

# Choked by Red Tape?

## The Political Economy of Wasteful Trade Barriers\*

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### Abstract

The implications of red-tape barriers (RTBs) in the presence of lobbying pressures differ markedly from those of traditional trade barriers. RTBs affect the extensive margin of trade and respond in surprisingly different ways to tariff liberalization and globalization (reductions in natural trade costs): tariff liberalization induces a protectionist backlash that can reduce trade both at the intensive and extensive margin, while globalization may induce a reduction in RTBs that magnifies its direct trade-increasing effects. Furthermore, if tariff commitments are optimized, the availability of RTBs limits the extent of tariff liberalization and political uncertainty tends to increase the prevalence of RTBs.

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# 1 Introduction

There is increasing evidence that “Red-Tape Barriers” (RTBs), defined as policy-induced barriers to trade that do not generate revenue or rents, are an important source of trade costs. In spite of their growing importance, RTBs have largely been ignored by the academic literature. In this paper we take a first step toward understanding the economic-political determinants of RTBs and their effects on trade. We will show that the implications of RTBs are subtle and quite different from those of more traditional trade barriers.

Typical examples of RTBs are procedural obstacles in the clearing of customs or in the application of non-tariff measures.<sup>1</sup> According to the International Trade Center’s 2016 survey of EU exporters (ITC (2016)), the most frequent procedural obstacles are “time constraints,” which include delays in the clearing of customs or in the process of obtaining an import license or product certification, or short deadlines for submitting documentation. Other frequent procedural obstacles are large numbers of required documents, lack of transparency on the licensing/certification process and arbitrary behaviour of customs officials when handling the exporter’s application (ITC (2016), Table B6).<sup>2</sup> Also, governments may resort to less obvious ways to increase exporters’ trade costs: one example is given by India’s decision in 2015 to allow apple imports only via the Nhava Sheva port of Mumbai, while other ports such as Chennai were more efficient options for serving large parts of the country.<sup>3</sup>

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<sup>1</sup>Our model does not focus on product regulations, but our notion of RTBs can be broadly interpreted as including excessive costs related to the application of regulations, or in the language of UNCTAD (2010), the so-called “procedural obstacles,” defined as “issues related to the process of application of a non-tariff measure, rather than to the measure itself.”

<sup>2</sup>Interestingly, when EU exporters are asked about the regulations they face in the importing country, they complain more about the procedural obstacles associated with the regulations than about the regulations themselves: see ITC (2016), Table B5.

<sup>3</sup>There are strong indications that this was a deliberate protectionist measure. According to the Indian Commerce and Industry Minister, Nirmala Sitharaman, “The government has received requests from several quarters, including public representatives, for increasing import duty on apples. The present import duty rates for apples is 50% which is also the bound rate of duty agreed to in GATT/WTO. As such, there is no scope for further increase in tariff rates without further negotiation under the WTO regime” (The Economic Times, August 3, 2016). Another newspaper commented: “The move was to protect the interests of the domestic producers who suffered on account of cheap imports from the US, China, Australia, New Zealand and Italy” (The Business Standard, October 24, 2015). We note that similar measures have been used also by developed countries. A well-known example is France’s decision in 1982 to allow imports of Japanese video tape recorders only through the bottleneck of Poitiers, a small inland town, which resulted in the number of customs clearances falling from 100,000 to 8,000 per month. (The New York Times, November 22, 1982)

Before we outline the model and our main results, it is useful to discuss briefly some empirical evidence about RTBs and their impact on trade.

First, there is an abundance of studies showing that RTBs are quantitatively important. For example, the 2012 WTO World Trade Report highlights that 76.5% of non-tariff measures entailed procedural obstacles, and the ITC survey points out that more than 90% of the reported product certifications were deemed problematic because of the procedural obstacles linked to the certification process. As another example, Djankov et al. (2010) estimate that 75% percent of the delays in shipping containers from origin to destination country are due to administrative hurdles, such as customs procedures, tax procedures, clearance and inspections.<sup>4</sup> Also, RTBs are quite common both in developed and developing countries, as clearly illustrated by the ITC (2016) survey (pp. 19 and 40).

Second, RTBs often affect variable trade costs. This is the case for example when RTBs cause delays in customs clearing or when they cause a shipment to be rejected at the customs with a certain probability. As an example of RTBs that affect variable costs, the ITC (2016) survey mentions the case of a small German company exporting musical instruments to India, which complains that the Indian inspection officials work very slowly, causing the goods to be delayed for up to 105 days, and estimates that this delay costs 50% of the value of the product.<sup>5</sup>

Finally, RTBs have important impacts on the extensive margin of trade. For example, Dennis and Shepherd (2011), Nordås et al. (2006), Persson (2013), Hendy and Zaki (2013), Shepherd (2013), Beverelli et al. (2015) and Fontagné et al. (2020) find that RTBs have a significant impact on the number of imported varieties.<sup>6</sup> It might be tempting to attribute the extensive-margin

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<sup>4</sup>In this paper we focus on RTBs as a deliberate policy choice, but RTBs may also be caused by technological limitations or resource constraints. We are not aware of systematic empirical studies that assess the relative importance of these two causes of RTBs, but there are many anecdotes suggesting that RTBs are often deliberate policy choices: see for example footnote 3 above. Also, one of the RTB indexes often considered in empirical studies (e.g. Beverelli et al. (2015) and Fontagné et al. (2020)) is the number of documents needed to export to a given market, which is more likely to be a policy choice than a technological constraint.

<sup>5</sup>As another example, a British exporter of lamb to Ghana complains that the required health certificate “has to be immaculate, as even a small typo could result in the goods being rejected despite there being no threat to human life. There is no possibility to amend the error, and we are given two options: either destroy the goods or return them, both of which cost roughly the same.”

<sup>6</sup>Also, calculations based on the data sets in Kee et al. (2009) and Nicita et al. (2018) imply that a high proportion of non-tariff barriers are at or close to prohibitive levels. Comparing estimated ad-valorem equivalents of non-tariff barriers from Kee et al. (2009) with prohibitive tariff levels calculated by Nicita et al. (2018) shows that the share of products for which the ad-valorem equivalents are at least 90 percent of the prohibitive tariff is

effects of RTBs to Melitz-type selection effects induced by fixed costs, and some of the authors cited above suggest such a mechanism. However, studies of RTBs that use firm-level data cast doubt on this interpretation: Fontagné et al. (2020) find that larger firms are more affected by RTBs than smaller ones, and a similar finding is reported in Shepherd (2013).<sup>7</sup> Also, Carballo et al. (2016) and ITC (2016, p. 17) find little difference in the impact of RTBs on small versus large firms. In this paper we will suggest a different mechanism for the extensive-margin impacts of RTBs that does not rely on fixed costs.<sup>8</sup>

Existing trade agreements, including the WTO, have gone a long way toward reducing trade barriers across the world. However it is difficult for a trade agreement to rein in the use of RTBs, because it is hard to specify them *ex ante*, and it is hard to monitor and verify them *ex post*.<sup>9</sup> This leads to a number of questions: What determines the level of RTBs? How does it depend on the tariffs set by trade agreements? How do RTBs affect the intensive and extensive margins of trade? And how are the optimal cooperative tariffs affected by the availability of RTBs?

To make our points more transparently, we assume a standard economic structure in the spirit of Grossman and Helpman (1994), and capture domestic lobbying pressures in a reduced-form way

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28 percent in the US and 35 percent in the world. We thank Marcelo Olarreaga for these calculations.

<sup>7</sup>Fontagné et al. (2020) find that reducing by 10% the complexity of border procedures (amount of documents needed etc.) and their uncertainty implies a 1% and 2.1% increase in the number of exported products for medium and large firms respectively.

<sup>8</sup>There is also some anecdotal evidence that variable-cost RTBs can affect the extensive margin of trade. One such anecdote is the situation facing the Scottish seafood firm Collins & Sons following Brexit. As reported by The Guardian (January 8, 2021), “. . . the new rules require every box of fresh seafood and salmon to be offloaded from lorries and inspected by vets before they leave Scotland. That had been taking five hours per lorry this week.” The newspaper reports that, for this reason, Collins & Sons had suspended exports to the EU. Another case reported by The Guardian (March 27, 2021) is that of the Cheshire Cheese Company, which is considering stopping exports to the EU because of the increase in red tape caused by Brexit: according to the company, “under the new rules each parcel needs to be accompanied by a health certificate costing £180, making low value sales unviable.”

<sup>9</sup>There are ways in which the WTO can potentially mitigate the issue of RTBs. One is the “Trade Facilitation Agreement” (TFA), which has the twin objectives of encouraging investment in trade-related infrastructure and reducing RTBs. Also the Agreement on Technical Barriers to Trade can potentially be used to tackle certain forms of RTBs, through the principle that regulations should pursue domestic policy objectives in the “least trade distorting” way. But arguably neither of these approaches has been able to fully overcome the difficulties of monitoring RTBs and drawing a clear boundary between legitimate and excessive costs imposed on exporters. Another potential way to mitigate the issue of RTBs is the so-called “non-violation” clause (GATT Article XXIII:1(b)), which is an “outcome-based” rule that commits the importing country to a minimum volume of imports. But the effectiveness of outcome-based rules is severely diminished if trade volumes are affected by demand or supply shocks that are imperfectly verifiable or can only be specified in the contract at a cost. We will come back to this point in footnote 20 below. Finally, one could argue that the WTO’s “safeguards” provisions can serve as safety valves to accommodate domestic political pressures, and thus might reduce the incentives to use RTBs. But overall, the simple observation that RTBs have remained empirically significant in recent decades suggests that the provisions above can at best mitigate, not eliminate, the issue of RTBs.

by assuming that governments attach extra weight to domestic producers in import-competing industries. We consider two types of trade policy: import tariffs and RTBs. Given that RTBs do not generate revenue, they are more inefficient than tariffs, so a government (even if politically motivated) would never use them if tariffs were unconstrained. But if a trade agreement constrains tariffs, RTBs may emerge. We distinguish between an ex-ante stage, when the trade agreement is written, and an ex-post stage, when governments choose RTBs given the tariffs specified in the agreement. At the ex-ante stage, the political weights are uncertain. Importantly, the trade agreement is incomplete in two dimensions. First, the agreement can specify tariffs but not RTBs, so RTBs are left to a government's discretion. Second, the tariffs specified in the agreement cannot be contingent on the level of political pressures in the various industries, so the agreement displays some rigidity.<sup>10</sup> Our basic model focuses on a small country setting where the trade agreement is motivated by domestic-commitment issues, but later we consider a setting with two large countries where the agreement is motivated by terms-of-trade externalities, and show that our main insights extend to this setting.

We start by examining a government's choice of RTBs taking tariffs as exogenous. The case of exogenous tariffs is interesting for several reasons. First, we can interpret the impact of parameter changes on RTBs as short-run effects, reflecting the fact that tariffs cannot be renegotiated frequently. Second, exogenous tariff changes can be interpreted as tariff changes caused by shocks outside our model. And third, this case can capture situations where a country has little choice on the tariff commitments, for example because it must choose whether or not to join a pre-existing trade agreement.

We distinguish between two sets of products, depending on the curvature of their import demand. The first set consists of products for which import demand is convex or not very concave. For these products, given any tariff level the optimal RTB is either zero (if political pressures are weak) or prohibitive (if political pressures are strong), so RTBs can "choke" trade for a whole range of products, thus affecting the extensive margin of trade. The second set consists of products for which import demand is sufficiently concave, in which case the optimal RTB is non-prohibitive

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<sup>10</sup>This view of trade agreements as incomplete contracts that can display both discretion and rigidity is similar in spirit to Horn et al. (2010).

for a range of tariff levels and political pressures.

It is worth highlighting that our model is consistent with the above-mentioned empirical evidence that RTBs impact the extensive margin of trade, and that such impact does not seem to arise from fixed costs. The extensive-margin effects of RTBs arise in our model because of a fundamental non-convexity in the government optimization problem, stemming from the fact that consumer surplus and producer surplus are convex in prices.

Next we examine how equilibrium RTBs respond to exogenous changes in two types of trade costs, namely tariffs and “natural” (i.e. non-policy) trade costs. We pay particular attention to the effects of an across-the-board reduction in tariffs, which we refer to as “tariff liberalization,” and an across-the-board reduction in natural trade costs, which we refer to as “globalization.”

Our first main result is that tariff liberalization can have surprising effects on trade, due to its interaction with the endogenous choice of RTBs. Tariff liberalization leads to a (weak) contraction of trade at the extensive margin, because prohibitive RTBs can be triggered for a range of products. Moreover, at the intensive margin, trade volume decreases for products covered by non-prohibitive RTBs, because for these products the government over-compensates for the tariff reduction with an increase in RTBs. Thus at both margins of trade, tariff liberalization can induce a “protectionist backlash” that more than offsets its direct trade-increasing effect. Tariff liberalization has the intuitive trade-increasing effect only for products that are unencumbered by RTBs before and after the tariff change.<sup>11</sup>

Our second main result concerns the impact of globalization on RTBs holding tariffs fixed. We find that reducing natural trade costs for a given product *reduces* the probability that imports of that product are choked by RTBs; and at the aggregate level, globalization expands trade at the extensive margin. This seems surprising, because natural trade costs and RTBs in our model have identical economic effects, so one might expect them to be substitutes. Importantly, this counterintuitive effect of natural trade costs arises if and only if RTBs affect trade through the extensive margin; if RTBs are non-prohibitive, a reduction in natural trade costs has the intuitive

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<sup>11</sup>The result that RTBs (when non-prohibitive) over-respond to tariff changes, so that tariff reductions have a perverse trade-reducing effect, contrasts with the policy-substitution effects highlighted in other papers, where typically the direct effect of the tariff reduction outweighs the indirect effect due to policy substitution toward non-tariff measures, so that trade increases as a result. See for example Copeland (1990) and Horn et al. (2010).

effect of increasing RTBs (weakly). Thus the impact of natural trade costs on RTBs depends critically on whether RTBs operate at the extensive or the intensive margin.

The above results have important implications for studies aimed at evaluating the welfare gains from reducing tariffs or natural trade costs. Tariff reductions trigger policy substitution toward RTBs, so if the endogenous RTB response is ignored, the welfare gains from tariff liberalization will be overstated. In contrast, to the extent that RTBs operate at the extensive margin, reductions in natural trade costs mitigate a government's incentive to use RTBs, and hence if RTBs are ignored the welfare gains from globalization may be understated.

Our next step is to examine the optimal tariff commitments. We start with the benchmark case of no political uncertainty. In this case, the optimal tariff cuts *just* prevent RTBs from arising in equilibrium. But even if RTBs remain off-equilibrium, the potential for their use affects the extent of tariff liberalization: tariffs are set above the level that would be optimal if RTBs were unavailable, in order to avoid a protectionist backlash in the form of RTBs.

The model suggests that RTBs tend to be more prevalent when political uncertainty is larger. The basic intuition stems from the result mentioned just above that, in the absence of uncertainty, the optimal tariff level is the one that just prevents RTBs from arising. When there is uncertainty, since tariffs cannot be contingent on the political shocks, optimality requires balancing the traditional gains from tariff reductions with the need to keep tariffs high in order to reduce a government's incentive to use RTBs, and for this reason the optimal tariffs allow RTBs to arise with positive frequency.

We then examine how optimal tariffs are affected by globalization. Recall that, for the set of products such that RTBs operate at the extensive margin, globalization reduces the government's incentive to use RTBs. Intuitively, then, globalization should reduce the need to keep tariffs high as a way to mitigate such incentive, and hence should lead to lower optimal tariffs. We find that this intuition is correct if political uncertainty is sufficiently small, but if political uncertainty is large the result may be reversed. On the other hand, when we focus on the set of products such that RTBs operate at the intensive margin, we find that globalization increases the optimal tariffs regardless of the degree of political uncertainty.

In the final part of the paper we extend the model in two directions. First we consider the case of partially wasteful trade barriers, meaning that only part of the revenue/rents associated with the policy is wasted. And second, we consider the case of two large countries that sign a trade agreement to address terms-of-trade externalities. In both cases, we find that our main results continue to hold, though with some interesting qualifications.

In the related literature, several papers examine the substitutability between tariffs and non-tariff policies. Copeland (1990) and Horn et al. (2010) focus on production subsidies and consumption taxes. The implications of these policies are different from those of RTBs, in part because they generate revenue. Bagwell and Staiger (2001a) focus on domestic regulations and argue that, in the absence of uncertainty, an “outcome-based” contract that specifies minimum levels of market access is sufficient to achieve international efficiency. In this paper we focus instead on “instrument-based” contracts, in the same spirit as Horn et al. (2010), and make very different points from Bagwell and Staiger’s.<sup>12</sup>

Beshkar and Lashkaripour (2016) show that, if tariffs are not available, RTBs can be welfare-optimal for some sectors if they improve the terms of trade in other sectors. In contrast, our paper presents a political-economy theory of RTBs, where RTBs can be chosen even if they do not affect the terms of trade. As a consequence, our model can explain the use of RTBs also for small countries. Furthermore, while they focus on interdependencies across sectors, we focus on within-sector questions such as the impact of tariffs and natural trade costs on RTBs, the impacts on the extensive and intensive margins of trade, and the implications of RTBs for the tariffs specified in a trade agreement.

Also related is Limão and Tovar (2011) consider partially wasteful trade barriers, but their focus is very different from ours: they argue that a government may want to commit to lower tariffs to improve its bargaining position vis-à-vis domestic lobbies in the choice of non-tariff measures. Furthermore, they assume that the optimal level of the non-tariff barrier is always interior; but as we show in this paper, this assumption is unlikely to hold for RTBs, or more generally for policies

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<sup>12</sup>On the empirical side, papers that have found evidence of policy-substitution effects are for example Ray (1981), Ray and Marvel (1984), Kee et al. (2009), Bown and Tovar (2011), Limão and Tovar (2011), Eibl and Malik (2016) and Niu et al. (2018).



with a large share of wasted revenue<sup>13</sup>

The paper is structured as follows. Section 2 lays out the basic model. Section 3 focuses on the case where RTBs affect only the extensive margin of trade. Section 4 considers the richer scenario where RTBs can also affect the intensive margin. Section 5 considers the optimal tariff commitments. Section 6 considers partially wasteful trade barriers. Section 7 considers terms-of-trade motivated trade agreements. Section 8 concludes. The Appendix contains proofs not included in the text.

## 2 The Basic Model

In this section we lay out the basic model. We start by describing the political-economic environment, and then introduce trade agreements.

### 2.1 The Political-Economic Environment

The setting is a small open economy that we call Home, trading with a large rest of the world, whose variables are denoted by an asterisk (\*). Markets are perfectly competitive. The economy produces and consumes a continuum of products ( $x_i, i \in \Omega$ ) plus an outside good ( $x_0$ ), which we take to be the numéraire.

In order to make our key points in the most transparent way, we assume quasi-linear and separable preferences.<sup>14</sup> Each individual at Home has the following utility function:

$$U = x_0 + \int_{i \in \Omega} u_i(x_i) di \tag{1}$$

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<sup>13</sup>Venables (1987) and Ossa (2011) also consider models where wasteful trade barriers can increase welfare, specifically because of firm-delocation effects under monopolistic competition. Staiger (2012) focuses on trade facilitation agreements that encourage trade-cost-reducing investments. While we allow a government to freely increase trade costs above their “natural” levels, Staiger allows a government to decrease trade costs below their “natural” levels by making costly investments. Finally, in the public economics literature there are several papers that focus on red tape, but they are only tangentially related to this paper. For example, Gordon and Li (2009) discuss the role of red tape in taxing firms operating in the informal sector in developing countries, and in a trade context, Davies (2013) illustrates how red tape enables a government offering an export subsidy to discriminate among firms.

<sup>14</sup>Allowing for substitutability across goods complicates the analysis without adding much insight. In an alternative version of our model where individuals have Melitz-Ottaviano preferences, it can be shown that our qualitative results remain unchanged.

Given this utility function, the demand function for each of the nonnuméraire goods depends only on the good's own price:  $x_i(p_i) = -s'_i(p_i)$ , where  $s_i(p_i) \equiv u_i(x_i(p_i)) - p_i x_i(p_i)$  is the surplus the consumer derives from good  $i$ . Integrating this over all goods  $i$  and adding individual income  $Y$  gives their indirect utility:  $Y + \int_{i \in \Omega} s_i(p_i) di$ .

On the supply side, each nonnuméraire good is produced using a specific factor and mobile labor with constant returns to scale. Aggregate supplies of all factors are fixed, equal to  $K_i$  for specific factor  $i$  and  $L$  for labor. The numéraire good uses only labor with constant returns to scale, and we assume that the labor supply is large enough that this good is always produced in equilibrium. Hence the wage is pinned down in the numéraire good sector. It is convenient to choose units of measurement such that both the wage and the aggregate supply of labor are equal to one (though it is sometimes more insightful to write  $L$  explicitly). The return to specific factor  $i$  is  $\pi_i = r_i K_i$ . Given the technology assumed,  $\pi_i$  depends only on  $p_i$ , so we denote it  $\pi_i(p_i)$ . By Hotelling's Lemma, the supply of each good is given by the derivative of the profit function:  $y_i(p_i) = \pi'_i(p_i)$ . Hence total factor income equals  $L + \int_{i \in \Omega} \pi_i(p_i) di$ .

Since we want to focus on import barriers, it is convenient to assume that (supply and demand parameters are such that) all nonnuméraire goods are imported while the numéraire good is exported.<sup>15</sup> We focus on specific tariffs  $\tau_i$ , so the revenue from a tariff is  $\tau_i m_i(p_i)$ , where  $m_i(p_i) = x_i(p_i) - y_i(p_i)$ . Tariff revenue is rebated to citizens in a non-distortionary way, but the government cannot make targeted lump-sum transfers to specific groups.

Welfare is defined as aggregate indirect utility. Letting  $\bar{Y} = L + \int_{i \in \Omega} \pi_i(p_i) di + \int_{i \in \Omega} \tau_i m_i(p_i) di$  denote aggregate income, we can write welfare as  $\bar{W} = \bar{Y} + \int_{i \in \Omega} s_i(p_i) di$ , or equivalently:

$$\bar{W} = L + \int_{i \in \Omega} W_i di \quad \text{where:} \quad W_i \equiv s_i(p_i) + \pi_i(p_i) + \tau_i m_i(p_i) \quad (2)$$

In addition to the tariffs, there are two types of trade costs: red-tape barriers (RTBs), which are denoted  $\theta_i$ , and "natural" (exogenous) trade costs  $\delta_i$ . For the present, we assume that RTBs generate no revenue or rents; in Section 6 we will allow them to generate some rents. The natural

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<sup>15</sup>This assumption *per se* is not restrictive, because the numéraire good can be interpreted as a composite of all exported goods, since we assume no export policies and we fix all prices of these goods.

trade costs  $\delta_i$  are unaffected by trade policy but can be interpreted as determined by factors such as technology and geography. RTBs and natural trade costs contribute to the wedge between domestic price and world price, so we can write the domestic price of good  $i$  as:

$$p_i = p_i^* + \delta_i + \tau_i + \theta_i \quad (3)$$

We now introduce the government’s objective function. To capture the idea that the government chooses trade policy subject to domestic political pressures, we assume that the government maximizes the following politically-adjusted welfare function:

$$\bar{V} = L + \int_{i \in \Omega} V_i di \quad \text{where:} \quad V_i \equiv s_i(p_i) + (1 + \gamma_i)\pi_i(p_i) + \tau_i m_i(p_i) \quad (4)$$

The weight  $\gamma_i > 0$  reflects the political influence of domestic producers of good  $i$ .<sup>16</sup> This type of reduced-form government objective is similar to Hillman (1982) and Baldwin (1987), and can be “micro-founded” along the lines of Grossman and Helpman (1994).<sup>17</sup>

Note that the structure we have laid out is separable across products. Nevertheless it is instructive to consider a setting with many imported products, rather than a single one, because this allows us to examine how the extensive and intensive margins of trade are affected by changes such as general reductions in tariffs and natural trade costs.

Before we consider trade agreements, it is useful to examine the noncooperative benchmark, that is the case in which the home government can choose tariffs and RTBs to maximize its

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<sup>16</sup>Our simple setting abstracts from trade in intermediate goods. Intuitively, in a richer setting with vertical linkages, the presence of politically powerful downstream industries may reduce the use of RTBs in upstream industries. One simple way to think about this in our model is that lobbying by downstream industries would reduce the  $\gamma$  weights attached to upstream industries. This in turn suggests that intermediate input industries should tend to have systematically lower  $\gamma$ ’s, and hence less RTBs, than downstream industries.

<sup>17</sup>We assume that tariffs and RTBs are chosen by a unitary government, but an alternative interpretation of the same setting is that RTBs are under the control of low-level bureaucrats, e.g. customs officials, who have a different objective than the central government. Suppose that customs officials can “sell” RTBs to local producers (in the spirit of Grossman and Helpman’s “protection for sale”), and their objective is to maximize the bribes they receive. If we think of the relationship between the central government and customs officials as a principal-agent relationship, and we abstract from informational frictions, then RTBs maximize the joint surplus of principal and agent, which in this setting boils down to a weighted average of consumer surplus, producer surplus and revenue. We also note that, since our basic model assumes that RTBs generate no revenue, it does not capture situations where customs officials can extract bribes *from exporters*, because such bribes are a form of revenue. However, if the government attaches less weight to such bribes than to the other components of welfare, this scenario fits in our extension of Section 6, where we consider RTBs with partial rent retention.

politically-motivated objective without any constraints.

Given separability across products, we can focus on a single imported product  $i$ . Both the tariff and the RTB protect home firms, but only the tariff raises revenue. Hence, in the absence of any constraints on its use of the tariff, the government will never use the RTB. Assuming that  $V_i$  is concave in  $\tau_i$ , the optimal noncooperative tariff  $\tau_i^N$  is defined by the following first-order condition:

$$\frac{dV_i}{d\tau_i} = \gamma_i y_i + \tau_i m_i' = 0 \quad (5)$$

This yields  $\tau_i^N = -\frac{\gamma_i y_i}{m_i'}$ . We note that the optimal tariff is prohibitive if  $\gamma_i$  is above some threshold level, which we label  $\gamma_i^H$ .<sup>18</sup>

## 2.2 Trade Agreements

We are now ready to introduce trade agreements in our model. We distinguish between an ex-ante stage in which the Home government can sign a trade agreement, and an ex-post stage in which the government chooses trade policies subject to the constraints imposed by the trade agreement.

We assume that the political weights  $\gamma_i$  are observed ex post but uncertain ex ante. Ex ante, each  $\gamma_i$  is distributed according to some cumulative distribution function  $G_i(\gamma_i)$ , with associated density function  $g_i(\gamma_i)$ . We assume that  $g_i(\gamma_i)$  is continuous with support  $[\gamma_i^{min}, \gamma_i^{max}]$ . The political weights are assumed to be independent across products. All other parameters of the model are assumed to be deterministic.

As mentioned in the introduction, we view trade agreements as contracts that are incomplete in two dimensions. First, a trade agreement can specify tariffs but not RTBs, reflecting the difficulties of verifying RTBs ex-post and of describing them in detail ex ante. This means that the agreement leaves *discretion* over RTBs. Note that, since RTBs are not covered by the agreement, they can respond flexibly to political pressures ex post. Second, the agreement cannot specify contingent tariffs. In our setting, the relevant contingencies are the political shocks  $\gamma_i$ , so we are assuming that tariffs cannot be made contingent on political shocks (while they can be tailored to all other

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<sup>18</sup>Note that if  $\gamma_i$  is slightly above  $\gamma_i^H$  then the optimal tariff is prohibitive but  $V_i$  is still concave in  $\tau_i$ , while if  $\gamma_i$  is much higher than  $\gamma_i^H$  then  $V_i$  is convex in  $\tau_i$  and the optimal tariff is *a fortiori* prohibitive.

product characteristics).<sup>19</sup> This means that the agreement also displays some *rigidity*. As will become clear, in our model the co-existence of rigidity and discretion in the trade agreement is responsible for the emergence of RTBs in equilibrium.<sup>20</sup>

We examine the implications of a trade agreement in two steps. First, in Sections 3 and 4, we take tariff commitments as exogenous. There we highlight how the choice of RTBs is affected by reductions in tariffs, and compare the effects of tariff reductions with those of declines in natural trade costs.<sup>21</sup> Second, in Section 5, we endogenise tariffs by modeling explicitly the formation of a trade agreement. In the basic model we consider a domestic-commitment motivated trade agreement, focusing on a small country. We capture domestic-commitment motives in a very stylized way, by assuming that the government’s ex-ante objective is different from its ex-post objective. In particular, ex ante the government maximizes social welfare (given by (2)), but when choosing trade policies ex post it maximizes the politically-adjusted social welfare function (given by (4)).<sup>22</sup> One interpretation of this reduced-form setting is that, when the agreement is signed, the government is in “constitution-writing” mode, and would like to prevent future policy-makers from engaging in protectionism. Alternatively, this setting could capture a government that faces time-consistency issues and would like to prevent its future self from caving in to domestic political pressures.<sup>23</sup> In Section 7 we consider also the case of a terms-of-trade motivated trade agreement

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<sup>19</sup>As an alternative to this assumption, we could have assumed that each good  $i$  is differentiated along some dimension (e.g. quality) and the tariff on each good  $i$  must be uniform.

<sup>20</sup>Rigidity and discretion in trade agreements can be explained as arising endogenously from contracting costs, as in Horn et al. (2010). As discussed in that paper, the problem of discretion over non-tariff policies can potentially be mitigated by outcome-based rules such as GATT’s “non-violation” clause (see footnote 9 above), but if trade volumes are affected by demand or supply shocks that are imperfectly verifiable or costly to specify ex-ante, an outcome-based contract cannot completely solve the problem of discretion, and may or may not be preferable to an instrument-based contract. Just as in Horn et al. (2010), in this paper we focus on instrument-based contracts rather than outcome-based contracts. A formal examination of the tradeoffs between these two types of contracts in a more general stochastic setting would be a worthwhile endeavor, but one that is beyond the scope of this paper.

<sup>21</sup>As we mentioned in the Introduction, the exogenous-tariff scenario can be interpreted as a short-run scenario, or as a situation where tariff changes are caused by shocks that fall outside the model, or as a situation where a country must choose whether or not to join a pre-existing trade agreement.

<sup>22</sup>Our qualitative results would not change if we allowed for political pressures also at the ex-ante stage, as long as they are less strong than at the ex-post stage.

<sup>23</sup>One way to provide micro-foundations for this reduced-form approach would be along the lines of Maggi and Rodríguez-Clare (1998). The idea is that a trade agreement is a long-run commitment and capital is mobile in the long run, so industry-level lobbying materializes only at the ex-post stage. What our reduced-form approach does not capture, of course, is that the tariff commitments made ex-ante affect the allocation of capital that emerges ex-post, and through this channel, the supply functions in the various industries. A fully micro-founded model would take this general-equilibrium effect into account.

between two large countries.

### 3 RTBs and the Extensive Margin of Trade

We start by examining the government's ex-post choice of RTBs given an exogenous set of tariff commitments. In this section we focus on the case where RTBs affect only the extensive margin of trade, whereas in Section 4 we consider the more general setting where RTBs can also affect the intensive margin.

#### 3.1 RTBs in the absence of tariffs

As a preliminary step, it is instructive to focus on the benchmark case where RTBs are the only instruments available, for example because a trade agreement sets the tariffs at zero. In this case, we ask, when will the government impose RTBs?

Recall that, given the separability of our structure, we can focus on a single product. The key observation here is that if  $\tau_i = 0$  then  $V_i$  is convex in  $\theta_i$ , because both consumer and producer surplus are convex in  $p_i$ :

$$(i) \frac{dV_i}{d\theta_i} = \gamma_i y_i - m_i \quad (ii) \frac{d^2V_i}{d\theta_i^2} = \gamma_i y_i' - m_i' > 0 \quad (6)$$

This implies a corner solution: the optimal  $\theta_i$  is either zero or prohibitive. Let  $V_i^{FT}$  denote the value of  $V_i$  when evaluated at free trade and  $V_i^{NT}$  (for "non traded") its value when evaluated at prohibitive trade costs. The optimal RTB is prohibitive if and only if  $V_i^{NT} > V_i^{FT}$ . This is the case if the political weight  $\gamma_i$  exceeds a threshold level:

$$V_i^{NT} > V_i^{FT} \quad \Leftrightarrow \quad \gamma_i > \gamma_i^L \equiv \frac{s_i^{FT} - s_i^{NT}}{\pi_i^{NT} - \pi_i^{FT}} - 1 \quad (7)$$

The condition in (7) means that  $\gamma_i$  is high enough that the gain in producer surplus when moving from free trade to no trade is valued more highly than the loss in consumer surplus. It is easy to show that  $\gamma_i^L$  is lower than  $\gamma_i^H$ , the value of  $\gamma_i$  above which the optimal tariff is prohibitive.

To rule out uninteresting cases, we assume that there is a non-empty intersection between the support of  $\gamma_i$  and the interval  $(\gamma_i^L, \gamma_i^H)$ .

The benchmark case in which tariffs are not available illustrates a simple but fundamental feature of the government's unilateral choice of wasteful trade barriers: it may be optimal to use such barriers if more efficient trade policies are not available, but then the government's objective function is not concave, due to the absence of revenue. This non-concavity will play a key role in what follows, and indeed will be the driver of the extensive-margin effects of RTBs in our model.

### 3.2 The bang-bang RTB response function

We are now ready to examine the government's ex-post choice of RTBs given arbitrary tariff commitments. Suppose that the tariff for product  $i$  is constrained at some level  $\tau_i < \tau_i^N$ , and consider the ex-post choice of  $\theta_i$  given this tariff.<sup>24</sup> A key determinant of such ex-post choice is whether  $V_i$  is concave or convex in  $\theta_i$ . Relative to the previous case of zero tariffs, an increase in the RTB now has an additional effect: increasing  $\theta_i$  lowers tariff revenue. Because of this effect,  $V_i$  may be concave in  $\theta_i$  for a range of  $\tau_i$  if import demand  $m_i$  is sufficiently concave. To see this, differentiate (4) with respect to  $\theta_i$ , allowing for a positive tariff:

$$(i) \frac{dV_i}{d\theta_i} = \gamma_i y_i - m_i + \tau_i m_i' \quad (ii) \frac{d^2V_i}{d\theta_i^2} = \gamma_i y_i' - m_i' + \tau_i m_i'' \quad (8)$$

As the expressions above indicate, if import demand  $m_i$  is convex or slightly concave then  $V_i$  is convex in  $\theta_i$  for all  $\tau_i$ , but if  $m_i$  is sufficiently concave then  $V_i$  is concave in  $\theta_i$  for  $\tau_i > 0$ .

To highlight sharply the implications of RTBs for the extensive margin of trade, in this section we assume that, for all products,  $V_i$  is convex in  $\theta_i$  for all  $\tau_i > 0$ , deferring the more general case until Section 4.

If  $V_i$  is convex, the ex-post choice of  $\theta_i$  exhibits a bang-bang pattern: it is either zero or prohibitive, depending on the realized political weight and the tariff. We let  $\theta_i^R(\gamma_i, \tau_i)$  denote the ex-post choice of  $\theta_i$  as a function of  $\gamma_i$  and  $\tau_i$ . We call this the ‘‘RTB response function.’’ Here

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<sup>24</sup>For simplicity we assume that the agreement specifies exact tariff levels, but our main qualitative results would be preserved if we assumed that the agreement specifies tariff caps instead.

and throughout the analysis, in order to avoid cluttering the notation, we omit the argument  $\delta_i$  from the RTB response function and all other functions, even though this is a key parameter of interest.

It is immediate to show that there exists a threshold  $\gamma_i^J(\tau_i)$  such that the RTB response is prohibitive for  $\gamma_i > \gamma_i^J(\tau_i)$  and zero for  $\gamma_i \leq \gamma_i^J(\tau_i)$ .<sup>25</sup> Figure 1 illustrates this result, and Remark 1 records it.

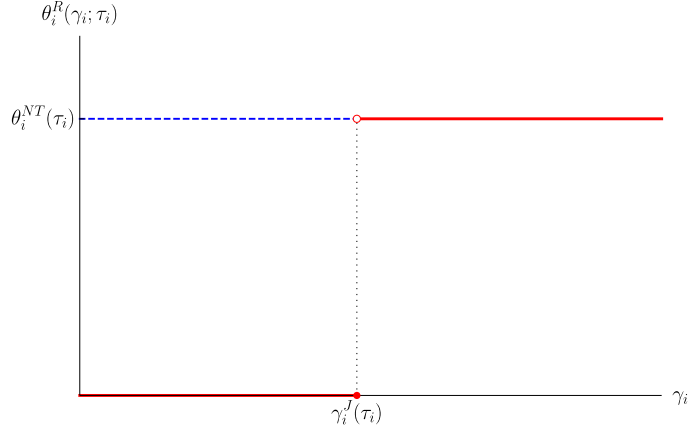


Figure 1: RTB Response as a Function of  $\gamma_i$ : Bang-Bang Case

**Remark 1.** *Suppose  $V_i$  is convex in  $\theta_i$ . Given a tariff  $\tau_i < \tau_i^N$ , there exists a threshold  $\gamma_i^J(\tau_i)$  such that the RTB response  $\theta_i^R(\gamma_i, \tau_i)$  is prohibitive if the political weight  $\gamma_i$  is above the threshold and zero if  $\gamma_i$  is below the threshold.*

Remark 1 is intuitive, given that the optimal  $\theta_i$  must be at a corner: holding the tariff fixed, imports of product  $i$  will be choked by RTBs if the realized political weight for this product is high, while RTBs will not be used at all if the realized political weight is low. The prediction that RTBs have important impacts on the extensive margin of trade seems consistent with the available empirical evidence on the effects of RTBs (see our discussion in the Introduction).

### 3.3 Tariff liberalization and the extensive margin of trade

Next we turn to the impact of tariffs on RTBs. It is intuitive and easy to show that the threshold  $\gamma_i^J(\tau_i)$  is increasing in  $\tau_i$ . As a consequence, it is clear that lowering  $\tau_i$  increases the probability

<sup>25</sup>We assume that in case of indifference the government chooses  $\theta_i = 0$ .



that imports of product  $i$  will be choked by red tape.

Consider next the impact of a general decrease in tariffs across all products. Let  $F^{choke}$  denote the fraction of products whose imports are choked by red tape. An immediate implication of the observation above is that, if  $\tau_i$  falls for all products,  $Pr(F^{choke} < x)$  decreases weakly for any  $x$ , therefore  $F^{choke}$  increases in the first-order stochastic sense. The following proposition summarizes the impact of tariff reductions on RTBs at the product level and at the aggregate level:

**Proposition 1.** *Suppose  $V_i$  is convex in  $\theta_i$  for all  $i$ . Then: (i) The probability that imports of product  $i$  are choked by RTBs increases (weakly) as  $\tau_i$  falls; (ii) If  $\tau_i$  falls for all products,  $F^{choke}$  increases (weakly) in the first-order stochastic sense.*

Proposition 1 reflects a kind of “policy substitution” effect: when tariffs are lower, the government has more incentive to use RTBs. The novel aspect of this substitution effect is that it occurs at the extensive margin.<sup>26</sup>

We next examine the effect of tariff liberalization on *trade* when we take into account both the direct effect of the tariff changes and the induced RTB response. As a direct consequence of the tariff reductions, trade increases at the intensive margin, because conditional on a product being imported the tariff reduction does not trigger the use of RTBs, but trade shrinks at the extensive margin, because the fraction of products whose imports are choked by RTBs increases.

**Corollary 1.** *The joint effect of tariff liberalization and the induced RTB response is a (weak) contraction of trade at the extensive margin and a (weak) increase of trade at the intensive margin.*

Corollary 1 highlights an interesting decoupling of the intensive-margin and extensive-margin effects of tariff liberalization: while the intensive-margin effect goes in the intuitive direction, the extensive-margin effect can go in the opposite direction because of the induced RTB response.

It is worth noting that, if the non-cooperative tariff level for a given product is prohibitive (recall this is the case if  $\gamma_i > \gamma_i^H$ ) and the tariff is reduced below the prohibitive level, the response is a prohibitive RTB, so trade volume for that product remains at zero.<sup>27</sup>

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<sup>26</sup>Policy-substitution effects have been highlighted at the theoretical level for other non-tariff measures, but not at the extensive margin (see e.g. Copeland (1990), Horn et al. (2010) and Limão and Tovar (2011)).

<sup>27</sup>While we are not aware of evidence that tariff liberalization can lead to a strict reduction of trade at the

### 3.4 Globalization and the extensive margin of trade

Next we focus on the impact of natural trade costs on RTBs. In light of the substitutability between tariffs and RTBs, one might think that a reduction in natural trade costs should increase the government's temptation to impose RTBs. Indeed, natural trade costs and red-tape barriers enter the government's objective function only through their sum  $\delta_i + \theta_i$ , suggesting that  $\delta_i$  and  $\theta_i$  should be even more closely substitutable than  $\tau_i$  and  $\theta_i$ . However, this intuition turns out not to be correct.

The key point is that, for each product, the threshold political weight  $\gamma_i^J$  increases as  $\delta_i$  decreases. To see why, consider a configuration of parameters such that the government is indifferent between  $\theta_i = 0$  and a prohibitive value of  $\theta_i$ . Since  $V_i$  is convex in  $\theta_i$  and takes the same value at the two extremes of  $\theta_i$ , it follows that  $V_i$  is U-shaped in  $\theta_i$ , and thus a small increase in  $\theta_i$  from zero reduces  $V_i$ . But an increase in  $\delta_i$  has the same effect as an increase in  $\theta_i$ , and has no impact on the no-trade payoff level,  $V_i^{NT}$ . Hence a rise in  $\delta_i$  favors the prohibitive level of the RTB over the zero level. Figure 2 visualizes this point.

An alternative perspective to understand this result is to consider the cross derivative of  $V_i$  with respect to  $\theta_i$  and  $\delta_i$ . Clearly, this cross derivative is equal to the second derivative of  $V_i$  with respect to  $\theta_i$ , which in this setting is positive. Thus, when the objective function is convex in  $\theta_i$ , so that the optimum is at a corner,  $\theta_i$  is complementary to  $\delta_i$ .

Consider next the impact of a general fall in natural trade costs (globalization). Applying a similar aggregation logic as the one we used above for tariffs, it is easy to argue that, if  $\delta_i$  falls for all products,  $F^{choke}$  must decrease in the first-order stochastic sense, and therefore trade expands at the extensive margin. We can thus state:

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extensive margin, our model can be reconciled with some recent empirical findings on the effects of trade barriers on the extensive margin of trade. In particular, Feenstra and Ma (2014) find that both tariffs and RTBs affect negatively the extensive margin of trade when they are both included as independent variables. At the same time, in some recent studies that do not use RTB data, such as Debaere and Mostashari (2010) and Feinberg and Keane (2009), the effect of tariff reductions on the extensive margin of trade seems negligible. These findings are consistent with our model under a certain range of parameters. First, in our model, controlling for the level of RTBs a tariff reduction can increase trade at the extensive margin, if the non-cooperative tariff level is prohibitive for some products due to very strong political pressures. And controlling for tariffs, a reduction in RTBs can of course reduce trade at the extensive margin. Thus our model can be reconciled with the findings in Feenstra and Ma (2014). Second, if one considers the RTB response induced by tariff reductions, it is possible that the RTB backlash offsets the effect of tariff reductions so that the overall effect on the extensive margin is negligible, thus our model can be reconciled also with the findings in Debaere and Mostashari (2010) and Feinberg and Keane (2009).

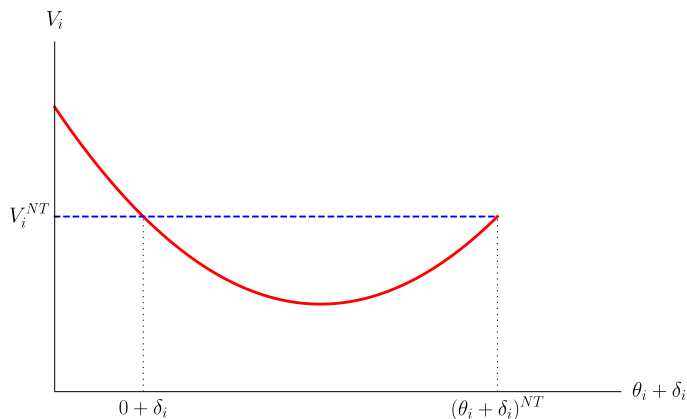


Figure 2: RTBs and Natural Trade Costs

**Proposition 2.** *Suppose  $V_i$  is convex in  $\theta_i$  for all  $i$ . Holding tariffs constant: (i) The probability that imports of product  $i$  are choked by red tape is increasing in the natural trade cost  $\delta_i$ . (ii) Globalization implies a reduction of  $F^{choke}$  in the first-order stochastic sense.*

Proposition 2(i) suggests a cross-sectional prediction of the model: products characterized by lower natural trade costs are less likely to be hit by RTBs.<sup>28</sup> Proposition 2(ii) suggests a “time-series” prediction of the model: holding tariffs fixed, globalization should lead to fewer RTBs, and through this channel, to an expansion of trade at the extensive margin (in addition to the direct positive effect on the intensive margin).

Before proceeding, we note an important implication of the results presented above. Tariff reductions trigger policy substitution toward RTBs, so if the endogenous RTB response is ignored, the welfare gains from tariff liberalization will be overstated. On the other hand, the sign of this “bias” is reversed when evaluating the welfare effects of globalization, because reductions in natural trade costs reduce a government’s incentive to use RTBs.

## 4 RTBs and the Two Margins of Trade

In the previous section we focused on the case in which equilibrium RTBs affect only the extensive margin of trade. This allowed us to focus sharply on the extensive-margin impacts of RTBs, but

<sup>28</sup> This suggests a possible explanation for why RTBs are more common in developing countries: exogenous trade costs are in part determined by technology and thus are likely to be higher for less advanced countries.

more generally RTBs can also operate at the intensive margin. In this section, we explore the general case in which RTBs may be non-prohibitive for a subset of goods.

## 4.1 RTB response function

Recall from equation (8) that for product  $i$ , given a positive tariff, if import demand is sufficiently concave the government objective  $V_i$  is concave in  $\theta_i$ .<sup>29</sup> In this case, the RTB response  $\theta_i^R(\gamma_i, \tau_i)$  may be non-prohibitive for a range of  $\gamma_i$  and  $\tau_i$ . In this section we generalize the analysis to allow for this possibility.

Let us start by focusing on a given product  $i$ . Fix the tariff  $\tau_i$  and consider how the optimal RTB depends on the realization of the political weight  $\gamma_i$ . Clearly  $\theta_i^R$  can be non-prohibitive only for an intermediate interval of  $\gamma_i$ , because  $\theta_i^R$  must be zero if  $\gamma_i$  is close to zero and prohibitive if  $\gamma_i$  is sufficiently high. It is also intuitive that, within the non-prohibitive interval,  $\theta_i^R$  is increasing in  $\gamma_i$ . In what follows we let  $\hat{\gamma}_i(\tau_i)$  denote the threshold value of  $\gamma_i$  below which  $\theta_i^R$  is zero, and  $\tilde{\gamma}_i(\tau_i)$  the threshold value of  $\gamma_i$  above which  $\theta_i^R$  is prohibitive, with  $\hat{\gamma}_i(\tau_i) \leq \tilde{\gamma}_i(\tau_i)$ . In the Appendix we prove:

**Remark 2.** *Given tariff  $\tau_i < \tau_i^N$ , there exist thresholds  $\hat{\gamma}_i(\tau_i)$  and  $\tilde{\gamma}_i(\tau_i)$  (with  $\hat{\gamma}_i(\tau_i) \leq \tilde{\gamma}_i(\tau_i)$ ) such that the RTB response  $\theta_i^R(\gamma_i, \tau_i)$  is zero for  $\gamma_i < \hat{\gamma}_i(\tau_i)$ , increasing in  $\gamma_i$  for  $\gamma_i \in (\hat{\gamma}_i(\tau_i), \tilde{\gamma}_i(\tau_i))$ , and prohibitive for  $\gamma_i > \tilde{\gamma}_i(\tau_i)$ .*

The bang-bang case examined in the previous section corresponds to the case in which there is a single threshold  $\hat{\gamma}_i(\tau_i) = \tilde{\gamma}_i(\tau_i)$  (in which case such threshold equals the threshold  $\gamma_i^J(\tau_i)$  defined in the previous section). It is important to keep in mind that we allow for many heterogeneous products, so in general there may be products for which  $\hat{\gamma}_i(\tau_i) < \tilde{\gamma}_i(\tau_i)$  and products for which  $\hat{\gamma}_i(\tau_i) = \tilde{\gamma}_i(\tau_i)$ .

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<sup>29</sup>An interesting question concerns the empirical relevance of the case of concave  $V_i$  examined in this section. Mrázová and Neary (2017) use estimates of average pass-through and markup from De Loecker et al. (2016) to back out the combinations of demand elasticity and convexity implied by the data, and discuss which demand specifications are consistent with them. (See Section IV.A, especially Figures 10 and 11.) The evidence convincingly rejects the widely-used CES specification, but does not reject highly concave demand, well within the range needed for the results in this section on interior RTBs. A specific example where  $\theta_i^R(\gamma_i, \tau_i)$  is non-prohibitive for a range of  $\gamma_i$  and  $\tau_i$  is the case in which supply is fixed and the demand function takes the Pollak (1971) form, that is  $x_i(p_i) = \alpha_i - \beta_i p_i^{\sigma_i}$ , with  $\sigma_i > 2$ .

In what follows, to simplify the analysis we assume that when the non-prohibitive interval of  $\gamma_i$  is non-empty (i.e.  $\tilde{\gamma}_i(\tau_i) < \hat{\gamma}_i(\tau_i)$ ), the RTB response function  $\theta_i^R(\gamma_i, \tau_i)$  is continuous.<sup>30</sup> Under this assumption, Figure 3 illustrates the RTB response as a function of  $\gamma_i$ .

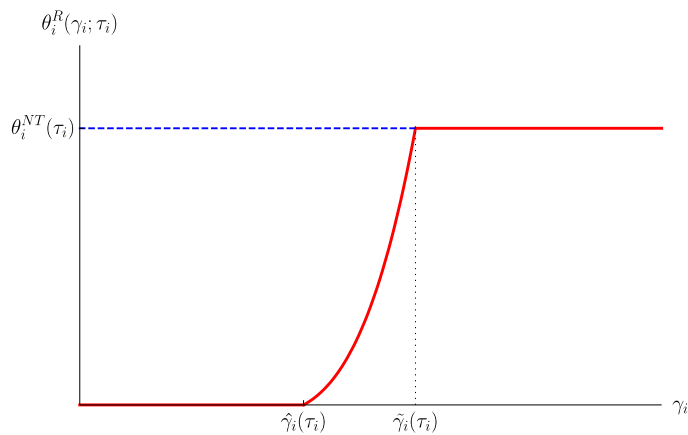


Figure 3: RTB Response as a Function of  $\gamma_i$ :  $\hat{\gamma}_i(\tau_i) < \tilde{\gamma}_i(\tau_i)$

## 4.2 Effects of tariff liberalization

How do tariff reductions affect RTBs? It is easy to show that reducing  $\tau_i$  decreases both thresholds  $\hat{\gamma}_i(\tau_i)$  and  $\tilde{\gamma}_i(\tau_i)$ , and it increases the level of  $\theta_i^R$  in the non-prohibitive interval if that interval is non-empty. As a consequence, decreasing  $\tau_i$  increases the probability that product  $i$  is affected by RTBs as well as the probability that imports of product  $i$  are choked by RTBs.

At the aggregate level, the above observations imply that tariff liberalization increases the fraction of products choked by RTBs ( $F^{choke}$ ) as well as the fraction of products “covered” by RTBs (i.e. such that  $\theta_i > 0$ ), which we denote by  $F^{cov}$ . With a slight abuse of terminology we will refer to  $F^{cov}$  as the “RTB coverage ratio.”<sup>31</sup> Formally, if  $\tau_i$  decreases for all products,  $F^{choke}$  and  $F^{cov}$  increase (weakly) in the first-order stochastic sense.

Another important point is the following. If the RTB level is non-prohibitive before the tariff change, it will increase by more than the tariff reduction:  $\frac{d\theta_i^R}{d\tau_i} < -1$ . To see this, note from (8)

<sup>30</sup>In general we cannot rule out jumps at  $\tilde{\gamma}_i(\tau_i)$  or  $\hat{\gamma}_i(\tau_i)$ . We can say something more definite in the case of fixed supply and Pollak demand. In this case, we can show that  $\theta_i^R(\gamma_i, \tau_i)$  may have a jump only at the upper threshold  $\tilde{\gamma}_i(\tau_i)$ . Furthermore, we can show that all of our results go through if a jump occurs only at the upper threshold (regardless of the functional forms of demand and supply).

<sup>31</sup>Note that, while  $F^{choke}$  captures the extensive margin of *trade* (since it is the fraction of products that are not traded because of RTBs),  $F^{cov}$  captures the extensive margin of RTB use, and the two margins are different.

that  $\frac{d^2V_i}{d\theta_i d\tau_i} = \gamma_i y_i' + \tau_i m_i'' < \frac{d^2V_i}{d\theta_i^2} = \gamma_i y_i' + \tau_i m_i'' - m_i' < 0$ . Thus, if RTBs are non-prohibitive, the government *over-compensates* for the tariff reduction with an increase in RTBs, thus *the total trade cost increases*. To gain intuition, recall that the FOC for  $\theta_i$  is  $\frac{dV_i}{d\theta_i} = \gamma_i y_i - m_i + \tau_i m_i' = 0$ . Start from a point on the RTB response function, where the FOC is satisfied, and decrease  $\tau_i$  by one unit: to restore the FOC,  $\theta_i$  must be increased by more than one unit, because  $\theta_i$  has a smaller impact than  $\tau_i$  on  $\frac{dV_i}{d\theta_i}$ , due to the lack of revenue. In the Appendix we show:

**Proposition 3.** (i) A reduction in the tariff  $\tau_i$  increases the probability that product  $i$  is affected by RTBs as well as the probability that imports of product  $i$  are choked by RTBs; (ii) For all products such that  $\theta_i$  is initially non-prohibitive,  $\theta_i$  increases by more than the tariff reduction ( $\frac{d\theta_i^R}{d\tau_i} < -1$ ); (iii) If  $\tau_i$  decreases for all products, the fraction of products choked by RTBs ( $F^{choke}$ ) and the RTB coverage ratio ( $F^{cov}$ ) increase (weakly) in the first-order stochastic sense.

The results of Proposition 3 have striking implications for the joint effect of tariff liberalization and the induced RTB response on the extensive and intensive margins of trade:

**Corollary 2.** As a result of tariff liberalization and the induced RTB response, trade shrinks (weakly) at the extensive margin, and it also shrinks at the intensive margin for all products such that  $\theta_i$  is non-prohibitive before and after the tariff reduction. Trade can increase at the intensive margin only for products such that  $\theta_i = 0$  before the tariff reduction.

The result that tariff liberalization (in combination with the induced RTB response) can lead to a contraction of trade at the extensive margin mirrors the finding in the bang-bang scenario of the previous section. But in this richer scenario, tariff reductions can have a perverse negative effect on trade also at the intensive margin: trade volume decreases for products covered by non-prohibitive RTBs, because for these products the government over-compensates for the tariff reduction with an increase in RTBs, so that total trade cost increases.<sup>32</sup>

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<sup>32</sup>If the tariff reduction triggers RTBs for a product that initially had none (that is, if  $\gamma_i$  is below  $\hat{\gamma}_i$  before the change but above  $\hat{\gamma}_i$  after the change), the RTB increase may be higher or lower than the tariff decrease.

### 4.3 Effects of globalization

Next we focus on the impact of changes in natural trade costs on the equilibrium RTBs. Recall from the previous section that, if the RTB response is bang-bang (i.e. if  $\hat{\gamma}_i(\tau_i) = \tilde{\gamma}_i(\tau_i)$ ), a reduction in  $\delta_i$  reduces the probability that product  $i$  is choked by RTBs. As we now show, the impact of natural trade costs is quite different if RTBs can be non-prohibitive (i.e.  $\hat{\gamma}_i(\tau_i) < \tilde{\gamma}_i(\tau_i)$ ).

With reference to Figure 3, the key observation is that a decrease in  $\delta_i$  leads to a one-for-one increase in  $\theta_i^R$  in the non-prohibitive interval  $(\hat{\gamma}_i(\tau_i), \tilde{\gamma}_i(\tau_i))$  and a decrease in the lower threshold  $\hat{\gamma}_i(\tau_i)$ , while the upper threshold  $\tilde{\gamma}_i(\tau_i)$  is not affected. That a decrease in  $\delta_i$  leads to a one-for-one increase in  $\theta_i^R$  when the latter is non-prohibitive follows from the fact that  $\delta_i$  and  $\theta_i$  enter the objective  $V_i$  through their sum: here, RTBs are used to neutralize the reduction in natural trade costs. Intuitively, this in turn implies that the lower threshold  $\hat{\gamma}_i(\tau_i)$  decreases. And the reason why the upper threshold  $\tilde{\gamma}_i(\tau_i)$  is not affected is that, for this level of  $\gamma_i$ , there is an interior maximum for  $\theta_i$ , and the value of the objective at an interior maximum is not affected by a change in  $\delta_i$ , since this is fully offset by the change in  $\theta_i$ .

The above observations have two immediate implications for the impact of natural trade costs at the product level. First, if the non-prohibitive interval of  $\gamma_i$  is non-empty ( $\hat{\gamma}_i(\tau_i) < \tilde{\gamma}_i(\tau_i)$ ), a decrease in  $\delta_i$  weakly increases  $\theta_i$  for all  $\gamma_i$ , but the probability of choking is not affected. Second, as  $\delta_i$  decreases, a range of non-prohibitive  $\theta_i$  can emerge, but cannot disappear; in other words, the thresholds  $\hat{\gamma}_i(\tau_i)$  and  $\tilde{\gamma}_i(\tau_i)$  may separate, but cannot merge.

We summarize the impact of natural trade costs on RTBs at the product level with:

**Remark 3.** *For a given tariff level  $\tau_i$ , there exist two intervals of  $\delta_i$  (each of which may be empty): (i) for high values of  $\delta_i$  the RTB response is bang-bang, and reducing  $\delta_i$  decreases the probability that imports are choked; (ii) for low values of  $\delta_i$  the RTB response is non-prohibitive for a range of  $\gamma_i$ , and decreasing  $\delta_i$  increases this range, while the probability of choking stays unchanged.*

Figure 4 illustrates the above result, assuming parameters are such that both intervals of  $\delta_i$  are non-empty. For a level of  $\delta_i$  in the higher range, the RTB is either zero or prohibitive depending on  $\gamma_i$ , and the range of  $\gamma_i$  where the RTB is prohibitive shrinks as  $\delta_i$  goes down. For a level of  $\delta_i$

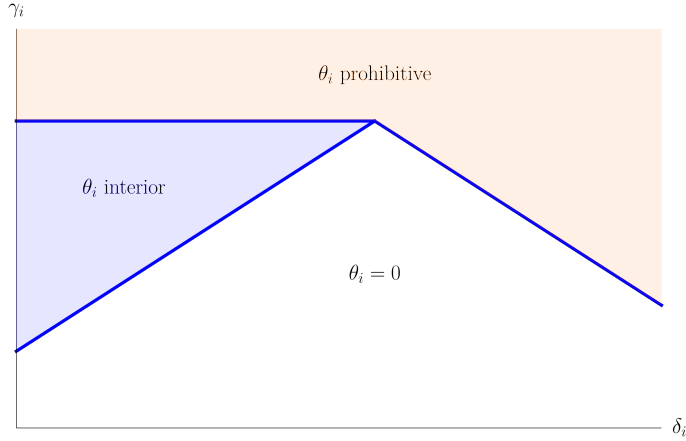


Figure 4: RTBs and Natural Trade Costs in the General Case

in the lower range, an interval of  $\gamma_i$  appears where the RTB is interior, and this interval expands as  $\delta_i$  falls, while the range of  $\gamma_i$  where the RTB is prohibitive remains unchanged.

Notice the non-monotonic effect of  $\delta_i$  on the probability that product  $i$  is hit by RTBs: as  $\delta_i$  falls, this probability initially decreases and then it increases.

Having characterized the impact of natural trade costs on RTBs at the product level, it is straightforward to derive the effects of a general fall in natural trade costs (globalization) at the aggregate level. An immediate implication of Figure 4 is that globalization weakly reduces the fraction of products whose imports are choked by RTBs. On the other hand, the non-monotonicity highlighted just above implies that globalization has an ambiguous impact on the RTB coverage ratio. Next recall that, for products that are initially covered by positive but non-prohibitive RTBs, globalization triggers a one-for-one increase in RTBs.

The following proposition, which we prove in Appendix, summarizes the model predictions regarding the aggregate effects of globalization on equilibrium RTBs:

**Proposition 4.** *Holding tariffs constant, globalization has the following effects: (i) The fraction of products whose imports are choked by RTBs decreases (weakly) in the first-order stochastic sense; (ii) For products such that  $\theta_i$  is positive but non-prohibitive before the change,  $\theta_i$  increases one-for-one ( $\frac{d\theta_i^R}{d\delta_i} = -1$ ).*

As Proposition 4 indicates, our model predicts that globalization should reduce RTBs when these operate at the extensive margin of trade, but increase RTBs when these operate at the



intensive margin.<sup>33</sup>

Next we draw the implications of Proposition 4 for the impact of globalization on the extensive and intensive margins of trade. Note that, for products such that  $\theta_i$  is positive but non-prohibitive before the change, globalization does not affect the total trade cost, while for products such that  $\theta_i = 0$  before the change the total trade cost goes down.<sup>34</sup> We can thus state:

**Corollary 3.** *As a result of globalization and the induced RTB response, trade expands (weakly) at the extensive margin. The intensive margin of trade is not affected for products such that  $\theta_i$  is positive but non-prohibitive before the change, and increases for products such that  $\theta_i = 0$  before the change.*

The results above suggest some interesting empirical predictions. Conditional on observing non-prohibitive RTBs, these should be *higher* when natural trade costs are lower, both in a cross-sectional sense (RTBs should be higher for products characterized by lower natural trade costs) and in a time-series sense (RTBs should get higher as natural trade costs fall). However, the fraction of products choked by RTBs should *decrease* over time as natural trade costs fall. And by a similar token, products characterized by lower natural trade costs should be less likely to be choked by RTBs.

## 5 Optimal Tariff Commitments

We are now ready to examine the optimal choice of tariff commitments in the presence of RTBs. In this section we consider the case in which the trade agreement is motivated by domestic commitment considerations; in Section 7 we consider a two-country version of the model where the agreement is motivated by terms of trade considerations.

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<sup>33</sup>In Section 3 we pointed out that, if RTBs operate at the extensive margin, ignoring the endogenous choice of RTBs will lead to understating the welfare gains from reductions in natural trade costs. In the richer scenario considered here this statement still holds if, broadly speaking, the extensive-margin effects of RTBs are stronger than their intensive-margin effects.

<sup>34</sup>Note that, if  $\theta_i = 0$  before the change, globalization may or may not trigger the use of RTBs. In either case the total trade cost goes down, with one exception: if the product is on the border between the  $\theta_i = 0$  region and the region where  $\theta_i$  is interior (see Figure 4), then globalization does not affect the total trade cost, but this is a measure-zero set in the parameter space, so for simplicity we ignore this case in what follows.

The agreement is chosen ex ante to maximize the Home country's welfare, taking into account that ex post the government will be subject to political pressures. Recall that the agreement can only specify tariffs, and that the tariffs cannot be contingent on the political shocks ( $\gamma_i$ ). We assume that the agreement specifies exact tariff commitments, but our main qualitative results would not be affected if the agreement specified tariff caps instead of exact tariff levels.

## 5.1 The bespoke tariffs

It is instructive to start with the benchmark case in which there is no political uncertainty, so each  $\gamma_i$  is deterministic. In this case each tariff can be tailored to the political weight of a product (as well as to the other product characteristics), so there is no rigidity in the tariffs. For this reason we call the optimal tariffs in this scenario the “bespoke” tariffs, and denote them  $\tau_i^B(\gamma_i)$ .

Given the separability of our structure, we can optimize the tariff product by product. Focusing on product  $i$ , the optimization problem can be written as follows:

$$\tau_i^B(\gamma_i) \equiv \arg \max_{\tau_i} W_i(\tau_i, \theta_i^R(\gamma_i, \tau_i)), \quad \text{where} \quad \theta_i^R(\gamma_i, \tau_i) \equiv \arg \max_{\theta_i} V_i(\tau_i, \theta_i, \gamma_i) \quad (9)$$

In what follows, we let **E** (for “extensive margin”) denote the set of products for which  $\hat{\gamma}_i(\tau_i) = \tilde{\gamma}_i(\tau_i)$ , so that the RTB response has a bang-bang nature (as in Figure 1), and **I** (for “intensive margin”) the set of products for which  $\hat{\gamma}_i(\tau_i) < \tilde{\gamma}_i(\tau_i)$ , so that RTBs can be non-prohibitive (as in Figure 3). Of course, each of these sets may be empty, depending on parameters.

Let us focus first on a product in set **E**. For a product in set **E**, recall from Proposition 1 that  $\theta_i^R(\gamma_i, \tau_i)$  is prohibitive if and only if  $\gamma_i > \gamma_i^J(\tau_i)$ , where  $\gamma_i^J(\tau_i)$  is increasing in  $\tau_i$ . It follows immediately that  $\theta_i^R$  is prohibitive if and only if  $\tau_i < \tau_i^J(\gamma_i)$ , where  $\tau_i^J(\cdot)$  is the inverse of  $\gamma_i^J(\cdot)$ . For all tariffs below  $\tau_i^J(\gamma_i)$ , imports are choked by RTBs, thus yielding the no-trade welfare level; but if the tariff is raised slightly above  $\tau_i^J(\gamma_i)$  the RTB response jumps down to zero, so the welfare level jumps up, and then falls as the tariff increases further. It follows that the bespoke tariff  $\tau_i^B(\gamma_i)$  is the lowest tariff that does not trigger RTBs, hence it coincides with  $\tau_i^J(\gamma_i)$ .<sup>35</sup> Figure 5a

<sup>35</sup>Recall the assumption that, in case of indifference, the government chooses  $\theta_i = 0$ . If instead it chooses  $\theta_i = 0$  with probability less than one, then the optimal tariff will be “just” above  $\tau_i^J(\gamma_i)$ .

illustrates the bespoke tariff for a product in set E.

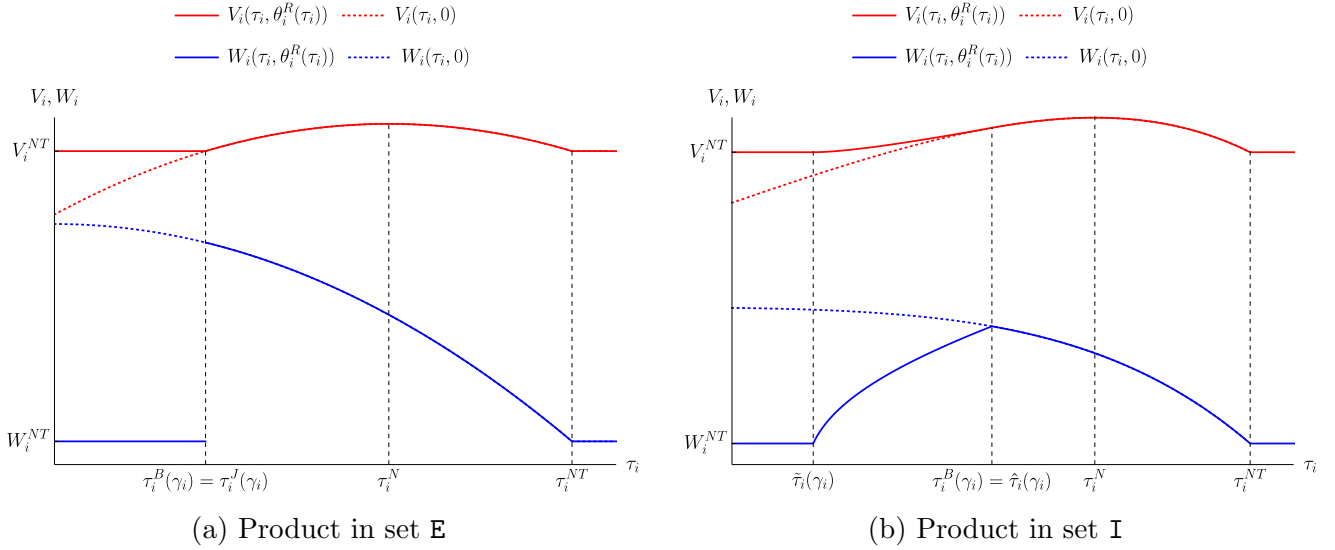


Figure 5: The Bespoke Tariff

Next consider products in set I, for which RTBs can operate at the intensive margin. Let us first characterize how the RTB response  $\theta_i^R(\gamma_i, \tau_i)$  varies with the tariff  $\tau_i$  for a given  $\gamma_i$ . Recalling Remark 2, it is easy to see that, for a given  $\gamma_i$ , the RTB response  $\theta_i^R$  is prohibitive for  $\tau_i < \tilde{\tau}_i(\gamma_i)$ , non-prohibitive and decreasing in  $\tau_i$  for  $\tau_i \in (\tilde{\tau}_i(\gamma_i), \hat{\tau}_i(\gamma_i))$ , and zero for  $\tau_i > \hat{\tau}_i(\gamma_i)$ , where  $\tilde{\tau}_i(\gamma_i)$  is the inverse of  $\tilde{\gamma}_i(\tau_i)$ , and  $\hat{\tau}_i(\gamma_i)$  is the inverse of  $\hat{\gamma}_i(\tau_i)$ .

We can show that, also in this case, the bespoke tariff is the lowest tariff that does not trigger *any* red tape barriers, that is  $\tau_i^B(\gamma_i) = \hat{\tau}_i(\gamma_i)$ . Intuitively, this is because in the non-prohibitive range  $(\tilde{\tau}_i(\gamma_i), \hat{\tau}_i(\gamma_i))$ , as we noted above, the RTB over-responds to changes in the tariff ( $\frac{d\theta_i^R}{d\tau_i} < -1$ ), so the benefit of lowering the tariff is outweighed by the cost of the induced increase in  $\theta_i^R$ . To see this, note that  $\frac{dW_i}{d\tau_i} = \frac{\partial W_i}{\partial \tau_i} + \frac{\partial W_i}{\partial \theta_i} \frac{d\theta_i^R}{d\tau_i} = (1 + \frac{d\theta_i^R}{d\tau_i}) \frac{\partial W_i}{\partial \theta_i} + m > 0$ , hence as soon as the tariff drops below  $\hat{\tau}_i(\gamma_i)$  and the RTB becomes positive, welfare decreases. Figure 5b visualizes the bespoke tariff for a product in set I.

## 5.2 Effects of globalization on the bespoke tariffs

Next we ask how the bespoke tariff varies with the natural trade cost  $\delta_i$ . Recall from Section 3 that, for products in set E, given the tariff, the threshold political weight  $\gamma_i^J$  is decreasing in  $\delta_i$ , thus when  $\delta_i$  is lower the incentive to impose RTBs is lower. With the same logic it is easy to show

that the threshold tariff  $\tau_i^J(\gamma_i)$  – and hence the bespoke tariff – is *increasing* in  $\delta_i$ . For products in set **I**, we just argued that the bespoke tariff is  $\hat{\tau}_i(\gamma_i)$ . Recall from Section 4 that,  $\hat{\gamma}_i(\tau_i)$  increases with  $\delta_i$  for any given  $\tau_i$ . This implies that  $\hat{\tau}_i(\gamma_i)$  decreases with  $\delta_i$  for any given  $\gamma_i$ . Thus in this case the bespoke tariff is *decreasing* in  $\delta_i$ .

We summarize our results on the bespoke tariffs with:

**Proposition 5.** *If  $\gamma_i$  is deterministic (so there is no rigidity in the tariff commitments), then:*

- (i) *The optimal tariff for each product  $i$  is the lowest  $\tau_i$  that does not trigger any RTBs.* (ii) *Globalization leads to a decrease in the optimal tariff for products in set **E** and an increase in the optimal tariff for products in set **I**.*

As Proposition 5(i) indicates, the bespoke tariffs prevent any RTBs from arising, regardless of whether RTBs operate at the extensive margin or at the intensive margin of trade. The intuition for this result is simple: a complete trade agreement would specify zero trade barriers in this small open economy, but given that the agreement cannot specify RTBs, the optimal (incomplete) agreement sets a tariff which is just high enough to avoid a “protectionist backlash” that would choke imports. Note that, in this benchmark case where tariffs are fully contingent, no RTBs emerge in equilibrium. However, the *potential* for use of RTBs limits the extent of tariff liberalization: if RTBs were not available the optimal agreement would lower tariffs all the way to zero, but given that RTBs are available, the optimal agreement sets strictly positive tariffs to prevent RTBs from emerging.<sup>36</sup>

Proposition 5(ii) states that globalization has a very different impact on the optimal tariffs depending on whether RTBs operate at the extensive margin or at the intensive margin. In the former case, when natural trade costs are lower the government is less tempted to use RTBs for given tariffs, so there is less need to keep tariffs high to keep this incentive in check. But in the latter case, a reduction in natural trade costs increases the government’s temptation to use RTBs, and an increase in tariffs serves to mitigate this temptation.

Recalling from the previous section that a fall in  $\delta_i$  can induce a switch of product  $i$  from set

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<sup>36</sup>This effect is reminiscent of the “indirect incentive-management” effect in Horn et al. (2010), where tariffs need to be kept relatively high to mitigate the incentive of governments to use production subsidies, if these are not specified in the agreement.

E to set I but not vice-versa, Proposition 5(ii) also implies an interesting non-monotonicity. As  $\delta_i$  falls, in general there are two phases (each of which may be empty): in the first phase the optimal tariff decreases, and in the second phase the optimal tariff increases. This in turn suggests that globalization may initially lead to tariff liberalization, but this effect may be reversed at a later stage.

### 5.3 Optimal tariffs with political uncertainty

Thus far we have considered the benchmark case of no uncertainty. This allowed us to make some interesting points about the optimal tariffs and how they are affected by the availability of RTBs and by natural trade costs. But the absence of uncertainty implies that no RTBs arise in equilibrium, a prediction that is clearly unrealistic. The fundamental reason for this is that, if there is no uncertainty, there is no rigidity in the tariffs, so that the optimal tariffs can surgically prevent the use of RTBs. In what follows we relax this assumption and introduce political uncertainty, by considering a non-degenerate distribution of  $\gamma_i$  for each  $i$ . In this case, given that the agreement cannot be contingent on  $\gamma_i$ , the agreement is incomplete both in the sense of allowing discretion over RTBs and in the sense of incorporating rigidity in the tariffs. And with tariff rigidity, RTBs now arise in equilibrium even when tariffs are optimized.

Let us reconsider the optimal tariff problem in the presence of political uncertainty. For each product  $i$ , the optimal tariff, denoted  $\bar{\tau}_i$ , maximizes expected welfare:

$$\bar{\tau}_i \equiv \arg \max_{\tau_i} \int_{\gamma_i^{min}}^{\gamma_i^{max}} W_i(\tau_i, \theta_i^R(\gamma_i, \tau_i)) dG_i(\gamma_i) \quad (10)$$

We assume that the expected welfare is globally concave in  $\tau_i$ , so we can rely on first-order conditions. We can re-write expected welfare as:

$$EW_i = \int_{\gamma_i^{min}}^{\hat{\gamma}_i(\tau_i)} W_i(\tau_i, 0) dG_i(\gamma_i) + \int_{\hat{\gamma}_i(\tau_i)}^{\tilde{\gamma}_i(\tau_i)} W(\tau_i, \theta^R(\gamma_i, \tau_i)) dG_i(\gamma_i) + \int_{\tilde{\gamma}_i(\tau_i)}^{\gamma_i^{max}} W_i^{NT} dG_i(\gamma_i), \quad (11)$$

where  $W_i^{NT}$  denotes the no-trade level of welfare, and we adopt the convention  $\int_a^b f(x) dx = 0$  if  $a > b$ . Note that for products in set E the RTB response is bang-bang, with  $\hat{\gamma}(\tau) = \tilde{\gamma}(\tau) = \gamma_i^J(\tau_i)$ .

Let us now reconsider the question of how the optimal tariffs are affected by globalization. Recall from Proposition 5(ii) that, absent uncertainty, globalization leads to a decrease in the optimal tariffs when RTBs operate at the extensive margin (i.e. for products in set  $\mathbf{E}$ ), and to an increase in the optimal tariffs when RTBs operate at the intensive margin (i.e. for products in set  $\mathbf{I}$ ). Intuitively, if uncertainty is small enough these results are preserved.

When uncertainty is large, we show that for products in set  $\mathbf{I}$  the result above is preserved: indeed, for these products globalization leads to higher tariffs for any distribution of  $\gamma_i$ . On the other hand, for products in set  $\mathbf{E}$  the impact of globalization may be reversed relative to the case of small uncertainty: in particular, when uncertainty is large, for these products globalization leads to higher tariffs for example if demand is linear, supply is fixed, and the distribution of  $\gamma_i$  is either Pareto or uniform (with the degree of uncertainty captured by the dispersion parameter in the Pareto case and by the width of the support in the uniform case).

To gain some intuition for the possible reversal of the impact of globalization on the optimal tariffs in product set  $\mathbf{E}$ , note that a small increase in  $\tau_i$  has two effects on expected welfare: it decreases the range of  $\gamma_i$  for which the product will be choked by RTBs (a positive effect), and it decreases the welfare level conditional on the product not being choked by RTBs (a negative effect). When  $\delta_i$  decreases, one key impact is that the positive marginal welfare effect of the tariff highlighted just above increases, since the gains from trade increase. This force – which is not present in the absence of uncertainty – pushes in favor of a higher tariff. Under the simple functional forms mentioned above, when uncertainty is large this effect turns out to outweigh the baseline effect that goes in the opposite direction. Note also that this effect is linked to the extensive-margin impact of RTBs, and hence is not operative for products in set  $\mathbf{I}$ .

The following proposition, proved in Appendix, summarizes the results on the impact of globalization on the optimal tariffs in the presence of uncertainty:

**Proposition 6.** *In the presence of political uncertainty: (i) For products in set  $\mathbf{I}$ , globalization leads to an increase in the optimal tariff, regardless of the degree of political uncertainty; (ii) For products in set  $\mathbf{E}$ , globalization leads to a decrease in the optimal tariff if political uncertainty is sufficiently small, but this effect may be reversed if political uncertainty is sufficiently large. Such*

reversal occurs for example if demand is linear, supply is fixed, and the distribution of  $\gamma_i$  is either Pareto or uniform.

In line with our previous results, Proposition 6 confirms that the impact of globalization on the endogenous choice of RTBs and tariffs depends in a critical way on whether RTBs operate at the extensive margin or at the intensive margin of trade. The additional aspect highlighted by Proposition 6 concerns how such impact changes with the degree of political uncertainty: increasing uncertainty can reverse the sign of such impact when RTBs operate at the extensive margin, while this cannot happen when RTBs operate at the intensive margin.

Our next step is to ask how political uncertainty affects the equilibrium level of RTBs when tariffs are optimized. Recall from Proposition 5(i) that, if there is no uncertainty, the optimal tariff level is the one that *just* prevents RTBs from arising. When there is uncertainty, on the other hand, tariffs cannot be precisely tailored, so they have to strike a balance: preventing RTBs for all levels of the political shock would require tariffs that are too high, so it is preferable to reduce tariffs somewhat and accept that RTBs will arise with positive frequency, in order to reap the gains from lower tariff levels. Thus, broadly speaking, the model suggests that RTBs should tend to be more prevalent when there is more uncertainty.

While we do not have a general monotonicity result linking the degree of uncertainty with the equilibrium level of RTBs, we do have a strong result for the case in which RTBs operate at the extensive margin, that is for products in set  $E$ .

Let  $\gamma_i^{med}$  denote the median value of  $\gamma_i$ . One way to increase dispersion in the distribution of  $\gamma_i$  is to reduce the density of  $\gamma_i$  at the median,  $g_i(\gamma_i^{med})$ . We note that, for the most common parametric distributions, including the Pareto, normal, lognormal, and uniform distributions, lowering the density at the median ( $g_i(\gamma_i^{med})$ ) can be shown to be equivalent to a mean-preserving spread. In Appendix we prove:

**Remark 4.** *Consider a product in set  $E$ . There exists a threshold  $\bar{g}$  such that, when tariffs are optimized, the probability that imports of product  $i$  are choked by red tape barriers is higher than  $1/2$  if  $g_i(\gamma_i^{med}) < \bar{g}$  and lower than  $1/2$  if  $g_i(\gamma_i^{med}) > \bar{g}$ .*

The result of Remark 4 can be interpreted as predicting that, when the degree of political

uncertainty is above a certain threshold, under the optimal tariffs the majority of the products in set  $E$  will be choked by red tape barriers, and when the degree of political uncertainty is below such threshold, the majority of products in set  $E$  will not be subject to any RTBs in equilibrium.

## 6 Partially Wasteful Trade Barriers

Thus far we have focused on import barriers that do not generate rents. How do our results extend to the case of trade barriers that generate some rents? A situation where RTBs can generate some rents is one where the bureaucrats who control the RTBs at the border can elicit bribes from exporters (see also footnote 17). To address this question, we revisit the previous analysis by assuming that a fraction  $\phi_i > 0$  of the rents associated with the trade barrier  $\theta_i$  is wasted, as in Anderson and Neary (1992) and Limão and Tovar (2011). The model analyzed in the previous sections corresponds to the special case where  $\phi_i$  equals one.

The government's objective function for good  $i$  now becomes  $V_i = s_i(p_i) + (1 + \gamma_i)\pi_i(p_i) + (\tau_i + (1 - \phi_i)\theta_i)m_i$ , where  $(1 - \phi_i)\theta_i m_i$  is the revenue generated by the RTB. For any  $\phi_i > 0$ , the RTB is a less efficient instrument than a tariff, therefore in the absence of restrictions on tariffs the government will not use RTBs. But if tariffs are constrained by a trade agreement, then the government may have an incentive to use RTBs.

For simplicity, in this section we focus on the case of linear demand and fixed supply. The first step is to consider whether the government objective is convex or concave. It is immediate to derive:  $\frac{d^2 V_i}{d\theta_i^2} = (1 - 2\phi_i)m'_i$ . Clearly,  $V_i$  is concave in  $\theta_i$  if and only if  $\phi_i < 1/2$ , that is, if RTBs are sufficiently wasteful. If  $\phi_i > 1/2$ , all our results from Section 3 continue to hold. We next examine the case  $\phi_i < 1/2$ .

If  $\phi_i < 1/2$ , so that  $V_i$  is concave in  $\theta_i$ , the characterization of the RTB response function is the same as in Section 4. In particular,  $\theta_i^R$  is zero for low values of  $\gamma_i$ , prohibitive for high values of  $\gamma_i$ , and non-prohibitive for an intermediate interval of  $\gamma_i$ , as in Remark 2. Moreover, the impact of tariff reductions is the same as described in Proposition 3.

Interestingly, however, the impact of natural trade costs on the optimal RTBs is very different from Section 4. If  $\delta_i$  decreases then  $\theta_i^R$  goes down weakly for all  $\gamma_i$  and  $\tau_i$ , and both thresholds



$\hat{\gamma}_i(\tau_i)$  and  $\tilde{\gamma}_i(\tau_i)$  increase. As a consequence, globalization leads to an increase in trade both at the extensive margin (the fraction of products whose imports are choked by RTBs goes down) and at the intensive margin, and the fraction of products covered by RTBs decreases. What underlies these results is the fact that, if  $\phi_i < 1/2$ , RTBs and natural trade costs are complementary. To see this, notice that with linear demand and fixed supply we have  $\frac{d^2 V_i}{d\delta_i d\theta_i} = -\phi_i m'_i > 0$ , and given that  $\frac{d^2 V_i}{d^2 \theta_i} < 0$  it follows that  $\frac{d\theta_i^R}{d\delta_i} > 0$ . Notice the contrast between this case and the case of non-prohibitive RTBs for  $\phi_i = 1$  (examined in Section 4), where RTBs and natural trade costs are substitutes.

Finally, this extension of our model suggests another reason (in addition to the one mentioned in footnote 28) why RTBs are more common in developing countries. Given that developing countries have weaker institutions, in these countries RTBs can be more easily used to elicit bribes from exporters, and since bribes are a form of rents associated with RTBs, this suggests that RTBs can generate more rents – and thus are a more attractive trade barrier – in developing countries.

## 7 Terms-of-Trade Motivated Trade Agreements

So far we have focused on domestic commitment as the motivation for a trade agreement. As we show in this section, the main qualitative insights hold when trade agreements are motivated by the presence of terms-of-trade (TOT) externalities. The economic structure is analogous to that of our basic model, except that now there are two large countries, Home and Foreign. We continue to assume that markets are perfectly competitive and that the economy produces a continuum of products plus an outside good (which again we take to be the numéraire). Home is the natural importer of all non-numéraire goods.

The Home government can use both tariffs and RTBs to maximise its politically-adjusted welfare function  $\bar{V}$ . For simplicity we return to the case of totally wasteful RTBs. Focusing on a single product, the Home government's payoff is as before  $V_i = s_i + (1 + \gamma_i)\pi_i + \tau_i m_i$ . To keep the exposition as simple as possible, we assume that the Foreign government is passive and its payoff

is  $V_i^* = s_i^* + (1 + \gamma_i^*)\pi_i^*$ .<sup>37</sup>

As in the small-country setting, in the absence of trade agreements the Home government would never use RTBs, because RTBs are dominated by tariffs.<sup>38</sup> Assuming that  $V_i$  is concave in  $\tau_i$ , the optimal noncooperative tariff is defined by the following first-order condition:

$$\frac{dV_i}{d\tau_i} = (\gamma_i y_i + \tau_i m'_i - m_i) \frac{dp_i}{d\tau_i} + m_i = 0 \quad (12)$$

This yields the optimal noncooperative tariff:  $\tau_i^N = \frac{\gamma_i y_i}{-m'_i} + \frac{1-p_i \tau_i}{p_i \tau_i} \frac{m_i}{-m'_i}$ . In this large country case, tariffs are used not only to protect domestic producers, but also to improve Home's terms of trade at the expense of Foreign. This terms-of-trade externality leads to trade policy choices which are inefficient from the perspective of the governments' joint payoff. The objective of a trade agreement in this setting is to correct this inefficiency. Thus here we abstract from domestic commitment motives. At the ex-ante stage, the governments sign a trade agreement on tariffs that maximizes the governments' joint payoff  $\bar{V} + \bar{V}^*$ .<sup>39</sup> At the ex-post stage, Home chooses its RTBs to maximize its payoff  $\bar{V}$  subject to the constraints on tariffs imposed by the trade agreement.

As in the small country case, we assume that the political weights for each product,  $\gamma_i$  and  $\gamma_i^*$ , are observed ex post but uncertain ex ante, and that the tariffs specified in the agreement cannot be contingent on these political shocks.

We now revisit the results of Section 4, which focuses on the richer scenario where RTBs can operate at both the extensive and intensive margins of trade. In the interest of space, we focus on the optimal choice of RTBs when tariff commitments are exogenously given. As before, we can focus on a single product  $i$ . Similarly to the case of a small country with commitment motives, given the tariff  $\tau_i$ , there will be two thresholds  $\hat{\gamma}_i(\tau_i)$  and  $\tilde{\gamma}_i(\tau_i)$ , with  $\hat{\gamma}_i(\tau_i) \leq \tilde{\gamma}_i(\tau_i)$ , such that for  $\gamma_i \leq \hat{\gamma}_i(\tau_i)$  the optimal RTB is zero, for  $\gamma_i \geq \tilde{\gamma}_i(\tau_i)$  the optimal RTB is prohibitive, and for

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<sup>37</sup>For a similar partial-equilibrium setting where trade agreements are motivated by terms-of-trade externalities, see for example Bagwell and Staiger (2001b) and Horn et al. (2010).

<sup>38</sup>Also notice that, even if the Home country has the power to manipulate terms of trade, it has no incentive to use RTBs for this purpose, given that they do not generate revenue. Indeed, absent political pressures there would be no RTBs even in this large-country setting. This is another important difference between tariffs and RTBs.

<sup>39</sup>The interpretation of this assumption is that governments bargain efficiently over the Home tariffs and a transfer (from Foreign to Home), with the transfer entering payoffs linearly. So, if  $T$  is the transfer made by Foreign, Home's (resp. Foreign's) payoff inclusive of the transfer is  $\bar{V} + T$  (resp.  $\bar{V}^* - T$ ). This payoff structure, together with efficient bargaining, implies that tariffs will maximize  $\bar{V} + \bar{V}^*$ .

$\gamma_i \in (\hat{\gamma}_i(\tau_i), \tilde{\gamma}_i(\tau_i))$  the optimal RTB is positive but non-prohibitive. If  $V_i$  is convex in  $\theta_i$  then  $\hat{\gamma}_i(\tau_i) = \tilde{\gamma}_i(\tau_i) = \gamma_i^J(\tau_i)$ , and the optimal RTB response function is bang-bang, as in Section 3.

It can easily be shown that the thresholds  $\hat{\gamma}_i$  and  $\tilde{\gamma}_i$  vary with the tariff  $\tau_i$  and the natural trade cost  $\delta_i$  in the same qualitative way as in Section 4. As a consequence, the results of Propositions 6 and 7 regarding the effects of tariff reductions and globalization on RTBs, as well as the results of Corollaries 2 and 3 on the overall impacts that these changes have on the extensive and intensive margins of trade, are qualitatively analogous to those in the case of a small country with commitment motives.

## 8 Conclusion

Red-tape barriers to trade are pervasive but have received little attention from scholars to date. In this paper we have taken a first step in exploring the implications of RTBs, and have shown that they are very different from those of more traditional trade barriers.

In our model, politically-motivated governments may have incentives to impose RTBs even though they yield no revenue, if a trade agreement can constrain tariffs but not RTBs. At the agreement stage, the extent of tariff liberalization is limited by the need to prevent such wasteful behavior: tariffs need to be set above the level that would be optimal with a complete agreement to avoid a “protectionist backlash” in the form of RTBs. However, RTBs may nonetheless emerge in equilibrium, if the tariff commitments are not fully contingent. The model further suggests that RTBs tend to be more frequent in equilibrium when the degree of political uncertainty is higher.

When RTBs are used, they are likely to “choke” trade for a range of products, implying that RTBs may have important impacts on the extensive margin of trade. At the same time, non-prohibitive RTBs can arise for products characterized by a sufficiently concave import demand. Whether RTBs operate at the extensive margin or at the intensive margin also matters for the effects of globalization: reductions in natural trade costs reduce a government’s incentive to resort to RTBs when these operate at the extensive margin of trade, but increases the level of RTBs when these operate at the intensive margin.

In the presence of RTBs, tariff liberalization can have perverse effects on trade, to the extent

that it induces an increase in RTBs. At the extensive margin, tariff reductions lead to a weak contraction of trade, and at the intensive margin, trade volume decreases for products covered by non-prohibitive RTBs, because the government over-compensates for the tariff reduction with an increase in RTBs. Tariff reductions increase trade only for products that are unencumbered by RTBs, which is the case if political pressures are sufficiently low.

Finally our model suggests an important lesson for studies that seek to evaluate the welfare gains from reducing tariffs or natural trade costs. Ignoring RTBs will lead to *overstating* the welfare gains from tariff liberalization, but may well lead to *understating* the welfare gains from globalization. This is because tariff reductions trigger policy substitution toward RTBs, while reductions in natural trade costs mitigate a government's incentive to use RTBs, to the extent that RTBs operate at the extensive margin of trade.

Before closing the paper, we briefly discuss two potentially interesting directions in which our model could be extended. The first one concerns the relation between regulations and RTBs. As we mentioned at the outset, in reality RTBs often take the form of “procedural obstacles” in the application of product regulations, that is, excessively burdensome procedures to certify that imported products meet the required regulations. A desirable extension of our model would introduce product standards, and allow governments to choose both the standards and the level of red tape required in the application of the standards. One important difference between the two policy measures is that the welfare rationale for product standards is typically to address some kind of externality, while the welfare rationale for certification procedures is to address some form of incomplete information, and this gives rise to interesting questions, for example whether and how each of these policy measures would be distorted by a politically-motivated government.

Finally, in this paper we have essentially ignored the export side of trade policies. In particular, we have abstracted from export subsidies and from the possibility of imposing RTBs on exporting industries. If RTBs cannot be negative, that is, if trade costs can artificially be raised but cannot artificially be lowered, then RTBs cannot be used to please producers on the export side. But if RTBs can be negative, in the sense that a government can reduce trade costs below their “natural” level by investing in trade infrastructure, new interesting questions arise, for example about

the effects of trade agreements that restrict the use of export subsidies. Intuitively, restricting export subsidies might induce a government to over-invest in trade facilitation on the export side. Exploring this new type of “policy substitution” might be a fruitful direction in which to extend our model.

# Appendix

Throughout the Appendix we omit the product index  $i$ , as this should not create confusion.

## Proof of Remark 2

The key step is to note that  $V_{\theta\gamma} = y > 0$ . This immediately implies that  $\theta^R(\tau, \gamma)$  is weakly increasing in  $\gamma$ . Thus, for any given  $\tau < \tau^N$ , in general there are three intervals of  $\gamma$ , each of which may be empty: a low interval  $(\gamma_{min}, \hat{\gamma}(\tau))$  where  $\theta^R = 0$ , an intermediate interval  $(\hat{\gamma}(\tau), \tilde{\gamma}(\tau))$  where  $\theta^R$  is positive but non-prohibitive, and a high interval  $(\tilde{\gamma}(\tau), \gamma_{max})$  where  $\theta^R$  is prohibitive. And since  $V_{\theta\gamma}$  is strictly positive,  $\theta^R$  is strictly increasing in the intermediate range  $(\hat{\gamma}(\tau), \tilde{\gamma}(\tau))$ .

## Proof of Proposition 3

In order to prove the aggregate results of Proposition 3, we start by showing how a tariff change affects the RTB response function at the product level. In this proof we focus on the case  $\hat{\gamma}(\tau) < \tilde{\gamma}(\tau)$ , since we already dealt with the bang-bang case  $(\hat{\gamma}(\tau) = \tilde{\gamma}(\tau))$  in Proposition 1.

We have already established in the text that  $\frac{d\theta^R}{d\tau} < -1$  in the non-prohibitive range, so we can focus on how the tariff affects the two thresholds  $\hat{\gamma}(\tau)$  and  $\tilde{\gamma}(\tau)$ . Let us start with  $\hat{\gamma}(\tau)$ . Recalling Remark 2 and the assumption that  $\theta^R$  is continuous, the first-order condition for optimality of  $\theta$  must be satisfied at this threshold, so  $\hat{\gamma}(\tau)$  is implicitly defined by  $V_{\theta}(\tau, 0, \hat{\gamma}) = 0$ . Differentiating this equation in  $\hat{\gamma}$  and  $\tau$ , we obtain  $\frac{d\hat{\gamma}}{d\tau} = -\frac{V_{\theta\tau}}{V_{\theta\hat{\gamma}}}$ . Note that the second-order condition  $V_{\theta\theta} < 0$  must hold, so  $V_{\theta\tau} < V_{\theta\theta} < 0$ , and furthermore  $V_{\theta\gamma} = y > 0$ , thus we can conclude that  $\frac{d\hat{\gamma}}{d\tau} > 0$ .

Next focus on the threshold  $\tilde{\gamma}(\tau)$ . This is implicitly defined by  $V_{\theta}(\tau, \theta^{NT}(\tau), \tilde{\gamma}) = 0$ . Differentiating this equation in  $\tilde{\gamma}$  and  $\tau$ , we obtain  $\frac{d\tilde{\gamma}}{d\tau} = \frac{V_{\theta\theta} - V_{\theta\tau}}{V_{\theta\tilde{\gamma}}}$ , where we used the fact that  $\frac{d\theta^{NT}}{d\tau} = -1$  (which in turn follows from the fact that  $\theta^{NT}(\tau)$  is defined by the condition that  $\theta + \tau$  equals the minimum prohibitive trade cost level). Again noting that  $V_{\theta\tau} < V_{\theta\theta} < 0$  and  $V_{\theta\gamma} > 0$ , it follows that  $\frac{d\tilde{\gamma}}{d\tau} > 0$ .

Consider next the probability that  $\theta > 0$ . Recalling that RTBs are imposed if  $\gamma > \hat{\gamma}(\tau)$ , we

obtain:

$$\Pr[\theta > 0] = \int_{\hat{\gamma}(\tau)}^{\gamma^{\max}} g(\gamma) d\gamma = 1 - G(\hat{\gamma}(\tau)) \quad (13)$$

Differentiating shows that this is decreasing in  $\tau$ :

$$\frac{d\Pr[\theta > 0]}{d\tau} = -g(\hat{\gamma}(\tau)) \frac{d\hat{\gamma}}{d\tau} < 0 \quad (14)$$

where we used the fact that  $\frac{d\hat{\gamma}}{d\tau} > 0$ . A similar argument allows us to sign the effect of  $\tau$  on the probability that  $\theta$  chokes imports:

$$\Pr[\theta \geq \theta^{NT}] = \int_{\tilde{\gamma}(\tau)}^{\gamma^{\max}} g(\gamma) d\gamma = 1 - G(\tilde{\gamma}(\tau)) \quad (15)$$

Differentiating and using  $\frac{d\tilde{\gamma}}{d\tau} > 0$  we conclude that this too is decreasing in  $\tau$ .

Having established that a tariff reduction decreases the probability that a product is covered by an RTB and the probability that it is choked by an RTB, it follows immediately that both  $F^{choke}$  and  $F^{cov}$  increase in the first-order stochastic sense.

## Proof of Proposition 4

The only component of this proof that was not formally shown in the text is that a decrease in  $\delta$  leads to a reduction of the threshold  $\hat{\gamma}$  and does not affect the threshold  $\tilde{\gamma}$ . In this proof we suppress the argument  $\tau$  and highlight instead the argument  $\delta$ , so we write the government objective as  $V(\delta, \theta, \gamma)$  and the prohibitive level of  $\theta$  as  $\theta^{NT}(\delta)$ .

Consider first the effect of a change in  $\delta$  on the threshold  $\hat{\gamma}$ . Recalling Remark 2 and the assumption that  $\theta^R$  is continuous,  $\theta = 0$  satisfies the first-order condition at this threshold, hence  $V_\theta(\delta, 0, \hat{\gamma}) = 0$ . Differentiating this equation with respect to  $\delta$  and  $\hat{\gamma}$ , we obtain  $\frac{d\hat{\gamma}}{d\delta} = -\frac{V_{\theta\delta}}{V_{\theta\hat{\gamma}}} = -\frac{V_{\theta\theta}}{V_{\theta\hat{\gamma}}}$ . Since the second-order condition  $V_{\theta\theta} < 0$  must hold and  $V_{\theta\hat{\gamma}} > 0$ , it follows that  $\frac{d\hat{\gamma}}{d\delta} > 0$ .

Consider next how  $\delta$  affects the threshold  $\tilde{\gamma}$ . Again recalling Remark 2 and the assumption that  $\theta^R$  is continuous,  $\theta = \theta^{NT}(\delta)$  satisfies the first-order condition at this threshold, hence  $V_\theta(\delta, \theta^{NT}(\delta), \tilde{\gamma}) = 0$ . Differentiating this equation with respect to  $\tilde{\gamma}$  and  $\delta$ , we obtain  $\frac{d\tilde{\gamma}}{d\delta} =$

$-\frac{V_{\theta\theta}-V_{\theta\delta}}{V_{\theta\gamma}}$ , where we used the fact that  $\frac{d\theta^{NT}}{d\delta} = -1$  (which in turn follows from the fact that  $\theta^{NT}(\delta)$  is defined by the condition that the total trade cost equals the minimum prohibitive trade cost level). But  $V_{\theta\theta} = V_{\theta\delta}$ , thus it follows that  $\frac{d\hat{\gamma}}{d\delta} = 0$ .

## Proof of Proposition 6

**Part (i):** We first focus on products in set I for which  $\hat{\gamma}(\tau) < \tilde{\gamma}(\tau)$ . We want to evaluate the cross derivative of (11) with respect to  $\delta$  and  $\tau$ . Consider first the derivative with respect to  $\delta$ . Recall that, when  $\theta^R$  is non-prohibitive, a change in  $\delta$  is exactly offset by a change in  $\theta^R$ , thus leaving welfare unchanged. Hence  $\delta$  does not affect the second integrand. Also the no-trade level of welfare is unaffected by  $\delta$ , so the third integrand is unaffected by  $\delta$ . Next, note that we can ignore the effect of  $\delta$  on the boundaries  $\hat{\gamma}(\tau)$  and  $\tilde{\gamma}(\tau)$ , because welfare is continuous at the lower boundary, and the upper boundary is unaffected by  $\delta$ . Thus we have  $\bar{W}_\delta = G(\hat{\gamma})W_\delta$ . The cross-derivative of expected welfare with respect to  $\delta$  and  $\tau$  is therefore:

$$\bar{W}_{\tau\delta} = GW_{\tau\delta} + G'\hat{\gamma}_\tau W_\delta, \quad (16)$$

where we have used the facts that  $W_\delta < 0$ , that  $W_{\tau\delta}$  has the same sign as  $m''$ , which recall is negative for products in set I, and that  $\hat{\gamma}_\tau > 0$  (from Proposition 3). It follows that a small decrease in  $\delta$  leads to an increase in the optimal tariff.

**Part (ii):** Next we give a heuristic proof for the claim that the optimal tariff is increasing in  $\delta$  if the distribution of  $\gamma$  is sufficiently concentrated. Fix two levels of  $\delta$ , say  $\delta' < \delta''$ , and consider a distribution  $G$  that is close (for example in the weak-convergence sense) to the degenerate distribution at  $\gamma^0$ , which we denote  $G^0$ . We now argue that if  $G$  is sufficiently close to  $G^0$  then the optimal tariff for  $\delta = \delta'$  must be lower than the optimal tariff for  $\delta = \delta''$ . To see this, recall how expected welfare depends on the tariff for a degenerate distribution such as  $G^0$ : it is constant up to the bespoke tariff, it jumps up, and then decreases monotonically as the tariff rises above the bespoke tariff. We denote  $\tau^B(\gamma^0, \delta)$  the bespoke tariff as a function of  $\gamma^0$  and  $\delta$ . Clearly, for a given level of  $\delta$ , if  $G$  is close to  $G^0$  then the shape of the expected-welfare function is close to



the shape of the welfare function just described, so the optimal tariff is close to the bespoke tariff  $\tau^B(\gamma^0, \delta)$ . Now recall that the bespoke tariff is increasing in  $\delta$ , so  $\tau^B(\gamma^0, \delta') > \tau^B(\gamma^0, \delta'')$ . Clearly then, if  $G$  is sufficiently close to  $G^0$ , the optimal tariff for  $\delta = \delta'$  must be lower than the optimal tariff for  $\delta = \delta''$ .

We now show that, in the case of linear demand, fixed supply and Pareto distribution, globalization raises the optimal tariff if political uncertainty is large enough.

Let  $\bar{W}$  denote expected welfare. Using (11), for a product in set  $\mathbf{E}$  we can write:

$$\bar{W} = G(\gamma^J(\tau))W(\tau, 0) + [1 - G(\gamma^J(\tau))]W^{NT}. \quad (17)$$

Note that when  $\gamma < \gamma^J(\tau)$  the product is imported at the tariff  $\tau$ , but when  $\gamma > \gamma^J(\tau)$  imports of product  $i$  are choked by red tape, yielding the no-trade welfare level.

In what follows we will use more compact notation than in the main text, and we omit the arguments of the various functions, as this should not cause confusion.

The FOC for the optimal tariff can be written as:

$$\bar{W}_\tau = G'\gamma_\tau^J \Delta W + GW_\tau = 0, \quad (18)$$

where  $\Delta W \equiv W(\tau, 0) - W^{NT}$  is the welfare loss caused by a prohibitive RTB relative to a zero RTB. We can now write down the cross derivative of expected welfare with respect to  $\tau$  and  $\delta$ :

$$\bar{W}_{\tau\delta} = G''\gamma_\delta^J \gamma_\tau^J \Delta W + G'\gamma_{\tau\delta}^J \Delta W + G'\gamma_\tau^J W_\delta + G'\gamma_\delta^J W_\tau + GW_{\tau\delta} \quad (19)$$

With linear demand and fixed supply, we have  $\gamma_{\tau\delta}^J = W_{\tau\delta} = 0$  and  $\gamma_\delta^J + \gamma_\tau^J = 0$ , thus:

$$\bar{W}_{\tau\delta} = G''\gamma_\delta^J \gamma_\tau^J \Delta W + G'\gamma_\tau^J (W_\delta - W_\tau) = (G''\gamma_\delta^J \Delta W - G'm) \gamma_\tau^J, \quad (20)$$

where we used the fact that  $W_\delta - W_\tau = -m$ . Next we substitute from the first-order condition

(18), which implies that  $\gamma_\delta^J \Delta W = -\gamma_\tau^J \Delta W = \frac{G}{G'} W_\tau$ , and use  $W_\tau = \tau m'$ , to obtain:

$$\bar{W}_{\tau\delta} = \left( \frac{GG''}{(G')^2} \frac{\tau}{p} \frac{pm'}{m} - 1 \right) mG' \gamma_\tau^J \quad (21)$$

Using the Pareto distribution,  $G = 1 - (\gamma^0)^k \gamma^{-k}$ , where the shape parameter  $k$  is an inverse measure of dispersion:  $G'_k = -(1 - G) \log \left( \frac{\gamma^0}{\gamma} \right) > 0$ . Note that  $G' = k (\gamma^0)^k \gamma^{-k-1} = \frac{k}{\gamma} (1 - G)$  and  $G'' = -k(k+1) (\gamma^0)^k \gamma^{-k-2} = -\frac{k(k+1)}{\gamma^2} (1 - G)$ . Substituting into (21) gives:

$$\bar{W}_{\tau\delta} = - \left( \frac{k+1}{k} \frac{G}{1-G} \frac{\tau}{p} \frac{pm'}{m} + 1 \right) mG' \gamma_\tau^J \quad (22)$$

Clearly this is negative for  $k$  sufficiently low. This immediately implies the claim.

One can show that the same result obtains if the distribution of  $\gamma$  is uniform and its support is large enough. The proof of this claim is omitted and available upon request.

## Proof of Remark 4

Recall that the FOC for the optimal tariff can be written as

$$g(\gamma^J(\tau)) \gamma_\tau^J(\tau) \Delta W(\tau, 0) + G(\gamma^J(\tau)) W_\tau(\tau, 0) = 0. \quad (23)$$

We evaluate (23) at  $\tau^J(\gamma^{med})$ . Recall that the first term of the left hand side is positive and the second term is negative. Note that  $\gamma^J(\tau^J(\gamma^{med})) = \gamma^{med}$  and  $G(\gamma^{med}) = 1/2$ . Thus, if we reduce the density of  $\gamma$  at the median,  $g(\gamma^{med})$ , the second term evaluated at  $\tau^J(\gamma^{med})$  does not change. Next focus on the first term. If  $g(\gamma^{med})$  is close to zero, the left-hand side of (23) is negative, and hence the optimal tariff is below  $\tau^J(\gamma^{med})$ . On the other hand, if  $g(\gamma^{med})$  is high enough, the first term outweighs the second term and hence the left-hand side of (23) is positive, thus the optimal tariff is above  $\tau^J(\gamma^{med})$ . Next note that  $\tau > \tau^J(\gamma^{med})$  is equivalent to  $\gamma^J(\tau) > \gamma^{med}$ , or equivalently, RTBs are prohibitive with probability lower than 1/2.

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