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The Welfare Effects of the Byrd Amendment

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Abstract

In this paper, I investigate the domestic welfare effects of the Byrd Amendment, a piece of legislation passed in the US in 2000, which mandated that the tariff revenues collected from antidumping (AD) cases be directly distributed to the American firms that initiated or supported these cases. In response to the amendment, 11 US trading partners filed a complaint with the World Trade Organization (WTO) requesting that the amendment be revoked as it violated the US obligations taken under the WTO. The WTO ruling not only demanded that the law be repealed, but also allowed the complainants to impose retaliatory tariffs against the US exports. This paper demonstrates that the imposition of this law is detrimental to domestic consumers and that foreign retaliation reduces domestic firms' profitability. Moreover, in the presence of the Byrd Amendment and with no or low retaliation abroad, if the AD tariff level is set to maximize tariff revenue, then petitioning domestic firms gain higher profits compared to the profits earned prior to the passage of the law.

Keywords: Antidumping, ByrdAmendment, Retaliation, Trade protection

1. Introduction

The Byrd Amendment (also known as the Continued Dumping and Subsidy Offset Act of 2000, CDSOA) was implemented in 2001, when the first direct payments were distributed to the American firms which filed or publicly supported antidumping (henceforth AD) cases against foreign firms. Prior to this act, the funds resulting from the collection of AD duties were incorporated into the US budget and did not directly benefit the US filing firms. From its inception, the Amendment was thought to be violating the World Trade Organization (henceforth WTO) provisions and it was challenged in a WTO dispute initiated by 11 US trading partners (Australia, Brazil, Canada, Chile, EU, India, Indonesia, Japan, Mexico, South Korea, and Thailand). In 2003, the WTO eventually ruled the Byrd Amendment as being illegal and allowed the petitioning countries to introduce retaliatory measures which could penalize the US for up to 72% of the duties raised and distributed through the Byrd Amendment.

In spite of the WTO ruling, the US authorities failed to repeal the law and, with the WTO's permission, some of the initiating countries began targeting imports from the US. During 2005, the EU, Canada, and Japan decided to levy a retaliatory tariff on a selection of US imports. In 2006, the US finally revoked the law, but payments to the American industries still continue under a so-called "transitional clause" along with the retaliation duties on the American exporters in their foreign markets. Currently, these retaliation duties are correlated with the AD duties disbursed to the American industries. The amount of retaliation the American exporters are subject to during year t is a share of the amount of AD tariffs distributed to the American AD petitioners under the Byrd Amendment during year $t-1$. The Byrd Amendment process has important implications concerning the behavior and welfare of various groups in the US economy.

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The purpose of this paper is to disentangle such effects. Thus, on the one hand, the US import-competing industries are benefiting twofold, through direct payments from the collected AD tariff revenues and indirectly through the increased protection from foreign competition.

However, their interests towards the size of the AD duty differ with the Byrd Amendment in place. The most illustrative example would be that of a prohibitive AD duty that perfectly shields the American producers against foreign competitors. Nevertheless, a prohibitive duty would completely eliminate the tariff revenues disbursed to them as part of the Byrd Amendment provisions. Therefore, in the presence of the Byrd Amendment, the American firms might have no incentive to petition for a complete halt in imports as it would subsequently terminate the distribution of any tariff revenues. On the other hand, American exporters are hurt by being charged the AD retaliation tariff in their export markets. In consequence, the gains accruing to the American import-competing industries might be totally offset by losses incurred by the American exporting industries. The US consumers are negatively affected by the AD tariff since the price of the AD targeted imported goods is higher in the US market. But the effects of the Byrd Amendment on the consumer surplus depend on how the amendment changes the domestic price and output levels in favor or against domestic consumers. Although the issue is relatively new, a strand of economic literature has already looked into this matter from both a theoretical as well as an empirical perspective. In a theoretical paper, Collie and Vandenbussche (2006) show that the Amendment can yield lower tariffs and higher welfare than in its absence, as long as the profits' weight in the welfare function is large enough. They do not incorporate, however, any retaliation aspect related to the Byrd Amendment.

On the empirical side, Reynolds (2006), Liebman and Reynolds (2006) show that the passage of the law had an effect on American industries' behavior, with more AD cases being filed and an intensified lobbying activity which might suggest that the domestic industries try to increase their chances of not only getting the protection through the AD cases, but also the tariff proceeds from them. In this paper, I theoretically model the welfare effects of the Byrd Amendment by taking into account its implications on the petitioning domestic industries, consumers, and exporters. The inclusion of the exporters in the model is important for two reasons. Firstly, the Byrd Amendment framework incorporating the export side provides a comprehensive picture of all the US parties affected by this law. Secondly, the pressure from the credible threat posed by the foreign retaliation offers a pertinent explanation as of why the law was repealed in 2006, only one year after the WTO-backed retaliatory measures commenced targeting US exports. The remainder of this paper is structured as follows: the next section introduces the general model followed by two sections that focus separately on the model for the Byrd Amendment and the no-Byrd Amendment cases. Section 5 examines the optimal AD tariff determination. The results are derived and discussed in section 6, and section 7 contains the conclusions.

2. Model

The model includes 2 firms, one domestic and one foreign, and 2 symmetric markets, Home (also referred to as the domestic market) and Foreign. The domestic firm sells its output in the domestic market (where it files an AD case and, under the Byrd Amendment, it is entitled to receive proceeds from the collected AD tariffs) and in the foreign market (where it is the target of the corresponding retaliatory tariffs). The foreign firm also sells in the Home and Foreign markets. This model assumes that the same industry files a petition against a foreign competitor and it is, at the same time, an exporter selling its products abroad in the domestic country of its competitors where it might be subject to retaliation. This assumption is a realistic one as it describes the case of the steel industry, often involved in AD disputes filed by the US steel manufacturers. More specifically, the US steel industry filed AD cases against Japanese steel imports that were slammed with AD duties in the US, but, at the same time, the US steel industry was targeted by retaliatory duties in its export market in Japan, as part of the WTO rulings against the Byrd Amendment. The domestic firm (referred to with subscript 1 throughout this paper) and the foreign firm (referred to with subscript 2) compete in a Stackelberg game both at home and abroad. Each firm is the Stackelberg leader in its own domestic market and the follower in its export market. The choice of the Stackelberg competition fits in the best manner the structure of the game that the domestic firm plays in the presence of the Byrd Amendment, since the tariff revenue term does not drop out in the equilibrium in a Stackelberg game as it does in a Cournot game. This difference allows for the domestic firm to take into consideration the tariff revenues when it makes its profit-maximizing output decisions in equilibrium.

In order to ensure the tractability of the calculations, the inverse market demand functions in the Home market and in the Foreign market are linear of the form $p = a - b(x_1 + x_2)$ and $p^* = a - b(x_1^* + x_2^*)$. The case of the Byrd Amendment with retaliation is the most general set-up for the model, therefore all calculations for the no-retaliation case hold true by simply setting the retaliation variable equal to 0.

Thus, profit functions for the domestic firm are $\pi_1 = (p - c_1)x_1 + (p^* - c_1 - st)x_1^* + tx_2$ (in the Byrd Amendment case) and $\pi_1 = (p - c_1)x_1 + (p^* - c_1)x_1^*$ (in the no-Byrd Amendment case) and for the foreign firm, $\pi_2 = (p^* - c_2)x_2^* + (p - c_2 - t)x_2$, where $x_1(x_1^*)$ is the domestic firm's output in the home (foreign) market, $x_2(x_2^*)$ is the foreign firm's output in the home (foreign) market, $p(p^*)$ is the price in the home (foreign) market, t is the specific AD/CV tariff imposed on the foreign firm's exports in the domestic market. The product st is the specific retaliatory tariff imposed on the domestic firm's exports in the foreign market (calculated as a share of the Byrd Amendment AD tariff, t, thus $s \in [0,1]$, with $s = 0$ in the no-retaliation case and $s = 1$ when the retaliation size set abroad equals the AD tariff imposed by the US) Parameters c_1 and c_2 are the domestic and foreign firms' constant marginal costs, respectively. The constant marginal cost is a standard assumption in oligopolistic models of international trade (see for instance, Brander and Krugman (1983)) since it allows firms to take independent output decisions in the Home and Foreign markets, thus treating the two countries as segmented markets. Parameters a and b are both positive, a measures the market size. From the inverse demand functions, it is obvious that non-negative prices require that the size of a be comparable to the size of the total demand.

3. Byrd Amendment Case

In the presence of the Byrd Amendment, tariff revenues are directed towards the petitioning American firms and are modeled as part of the petitioners' profits.

3.1. Domestic Market Game

The domestic market optimal output levels are obtained by solving a Stakelberg model where the follower (firm 2) chooses its profit-maximizing output depending on the output level chosen by the leader (firm 1). The domestic firm's profit function depends not only on its own sales in the Home and Foreign markets, but also on the size of the tariff revenues. Thus, the optimal leader's output level, x_1, and the follower's optimal output level,x_2, are $x_1 = (a - 2c_1 + c_2)/2b$ and $x_2 = (a + 2c_1 - 3c_2 - 2t)/4b$ (derived in Appendix 1). As can be noted from the expressions above, the equilibrium domestic firm's output does not depend on the tariff level. However, the domestic firm takes into account the tariff level through the tariff revenue term (now part of the profit function) when it maximizes its profit. As for the foreign output sold in the Home market (x_2), it is decreasing in the AD tariff, t.

3.2. Foreign Market Game

Similarly, the same game is played abroad as in the Home market, this time the follower (firm 1) chooses the profit-maximizing output as a function of the output of the leader (firm 2). The Stackelberg game yields the following optimal output levels for the follower (x_1^*) and the leader (x_2^*): $x_1^* = (a - 3c_1 + 2c_2 - 3st)/4b$ and $x_2^* = (a + c_1 - 2c_2 + st)/2b$ (as calculated in Appendix 1). Home's and Foreign's equilibrium prices are: $p = (a + 2c_1 + c_2 + 2t)/4$ and $p^* = (a + c_1 + 2c_2 + st)/4$.

4. No-Byrd Amendment Case

The structure of the Stackelberg game is identical to the game played in the Byrd Amendment case in both domestic and foreign markets. The tariff revenue is not part of the domestic profit function anymore.

4.1. Domestic Market Game

The follower (foreign firm) chooses its profit-maximizing output depending on the output level chosen by the leader (the US firm). Solving for the optimal leader's output level x_1 and then for the follower's output level x_2, they are calculated as $x_1 = (a - 2c_1 + c_2 + t)/2b$ and $x_2 = (a + 2c_1 - 3c_2 - 3t)/4b$ (in Appendix 2).

4.2. Foreign Market Game

The same game is played abroad as in the Home market, the follower (firm 1) chooses the profit-maximizing output as a function of the output of the leader (firm 2) and the optimal output levels are (as shown in Appendix 2): $x_1^* = (a - 3c_1 + 2c_2)/4b$ and $x_2^* = (a + c_1 - 2c_2)/2b$.It follows that Home's and Foreign's equilibrium prices are: $p = (a + 2c_1 + c_2 + t)/4$ and $p^* = (a + c_1 + 2c_2)/4$. By comparing the equilibrium output levels in the Byrd Amendment case and the no-Byrd amendment case, it can be noted that they are identical when $t = 0$. However, for the same non-negative tariff, the domestic firm's output sold domestically is larger in the no-Byrd Amendment case than in the Byrd Amendment case. Conversely, the foreign firm's exports are smaller in the no-Byrd Amendment case than in the Byrd Amendment case. For the domestic firm, a lower level of output sold in the domestic market might be compensated by the tariff revenues collected on a higher volume of imports in the domestic market. These differences in the equilibrium output levels reinforce the idea that the domestic firm has different interests towards the amount of imports and level of protection obtained through the AD process.

5. The Optimal Tariff Level Determination

An AD petition starts at the industry level when firms file a complaint with the AD designated official authority. The authority investigates the allegations of unfair trade (whether the domestic industry is injured by the imports and the dumping size) and decides on the reparative measures to be taken. If the authority rules affirmatively (finds both injury and dumping), the petition ends with the imposition of AD duties. The AD laws state that the first method to be applied in the AD duties calculation is the dumping margin determination as the difference between the imports' price and the price of the same goods in their domestic market. The AD duty is then set equal to the dumping margin. However, in most of the US AD petitions recently filed, the dumping margin has not been computed as the difference between the export price and the actual foreign price (also called the "normal value"). The law allows for a second method of calculation of the dumping margin as the difference between the export price and a so-called "constructed value" which is derived from actual (or, in many cases, estimated) production costs. The "constructed value" method is employed in situations when reliable foreign prices are not available for the same type of goods. This happens when a targeted country in an AD investigation is a non-market economy or when similar products are not sold in their own domestic market or in any other third party market or when the importer practices dumping in all markets where it sells. Since an investigation is normally initiated at the industry level, it is in the US industry's power to name imports that easily qualify under the "constructed value" method and, needless to say, dumping margins are found to be larger in the AD investigations which use the constructed price method than in those which use actual foreign prices. Apparently, the constructed value method introduces a great amount of arbitrariness which, in turn, allows various interests to be served. The widespread use of the constructed value in the calculation of the AD duty, coupled with the previous AD literature findings (see for instance, Reynolds(2006)), which indicate an intensified lobby activity after the inception of the Byrd Amendment, might signal that there are political and strategic considerations playing an important role in the US AD process.

This paper will model two possible methodologies of calculating the AD tariff. The first one (henceforth, called the dumping-margin elimination method) sets the tariff equal to the dumping margin such that prices are equalized across countries. This method conforms with what the AD ruling agencies should apply first in an AD investigation. The second one (henceforth, called the tariff-revenue maximizing method) determines the tariff as the outcome of an optimization problem (to maximize tariff revenues) that the AD authorities face when a petition is filled. This second method could be considered in line with the political economy of trade protection, especially because the tariff revenue will directly benefit the petitioning domestic industries in the Byrd Amendment case.

5.1. The Dumping-Margin Elimination Method

The AD authorities will set the tariff level equal to the dumping margin, such that the foreign and domestic prices are equalized. This is the first method prescribed by the AD legislation in assessing the size of the dumping.

Denote by t_{dm} the tariff level equal to the dumping margin. In the Byrd amendment case, t_{dm} is set such that $p = p^*$ which implies $t_{dm}^{BA} = (c_2 - c_1)/(2 - s)$. The condition for the non-negativity of t_{dm}^{BA} is $c_2 \geq c_1$. This condition also establishes that the foreign country dumps prior to the investigation (since $p < p^*$).

As demonstrated in Appendix 3, the other non-negativity conditions for the output and prices are:

$$if \frac{4c_1}{3} \geq c_2 \geq c_1 then\ a \geq 2c_2 \quad (1)$$

$$if c_2 \geq \frac{4c_1}{3}\ then\ \ a + 4c_1 - 5c_2 \geq 0 \quad (2)$$

In the no-Byrd Amendment case, t_{dm} is also set such that $p = p^*$which means $t_{dm}^{NBA} = c_2 - c_1$. The same condition for the non-negativity of t_{dm}^{NBA} is that $c_2 \geq c_1$, with dumping occurring in this instance as well, as $p < p^*$ and the tariff equalizes prices across countries.

Summarizing, from Appendix 3, the required conditions for non-negative output levels and prices are:

$$a \geq c_2 \geq c_1,\quad a - 2c_1 + c_2 \geq 0,\quad and a + 5c_1 - 6c_2 \geq 0 \quad (3)$$

Obviously, if the cost structure is such that $c_1 \geq c_2$, then the AD investigating authority would not find dumping using the dumping-margin elimination method and thus would dismiss the petition. If the dumping-margin elimination method is used to determine the AD tariff, then the tariff is set higher in the no-Byrd Amendment case, i.e., $t_{dm}^{NBA} > t_{dm}^{BA}$, because $t_{dm}^{NBA} = c_2 - c_1 > t_{dm}^{BA} = (c_2 - c_1)/(2 - s)$.

5.2. The tariff-revenue maximizing method

The AD authorities will set the tariff level such that it maximizes the tariff revenue (which is directly disbursed to the petitioning industries in the case of Byrd Amendment). Denote this tariff level by t_{tr}. In the case of the Byrd Amendment, the tariff revenue is $TR = tx_2^{BA} = t(a + 2c_1 - 3c_2 - 2t)/4b$ and the optimal tariff level that maximizes the tariff revenue is $t_{tr}^{BA} = (a + 2c_1 - 3c_2)/4$ (with $\partial^2 TR/\ \partial t^2 = -1/b < 0$).

From Appendix 3, the required conditions for the non-negativity of output, prices, and tariff level are:

$$if c_2 \geq c_1\ then\ a \geq c_2 \geq c_1, a - 2c_1 + c_2 \geq 0\ and a + 2c_1 - 3c_2 \geq 0 \quad (4)$$

$$if c_1 \geq c_2\ then\ a \geq c_1 \geq c_2,\ a - 18c_1 + 17c_2 \geq 0\ and a + c_1 - 2c_2 \geq 0 \quad (5)$$

In the case of the no-Byrd Amendment, the tariff revenue is $TR = tx_2^{NBA} = t(a + 2c_1 - 3c_2 - 3t)/4b$ and the optimal revenue-maximizing tariff is $t_{tr}^{NBA} = (a + 2c_1 - 3c_2)/6$ thus $t_{tr}^{NBA} = 2t_{tr}^{BA}/3$. Therefore, if the tariff-revenue maximizing method is used to determine the AD tariff, then $t_{tr}^{NBA} < t_{tr}^{BA}$.

From Appendix 3, the following inequalities ensure the non-negativity of the output, tariff, and prices:

$$if c_2 \geq c_1\ then\ a \geq c_2 \geq c_1,\ a + 2c_1 - 3c_2 \geq 0\ and a - 3c_1 + 2c_2 \geq 0 \quad (6)$$

$$if c_1 \geq c_2\ then\ a \geq c_1 \geq c_2,\ a - 3c_1 + 2c_2 \geq 0\ and a + c_1 - 2c_2 \geq 0 \quad (7)$$

6. Results

Result 1 Consumers are hurt by the imposition of the Byrd Amendment, irrespective of the method used to determine the tariff level, dumping-margin elimination or tariff-revenue maximization. Thus, $CS^{BA} < CS^{NBA}$, where CS^{BA} and CS^{NBA} are the consumer surpluses in the Byrd Amendment and no-Byrd Amendment case, respectively.

Proof. Case 1: The tariff level is set to eliminate the dumping margin. It can be easily shown that with a linear inverse demand, the consumer surplus in the Byrd Amendment and no-Byrd Amendment cases, respectively are $CS^{BA} = (3a - 2c_1 - c_2 - 2t_{dm}^{BA})^2/32b$ and

$CS^{NBA} = (3a - 2c_1 - c_2 - t_{dm}^{NBA})^2/32b$. But $t_{dm}^{NBA} = (2-s)t_{dm}^{BA} < 2t_{dm}^{BA}$, for all $s \in [0,1]$. It follows immediately that $CS^{BA} < CS^{NBA}$.

Case 2: The tariff level is set to maximize tariff revenue. Similarly, with a linear inverse demand, the consumer surplus in the Byrd Amendment and no-Byrd Amendment cases, respectively are $CS^{BA} = (3a - 2c_1 - c_2 - t_{tr}^{BA})^2/32b$ and $CS^{NBA} = (3a - 2c_1 - c_2 - t_{tr}^{NBA})^2/32b$. But $t_{tr}^{NBA} < t_{tr}^{BA}$, for all $s \in [0,1]$.Hence, $CS^{BA} < CS^{NBA}$.

Result 2 *Domestic profits are decreasing in the size of the foreign retaliation, i.e., $\partial\pi^{BA}/\partial s < 0$, irrespective of the method employed in determining the tariff level (dumping-margin elimination or tariff-revenue maximization).*

Proof. See Appendix 4.

This result sheds light on why foreign retaliation might have decisively contributed to the repeal of the amendment. Once the US trading partners were allowed to implement retaliatory measures against American exports in foreign markets, the US firms' overall profitability declined (even as they collected the tariff revenue at home) and this should have normally reduced the domestic support for the law.

Result 3 *If the tariff level is set to eliminate dumping, the domestic firms do not benefit from the Byrd Amendment in the sense that their profitability is lower in the Byrd Amendment case compared to no-Byrd Amendment, i.e., $\pi^{BA}_{|t_{dm}^{BA}} < \pi^{NBA}_{|t_{dm}^{NBA}}$ for all $s \in [0,1]$.*

Proof. When $s = 0$, the foreign price level (p^*) and domestic firm's exports (x_1^*) are identical in both cases (Byrd Amendment and no-Byrd Amendment). In addition, as the previous result demonstrated, $\pi^{BA}_{|t_{dm}^{BA}}$ attains its maximum when $s = 0$ and it can be written as:

$$\pi^{BA}_{|t_{dm}^{BA},s=0} = \frac{(a-3c_1+2c_2)(a-2c_1+c_2)}{8b} + (p^* - c_1)x_1^* + \frac{(c_2-c_1)(a+3c_1-4c_2)}{8b}$$

Similarly, the profit function in the no-Byrd Amendment case can be written as:

$$\pi^{NBA}_{|t_{dm}^{NBA}} = \frac{(a-3c_1+2c_2)(a-3c_1+2c_2)}{8b} + (p^* - c_1)x_1^*$$

Their difference yields:

$$\pi^{BA}_{|t_{dm}^{BA},s=0} - \pi^{NBA}_{|t_{dm}^{NBA}} = \frac{-6}{8b}(c_2 - c_1)^2 < 0 \qquad \pi^{BA}_{|t_{dm}^{BA}} < \pi^{NBA}_{|t_{dm}^{NBA}} \quad \forall \quad s \in [0,1]$$

Together with Result 1, this result shows that absolutely no group in the society gains from the imposition of the Byrd Amendment, if the tariff level is calculated by using the dumping-margin elimination method. And this holds irrespective of the size of the foreign retaliation. At a first inspection, this might seem counter-intuitive but, one must keep in mind that the tariff level determination follows the rules specified by the legislation of using actual prices in order to calculate the dumping margin. This method does not necessarily offer much leeway in manipulating the tariff size in favor of certain groups, and, to no surprise, it is rarely used in AD investigations initiated by the US industries. However, as the next two results illustrate, when political economy considerations are involved and the tariff level is set to maximize the tariff revenue, domestic petitioning firms are benefiting from the law by increasing their overall profitability, as long as they are not targeted by high levels of retaliation abroad.

Result 4 *When the AD tariff is calculated to maximize the tariff revenue and the domestic petitioners are not subject to any foreign retaliation ($s = 0$), the domestic petitioners benefit from the Byrd Amendment, i.e., $\pi^{BA}_{|t_{tr}^{BA},s=0} > \pi^{NBA}_{|t_{tr}^{NBA}}$.*

Proof. The domestic firm's profit functions for the Byrd Amendment and no-Byrd Amendment cases, respectively are:

$$\pi^{BA}_{|t_{tr}^{BA},s=0} = \frac{(a+c_2-2c_1)^2}{8b} + \frac{t_{tr}^{BA}(a+c_2-2c_1)}{4b} + \frac{(a-3c_1+2c_2)^2}{16b} + \frac{(t_{tr}^{BA})^2}{2b}$$

$$\pi^{NBA}_{|t_{tr}^{NBA}} = \frac{(a+c_2-2c_1)^2}{8b} + \frac{2t_{tr}^{NBA}(a+c_2-2c_1)}{8b} + \frac{(t_{tr}^{NBA})^2}{8b} + \frac{(a-3c_1+2c_2)^2}{16b}$$

But since $t_{tr}^{NBA} = \frac{2}{3}t_{tr}^{BA}$, it follows that the profits difference is:

$$\pi^{BA}_{|t_{tr}^{BA},s=0} - \pi^{NBA}_{|t_{tr}^{NBA}} = \frac{t_{tr}^{BA}(a+c_2-2c_1)}{4b} - \frac{t_{tr}^{BA}(a+c_2-2c_1)}{6b} + \frac{(t_{tr}^{BA})^2}{2b} - \frac{4(t_{tr}^{BA})^2}{72b} > 0$$

This result clearly indicates that when there is no foreign retaliation, domestic firms benefit from the Byrd Amendment, if the calculation of the tariff aims at maximizing the tariff revenue.

Result 5 If the tariff-revenue maximization method is used to determine the AD tariff and the domestic petitioners are subject to full retaliation abroad (i.e., $s = 1$), then domestic petitioners' profitability is higher in the non-Byrd Amendment case vs. Byrd Amendment case (i.e., $\pi^{NBA}_{|t_{tr}^{NBA}} > \pi^{BA}_{|t_{tr}^{BA},s=1}$) if:

(a.) domestic petitioning firms have lower marginal costs (i.e., $c_2 > c_1$) or

(b.) domestic petitioning firms have higher marginal costs (i.e., $c_1 > c_2$) and the size of the market (i.e., parameter a) is larger then the marginal cost of the domestic firm or the foreign firm (more specifically, $a > (819\beta/23) + c_1$ or equivalently, $a > (842\beta/23) + c_2$, $\forall \beta > 0$).

Proof. See Appendix 4.

From Result 3, $\partial\pi^{BA}/\partial s < 0 \forall s \in [0,1] \pi^{BA}$ is monotonically decreasing in s. From Result 4, $\pi^{BA}_{|t_{tr}^{BA},s=0} > \pi^{NBA}_{|t_{tr}^{NBA}}$ and, from Result 5, $\pi^{NBA}_{|t_{tr}^{NBA}} > \pi^{BA}_{|t_{tr}^{BA},s=1}$ (given $c_1 > c_2$ or $a > (819\beta/23) + c_1$). Summarizing these findings, then $\exists s \in [0,1]$, denoted s^* where $\pi^{NBA}_{|t_{tr}^{NBA}} = \pi^{BA}_{|t_{tr}^{BA}}$. As long as the foreign retaliation is below s^*, domestic firms' profitability is larger in the Byrd Amendment case. However, if the retaliation level is set above s^*, petitioners' profits decline and they might support the repeal of the law. A level of retaliation set below the s^*threshold is illustrated in Figure 1, whereas Figure 2 depicts a level of retaliation above s^*.

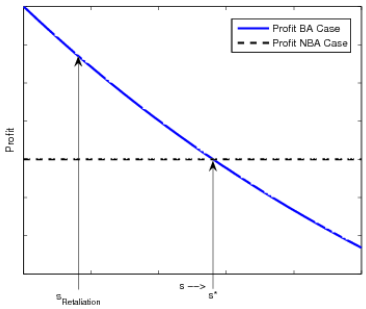

Figure 1: Retaliation Set Below s^*

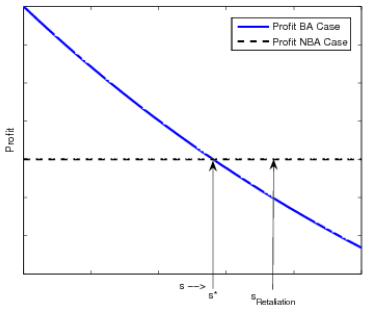

Figure 2: Retaliation Set Above s^*

In essence, Result 5 predicts that if a firm operates in large domestic and foreign markets (more precisely, when $a > (842\beta/23) + c_2$ or equivalently, $a > (819\beta/23) + c_1$) where it can potentially sell large volumes of output, then a high level of foreign retaliation hurts its profitability, even if the tariff level is set to maximize the tariff revenue (which is ultimately disbursed to the petitioners and becomes part of their profits).

7. Conclusions

As part of the assessment of the Byrd Amendment's welfare implications, this paper's goal has been to establish what gains or losses accrue to different groups in the society. Thus, with a tariff calculated as to eliminate dumping, the paper demonstrates that there are only losers from the implementation of the law, with reducedconsumer surplus and profits. In addition, domestic profitability declines with foreign retaliation. However, this method of calculating the tariff does not allow for any special interests to be served and constitutes a possible explanation as of why it is not used on a large scale in the AD investigations initiated by the US industries.

If the authorities set the tariff level to maximize the tariff revenue, then the domestic firms obtain higher profits from the imposition of the Byrd Amendment compared to their profits with no law in place, if they are not targeted by large levels of retaliation abroad. However, when high retaliation levels target domestic exports abroad, domestic firms' overall profitability declines and even petitioners in AD cases have a strong incentive to lobby for the repeal of the law. Consumers, on the other hand, continue to be hurt and they are the group that does not benefit from this law, no matter how the tariff is calculated. In conclusion, the Byrd Amendment had and continues to have an impact on US firms' behavior toward the protection obtained through AD cases. Moreover, the distortions introduced by this piece of legislation were serious enough to warrant foreign retaliation against the US exports. As this paper proves, foreign retaliation had negatively impacted the domestic firm's profitability which ultimately ceased to support the amendment.

8. Appendices

Appendix 1: The Byrd Amendment Case Game

Domestic market (Stackelberg leader = domestic firm; follower = foreign firm)

The follower chooses its profit-maximizing output depending on the leader's output. The follower's profit function is$\pi_2 = (a - bx_1^* - bx_2^* - c_2)x_2^* + (a - bx_1 - bx_2 - c_2 - t)x_2$. Solve for the optimal x_2 as a function of x_1, it yields$x_2 = (a - c_2 - bx_1)/2b$.

The leader's profit-maximizing output is obtained by plugging the expression for x_2 into its profit function and solving for the profit-maximizing output x_1. The leader's (domestic firm) profit function is

$\pi_1 = [(a - 2c_1 + c_2 + t - bx_1)/2]x_1 + (a - bx_1^* - bx_2^* - c_1 - st)x_1^* + t[(a - c_2 - t - bx_1)/2b]$.
Solving for x_1, it yields$x_1 = (a - 2c_1 + c_2)/2b$ and $x_2 = (a + 2c_1 - 3c_2 - 2t)/4b$.

Foreign market (Stackelberg leader = foreign firm; follower = domestic firm)

The same game is played as in the Home market, this time the follower (firm 1) chooses the profit-maximizing output x_1^* as a function of the output x_2^* of the leader (firm 2). Follower's profit function can be written as$\pi_1 = (a - bx_1 - bx_2 - c_1)x_1 + (a - bx_1^* - bx_2^* - c_1 - st)x_1^* + tx_2$ and solving for the optimal level of x_1^*,it yields$x_1^* = (a - c_1 - st - bx_2^*)/2b$.

Plugging the expression for x_1^* into the foreign firm's profit function π_2, the foreign firm's profit function becomes$\pi_2 = [(a + c_1 - 2c_2 + st - bx_2^*)/2]x_2^* + (a - bx_1 - bx_2 - c_2 - t)x_2$. Solving for the optimal x_2^*, it yields $x_2^* = (a + c_1 - 2c_2 + st)/2b$ and $x_1^* = (a - 3c_1 + 2c_2 - 3st)/4b$. Thus, it follows immediately that Home's and Foreign's equilibrium prices are$p = (a + 2c_1 + c_2 + 2t)/4$ and $p^* = (a + c_1 + 2c_2 + st)/4$.

Appendix 2: The no-Byrd Amendment Case Game

Domestic market (Stackelberg leader = domestic firm; follower = foreign firm)

The follower chooses its profit-maximizing output depending on the output level chosen by the leader. The follower's profit function is

$\pi_2 = (a - bx_1^* - bx_2^* - c_2)x_2^* + (a - bx_1 - bx_2 - c_2 - t)x_2$. Solve for the optimal x_2 as a function of x_1 and obtain $x_2 = (a - c_2 - t - bx_1)/2b$.

The leader's profit-maximizing output is obtained by plugging the expression for x_2 into its profit function and solving for the profit-maximizing output x_1. The leader's (domestic firm) profit function is

$\pi_1 = [(a - 2c_1 + c_2 + t - bx_1)/2]x_1 + (a - bx_1^* - bx_2^* - c_1)x_1^*$. Solving for the optimal leader's output level x_1, thus$x_1 = (a - 2c_1 + c_2 + t)/2b$ and $x_2 = (a + 2c_1 - 3c_2 - 3t)/4b$.

Foreign market (Stackelberg leader = foreign firm; follower = domestic firm)

The same game is played as in the Home market. Firm 1 chooses the profit-maximizing output as a function of the output of the leader (firm 2). Follower's profit function

is$\pi_1 = (a - bx_1 - bx_2 - c_1)x_1 + (a - bx_1^* - bx_2^* - c_1)x_1^*$ and the optimal output is $x_1^* = (a - c_1 - bx_2^*)/2b$.

Plugging the expression for x_1^* into the foreign firm's profit function π_2, the profit becomes$\pi_2 = [(a + c_1 - 2c_2 - bx_2^*)/2]x_2^* + (a - bx_1 - bx_2 - c_2 - t)x_2$. Solving for the optimal leader's output level x_2^*, it yields$x_2^* = (a + c_1 - 2c_2)/2b$ and $x_1^* = (a - 3c_1 + 2c_2)/4b$. Therefore, it follows immediately that Home's and Foreign's equilibrium prices are$p = (a + 2c_1 + c_2 + t)/4$ and $p^* = (a + c_1 + 2c_2)/4$.

Appendix 3: Non-negativity conditions-tariff, output, and prices

Dumping-margin elimination method: Byrd Amendment case (Conditions 1 and 2)

Since $\partial t_{dm}^{BA}/\partial s > 0$ and $\partial s t_{dm}^{BA}/\partial s > 0$, then$x_2$ and $x_1^*$are decreasing in s and x_2^* is increasing in s. For $x_1^* \geq 0 \forall s \in [0,1]$one has$a \geq 2c_2$ which also ensures that $x_1 \geq 0$and $x_2^* \geq 0 \forall s \in [0,1]$. The only remaining condition is $x_2 \geq 0 \forall s \in [0,1]$, which boils down to having $a + 4c_1 - 5c_2 \geq 0$ when $s = 1$. If $4c_1/3 \geq c_2 \geq c_1$, then condition $a \geq 2c_2$ is stronger than condition $a + 4c_1 - 5c_2 \geq 0$, which guarantees that output levels, the tariff level, and prices are all non-negative. Conversely, if $c_2 \geq 4c_1/3$, then condition $a + 4c_1 - 5c_2 \geq 0$ is stronger than condition $a \geq 2c_2$ such that output levels, the tariff level, and prices are all non-negative.

Dumping-margin elimination method: No-Byrd Amendment case (Condition 3)

The non-negativity condition for x_1 is $a - 2c_1 + c_2 \geq 0$, which also satisfies $x_1^* \geq 0$. For $x_2 \geq 0$, it is required that $a + 5c_1 - 6c_2 \geq 0$ and for $x_2^* \geq 0$, it is required that $a + c_1 - c_2 \geq 0$. With $c_2 \geq c_1$, condition $a + 5c_1 - 6c_2 \geq 0$ is stronger than $a + c_1 - c_2 \geq 0$ and thus it ensures that both x_2 and x_2^* are non-negative. Conditions $a - 2c_1 + c_2 \geq 0$ and $a + 5c_1 - 6c_2 \geq$ must hold simultaneously, which requires that $a \geq c_2 \geq c_1$.

Tariff revenue-maximizing method: Byrd Amendment case (Conditions 4 and 5)

$x_1^* = (a - 18c_1 + 17c_2)/4b \geq 0$ (at $s = 1$, as x_1^* is decreasing in s) and $x_1 = (a - 2c_1 + c_2)/2b \geq 0$. If $c_2 \geq c_1$, then $a - 18c_1 + 17c_2 \geq a - 2c_1 + c_2$, thus $a - 2c_1 + c_2 \geq 0$ ensures that both $x_1 \geq 0$ and $x_1^* \geq 0$. If $c_1 \geq c_2$, $a - 2c_1 + c_2 \geq a - 18c_1 + 17c_2$, thus condition $a - 18c_1 + 17c_2 \geq 0$ ensures that $x_1 \geq 0$ and $x_1^* \geq 0$.

Additionally, for $x_2 = (a + 2c_1 - 3c_2 - 2t_{tr}^{BA})/4b \geq 0$ the following inequality must hold $(a + 2c_1 - 3c_2)/8b \geq 0$ which also guarantees that $t_{tr}^{BA} \geq 0$, $p \geq 0$, and $x_2^* = (a + c_1 - 2c_2)/2b \geq 0$ at $s = 0$ (x_2^* is increasing in s). If $c_2 \geq c_1$, comparing conditions $a + 2c_1 - 3c_2 \geq 0$ and $a + c_1 - 2c_2 \geq 0$, it can be easily demonstrated that condition $a + 2c_1 - 3c_2 \geq 0$ is stronger and therefore ensures that $x_2 \geq 0$, $t_{tr}^{BA} \geq 0$, $p \geq 0$, and $x_2^* \geq 0$. Conversely, if $c_1 \geq c_2$, then condition $a + c_1 - 2c_2 \geq 0$ is stronger than condition $a + 2c_1 - 3c_2 \geq 0$ and thus condition $a + c_1 - 2c_2 \geq 0$ ensures the following inequalities hold$x_2 \geq 0$, $t_{tr}^{BA} \geq 0$, $p \geq 0$, and $x_2^* \geq 0$.

Moreover, if $c_2 \geq c_1$ conditions $a - 2c_1 + c_2 \geq 0$ and $a + 2c_1 - 3c_2 \geq 0$ must hold simultaneously to guarantee that x_1, x_1^*, x_2, x_2^*, p, and t_{tr}^{BA} are all positive, which leads to the following condition $a \geq c_2$. Summarizing, when $c_2 \geq c_1$, the set of conditions are $a \geq c_2 \geq c_1$, $a - 2c_1 + c_2 \geq 0$, and $a + 2c_1 - 3c_2 \geq 0$. If $c_1 \geq c_2$,conditions $a - 18c_1 + 17c_2 \geq 0$ and $a + c_1 - 2c_2 \geq 0$ must hold simultaneously, which means $a \geq c_1$. Summarizing, when $c_1 \geq c_2$, the conditions are $a \geq c_1 \geq c_2$, $a - 18c_1 + 17c_2 \geq 0$, and $a + c_1 - 2c_2 \geq 0$.

Tariff revenue-maximizing method: No-Byrd Amendment case (Conditions 6 and 7)

The required non-negativity conditions for this case are: $t_{tr}^{NBA} \geq 0$,or equivallently,$a + 2c_1 - 3c_2 \geq 0$ which also ensures that $x_2 \geq 0$. Condition $x_1 \geq 0$ requires $a \geq 2c_1 - c_2$. Condition $x_2^* \geq 0$ requires $a + c_1 - 2c_2 \geq 0$. It can be easily verified that if $c_2 \geq c_1$, then $a + 2c_1 - 3c_2 \geq 0$ is stronger than condition $a + c_1 - 2c_2 \geq 0$, which guarantees that $t_{tr}^{NBA} \geq 0$, $x_2 \geq 0$, and $x_2^* \geq 0$. However, if $c_1 \geq c_2$, the reverse is true, i.e., $a + c_1 - 2c_2 \geq 0$ is stronger than condition $a + 2c_1 - 3c_2 \geq 0$ such that $t_{tr}^{NBA} \geq 0$, $x_2 \geq 0$, and $x_2^* \geq 0$. Further on, condition $x_1^* \geq 0$ requires $a - 3c_1 + 2c_2 \geq 0$. Thus, if $c_2 \geq c_1$, conditions $a + 2c_1 - 3c_2 \geq 0$ and $a - 3c_1 + 2c_2 \geq 0$ must hold simultaneously, which required the following inequalities to hold $a \geq c_2 \geq c_1$. Similarly, if $c_1 \geq c_2$, conditions $a - 3c_1 + 2c_2 \geq 0$ and $a + c_1 - 2c_2 \geq 0$ must hold simultaneously, which leads to $a \geq c_1 \geq c_2$.

Appendix 4: Proof of Results

Proof Result 2:

Case 1: (The tariff level is set to eliminate the dumping margin)

Domestic firm's profit function is $\pi^{BA}_{|t^{BA}_{dm}} = (p - c_1)x_1 + (p^* - c_1 - st^{BA}_{dm})x_1^* + t^{BA}_{dm}x_2$ or:

$$4b\pi^{BA}_{|t^{BA}_{dm}} = \left(\frac{a-2c_1+c_2}{2} + t^{BA}_{dm}\right)(a + c_2 - 2c_1) + \frac{(a-3c_1+2c_2-3st^{BA}_{dm})^2}{4} + t^{BA}_{dm}(a - 3c_2 + 2c_1) - 2(t^{BA}_{dm})^2$$

Differentiating with respect to s, it yields:

$$\frac{\partial 4b\pi^{BA}_{|t^{BA}_{dm}}}{\partial s} = \frac{dt^{BA}_{dm}}{ds}(a + c_2 - 2c_1) - \frac{12}{8}\frac{d(st^{BA}_{dm})}{ds}(a - 3c_1 + 2c_2 - 3st^{BA}_{dm}) +$$
$$+ \frac{dt^{BA}_{dm}}{ds}(a - 3c_2 + 2c_1) - 2\frac{d((t^{BA}_{dm})^2)}{ds}$$

Since $t^{BA}_{dm} = (c_2 - c_1)/(2 - s)$, the above derivatives are calculated as: $dt^{BA}_{dm}/ds = (c_2 - c_1)/(2 - s)^2$, $d(st^{BA}_{dm})/ds = 2dt^{BA}_{dm}/ds$, and $d(t^{BA}_{dm})^2/ds = 2t^{BA}_{dm}(dt^{BA}_{dm}/ds)$. Thus

$$\frac{\partial 4b\pi^{BA}_{|t^{BA}_{dm}}}{\partial s} = \frac{dt^{BA}_{dm}}{ds}(a + c_2 - 2c_1) - \frac{3dt^{BA}_{dm}}{ds}(a - 3c_1 + 2c_2 - 3st^{BA}_{dm}) +$$
$$+ \frac{dt^{BA}_{dm}}{ds}(a - 3c_2 + 2c_1) - 4t^{BA}_{dm}\frac{dt^{BA}_{dm}}{ds}$$

Rearranging, the above becomes:

$$\partial 4b\pi^{BA}_{|t^{BA}_{dm}}/\partial s = (dt^{BA}_{dm}/ds)(2 - s)^{-1}[-a(2 - s) - 20c_2 + 22c_1 + 17sc_2 - 18sc_1].$$

Denote the expression in the square brackets by γ, then $\partial\gamma/\partial s = 2bx_1 + 16(c_2 - c_1) > 0$. Thus, γ is maximum when

$s = 1$.But

$$\gamma_{|s=1} = -(a - 2c_1 + c_2) - 2(c_2 - c_1) < 0, thus\ \partial\pi^{BA}_{|t^{BA}_{dm}}/\partial s < 0 \forall s \in [0,1].$$

Case 2: (The tariff level is set to maximize tariff revenue.) The domestic firm's profit function is:

$$\pi^{BA}_{|t^{BA}_{tr}} = \left(\frac{a-2c_1+c_2+2t^{BA}_{tr}}{4}\right)\left(\frac{a-2c_1+c_2}{2b}\right) + t^{BA}_{tr}\frac{a+2c_1-3c_2-2t^{BA}_{tr}}{4b} + \frac{(a-3c_1+2c_2-3st^{BA}_{tr})^2}{16b}$$

Differentiating it with respect to s, it yields:

$$\frac{\partial\pi^{BA}_{|t^{BA}_{tr}}}{\partial s} = \frac{-6t^{BA}_{tr}(a-3c_1+2c_2-3st^{BA}_{tr})}{16b} = \frac{-6t^{BA}_{tr}x_1^*}{4} < 0$$

It follows that $\pi^{BA}_{|t^{BA}_{tr}}$ attains its maximum when the domestic firm faces no retaliation abroad.

Proof Result 5: In the Byrd Amendment case, the domestic profit evaluated at the tariff level that maximizes the tariff revenue is

$\pi^{BA}_{|t^{BA}_{tr}} = (p - c_1)x_1 + (p^* - c_1 - st^{BA}_{tr})x_1^* + t^{BA}_{tr}x_2$. Thus,

$$\pi^{BA}_{|t^{BA}_{tr}} = \frac{(a-2c_1+c_2)^2}{8b} + t^{BA}_{tr}\frac{(a-2c_1+c_2)}{4b} + \frac{(a-3c_1+2c_2)^2}{16b}$$
$$-6st^{BA}_{tr}\frac{(a-3c_1+2c_2)}{16b} + \frac{9s^2(t^{BA}_{tr})^2}{16b} + \frac{(t^{BA}_{tr})^2}{2b}$$

When domestic firms face full retaliation abroad ($s = 1$) the domestic profit is:

$$\pi^{BA}_{|t^{BA}_{tr},s=1} = \frac{(a-2c_1+c_2)^2}{8b} + t^{BA}_{tr}\frac{(-a+5c_1-4c_2)}{8b} + \frac{(a-3c_1+2c_2)^2}{16b} + \frac{17(t^{BA}_{tr})^2}{16b}$$

In the no-Byrd Amendment case, the domestic profit evaluated at the tariff that maximizes the tariff revenue is $\pi^{NBA}_{|t^{NBA}_{tr}} = (p-c_1)x_1 + (p^*-c_1)x_1^*$. Plugging in the optimal levels for output and prices, it yields:

$$\pi^{NBA}_{|t^{NBA}_{tr}} = \frac{(a-2c_1+c_2)^2}{8b} + 2t^{NBA}_{tr}\frac{(a-2c_1+c_2)}{8b} + \frac{(t^{NBA}_{tr})^2}{8b} + \frac{(a-3c_1+2c_2)^2}{16b}$$

Since $t^{NBA}_{tr} = 2t^{BA}_{tr}/3$, the domestic profit evaluated at the tariff that maximizes the tariff revenue is:

$$\pi^{NBA}_{|t^{NBA}_{tr}} = \frac{(a-2c_1+c_2)^2}{8b} + t^{BA}_{tr}\frac{(a-2c_1+c_2)}{6b} + \frac{(t^{BA}_{tr})^2}{18b} + \frac{(a-3c_1+2c_2)^2}{16b}$$

Thus, the difference of the profits in the Byrd and No-Byrd Amendment cases is written as:

$$\pi^{BA}_{|t^{BA}_{tr},s=1} - \pi^{NBA}_{|t^{NBA}_{tr}} = t^{BA}_{tr}\frac{(-a+5c_1-4c_2)}{8b} + \frac{17(t^{BA}_{tr})^2}{16b} - t^{BA}_{tr}\frac{(a-2c_1+c_2)}{6b} - \frac{(t^{BA}_{tr})^2}{18b}$$

Further simplifications yield the following inequality $\pi^{BA}_{|t^{BA}_{tr},s=1} < \pi^{NBA}_{|t^{NBA}_{tr}}$ if and only if $9(9a+74c_1-83c_2) < 8(13a-22c_1+9c_2) \Leftrightarrow 23a-842c_1+819c_2 > 0$.In order to establish when this inequality holds, two possible cases emerge based on the non-negativity conditions derived for the tariff revenue-maximizing method.

Case 1: $a > c_2 > c_1$ (which corresponds to the non-negativity Conditions 4 and 6). Then, $23a-842c_1+819c_2 = 23a-23c_1-819c_1+819c_2 > 0or\pi^{NBA}_{|t^{NBA}_{tr}} > \pi^{BA}_{|t^{BA}_{tr},s=1}$.

Case 2: $a > c_1 > c_2$ (which corresponds to the non-negativity Conditions 5 and 7). Let $a = c_1 + \alpha$ and $c_2 = c_1 - \beta$, with $\alpha > 0$ and $\beta > 0$. Replacing these values in expression $23a-842c_1+819c_2$, it becomes $23a-842c_1+819c_2 = 23\alpha - 819\beta$. If $23\alpha - 819\beta > 0$, then
$23a-842c_1+819c_2 > 0$or$\pi^{NBA}_{|t^{NBA}_{tr}} > \pi^{BA}_{|t^{BA}_{tr},s=1}$.

With $a = c_1 + \alpha$ and $c_2 = c_1 - \beta$then$a = c_2 + \alpha + \beta$ and, $23\alpha - 819\beta > 0$ is equivalent to $\alpha > \frac{842}{23}\beta + c_2$ or $a > \frac{819}{23}\beta + c_1$. The last two inequalities can be interpreted in the following manner: if the domestic and the foreign markets are large enough (i.e., parameter a exceeds the right-hand side values), in addition to less cost-efficient domestic firms (i.e., $c_1 > c_2$), the domestic profitability is lower in the Byrd Amendment case compared to the no-Byrd Amendment case, if there is full retaliation abroad.

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