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Cascading Trade Protection: Theory and Evidence from the U.S.*

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Abstract

In a world with increasingly integrated global supply chains, trade policy targeting upstream products has unintended consequences on their downstream industries. In this paper, we examine whether protection granted to intermediate manufacturers leads to petition for protection by their downstream users. We first provide a simple model which identifies the key factors and their interactions that cause cascading protection to motivate our empirical analysis. Then, we test our model by identifying the input-output relationships among the time-varying temporary trade barriers of the U.S. using its detailed input-output tables. As predicted by the theory, we find that measures on imported inputs increase the likelihood of their downstream users' subsequent trade remedy petition over the 1988-2013 period. Additionally, our simulation exercise shows that cascading protection can cause additional welfare losses, and hence we propose that trade policy investigations should take vertical linkages into account.

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1 Introduction

The U.S. President Barack Obama, moments before signing The Manufacturing Enhancement Act of 2010, stated in his speech that "...[manufacturers] *often have to import certain materials from countries and pay tariffs on those materials. This legislation will reduce or eliminate some of those tariffs, which will significantly lower costs for American companies across the manufacturing landscape...*" (Obama, 2010). Input trade liberalization certainly has benefits. Amiti and Konings (2007), for example, show that a 10 percentage point fall in input tariffs results in a 12 percent gain in productivity for Indonesian firms that import these goods. Similarly, Goldberg et al. (2009) find that the Indian trade liberalization in 1991 enabled domestic firms to import new varieties and thus produce new products. Research on this area is mostly focused on liberalization and not protection. However, following the rationale of the input liberalization literature, *increasing* import duties on key intermediates is clearly detrimental to the domestic manufacturing firms that use these inputs. One way for these downstream firms to pass on these losses to final consumers is to gain import protection for their own products. This type of protection, fittingly coined "cascading protection" by Hoekman and Leidy (1992), is the subject of this paper.

In this paper, we examine systematically whether protection granted to intermediate manufacturers leads to petition for protection by their downstream users. We were motivated by the use of temporary trade barriers (TTBs) in the U.S., which include anti-dumping (AD), countervailing duties (CVD), and safeguards (SG), on vertically-linked products. For example, the World Bank's detailed Temporary Trade Barriers Database (Bown, 2014) shows that, in 1998, several U.S. manufacturers of *hot-rolled carbon steel* applied for anti-dumping protection and the Department of Commerce imposed measures in 1999 on these products coming from Japan and Russia.[1] In 2001, the U.S. initiated a massive safeguard investigation covering 611 10-digit Harmonized Tariff Schedule (HTS) products that are heavy downstream users of *hot-rolled carbon steel*. Measures were imposed on a large majority of these products in 2002.[2] In another example, in 2001, the U.S. applied anti-dumping duties on *polyethylene terephthalate (PET) film* imported from India and Taiwan, after a petition by Dupont Teijin Films, Tsubishi Polyester Film, and Toray Plastics Incorporated. In 2003, five U.S. producers of *polyethylene retail carrier bags*, a user of *PET film*, requested anti-dumping duties on their products imported from China, Malaysia, and Thailand. Final measures were imposed in 2004.[3]

In order to guide our empirical analysis we first provide a simple model of vertically-linked industries which identifies the key factors and their interactions that cause cascading protection to occur. In this model, upstream protection increases the input price index of the downstream firms and this, assuming price-taking behavior, leads to an increase in import penetration for the downstream industry and thus a higher likelihood to petition for protection, which is the model's main empirically

[1]These products were investigated once again in 2000, this time targeting 11 additional countries, with final measures imposed in 2001.

[2]See Durling and Prusa (2003, 2006) for a closer look at trade protection in the U.S. steel industry, with focus on the crucial *hot-rolled steel* market.

[3]See Appendix Table A.2 for additional examples.

testable implication.[4]

We test our prediction by first identifying the input-output relationships among the time-varying TTBs of the U.S. using its detailed input-output tables provided by the Bureau of Economic Analysis (BEA).[5] We get the trade barrier data from the World Bank's Temporary Trade Barriers Database (Bown, 2014) and combine it with industry-level data from the BEA. Our identification relies on the fact that U.S. temporary trade barrier proceedings do not give legal voice to downstream firms during an investigation on one of their inputs. This affirms that upstream protection acts as an exogenous shock to the downstream firm. In fact, our empirical results show that measures on imported inputs increase the likelihood of their downstream users' subsequent trade remedy petition by 3 percentage points for the median downstream industry. This represents about 23 percent of the mean initiation rate (13 percent) in 1997-2013. The effect depends not only on the importance of the input in terms of its cost share but also on upstream and downstream industry characteristics such as import penetration, demand elasticity, and market size. In the last analytical part, we do a simulation exercise and find that welfare loss for the importing country is 1.04 percent when cascading protection exists, much larger than the loss of 0.55 percent without it. Our counterfactual analyses show that these losses are exacerbated in a world with deeper global supply chains, and we argue that trade policy investigations should take vertical linkages into account in order to mitigate the losses.

Our findings relate mostly to the literature on vertically-linked trade policy schemes. Cascading trade protection, which is the main focus of this paper, was first identified by Feinberg and Kaplan (1993) who show that anti-dumping petitions that target downstream goods tend to follow anti-dumping initiations by upstream industries in the U.S. chemicals and metals industries during 1980-86. However, they do not match upstream/downstream pairs and thus do not empirically test for cascading protection.[6] Hoekman and Leidy (1992) present a theoretical model, based on their earlier work on rent-seeking (Leidy and Hoekman, 1991) that explains how a downstream industry will follow its upstream counterpart in petitioning for anti-dumping duties due to depressed profits. Their model also explains why downstream users will not necessarily object to trade protection on their intermediate goods as long as they will also obtain protection. Note, however, that their paper simply offers a cost-benefit analysis of cascading protection and does not discuss the role of market structure. Sleuwaegen et al. (1998) extend Hoekman and Leidy (1992) by incorporating market structure and predict that cascading protection is more likely to occur when the upstream industry is concentrated and has high import penetration, and the downstream industry is less concentrated. However, they pose strong asymmetric assumptions on the structure of production, and also predict a sequential rather than a causal relationship between upstream protection and downstream petition.

[4]Note that this structure can be applied to all types of trade policy, and not just TTBs. We use TTBs to proxy for trade policy changes because they are the most transparent and frequently used type of *time-varying* trade policy in the U.S. during 1995-2013. We also assume away political economy channels for simplicity.

[5]Ideally we would test our prediction for all TTB user countries but no country except for the U.S. has such a highly disaggregated IO table available necessary for our analysis.

[6]They do employ the non-parametric Mann-Whitney U-test and conclude that there is a tendency for downstream petitions to occur after upstream petitions.

In the empirical literature, Blonigen (2013) uses subsidy and trade protection data and finds that industrial policy that promotes the steel sector has adverse effects on the export performance of steel-using industries. Konings and Vandenbussche (2013) use French firm-level data and find that anti-dumping duties depress sales and exports of export-oriented firms. The study that is closest to our paper in its approach and goal is Krupp and Skeath (2002), who examine certain upstream/downstream product pairs that were affected by U.S. anti-dumping in 1977-92, and show that anti-dumping duties on upstream products negatively affect the quantity of downstream production. They find no evidence of an effect on the value of downstream production, which indicates that prices might play a role. They do not, however, look at the incidence of cascading protection. Interestingly, while examples are abundant, there is no rigorous empirical examination of cascading protection in the international trade literature.[7] Hence, this paper provides the first systematic look at how trade barriers on imported inputs increase the likelihood of their downstream users' trade remedy petition. This is crucial in understanding the relationship between the increasingly integrated global supply chains and the amplification of welfare distortions due to cascading protection.

Finally, our results are related to an extensive literature on anti-dumping use in the U.S., one of the most prominent users of contingent trade protection. Takacs (1981) and Finger et al. (1982) were among the first studies that look at U.S. anti-dumping and safeguard use in the pre-1980 period. Initially created to combat predatory pricing, anti-dumping has become a tool for trade protectionism that aims to limit foreign competition, especially to help out declining industries.[8] Staiger and Wolak (1994), Prusa (1996, 2011), and Irwin (2005) are among the important studies on anti-dumping use in the U.S. The literature then began to focus on the proliferation of anti-dumping in the world, as described in detail by Prusa (2001), Vandenbussche and Zanardi (2008), and Bown (2011). None of these papers, however, have looked at vertical linkages between anti-dumping measures as we do in this paper.

The rest of the paper proceeds as follows. Section 2 presents a model of cascading protection tailored for anti-dumping procedures that guides our empirical analysis. Section 3 describes the data in detail. Section 4 has our empirical analysis with robustness checks. In Section 5, we do a simulation exercise under different scenarios and calculate welfare effects. Section 6 concludes.

2 A Model of Cascading Trade Protection

2.1 Basic Environment

We consider a world with two countries, each having S downstream industries indexed by s and W upstream industries indexed by w. Each industry consists of a continuum of differentiated varieties.

[7]There is, however, related research on the effective rates of protection which looks at countries' tariff structures in a static way.

[8]See, for example, Boltuck and Litan (1991) who examine the lax application of AD criteria. For in-depth analyses on declining industries and trade protection, see Hillman (1982), Brainard and Verdier (1997), and Magee (2002).

Preferences are identical across countries. Consumers consume downstream varieties and a homogeneous non-manufacturing good. Their preferences are given by the following utility function:

$$U_i = \prod_s \left(\sum_{j \in \{1,2\}} \int_0^{N_{js}} x_{jis}(u_{js})^{\frac{\sigma_s - 1}{\sigma_s}} du_{js} \right)^{\frac{\mu_s \sigma_s}{\sigma_s - 1}} Y_i^{\mu_Y},$$

where x_{jis} is the quantity of a downstream industry s variety from country j consumed in country i, N_{js} is the mass of the industry s varieties produced in country j, $\sigma_s > 1$ is the elasticity of substitution between industry s varieties, and μ_s is the fraction of income spent on downstream industry s, with $\sum_s \mu_s + \mu_Y = 1$. Y is the free-traded, homogeneous sector used to pin down wages, which we normalize to 1 for both countries.[9]

Downstream industries use upstream intermediates to produce final goods. Their technologies are given by:

$$x_{is} = \phi_{is} \prod_w \left(\sum_{j \in \{1,2\}} \int_0^{N_{jw}} x_{jiws}(\nu_{jw})^{\frac{\sigma_w - 1}{\sigma_w}} d\nu_{jw} \right)^{\frac{\beta_{ws} \sigma_w}{\sigma_w - 1}},$$

where x_{is} is the quantity produced by downstream industry s in country i, N_{jw} is the mass of the upstream industry w varieties produced in country j, x_{jiws} is the quantity of an input variety from industry w in country j, used by industry s in country i, ϕ_{is} is what we call "efficiency" which affects the marginal cost of production and differs across country-industries, σ_w is the elasticity of substitution, and β_{ws} is the fraction of costs that industry s spends on purchasing inputs from upstream industry w.

Upstream industries use labor as the only input and their marginal cost is $1/\phi_{iw}$. For both upstream and downstream industries, each variety is uniquely associated with an individual firm, hence firms have monopoly power with respect to their own variety. We take the number of firms in each industry as given. Since we are interested in the impact of *temporary* trade barriers, which are often in place for five years, it is reasonable to assume that the number of firms is fixed in the short run.[10]

We assume industries in country 1, both upstream and downstream, may file for protection against imports, while country 2 is passive. If cascading protection is to occur, several sequential steps have to be taken. First, an upstream industry decides to petition for protection (costly)[11] and then the authority decides to grant protection.[12] Next, the downstream industry has to decide to petition or

[9]For simplicity, we use Y to denote both the industry and the quantity consumed.

[10]The WTO mandates that anti-dumping measures expire in five years. However, they can be extended by affirmative sunset reviews if the investigating authority finds that the measures continue to be necessary to prevent injury to the domestic industry (GATT, 1994).

[11]In the U.S. anti-dumping investigations, the petition is deemed admissible if it is filed *on behalf of* a domestic industry: "*(i) the domestic producers or workers who support the petition account for at least 25 percent of the total production of the domestic like product, and (ii) the domestic producers or workers who support the petition account for more than 50 percent of the production of the domestic like product produced by that portion of the industry expressing support for or opposition to the petition*" (Commission et al., 2005).

[12]The anti-dumping investigations in the U.S. are conducted jointly by the quasi-judicial International Trade Commission (ITC) which examines whether there is injury to the domestic industry, and the Commerce Department's Interna-

not. Then the authority again has to start an investigation and decide whether to grant protection. It is important to mention that the political economy forces are not in play here as temporary trade barriers are contingent on certain rules and thus we assume away lobbying. Crucially, the U.S. investigations do not have a "public interest clause" that would mandate the authorities to consider the downstream effects of protection, which therefore fails to provide a legal standing for downstream users to oppose protection.[13]

We assume that the government in country i grant protection with a likelihood θ if an industry petitions.[14] Protection is assumed to take the form of an ad-valorem duty, whose ex-ante value raises the price of imports to domestic level.[15] Furthermore, we assume that the applied duty is in the form of iceberg trade cost and hence it does not accrue to revenue.[16]

2.2 Equilibrium for Given Temporary Trade Protection

To facilitate the discussion on the cascading mechanism and quantitative exercises in later sections, we first present the equilibrium of the economy taking the petition and protection conditions as given. Assume the number of firms in each industry is large enough so that firms take the market demand curve as given. Cost minimization of the downstream implies that firms in upstream industry w of country j face the following demand from country i:

$$x_{jiw} = \frac{(p_{jw}\tau_{jiw})^{-\sigma_w}}{P_{iw}^{1-\sigma_w}} \sum_s \beta_{ws} Q_{is},$$

where P_{iw} is the price index of industry w varieties faced by country i consumers. Q_{is} is the total amount that the downstream industry s of country i spend on purchasing inputs. As production function is of Cobb-Douglas at industry level, each industry spends a β_{ws} fraction of their total expenditure on intermediates w. Also, p_{jw} is the ex-factory price of intermediates in industry w; $\tau_{jiw} = 1 + t_{jiw}\mathbb{P}_{iw}$, where $\mathbb{P}_{iw}$ is the indicator variable which equals 1 when industry w of country i gets protected (and 0 otherwise); t_{jiw} is the duty country i imposes on imports of w from country j, with $t_{iiw} = 0$, $t_{jiw} \geq 0$ and whose value equals $max\{0, \frac{p_{iw}-p_{jw}}{p_{jw}}\}$. The aggregated price index P_{iw} is given by:

$$P_{iw} = \left(\sum_{j\in\{1,2\}} N_{jw}(p_{jw}\tau_{jiw})^{1-\sigma_w} \right)^{\frac{1}{1-\sigma_w}}. \tag{1}$$

tional Trade Administration (ITA) which determines the existence of dumping. *Injury* is classified into three categories: *material injury, threat of material injury* and *material retardation of the establishment of an industry. Dumping* occurs if the price of the subject imports is "less than fair value" (Commission et al., 2005).

[13]The EU, another large anti-dumping user, does have a "public interest clause."

[14]Given that the ITA finds *dumping* in the large majority of investigations (more than 90 percent), the ITC's *injury* determination often determines whether measures are imposed.

[15]Almost all TTB duties in the U.S. are in the ad-valorem form, calculated as percentage of the sale price (i.e. the dumping margin).

[16]We make this assumption for two reasons. First, it enables us to have a tractable reduced form equation for empirical analysis; second, it simplifies our calibration results as they do not depend on existing tariffs.

Profit-maximizing firm charges a constant mark-up over marginal cost. Given the wage normalization, the ex-factory price is $p_{iw} = \frac{\sigma_w}{(\sigma_{w-1})\phi_{iw}}$. Cost minimization also gives the unit cost of downstream firms in industry s, country i as:

$$c_{is} = \frac{A_s}{\phi_{is}} \prod_w P_{iw}^{\beta_{ws}}, \tag{2}$$

where $A_s = \prod_w \beta_{ws}^{-\beta_{ws}}$.

Similarly, utility maximization implies firms in downstream industry s of country j face the following demand in country i:

$$x_{jis} = \frac{(p_{js}\tau_{jis})^{-\sigma_s}}{P_{is}^{1-\sigma_s}} \mu_s E_i,$$

where P_{is} is the price index of industry s faced by country i consumers. E_i is the nominal income of country i and p_{js} is the ex-factory price of final goods in industry s of country j. τ_{jis} is defined analogously to τ_{jiw}. For simplicity, we assume that E_i is fixed for both countries. An endogenous E_i would create an additional *income* incentive to file for protection. Specifically, if we assume that industry profits accrue to consumer income, on one hand, protection increases industry profits, which translates to higher domestic income, hence greater consumption level which benefits all industries; on the other hand, costly petition has exactly the opposite income effect as it generates lump-sum loss in profit. Assuming a fixed E_i is equivalent to assuming that in an economy with many industries, the *net* change contributed by protected industry is negligible in changing consumer income. This assumption is rather innocuous given that TTB protection is a rare event (the mean industry initiation rate is 6 percent in 1988-2013).

The price index of downstream industry s is:

$$P_{is} = \left(\sum_{j \in \{1,2\}} N_{js} (p_{js}\tau_{jis})^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}}. \tag{3}$$

Similar to the upstream case, downstream firms in country j, industry s charge a constant mark-up over marginal cost: $p_{js} = \frac{\sigma_s}{\sigma_{s-1}} c_{js}$. As a result, operating profits of industry s in country i can be written as:

$$\Pi_{is} = \frac{1}{\sigma_s} \sum_{j \in \{1,2\}} N_{is} \left(\frac{p_{is}\tau_{ijs}}{P_{js}} \right)^{1-\sigma_s} \mu_s E_j. \tag{4}$$

The *net* profit therefore equals $\Pi_{is} - C_s \mathbb{F}_{is}$, where $\mathbb{F}_{is}$ is an indicator variable which equals 1 when industry s of country i files for protection (and 0 otherwise). C_s is the industry specific cost for petition.[17] Constant mark-up implies that downstream firms always spend proportional to their

[17]It is well known that protection has the characteristics of a public good. In particular, existing AD procedures do not require *all* firms in an industry to participate in a petition. We follow the previous literature and assume that such internationalization costs are solved. The political economy of trade policy literature typically considers that this petition cost is a function of industry characteristics such as market concentration (see Baldwin (1989)).

revenue on their input purchases, which is equivalent to saying that their input expenditures are proportional to their operating profits before netting out the petition cost; this can be expressed as $Q_{is} = (\sigma_s - 1)\Pi_{is}$. This yields the profits of upstream industry w:

$$\Pi_{iw} = \frac{1}{\sigma_w} \sum_{j \in \{1,2\}} N_{iw} \left(\frac{\tau_{ijw} p_{iw}}{P_{jw}} \right)^{1-\sigma_w} \left(\sum_s (\sigma_s - 1)\beta_{ws}\Pi_{js} \right), \tag{5}$$

with net profit equaling $\Pi_{iw} - C_w\mathbb{F}_{iw}$, and $\mathbb{F}_{iw}$ is defined analogously to $\mathbb{F}_{is}$.

Obviously, since we assume country 2 is passive in terms of protection, $\mathbb{F}_{2s}= \mathbb{P}_{2s} = 0$ for all $s \in S$, $w \in W$. Taking the protection status $\mathbb{P}$ and the tariff level τ for both upstream and downstream industries as given, equations (1)-(5) present a system of $2(2W + 3S)$ equations with $2(2W + 3S)$ unknowns: P_{iw}, P_{is}, c_{is}, Π_{iw} and Π_{is} for $i \in \{1, 2\}$. Therefore the system is exactly identified. With information on petition cost C, granting probability θ, and protection status $\mathbb{P}$, we can further compute industries' expected *net* gains/losses from petitioning.

2.3 Cascading Protection, Market Structure and Upstream Incentives

In this subsection, we first show that cascading protection emerges naturally given our model's setting, then we examine the implications of market structure on the likelihood of cascading protection. Lastly, we analyze whether the anticipation of cascading protection provides an additional incentive for upstream industries to file for protection.

The existing literature typically defines cascading protection as "both intermediate and final good industries petition for protection" (Sleuwaegen et al., 1998). This definition is rather problematic as it does not guarantee any causal relationship between the upstream and downstream actions. Hence before proceeding further, we provide a formal definition of cascading protection:

DEFINITION 1. *Cascading protection refers to the case when the protection of an upstream industry increases the likelihood of its downstream counterpart's petition for protection.*

As only industries in country 1 can file for protection in our setup, we suppress the country subscript of $\mathbb{P}$, $\mathbb{F}$ and C to simplify notation. Denoting upstream industries' protection condition by $\{\mathbb{P}_w\}$, where $\{\mathbb{P}_w\}$ is a $W \times 1$ vector and the w^{th} element of which is $\mathbb{P}_w$, Π_{1s} can then be expressed as a function of its protection and $\{\mathbb{P}_w\}$, i.e. $\Pi_{1s} \equiv \Pi_{1s}(\mathbb{P}_s, \{\mathbb{P}_w\})$. A downstream industry s in country 1 chooses to pursue protection ($\mathbb{F}_s = 1$) iff:

$$\theta\big[\Pi_{1s}(1, \{\mathbb{P}_w\}) - \Pi_{1s}(0, \{\mathbb{P}_w\})\big] - C_s > 0. \tag{6}$$

Inequality (6) describes that the downstream industry petitions for protection if and only if the expected gain exceeds the cost. Assume that C_s is positive, exogenous and consists of a random, independent disturbance with mean zero, then the likelihood a downstream industry petitions is positively correlated with $\Pi_{1s}(1, \{\mathbb{P}_w\}) - \Pi_{1s}(0, \{\mathbb{P}_w\})$, which we write as $\frac{\Delta\Pi_{1s}(\{\mathbb{P}_w\})}{\Delta\mathbb{P}_s}$. The definition of cascading protection therefore can be formally presented as:[18]

$$\frac{\Delta^2 \Pi_{1s}}{\Delta \mathbb{P}_s \Delta \mathbb{P}_w} \equiv \frac{\Delta \Pi_{1s}(\mathbb{P}_w = 1)}{\Delta \mathbb{P}_s} - \frac{\Delta \Pi_{1s}(\mathbb{P}_w = 0)}{\Delta \mathbb{P}_s} > 0. \tag{7}$$

Inequality (7) implies that cascading protection happens if and only if $\mathbb{P}_s$ and $\mathbb{P}_w$ are complementary in increasing Π_{1s}.

Under the fixed-income assumption, the framework developed in the previous subsections naturally leads to cascading protection. To see this, use equation (4) to substitute Π_{is} in equation (6), and rewrite $\frac{\Delta \Pi_{1s}}{\Delta \mathbb{P}_s}$ as:

$$\frac{\Delta \Pi_{1s}}{\Delta \mathbb{P}_s} = \frac{\mu_s E_1}{\sigma_s} \left(M_s - M_s^1 \right), \tag{8}$$

where $M_s \equiv 1 - \frac{N_{1s} p_{1s}^{1-\sigma_s}}{N_{1s} p_{1s}^{1-\sigma_s} + N_{2s} p_{2s}^{1-\sigma_s}}$ and $M_s^1 \equiv 1 - \frac{N_{1s}}{N_{1s}+N_{2s}}$ are import penetration rates of the downstream industry before and after its protection respectively. Note that when an upstream industry w gets protected, the domestic price index of w rises to $P'_{1w} = \left(N_{1w}(p_{1w})^{1-\sigma_w} + N_{2w} \left(p_{2w} \tau_{21w} \right)^{1-\sigma_w} \right)^{\frac{1}{1-\sigma_w}}$. As petition is costly, w files for protection if and only if $\tau_{21w} > 1$. Conditional on this, and using (2), one can verify that p_{1s} is a strictly increasing function of $\mathbb{P}_w$.[19] Since M_s is an increasing function of p_{1s}, by chain rule it follows that $\frac{\Delta^2 \Pi_{1s}}{\Delta \mathbb{P}_s \Delta \mathbb{P}_w} > 0$. This is summarized in the following lemma:

LEMMA 1. *Cascading protection always exists as the downstream industry's profit is supermodular in upstream and downstream protections.*

The intuition behind Lemma 1 is that the injury transmission of upstream protection works through an increase in the import penetration rate of the downstream industry. With fixed consumer income and constant mark-ups, an increase in import penetration directly translates to a fall in industry profits. As the level of duty is contingent (i.e. the dumping margin), the downstream industry will expect a higher level of protection which in turn will increase its likelihood of petition. This is the "component price effect" mentioned in Hoekman and Leidy (1992).

Both Hoekman and Leidy (1992) and Sleuwaegen et al. (1998) emphasize that upstream protection will increase the probability that protection will be *granted* if sought by the downstream industry. However, it is not clear whether the authority's decision will be affected by the *cause* of the injury.[20] It seems more natural to assume that the effects work through injury transmission; conditional on petitioning, whether injury is caused by upstream protection or not should have zero predictive power in granting probability. Indeed we were not able to find a relationship between upstream protection

[18] As all upstream industries are isomorphic, it is sufficient to analyze one; here we also slightly abuse notation as $\frac{\Delta \Pi_{1s}(\mathbb{P}_w)}{\Delta \mathbb{P}_s}$ should be formally written as $\frac{\Delta \Pi_{1s}(\mathbb{P}_w, \mathbb{P}_{-w})}{\Delta \mathbb{P}_s}$.

[19] Formally, the result holds besides the trivial case when $\beta_{ws} = 0$ or $M_w = 0$. This is intuitive, as $\beta_{ws} = 0$ or $M_w = 0$ imply that the downstream industry s use no imported intermediates from industry w, and thus a tariff imposed on imported w has no impact on downstream industry's cost.

[20] In fact, the ITC has been criticized heavily for not establishing a causal relationship between *dumping* and *injury* as necessitated by the WTO.

and the probability of obtaining downstream protection given petition. Appendix section A.3 shows our results. Lemma 1 is therefore important in two aspects: first, it reveals that cascading protection rises naturally from the vertical market structure; second, its existence does not rely on the assumption of granting probability as the previous literature argues.

In what circumstances is cascading protection more likely to happen? Using equation (8), $\frac{\Delta^2\Pi_{1s}}{\Delta\mathbb{P}_s\Delta\mathbb{P}_w}$ can be written as:

$$\frac{\Delta^2\Pi_{1s}}{\Delta\mathbb{P}_s\Delta\mathbb{P}_w} = \frac{\mu_s E_1}{\sigma_s}\left(M_s' - M_s\right), \tag{9}$$

where $M_s' \equiv 1 - \frac{N_{1s}p_{1s}'^{1-\sigma_s}}{N_{1s}p_{1s}'^{1-\sigma_s}+N_{2s}p_{2s}^{1-\sigma_s}}$ is the import penetration rate of the downstream industry with upstream protection as p_{1s}' denote prices of industry s with upstream protection. It is easy to verify that $\frac{\Delta^2\Pi_{1s}}{\Delta\mathbb{P}_s\Delta\mathbb{P}_w}$ is an increasing function of the downstream industry's demand elasticity σ_s, domestic market size $\mu_s E_1$, cost share parameter β_{ws} with respect to its protected input, and upstream industry's import penetration rate M_w. Moreover, it is increasing in M_s when $M_s \leq 1/2$, and decreasing when $M_s > 1/2$. An intuitive way of seeing this is to perform the first order Taylor approximation of equation (9) around $t_{21w} = 0$:

$$\frac{\Delta^2\Pi_{1s}}{\Delta\mathbb{P}_s\Delta\mathbb{P}_w} \approx \frac{(\sigma_s - 1)\mu_s E_1}{\sigma_s}(1 - M_s)M_s\beta_{ws}M_w t_{21w}. \tag{10}$$

Higher $\frac{\Delta^2\Pi_{1s}}{\Delta\mathbb{P}_s\Delta\mathbb{P}_w}$ implies that the expected gain from petition for a downstream industry reacts more to upstream protection. Hence, cascading protection is more likely to happen when $\frac{\Delta^2\Pi_{1s}}{\Delta\mathbb{P}_s\Delta\mathbb{P}_w}$ is large. The following proposition is immediate:

PROPOSITION 1. *Cascading protection is more likely to happen if the protected upstream industry has high import penetration rate and/or is heavily used by its downstream industry; it is also more likely to happen if the affected downstream industry has a large domestic market and/or a high demand elasticity. When the import penetration rate of the downstream industry rises, it first increases and then decreases the likelihood of cascading protection.*

Proposition 1 sheds light on how the market structure affects the likelihood of cascading protection. Specifically, if the protected input is heavily used, or if its import penetration rate is high, the injury transmitted to its downstream industry is more likely to be severe—this increases the likelihood that cascading protection will occur. Higher σ_s also encourages petition for protection as consumers substitute to foreign downstream goods once the duty is imposed.

Interestingly, increased import penetration makes cascading protection more likely when $M_s \leq 1/2$, and less likely when $M_s > 1/2$. The intuition of the non-monotonic effect is also straightforward: when import penetration is high, there is already an incentive to ask for protection, hence the marginal increase of petition likelihood incurred by upstream protection is rather low. The opposite is true when import penetration is low. To further illustrate the point, think of a case where a certain downstream industry has import penetration close to 100 percent. Given plausible values for C_s and

θ, its likelihood to file for protection approaches unity independent of upstream protection. This non-monotonic effect of import penetration is worth emphasizing, as existing literature does not distinguish between the downstream industry's intrinsic tendency to petition and the part motivated by upstream protection, while our analysis indicates that it is essential to make such distinctions.

In their seminal paper, Hoekman and Leidy (1992) propose that when an upstream industry seeks protection that stands to severely harm its domestic downstream customers, the motivation must lie in the expectation that the transmission of injury will make downstream protection highly likely. Thus, we now ask whether potential cascading protection creates incentives for the upstream industry to pursue protection in the first place. Taking into account that its eventual protection will increase its downstream industries' petition likelihood, the upstream industry w will file for protection iff:

$$\theta\big[E\big(\Pi_{1w}(\mathbb{P}_w = 1)\big) - E\big(\Pi_{1w}(\mathbb{P}_w = 0)\big)\big] - C_w > 0,$$

where $E(\Pi_{1w}(\mathbb{P}_w = 1))$ is the expected payoff of the upstream industry when it receives protection. Protection granted to the upstream industry increases the likelihood of downstream industries' petition (and thus the unconditional probability of downstream protection), which in turn affects the expected profits of the upstream industry. Denoting the downstream protection outcomes by an $s \times 1$ vector $\{\mathbb{P}_s\}$, and the probability of the realization as $Pr(\{\mathbb{P}_s\}|\mathbb{P}_w)$, $E(\Pi_{1w}\big(\mathbb{P}_w = 1)\big)$ can be written as:

$$E\big(\Pi_{1w}(\mathbb{P}_w = 1)\big) \equiv \sum_{\{\mathbb{P}_s\}} \Pi_{1w}\left(\mathbb{P}_w = 1, \{\mathbb{P}_s\}\right) Pr(\{\mathbb{P}_s\}|\mathbb{P}_w = 1).$$

If the upstream industry does not consider the impact of its behavior on its downstream industries' protection likelihood, then it perceives $Pr(\{\mathbb{P}_s\}|\mathbb{P}_w = 1) = Pr(\{\mathbb{P}_s\}|\mathbb{P}_w = 0)$. In this case, its expected payoff from getting protected becomes:

$$E_0\big(\Pi_{1w}(\mathbb{P}_w = 1)\big) \equiv \sum_{\{\mathbb{P}_s\}} \Pi_{1w}\left(\mathbb{P}_w = 1, \{\mathbb{P}_s\}\right) Pr(\{\mathbb{P}_s\}|\mathbb{P}_w = 0).$$

If the existence of cascading protection increases the upstream industry's petition incentive, we expect that $E(\Pi_{1w}\big(\mathbb{P}_w = 1)\big) > E_0(\Pi_{1w}(\mathbb{P}_w = 1))$. To illustrate, consider an example with only one upstream and one downstream industry; then, the upstream industry's decision function becomes:

$$\begin{aligned} \mathbb{F}_w = 1 \ \text{ iff } \ & \theta^2 r_s(1)\Pi_{1w}(1,1) + \theta\big(1 - \theta r_s(1)\big)\Pi_{1w}(1,0) \\ & - \theta^2 r_s(0)\Pi_{1w}(0,1) - \theta\big(1 - \theta r_s(0)\big)\Pi_{1w}(0,0) > C_w, \end{aligned} \tag{11}$$

where $r_s(0)$ is the likelihood that downstream industry s asks for protection conditional on $\mathbb{P}_w = 0$, and $\Pi_w(0,1)$ is the upstream industry's profit when $\mathbb{P}_w = 0$ and $\mathbb{P}_s = 1$. If the upstream industry behaves without considering the impact of its behavior on downstream actions, then it perceives $r = r_s(0)$. In this case the decision function becomes:

$$\mathbb{F}_w = 1 \text{ iff } \theta^2 r_s(0)\Pi_{1w}(1,1) + \theta\big(1-\theta r_s(0)\big)\Pi_{1w}(1,0) - \theta^2 r_s(0)\Pi_{1w}(0,1) - \theta\big(1-\theta r_s(0)\big)\Pi_{1w}(0,0) > C_w. \quad (12)$$

Comparing petition conditions (11) and (12), it is easy to see that when the cascading protection mechanism exists (i.e. $r_s(1) > r_s(0)$), the anticipation of it creates an additional incentive for the upstream industry to seek protection if and only if $\Pi_w(1,1) - \Pi_w(1,0) > 0$. That is, the protection of both industries increases the upstream industry's profit even more. This can be verified using (5). The intuition is straightforward: as income is fixed, consumers spend a fixed proportion on purchasing downstream goods. From an upstream industry perspective, downstream protection acts as a transfer of foreign to domestic demand. This provides an additional incentive for the upstream industry to file as its own protection would make the industry even more competitive in its domestic market. The case for multi-industries follows the same intuition and we relegate the formal proof to Appendix section A.1. This result is summarized in the following proposition:

PROPOSITION 2. *The existence of cascading protection increases the likelihood of upstream industry to file for protection.*

The key insight of Proposition 2 is that when industries are vertically linked, the upstream industry may file "too many" petitions at the expense of its downstream users and consumers. A duty imposed on upstream goods directly decreases the domestic consumer's welfare by making domestic downstream products more expensive; in addition, due to the possibility of cascading protection it may further cast a negative impact on consumer welfare by triggering downstream protection, which raises the price of foreign final goods. Moreover, Proposition 2 indicates that these effects can be even larger as upstream industries are more likely to file for protection when they know that their downstream counterparts can also obtain protection. As is well-known, TTBs are often imposed for import relief rather than welfare maximization, and often does so at the expense of consumers. Our theoretical exercise indicates that the welfare loss associated with trade protection may be much larger than one conventionally thinks when vertical linkages are taken into account.

3 Data and Specification

3.1 Data Description

Our empirical analysis uses data mainly from two sources. First, we get temporary trade barrier (TTB) data from the World Bank's Temporary Trade Barriers Database (Bown, 2014) that has detailed information on anti-dumping (AD), countervailing duty (CVD), and safeguard (SG) investigations by all user countries in the world with each investigation mapped to the targeted Harmonized System (HS) codes. For the U.S., products are often identified at the 10-digit Harmonized Tariff Schedule (HTS) level which enables us to identify the subject products at a very disaggregated level.

Between 1988 and 2013,[21] the U.S. initiated 1,167 TTB cases and imposed 567 measures (51 percent affirmative),[22] targeting 69 different countries and 928 distinct 6-digit HS products.[23] The majority of these TTBs were AD (77 percent), with the rest consisting of CVDs (22 percent) and SGs (1 percent).[24] According to Bown (2014), U.S. TTBs in stock as of end-2013 covered 3 percent of its imports in 2013, a staggering figure which makes U.S. the second-largest TTB user after India. Figure 1 shows the annual counts of U.S. TTB initiations and measures. Note that there are spikes in certain years due mostly to macroeconomic conditions such as recessions and currency appreciations.[25] This reveals the need to control for macroeconomic factors in our empirical specification. Moreover, the number of measures seems to follow the number of initiations almost proportionally with a lag—this justifies the fixed likelihood of protection assumption in our model.

Investigations cover a large variety of products, mainly in the manufacturing sector. Table 1 shows the 3-digit North American Industry Classification System (NAICS) composition of U.S. TTBs in 1988-2013 counted by the number of "unique" investigations, where "unique" refers to a product (which might include multiple HTS10 lines), not a product-country as illustrated in Figure 1.[26] As can be seen from Table 1, the *Primary Metals* and the *Fabricated Metals* sectors together make up 36 percent of all investigations—two closely related sectors where the cost share of *Primary Metals* in *Fabricated Metals* is 32 percent. The figure also shows that TTBs affect a wide range of industries as *Other sectors*, which include 15 distinct NAICS3, make up 17 percent of all investigations. Table A.1 in the Appendix shows all the affected industries, ordered by how frequently they were targeted by U.S. TTBs, and their summary statistics.

The second major component of the data we use is the Bureau of Economic Analysis' (BEA) 1997 Input-Output (IO) tables that enable us to link U.S. TTBs to each other based on cost shares. These IO tables cover 486 industries (343 manufacturing) at the 6-digit BEA industry level based on NAICS codes. We use the BEA's *direct* requirement coefficients as cost shares in our analysis to focus on a minimum degree of separation between inputs and outputs and avoid overemphasizing IO relationships. Furthermore, in order to avoid circularities, we drop IO pairs where input and output are the same 6-digit BEA industry.

The most crucial foundation of our empirical analysis is the matching of U.S. TTBs, which are at the 10-digit HTS level, to the IO tables, which are at the 6-digit BEA industry level. To do this we use Schott's (2008) U.S. import data at HTS level and Pierce and Schott's (2009) methodology to convert HS codes from U.S. TTB data to 10-digits and then concord them over time to achieve maximum

[21] We use the 1988-2013 period since the HTS system, which we use to concord with the BEA's input-output tables, was introduced in 1988 even though the U.S. TTB data is available from 1979.

[22] There were 54 cases under investigation as of January 2014.

[23] Here, in line with the previous literature, a case refers to an official petition, which targets a product-country combination. Note that the investigated "product" can include multiple HTS lines.

[24] These SGs include the transitional China-specific safeguards as well. Note that global-SGs are underrepresented here since an SG is counted as a single case even though it targets all countries.

[25] See Knetter and Prusa (2003) and Bown and Crowley (2013) for the macroeconomic determinants of TTB investigations.

[26] We also count simultaneous AD and CVD petitions as a single unique investigation in Table 1.

number of matches to the HTS-BEA concordance tables provided by the BEA. See Appendix section A.2 that explains this matching procedure in detail as well as the potential measurement error it creates.

Combining the TTB data with the IO tables allows us to find out the targeted products' relative position in the value chain. Figure 2 shows the evolution of the "upstreamness" of targeted products in U.S. TTB investigations in 1988-2013. We apply the methodology developed by Antràs et al. (2012) to the BEA's 1997 IO tables and obtain upstreamness figures by industry, larger figures indicating higher upstreamness.[27] For example, the industry *Automobile and Light Trucks* has an upstreamness of 1.00 (the minimum), whereas the industry *Petrochemicals* has an upstreamness of 4.65 (the maximum). The graph shows that TTB investigations, on average, have targeted relatively more upstream products as the solid line is always higher than the dashed line which is the trade-weighted upstreamness of U.S. imports. This is not to say, however, that TTBs do not target downstream products—only the average product is further upstream. In fact, 23 percent of investigations had upstreamness lower than the dashed line. One can also see from the figure that there is no clear trend and that U.S. TTB investigations cover very upstream products in some years (e.g. 1993 and 2013) and more downstream products in others (e.g. 1989 and 2012). See Appendix Table A.1 for the upstreamness of all targeted industries.

With the data at hand, we can also visualize the connections between NAICS3 manufacturing sectors to reveal whether petitioning sectors are structurally clustered. Figure 3, which has sectors colored by whether they are heavily targeted by TTBs (dark gray: heavy TTB target, light gray: light TTB target) clearly demonstrates that sectors that use TTBs are closely linked in terms of cost share. Note the cluster of heavily targeted sectors on the left side of the figure, especially the connection between the *Primary Metals* and the *Fabricated Metals* sector emphasized by the thick arrow indicating a high cost share. The relationship between *Chemicals* and *Plastics and Rubber* is also worth mentioning. The size of the nodes specifies how self-reliant a sector is (e.g. 42 percent of *Computer and Electronics*' cost comes from *Computer and Electronics*, while 2 percent of *Furniture*'s cost comes from *Furniture*)—notice how the heavily targeted sectors are relatively more self-reliant which might indicate cascading protection *within* a sector (i.e. *between* industries).[28]

Additional data we use include import penetration ratios for 1987 (pre-sample period) based on Bernard et al. (2006) and import penetration rates and market size for 1997 (mid-sample) from the BEA.[29] We calculate industry-level import demand elasticities using data from Broda and Weinstein (2006).[30]

[27]Antràs et al. (2012) use the BEA's 2002 Input-Output tables to calculate the "average distance from final use" of an industry, and call this "upstreamness."

[28]In this paper, we refer to NAICS3 codes as sectors, and NAICS6 as industries.

[29]We concord the import penetration rates in Bernard et al. (2006) from Standard Industrial Classification (SIC) codes to BEA industry codes using SIC87-NAICS97 and NAICS97-BEA concordance tables provided by the U.S. Census Bureau.

[30]For each industry, we take the mean of the HTS10 elasticities provided by Broda and Weinstein (2006) using HTS10-BEA industry concordance tables.

3.2 Empirical Specification

To get our main empirical specification, we perform a first order Taylor expansion around $\mathbb{P}_w = 0$, and thus approximate the downstream petition condition (6) as:

$$\mathbb{F}_s = 1 \text{ iff } \underbrace{\theta \frac{(\sigma_s - 1)\mu_s E_1}{\sigma_s}(1 - M_s)M_s}_{\stackrel{\text{def}}{=} Zs} \underbrace{\sum_w \beta_{ws} M_w t_{21w} \mathbb{P}_w}_{\stackrel{\text{def}}{=} (affected\ share)_s} + f_s > 0,$$

where $f_s \equiv \frac{\theta \mu_s E_1}{\sigma_s}(M_s - M_s^1) - C_s$. Note that here M_s denotes the downstream import penetration without downstream nor upstream protection. The first term in f_s is the expected gain from petition without upstream protection, and together with petition cost C_s, it captures the inherent ability of an industry to petition for TTBs.

We get $\mathbb{F}_s$ (the indicator variable for downstream petition), $\mathbb{P}_w$ (the indicator variable for upstream protection), and t_{21w} (the duty imposed on upstream industry) from the Temporary Trade Barriers Database (Bown, 2014); β_{ws} (the direct requirement coefficient) and $\mu_s E_1$ (the market size of downstream industry) are from the BEA (1997); M_s and M_w (import penetration rates for downstream and upstream respectively) are from Bernard et al. (2006) for 1987 and from BEA (1997) for 1997; and σ_s is based on Broda and Weinstein (2006). For clarity, we separate our independent variable into two parts and call the first part that summarizes the downstream industry's market structure as Z_s, and call the second part that generates the input price shock as $(affected\ share)_s$.

Since we are dealing with a binary dependent variable we assume that the error term follows a logistical distribution, and we add a time dimension as there needs to be a time-lag between the protection of the upstream good and the initiation of a new investigation by the downstream user. Thus we lag our time-varying right-hand side variable, $(affected\ share)_{s,t-k}$, where t is year and k denotes the lag. We use one-, two-, and three-year lags, and take the mean of these for each downstream industry at time t in our main specification. The reason we do this is because in U.S. TTB investigations, the ITC requests that the petitioner(s) present data on economic factors such as profits for "*the three most recent complete calendar years as well as the year-to-date period of the current year and the like period of the previous year*" (Commission et al., 2005).[31] Finally, we proceed to estimate the following with conditional logit due to fixed effects:

$$Pr(\mathbb{F}_{st} = 1 | Z_s, \frac{1}{3}\sum_{k=1}^{3}(affected\ share_{s,t-k}), f_s, f_t) = \Lambda(\theta Z_s \frac{1}{3}\sum_{k=1}^{3}(affected\ share_{s,t-k}) + f_s + f_t), \quad (13)$$

where industry fixed effects f_s control for the inherent ability of an industry to petition, and time fixed effects f_t control for overall macroeconomic shocks. We also cluster standard errors at the downstream industry level for arbitrary industry correlations. If cascading protection indeed exists in the data,

[31] As a robustness check, we use the maximum instead of the mean and results do not change.

we expect to find a statistically significant positive estimate of θ. As a robustness check we use the linear probability model and results generally hold qualitatively. Crucially, our identification strategy relies on the plausible assumption that upstream protection is an exogenous shock for its downstream industries.

4 Results

Before directly estimating equation (13), we run simpler conditional logit regressions to get a sense of the relationship between downstream petitions and upstream protection. Table 2 has our results which report marginal effects calculated at the median.[32] In column (1), we use a simple independent variable by summing the multiplication of cost share and the upstream protection dummy for each downstream industry (i.e. without taking the level of duty nor import penetration into account), and find that the effect is significant and positive. Column (2) incorporates the *level* of duty and the marginal effect becomes more precisely estimated and stays positive. In column (3), we use ($affected\ share$) as our independent variable ignoring market characteristics. The effect stays highly significant and positive. In column (4), as a sensitivity check, we weight ($affected\ share$) by the imposed measure's industry coverage ratio, defined as $\frac{\text{no of HTS10 targeted by measures}_{wt}}{\text{no of HTS10}_{w}}$, and find that the effect stays significant and positive. We do this since TTB measures rarely cover an entire industry and the measurement error this creates might be biasing our coefficient downwards.[33,34]

In the remaining columns of Table 2, we look at downstream market characteristics. In column (5) we add an interaction variable that is 1 for downstream industries that have more than 50 percent import penetration rate (and 0 otherwise), and find that the marginal effect of a one unit change in the independent variable is significant and positive only for downstream industries that have less than 50 percent import penetration ratio as indicated by our theory. In column (6), we instead add a binary interaction term that indicates whether the downstream industry has high elasticity of demand by dividing our sample to two based on the mean value of elasticity (10.05). As hinted by our theory, the marginal effect of a one unit change in the independent variable is significant and positive only for industries that have high demand elasticity. These results seem to indicate that there is a positive relationship between downstream petitions and upstream protection, and this relationship is stronger in downstream industries that have low import penetration and high demand elasticity as predicted by our theory. Note that using the maximum instead of the mean of the independent variable, or estimating using the linear probability model do not change the results; available on request.[35]

We now turn to estimating equation (13) to get our main results. Note that since we are using conditional logit, the sample is reduced substantially as the calculation of the minimum sufficient statistic drops groups without variation in the dependent variable (i.e. industries that never petitioned

[32] Marginal effects calculated at the mean are similar.
[33] See Appendix section A.2.2 for a discussion on this type of measurement error.
[34] The average measure covers 22 percent (median: 9 percent) of an industry with standard deviation 29 percent.
[35] Looking at the second half of the sample only with 1997 import penetration rates also gives robust results.

for a TTB in the sample period). Out of the 331 downstream industries, only 152 have petitioned at least once in the sample period and thus 179 industries are dropped from the estimation. A further 12 industries do not have 1987 (pre-sample period) import penetration ratios so they are dropped as well in our full sample (1988-2013) shown in Table 3. Columns (1) and (2) show that the marginal effect is highly significant and positive for both mean and maximum of the independent variable respectively. To be more precise, a one standard deviation (0.135) increase in the mean affected share increases the likelihood of downstream petition by 0.7 percentage points.[36] Given that the mean initiation rate is 10 percent in the 1988-2013 conditional logit sample, this represents 7 percent of the average industry's petition probability.

Note that we use 1997 domestic market size data, $\mu_s E_1$, and cost shares, β_{ws}, in constructing our right hand side variable and these might be endogenous in the first half of the sample. For instance, a duty imposed on an industry can increase the size of a market and this might create reverse causality, biasing the coefficient upwards. Similarly, a duty imposed on an upstream industry might cause its downstream industry to switch to another input and thus alter its cost shares. Thus our benchmark results correspond to Table 3 columns (3) and (4) in which we only include the second half of the sample (1997-2013) to address potential endogeneity concerns. Column (3) shows that a one standard deviation (0.040) increase in the mean affected share increases the petition likelihood by 3.5 percentage points for an average downstream industry.[37] This effect is not small when compared to the mean initiation rate of 13 percent in the 1997-2013 conditional logit sample (and 5 percent in the full sample), and it varies substantially depending on the downstream industry as will be shown in this section.

Before quantifying the importance of these marginal effects, we do several sensitivity analyses to make sure our result is robust. Table 4 has these results for both the full 1988-2013 sample in panel (a) and the 1997-2013 sample in panel (b). Column (1) restricts the sample to manufacturing industries only as other sectors such as agriculture rarely use TTBs and have very distinct political economy channels to obtain trade protection. Marginal effects remain significant and positive for both sample periods. In column (2), we exclude the biggest TTB user, the *Primary Metals* sector (NAICS3: 331), from our analysis to understand whether our results are driven by this sector. As results show the marginal effect is not statistically significant at the conventional levels anymore, albeit retaining its positive sign. This reveals how important the upstream sector *Primary Metals* is in driving cascading protection. Column (3) alters our Y matrix by removing observations for each downstream industry that already has a measure in stock, since this would eliminate any incentives for the downstream industry to petition for protection.[38] We find that the results are robust for the full sample but not for the 1997-2013 period, likely due to the small sample size.

Table 4 column (4) divides the industries into two distinct downstream and upstream categories based on the median upstreamness index of 2.11. This makes sure that there is no overlap between

[36]This is calculated as $0.052 * 0.135 * 100 = 0.702$.

[37]Calculated as $0.865 * 0.04 * 100 = 3.46$.

[38]There might still be an incentive as investigations rarely cover an entire industry as mentioned before. Nevertheless, we do this robustness check to be more in line with the structure of our model.

the two per our theory, and even though the sample is reduced dramatically, the coefficient stays significant and positive for the full sample period in panel (a). Column (4) of panel (b), on the other hand, shows a positive but imprecisely estimated marginal effect, probably due to the reduced sample size. In column (5), in order to verify that our results are not due to spurious correlation, we do a falsification analysis where we replace the mean of the *last* three years' affected share with the mean of the *next* three years' affected share, and find that the coefficient turns statistically insignificant in both sample periods. In column (6), we use the linear probability model which enables us to include all industries and find that the coefficients are no longer statistically significant at the conventional levels, albeit having the correct sign. Finally, column (7) uses the linear probability model on the conditional logit sample only (i.e. excluding downstream industries that never petitioned for protection in the sample period) and finds that the coefficients are significant and positive. This difference between columns (6) and (7) reveals that there might be a sunk cost to "access" TTBs and perhaps some downstream industries in our sample have not yet paid this sunk cost in the 1988-2013 period.[39]

To get an idea of how much an upstream industry's protection contributes to the petition of its downstream industry we evaluate the marginal effects from our benchmark specification in Table 3 columns (1) and (3) for a sample of upstream-downstream dyads at their respective values for our independent variable. In order to save space, we restrict the sample to manufacturing dyads that are "close" (i.e. cost share larger then 10 percent) and that have at least initiated one TTB investigation in 1988-2013. Table 5 columns (1) and (2) identify the upstream and downstream industries respectively. The last two columns of the table show the mean initiation rates for the downstream industry in 1988-2013 and 1997-2013 respectively. Note how these rates differ markedly between industries: while the unconditional likelihood of initiation for *Steel Wire Drawing* is 67 percent, it is only 8 percent for the median downstream industry.

Table 5 column (3) shows the percentage point increase in the downstream industry's petition likelihood attributed to a measure imposed in the upstream industry. These are calculated by multiplying the marginal effect when the downstream industry is not affected by any upstream measure with $Z_s * (affected\ share)_{sw}$ where the $(affected\ share)_{sw}$ is IO-specific and the duty levels are evaluated at the observed mean value. Figures that are in bold indicate that a corresponding output initiation within three years of the input measure has occurred in the data. Note that the effects are usually less than a percentage point but some IO combinations stand out. For instance, the most heavily targeted upstream industry, *Iron and Steel Mills*, affects a minimum of 11 downstream industries, and according to our predictions, a measure on this industry most directly affects *Steel Wire Drawing* by increasing its likelihood of initiation by 9.7 percentage points in the 1997-2013 period, mostly because *Steel Wire Drawing* is the industry whose cost share for *Iron and Steel Mills* is the largest at 32 percent. Other industries that are relatively prone to initiation (i.e. higher than a 1

[39] Using the maximum instead of the mean in Table 4 do not change the results qualitatively except for panel (a) column (2) where the marginal effect becomes significant at the 10 percent level, panel (b) column (1) where the marginal effect turns marginally insignificant, panel (b) column (6) where the coefficient becomes significant at the 10 percent level, and panel (b) column (7) where the coefficient turns marginally insignificant.

percentage point increase) due to a measure on *Iron and Steel Mills* in order are *Industrial Truck, Trailer and Stacker*, *Motorcycle, Bicycle, and Parts*, and *Electric Power and Specialty Transformer*.

A measure on the most upstream industry *Petrochemicals* increases its close downstream industries' petition likelihood by 0.6 to 7.2 percentage points in 1997-2013. Note that these affected downstream industries also act as upstream industries to further downstream users, and this can exacerbate cascading protection as the supply chain gets further broken down. An upstream industry that stands out is *Other Basic Organic Chemicals*—a measure imposed on this industry increases the petition likelihood of its "close" downstream industries by 1.1 to 11.8 percentage points in 1997-2013, which for *Plastics Material and Resin* can explain more than 80 percent of its mean initiation likelihood. Note how *Plastics Material and Resin* in return can affect its own downstream industries by increasing their likelihood of initiation by 3.0 to 5.8 percentage points—an upstream-midstream-downstream effect with *Plastics Material and Resin* being the midstream industry.

The largest effect is caused by a measure in *Semiconductors and Related Device* which increases the petition likelihood of *All Other Electronic Components* and *Electronic Computer* by 59.4 and 21.3 percentage points respectively, explaining these industries' entire mean initiation probabilities. In addition to high cost shares (larger than 10 percent), this is mostly due to the high import penetration rate in *Semiconductors and Related Device* (36 percent). Also note the powerful effects of *Primary Aluminum* on *Aluminum Sheet, Plate, and Foil* due mostly to a very high cost share (36 percent), of *Primary Smelting and Refining of Copper* on *Copper Rolling, Drawing, and Extruding* again due to a strong vertical relationship (38 percent cost share), of *Nonferrous Metal* on *Jewelry and Silverware* caused mostly by the highly import penetrated upstream industry at 60 percent, of *Electron Tubes* on *Audio and Video Equipment* due mostly to the 35 percent import penetration ratio in the upstream industry, and of *All Other Electronic Components* on both its close downstream industries due to its own import penetration ratio (47 percent) as well as the very large domestic market size of its two close downstream industries ($94 billion in 1997).[40]

Overall, even though the estimated effects do not seem too large, most often there are measures imposed on multiple upstream industries, which, if they are important for their downstream users, can exacerbate cascading protection. These evaluations help to anticipate which downstream industries will initiate new petitions after seeing higher duties on certain important inputs. In the next section we try an alternative approach and evaluate the welfare effects of cascading protection under different scenarios.

5 Simulation Exercise

Now that we have established the existence of cascading protection empirically, the next question arises naturally: what are its welfare consequences? Moreover, we want to know, if the U.S. modifies its TTB procedures and internalizes the impact of upstream protection on downstream users, such

[40] The mean (median) domestic market size for a downstream industry was $13 billion ($6 billion) in 1997.

as by implementing a "public interest clause" like in the EU, what will be the consequences on industries' petition frequency and consumer welfare? Also, how would the results change as the world gets increasingly integrated via supply chains? To answer these questions, we calibrate the model proposed in Section 2 using the key feature of the data.

In Section 2.2 we show that the equilibrium of the economy, taking the petition and protection conditions as given, can be presented by a system of $2(2W+3S)$ equations (equations (1)-(5)) with $2(2W+3S)$ unknowns (P_{iw}, P_{is}, c_{is}, Π_{iw} and Π_{is} for $i \in \{1,2\}$). Denoting the counterfactual value of Π_{is} by Π'_{is} and counterfactual changes in $\hat{\Pi}_{is}$ and so forth, one can easily verify using the technique of Dekle et al. (2007) that equations (1)-(5) can be rewritten in changes as:

$$\hat{P}_{iw} = \left(\sum_{j \in \{1,2\}} \delta_{jiw} \hat{\tau}_{jiw}^{1-\sigma_w} \right)^{\frac{1}{1-\sigma_w}}, \tag{14}$$

$$\hat{c}_{is} = \prod_{w} \hat{P}_{iw}^{\beta_{ws}}, \tag{15}$$

$$\hat{P}_{is} = \left(\sum_{j \in \{1,2\}} \delta_{jis} (\hat{c}_{js} \hat{\tau}_{jis})^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}}, \tag{16}$$

$$\hat{\Pi}_{is} = \sum_{j \in \{1,2\}} \alpha_{ijs} \hat{\tau}_{ijs}^{1-\sigma_s} \hat{c}_{is}^{1-\sigma_s} \hat{P}_{js}^{\sigma_s - 1}, \tag{17}$$

$$\hat{\Pi}_{iw} = \sum_{j \in \{1,2\}} \sum_{s} \alpha_{ijws} \hat{\tau}_{ijw}^{1-\sigma_w} \hat{P}_{jw}^{\sigma_w - 1} \hat{\Pi}_{js}, \tag{18}$$

where α_{ijs}, α_{ijws}, δ_{jiw}, and δ_{jis} are functions of β, σ, and trade flows T. In particular, $\alpha_{ijs} \equiv \frac{T_{ijs}}{\sum_j T_{ijs}}$, $\alpha_{ijws} \equiv \frac{T_{ijws}}{\sum_j \sum_s T_{ijws}} \equiv \frac{T_{ijw}}{\sum_j T_{ijw}} \frac{(\sigma_s-1)\beta_{ws}\Pi_{js}}{\sum_s (\sigma_s-1)\beta_{ws}\Pi_{js}}$, $\delta_{jiw} \equiv \frac{T_{jiw}}{\sum_j T_{jiw}}$, and $\delta_{jis} \equiv \frac{T_{jis}}{\sum_j T_{jis}}$. Here, T_{ijw} is the exports of country i sector w to country j evaluated at world prices and so forth.[41] Given σ, β, T, and the *potential* dumping margin t for all industries, equations (14)-(18) can be used to compute the counterfactual changes in upstream operating profit Π_{iw}, downstream operating profit Π_{is}, downstream production cost c_{is}, and industry price indices P_{is} and P_{iw}. Counterfactual welfare change can then be calculated from $\hat{W}_{is} = \prod_s \hat{P}_{is}^{-\mu_s}$ since indirect utility is given by $W_{is} = \mu_Y{}^{\mu_Y} \prod_s (\mu_s^{\mu_s} P_{is}^{-\mu_s})$.

To determine a downstream industry's petition decision, we need to compare its expected operating profit gain with filing costs. Specifically, downstream industry s will pursue protection when $\theta \hat{\Pi}_{is} \Pi_{is} > C_{is}$, where $\Pi_{is} = \frac{1}{\sigma_s} \sum_j T_{ijs}$ according to our model. We assume that C_{is} are drawn from a logistic distribution with dispersion parameter λ_{disp} and a scale parameter $\lambda_c + \lambda_h H_{sector} + \lambda_{h2} H_{sector}^2 +$

[41] We obtain trade data (T_{ji}) from UN Comtrade (WITS), and proxy for T_{ii} (consumption of domestic production) by subtracting the export value of an industry from its production value, which we get from the BEA. Due to data unavailability for many industries' T_{ii} for earlier years and 2012-13, we are only able to do the numerical exercise for the 1998-2011 period.

$\lambda_g \Delta GDP_t$, where H_{sector} is the Herfindahl index measuring industry concentration,[42] and ΔGDP_t is the real GDP growth of the U.S. in year t.[43] The parameters are: σ, β, μ, T, H_{sector}, ΔGDP_t, t, and $\lambda = \{\lambda_c, \lambda_h, \lambda_{h2}, \lambda_g, \lambda_{disp}\}$. We treat country 1 as the U.S. and country 2 as the rest of the world (ROW). Also, in line with our empirical analysis, we assume that it takes about three years for upstream protection to affect downstream industries.

As the ROW is passive, we set t_{11}, t_{21}, and t_{22} equal to zero. Next, we turn to compute dumping margin t_{12}, which has to fulfill several criteria: first, it has to be *known* by all industries (even though we only observe it for industries that got protected); second, it should be time-varying as the price differential between domestic and imported goods varies; and third, it should vary according to changes in upstream protection. Based on these reasons, we adopt a "hybrid" approach to construct a *potential* dumping margin. For the industry-year combinations that did get protection, we use the actual dumping margins reported in the Temporary Trade Barriers Database. To fill in the other industry-year observations, we compute the difference between the unit value of U.S. exports and imports,[44] and project that this margin will be the duty an upstream industry will obtain if it gets protected. For downstream industries, the potential duty conditional on upstream protection can then be computed endogenously from equation system (14)-(18). When the projected margin is less than zero, we set it equal to zero. Also, to get a sense of how good our unit value approach is in proxying dumping margins t_{12}, we calculate potential margins for protected industries and compare them to observed duties, and find a positive correlation of 0.33.

We merge data on σ, β, μ, T, H_{sector}, ΔGDP_t, t with the TTB data for simulation. Unfortunately, many industries are missing Herfindahl indices, which leaves us with only 156 industries for simulation. We divide industries into identical sub-samples. In particular, we assign industries that never been used directly for final consumption to upstream, and divide all remaining industries based on Antras' upstreamness index (the cut-off value now becomes 2.96). Then we normalize β and μ, setting μ_Y equal to 0.03, the yearly average direct consumption share of agricultural products. We present the summary statistics of these variables in Table 6.

We choose petition cost parameters λ via a simulated method of moments strategy. In particular, we simulate 100 observations for each industry-year by drawing its petition cost shock from the logistic distribution.[45] We treat upstream protection as given to simulate downstream industries' petition incidence by comparing simulated $\theta \hat{\Pi}_{is} \Pi_{is}$ with the petition cost C_{is} for each industry. We use the simulated data to construct the average petition incidence of each downstream industry, $\hat{m}_s$, and select parameters to match the actual petition incidence observed in the data. Formally, we describe the difference between the moments in the data and in simulated model by $\Delta m(\lambda)$:

[42]The Herfindahl indices, which are rescaled by multiplying by 100, are from the U.S. Census Bureau and are for the year 2002, the earliest year of data availability by NAICS.
[43]Real GDP growth data is from the World Bank's World Development Indicators Database.
[44]Unit values are trade-weighted averages of HS6 products based on UN COMTRADE (WITS) data.
[45]We choose 100 mainly for computational limitations. Depending on the choice of initial value, it takes about three days to run the estimation algorithm in a computer with 16 GB ram and 4 Core 3.10GHz CPU.

$$\Delta m(\lambda) = m(\lambda) - \hat{m}(\lambda) = \begin{bmatrix} m_1(\lambda) - \hat{m}_1(\lambda) \\ ... \\ m_S(\lambda) - \hat{m}_S(\lambda) \end{bmatrix}. \tag{19}$$

The following moment condition is assumed to hold at the true parameter value λ_0:

$$E[\Delta m(\lambda_0)] = 0, \tag{20}$$

and we select model parameters that minimize the following objective function:

$$\hat{\lambda} = \arg\min_{\lambda}[\Delta m(\lambda_0)]^T \mathbf{W}[\Delta m(\lambda_0)] = 0. \tag{21}$$

We choose the identity matrix as the weighting matrix $\mathbf{W}$. The resulting parameters are: $\lambda_c = 1074.33$, $\lambda_h = -15.94$, $\lambda_{h2} = 13.37$, $\lambda_g = 243.17$, and $\lambda_{disp} = 0.95$. The calibrated parameters have the expected signs. In particular, the negative λ_h implies that industry concentration makes petitioning costs lower due to organizational easiness, albeit at a decreasing rate since $\lambda_h > 0$; also, $\lambda_g > 0$ is consistent with Figure 1 that petitions are more likely to happen during recessions.[46] The simulated downstream petition data matches 89 percent of the actual petition decision observed in the data. In terms of average petition per year, it slightly underestimates with value of 4.09 versus 5.18 in the actual data.

Given the estimates of λ, we can compute industry profits, costs, and consumer welfare change due to TTBs and perform various counterfactual analysis. Table 7, column (1), presents the change caused by upstream (actual) and downstream (simulated) protection for the benchmark case. Here, $\Delta\Pi_{1w}$ refers to the simple average change in operating profits of U.S. upstream industries, and so forth. The average operating profit of U.S. upstream industries increases by 1.67 percent as both upstream and downstream protection help boost their profit. The expansion of U.S. intermediate suppliers costs their foreign competitors, whose profits decline by 0.26 percent. On the other hand, U.S. downstream industries' profits decline slightly due to two opposing forces: upstream protection increases their marginal costs hence decrease profitability—we can see this from the average 0.89 percent (Δc_{is}) rise in downstream marginal costs, and the subsequent increase in profits due to obtained protection. The two forces largely cancel out each other and leave a 0.26 percent loss for downstream industries. The cost disadvantage of downstream industries translates into a 0.41 percent increase in profits for foreign downstream producers. Consumers in the U.S. and ROW face welfare losses of 1.04 and 0.05 percent respectively. These figures are larger than expected as, though not directly comparable, Ossa's (2011) computations on the largest counterfactual welfare loss caused by moving from free trade to autarky is 0.71 percent (when $\sigma = 4.60$).

The substantial welfare decline makes us wonder whether an adjustment in U.S. TTB policy to internalize the impact of upstream protection on its users, such as implementing a "public interest clause," can mitigate the losses. To keep the analysis simple, we assume that any upstream petition

[46] This result is established empirically in Knetter and Prusa (2003) and Bown and Crowley (2013).

that might harm a domestic downstream industry will be rejected by the U.S. administering authority, and compute downstream behavior with associated profit, cost, and welfare changes. The results are presented in Table 7, column (2). Intuitively, the upstream industries stop seeking protection as they know that their petition will get rejected. Notice that in this case, simulated downstream petition frequency decreases, confirming the existence of cascading protection. Interestingly, the average upstream profit increases, as the majority of industries that are not protected now will not get hurt due to the loss in competitiveness of their domestic downstream users. Without upstream cost pressure, the downstream average profit increases by 1.81 percent due to protection, while the opposite is true for foreign. Importantly, the loss in consumer welfare in both countries shrinks dramatically. In particular, the U.S. welfare loss falls to 0.55 percent, meaning that a mechanism such as a "public interest test" in TTB investigations can eliminate up to 47.38 percent of the welfare loss due to cascading protection.

What about the effects of cascading protection in a world with deeper global value chains (GVCs)? We hypothesize that, in this case, due to increased transmission of injury from upstream protection, downstream industries will be more likely to pursue protection. To test this, we reallocate 50 and 90 percent of U.S. usage of domestically produced upstream goods to foreign producers, while holding total production in both U.S. and the ROW unchanged (i.e. U.S. downstream industries use more intermediates from the ROW and the ROW downstream industries use more U.S. intermediates). We treat this as counterfactual pre-adjustment equilibrium and repeat the benchmark exercise.[47] Results are reported in Table 7, columns (3) and (5). Compared to the benchmark case where the upstream-caused petitions count only 4.40 percent of total downstream filings, this number almost doubles (8.49 percent) when 50 percent of domestic tasks are offshored and further rises to 13.98 percent in the 90 percent case. However, since petition is costly, many injured industries will still choose not to petition and suffer losses, and this renders significant profit losses for U.S. downstream industries: 1.77 and 4.16 percent respectively, while the foreign experiences the opposite. The welfare loss increases as GVC trade becomes pervasive, and rises to 2.63 percent in the 90 percent case. In this case, welfare correction through a "public interest" mechanism is larger since cascading protection is more likely in a world with deeper GVCs. In particular, the value of welfare losses corrected by adjusted trade policy are 1.28 and 2.08 percent respectively compared to the 0.49 percent in the benchmark case; similarly, the shares of correction are 69.95 and 79.12 percent respectively compared to 47.38 percent in the benchmark case.

Note that in proposing an adjusted TTB investigation procedure that takes vertical linkages into account, we not only eliminate cascading protection, but also eliminate *all* upstream protection. To ensure that our calculations are not purely driven by the elimination of the latter, we decompose welfare losses associated with TTBs into four mutual exclusive components: welfare loss directly caused by upstream protection, welfare loss due to downstream protection caused by upstream protection

[47]Note that total production of certain ROW industries are less than 50 percent of U.S. consumption. In this case, we set it so that ROW reallocates 90 percent of domestic usage to U.S. producers.

(extensive margin), welfare loss due to *higher* duties that are obtained by downstream industries caused by upstream protection (intensive margin), and the direct welfare loss caused by downstream protection regardless of upstream protection. Table 8 presents the results. In the benchmark case, direct upstream protection counts for less than half of the total consumer welfare loss, yet this number rises rapidly as GVCs deepen. This is intuitive as downstream industries use more foreign intermediates, an increase in tariffs leads to higher marginal costs for downstream producers, which eventually hurts final consumers. However, this is not the only story. The extensive and intensive margins also indicate that with the development of GVCs, the welfare loss caused by cascading protection increases as well. In total, cascading protection counts 0.77 to 5.51 percent of the welfare loss (sum of rows three and four divided by row six). Note that, in terms of measuring the welfare loss caused by cascading protection, the intensive margin contributes only a small fraction: most of the welfare loss is due to adjustments in the extensive margin.

Overall, our simulation exercise shows that temporary trade protection can cause substantial welfare losses for consumers, and cascading protection accounts a sizable share of it. Moreover, as the world gets increasingly integrated through offshoring, the cascading effect exacerbates the welfare loss. The introduction of a "public interest clause" that takes vertical linkages into account before granting protection can lead to welfare improvement, primarily by curbing upstream protection but also by limiting cascading protection.

6 Conclusion

Influenced by Hoekman and Leidy's (1992) cascading protection model and Feinberg and Kaplan's (1993) early evidence, this paper provides a simple theoretical model to guide our empirical specification that tests whether trade protection on upstream goods increases the likelihood of their downstream users' trade remedy petition in the U.S during 1988-2013. Using the detailed input-output tables and time-varying temporary trade barriers of the U.S., we find that upstream protection does lead to downstream petition for protection and this effect is heterogenous. We show that the effect varies substantially depending on input-output pairs' market characteristics such as import penetration of both industries, market size and demand elasticity of the downstream industry, and the importance of the input for the downstream industry in terms of its cost share. Our numerical solutions of the model suggest that welfare losses due to cascading protection can be significantly large.

This paper contributes to the literature by providing the first rigorous and systematic study of vertical linkages in temporary trade barriers. Our results call for a change in trade barrier investigations by giving downstream users a legal standing. The EU and a few other countries have already implemented a "public interest clause" into their anti-dumping regulations in order to make sure that downstream industries and consumers have an active role in investigations. However, the U.S. and the large majority of anti-dumping users have yet to add in this crucial piece of legislation. As supply chains get increasingly integrated worldwide, trade policy targeting upstream products has to consider its potential consequences on downstream user industries and consumers as shown in detail in this paper.

References

Amiti, M. and Konings, J. (2007). Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. *The American Economic Review*, pages 1611–1638.

Antràs, P., Chor, D., Fally, T., and Hillberry, R. (2012). Measuring the upstreamness of production and trade flows. *American Economic Review Papers and Proceedings*, 102(3):412–416.

Baldwin, R. E. (1989). The political economy of trade policy. *The Journal of Economic Perspectives*, pages 119–135.

BEA (1997). 1997 Supplementary Make, Use, and Direct Requirements Tables at the detailed level.

Bernard, A. B., Jensen, J. B., and Schott, P. K. (2006). Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of us manufacturing plants. *Journal of International Economics*, 68(1):219–237.

Blonigen, B. (2013). Industrial policy and downstream export performance. *National Bureau of Economic Research*.

Boltuck, R. and Litan, R. E. (1991). *Down in the dumps: Administration of the unfair trade laws*. Brookings Institution Press.

Bown, C. P. (2011). Taking stock of antidumping, safeguards and countervailing duties, 1990-2009. *The World Economy*, 34(12):1955–1998.

Bown, C. P. (2014). Temporary trade barriers database. *The World Bank [available at http://econ.worldbank.org/ttbd/], June. [First version published in 2010]*.

Bown, C. P. and Crowley, M. A. (2013). Import protection, business cycles, and exchange rates: Evidence from the great recession. *Journal of International Economics*, 90(1):50–64.

Brainard, S. L. and Verdier, T. (1997). The political economy of declining industries: Senescent industry collapse revisited. *Journal of International Economics*, 42(1):221–237.

Broda, C. and Weinstein, D. E. (2006). Globalization and the gains from variety. *The Quarterly Journal of Economics*, 121(2):541–585.

Commission, U. I. T. et al. (2005). *Antidumping and Countervailing Duty Handbook*. DIANE Publishing.

Dekle, R., Eaton, J., and Kortum, S. (2007). Unbalanced trade. *American Economic Review*, 97(2):351–355.

Durling, J. P. and Prusa, T. J. (2003). Using safeguard protection to raise domestic rivals' costs. *Japan and the World Economy*, 15(1):47–68.

Durling, J. P. and Prusa, T. J. (2006). The trade effects associated with an antidumping epidemic: The hot-rolled steel market, 1996–2001. *European Journal of Political Economy*, 22(3):675–695.

Feinberg, R. M. and Kaplan, S. (1993). Fishing downstream: The political economy of effective administered protection. *Canadian Journal of Economics*, pages 150–158.

Finger, J. M., Hall, H. K., and Nelson, D. R. (1982). The political economy of administered protection. *The American Economic Review*, pages 452–466.

Goldberg, P., Khandelwal, A., Pavcnik, N., and Topalova, P. (2009). Trade liberalization and new imported inputs. *The American Economic Review*, pages 494–500.

Hillman, A. L. (1982). Declining industries and political-support protectionist motives. *The American Economic Review*, pages 1180–1187.

Hoekman, B. M. and Leidy, M. P. (1992). Cascading contingent protection. *European Economic Review*, 36(4):883–892.

Irwin, D. A. (2005). The rise of US anti-dumping activity in historical perspective. *The World Economy*, 28(5):651–668.

Knetter, M. M. and Prusa, T. J. (2003). Macroeconomic factors and antidumping filings: Evidence from four countries. *Journal of International Economics*, 61(1):1–17.

Konings, J. and Vandenbussche, H. (2013). Antidumping protection hurts exporters: Firm-level evidence. *Review of World Economics*, 149(2):295–320.

Krupp, C. M. and Skeath, S. (2002). Evidence on the upstream and downstream impacts of antidumping cases. *The North American Journal of Economics and Finance*, 13(2):163–178.

Leidy, M. P. and Hoekman, B. M. (1991). Spurious injury as indirect rent seeking: Free trade under the prospect of protection. *Economics & Politics*, 3(2):111–137.

Lindsey, B. and Ikenson, D. J. (2003). Antidumping exposed: The devilish details of unfair trade law. Cato Institute, Washington, D.C.

Magee, C. (2002). Declining industries and persistent tariff protection. *Review of International Economics*, 10(4):749–762.

Obama, B. H. (2010). Remarks by the President at the Signing of the Manufacturing Enhancement Act of 2010.

Ossa, R. (2011). A "new trade" theory of gatt/wto negotiations. *Journal of Political Economy*, 119(1):pp. 122–152.

Pierce, J. R. and Schott, P. K. (2009). Concording US harmonized system categories over time. *National Bureau of Economic Research.*

Prusa, T. J. (1996). The trade effects of US antidumping actions. *National Bureau of Economic Research.*

Prusa, T. J. (2001). On the spread and impact of anti-dumping. *Canadian Journal of Economics/Revue canadienne d'économique*, 34(3):591–611.

Prusa, T. J. (2011). USA: Evolving trends in temporary trade barriers. *The Great Recession and Import Protection: The Role of Temporary Trade Barriers*, pages 53–83.

Schott, P. K. (2008). The relative sophistication of Chinese exports. *Economic policy*, 23(53):5–49.

Sleuwaegen, L., Belderbos, R., and Jie-A-Joen, C. (1998). Cascading contingent protection and vertical market structure. *International Journal of Industrial Organization*, 16(6):697–718.

Staiger, R. W. and Wolak, F. A. (1994). Measuring industry specific protection: Antidumping in the United States. *National Bureau of Economic Research.*

Takacs, W. E. (1981). Pressures for protectionism: An empirical analysis. *Economic Inquiry*, 19(4):687–693.

Vandenbussche, H. and Zanardi, M. (2008). What explains the proliferation of antidumping laws? *Economic Policy*, 23(53):93–138.

Tables and Figures

Table 1: Sector Composition of TTBs

Sector (NAICS3)	Number of investigations	Percent of total
Primary Metals (331)	121	25.7
Chemicals (325)	84	17.8
Fabricated Metals (332)	47	10.0
Machinery (333)	34	7.2
Computer and Electronics (334)	23	4.9
Food Manufacturing (311)	18	3.8
Electrical Equipment and Appliances (335)	18	3.8
Transportation Equipment (336)	17	3.6
Nonmetallic Minerals (327)	14	3.0
Plastics and Rubber (326)	13	2.8
Other sectors (15 distinct NAICS3)	82	17.4
Total	471	100.0

Source: Authors' calculations based on the Temporary Trade Barriers Database (Bown, 2014).

Table 2: Correlations

Dep. variable:	(1)	(2)	(3)
Downstream petition	Basic measure	Basic duty	Affected share
Marginal effect	0.537*	1.048***	4.573***
	(0.304)	(0.321)	(1.516)
Number of industries	153	153	153
Number of observations	3519	3519	3519
Pseudo R^2	0.07	0.07	0.07
	(4)	(5)	(6)
	Coverage ratio	X Imp. pen. dummy (0.5)	X Elasticity dummy (mean)
Marginal effect	11.533***	4.797***; 0.765	1.617; 11.171***
	(4.155)	(1.438); (6.168)	(2.252); (4.043)
Number of industries	153	140	152
Number of observations	3519	3220	3496
Pseudo R^2	0.07	0.07	0.07

Notes: Coefficients are marginal effects. All regressions include industry and year fixed effects. Marginal effects for columns (5) and (6) are calculated for when the dummy equals 0 and 1 separately. Standard errors clustered by industries in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels respectively.

Table 3: Main Results

Dep. variable:	1988-2013		1997-2013	
Downstream petition	(1)	(2)	(3)	(4)
Z_s X mean affected share	1.353**		45.665**	
	(0.203)		(68.564)	
Z_s X max. affected share		1.077**		4.127*
		(0.033)		(3.000)
Marginal effect	0.052*	0.013**	0.865**	0.321*
	(0.027)	(0.005)	(0.340)	(0.165)
Increase in pp	0.702	0.515	3.460	2.761
Number of industries	140	140	113	113
Number of observations	3220	3220	1582	1582
Pseudo R^2	0.07	0.07	0.08	0.08

Notes: Coefficients are odd ratios. All regressions include industry and year fixed effects. Standard errors clustered by industries in parentheses. Increase in pp (percentage points) is calculated by multiplying the marginal effect by the standard deviation of the independent variable times 100. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels respectively.

Table 4: Robustness Checks

(a) 1988-2013

Dep. variable: Downstream petition	(1) manufacturing	(2) no PM	(3) stock	(4) DS-US separate	(5) falsification	(6) LPM[a]	(7) LPM-CL[a]
Marginal effect	0.053**	0.021	0.058***	0.039**	-0.585	0.010	0.018*
	(0.027)	(0.013)	(0.022)	(0.019)	(0.765)	(0.008)	(0.010)
Number of industries	138	129	121	54	149	304	140
Number of observations	3174	2967	2143	1242	3427	6992	3220
Pseudo R^2	0.07	0.07	0.08	0.20	0.06	0.21	0.18

(b) 1997-2013

Dep. variable: Downstream petition	(1) manufacturing	(2) no PM	(3) stock	(4) DS-US separate	(5) falsification	(6) LPM[a]	(7) LPM-CL[a]
Marginal effect	0.658**	0.816	0.540	0.338	-0.276	0.008	0.511**
	(0.270)	(0.658)	(0.641)	(1.018)	(0.924)	(0.005)	(0.249)
Number of industries	107	103	84	39	105	331	113
Number of observations	1498	1442	864	546	1470	4634	1582
Pseudo R^2	0.08	0.08	0.14	0.23	0.08	0.23	0.17

Notes: Coefficients are marginal effects. All regressions include industry and year fixed effects. Standard errors clustered by industries in parentheses. [a] For LPM pseudo R^2 is replaced by R^2. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels respectively.

Table 5: Upstream-Downstream Effects

upstream industry (BEA)	downstream industry (BEA)	increase in petition likelihood, 1988-2013	increase in petition likelihood, 1997-2013	mean petition likelihood, 1988-2013	mean petition likelihood, 1997-2013
Broadwoven fabric mills (313210)	Textile bag and canvas mills (314910)	0.03	0.66	4.17	7.14
Leather and hide tanning and finishing (316100)	Other leather products (316900)	0.22	4.04	4.17	7.14
Sawmills (321113)	Wood preservation (321114)	**0.14**	**0.23**	8.33	7.14
	Other millwork, including flooring (321918)	**0.16**	**2.52**	12.50	14.29
	Miscellaneous wood products (321999)	**0.22**	**3.20**	12.50	7.14
Paper and paperboard mills (3221A0)	Paperboard container (322210)	**0.22**	**2.01**	4.17	7.14
	Surface-coated paperboard (322226)	**0.01**	**0.65**	8.33	14.29
	Coated and uncoated paper bag (32222B)	**0.02**	**1.43**	8.33	14.29
	Stationery and related products (322233)	**0.01**	**0.55**	8.33	7.14
Petrochemicals (325110)	Other basic organic chemicals (325190)	0.55	7.21	62.50	64.29
	Plastics material and resin (325211)	0.20	4.76	16.67	14.29
	Synthetic rubber (325212)	0.07	0.63	12.50	7.14
Other basic organic chemicals (325190)	Plastics material and resin (325211)	**0.17**	**11.79**	16.67	14.29
	Synthetic rubber (325212)	**0.04**	**1.05**	12.50	7.14
	Noncellulosic organic fiber (325222)	**0.07**	**4.87**	12.50	7.14
Plastics material and resin (325211)	Plastics packaging materials, film and sheet (326110)	**0.03**	**2.99**	16.67	21.43
	Plastics plumbing fixtures and all other plastics products (32619A)	**0.13**	**5.77**	12.50	7.14
Synthetic rubber (325212)	Tires (326210)	0.20	3.28	8.33	14.29
Noncellulosic organic fiber (325222)	Tire cord and tire fabric mills (314992)	**>0.00**	**0.78**	8.33	7.14
Other rubber products (326290)	Oil and gas field machinery and equipment (333132)	**0.01**	**0.27**	8.33	14.29

Continued on next page

Table 5 – *Continued from previous page*

upstream industry (BEA)	downstream industry (BEA)	increase in petition likelihood, 1988-2013	increase in petition likelihood, 1997-2013	mean petition likelihood, 1988-2013	mean petition likelihood, 1997-2013
Iron and steel mills (331111)	Steel wire drawing (331222)	**0.35**	**9.67**	66.67	64.29
	Saw blade and handsaw (332213)	**0.02**	**0.37**	4.17	7.14
	Fabricated structural metal (332312)	**0.01**	**0.70**	8.33	14.29
	Plate work (332313)	**0.01**	**>0.00**	4.17	7.14
	Sheet metal work (332322)	**0.01**	**0.03**	4.17	7.14
	Ornamental and architectural metal work (332323)	**0.04**	**0.12**	8.33	14.29
	Metal tank, heavy gauge (332420)	**0.01**	**0.24**	4.17	7.14
	Elevator and moving stairway (333921)	**0.01**	**0.38**	4.17	7.14
	Industrial truck, trailer, and stacker (333924)	**0.07**	**2.35**	8.33	14.29
	Electric power and specialty transformer (335311)	**0.06**	**1.26**	4.17	7.14
	Motorcycle, bicycle, and parts (336991)	**0.10**	**1.91**	8.33	7.14
Steel wire drawing (331222)	Spring and wire products (332600)	**0.05**	**1.59**	8.33	14.29
Primary aluminum (331312)	Aluminum sheet, plate, and foil (331315)	0.52	10.50	8.33	14.29
	Other aluminum rolling and drawing (331319)	0.02	0.97	4.17	7.14
Aluminum sheet, plate, and foil (331315)	Other aluminum rolling and drawing (331319)	**>0.00**	**0.13**	4.17	7.14
Primary smelting and refining of copper (331411)	Other aluminum rolling and drawing (331319)	0.01	0.37	4.17	7.14
	Copper rolling, drawing, and extruding (331421)	0.22	8.08	4.17	7.14
Primary nonferrous metal, except copper and aluminum (331419)	Nonferrous metal, except copper and aluminum, shaping (331491)	**0.16**	**3.48**	8.33	7.14
	Jewelry and silverware (339910)	**2.49**	**38.57**	4.17	7.14
Spring and wire products (332600)	Mattress (337910)	**0.02**	**0.03**	8.33	14.29
Turned product and screw, nut, and bolt (332720)	Military armored vehicles and tank parts (336992)	**0.01**	**0.05**	4.17	7.14

Continued on next page

Table 5 – *Continued from previous page*

upstream industry (BEA)	downstream industry (BEA)	increase in petition likelihood, 1988-2013	increase in petition likelihood, 1997-2013	mean petition likelihood, 1988-2013	mean petition likelihood, 1997-2013
Other engine equipment (333618)	Lawn and garden equipment (333112)	0.03	0.44	4.17	7.14
Electron tubes (334411)	Audio and video equipment (334300)	0.11	21.29	4.17	7.14
Semiconductors and related device (334413)	Electronic computer (334111)	**2.45**	**21.32**	8.33	7.14
	All other electronic components (33441A)	**2.62**	**59.35**	8.33	7.14
All other electronic components (33441A)	Electronic computer (334111)	**1.04**	20.77	8.33	7.14
	Other computer peripheral equipment (334119)	**1.10**	44.23	16.67	7.14

Notes: The sample is restricted to upstream-downstream combinations that are close (cost share > 0.1) and that have at least initiated one TTB investigation in 1988-2013. Increase in petition probabilities are calculated by multiplying the marginal effect (from Table 3 columns (1) and (3) (for 1988-2013 and 1997-2013 respectively)) when the downstream industry is not affected by any upstream measure with $Z_s * (affected\ share)_{sw}$ where the $(affected\ share)_{sw}$ is IO-specific and the duty levels are evaluated at the observed mean value. Figures in bold indicate that a corresponding downstream initiation within three years of the upstream measure has occurred in the data.

Table 6: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
σ	156	8.816	9.916	1.300	65.278
H	156	4.124	2.330	0.191	9.913
μ	156	0.006	0.020	0	0.200
β	1897	0.041	0.110	0	0.984
T_{ii}	2184	20627	42493	1000	747044
T_{ji}	2184	7610	15189	4	127891
T_{ij}	2184	5353	10290	13	97759
T_{jj}	2184	49636	93391	0	885272
t	2184	0.457	0.868	0	4.896
ΔGDP	14	2.253	2.021	-2.804	4.787

Notes: β is normalized to sum up to one for each downstream industry, and μ and μ_Y are normalized to sum up to one.

Table 7: Profit, Price and Welfare Adjustment due to TTBs

Variables	Benchmark (1)	(2)	GVC (50%) (3)	(4)	GVC (90%) (5)	(6)
# of $\mathbb{F}_{1s}$	4.09	3.91	4.27	3.91	4.55	3.91
$\Delta\Pi_{1w}$	1.67%	2.86%	1.18%	1.35%	2.23%	0.53%
$\Delta\Pi_{2w}$	-0.26%	-0.44%	-1.77%	2.18%	-4.16%	2.68%
$\Delta\Pi_{1s}$	-0.57%	1.81%	-3.43%	1.81%	-6.42%	1.81%
$\Delta\Pi_{2s}$	0.41%	-0.43%	1.71%	-0.43%	3.05%	-0.43%
Δc_{1s}	0.89%	0.00%	2.02%	0.00%	3.89%	0.00%
ΔW_1	-1.04%	-0.55%	-1.83%	-0.55%	-2.63%	-0.55%
ΔW_2	-0.05%	0.00%	-0.11%	0.00%	-0.17%	0.00%
$\mathbb{F}_{1s}$ caused by upstream	4.40%		8.49%		13.98%	
W corr. (value)	0.49%		1.28%		2.08%	
W corr. (share)	47.38%		69.95%		79.12%	

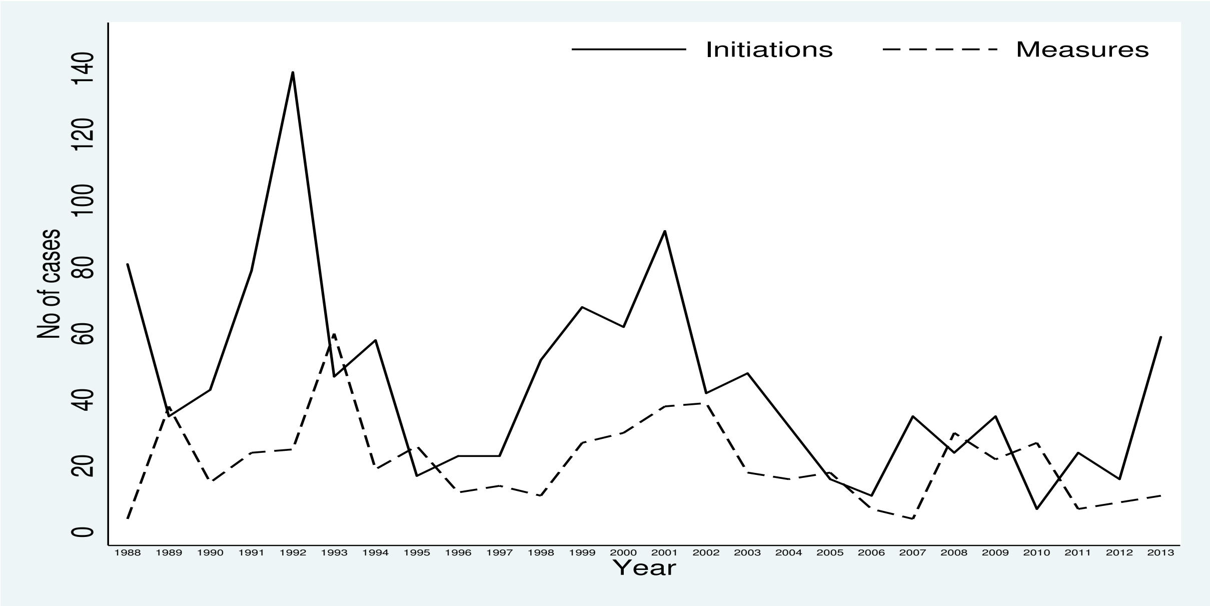
Notes: Rows (2)-(8) report the percentage change in the variable of interest when downstream industries (endogenously) petition and obtain protection; the benchmark case is with observed import penetration rates whereas GVC (50%) and GVC (90%) use counterfactual import penetration rates as the U.S. switches 50 and 90 percent of its domestic sourcing to foreign inputs respectively. Columns (1), (3), and (5) represent the case for when both upstream and downstream are protected (i.e. cascading protection), whereas columns (2), (4), and (6) show the results for the counterfactual case without any upstream protection (i.e. "public interest clause" in effect).

Table 8: Decomposition of Welfare Losses

Value	Benchmark	GVC 50%	GVC 90%
Upstream	-0.487%	-1.226%	-1.938%
Downstream	-0.557%	-0.602%	-0.695%
Ext. Margin	-0.006%	-0.048%	-0.136%
Int. Margin	-0.002%	-0.005%	-0.009%
Natural	-0.550%	-0.550%	-0.550%
Total	-1.045%	-1.829%	-2.632%

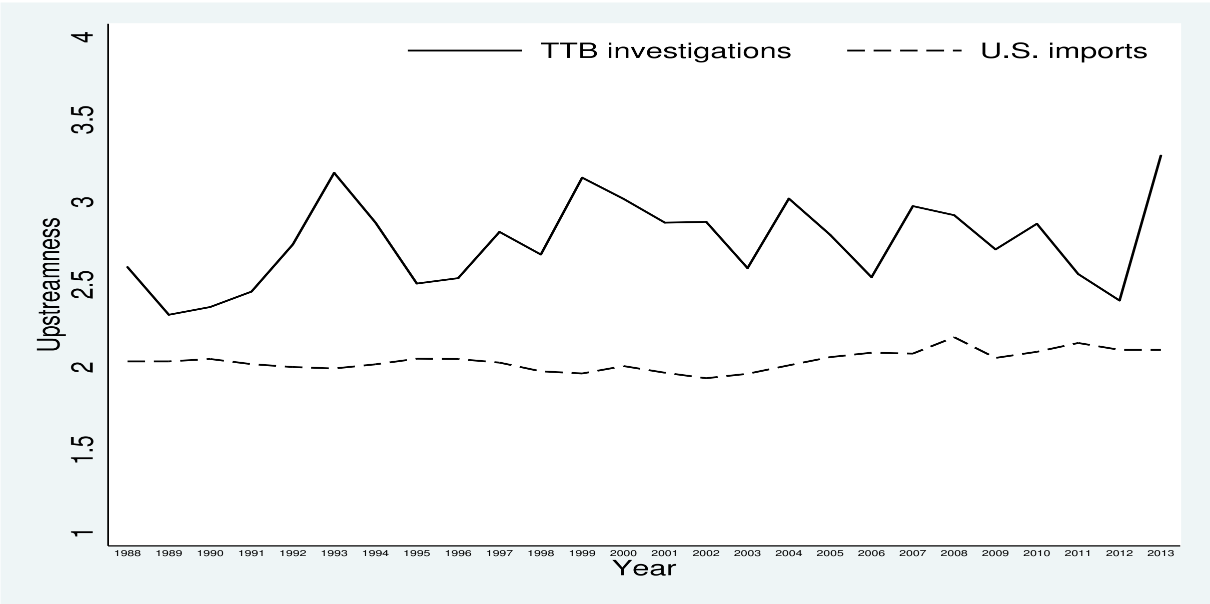
Notes: The table decomposes welfare losses associated with TTBs into four mutually exclusive categories: welfare loss directly caused by upstream protection, welfare loss due to downstream protection caused by upstream protection (extensive margin), welfare loss due to *higher* duties that are obtained by downstream industries caused by upstream protection (intensive margin), and the direct welfare loss caused by downstream protection regardless of upstream protection (natural).

Figure 1: U.S. TTBs



Source: Authors' calculations based on the Temporary Trade Barriers Database (Bown, 2014).

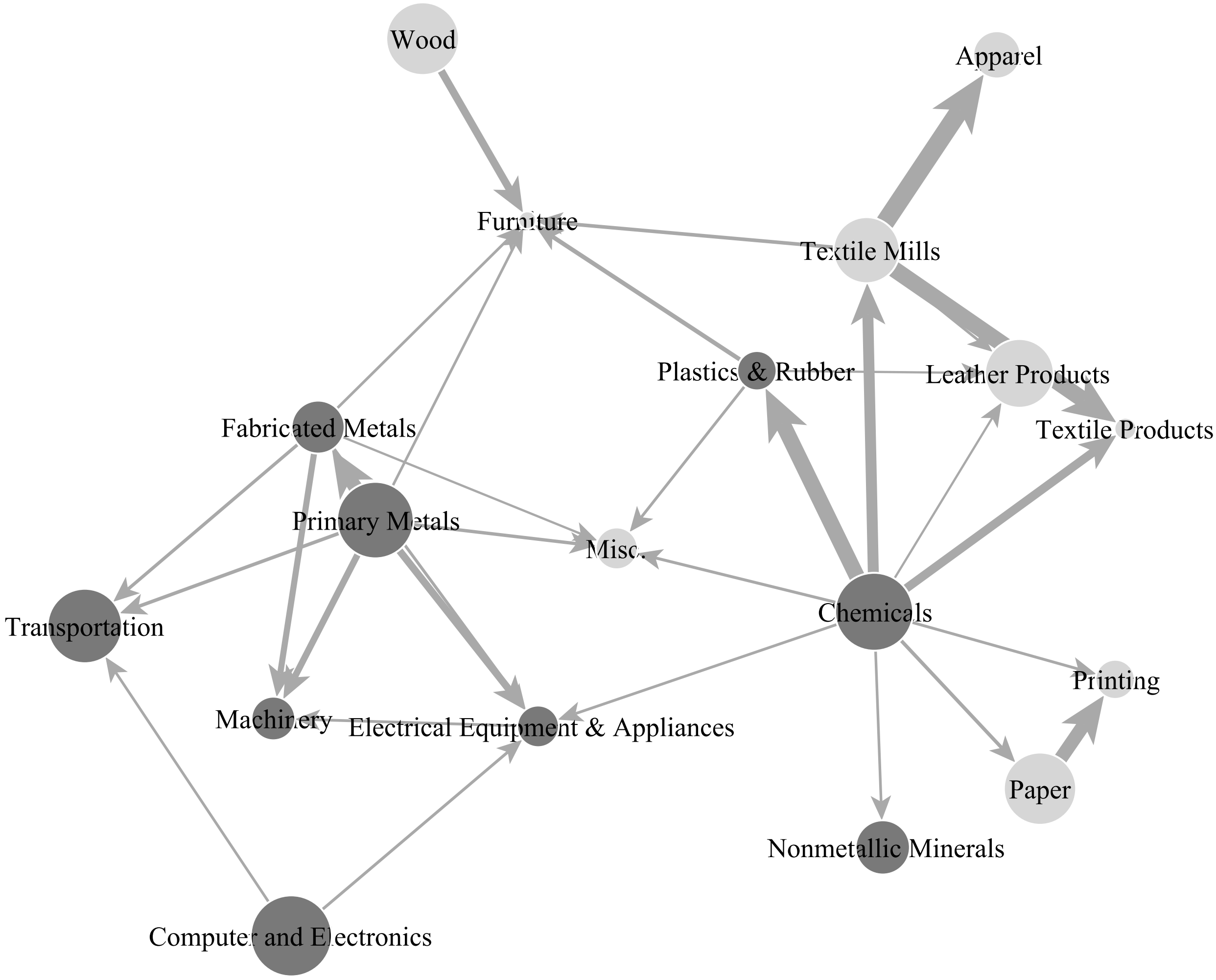
Figure 2: Upstreamness of U.S. TTBs



Notes: We use the 1989 and 2012 imports for 1988 and 2013 respectively due to data unavailability.

Source: Authors' calculations based on Antràs et al. (2012), Schott (2008), and the Temporary Trade Barriers Database (Bown, 2014).

Figure 3: Sector Relationships



Notes: Nodes indicate NAICS3 sectors and links indicate input to output relationships. The links thicken as cost shares increase (with minimum cost share set at 10 percent for visual clarity). The locations of the nodes are based on the number of links each node has (i.e. centrality indices). The size of the nodes specifies how self-reliant a sector is. The colors indicate target concentration (dark gray: heavy TTB target, light gray: light TTB target). A sector is a heavy target if it's on the top 10 targeted sectors listed in Table 1.

Source: Authors' calculations based on the Temporary Trade Barriers Database (Bown, 2014) and the Bureau of Economic Analysis' 1997 Input-Output tables (BEA, 1997) using network visualization software Visone.

A Appendix

A.1 Proof of Proposition 2

We decompose the proofs for Proposition 2 into three parts. In Part 1, we show that given protection on the upstream industry, a duty imposed on downstream imports increases upstream profits; in Part 2, we show that the upstream profits can be decomposed into a particular form; then in Part 3 we prove Proposition 2 using results obtained from Part 1 and Part 2.

Part 1. $\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_s = 1, \mathbb{P}_{-s}) - \Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_s = 0, \mathbb{P}_{-s}) > 0$

Proof. To simplify notation, denote $\Delta_{\Pi_{1w,s}} \equiv \Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_s = 1, \mathbb{P}_{-s}) - \Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_s = 0, \mathbb{P}_{-s})$. From equation (4) and $Q_{is} = (\sigma_s - 1)\Pi_{is}$, one can see that when industry s gets protected, Q_{is} becomes Q'_{is}; industries other than s, $\mathbb{P}_{-s}$, has their protection status unchanged. Because utility function is Cobb-Douglas and income is fixed, protection in s has no impact on other downstream industries. Substituting for Π_{1w} using the profit equation (5), $\Delta_{\Pi_{1w,s}}$ can be expressed as:

$$\Delta_{\Pi_{1w,s}} = \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \beta_{ws} \left(\frac{Q'_{1s} - Q_{1s}}{P_{1w}^{1-\sigma_w}} + \frac{Q'_{2s} - Q_{2s}}{P_{2w}^{1-\sigma_w}}\right). \tag{22}$$

Similarly, substituting Q_{is}, Q'_{is} using downstream profit function (4), we get:

$$Q'_{1s} - Q_{1s} > 0,$$
$$Q_{1s} + Q_{2s} = Q'_{1s} + Q'_{2s} = \mu_s\left(1 - \frac{1}{\sigma_s}\right)(E_1 + E_2).$$

As $\mathbb{P}_w = 1$, equation (1) implies $P_{1w} > P_{2w}$. Thus, equation (22) can be rewritten as:

$$\Delta_{\Pi_{1w,s}} = \frac{N_{iw} p_{iw}^{1-\sigma_w}}{\sigma_w} \beta_{ws} (Q'_{1s} - Q_{1s}) \left(\frac{1}{P_{1w}^{1-\sigma_w}} - \frac{1}{P_{2w}^{1-\sigma_w}}\right) \tag{23}$$

As $\sigma_w > 1$, therefore $(\frac{1}{P_{1w}^{1-\sigma_w}} - \frac{1}{P_{2w}^{1-\sigma_w}}) > 0$, and hence $\Delta_{\Pi_{1w,s}} > 0$. □

Part 2. $\Pi_{1w}(\mathbb{P}_s = 1, \mathbb{P}_{-s}) = \Pi_{1w}(\mathbb{P}_s = 0, \mathbb{P}_{-s}) + \Pi_{1w}(\mathbb{P}_s = 1, \mathbb{P}_{-s} = 0) - \Pi_{1w}(\mathbb{P}_s = 0, \mathbb{P}_{-s} = 0)$[48]

Proof. Following the definition of Part 1, we denote pre-protection and post-protection spending on inputs as Q_{is} and Q'_{is} respectively. We also define the input expenditure of industries other than s as

[48]Here, we simplify notation by writing $\Pi_{1w}(\mathbb{P}_w, \mathbb{P}_s = 1, \mathbb{P}_{-s})$ as $\Pi_{1w}(\mathbb{P}_s = 1, \mathbb{P}_{-s})$.

$\tilde{Q}_{i,-s}$. Then $\Pi_{1w}(\mathbb{P}_s = 1, \mathbb{P}_{-s})$ can be written as:

$$\begin{aligned}
\Pi_{1w}(\mathbb{P}_s = 1, \mathbb{P}_{-s}) &= \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \beta_{ws} \frac{Q'_{js}}{P_{jw}^{1-\sigma_w}} + \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \sum_{-s} \beta_{w,-s} \frac{\tilde{Q}_{j,-s}}{P_{jw}^{1-\sigma_w}} \\
&= \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \beta_{ws} \frac{Q_{js}}{P_{jw}^{1-\sigma_w}} + \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \sum_{-s} \beta_{w,-s} \frac{\tilde{Q}_{j,-s}}{P_{jw}^{1-\sigma_w}} \\
&+ \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \beta_{ws} \frac{Q'_{js}}{P_{jw}^{1-\sigma_w}} + \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \sum_{-s} \beta_{w,-s} \frac{Q_{j,-s}}{P_{jw}^{1-\sigma_w}} \\
&- \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \beta_{ws} \frac{Q_{js}}{P_{jw}^{1-\sigma_w}} - \frac{N_{1w} p_{1w}^{1-\sigma_w}}{\sigma_w} \sum_{j=1,2} \sum_{-s} \beta_{w,-s} \frac{Q_{j,-s}}{P_{jw}^{1-\sigma_w}} \\
&= \Pi_{1w}(\mathbb{P}_s = 0, \mathbb{P}_{-s}) + \Pi_{1w}(\mathbb{P}_s = 1, \mathbb{P}_{-s} = 0) - \Pi_{1w}(\mathbb{P}_s = 0, \mathbb{P}_{-s} = 0).
\end{aligned}$$

□

Part 3. $E(\Pi_{1w}(\mathbb{P}_w = 1)) > E_0(\Pi_{1w}(\mathbb{P}_w = 1))$

Proof. We use mathematical induction for this part in the following way. Order downstream industries and refer to the j^{th} industry as s_j. Industries ordered before s_j are denoted as $s_j(-)$ and ordered after are denoted as $s_j(+)$. Recall that the likelihood an industry s seeks for protection is r_s, and the existence of cascading protection implies $r_s(1) > r_s(0)$. First we consider the case where industries other than $j = 1$ get no protection. Then, the expected payoff of upstream industries, taking into account its impact on industry s_1's petition likelihood, becomes:

$$E(\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_1(+)} = 0)) = \theta r_{s_1}(1)\Pi_{1w}(1, 0, \mathbb{P}_{s_1} = 1) + (1 - \theta r_{s_1}(1))\Pi_{1w}(1, 0, \mathbb{P}_{s_1} = 0).^{49}$$

Similarly, the upstream industry's expected payoff without considering the cascading effect is:

$$E_0(\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_1(+)} = 0)) = \theta r_{s_1}(0)\Pi_{1w}(1, 0, \mathbb{P}_{s_1} = 1) + (1 - \theta r_{s_1}(0))\Pi_{1w}(1, 0, \mathbb{P}_{s_1} = 0).$$

Let $E^1 \stackrel{\text{def}}{=} E(\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_1(+)} = 0))$ and $E_0^1 \stackrel{\text{def}}{=} E_0(\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_1(+)} = 0))$, take the difference between the two equations above to get:

$$E^1 - E_0^1 = (r_{s_1}(1) - r_{s_1}(0)) (\Pi_{1w}(1, 0, P_{s_1} = 1) - \Pi_{1w}(1, 0, P_{s_1} = 0)).$$

Because $\Pi_{1w}(1, 0, P_{s_1} = 1) - \Pi_{1w}(1, 0, P_{s_1} = 0) > 0$ by Part 1 and $r(1)_{s_1} - r(0)_{s_1} > 0$ by cascading protection, $E^1 - E_0^1 > 0$.

Next we consider the case when $j > 2$ and industries ordered after j get no protection. Then, the

[49] $\Pi_{1w}(1, 0, P_{s_1} = 0)$ is the simplification of $\Pi_{1w}(\mathbb{P}_w = 1, P_{s_j(+)} = 0, P_{s_1} = 0)$.

expected upstream payoff E^j is:

$$\begin{aligned}
E^j &= E(\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_j(+)} = 0)) \\
&= \sum_{\{\mathbb{P}_{s_j(-)}\}} \theta r_{s_j}(1)\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_j(+)} = 0, \mathbb{P}_{s_j} = 1, \mathbb{P}_{s_j(-)})Pr(\mathbb{P}_{s_j(-)}) \\
&+ \sum_{\{\mathbb{P}_{s_j(-)}\}} (1 - \theta r_{s_j}(1))\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_j(+)} = 0, \mathbb{P}_{s_j} = 0, \mathbb{P}_{s_j(-)})Pr(\mathbb{P}_{s_j(-)}). \qquad (24)
\end{aligned}$$

Using results from Part 2, $\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_j(+)} = 0, \mathbb{P}_{s_j} = 1, \mathbb{P}_{s_j(-)})$ can be written as:

$$\begin{aligned}
\Pi_{1w}(\mathbb{P}_w = 1, \mathbb{P}_{s_j(+)} = 0, \mathbb{P}_{s_j} = 1, \mathbb{P}_{s_j(-)}) &\equiv \Pi_{1w}(1, 0, 1, \mathbb{P}_{s_j(-)}) \\
= \Pi_{1w}(1, 0, 0, \mathbb{P}_{s_j(-)}) &+ \Pi_{1w}(1, 0, 1, 0) - \Pi_{1w}(1, 0, 0, 0),
\end{aligned}$$

and substituting this into (24) gives E^j as:

$$\begin{aligned}
E^j &= \sum_{\{\mathbb{P}_{s_j(-)}\}} \theta r_{s_j}(1) \left(\Pi_{1w}(1, 0, 1, 0) - \Pi_{1w}(1, 0, 0, 0)\right) Pr(\mathbb{P}_{s_j(-)}) \\
&+ \sum_{\{\mathbb{P}_{s_j(-)}\}} \Pi_{1w}(1, 0, 0, \mathbb{P}_{s_j(-)})Pr(\mathbb{P}_{s_j(-)}) \\
&= \theta r_{s_j}(1) \left(\Pi_{1w}(1, 0, 1, 0) - \Pi_{1w}(1, 0, 0, 0)\right) + E^{j-1}.
\end{aligned}$$

Similarly, E_0^j can be written as:

$$E_0^j = \theta r_{s_j}(0) \left(\Pi_{1w}(1, 0, 1, 0) - \Pi_{1w}(1, 0, 0, 0)\right) + E_0^{j-1}.$$

Since $r_{s_j}(1) > r_{s_j}(0)$ and $\Pi_{1w}(1, 0, 1, 0) - \Pi_{1w}(1, 0, 0, 0) > 0$, $E^j > E_0^j$ as long as $E^{j-1} > E_0^{j-1}$. Since we already proved $E^1 > E_0^1$, by iteration we know that $E^j > E_0^j$ holds. By iterating until the last downstream industry, we prove that $E(\Pi_{1w}(\mathbb{P}_w = 1)) > E_0(\Pi_w(\mathbb{P}_w = 1))$. □

A.2 Concordance and Measurement Error

A.2.1 Concordance in steps

This section explains the concordance of HTS products to BEA industry codes (based on NAICS6) in detail since the accuracy of this matching procedure is crucial in identifying the correct input-output relationships. In order to achieve maximum precision, we follow the steps below:

1. Convert all HS codes specified for U.S. TTBs to HTS10 level using Schott's import data: *This allows us to expand the investigated HS8, HS6, HS4 codes to HTS10 level and have a consistent product level dataset.*

2. Match HTS10 to BEA industry codes using the BEA's 1997 concordance table: *This results in*

69 percent of cases matched with at least one BEA industry code.

3. Concord the HTS10 of the "unmatched" TTB cases overtime using the methodology by Pierce and Schott and rematch them to BEA industry codes using the BEA's 1997 concordance table: *Now, 76 percent of cases are matched with at least one BEA industry code.*

4. Match the HS8 of the "unmatched" TTB cases to BEA industry codes using the BEA's 1997 concordance table collapsed to the HS8 level: *Now, 97 percent of cases are matched with at least one BEA industry code.*

5. Match the remaining 33 cases manually using the names of the investigated products.

This procedure allows us to identify all the industries that are targeted by TTB investigations.[50] Note that since an investigation often includes several HTS10 codes, they can be assigned to multiple industries. In fact, the average TTB investigation covers 1.4 industries (median: 1). While the majority (82 percent) of investigations target only a single industry, two investigations stand out as they comprise more than 10 industries: *Steel Wheels* from China in 2011 (16 industries), and the *Steel* safeguard (12 industries) in 2001. Table A.1 shows the industries that have petitioned for protection in the sample period, with their respective counts, *ex-post* likelihood of successful petition (conditional on initiation), upstreamness, 1997 import penetration rates, and average import demand elasticities.

A.2.2 Potential measurement error

In this paper, inputs and outputs are linked using an IO table which is at the industry level. However, TTBs target products, and thus the concordance done at the industry level leads to measurement error. In order to make sure that this error is not systematic, we look at whether the IO-matched TTB investigations make economic sense. Table A.2 shows examples of *correct*, *incorrect*, and *missed* matches. The majority of matches make economic sense, even though some require a product-level IO table to confirm.

It is important to note that there are IO-matched pairs that are not likely to be related (incorrect matches)—for example, *silicon metal* is matched as an input for *manganese metal* but this cannot be confirmed in industrial publications. On the other hand, there are also economically viable IO-relationships that are not matched in the data (missed matches). This happens largely because the products are within the same industry. An important example of this is the measures on *cut-to-length steel place*, and the subsequent AD initiation on its direct consumer *clad steel plate*. Thankfully, these two types of measurement error, which affect both the dependent and the independent variables, do not seem to be severe in the data, and can only bias the regression coefficients towards zero.

[50]The output of this TTBs-to-industries match is available on request.

A.3 Likelihood of Obtaining Protection: θ

In our model, we assume that the likelihood of obtaining protection given initiation of an investigation, θ, does not depend on whether there is an existing TTB measure on the petitioning downstream industry's input. In their paper, Hoekman and Leidy (1992) emphasize that cascading protection happens because an upstream measure increases the probability of obtaining protection by a downstream industry since it makes it more likely to pass the ITC's injury test. However, as argued by Boltuck and Litan (1991) and Lindsey and Ikenson (2003), the ITC almost never rigorously establishes a *causal* relation between dumping (or any other cause) and injury in U.S. AD investigations. This implies that a specific cause such as a measure on an input should not change the likelihood of an affirmative determination by the ITC.

To test whether a downstream industry's likelihood of getting protection depends on existing measures on its inputs, we use the same independent variable that proxies for the intensity of an industry's input TTB coverage,[51] but now change the dependent variable to a dummy that indicates whether a measure was imposed at the end of an investigation. Note that for these downstream industries in our sample, the mean probability of obtaining protection (given petition) is 57 and 61 percent for 1988-2013 and 1995-2013, respectively. Table A.3 shows the marginal effects from our conditional logit estimation that includes industry and year fixed effects. Like our main results in Table 3, we do the estimation for two time periods and use the maximum instead of the mean affected share as a robustness check. As expected, marginal effects are not significantly different than zero, giving support to our fixed θ assumption.[52]

[51] Section 4 shows that an increase in this variable raises the likelihood of petitioning.

[52] A caveat in these regressions is that we can only include investigations that have been initiated resulting in a selected sample—an industry might know that it won't be granted protection and thus not petition, and this is omitted from our analysis.

Appendix Tables

Table A.1: Industry Characteristics

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
331111	Iron and steel mills	76	0.80	3.36	0.18	12.22
325190	Other basic organic chemicals	29	0.69	3.85	0.20	8.09
331222	Steel wire drawing	23	0.78	3.45	0.24	10.96
325180	Other basic inorganic chemicals	22	0.68	3.42	0.15	6.28
332910	Metal valve manufacturing	16	0.75	2.54	0.20	2.84
331419	Primary nonferrous metal, except copper and aluminum	13	0.85	3.42	0.60	9.14
336300	Motor vehicle parts	11	0.64	2.30	0.22	6.31
325130	Synthetic dye and pigments	10	0.50	3.52	0.27	12.56
332991	Ball and roller bearing	9	0.89	3.15	0.25	4.59
33361A	Speed changers and mechanical power transmission equipment	9	0.78	2.75	0.38	1.84
331112	Ferroalloy and related products	7	0.86	3.36	0.56	4.50
114100	Fishing	7	0.71	2.21	0.83	19.08
325211	Plastics material and resin	6	1.00	3.57	0.12	5.22
3221A0	Paper and paperboard mills	6	1.00	3.03	0.14	17.24
332999	Miscellaneous fabricated metal products	6	0.83	2.64	0.28	7.69
325998	Other miscellaneous chemical products	6	0.67	2.88	0.11	8.38
332720	Turned product and screw, nut, and bolt	6	0.50	2.96	0.12	3.68
112A00	Animal production, except cattle and poultry and eggs	5	1.00	2.58	0.07	20.47
333415	AC, refrigeration, and forced air heating	5	1.00	2.12	0.13	10.52

Continued on next page

Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
311420	Fruit and vegetable canning and drying	5	1.00	1.44	0.08	11.34
311410	Frozen food	5	0.80	1.28	0.05	12.73
339994	Broom, brush, and mop	5	0.60	1.81	0.24	12.31
111200	Vegetable and melon farming	5	0.60	1.36	0.14	7.96
31499A	Other miscellaneous textile product mills	5	0.40	2.12	0.17	28.92
327310	Cement	4	1.00	2.99	0.12	4.28
334413	Semiconductors and related device	4	1.00	2.91	0.36	7.46
326110	Plastics packaging materials, film and sheet	4	1.00	2.79	0.07	3.73
325400	Pharmaceutical and medicine	4	1.00	2.19	0.28	9.73
337127	Institutional furniture	4	1.00	1.09	0.26	2.68
326290	Other rubber products	4	0.75	2.55	0.14	6.40
334119	Other computer peripheral equipment	4	0.75	1.69	0.65	7.86
325212	Synthetic rubber	4	0.50	3.05	0.14	3.56
333111	Farm machinery and equipment	4	0.50	1.36	0.26	7.88
325311	Nitrogenous fertilizer	3	1.00	3.76	0.25	15.08
331510	Ferrous metal foundries	3	1.00	3.13	0.04	7.58
325222	Noncellulosic organic fiber	3	1.00	3.11	0.11	12.40
321918	Other millwork, including flooring	3	1.00	2.43	0.11	4.48
32619A	Plastics plumbing fixtures and all other plastics products	3	1.00	2.42	0.09	3.19
33399A	Scales, balances, and misc. general purpose machinery	3	1.00	1.62	0.56	12.49
315200	Cut and sew apparel	3	1.00	1.46	0.52	13.63
333611	Turbine and turbine generator set units	3	1.00	1.44	0.25	26.75

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Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
33451A	Watch, clock, and other measuring and controlling device	3	1.00	1.38	0.48	5.50
336110	Automobile and light truck	3	1.00	1.00	0.32	24.94
335312	Motor and generator	3	0.67	2.34	0.28	7.42
321999	Miscellaneous wood products	3	0.67	2.23	0.30	4.71
327112	Vitreous china and earthenware articles	3	0.67	1.73	0.63	3.69
333120	Construction machinery	3	0.67	1.29	0.27	23.74
336214	Travel trailer and camper	3	0.67	1.26	0.02	28.97
335211	Electric housewares and household fan	3	0.67	1.20	0.58	3.50
2122A0	Gold, silver, and other metal ore mining	2	1.00	4.02	1.00	12.14
327125	Nonclay refractory	2	1.00	3.46	0.16	2.28
331492	Secondary processing of other nonferrous	2	1.00	3.40	0.19	15.74
331491	Nonferrous metal, except copper and aluminum, shaping	2	1.00	3.40	0.11	4.00
331315	Aluminum sheet, plate, and foil	2	1.00	3.14	0.09	9.28
339991	Gasket, packing, and sealing device	2	1.00	3.13	0.21	2.65
327910	Abrasive products	2	1.00	3.03	0.17	4.37
321113	Sawmills	2	1.00	3.01	0.24	21.31
321114	Wood preservation	2	1.00	3.01	0.01	2.03
33441A	All other electronic components	2	1.00	2.90	0.47	5.01
325992	Photographic film and chemicals	2	1.00	2.88	0.21	5.53
313320	Fabric coating mills	2	1.00	2.82	0.17	3.44
322226	Surface-coated paperboard	2	1.00	2.64	0.27	2.16
326220	Rubber and plastics hose and belting	2	1.00	2.62	0.17	7.47
32121A	Veneer and plywood	2	1.00	2.60	0.14	6.18

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Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
332500	Hardware	2	1.00	2.55	0.22	4.32
32721A	Glass and glass products, except glass containers	2	1.00	2.55	0.16	8.24
332212	Hand and edge tool	2	1.00	2.27	0.23	1.92
333618	Other engine equipment	2	1.00	2.26	0.22	7.60
322233	Stationery and related products	2	1.00	2.10	0.21	2.48
339940	Office supplies, except paper	2	1.00	1.98	0.26	2.38
326210	Tire	2	1.00	1.94	0.20	9.63
334513	Industrial process variable instruments	2	1.00	1.81	0.32	3.01
333132	Oil and gas field machinery and equipment	2	1.00	1.76	0.12	22.60
327113	Porcelain electrical supply	2	1.00	1.73	0.18	1.43
333924	Industrial truck, trailer, and stacker	2	1.00	1.60	0.31	21.73
333922	Conveyor and conveying equipment	2	1.00	1.60	0.12	22.14
333513	Metal forming machine tool	2	1.00	1.41	0.53	25.62
334515	Electricity and signal testing instruments	2	1.00	1.38	0.22	1.67
333313	Office machinery	2	1.00	1.35	0.51	16.68
336991	Motorcycle, bicycle, and parts	2	1.00	1.22	0.51	10.84
336120	Heavy duty truck	2	1.00	1.12	0.19	35.73
334111	Electronic computer	2	1.00	1.04	0.13	5.46
32222B	Coated and uncoated paper bag	2	1.00	.	0.21	2.80
112100	Cattle ranching and farming	2	0.50	2.94	0.02	.
332600	Spring and wire products	2	0.50	2.74	0.14	4.76
332323	Ornamental and architectural metal work	2	0.50	2.48	0.01	5.86
314992	Tire cord and tire fabric mills	2	0.50	2.12	0.16	16.65

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Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
311611	Animal, except poultry, slaughtering	2	0.50	1.70	0.06	18.37
333293	Printing machinery and equipment	2	0.50	1.58	0.48	8.48
1113A0	Fruit farming	2	0.50	1.51	0.40	12.88
333220	Plastics and rubber industry machinery	2	0.50	1.47	0.46	48.05
333112	Lawn and garden equipment	2	0.50	1.21	0.04	8.24
339992	Musical instrument	2	0.50	1.15	0.51	4.56
335221	Household cooking appliance	2	0.50	1.09	0.34	7.72
337910	Mattress	2	0.50	1.03	0.01	3.12
113A00	Forest nurseries, forest products, and timber tracts	2	0.00	4.60	0.19	4.68
332312	Fabricated structural metal	2	0.00	2.64	0.03	7.32
332313	Plate work	2	0.00	2.64	0.00	2.80
331312	Primary aluminum production	1	1.00	3.81	0.26	14.50
335991	Carbon and graphite products	1	1.00	3.75	0.21	2.79
331421	Copper rolling, drawing, and extruding	1	1.00	3.61	0.15	6.16
327992	Ground or treated minerals and earths	1	1.00	3.49	0.09	4.60
1111B0	Grain farming	1	1.00	3.40	0.03	5.18
333515	Cutting tool and machine tool accessory	1	1.00	3.16	0.17	4.18
334612	Audio and video media reproduction	1	1.00	3.15	0.09	4.27
334611	Software reproducing	1	1.00	3.15	0.01	1.50
325221	Cellulosic organic fiber	1	1.00	3.11	0.15	10.15
325920	Explosives	1	1.00	2.88	0.12	7.52
313100	Fiber, yarn, and thread mills	1	1.00	2.77	0.06	6.93

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Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
212320	Sand, gravel, clay, and refractory mining	1	1.00	2.76	0.01	6.06
322210	Paperboard container	1	1.00	2.75	0.01	3.47
335314	Relay and industrial control	1	1.00	2.73	0.25	1.89
332998	Enameled iron and metal sanitary ware	1	1.00	2.64	0.10	3.05
332430	Metal can, box, and other container	1	1.00	2.63	0.03	2.82
334512	Automatic environmental control	1	1.00	2.58	0.14	7.95
323118	Blankbook and looseleaf binder	1	1.00	2.57	0.19	2.87
334613	Magnetic and optical recording media	1	1.00	2.43	0.36	35.34
336413	Other aircraft parts and equipment	1	1.00	2.43	0.30	13.43
335930	Wiring device	1	1.00	2.42	0.20	4.24
332996	Fabricated pipe and pipe fitting	1	1.00	2.39	0.02	2.52
313220	Narrow fabric mills and schiffli embroidery	1	1.00	2.30	0.22	6.47
332213	Saw blade and handsaw	1	1.00	2.27	0.18	4.66
314910	Textile bag and canvas mills	1	1.00	2.10	0.14	8.33
333131	Mining machinery and equipment	1	1.00	1.76	0.25	18.78
332420	Metal tank, heavy gauge	1	1.00	1.75	0.04	2.89
333921	Elevator and moving stairway	1	1.00	1.60	0.12	13.62
333923	Overhead cranes, hoists, and monorail systems	1	1.00	1.60	0.12	11.47
333298	All other industrial machinery	1	1.00	1.58	0.25	18.93
316900	Other leather products	1	1.00	1.50	0.71	5.46

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Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
335311	Electric power and specialty transformer	1	1.00	1.50	0.18	19.93
337215	Showcases, partitions, shelving, and lockers	1	1.00	1.47	0.04	2.30
33999A	Buttons, pins, and all other miscellaneous products	1	1.00	1.44	0.35	3.62
339112	Surgical and medical instrument	1	1.00	1.44	0.18	22.89
333512	Metal cutting machine tool	1	1.00	1.41	0.52	39.25
334210	Telephone apparatus	1	1.00	1.35	0.25	7.37
111400	Greenhouse and nursery production	1	1.00	1.35	0.10	4.74
334516	Analytical laboratory instrument	1	1.00	1.31	0.27	4.23
333912	Air and gas compressor	1	1.00	1.29	0.29	10.51
314120	Curtain and linen mills	1	1.00	1.24	0.20	4.26
336999	All other transportation equipment	1	1.00	1.22	0.07	66.67
311823	Dry pasta	1	1.00	1.18	0.14	30.12
339910	Jewelry and silverware	1	1.00	1.14	0.50	9.20
334300	Audio and video equipment	1	1.00	1.13	0.77	10.36
333991	Power-driven handtool	1	1.00	1.13	0.34	1.93
337124	Metal household furniture	1	1.00	1.10	0.31	3.20
336992	Military armored vehicles and tank parts	1	1.00	1.07	0.09	4.50
335224	Household laundry equipment	1	1.00	1.06	0.10	5.87
335222	Household refrigerator and home freezer	1	1.00	1.05	0.10	9.67

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Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
337122	Nonupholstered wood household furniture	1	1.00	1.01	0.32	3.18
211000	Oil and gas extraction	1	0.00	3.35	0.44	10.94
325120	Industrial gas	1	0.00	3.23	0.02	5.74
331319	Other aluminum rolling and drawing	1	0.00	3.14	0.25	18.78
212310	Stone mining and quarrying	1	0.00	2.77	0.02	13.18
335929	Other communication and energy wire	1	0.00	2.74	0.20	2.63
336412	Aircraft engine and engine parts	1	0.00	2.69	0.38	21.52
333996	Fluid power pump and motor	1	0.00	2.62	0.19	2.29
333995	Fluid power cylinder and actuator	1	0.00	2.62	0.13	2.23
313240	Knit fabric mills	1	0.00	2.53	0.10	7.08
311221	Wet corn milling	1	0.00	2.52	0.05	4.18
332322	Sheet metal work	1	0.00	2.48	0.00	6.43
334411	Electron tube	1	0.00	2.40	0.35	14.80
335313	Switchgear and switchboard apparatus	1	0.00	2.05	0.13	20.70
335120	Lighting fixture	1	0.00	2.02	0.24	2.09
335911	Storage battery	1	0.00	1.98	0.31	3.95
334514	Totalizing fluid meters and counting devices	1	0.00	1.97	0.20	2.30
311700	Seafood product preparation and packaging	1	0.00	1.82	0.14	13.85
311612	Meat processed from carcasses	1	0.00	1.70	0.02	7.80
311942	Spice and extract	1	0.00	1.55	0.10	7.52
311615	Poultry processing	1	0.00	1.50	0.00	2.43
311511	Fluid milk	1	0.00	1.47	0.00	20.38
333911	Pump and pumping equipment	1	0.00	1.44	0.17	1.80

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Table A.1 – *Continued from previous page*

BEA code	industry	no of cases	likelihood of protection	upstreamness	import penetration	demand elasticity
333319	Other commercial and service industry machinery	1	0.00	1.29	0.05	12.59
311911	Roasted nuts and peanut butter	1	0.00	1.19	0.16	24.08
31181A	Bread and bakery products, except frozen	1	0.00	1.18	0.02	23.17
335912	Primary battery	1	0.00	1.12	0.16	5.69

Source: Authors' calculations based on the Temporary Trade Barriers Database (Bown, 2014). Upstreamness is based on Antràs et al. (2012), import penetration rates ($imports/(output - exports + imports)$) are based on BEA (1997), and import demand elasticities are calculated using Broda and Weinstein (2006).

Table A.2: Examples of Correct, Incorrect, and Missed Matches

Measures on input	Initiation on output
A. Correct matches	
Ball bearings (1988)	Minivans (1989) Limousines (1991)
Cold-rolled carbon steel sheet (1993)	Bicycles (1995) Roofing nails (1996)
Manganese metal (1995)	Stainless steel products (1996, 1997, 1998)
Hot-rolled carbon steel flat products (1999)	Steel wire rope (2000) Steel safeguard (2001)
PET film (2001)	Polyethylene retail carrier bags (2003)
Steel safeguard (2002)	Hand trucks (2003) Steel wire strand (2003)
Carboxymethylcellulose (2004)	Commodity matchbooks (2008)
Graphite electrodes (2008)	Steel cylinders (2011)
Aluminum extrusions (2010) Copper pipe and tube (2010) Galvanized steel wire (2011)	Residential washers (2012)
B. Incorrect matches	
Sulfanilic acid (1992)	Aramid fiber (1993)
Saccharin (2002)	PET resin (2004)
C. Missed matches	
Stainless steel wire rod (1993)	Stainless steel bar (1994) Steel reinforcing bars (1996)
Cut-to-length carbon steel plate (1993)	Clad steel plate (1995)

Notes: Years in parentheses are the imposition and initiation years for inputs and outputs respectively. Inputs and outputs are matched according to the information provided by the ITC publications. This list is not exhaustive for any of the three categories.
Source: The ITC's publications and the Temporary Trade Barriers Database (Bown, 2014).

Table A.3: Likelihood of Obtaining Protection

	1988-2013		1997-2013	
Dep. variable:	(1)	(2)	(3)	(4)
Final measure imposed	mean	max.	mean	max.
Marginal effect	-0.383	-0.371	-0.789	-0.505
	(0.861)	(0.556)	(1.088)	(0.691)
Number of industries	52	52	34	34
Number of observations	217	217	120	120
Pseudo R^2	0.29	0.29	0.37	0.37

Notes: Coefficients are marginal effects. All regressions include industry and year fixed effects. Standard errors clustered by industries in parentheses.