics by year and treatment status. A treatment of zero denotes the control group and a treatment of one denotes the treatment group. Mean TVS is the mean plant-level value of shipments. Mean capital intensity is the mean plant-level book value of capital divided by the number of employees. Qty. Share is the share of a plant's shipments associated with a product for which quantity data are reported. Treatment share is the mean share of a plant's shipments associated with a product defined in the treatment or control groups. Effective AD Rate is the trade-weighted antidumping duty rate. Sum TVS is the total value of shipments for the treatment and control groups in a particular year. QTY Sum TVS is the value of shipments for the plants reporting quantity data that meet the criteria for inclusion in the quantity sample.

Table 4: Results of Multinomial Logit and Logit Models for Matched Control Groups

	Probability of Protection	Determinants of Protection Given Filing	Determinants of Termination Given Filing
Lagged Import Penetration	0.453**	0.212***	-0.053
	0.181	0.061	0.101
ln(Lagged Employment)	-0.016	0.407***	0.405***
	0.086	0.056	0.056
ln(Labor Productivity)	0.550***	0.093	-0.299***
	0.151	0.098	0.104
Real GDP Growth	0.001	0.024	0.002
	0.061	0.045	0.044
Price Growth	-0.045***	-4.502***	-0.012
	0.017	1.216	0.013
Number of Observations	694	3,423	3,423
Pseudo-R Squared	0.03	0.03	0.03
Estimation Technique	Logit	Multinomial Logit	Multinomial Logit

Notes: This table summarizes estimation results for the logit and multinomial logit models used to generate the two matched control groups. In the logit model (used to define the preferred control group), the dependent variable takes a value of 1 if an industry applied for and received protection and 0 if it applied for, but did not receive protection. In the multinomial logit model (used to define AC2), the dependent variable takes a value of 1 if an industry never filed for protection, 2 if it filed but was turned down for protection and 3 if it applied for and received protection. Independent variables are at the industry-year-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 5: The Effect of AD on Plant-Level Revenue Productivity

	TFP	LP	TFP	LP
Treatment*Post	0.0815***	0.0645***	0.0915**	0.0703***
	0.0306	0.0187	0.0380	0.0250
Post*Rate			-0.0006	-0.0003
			0.0023	0.0015
Year FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Observations	98,551	98,551	98,551	98,551
R-Squared	0.643	0.298	0.643	0.298

Notes: This table summarizes OLS regression coefficients of plant-level total factor productivity (TFP) and labor productivity (LP) on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 6: The Effect of AD on Physical Productivity

	Physical Productivity Measures				Revenue Productivity Measures			
	TFPQ	LPQ	TFPQ	LPQ	TFP	LP	TFP	LP
Treatment*Post	-0.3921*	-0.3876*	0.1934	0.2141	-0.012	-0.0094	0.0246	0.0409
	0.207	0.2074	0.1664	0.1584	0.064	0.03	0.062	0.0288
Post*Rate			-0.0316***	-0.0325***			-0.002	-0.0027**
			0.0045	0.0044			0.0018	0.0013
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,419	10,419	10,419	10,419	10,419	10,419	10,419	10,419
R-Squared	0.65	0.618	0.654	0.622	0.86	0.415	0.86	0.415

Notes: This table summarizes OLS regression coefficients of plant-level productivity on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." The first four columns show regression results using measures of physical total factor productivity (TFPQ) and physical labor productivity (LPQ) as the dependent variable, for the subset of plants reporting quantity-based output data. The last four columns show regression results using measures of revenue total factor productivity (TFP) and revenue labor productivity (LP) as the dependent variable, for the same subset of plants. Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 7: The Effect of AD on Plant-Level Prices and Mark-Ups

	Price	Price	P/AVC	P/AVC	P/ATC	P/ATC
Treatment*Post	0.40*	-0.20	0.01	-0.05	0.01	-0.02
	0.21	0.16	0.04	0.04	0.03	0.03
Post*Rate		0.03***		0.0029**		0.0017**
		0.004		0.0012		0.0007
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,419	10,419	10,419	10,419	10,419	10,419
R-Squared	0.64	0.65	0.08	0.08	0.08	0.08

Notes: These tables summarize OLS regression coefficients of product-level prices and mark-ups on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 8: The Effect of AD on the Probability of Product-Dropping and Plant Exit

	Drop	Drop	Exit	Exit
Treatment*Post	-0.0379***	0.0014	-0.0002	0.0064
	0.013	0.015	0.011	0.0139
Post*Rate		-0.0032***		-0.0005
		0.001		0.0007
Product Shipments	-0.0761***	-0.0761***		
	0.002	0.0023		
Product Tenure	-0.1208***	-0.1208***		
	0.012	0.0118		
No. Employees			-0.0919***	-0.0919***
			0.003	0.003
Plant Age			-0.0022***	-0.0022***
			0.0004	0.0004
Capital Intensity			-0.0158***	-0.0158***
			0.0025	0.0025
Avg. Wage			-0.0708***	-0.0708***
			0.0071	0.0071
Multi-Unit			0.0958***	0.0958***
			0.007	0.007
Multi-Product			-0.0202***	-0.0202***
			0.0043	0.0043
Observations	46,851	46,851	62,720	62,720
R-Squared	0.192	0.193	0.102	0.102

Table 9: Relative Productivity of Product-Droppers

	TFP	LP
Drop	-0.0551***	-0.0825***
	0.0209	0.0155
Year FE	Yes	Yes
Product FE	Yes	Yes
Observations	46,851	46,851
R-Squared	0.658	0.346

Notes: This table summarizes OLS regression coefficients of revenue-based total factor productivity (TFP) and labor productivity (LP) on a binary variable indicating whether a plant dropped an investigated product. Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 10: Antidumping Duties and Output Rationalization

Year	Treatment	Rationalization	Aggregate	Mean
1987	0	0.086	1.69	1.60
1987	1	0.135	1.02	0.89
1992	0	0.169	1.82	1.65
1992	1	0.162	1.08	0.92
1997	0	0.154	1.87	1.71
1997	1	0.133	1.10	0.96

Notes: This table reports a decomposition of revenue-based total factor productivity by year and treatment status (Treatment). “Rationalization” is a term measuring the level of output rationalization, as described in the narrative. “Aggregate” is aggregate productivity. “Mean” is mean plant-level total factor productivity. “Treatment” equals 1 for plants that received protection and 0 for plants that did not receive protection. “Post” equals 1 for plants that had already been involved in an antidumping investigation in time t and 0 for plants that had not yet been involved in an investigation.

Appendix: Not For Publication

Matching HTS Codes to SIC Codes

Products involved in antidumping investigations are classified based on their Harmonized Tariff System (HTS) import codes. The product-level domestic shipment data contained in the Census of Manufactures (CM), however, are classified using the Standard Industrial Classification (SIC). In order to identify plants producing products that were involved in antidumping investigations, it is necessary to utilize a concordance between the two product classification systems.

Because the HTS classifies products based solely on their physical characteristics, while the SIC also incorporates aspects of the method of production, the Census Bureau creates a set of SIC Base Codes (SICBase) that serve as a bridge between the two systems. Census then publishes two concordances—one that maps each ten-digit HTS (HTS10) product to a single SICBase and another that maps each five-digit SIC product (SIC5) to a single SICBase. Using these concordances, I am able to match ten-digit HTS products to five-digit SIC products in a three-step process:

> Step 1: HTS10 products associated with antidumping investigations are matched to SICBase codes using an HTS10-SICBase concordance (HTS_SICBase) published by the Census Bureau.
>
> Step 2: SIC5 products in the CM are assigned a SICBase using a SIC5-SICBase concordance known as the Principle Differences file (PD). The 1992 principle differences file, which is used for the analysis in this paper can be found online at http://www.census.gov/epcd/www/intronet.html.
>
> Step 3: The dataset of antidumping products is merged to the CM using the assigned SICBase codes.

Because a complete HTS-SICBase concordance is only available in 1992, new HTS codes that were created between 1992 and 1997 were matched to their 1992 equivalents using a concordance of HTS codes over time described in Pierce and Schott (2009a). A detailed description of concordances between H10 and SIC5 is available in Pierce and Schott (2009b).

Using this procedure, I was able to assign one or more SIC5 codes to every antidumping investigation involving manufactured products between 1988 and 1996, with the exception of Shock Absorbers from Brazil.[37] The 8-digit HTS code assigned to the product in this investigation—87038050—does not appear in U.S. import data and hence does not appear in the concordances described above.

Deflation

When calculating revenue productivity, I control for changes in prices—to the extent possible—by deflating revenue using industry-level price indexes, applied to the set of products produced at each plant. This technique results in a plant-level deflator that is constructed by weighting the industry-level deflators according the share of a plant's output that is assigned to that industry. Industry-level output deflators, as well as industry-level deflators for cost of materials and capital are from the NBER-CES Manufacturing database reported in Bartelsman, Becker and Gray (2000).

Even with this relatively sophisticated deflation technique, I still find that antidumping duties have substantially different effects on revenue versus physical productivity. There are at least two reasons for these differences. First, since the deflators are based on average price indexes, they do not allow for heterogeneity in pricing across plants. In this sense, plants that charge high prices—due to high local market power, for example—would be misinterpreted as high-productivity plants. Second, because the price indexes are calculated at the industry, rather than the product level, they will not fully reflect increases in product-level prices. This higher level of aggregation means that revenue-based productivity measures will overstate productivity growth in situations where mark-ups are increasing, as is likely the case in the situation considered in this paper. The finding that antidumping duties are associated with increases in revenue productivity, but decreases in physical productivity underscores that even properly deflated revenue productivity measures can still be affected by changes in prices and markups.

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[37] This investigation is listed as Case ID USA-AD-421 in Bown's antidumping database

Table A.1: The Effect of AD on Revenue Productivity – Alternate Control Groups

	Alternate Control Group 1 (AC1)				Alternate Control Group 2 (AC2)			
	TFP	LP	TFP	LP	TFP	LP	TFP	LP
Treatment*Post	0.0790***	0.0699***	0.0911**	0.0767***	0.1288***	0.1109***	0.1414***	0.1223***
	0.0304	0.0194	0.0379	0.0259	0.0332	0.0227	0.0442	0.0292
Post*Rate			-0.0007	-0.0004			-0.0008	-0.0007
			0.0023	0.0015			0.0027	0.0016
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	117,807	117,807	117,807	117,807	213,607	213,607	213,607	213,607
R-Squared	0.678	0.315	0.678	0.315	0.794	0.478	0.794	0.478

Notes: This table summarizes OLS regression coefficients of plant-level total factor productivity (TFP) and labor productivity (LP) on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table A.2: The Effect of AD on Physical Productivity – Alternate Control Groups

	Alternate Control Group 1 (AC1)				Alternate Control Group 1 (AC2)			
	TFPQ	LPQ	TFPQ	LPQ	TFPQ	LPQ	TFPQ	LPQ
Treatment*Post	-0.2787	-0.2513	0.3132*	0.3619**	-0.4677**	-0.4773**	0.1292	0.1193
	0.1943	0.1985	0.1733	0.169	0.2121	0.2182	0.1753	0.1717
Post*Rate			-0.0311***	-0.0322***			-0.0319***	-0.0319***
			0.0051	0.0051			0.005	0.0046
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,190	14,190	14,190	14,190	9,177	9,177	9,177	9,177
R-Squared	0.639	0.61	0.642	0.613	0.652	0.624	0.655	0.627

Notes: This table summarizes OLS regression coefficients of plant-level physical productivity on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table A.3: Antidumping Duties, Prices and Mark-ups– Alternate Control Group 1

	Price	Price	P/AVC	P/AVC	P/ATC	P/ATC
Treatment*Post	0.28	-0.33**	-0.01	-0.06	0.01	-0.02
	0.19	0.15	0.03	0.04	0.02	0.03
Post*Rate		0.03***		0.0026**		0.0017**
		0.004		0.0011		0.0008
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,190	14,190	14,190	14,190	14,190	14,190
R-Squared	0.66	0.67	0.08	0.08	0.07	0.07

Notes: This table summarizes OLS regression coefficients of plant-level price and mark-ups on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table A.4: Antidumping Duties, Prices and Mark-ups– Alternate Control Group 2

	Price	Price	P/AVC	P/AVC	P/ATC	P/ATC
Treatment*Post	0.48**	-0.12	0.01	-0.05	0.02	-0.01
	0.22	0.17	0.04	0.04	0.03	0.03
Post*Rate		0.03***		0.0033**		0.0018**
		0.004		0.0015		0.0008
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,177	9,177	9,177	9,177	9,177	9,177
R-Squared	0.63	0.63	0.08	0.08	0.08	0.08

Notes: This table summarizes OLS regression coefficients of plant-level price and mark-ups on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table A.5: Duration of Protection and Plant-Level Performance

	Revenue TFP	Revenue LP	Physical TFP	Physical LP	Price	P/AVC	P/ATC
Treatment*Post	-0.037	0.003	0.122	0.141	-0.156	0.007	-0.010
	0.055	0.030	0.171	0.159	0.149	0.046	0.032
Post*Rate	-0.002	-0.003**	-0.032***	-0.032***	0.032***	0.003**	0.002**
	0.002	0.001	0.005	0.004	0.004	0.001	0.001
Post*Duration	0.022	0.013**	0.025	0.026	-0.015	-0.019*	-0.003
	0.018	0.006	0.026	0.024	0.022	0.010	0.006
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,419	10,419	10,419	10,419	10,419	10,419	10,419
R-Squared	0.86	0.42	0.65	0.62	0.65	0.08	0.08

Notes: These tables summarize OLS regression coefficients of product-level productivity, prices and markups on the difference-in-difference interaction term "Treatment*Post", the effective duty rate interaction term "Post*Rate" and the duration interaction term Post*Duration. Robust standard errors are reported below each coefficient after adjustment for clustering at the product-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table A.6: The Effect of AD on Revenue Productivity - Within-Plant Estimates

	TFP	LP	TFP	LP
Treatment*Post	0.042***	0.030***	0.0505***	0.031***
	0.010	0.008	0.013	0.011
Post*Rate			-0.001	-0.0001
			0.001	0.001
Year FE	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes	Yes
Observations	28,758	28,758	28,758	28,758
R-Squared	0.903	0.873	0.903	0.873

Notes: This table summarizes OLS regression coefficients of plant-level total factor productivity (TFP) and labor productivity (LP) on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the plant-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table A.7: The Effect of AD on Physical Productivity and Prices - Within-Plant Estimates

	TFPQ	LPQ	TFPQ	LPQ	Price	Price
Treatment*Post	-0.3529***	-0.2639***	0.2415*	0.2746**	0.31***	-0.35***
	0.0966	0.0909	0.1376	0.1332	0.09	0.13
Post*Rate			-0.0401***	-0.0364***		0.04***
			0.0092	0.0089		0.009
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,348	2,348	2,348	2,348	2,348	2,348
R-Squared	0.905	0.91	0.911	0.916	0.89	0.90

Notes: This table summarizes OLS regression coefficients of physical productivity and price on the difference-in-difference interaction term "Treatment*Post" and the effective duty rate interaction term "Post*Rate." Robust standard errors are reported below each coefficient after adjustment for clustering at the plant-level. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table A.8: The Effect of AD on Exit and Product-Dropping, Alternate Control Group 1

	Drop	Drop	Exit	Exit
Treatment*Post	-0.0601***	-0.009	0.0016	0.0083
	0.016	0.018	0.0112	0.0146
Post*Rate		-0.0042***		-0.0005
		0.0011		0.0008
Product Shipments	-0.0729***	-0.0729***		
	0.002	0.0024		
Product Tenure	-0.1128***	-0.1129***		
	0.011	0.0111		
No. Employees			-0.0964***	-0.0964***
			0.003	0.003
Plant Age			-0.0023***	-0.0023***
			0.0003	0.0003
Capital Intensity			-0.0161***	-0.0161***
			0.0022	0.0022
Avg. Wage			-0.0816***	-0.0816***
			0.0074	0.0074
Multi-Unit			0.0919***	0.0919***
			0.0061	0.0061
Multi-Product			-0.0209***	-0.021***
			0.0042	0.0042
Observations	55,728	55,728	76,496	76,496
R-Squared	0.199	0.199	0.123	0.123

Table A.9: The Effect of AD on Exit and Product-Dropping, Alternate Control Group 2

	Drop	Drop	Exit	Exit
Treatment*Post	-0.036***	0.0081	-0.0093	0.0159
	0.011	0.017	0.0122	0.0142
Post*Rate		-0.0036***		-0.0021**
		0.0011		0.0009
Product Shipments	-0.0629***	-0.0629***		
	0.004	0.0039		
Product Tenure	-0.1091***	-0.1091***		
	0.010	0.0096		
No. Employees			-0.0939***	-0.0939***
			0.0049	0.0049
Plant Age			-0.003***	-0.003***
			0.0005	0.0005
Capital Intensity			-0.0166***	-0.0167***
			0.0021	0.0021
Avg. Wage			-0.0779***	-0.078***
			0.0082	0.0082
Multi-Unit			0.0684***	0.0684***
			0.0113	0.0113
Multi-Product			-0.0289***	-0.0291***
			0.0042	0.0042
Observations	94,677	94,677	138,103	138,103
R-Squared	0.194	0.194	0.156	0.156