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Size Inequality, Coordination Externalities and International Trade Agreements

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Abstract

Developing countries now account for a significant fraction of world trade and two thirds of the membership of the World Trade Organization (WTO). However, many are still individually small and thus have a limited ability to bilaterally extract and enforce trade concessions from larger developed economies even though as a group they would be able to do so. We show that this coordination externality generates asymmetric outcomes under agreements that rely on bilateral threats of trade retaliation---such as the WTO---but not under agreements extended to include certain financial instruments. In particular, we find that an extended agreement generates improvements in global efficiency and equity if it includes the exchange of bonds prior to trading but not if it relies solely on ex-post fines. Moreover, a combination of bonds and fines generates similar improvements even if small countries are subject to financial constraints that prevent them from posting bonds.

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1 Introduction

International trade relations between developed and developing countries have often been adversarial. As early as 1947, some developing countries were denouncing the United States' proposals for the predecessor of the World Trade Organization (WTO) as "serving the interests of developed countries and undermining the development prospects of poor countries" (Srinivasan, 1999, p. 1050). More recently, the Uruguay Round was seen by most developing countries as having produced a multilateral bargain that is biased heavily in favor of developed countries. Partly to rectify the perceived imbalance of the Uruguay Round outcome, the Doha *Development* Round was launched in 2001 with the idea that it would put the interests of developing countries at the forefront.¹

Developing countries now account for two thirds of the 157 WTO members (up from 11 in the GATT) and over a third of world trade and have increasingly begun to demand a more active voice in multilateral negotiations. However, they still face considerable challenges in translating such demands into tangible outcomes: despite having been launched over a decade ago, the Doha Round has yet to be concluded. In this paper we analyze a key problem that developing countries face in trying to achieve a more favorable outcome in international trade negotiations – i.e. the presence of a *coordination externality* among themselves. Even though developing countries are now large on aggregate, most are still individually small and thus have a limited ability to bilaterally extract and enforce trade concessions from larger developed economies. We show that under standard agreements that rely on bilateral threats of trade retaliation – such as the WTO – this coordination externality generates asymmetric outcomes that are less favorable to developing countries (as well as globally) than those obtained under an agreement extended to include certain types of financial instruments.

The traditionally dominant role of large countries in the world trading system is partly due to the bilateral and reciprocal nature of negotiations in international trade agreements such as the GATT/WTO. The key idea is the following: if the European Union (EU) wants the United States (US) to lower its tariffs on EU exports then it must reciprocate with lower tariffs on goods it imports from the US. However, this reciprocal exchange relies on the presence

¹The Doha ministerial declaration of November 2001 states: "We recognize the need for all our peoples to benefit from the increased opportunities and welfare gains that the multilateral trading system generates. The majority of WTO members are developing countries. We seek to place their needs and interests at the heart of the Work Programme adopted in this Declaration."

of relatively symmetric market power on both sides: while a tariff reduction by a country with a sufficiently high import share and market power increases the price received by foreign exporters, no significant bilateral concessions occur when the reduction is undertaken by a small country.² Market power is also essential in enforcing cooperation since the threat to abandon the agreement and increase tariffs on the part of a country that lacks such power is not credible and therefore fails to act as a useful deterrent. Thus, *bilateral asymmetries* in market power undermine international cooperation and may explain why some exports from (smaller) developing countries (e.g. in agriculture, textiles, some manufactures) have historically faced relatively higher tariffs in (larger) developed countries. By undermining cooperation, this asymmetry can also lead to higher tariffs by developing countries but, as long as they remain small as a group, the large countries do not lose much from this, which may explain why the latter have not pushed developing countries to liberalize further until recently.³

Most formal analyses of the GATT/WTO focus on two large countries.⁴ The focus on this canonical case has yielded important insights and was a reasonable approximation until the Uruguay Round since up to that point GATT/WTO negotiations were led primarily by the US and Europe (c.f. Schott, 2009). However, the global economic landscape has changed significantly with the emergence of the BRICs – Brazil, Russia, India and China. From 2000 to 2009 alone the world import share of the largest traders, the US and EU, fell from 43% to 34% (54% to 42% if we also include Japan and Canada) and their bilateral trade accounts for less than 20% of their total trade.⁵ The relative decline of the US and EU in world trade suggests that it is important to analyze international trade agreements between multiple countries of asymmetric size, something that we focus on this paper.

²For evidence of the positive relationship between market power and either import shares or GDP see Broda, Limão and Weinstein (2008).

³In fact, if the asymmetry is sufficiently large, the large country would be strictly better off by not cooperating (cf. Johnson, 1953-54). An additional explanation for relatively higher tariffs by the large developed countries on exports of small developing countries is that historically the latter have tended to not take an active role in multilateral trade negotiations. One reason for such non-participation and higher tariffs by large countries arises when, as in our setup, a large country imports the same good from many small countries. Ludema and Mayda (2009) show how the WTO's MFN rule requiring the importer to set the same tariff on all exporters lowers the incentive for the latter to participate in reciprocal negotiations in an attempt to minimize reductions in their own tariffs. Since this incentive is well understood theoretically we abstract from it (by assuming all exporters either participate or not) and focus instead on the coordination externality.

⁴See for example Mayer (1981), Grossman and Helpman (1995) and Bagwell and Staiger (1999). The latter also considers a third large country to study tariff discrimination.

⁵Authors calculations based on data from the WTO's "International trade statistics 2010". We treat the EU as a single country since it has a common tariff and negotiates as a block. Thus, world imports exclude flows within EU-27.

While some of the recent decline of the US and EU in world trade is mirrored in the rise of the BRICs – particularly China – there is also a longer trend driven by other developing countries’ trade liberalization and growth.⁶ This is important in motivating the coordination externality underlying our model since this externality is most relevant if several countries jointly account for a non-negligible amount of exports of a larger country. For example, if we exclude Japan, Australia and China, the next top ten Asian destinations in 2009 accounted for 13% of total US exports but their median share was only 1.3% (the largest is Korea with less than 3%). Another case in point is South and Central America: while the region jointly accounts for 10% of US exports all but one country accounts for less than 1% (the only exception is Brazil, whose share is 2.5%). More broadly, if the US were to negotiate only with the top 5 destinations for its products it would cover only 64% of its exports, with the analogous figure for the EU being even smaller, 44%.⁷

Our model highlights the role of *bilateral size asymmetry* in international trade agreements by focusing on two “regions” of equal size with one containing a single country (Large) and the other multiple countries, each of whom individually has less market power in trade. Large exports a single good, x , to all small countries and imports a different good in return. The bilateral size asymmetry generates lower tariffs and welfare for the smaller countries in the absence of an agreement because their tariff choices are subject to a coordination externality, i.e. when setting its tariff on good x each small country ignores any positive terms-of-trade effect that its tariff has on all other *importers* of the same good. We then show that this imbalance remains even if countries cooperate through a standard trade agreement that relies on the threat of tariff retaliation because cooperation is ultimately sustained by the threat of non-cooperative tariffs, which are subject to the coordination externality.⁸ The small countries would gain from jointly threatening higher tariffs to punish any deviation by Large but this

⁶As the Director General of the WTO notes “Between 1973 and 1997 the developing countries’ share of manufactured imports in developed markets tripled – from 7.5 per cent to 23 per cent. What these figures reflect is the developing world’s truly remarkable integration into the global economy over the past three decades.” Source: Ruggiero (1999) accessed at <http://www.wto.org/english/news_e/pres99_e/pr122_e.htm>. Besedes and Prusa (2011) examine the sources of export growth for 46 countries between 1975-2003.

⁷Moreover, the recent increases in this dispersion measure suggests an increasingly important role for the coordination externality among importers of US goods. For example, the top 5 US destinations in 2000 accounted for 70% of its exports but those in 2009 only accounted for 64%. At the industry level we see a similar trend with over 2/3 of HS 2 industries showing declines averaging 7 percentage points in the share of top 5 destinations (the average for those with an increase was about 4 p.p.).

⁸We should note that tariff retaliation at the WTO is permitted as a last resort after negotiations between the affected parties have failed and any panel ruling calling for compliance has gone unheeded by the defendant.

threat is not credible: in the event the agreement breaks down, each small country has an individual incentive to free ride on the others if they were to try punishing the large country via a jointly optimal Nash tariff.

In the model all countries have identical *income per capita* in the absence of trade policies. When trade policy is used it generates an asymmetry in income per capita: increasing it for the larger country and reducing it for the smaller ones when cooperation is based on tariff retaliation alone. The most parsimonious way to show this result involves a “developing” region with K countries and a “developed” one with a single large country, but a similar insight should hold as long as the representative country in the developed region was larger. Given this, and the current distribution of world trade—where about half is accounted for by a large number of developing countries—we think it is reasonable to identify the region with more countries as the developing one.⁹ Moreover, as we discuss next, the type of reforms proposed to standard trade agreements to address the size asymmetry issue have mainly originated with developing countries.

Next, we examine how standard agreements – i.e. those based on tariff retaliation alone – can be reformed to counter the coordination externality and generate more efficient and equitable (i.e. symmetric) outcomes. More specifically, we extend the standard trade agreement to include financial instruments such that a country that deviates must incur a monetary cost, such as paying a fine or losing a bond that it previously posted. Some such instruments have been proposed in the WTO, particularly by developing countries arguing that their limited market power prevents them from using tariffs to obtain proper compensation in case of a violation.

Before explaining why and how such extended agreements may generate more efficient and equitable outcomes, we describe some of the ongoing debate surrounding the use of financial instruments in trade agreements. The situation confronting developing countries is well illustrated by the case in which Ecuador challenged the preferential treatment that the EU accorded to banana exporting nations that were its former colonies. The US too had challenged the EU’s regime and, like Ecuador, was authorized to impose retaliatory tariffs on the EU. However, while the US was in a good position to make use of this authorization, Ecuador

⁹About 51% of world imports in 2009 were accounted for by the US, EU and 8 other high income countries (Japan, Canada, Korea, Australia, Switzerland, Norway, New Zealand and Israel). The remaining half of world imports was accounted for by a very large number of developing countries since the BRICs together accounted for only about 16% of world imports.

simply did not import enough from the EU to be able to effectively retaliate in tariffs. If it had done so it would have simply imposed a distortion on itself without much harm to the EU. Given this, Ecuador went so far as to seek WTO approval to cross-retaliate in the area of intellectual property by not allowing local producers of red wine to use the ‘Bordeaux’ label and by allowing local firms to produce unauthorized copies of hit European recordings.¹⁰

The idea that financial compensation could be used as means for settling international trade disputes has a long history—in fact it was discussed during the original GATT 1947 negotiations. While the GATT did not adopt this idea, calls for its usage have resurfaced periodically. For example, in 1964 Brazil and Uruguay formally suggested its consideration and the idea was floated and discussed also during the Uruguay Round negotiations (Mercurio, 2009). While the dispute settlement system of the WTO has yet to embrace financial compensation as a mandatory trade remedy, it does allow for ‘voluntary compensation’ as an alternative to trade retaliation. Financial compensation was actually used in the *US-Copyright* dispute between the US and the EU. This case was filed by the EU to challenge US laws that exempted small businesses such as restaurants and bars from paying royalties when playing copyrighted music (Grossman and Mavroidis, 2004). The EU challenged these laws on the grounds that they were inconsistent with Article 9.1 of the Trade Related Intellectual Property Agreement (TRIPS). The WTO panel ruled that at least part of the exemptions granted by the US were indeed in conflict with TRIPS. Instead of amending its laws to make them WTO compliant, the US entered into discussions with the EU in order to find a mutually agreeable level of financial compensation.¹¹

In recent years, the use of financial compensation has also become more common in bilateral trade agreements. For example, Mercurio (2009) notes that in several recent free trade agreements involving the United States – and countries such as Australia, Chile, and Singapore – the signatories have agreed to a format under which a non-compliant country can stop the complainant country from instituting retaliatory measures by paying an annual ‘monetary assessment’, much like in the *US-Copyright* case between the US and the EU.

In case of a trade dispute it is typically more efficient to use financial compensation than

¹⁰For an elaborate discussion of the legal and economic arguments in favor of financial compensation as a means for settling trade disputes see Bronckers and Van Den Broek (2005). A comprehensive overview of the various aspects of the dispute settlement process in the WTO is provided by Lawrence (2003).

¹¹Ultimately, the two sides could not come to agreement and had to resort to binding WTO arbitration, which determined the annual level of compensation that the US would have to pay to the EC so long as its laws remained incompatible with TRIPS.

a distortionary instrument such as a tariff, provided the compensation can be enforced. What existing proposals and their analyses typically neglect however, and what we focus on, is the more difficult question of how financial compensation can be enforced and whether such instruments can deter deviations and generate more cooperation *ex-ante*.¹² We show that agreements extended to include specific financial instruments can enhance cooperation and generate outcomes that are more symmetric relative to a standard trade agreement. In particular, we show these improvements occur when countries exchange bonds *prior to trading and agree to forfeit them in case of a violation*. The use of bonds in this fashion accomplishes two important tasks. First, by requiring a high enough bond to be posted *ex-ante*, we remove the incentive of the large country to deviate (so as not to forfeit its bond). Second, the use of bonds neutralizes the tariff coordination externality amongst small countries. It does so because if the large country deviates then any one of the small countries can, and will, keep the bond that the large country posted with it and doing so has *no effect on the values of bonds held by any other small countries*.¹³

We also show that the specific choice of the financial instrument is crucial since the obvious alternative, i.e. a monetary fine, does *not* improve on the standard agreement *when used in isolation*. The reason is that for the fine to be paid by the violating country it must still be enforced by small countries through the threat of tariff retaliation, which is subject to the coordination externality. Relative to Limão and Saggi (2008), the crucial novel element in our present paper is the presence of the coordination externality among small countries, each of which is not in a position to credibly threaten tariff retaliation. As noted earlier, this scenario is an apt description of the situation confronting developing countries at the WTO.

There are potentially important obstacles in reforming standard agreements to include financial instruments. The main obstacle that we consider is the limited ability countries might have to post bonds with trading partners. We show that our main results are robust to the presence of some bond constraints even if they are severe for small countries provided the

¹²The financial transfers do not have to come directly from the country that violates the agreement. For example, Mexico has proposed that countries should be allowed to sell their right to retaliate to others that possess more market power to retaliate. This proposal has been analyzed by Bagwell et. al. (2007) in an auction framework that assumes the violation has already occurred and a country has “earned” the right to retaliate against another (offending) country. They show that in some cases it is the offending country that wins that auction so the transfer is direct but that is not always the case.

¹³We further show that this benefit of bonds relative to the standard agreement is eliminated when there are just two symmetric countries, which is the special case that Limão and Saggi (2008) study. Thus, the underlying asymmetry among trading partners is necessary for bonds to enhance the scope for cooperation.

extended agreement includes both bonds (posted by the large country) *and* fines that are paid in the event of a deviation. However, if the bond constraint is also severe for the large country then this extended agreement must rely on fines alone and it yields the same outcome as the standard trade agreement that relies only on tariff retaliation. The intuition for this result is that the payment of fines can ultimately only be enforced by the threat of tariffs (if no bonds were posted).¹⁴

Our basic approach is common in the literature on trade agreements: we model such agreements as an equilibrium outcome of repeated interaction between governments. However, most of this literature ignores the role of financial instruments. An exception is Bagwell and Staiger (2005) who show that if governments face private anticipated shocks then cash transfers can help enforce more cooperative tariffs. However, Limão and Saggi (2008) show that their result will not hold if we instead consider fines enacted in the case of a deviation. The fact that different types of financial instruments lead to different levels of tariff cooperation highlights the importance of carefully modelling each of their roles in international trade agreements. Unlike these two papers, we examine countries that are asymmetric in their market power and show this generates a role for bonds, that is absent in Limão and Saggi (2008). Park (2000) also examines cooperation between asymmetric countries but focuses on a case where there is a single small country with *no* market power and one large country; he shows that cash transfers from the former to the latter can help enforce lower tariffs. This purchase of market access by a single infinitesimally small country is fundamentally different from the coordination externality among many small countries that we analyze and argue is empirically relevant. Thus the results we find are naturally different, e.g. we find that cooperation in tariffs can be achieved without requiring the small countries to purchase market access from the large country.

The paper is structured as follows. In section 2 we set up the model and describe the policy externalities. In section 3 we derive the policy and welfare impacts of standard agreements, contrast them with the extended agreements and analyze the implementation issues that may arise. We conclude in section 4. All proofs are in the Appendix.

¹⁴This extends one of the basic insights in Limão and Saggi (2008) —that allowing for fines does not improve cooperation relative to standard agreements— to a setting with asymmetric countries.

2 Setup and Trade Policy Externalities

2.1 Setup

The economic structure within each country is a standard one in the analysis of trade agreements (cf. Limão and Saggi, 2008). However, instead of focusing on two symmetric countries, we allow for multiple asymmetric countries. To clearly highlight the role of size asymmetries we focus on a single large country trading with a finite number of small countries, $K > 1$, where the latter are identical among themselves.

Given that preferences and technologies are identical across countries, we describe the setup in detail for the large country (using variables without asterisks), and then point out any modification for the small ones. Each country can produce two homogeneous goods, $i = x, y$ and a numeraire, n . Individual utility over the consumption levels, c , of these goods is given by $u \equiv c_n + \sum_i u_i(c_i)$. Since utility is quasi-linear and separable, the demand function for good i depends only on its own price and is same for all individuals so we denote aggregate demand by $D_i(p_i)$.

Each unit of the numeraire, c_n , is produced with a constant returns to scale technology using only labor. Each non-numeraire good is also produced with a constant returns technology but it uses both labor and a specific factor. We denote the supply function for non-numeraire goods by $S_i(p_i)$, omitting its dependence on the specific factor endowment since both labor and specific capital endowments are assumed constant and inelastically supplied.

We assume that the large country is a mirror image of the set of small countries so it imports one of the non-numeraire goods, which we label y , and exports the other, x . Under trade, the domestic import price in the large country is then $p_y = p_y^w + \tau$ where p^w is the “world” price and τ is a specific import tariff on y , which satisfies an MFN constraint, i.e. it does not discriminate by country of origin. The large country’s imports of y are then $M_y \equiv D_y(p_y) - S_y(p_y)$ and its world price is determined by the market clearing condition

$$M_y(p_y^w + \tau) + \sum_k M_y^{*k}(p_y^w) = 0 \quad (1)$$

where M_y^{*k} denote exports of good y by each of the k small countries. An analogous condition applies to good x .

We assume that no export policies are available so trade policy is described by the level of the import tariff in each country. Reductions in the large country’s import demand affect the

world price of y and it is simple to verify that in this setup an increase in the large country's tariff lowers the world price, $p_y^w(\tau)$, and raises the domestic one. Similarly, if the K small countries jointly increased their tariffs on x they would reduce its world price; i.e. small countries as a whole also have market power in trade.

The government chooses trade policies that maximize the political objective function below, which reflects social welfare and allows for extra weight ($\lambda_i \geq 1$) on specific factor owners:¹⁵

$$W(\tau, \boldsymbol{\tau}^*) \equiv \sum_i \left[\int_{p_i}^{\infty} D_i(p_i) dp_i + \lambda_i \int_0^{p_i} S_i(p_i) dp_i + \tau_i M_i(p_i) \right] + L \quad (2)$$

where we recall that the tariff τ affects W both directly through tariff revenue, the term $\tau_y M_y$, and through its effect on home prices; whereas the effect of small countries' import tariffs, $\boldsymbol{\tau}^*$, is indirect and occurs only through the world price, $p_x^w(\boldsymbol{\tau}^*)$. In equation (2), the first term in parenthesis is consumer surplus; the second term can be interpreted as producer surplus or the quasi-rents accruing to the fixed factor owners; and the last term, L , is simply the total wage income of the large country when the wage is unity. This objective function is concave in τ and decreasing in each of the elements of $\boldsymbol{\tau}^*$.¹⁶

Each of the individual small countries has an objective function, which is denoted by W^{*k} . It has the same functional form as (2) so we do not rewrite it but simply note that it is evaluated using the prices and endowments in each k . To simplify the exposition and focus on the size asymmetry we now describe some restrictions. Each of these K small countries owns a constant fraction ($1/K$) of its region's population (L^*) so $L^{*k} = L^*/K$ and of its specific inputs. Moreover, given identical preferences, technologies and political parameters in the region ($\lambda_i^{*k} = \lambda_i^*$), the only potential difference that can arise across W^{*k} is if some k faces different prices because it sets or faces different tariffs than the others. It will often be useful to focus on equilibria where all small countries set the same tariff, $\tau^* = \tau^{*k}$ for all k and face the same tariff exporting to Large, τ , which can be different from τ^* . In this case prices and quantities are identical for all k so, given constant returns, the aggregate variables for the region are $Z_i^* \equiv \sum_k Z_i^{*k}(p_i^{*k}) = K Z_i^{*k}(p_i^*)$ (where $Z^* = D^*, S^*, M^*$). Moreover, the aggregate political welfare in the region when $\tau_i^{*k} = \tau_i^*$ and $\lambda_i^{*k} = \lambda_i^*$ is $W^* \equiv \sum_k W^{*k} = K W^{*k}$.

We also assume that the two regions as a whole have equal populations ($L = L^*$) and equal

¹⁵This can be obtained as the reduced form of a political economy model such as Grossman and Helpman (1994).

¹⁶We assume there is sufficient labor to ensure a positive supply of the numeraire so that the wage rate in the economy is fixed by the marginal productivity of labor in the numeraire, which is normalized to unity.

supplies of fixed factors in their respective import and export sectors. This symmetry assumption implies that the “aggregate” import market power of small countries is no different from that of the large country. This underlying symmetry across regions simplifies our exposition but is not crucial for our results; the same is true of our assumption of equal political weights in each region ($\lambda_y = \lambda_x^* = \lambda$) and their absence in the respective export sectors ($\lambda_x = \lambda_y^* = 1$).¹⁷

2.2 Trade Policy Externalities among Asymmetric Countries

The large country’s Nash tariff is obtained by maximizing (2) while taking the small countries’ tariffs as given. Since we do not model export policies we drop the good subscript, i , and any subscripts below denote partial derivatives. The large country’s Nash tariff on y solves

$$\tau^N \equiv \arg_{\tau} \max W(\tau, \tau^*) \quad (3)$$

Recalling that the equilibrium prices are a function of tariffs, the first order condition for τ is

$$-Dp_{\tau} + \lambda Sp_{\tau} + M + \tau M' p_{\tau} = 0 \quad (4)$$

Using $M = D - S$, $M' \equiv dM(p)/dp$ and $p_{\tau} = p_{\tau}^w + 1$ and the elasticity expressions defined below we obtain a Nash tariff in ad-valorem terms, $\tau^N/p^w(\tau)$, implicitly defined by:

$$\frac{\tau^N}{p^w(\tau)} = \frac{1}{\varepsilon(\tau)} + (\lambda - 1) \frac{S(\tau)/M(\tau)}{\xi(\tau)} \quad (5)$$

We show the potential dependence of the endogenous variables on the tariff. We do so for clarity in the formula but will omit it below for notational simplicity. The first term, $1/\varepsilon \equiv M^*/(p^w M'^*)$, is the inverse of the elasticity of the aggregate export supply curve of small countries (since τ applies to all small countries) and it reflects the large country’s terms-of-trade (TOT) motive for the use of tariffs. The second term reflects a political economy motive that is increasing in the extra weight placed on specific factor owners (λ) and decreasing in the large country’s import demand elasticity ξ where $\xi \equiv -(\partial M/\partial p^w)(p^w/M) = -M'p^w/M$.

If the small countries cannot successfully coordinate their tariff choices, then the Nash tariff of an individual small country in its import sector (x) is

$$\frac{\tau^{*Nk}}{p^w} = \frac{1}{\varepsilon^{*k}} + (\lambda - 1) \frac{S^{*k}/M^{*k}}{\xi^{*k}} \quad (6)$$

¹⁷A more important assumption we make is that the political economy parameter is fixed and public information. For an interesting analysis of the role of the WTO where that is not the case see Beshkar (2010).

where all the variables are defined similarly to τ^N in (5) but from the perspective of country k , as detailed in the appendix.

A country's import tariff lowers the price received by exporters of that good, this is the standard negative *terms-of-trade externality*, which we will confirm below is a central reason for a trade agreement. However, the outcome of that agreement will depend on another externality that is present when there are several countries importing the same good, what we will refer to as a *coordination externality*. To understand it suppose that small countries could coordinate their tariffs choices in order to maximize their region's aggregate objective, $\sum_k W^{*k}$, then their *coordinated* Nash tariff, denoted by $\tau^{*Ncoord}$, would be given by (6) evaluated at the *aggregate* regional quantities (S^*/M^*) and elasticities, ε^* and ξ^* . We argue that small countries set a higher tariff when acting jointly than individually because their market power is higher under coordination. We show this by contradiction. Suppose τ^{*Nk} and $\tau^{*Ncoord}$ are identical and then evaluate the TOT and political economy components of welfare. Note that given the symmetry across small countries we have the same τ^{*Nk} across all of them and thus the same price, therefore $(S^{*k}/M^{*k})/\xi^{*k} = (S^*/M^*)/\xi^*$, so with $\tau^{*Nk} = \tau^{*Ncoord}$ and thus equal prices the political economy component is also identical. However, at any given tariff and prices we can show that $1/\varepsilon^{*k} < 1/\varepsilon^*$ if $K > 1$. The intuition for this is simple, when small countries set their tariffs independently, each small country does not take into account the positive TOT benefits that accrue to other small countries. As might be expected, this coordination externality is increasing in the number of countries.

The empirical relevance of the expressions above in tariff policy setting requires at least three pieces of evidence. First, countries should have at least some market power in imports. Second, prior to trade agreements countries should set higher tariffs on products with higher market power. Third, larger countries (in terms of GDP or import quantities) should have more market power than smaller countries. Evidence for each of these is provided by Broda, Limão and Weinstein (2008).¹⁸ Evidence for the third point is particularly relevant for this paper since as we divide a region of given size each of the resulting K countries will have lower GDP and imports than the whole region and lower market power, $1/\varepsilon^{*k}$.

As we noted before, to highlight the size differences it is useful to keep other factors constant. If we assume symmetry across regions in their respective import and export sectors then two other implications emerge. First, since $\tau^N = \tau^{*Ncoord}$ the lack of coordination among small

¹⁸They also find evidence of a positive impact of the political economy component, captured by $(S/M)/\xi$.

countries implies that their respective tariffs are lower than that of the large country. Note that the tariff τ^N applies to good y and is independent of the tariffs that small countries set on x because (i) the utility function is quasilinear and separable and (ii) the only mobile factor is labor and its factor price is pinned down by its productivity in the numeraire sector. The second implication of symmetric regions is as follows. Under an agreement without enforcement problems countries could choose tariffs to maximize their joint objective $W + KW^{*k}$ and, if regions were symmetric, this would be equivalent to maximizing the objective of either region after imposing $\tau = \tau^*$. Thus we obtain

$$\tau^G \equiv \arg_{\tau^C} \max W(\tau^C, \tau^* = \tau^C) \quad (7)$$

so the globally optimal ad-valorem tariff $\tau^G/p^w(\tau^G)$ (derived in the appendix) is

$$\frac{\tau^G}{p^w(\tau)} = (\lambda - 1) \frac{S(\tau)/M(\tau)}{\xi(\tau)} \quad (8)$$

It is simple to see that $\tau^G/p^w < \tau^N/p^w$. The difference between the Nash and globally cooperative policies confirms that market power in trade leads to international externalities motivating the need for a trade agreement (Bagwell and Staiger, 1999). Note also that even in the presence of an international agreement, countries may choose to have positive tariffs due to internal political economy distortions (i.e. when $\lambda > 1$).¹⁹

Since the globally optimal tariff τ^G is below the level that is optimal for each *individual* country, each country has an incentive to deviate from it and would do so if it faced no punishment. Before addressing how the threat of tariff retaliation can be used to sustain international cooperation, we make an important observation. Note from (6) that if the number of small countries is sufficiently high and governments face no political pressures (i.e. $\lambda = 1$), the Nash tariff of each small country in the absence of coordination among them, τ^{*Nk} , approaches zero. Under such circumstances, a small country cannot individually offer *any* tariff reduction to the large country nor can it credibly threaten the large country with any tariff retaliation in case the latter reneges on a cooperative trade agreement. Thus, as K increases so does the coordination externality and this lowers the incentive of the large country to enter into any agreement that relies only on uncoordinated tariff retaliation to enforce cooperation. Naturally

¹⁹Broda et al (2008) provide evidence that countries set higher protection in goods where they have higher market power if they are either non-WTO members or the policy is not subject to strong WTO discipline. Bagwell and Staiger (2011) find that WTO accession leads to greater tariff reductions in products with higher initial import volumes and market power.

if K is so high that the value of τ^{*Nk} is close to the global optimum τ^G then the large country would always prefer not to cooperate at all. On the other hand, an individual small country has a much stronger incentive to cooperate since it has limited ability to manipulate its TOT. In what follows, we assume that $K \in (1, \bar{K}]$, i.e. there is more than one “small” country (thus the asymmetry) but not so many of them as to make their cooperation unattractive to the large country.²⁰

3 Trade Agreements among Asymmetric Countries

3.1 Standard Agreements: Asymmetric Outcomes under Tariff Retaliation

We now examine the role of agreements in enforcing tariff cooperation between asymmetric countries. We show that if standard agreements, which rely solely on tariff threats, can't sustain the globally optimal tariff for all countries then the outcome is an asymmetric one with the large country setting a higher tariff than the small ones (Proposition 1). The asymmetry is driven by the coordination externality previously highlighted. In the next section, we show that if we go beyond the enforcement instruments in standard agreements and include financial ones, namely bonds, then we can both improve cooperation and make the outcome more equitable by sustaining the symmetric global tariff (Propositions 2 and 3).

Consider an infinitely repeated game where the stage game delivers the Nash tariffs previously derived, i.e. τ^N and τ^{*Nk} . Assume that countries observe each other's actions at the end of each period. The strategy for each country is to cooperate until any country deviates by raising its tariff. Any such deviation is followed by a punishment of n periods during which the country that originally deviated faces Nash tariffs on its exports and demonstrates its willingness to restart cooperation by setting a cooperative tariff level. If this occurs then cooperative tariffs are set by all after the n periods, otherwise the agreement breaks down and countries permanently revert to Nash tariffs.

To find the lowest cooperative tariff that is *weakly renegotiation proof* (or simply *WRP*) we first define each country's payoffs under the alternative situations that can arise. We focus on WRP strategies for three reasons. First, taking account of the WRP constraint is intuitively

²⁰A sufficient condition for the large country to accept setting a tariff below its Nash and at (or above) its global optimum in exchange for small setting τ^{*G} is for $W(\tau^G, \tau^{*G}) \geq W(\tau^N, \tau^{*Nk}(K))$, which holds strictly when $K = 1$. There are sufficient free parameters in the model to ensure that the condition also holds for some $K > 1$. But there is some \bar{K} such that $\tau^{*Nk}(K)$ is so low that the condition above holds with equality and thus we assume that $K \in (1, \bar{K}]$.

appealing since it ensures that punishing parties actually have an incentive to implement the punishment. Second, temporary punishments are more realistic in the context of disputes in the WTO than infinite Nash reversion after any deviation (the latter is a possibility but we view it as the ultimate punishment corresponding to an unravelling of the GATT/WTO system that results from member countries not following its rules). The third reason is to easily contrast the results with Limão and Saggi (2008) who also employ this approach.²¹

Let $\boldsymbol{\tau}^{*N}$ represent the vector of Nash tariffs composed of each of the (uncoordinated) small countries' equilibrium values, τ^{*Nk} . In the absence of cooperation, the payoff to the large country equals its government's objective evaluated at non-cooperative tariffs:

$$W^N \equiv W(\tau^N, \boldsymbol{\tau}^{*N}) \quad (9)$$

The cooperative tariff vector (to be found) for the small countries is represented by $\boldsymbol{\tau}^{*C}$ and its representative element, τ^{*Ck} , will be common to all k during periods of cooperation since these countries are identical. We denote the large country's cooperative tariff by τ^C so the cooperative payoff of the large country is:

$$W^C \equiv W(\tau^C, \boldsymbol{\tau}^{*C}) \quad (10)$$

If the large country deviates, it does so by imposing its optimal Nash tariff τ^N , which we recall is non-discriminatory and so applies to all small countries. In that period, the small countries are still setting cooperative tariffs.²² The deviation payoff to the large country in the period is

$$W^D \equiv W(\tau^N, \boldsymbol{\tau}^{*C}) \quad (11)$$

According to the strategy we consider if the large country deviates, then in *each* of the n punishment periods its payoff is

$$W^P \equiv W(\tau^C, \boldsymbol{\tau}^{*N})$$

We can then define the large country's continuation payoff after a deviation as:

$$V^\tau \equiv \sum_{t=1}^n \delta^t W^P + \sum_{t=n+1}^{\infty} \delta^t W^C \quad (12)$$

²¹A further motive is that Ludema (2001) shows that the reliance on reciprocity during dispute settlement at the WTO implies that only trade agreements that are renegotiation proof can be sustained in equilibrium.

²²The large country's deviation tariff level is independent of the level for the small ones because of the separability across sectors.

i.e. it undergoes punishment for n periods after which cooperation resumes. Given these payoffs, the incentive compatibility (IC) constraint for the large country to cooperate is

$$W^D + V^\tau \leq \frac{W^C}{1 - \delta} \quad (13)$$

That is, the sum of the payoff from a deviation, W^D , and the continuation payoff, V^τ , should not exceed the present value of the stream of cooperative payoffs.

Since the per period punishment payoff is lower than the Nash payoff, i.e. $W^P < W^N$, the punishment phase is subgame perfect only if it is not profitable for the country that is being punished (in this case the large country) to simply abandon the agreement and revert to Nash tariffs forever. So V^τ must be at least as large as the Nash payoff in order for the cooperative equilibrium to be *WRP*:

$$V^\tau \geq \frac{\delta}{1 - \delta} W^N \quad (14)$$

Because $W^C > W^P$, the longer the punishment phase n , the lower the continuation payoff V^τ . Therefore, the maximum punishment phase that is *WRP* is found by equating the continuation payoff V^τ to the RHS of (14). We define this maximum punishment period as n^{\max} , and it is implicitly given by

$$V^{\tau \min} \equiv \delta \frac{1 - \delta^{n^{\max}}}{1 - \delta} W^P + \frac{\delta^{n^{\max}+1}}{1 - \delta} W^C = \frac{\delta}{1 - \delta} W^N \quad (15)$$

Therefore, the lowest cooperative *WRP* tariff is obtained at n^{\max} and implicitly defined when (13) holds with equality. Given the maximum *WRP* punishment it is also simple to see that this cooperative tariff level would also be obtained under an alternative strategy where if any country deviates then they all permanently revert to Nash. To see this clearly, we substitute $V^{\tau \min}$ in (13) and use the definitions for W^D , W^N and W^C to obtain

$$W(\tau^N, \tau^{*C}) + \frac{\delta}{1 - \delta} W(\tau^N, \tau^{*N}) \leq \frac{W(\tau^C, \tau^{*C})}{1 - \delta} \quad (16)$$

which is identical to the large country's incentive constraint under infinite Nash reversion. Thus the lowest self-enforcing tariff under infinite Nash reversion or *WRP* is implicitly defined when (16) holds with equality.

To understand the effect of the coordination externality on cooperation, note that the worst punishment that uncoordinated small countries can inflict on the large one is for each to revert to its individual Nash tariff, τ^{*Nk} , which is lower than their coordinated punishment

tariff, $\tau^{*Ncoord}$. Therefore, for any given cooperative tariff, the total payoff of deviating for the large country, as given by the LHS of (16), is greater relative to the case where small countries coordinate their tariff decisions. In other words, the lack of coordination between small countries increases the large country's incentive to deviate, which is one component of the asymmetric outcome. The other component arises because the coordination externality reduces the incentive of each small country to deviate since the short-term gain from such a deviation is smaller relative to coordination.²³ To see this more explicitly we now derive the IC for each small country.

We use τ^{*Dk} to denote the tariff vector of a small country k when it deviates. To clearly isolate and understand the role of the coordination externality we first describe what are the alternative deviation possibilities one could consider. First, consider a full coordination scenario, that is suppose that we allowed small countries to act as a single country (e.g. if they formed a customs union that maximized their joint welfare under cooperation, deviation and punishment periods). Under this scenario, τ^{*Dk} is the same for all k and simply reflects their Nash tariff and it would be equal to τ^N , i.e. Large's non-cooperative value (since the regions are symmetric). Therefore, not surprisingly, the IC for each of the k countries and Large would be identical under full coordination and the setting would be the same as in Limão and Saggi (2008), who show there is no role for bonds. Second, consider a scenario where all small countries happen to deviate at the same time but can't coordinate on the level of the optimal tariff, so they choose the level that maximizes their *individual* government objectives. In this case $\tau^{*Dk} = \tau^{*N}$ so it is the same for all k but evaluated at τ^{*Nk} , the uncoordinated Nash value previously derived. Finally, consider an alternative scenario with individual and uncoordinated deviations where we require all other countries to be cooperating in the period when any small country deviates. In this case τ^{*Dk} will include the non-cooperative tariff for country k evaluated at the prices that result when the other small countries are still cooperating.

We focus on the second scenario described above for two reasons. First, it allows us to isolate the coordination externality since the only difference relative to the case where the small countries act as a unified decision maker is that they deviate and punish using $\tau^{*Nk} < \tau^{*Ncoord}$. Second, the results are qualitatively similar if we focus on individual deviations instead.²⁴

²³The incentive to deviate by the small countries is also reduced by the fact that reversion to Nash is more costly to them, which implies that if they would deviate the large country would impose a relatively harsher punishment that would still be WRP.

²⁴More specifically, in a supplementary appendix we show that the IC for small countries under individual

Following the derivation for the large country, the IC of a small country is given by

$$W^{*k}(\tau^C, \tau^{*Dk}) + \frac{\delta}{1-\delta} W^{*k}(\tau^N, \tau^{*N}) \leq \frac{W^{*k}(\tau^C, \tau^{*C})}{1-\delta} \quad (17)$$

We use these incentive constraints to establish the first result, which is a building block to showing that the coordination externality leads to asymmetric tariffs in standard agreements.

Lemma 1 (Asymmetric cooperation incentives under standard agreements): *The large country's payoff is higher than the respective aggregate payoff to K uncoordinated small countries under (i) a deviation from a given symmetric cooperative tariff i.e. $W(\tau^N, \tau^{*C}) > \sum_k W^{*k}(\tau^C, \tau^{*Dk})$ at $\tau^C = \tau^{*Ck}$ and (ii) under non-cooperative tariffs i.e. $W(\tau^N, \tau^{*N}) > \sum_k W^{*k}(\tau^N, \tau^{*N})$.*

It is worth relating Lemma 1 to the recent literature on tariff wars. Zissimos (2009) obtains a similar result in a Heckscher-Ohlin model of North-South trade where each region comprises many (similar) countries. In his model, holding constant the number of countries in the North at one, if the number of countries in the South increases then the tariffs set by individual Southern countries falls below their jointly optimal tariff, so that the South necessarily loses from a tariff war when it is comprised of many countries. He notes that the asymmetry between the two regions in terms of number of countries is crucial for this result: indeed, in a two-country set-up Syropoulos (2002) has shown that a sufficient condition for a country to be better off under a non-cooperative tariff war relative to free trade is that its relative size be sufficiently large. These papers focus on the outcome of trade wars whereas we use Lemma 1 as a building block to analyze alternative self-enforcing trade agreements.²⁵

Lemma 1 fixes the cooperative tariff at a fixed symmetric level to highlight the fact that the larger country may have a weaker incentive to cooperate than the uncoordinated small

deviations does not bind when evaluated at the solution under simultaneous deviations. Moreover, the type of deviations for small countries does not affect whether or not the IC for the large country binds at the global optimum, which is the source of the inefficiency in the standard agreement. We thank an anonymous referee for suggesting that we clarify this point.

²⁵In a recent paper, Dinopoulos and Syropoulos (2012) show that when there are three countries and international income transfers are not possible, a relatively small country may prefer an equilibrium with tariffs over free trade provided that the tariffs used are non-discriminatory in nature, as is required by the core WTO rule of MFN. See also Saggi and Yildiz (2010) where a small country is the one that prevents the obtainment of free trade when liberalizing countries cannot tariff discriminate and must extend any tariff concessions to non-participating countries on an MFN basis. In their model, the possibility of forming FTAs induces the smaller country to vote in favor of free trade since such FTAs are worse from its perspective than MFN based liberalization amongst other countries.

countries.²⁶ We now show that this coordination externality not only generates an imbalance in market power across countries but it also generates asymmetric cooperative tariffs (and thus unequal welfare outcomes) in a trade agreement enforced by the threat of tariff retaliation. As will be clear enforcement is only an issue if the large country is not sufficiently patient to sustain the global optimum tariff in a standard agreement, i.e. if $\delta < \delta_G$ where δ_G is implicitly defined to ensure that the incentive constraint in (16) is satisfied at τ^G .

Proposition 1 (Asymmetric outcomes under standard agreements):

*In a standard trade agreement supported by the threat of tariff retaliation, the most cooperative tariff set by a large country exceeds the tariff set by each of the K uncoordinated small countries: i.e. $\tau^C > \tau^{*Ck}$ whenever the large country is not sufficiently patient to sustain the globally optimal tariff ($\delta < \delta_G$) and thus this agreement yields higher welfare for the large country than for the set of small ones, i.e. $W(\tau^C, \tau^{*C}) > KW^{*k}(\tau^C, \tau^{*C})$.*

Proposition 1 emphasizes the asymmetry in market power across countries and how this asymmetry leads to an outcome that is skewed in favor of the large country when tariff cooperation is sustained solely on the basis of tariff retaliation. We next consider how the use of financial instruments alters the scope for cooperation as well as the welfare of each country.

3.2 Extended Agreements: Efficiency and Equity with Financial Instruments

We now show how the coordination externality can be offset when we extend the set of enforcement instruments to allow for certain type of financial instruments. We show that such an extended trade agreement generates (i) an improvement in global welfare relative to the standard agreement and (ii) more symmetric welfare outcomes across countries.

First, we consider the exchange of bonds as a means for sustaining cooperation when countries pursue the following strategy. Countries start cooperating by posting a bond with each of its import sources. At the end of a period, if the countries have cooperated then they “return”

²⁶The prediction of higher protection for the larger country in our model would seem to contradict the fact that large developed WTO members typically have lower *average* tariffs. We could easily change the model to replicate this fact if we allowed for lower political pressure for protection (i.e. λ) in these countries relative to the small ones. We could also introduce an additional block of countries (one large and another K small) and allow for additional goods that are mainly traded between the two large countries, such that the prediction would then be that large countries have relatively higher tariffs on goods that they import from small countries than from large ones, a fact that has been documented. Our model abstracts from these considerations to focus directly on the coordination externality.

their respective bonds. If a country deviates from the cooperative tariff, it loses its bond. For cooperation to resume, the deviating country must return the present discounted value of the bond of the injured country. If it does so in the period after the deviation occurs, then tariffs return to the cooperative level. If it does not, cooperation breaks down and all countries switch to their optimal Nash tariffs.

To understand the basic insight, consider a situation where each country has a similar discount factor, just below the level required for the large country to sustain the global optimum under a standard agreement (i.e. δ is just below δ_G). Recall that in that case the small countries are still patient enough to sustain the global optimum so their IC holds with slack. If we then allowed the large country to post a bond with a value exceeding what it receives from the collection of small countries then its incentive to deviate declines (it stands to lose more from forfeiting its bond) so it could sustain a lower cooperative tariff. While this bond would also increase each small country's incentive to deviate, they could still sustain the same cooperation as before since the incentive constraint of each small country had slack at the initial symmetric tariffs $\tau^C = \tau^{*Ck} = \tau^G$ for some $\delta < \delta_G$. We demonstrate this intuition formally below.

Suppose the large country posts a bond of value b^k (in units of the numeraire) with each of the small countries it imports from, and receives $\Sigma_k b^{*k}$ from them. Since all small countries are ex-ante identical we assume from the start that when cooperating they each post a bond of equal value, $b^{*k} = b^*$, and receive an equal share of the large country's bond, $b^k = b/K$. The *WRP* incentive constraint for the large country and *each* of the small countries are respectively given by

$$W(\tau^N, \tau^{*C}) - b + Kb^* + V^b \leq \frac{W(\tau^C, \tau^{*C})}{1 - \delta} \quad (18)$$

$$W^{*k}(\tau^C, \tau^{*Dk}) - b^* + b/K + V^{*b} \leq \frac{W^{*k}(\tau^C, \tau^{*C})}{1 - \delta} \quad (19)$$

where their respective continuation payoffs are defined as

$$V^b \equiv -\frac{\delta Kb^*}{\delta} + \frac{\delta W(\tau^C, \tau^{*C})}{1 - \delta} \quad (20)$$

$$V^{*b} \equiv -\frac{\delta b}{\delta K} + \frac{\delta W^{*k}(\tau^C, \tau^{*C})}{1 - \delta} \quad (21)$$

The first term in the large country's continuation payoff V^b equals the present value of the bonds posted by the small countries that must be returned by the large country for cooperation to

resume and the second term is the present discounted value of its payoff under cooperation. A similar interpretation applies to a small country's continuation payoff V^{*b} .

We now derive the minimum bond values required to enforce the global optimum assuming the *WRP* constraint is satisfied (which we will verify below). To do so, we substitute these continuation payoffs into (18) and (19) respectively and solve for b^g and b^{*g} :

$$b^g = W(\tau^N, \boldsymbol{\tau}^{*G}) - W(\tau^G, \boldsymbol{\tau}^{*G}) \quad (22)$$

$$b^{*g} = W^{*k}(\tau^G, \boldsymbol{\tau}^{*Dk}) - W^{*k}(\tau^G, \boldsymbol{\tau}^{*G}) \quad (23)$$

These bond values are quite intuitive: the minimum bonds required to achieve globally optimal tariffs are equal to each country's TOT gain of deviating from those tariffs. Further note that the large country requires a larger bond than the set of K small countries. That is, $b^g > Kb^{*g}$ since $W(\tau^N, \boldsymbol{\tau}^{*G}) > KW^{*k}(\tau^G, \boldsymbol{\tau}^{*Dk})$ (as proved in Lemma 1) and $W(\tau^G, \boldsymbol{\tau}^{*G}) = KW^{*k}(\tau^G, \boldsymbol{\tau}^{*G})$ (due to symmetry). In sum, since the large country deviates to an optimal tariff, τ^N , that is larger than the optimal tariff of a typical small country (τ^{*Nk}), its TOT gain from deviating is larger than the corresponding total gain of K uncoordinated small countries. Therefore, the large country must post a larger bond, i.e. $b^g > Kb^{*g}$, which reduces its incentive to deviate relative to that under tariff retaliation thereby opening up the possibility of increased cooperation.

The final step is to show that there is some $\delta < \delta_G$ such that tariff retaliation does *not* enforce globally optimal tariffs whereas the bonds b^g and b^{*g} do while also satisfying the *WRP* constraint. Let b^{\max} be the bond value that equates the continuation payoff of a small country V^{*b} in (21) to its payoff from abandoning the agreement $W^{*k}(\tau^N, \boldsymbol{\tau}^{*N})\delta/(1 - \delta)$. We have

$$\begin{aligned} V^{*b} &= -\frac{b^{\max}}{K} + \frac{\delta W^{*k}(\tau^C, \boldsymbol{\tau}^{*C})}{1 - \delta} = \frac{\delta W^{*k}(\tau^N, \boldsymbol{\tau}^{*N})}{1 - \delta} \\ b^{\max} &= K \frac{\delta [W^{*k}(\tau^C, \boldsymbol{\tau}^{*C}) - W^{*k}(\tau^N, \boldsymbol{\tau}^{*N})]}{1 - \delta} \end{aligned} \quad (24)$$

In other words, if the bond posted by the large country exceeds b^{\max} , then a typical small country is better off cheating on the agreement and abandoning it altogether since its continuation payoff falls below what it gets outside the agreement.

Similarly, let $b^{*\max}$ be the value of the bond posted by a small country that equates the large country's continuation payoff V^b in (21) to $W(\tau^N, \boldsymbol{\tau}^{*N})\delta/(1 - \delta)$, i.e. its payoff from abandoning the agreement. We have

$$V^b = -Kb^{*\max} + \frac{\delta W(\tau^C, \tau^{*C})}{1 - \delta} = \frac{\delta W(\tau^N, \tau^{*N})}{1 - \delta} \quad (25a)$$

$$Kb^{*\max} = \frac{\delta[W(\tau^C, \tau^{*C}) - W(\tau^N, \tau^{*N})]}{1 - \delta} \quad (25b)$$

Note that since $W(\tau^N, \tau^{*N}) > KW^{*k}(\tau^N, \tau^{*N})$, we have that $b^{\max} > Kb^{*\max}$ at any symmetric cooperative tariff. The intuition for this is clear: due to its greater market power, abandoning the agreement is relatively more attractive to the large country and therefore a smaller (aggregate) bond on the part of small countries is necessary to ensure that the large country prefers to resume cooperation by returning bonds of small countries as opposed to abandoning the agreement. In other words, since cooperation is relatively less attractive to the large country, it is willing to suffer a relatively smaller punishment to resume cooperation (as measured by the value of bonds it has to repay to resume cooperation).

As before, if the bonds posted by the small countries exceed $Kb^{*\max}$, the continuation payoff of the large country is too low for it to prefer to resume cooperation as opposed to abandoning the agreement altogether. The two *WRP* constraints together ensure that the bonds required to sustain the global optimum (τ^G, τ^{*G}) are not so high that countries prefer to abandon the agreement altogether:

$$b^g \leq b^{\max}(\tau^G, \tau^{*G}) \text{ and } b^{*g} \leq b^{*\max}(\tau^G, \tau^{*G})$$

First consider $b^g \leq b^{\max}(\tau^G, \tau^{*G})$. Since $b^g = W(\tau^N, \tau^{*G}) - W(\tau^G, \tau^{*G})$ we can use the definition of δ_G and re-arrange (16) to obtain

$$b^g = \frac{\delta_G[W(\tau^G, \tau^{*G}) - W(\tau^N, \tau^{*N})]}{1 - \delta_G}$$

From the symmetry of W and KW^{*k} at the global optimum we can rewrite b^g as

$$\begin{aligned} b^g &= \frac{\delta_G[KW^{*k}(\tau^G, \tau^{*G}) - W(\tau^N, \tau^{*N})]}{1 - \delta_G} \\ &< K \frac{\delta_G[W^{*k}(\tau^G, \tau^{*G}) - W^{*k}(\tau^N, \tau^{*N})]}{1 - \delta_G} = b^{\max}(\tau^G, \tau^{*G}) \end{aligned} \quad (26)$$

The last inequality follows from the coordination externality, which implies that $W(\tau^N, \tau^{*N}) > KW^{*k}(\tau^N, \tau^{*N})$ for $K > 1$, as proved in Lemma 1. Since the RHS in the last line is equal to b^{\max} evaluated at the globally optimal tariffs and it is continuous in δ , we have that when

$K > 1$ there exist $\delta < \delta_G$ s.t. $b^g \leq b^{\max}(\tau^G, \tau^{*G})$, where we recall that b^g is independent of δ . Intuitively, the inequality above says that at the critical discount factor where the large country's incentive constraint just binds under tariff retaliation (i.e. at $\delta = \delta_G$), the bond b^g that the large country has to post in order to sustain cooperation over the global optimum is less than the maximum bond $b^{\max}(\tau^G, \tau^{*G})$ that satisfies the *WRP* constraint at globally optimal tariffs (which equals the present discounted value of cooperation to small countries as a whole discounted by one period).

Now consider $b^{*g} \leq b^{*\max}$. Using the value for b^{*g} in (23) on the LHS we have

$$\begin{aligned} Kb^{*g} &= K \left[W^{*k}(\tau^G, \tau^{*Dk}) - W^{*k}(\tau^G, \tau^{*G}) \right] < W(\tau^N, \tau^{*G}) - W(\tau^G, \tau^{*G}) \quad (27) \\ &= \frac{\delta_G [W(\tau^G, \tau^{*G}) - W(\tau^N, \tau^{*N})]}{1 - \delta_G} = Kb^{*\max} \end{aligned}$$

where the first inequality follows from $W(\tau^G, \tau^{*G}) = W^*(\tau^G, \tau^{*G})$ (by symmetry) and $W(\tau^N, \tau^{*G}) > W^*(\tau^G, \tau^{*Dk})$ for $K > 1$, as proved in Lemma 1. The equality on the second line follows from the definition of δ_G . Since the RHS in the last line is equal to $Kb^{*\max}(\tau^G, \tau^{*G})$ in (25b), and is continuous in δ_G , we have that when $K > 1$ there exists a $\delta < \delta_G$ s.t. $b^{*g} \leq b^{*\max}(\tau^G, \tau^{*G})$. Intuitively, the last inequality says that at the critical discount factor where the large country's incentive constraint just binds under tariff retaliation (i.e. at $\delta = \delta_G$), the collective value of the bonds posted by small countries required to sustain cooperation over the global optimum is less than the present discounted value of cooperation to the large country (discounted by one period).

The main result can now be stated:

Proposition 2 (Improved cooperation and symmetric outcomes with bonds):

*In a trade agreement extended to include bond exchange as an enforcement instrument the large country and the K uncoordinated small countries can sustain the globally optimal tariffs ($\tau^C = \tau^{*Ck} = \tau^G$) even if they can not enforce it under a standard agreement. Therefore, for some $\delta < \delta_G$, the extended agreement generates (i) an increase in welfare for the small countries; (ii) a global increase in welfare and (iii) a more equitable outcome relative to the standard agreement.*

The first part of the proposition follows directly from what we showed above: that there exist *WRP* bonds that sustain the global optimum for at least some $\delta < \delta_G$. Since the global optimum tariffs are symmetric it follows that the outcome is more equitable than under the

standard agreement where the large country sets higher tariffs than the small ones (part iii). Moreover, the tariffs for the large country are lower under the extended agreement and those for the small countries are no higher (at least for some $\delta < \delta_G$) so welfare is higher for small countries (part i) and globally since $W + KW^{*k}$ is concave and decreasing in tariffs above the global optimum.

To understand the intuition behind proposition 2 it is useful to consider an extreme case where $K = 1$ so the asymmetry disappears. In that case the bonds that can support the global optimum can only be *WRP* if $\delta = \delta_G$, as we can see from (26) and (27) but if the two symmetric countries are that patient then they can sustain τ^G in a standard agreement. More generally, if $\delta < \delta_G$ and two symmetric countries exchange bonds then their incentives to deviate remain unchanged because their bonds are of equal value (as shown in Limão and Saggi, 2008). However, if countries are asymmetric then we can require one to post a bigger bond than its smaller partner to offset its incentive to deviate from cooperative tariffs. This increases the incentive to deviate by the smaller country (to keep the bigger bond) but the threat of future tariff retaliation prevents it from doing so.

This proposition provides an enforcement rationale for why some small countries have advocated for trade agreements to be extended to include financial instruments. In our model, the reason why bonds can help cooperation is that tariffs and bonds have rather different properties from an enforcement perspective. Namely, only tariffs are subject to a coordination externality: their non-cooperative levels reflect the individual small country's TOT motive and ignore the spillover TOT effects on other small countries. So if Large deviates against all small countries then they set a positive tariff that is above the cooperative level but lower than if they were to coordinate their punishment and internalize all the TOT effects on each other; thus the standard agreement fails to enforce the global optimum. The coordination externality is not present with bonds since, conditional on a sufficiently large bond being posted by Large with each of the small countries, if Large deviates then all that each small country has to do is keep the bond that it already received. The decision to keep the bond by a single small country has *no effect on the values of bonds held by others*.

It is worth discussing more broadly why bonds can assist with cooperation when there are asymmetries across countries. While we focus on size asymmetry due to its empirical relevance and in order to highlight the coordination externality that appears to be an important feature of the current world trading system, it is clear that other types of asymmetries could generate

a motive for the use of bonds in improving cooperation. For example, bonds can improve cooperation if there are differences in political economy pressures for protection across countries that lead to different non-cooperative tariffs or if patience levels differ across countries so that incentive constraints of relatively impatient countries are harder to satisfy.²⁷ The basic intuition for the role for bonds in the presence of such type of asymmetries is that bonds posted by those that are less willing to cooperate can help *transfer enforcement power* to countries that are more willing to do so.

We now discuss possible obstacles to reforming standard agreements to include financial instruments.

3.3 Agreement Reform

There are potentially important obstacles in reforming standard agreements to include financial enforcement instruments. One would be the cost of setting up and administering a system with financial instruments. However, the proposals by different WTO members to implement such schemes suggest that this may not be prohibitively costly. Therefore, the main obstacle we focus on is the limited ability and/or willingness to post bonds with trading partners. We show that even severe “bond constraints” for small countries can be overcome to achieve the outcomes in Proposition 2 if we design the extended agreement to also include fines. However, if the bond constraint is also severe for the large country then this extended agreement will result in the same asymmetric outcome as the standard one. These results highlight the importance of formally modelling alternative instruments to successfully reform standard agreements. We also discuss how to overcome another potential obstacle; namely, that the large country may prefer the standard agreement whereas the small countries prefer the extended one.

It is not difficult to motivate or provide a simple formal model of why certain countries may be unable or unwilling to post a large bond at the start of a period in order to induce another country to set a more cooperative tariff. Therefore, instead of committing to a specific motive

²⁷As a concrete example, consider cooperation between two countries (Home and Foreign) that are symmetric along all dimensions except their discount factors. Suppose that if both countries had a discount factor of δ_G they could sustain the global optimum in a standard agreement but Home’s discount factor is below this critical level while Foreign’s is above it, i.e. $\delta < \delta_G < \delta^*$. As a result, Home’s IC does not hold at the global optimum but Foreign’s IC has some slack in it. This asymmetric situation generates a role for Home to post a bond that would lower its incentive to deviate and thus improve the maximum sustainable cooperation. Suppose Home posts a bond such that its IC just binds at the global optimum. The bond increases Foreign’s incentive to deviate, but if Foreign is sufficiently patient, its IC will continue to hold at the global optimum in the presence of the bond.

for this we instead assume that countries face exogenous “bond constraints”, i.e. $b < b^g$ and $b^* < b^{*g}$, and in Proposition 3 we show that the outcome in Proposition 2 can be achieved even if the small countries post *no bond at all* and the large one posts a bond that is of a value smaller than b^g but still positive. So bond constraints may not be an important obstacle to reform a standard agreement even if they are very severe for small countries (if $b^* = 0$). However, in order for agreements to generate efficient and symmetric outcomes in the presence of bond constraints we need to include another financial instrument in the trade agreement, i.e., a fine. The advantage of fines over bonds is that the latter must be posted every period before trading starts whereas fines need only be paid if a deviation ever occurs and are therefore not subject to the same type of financial constraint that bonds are. This raises the question if we need bonds at all in an extended agreement with fines and in Proposition 4 we also constrain $b = 0$ to show that they must be included and posted by the large country.²⁸

To understand why fines can overcome bond constraints on small but not large countries we must explain why *WRP* fines face an enforcement issue relative to bonds. Namely, the deviating country has to be induced to pay the fine, whereas the bond is already in the hands of its partner and is thus automatically foregone. Thus fines require some threat of tariff retaliation if they are not paid. We model this tariff threat as a last resort that would only ever materialize if the agreement breaks down. So, the large country will find it easy to enforce large fines, which prevents small ones from deviating even if they post no bond ($b^* = 0$). But small countries will not have the same ability due to the coordination externality.

Proposition 3 summarizes the results when the extended agreement includes fines and countries face some bond constraints.

Proposition 3 (Improved cooperation and symmetric outcomes with fines and bond constraints):

In a trade agreement extended to include WRP fines and constrained bond exchange ($b \in [\tilde{b}^g, b^g]$; $b^ \in [0, b^{*g}]$) the large country and the K uncoordinated small countries can sustain the globally optimal tariffs ($\tau^C = \tau^{*Ck} = \tau^G$) even if they can not enforce it under a standard agreement. Therefore, for some $\delta < \delta_G$, there is a $\tilde{b}^g > 0$ such that this agreement generates (i) an increase*

²⁸One simple way to model the “bond constraints” is to assume that production of the numeraire can only take place after policies are set so none of it is available for the initial bonds. If we want the larger country to be able to post some bond we can allow it to have some endowment of the numeraire available at the start of the period. To maintain symmetry we can allow for a similar endowment for the K small countries that is only available after the policies are set so it affects only their ability to post a bond.

in welfare for the small countries; (ii) a global increase in welfare and (iii) a more equitable outcome relative to the standard agreement. Furthermore these results hold even if the small countries face severe bond constraints, i.e. if $b^* = 0$.

A corollary is that if the bond constraints were also severe for the large country, i.e. $b = 0 = b^*$, then Proposition 3 would not hold since $\tilde{b}^g > 0$ unless $\delta = \delta_G$. In fact, under such severe bond constraints, the outcome would be the same as that under the standard agreement. The intuition is straightforward: the outcome under the standard agreement is ultimately determined by the threat of the agreement breaking down and thus infinite tariff reversion, which is the same threat that enforces fines so the two yield the same IC. Proposition 4 summarizes this result.

Proposition 4: (Equivalence of standard and extended agreements with fines under severe bond constraints):

A trade agreement extended to include WRP fines and subject to severe constraints on bond exchange ($b = b^ = 0$) yields the same outcomes as those in Proposition 1 for a standard trade agreement supported by tariff retaliation.*

This last result makes it clear that an extended agreement has to be carefully designed to include the relevant instruments. In this case, what is needed is a bond posted by the large country that removes the need for small countries to coordinate on a particular tariff level in case a retaliation is required. This result extends Proposition 2 of Limão and Saggi (2008), which showed that fines do not enhance cooperation relative to tariff retaliation between two *symmetric* countries. Here, we show that in the absence of bonds, fines do not enhance the cooperation even in this setting with asymmetric countries.

We now turn to the choice of agreement. Any of the agreements considered thus far increases the payoffs for *each* of the countries relative to non-cooperation. This should be clear for the small countries. The large country will also be better off relative to non-cooperation if, as we assume throughout, there is a finite number of small countries. However, large and small countries can have different preferred agreements since for some $\delta < \delta_G$ we obtain $\tau^C > \tau^{*Ck} = \tau^G$ under the standard agreement (Proposition 1) and $\tau^C = \tau^{*Ck} = \tau^G$ under the extended agreements with \tilde{b}^g (Propositions 2 and 3). Therefore, the small countries prefer the extended agreement but the large country prefers the standard one since $W(\tau, \tau^{*G})$ is increasing in its own tariff when $\tau < \tau^N$. This raises the question of which agreement would be adopted. If

ex-ante transfers were available then we would expect the extended agreement to be adopted since it generates the highest global political welfare (Propositions 2 and 3).

One may then ask how to implement this reform in terms of the model and in practice. In this model of agreements with financial instruments, it seems reasonable to allow for transferable utility (via an ex-ante transfer of the numeraire good). If we were to then model an initial stage where countries bargain (efficiently) over the type of agreement (standard or extended) and the associated value of the ex-ante transfer, then the extended agreement would be adopted. The value of the transfer from each small country would depend on the precise details of the initial bargaining. If the large country had all the bargaining power then it may be able to extract the full additional gain of the extended agreement relative to the standard one. However, there is no reason to believe this is the only distribution of bargaining power. First, small countries are not negligible in size individually and may also be able to exert their collective power at the negotiation stage even if they can't coordinate their tariffs after a trade war breaks out. Second, in practice negotiation outcomes are affected not only by relative size but also by the fairness of outcomes, which is a goal of the Doha Round. In sum, if ex-ante transfers using the numeraire are possible then it is plausible that the extended agreement would be adopted.

The issue is more complicated if, as considered in the last two propositions, small countries are constrained in their transfers of the numeraire. Note that even if these constraints are severe they do not necessarily *eliminate* the possibility that an extended agreement is adopted. As we argued in the last paragraph, the amount of the transfer will reflect not just the benefit of the extended agreement relative to the standard one but also the initial bargaining procedure; so even a small ex-ante transfer may be enough to adopt an extended agreement with large benefits.²⁹ More generally, if transfers are required but the small countries are constrained in terms of the numeraire then a narrow interpretation of our results is that they show the extended agreement provides a potential Pareto improvement. However, we have also clearly identified the potential constraint to implementing this agreement: the ex-ante transfer of the numeraire. One way to overcome this constraint is to enrich the model to allow transfers to take the form of an initial concession by small countries in non-trade issues. One example of this was the acceptance by developing countries of the TRIPS agreement in the Uruguay Round, which many viewed as a transfer from developing to developed countries.

²⁹In fact, we could consider an alternative initial stage choice mechanisms where the agreements are put to a vote in the WTO such that the larger number of small countries would imply that their preferred outcome is implemented without *any* transfers.

Naturally any transfer that makes the extended agreement more attractive for the large country also reduces some of its attractiveness to the small ones and would not generate symmetric welfare outcomes. But the small countries would still enjoy higher welfare than under non-cooperation or the standard agreement.

4 Conclusion

The multilateral trading system has changed dramatically since 23 founding members signed the GATT in 1947. The WTO now comprises 157 members, many of which are small individually but jointly account for a substantial fraction of trade. The recent emergence of the BRICs and the longer trend of trade liberalization across the developing world has eroded the relative standing of the US and EU in world trade. These salient changes in the global economic landscape have also started to alter the dynamic underlying multilateral trade negotiations. Whereas the first eight rounds of trade negotiations saw limited participation from developing countries and were led primarily by the USA and the EU, the most recent, and currently ongoing, round of negotiations – i.e. the Doha Round – puts (or at least claims to put) the interests of developing countries at center stage.

The increasingly dispersed pattern of world trade along with the increased participation of developing countries at the WTO suggests that the standard two-country paradigm underlying formal models of international trade agreements may no longer adequately capture actual trade negotiations. In this paper we analyze one basic problem that arises under this “new trade order”: a *coordination externality* among countries that import a common good. The externality is strongest when each importer is bilaterally small relative to the exporter, but would have a reasonable degree of market power if it were to coordinate its tariff choices with other importers. This coordination externality implies that smaller countries have less of a threat to use tariffs and therefore a limited ability to bilaterally extract and enforce cooperation from larger countries. Thus international cooperation based on the threat of tariff retaliation yields an asymmetric equilibrium outcome that is biased in favor of the large country.

We examine the use of financial instruments as a means for resolving this coordination externality and the asymmetric outcome that results because of it. To this end, we consider an extended trade agreement under which countries post bonds prior to trading, with the understanding that a country violating the agreement would forfeit its bond. We show that the use of bonds in this fashion does not suffer from the coordination externality that characterizes

the tariff choices of small countries. Indeed, we find that when the trade agreement is extended to allow for bonds, the resulting outcome is preferable from both an efficiency and equity perspective.³⁰ Since the implementation of such an extended agreement might be problematic due to the inability to post bonds (especially on the part of small countries) we show that our results hold even if small countries do not post *any* bonds at all provided the extended agreement allows for fines. Furthermore, the use of such fines also allows the large country to post a smaller bond.

The new trade order arising from the relative decline of the US and EU driven by the emergence of several smaller developing countries in the world trading system raises a number of interesting questions and challenges. We argue that to adequately address these new issues, one needs to go beyond the canonical economic theories of agreements. In this paper, we construct a model that isolates a specific issue that is arguably central to the new global economic landscape: a coordination externality. Future research should consider the implications of such an externality for WTO rules and for the process via which trade concessions are exchanged, e.g. whether to add other instruments to enforce joint punishments and/or adjust the bilateral reciprocity principle. This externality also highlights the incentive of smaller countries to coordinate on a common external tariff via the formation of a customs unions. Future research could extend our approach by allowing for discriminatory tariffs in order to analyze the interaction between preferential and multilateral liberalization in the presence of bonds.³¹ Finally, this new trade order seems to be one where bilateral trade shares and patterns are both dynamic and uncertain, two dimensions that should be better incorporated in future research on trade agreements.

³⁰Although we do not consider this in our model, posting bonds with a third party may also help improve cooperation. For example, if bonds of sufficient value are deposited in an escrow fund, tariff retaliation is no longer necessary for sustaining cooperation since the bond posted by the violating country can be used to compensate the injured country. Such an escrow scheme was in fact proposed by Chile in its bilateral trade agreement with the US. “Chile Looks for Monetary Sanctions as Enforcement Mechanism”, INSIDE U.S. TRADE 13, 11/11/2002.

³¹While some countries have tried to do so (e.g. Mercosur) customs unions are difficult to negotiate and are thus unlikely to eliminate the need for alternatives such as financial instruments in the WTO. For an interesting analysis of links between preferential and multilateral liberalization in the absence of other enforcement mechanisms see Ornelas (2005) and Syropoulos and Dinopoulos (2012).

5 Appendix

Nash tariff for smaller countries

The tariff in (6) is obtained by solving the following first-order condition for τ^{*k} , where all variables correspond to their import, x .

$$\begin{aligned} W_{\tau^{*k}}^k &= 0 : (1 + p_{\tau^{*k}}^w)[\tau^{*k} M'^{*k} + (\lambda - 1)S^{*k}] - p_{\tau^{*k}}^w M^{*k} = 0 \\ \tau^{*k} &= \frac{p_{\tau^{*k}}^w}{1 + p_{\tau^{*k}}^w} \frac{M^{*k}}{M'^{*k}} - (\lambda - 1) \frac{S^{*k}}{M'^{*k}} \end{aligned}$$

where here and below we use $M'^c \equiv dM^c(p^c)/dp^c$ for each country c 's import derivative w.r.t. own price and recall that with a specific tariff $\partial M^{*k}(p^w + \tau^{*k})/\partial \tau^{*k} = \partial M^{*k}(p^w + \tau^{*k})/\partial p^w = M'^{*k}$.

To obtain $p_{\tau^{*k}}^w$ we implicitly differentiate the market clearing condition for x holding all other tariffs constant

$$\begin{aligned} M(p^w) + \sum_{j \neq k} M^{*j}(p^w + \tau^{*j \neq k}) + M^{*k}(p^w + \tau^{*k}) &= 0 \\ p_{\tau^{*k}}^w &= -\frac{M'^{*k}}{M' + \sum_{j \neq k} M'^{*j} + M'^{*k}} \Leftrightarrow \frac{p_{\tau^{*k}}^w}{1 + p_{\tau^{*k}}^w} = \frac{-M'^{*k}}{M' + \sum_{j \neq k} M'^{*j}} \end{aligned}$$

Replacing in the first order condition and simplifying we obtain

$$\begin{aligned} \frac{\tau^{*k}}{p^w} &= \frac{-M'^{*k}}{M' + \sum_{j \neq k} M'^{*j}} \frac{M^{*k}}{p^w M'^{*k}} - (\lambda - 1) \frac{S^{*k}/M^{*k}}{M'^{*k} p^w / M^{*k}} \\ \frac{\tau^{*k}}{p^w} &= \frac{1}{\varepsilon^{*k}} + (\lambda - 1) \frac{S^{*k}/M^{*k}}{\xi^{*k}} \end{aligned}$$

where the last line uses the following definitions of k 's import elasticity, ξ^{*k} , and what we refer to as its residual foreign export supply elasticity, ε^{*k} , respectively

$$\begin{aligned} -\xi^{*k} &\equiv -\frac{\partial M^{*k}}{\partial p^w} \frac{p^w}{M^{*k}} = \frac{-M'^{*k} p^w}{M^{*k}} \\ 1/\varepsilon^{*k} &\equiv \frac{M + \sum_{j \neq k} M^{*j}}{p^w (M' + \sum_{j \neq k} M'^{*j})} \end{aligned}$$

Relationship between elasticities of individual small countries and regional aggregate

Notice that if all k have the same tariffs then the individual country and regional import demand elasticities are identical

$$\xi^{*k} = -M'^{*k} p^w / M^{*k} = -(M'^{*} / K) p^w / (M^{*} / K) = \xi^{*}$$

However, the market power of individual small countries, as measured by the inverse of their residual foreign export supply elasticity, is lower than the region's, i.e. $1/\varepsilon^{*k} < 1/\varepsilon^*$ whenever $K > 1$ since

$$\frac{1}{\varepsilon^{*k}} \equiv \frac{M + \sum_{j \neq k} M^{*j}}{p^w (M' + \sum_{j \neq k} M'^{*j})} < \frac{M}{p^w M'} \equiv \frac{1}{\varepsilon^*} \quad (28)$$

The inequality follows since at any given tariff and world prices (i) the numerator on the LHS of the inequality is lower in absolute value than the one on the RHS (recall that $M < 0$ and $\sum_{j \neq k} M^{*j} > 0$ for the good exported by Large) and (ii) the denominator on the LHS of the inequality is larger in absolute value (since both M' and $\sum_{j \neq k} M'^{*j}$ are negative).

Global optimum tariffs (eq. (8)): These are obtained by solving the following first-order condition for τ^C

$$W_\tau(\tau^C) + W_{\tau^*}(\tau^* = \tau^C) = 0 : (1 + p_\tau^w)[\tau^C M' + (\lambda - 1)S] = 0$$

Proof of Lemma 1

To see (i) recall that if all small countries set equal tariffs then $\sum_k W^{*k} = KW^{*k}$ and this "regional" welfare measure is mirror symmetric to W so if $\tau^C = \tau^{*Ck}$ and $\tau^* = \tau^N$ for all small countries we have the equality below

$$\begin{aligned} W(\tau = \tau^N, \tau^* = \tau^C) &= KW^{*k}(\tau = \tau^C, \tau^* = \tau^N) \\ &> KW^{*k}(\tau = \tau^C, \tau^{*Dk}) \end{aligned}$$

where the inequality arises because $\tau^N = \tau^{*Ncoord}$ maximizes KW^{*k} for a given τ^C and the elements of τ^{*Dk} are τ^{*Nk} , which are smaller than $\tau^{*Ncoord}$ (from (6) when $K > 1$).

To see (ii) note that symmetry implies that

$$W(\tau^N, \tau^* = \tau^N) = KW^{*k}(\tau^N, \tau^* = \tau^N)$$

which implies that

$$W(\tau^N, \tau^{*N}) > W(\tau^N, \tau^* = \tau^N) = KW^{*k}(\tau^N, \tau^* = \tau^N)$$

This is because $\tau^{*N} = \tau^{*Nk}$ for all K and it is smaller than τ^N (from (6)) and so the export price obtained by the large country is higher relative to when it faces τ^N in all small countries. Furthermore, we have

$$KW^{*k}(\tau^N, \tau^* = \tau^N) > KW^{*k}(\tau^N, \tau^{*N})$$

This is because $\tau^* = \tau^N$ for all K maximizes the aggregate payoff of small countries for any given tariff of the large country, not τ^{*N} whose elements comprise of K tariffs each of which equals $\tau^{*Nk} < \tau^{*Ncoord}$. Combining the last two inequalities we obtain $W(\tau^N, \tau^{*N}) > \Sigma_k W^{*k}(\tau^N, \tau^{*N})$. QED

Proof of Proposition 1

Suppose that $\delta = \delta_G$ so that by definition the incentive constraint of the large country (16) holds with equality when each country sets its tariff to equal the globally optimal tariff τ^G . The incentive constraint for a typical small country is similar to (16), except that small country exporters face a higher tariff relative to that faced by exporters from the large country, i.e. $\tau^N > \tau^{*Nk}$, and the payoff of each small country is divided by K (but K cancels out because it enters similarly on both sides of the IC). Thus, the cooperative payoff for the small countries as a group is equal to that for the large one (due to symmetry) and the payoffs for small countries from deviating are smaller, as shown in lemma 1. This means that at δ_G , where (16) holds with equality, *there must be slack in the corresponding IC for each small country*. If we lower δ below δ_G then the large country's incentive constraint (16) no longer holds at τ^G . So under tariff retaliation, the global optimum is not feasible for $\delta < \delta_G$. But the corresponding constraint for each small country continues to hold and has slack, at least for some $\delta < \delta_G$.

Since, by definition, for any $\delta < \delta_G$ tariff retaliation cannot sustain τ^G , to prove Proposition 1 we need only show that when $\delta < \delta_G$ the lowest self-enforcing cooperative tariffs used are such that $\tau^C > \tau^{*Ck}$. We prove this by contradiction. Assume that the lowest self-enforcing cooperative tariffs for all countries is the same, i.e., $\tau^C = \tau^{*Ck}$ and that it is such that the IC of the large country (16) binds.³² We then show that if $\tau^C = \tau^{*Ck}$ then the IC of a small country (17) has slack implying that such a tariff is not the most cooperative tariff on the part of small countries. Since the RHS of (16) is equal to K times the RHS of (17) at $\tau^C = \tau^{*Ck}$ (due to symmetry) we need only show that the LHS of (16) exceeds K times the RHS of (17), which is done in lemma 1. Given this there must be some $\tau^{*Ck} < \tau^C$ for small countries that is still self-enforcing since the reduction in τ^{*Ck} reduces the slack in (17) without violating the large country's IC in (16).

Given the asymmetry in the cooperative tariffs, the large country will have a higher welfare than the collection of small ones even though they are mirror images and there is constant

³²It is clear that we need not consider the case where $\tau^C > \tau^{*Ck}$.

returns to scale in production.³³ QED

Proof of Proposition 2

See the text.

Proof of Proposition 3

To prove Proposition 3 we need only show that for some $\delta < \delta_G$ the global optimum can be sustained using bonds $b^* = 0 < b^{*g}$ and $b < b^g$. Once that is done the results in (i), (ii) and (iii) follow directly from the same arguments in proposition 2. Consider the following strategy: similarly to before, each country must first post a bond in order for cooperation to begin. We will focus on the case where the total value of this bond is $\tilde{b} > 0$ for the large country (equally divided among the K small countries) whereas b^* is arbitrarily small, in practice $b^* = 0$. If a country deviates, it loses its bond but keeps any foreign bond(s) it may hold. But now, if a deviation were to occur then cooperation resumes only after a fine is paid by the deviating country. The incentive constraints for the large and each of the small countries are respectively

$$W(\tau^N, \tau^{*G}) - \tilde{b} + V^{\tilde{b}} \leq \frac{W(\tau^G, \tau^{*G})}{1 - \delta} \quad (29)$$

$$W^{*k}(\tau^G, \tau^{*N}) + \tilde{b}/K + V^{*\tilde{b}} \leq \frac{W^{*k}(\tau^G, \tau^{*G})}{1 - \delta} \quad (30)$$

and the minimum continuation payoffs for each are

$$V^{\tilde{b}} \equiv -\delta f + \frac{\delta W(\tau^G, \tau^{*G})}{1 - \delta} \quad \text{and} \quad V^{*\tilde{b}} \equiv -\delta f^* + \frac{\delta W^{*k}(\tau^G, \tau^{*G})}{1 - \delta}$$

where f and f^* are the fine values paid by the large and small countries respectively. As before, we require the continuation payoff to be *WRP* in that no country prefers to abandon the agreement altogether. This implies that the minimum continuation payoff for each country must be no lower than the payoff obtained under non-cooperation:

$$V^{\tilde{b} \min} \equiv -\delta f^{\max} + \frac{\delta W(\tau^G, \tau^{*G})}{1 - \delta} = \frac{\delta W(\tau^N, \tau^{*N})}{1 - \delta} \quad (31)$$

$$V^{*\tilde{b} \min} \equiv -\delta f^{*\max} + \frac{\delta W^{*k}(\tau^G, \tau^{*G})}{1 - \delta} = \frac{\delta W^{*k}(\tau^N, \tau^{*N})}{1 - \delta} \quad (32)$$

³³This is not to say that the welfare distribution across countries is *more* unequal under the agreement than under non-cooperation since the Nash policies are also asymmetric. In fact, if $\delta = \delta_G$ the agreement sustains the symmetric global optimum and so generates a more equal welfare distribution than non-cooperation. By continuity, this must also be true for at least some $\delta < \delta_G$.

These constraints pin down the maximum fine that each country is willing to pay and re-arranging them we can interpret that maximum fine to be the net present discounted value of cooperation:

$$\begin{aligned} f^{\max} &= \frac{W(\tau^G, \tau^{*G}) - W(\tau^N, \tau^{*N})}{1 - \delta} \\ f^{*\max} &= \frac{W^{*k}(\tau^G, \tau^{*G}) - W^{*k}(\tau^N, \tau^{*N})}{1 - \delta} \end{aligned}$$

Replacing $V^{\tilde{b}^{\min}}$ in (29) by $\delta W(\tau^N, \tau^{*N})/(1 - \delta)$ allows us to solve for the minimum bond required to sustain globally optimal tariffs.

$$\tilde{b}^g = W(\tau^N, \tau^{*G}) + \frac{\delta W(\tau^N, \tau^{*N})}{1 - \delta} - \frac{W(\tau^G, \tau^{*G})}{1 - \delta}$$

To clearly see the relationship between this and the bond required without fines we rewrite the expression above and use the value of b^g in (22) to obtain

$$\tilde{b}^g = \underbrace{[W(\tau^N, \tau^{*G}) - W(\tau^G, \tau^{*G})]}_{=b^g} - \frac{\delta}{1 - \delta} [W(\tau^G, \tau^{*G}) - W(\tau^N, \tau^{*N})] < b^g \quad (33)$$

The inequality $\tilde{b}^g < b^g$ holds because the second term in parenthesis (i.e. $W(\tau^G, \tau^{*G}) - W(\tau^N, \tau^{*N})$) is positive whenever the number of small countries is small enough that the large country prefers a cooperative trade agreement to a trade war, which is our assumption throughout (see footnote 20). Intuitively, when fines can be used in conjunction with bonds, the large country can post a lower bond because the threat of the maximum fine f^{\max} (off the equilibrium path) ensures that its continuation payoff is no higher than when fines are not used (since it equals $\delta W(\tau^N, \tau^{*N})/(1 - \delta)$ in either case) while the posting of zero bonds by small countries implies that its short term gain of deviating from cooperation is lower relative to the case without fines. It should also be clear that for $\delta < \delta_G$ we have $\tilde{b}^g > 0$ since if $\delta = \delta_G$ then $\tilde{b}^g = 0$ and reducing δ reduces the gains from cooperation, which is the second term in (33).

To show that \tilde{b}^g does not violate the incentive constraint for small countries in (30) we replace \tilde{b}^g and $V^{*b^{\min}}$ into (30) and rearrange it to obtain

$$W(\tau^N, \tau^{*G}) + \frac{\delta W(\tau^N, \tau^{*N})}{1 - \delta} + K[W^{*k}(\tau^G, \tau^{*N}) + \frac{\delta W^{*k}(\tau^N, \tau^{*N})}{1 - \delta}] \leq \frac{W(\tau^G, \tau^{*G})}{1 - \delta} + K \frac{W^{*k}(\tau^G, \tau^{*G})}{1 - \delta} \quad (34)$$

This is simply the sum of the IC in the standard agreement given by (16) and (17) when evaluated at the global optimum. We know that at δ_G the IC for the large country holds with

equality at τ^G (by the definition of δ_G) and the IC for each small country holds with slack (Proposition 1) so (34) holds strictly at δ_G and continuity ensures it must also hold for some $\delta < \delta_G$. QED

Proof of proposition 4

Substitute the minimum continuation payoffs for the extended agreement, $V^{\tilde{b}\min}$ and $V^{*\tilde{b}\min}$, and set $\tilde{b} = 0$ in the IC in (29) and (30). Evaluating these at a general cooperative tariff level (instead of requiring it to be the global optimum) we obtain the IC under the standard agreement, (16) and (17).

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Supplementary Appendix: Role of individual vs. simultaneous deviations

In section 3.1 we focus on a scenario where small countries can deviate simultaneously to their (uncoordinated) tariff levels and claim that: “the results are qualitatively similar if we instead focused on individual deviations instead, as we show in the appendix.” We now provide the details to support this claim. We focus on a case with two small countries and infinite Nash reversion punishments for ease of exposition. At the end we also describe how the results extend to WRP strategies.

Standard trade agreement. The two small countries are identical so we can consider the IC for either. Under the standard trade agreement a given small country k can choose to cooperate in its import tariff ($\tau^{*k} = \tau^{*C}$) or deviate ($\tau^{*k} = \tau^{*D}$), where we recall that these tariffs apply regardless of country of origin (so there is no motive for transshipment across small countries). If both small countries *happen* to deviate simultaneously then $\tau^{*D} = \tau^{*Nk}$, and we have the *simultaneous deviation IC* in eq. (17) and reproduced here

$$W^{*k}(\tau^C, \tau^{*Dk}) + \frac{\delta}{1-\delta} W^{*k}(\tau^N, \tau^{*N}) \leq \frac{W^{*k}(\tau^C, \tau^{*C})}{1-\delta} \quad \text{for each } k \quad (35)$$

If a single small country k deviates then in *that* period both the large country and the small country that did not deviate still set cooperative tariffs, so the relevant vector for a single deviating country k is $\tau^{*D1} = \{\tau^{*D1}, \tau^{*C-k}\}$, where τ^{*D1} is determined by evaluating the non-cooperative expression in eq.(6) at the prices and quantities that result when the other small country still cooperates. To determine what occurs in the following periods we need to specify the punishment strategy. Consider the simplest one: cooperate unless there is a deviation by any country and if it were to occur then all countries revert to Nash. In this case, one period after either small country deviates, the large country and the other small country revert to their Nash tariffs.³⁴ This implies that the *IC under individual deviations* for any given small country is

$$W^{*k}(\tau^C, \tau^{*D1}) + \frac{\delta}{1-\delta} W^{*k}(\tau^N, \tau^{*N}) \leq \frac{W^{*k}(\tau^C, \tau^{*C})}{1-\delta} \quad \text{for each } k \quad (36)$$

This IC differs from the one under simultaneous deviations only in terms of the value of the

³⁴If instead the strategy was “cooperate until any country deviates and then any country that faces higher tariffs relative to cooperation reverts to its Nash tariff” we would have the same IC. To see this note that with this strategy if *any* small country deviates then Large punishes by setting a higher tariff that affects all small countries (due to the non-discrimination constraint). Given that, all small countries revert to Nash after any deviation.

deviation payoff, which is lower. That is $W^{*k}(\tau^C, \tau^{*D1}) < W^{*k}(\tau^C, \tau^{*Dk})$ because the TOT gain from a single country setting its non-cooperative tariff is smaller than if the other importers of that good also raise their tariffs. Therefore, for any given cooperative tariff profile (τ^C, τ^{*C}) if the IC under simultaneous deviations holds then so does the IC under individual deviations. This implies that any solution under the standard trade agreement that can be sustained under simultaneous deviations by small countries can also be sustained if we were to instead allow for individual deviations by small countries.

Extended agreement with bonds. A similar point applies when we extend the agreement to include bonds. The IC for each small country under *simultaneous deviations* under Nash reversion is

$$W^{*k}(\tau^C, \tau^{*Dk}) - b^* + b/K + \frac{\delta}{1-\delta} W^{*k}(\tau^N, \tau^{*N}) \leq \frac{W^{*k}(\tau^C, \tau^{*C})}{1-\delta} \text{ for each } k$$

whereas under *individual deviation* it is

$$W^{*k}(\tau^C, \tau^{*D1}) - b^* + b/K + \frac{\delta}{1-\delta} W^{*k}(\tau^N, \tau^{*N}) \leq \frac{W^{*k}(\tau^C, \tau^{*C})}{1-\delta} \text{ for each } k$$

We can see again that the only difference is the lower incentive to deviate individually. Therefore, the bonds that sustain the global optimum tariffs under simultaneous deviation remain incentive compatible if we instead allowed small countries to deviate individually. In fact, under individual deviations by small countries it would be even easier for them to cooperate but this would not change whether or not Large's IC binds at the global optimum.

WRP strategies. The argument above can be readily extended to the WRP case. For the large country setting MFN tariffs the WRP IC is the one given in section 3.1. For each of the small countries we need to specify the strategy to be followed in case either of them deviates. In the case of the standard agreement based on tariff retaliation, we assume that if a country k deviates then in the following period it must resume its cooperative tariff while the Large country punishes it using τ^N . Since the latter tariff is MFN and therefore applies also to the other small country, we allow the second small country to also revert to non-cooperation during this off equilibrium stage. If any of the countries fails to follow this strategy after the deviation then they all permanently revert to the Nash. The lowest continuation payoff that the small country can be held to without inducing it to abandon the agreement is $V^{*\tau \min} = \frac{\delta}{1-\delta} W^{*k}(\tau^N, \tau^{*N})$, which pins down the maximum punishment period $n^{*\max}$. Thus when the punishment is maximized to ensure the most cooperation possible under individual deviations

the IC for each k is exactly the same as given above in (36). If both small countries deviate simultaneously then the IC is the one given above by (35) so the only difference is again the lower incentive to deviate individually.³⁵

Let's consider bonds now under WRP. If a single country k deviates in its tariff and keeps Large's bond then it loses its bond, b^* . In the following period it must repay Large's bond (as we assumed in the text for joint deviations) and if it does so then all tariffs return to the cooperative level. If, in the period after a small country deviation, that country does not return the bond and play cooperatively (or if the other countries do not play cooperatively) then all revert to Nash permanently. The continuation payoffs for Large and each of the small countries will be identical to the case of simultaneous deviations, i.e. eqs. (18) and (19). But now the bond required by the small country to sustain the global optimum is

$$b^{*g} = W^{*k}(\tau^G, \tau^{*D1}) - W^{*k}(\tau^G, \tau^{*G}) \quad (37)$$

which is lower than under joint deviations because the individual gain from deviating is now lower. The bond required for Large to sustain the global optimum is still the one we provide in the paper since it does not depend on the deviations of small countries.

The maximum bonds such that countries prefer to remain in the agreement after a deviation are still given by $b^{\max}(\tau^G, \tau^{*G})$ and $b^{*\max}(\tau^G, \tau^{*G})$ (reported in the main text) since these are pinned down by the payoffs under full cooperation or Nash reversion by all. Thus the only requirement to check is that the bonds required to sustain the global optimum under individual deviations are lower than these maximum values:

$$b^g \leq b^{\max}(\tau^G, \tau^{*G}) \text{ and } b^{*g} \leq b^{*\max}(\tau^G, \tau^{*G})$$

We showed in the text this was true for joint deviations and note above that under individual deviations the only difference is the value of b^{*g} , which is now lower. So if these inequalities hold under joint deviations, as shown in proposition 2, they would also hold under individual deviations.

³⁵The other difference is that the number of periods of punishment to ensure the continuation payoff is held at the Nash level is different for joint deviations. But that plays no role in the main results.