The Political Economy of International Regulatory Cooperation[*]

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Abstract

In this paper we examine international regulatory agreements that are negotiated under lobbying pressures from producer groups. The way in which lobbying influences the cooperative setting of regulatory policies, as well as the welfare impacts of international agreements, depend crucially on whether the interests of producers in different countries are aligned or in conflict. The former situation tends to occur for product standards, while the latter tends to occur for process standards. We find that, if producer lobbies are strong enough, agreements on product standards lead to excessive de-regulation and decrease welfare, while agreements on process standards tighten regulations and enhance welfare.

1   Introduction

After decades of trade liberalization, tariffs have reached historically low levels, so there is limited scope for further tariff reductions. As a result, recent trade agreements largely revolve around non-tariff issues such as domestic regulations. For example, all the agreements signed by the US since the North American Free Trade Agreement (NAFTA) contain provisions on environmental and labor standards, and the same is true for most of the agreements signed by the EU, including the recent Comprehensive Economic and Trade Agreement (CETA) with Canada.[1] Furthermore, many recent agreements have established regulatory cooperation councils that aim to coordinate national regulatory agencies on an ongoing basis.[2]

International agreements whose scope extends to domestic policies are often referred to as "deep" agreements, in contrast with "shallow" agreements that focus only on border policies. Deep agreements have been very controversial, as evidenced for example by the massive protests against CETA and TTIP in Europe, which drew hundreds of thousands of people to the streets. While some opponents criticize any form of economic globalization, most object specifically to the deep integration elements. The overarching concern is that deep agreements may get hijacked by special interests. In particular, a common claim is that business groups exert disproportionate influence on regulatory cooperation bodies, thus undermining consumer safety and endangering the environment. A case in point was the public uproar against allowing the sale of chlorine-washed chicken in Europe, which had been banned earlier by the EU. An example of this kind of criticism is the following statement by the Institute for Agriculture and Trade Policy: "*Regulatory cooperation activities most often take place behind closed doors, with a corporate-directed deregulatory agenda, and with minimal participation by civil society or stakeholders outside of the regulated industries...*" (www.iatp.org/new-nafta-grp)

These concerns are shared by some academic economists. For example, Dani Rodrik (2018) argues informally that shallow integration is likely to enhance welfare because it empowers exporter lobbies and pits them against import-competing interests, but warns that deep integration may be bad for welfare because it empowers the "wrong" special interests.

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[1]See for example ustr.gov/issue-areas/environment/bilateral-and-regional-trade-agreements and ec.europa.eu/trade/policy/policy-making/sustainable-development.

[2]Some well-known regulatory cooperation councils are CETA's Regulatory Cooperation Forum, the Canada-US Regulatory Cooperation Council and the US-Mexico High Level Regulatory Cooperation Council, and a similar council is part of the proposed Transatlantic Trade and Investment Partnership (TTIP) between the EU and the US.

Academic research on the impact of special interests on trade agreements has focused mostly on questions surrounding shallow integration. One of the insights that has emerged from this body of research is consistent with Dani Rodrik's argument above: absent trade agreements, import-competing producers tend to have more influence than exporter lobbies on the non-cooperative choice of import barriers, but trade negotiations change the political balance and pit exporter interests against import-competing interests, thereby diluting the overall effect of special interests on trade policy and reducing trade barriers.

In contrast, the academic literature has paid little attention to the political economy of deep agreements. In this paper we take a first step in this direction, with a particular focus on the question of how global welfare is impacted by international regulatory agreements when these are influenced by industrial lobbies.

The simple overarching idea underlying our theory can be described as follows. A key determinant of the welfare impact of politically-pressured agreements is whether lobbies have more influence when policies are set unilaterally or when they are set by international negotiations; in the former case, international negotiations *dilute* the influence of lobbies, and agreements tend to increase welfare; in the latter case, international negotiations *intensify* the influence of lobbies, so agreements may decrease welfare.[3] This depends crucially on whether the interests of a country's lobbies are aligned or in conflict with those of foreign countries' lobbies: in the former case, international negotiations induce "co-lobbying"; in the latter, they induce "counter-lobbying."

Whether international negotiations induce co-lobbying or counter-lobbying in turn depends crucially on the nature of the policy on the negotiating table. Our theory emphasizes a distinction between two types of domestic regulations: *product* standards (defined as restrictions on the characteristics of products sold in the local market) and *process* standards (defined as restrictions on production processes that take place on domestic soil). If a country loosens its product standards (in a non-discriminatory way), this benefits both domestic and foreign producers, so in this case there is co-lobbying. On the other hand, loosening process standards benefits domestic producers while hurting foreign producers, so in this case there is counter-lobbying. This basic intuition thus suggests that international cooperation may be less benign when negotiations focus on product standards than when they focus on process

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[3]The statement above is based on the notion that lobbying tends to be detrimental for welfare. In our setting this is always true if lobbies are sufficiently powerful, but may not be true if the power of lobbies is moderate. We will come back to this point below (see footnote 43).

standards.[4]

It is important to note that in reality both product standards and process standards play an important role in international regulatory cooperation. Product standards have been quite central in recent agreements such as the CETA agreement and the proposed TTIP agreement. It is noteworthy that some of the most well-known controversies regarding deep integration (including the famous case of chlorine-washed chicken) have revolved around product standards. Also process standards, such as environmental regulations for factories and safety standards for workers, have been an important area of concern for many trade agreements in the last couple of decades, as mentioned at the outset.[5]

Interestingly, Young (2016, 2017) provides an anecdotal account of the CETA and TTIP negotiations that resonates with a key theme of our paper, namely the coordination of lobbies across borders in their efforts to influence the agreements. For example, Young documents that US and European business groups acted in a coordinated way both in supporting TTIP negotiations and in influencing the content of this agreement. He reports that "...*rather than being rivals, American and European business interests are allies, adopting common positions on what they want the agreement to look like.*" (Young, 2016, p. 345). According to this account, conflict across business groups was observed only in the agricultural sector, where no transatlantic alliances were formed.[6]

We now describe in more detail the main steps of our analysis and our main results.

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[4]The reason we define product standards as restrictions on the characteristics of products sold in the local market is that we want to focus on policies that a government can directly and unilaterally enforce, and for product standards this is the case only if they are destination-specific, because government A cannot restrict characteristics of products that are sold in country B. Similarly, a government cannot directly restrict characteristics of a process that takes place in a different jurisdiction, and this is why we define process standards as restrictions that a government imposes on *local* production processes. Having said this, it is important to mention that in reality there is a category of standards that does not fit within our notions of product standards or process standards, and namely, restrictions on the sale of products that are produced with certain processes. Examples of such standards are bans on the sale of clothes that are produced with child labor, or of tuna caught with dolphin-unsafe nets. This type of standards may be motivated by cross-border externalities (e.g. global moral externalities in the case of child labor or dolphin-unsafe processes) and are often proposed as unilateral policies to address such externalities, but note that they are less efficient than process standards imposed at the origin, so they are in a sense "third best" instruments.

[5]We note that not all labor standards can be included in our definition of process standards: for example, workplace safety standards do fall within our notion of process standards, but minimum wages do not.

[6]We note that the transatlantic business alliances documented by Young and the fact that they strongly influenced TTIP negotiations are consistent both with the notions of "co-lobbying" and "counter-lobbying" as defined in our theory. These notions refer to whether the interests of domestic and foreign producers are aligned or in conflict with respect to a country's standards. But regardless of whether these interests are aligned or in conflict, our theory suggests that there is scope for coordination among lobbies across the borders, and that lobbies will support the agreement if they are powerful enough, because a key role of the agreement is to internalize the externalities exerted by a country's standards on foreign producers.

To focus sharply on issues of deep integration, we consider a world where shallow integration has already occurred, and we assume that domestic regulations are non-discriminatory, so they cannot be used to create trade barriers. Our basic model focuses on a continuum of perfectly competitive small countries. This allows us to put lobbying at the heart of international negotiations, as small countries have no ability to manipulate terms of trade,[7] but later we extend the model to allow for large countries.

We start by focusing on product standards. To provide a meaningful role for product standards, we allow consumption to generate a local negative externality. Products are vertically differentiated, with lower-quality products generating worse externalities (e.g. dirtier cars causing more pollution, or more hazardous toys causing worse health-cost externalities).[8] Governments can use product standards to address the consumption externality, but they do so under political pressure from producer lobbies.

We first examine the "positive" effects of international cooperation on product standards relative to the noncooperative equilibrium, and then we characterize its effects on global welfare. We find that international cooperation loosens product standards in all countries. The basic logic behind this result is that, if a group of countries loosen their product standards, this boosts demand in these countries and increases world prices, and this in turn generates two positive externalities on other countries: it reduces consumption and hence mitigates pollution (environmental externality); and it benefits producer lobbies (political externality).

At the normative level, we find that cooperation on product standards increases welfare if lobbying pressures are sufficiently weak, but decreases welfare if lobbies are powerful enough. The broad intuition for this result is that the interests of producers world-wide are aligned, because de-regulation in any given group of country benefits producers in the whole world, so international cooperation strengthens the overall influence of lobbies on the choice of standards. This is the notion of "co-lobbying" mentioned above. If lobbies are not very powerful, the welfare motivations for regulatory cooperation dominate political considerations, and thus the agreement enhances welfare, but if lobbies are sufficiently powerful then international cooperation leads to excessive de-regulation and damages welfare.[9]

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[7]The feature that lobbying is key to the purpose of an international agreement is present also in some domestic-commitment models of trade agreements, e.g. Maggi and Rodriguez-Clare (1998) and Mitra (2002). But these papers make very different points from the present paper, and they do not address deep agreements.

[8]In this paper we focus on vertical standards. An examination of horizontal standards, such as compatibility standards motivated by the presence of network externalities, would require a very different setup. We briefly discuss horizontal standards in the Conclusion.

[9]We also consider the possibility that governments may use both product standards and consumption taxes to address consumption externalities, and in this case the results are more pessimistic, in the sense that

These results may seem pessimistic, but it should be kept in mind that our model abstracts from potentially important considerations, such as the presence of trans-boundary pollution externalities, that may increase the potential welfare gains from an agreement. But aside from the *sign* of the welfare change from the agreement, the more general prediction is that the influence of producer lobbies tends to decrease the welfare gain, or increase the welfare loss, from an agreement on product standards.

It should also be kept in mind that many real-world trade agreements, including the GATT/WTO, are concerned with preventing the use of regulatory policies as a way to discriminate against foreign producers and thereby creating barriers to trade. In principle, the "National Treatment" rule prohibits discriminatory product standards, but in practice this is an unfinished job, both in the GATT/WTO and in many regional agreements. We view this unfinished job as part of "shallow" integration rather than "deep" integration, and for this reason we abstract from discriminatory standards in our model. But the intuition suggested by the literature on shallow integration, which we discussed at the outset, is that to the extent that an agreement focuses on the issue of discrimination in standards, the influence of lobbies on the agreement is likely to be benign, because there should be counter-lobbying between import-competing interests and exporter interests.

We next turn our attention to process standards. These include environmental standards imposed on factories and workplace safety standards. To introduce a role for process standards, we allow for local production externalities and suppose that production processes are vertically differentiated, with cheaper processes generating worse externalities. In analogy with the case of product standards, governments can use process standards to address production externalities, but they do so under pressure from producer lobbies.

Unlike the case of product standards, we find that international cooperation does not necessarily lead to de-regulation. If lobbying pressures are weak an international agreement does loosen process standards, but if lobbying is strong then the agreement tightens regulations. The reason is that the two international externalities mentioned above – environmental and political – now work in opposite directions. If a group of countries loosen their process standards, this boosts supply in these countries and depresses world prices. At the environmental level this is beneficial for other countries, because it reduces production and mitigates pollution, but at the political level this damages them, because it decreases their producer surplus. If lobbying is strong enough, the negative political externality dominates, and hence

international agreements on product standards decrease welfare as long as there is any lobbying.

the agreement tightens process standards.

The welfare impacts of international cooperation on process standards are strikingly different from the case of product standards. We find that an international agreement on process standards increases welfare if the power of lobbies is either sufficiently large or sufficiently small, and can decrease welfare only for an intermediate range of lobbying powers. Intuitively, a key ingredient of this result is that international negotiations induce counter-lobbying, because each lobby would like a loosening of its domestic regulations and a tightening of regulations in foreign countries. This counter-lobbying effect implies that international negotiations tend to dilute the overall impact of lobbies on policy-making. But note one subtle aspect of the above-mentioned result: in spite of the countervailing-lobbying effect, an agreement may decrease welfare for an intermediate range of lobbying powers, and this is guaranteed to happen if countries are not too asymmetric.

We then extend our analysis to the case of large countries. Two new effects emerge in this setting. The first one is best illustrated by focusing on the case in which countries are symmetric and hence do not trade. Now an individual country's choice of standards affects world prices. In the case of product standards, this implies that the incidence of such standards falls not only on domestic consumers but also on domestic producers, so lobbying matters also in the noncooperative scenario. This contrasts with the small-country case, where the incidence of product standards falls only on consumers and thus lobbying does not matter in the noncooperative scenario. Nonetheless, the basic logic of co-lobbying highlighted in the small-country model is still present, and our main results go through: in particular, the agreement loosens product standards, and it decreases welfare if lobbying is strong enough. Similarly, in the case of process standards, the incidence is shared between producers and consumers, but the basic logic of counter-lobbying is still present, and our main results still hold: in particular, the agreement tightens process standards and increases welfare if lobbying is strong enough.

The second new effect emerges when countries are asymmetric and trade in equilibrium. Now countries have incentives to manipulate the terms of trade: in the noncooperative scenario, each country has an incentive to tighten product standards and loosen process standards (other things equal) in sectors where it imports, in order to push down world prices, and vice-versa in sectors where it exports. An international agreement now addresses three issues: environmental externalities, political externalities and terms-of-trade manipulation. The presence of the terms-of-trade motive can affect the direction in which the agreement

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changes standards, but when lobbying is strong enough political externalities dominate and our key results go through.

Finally, our model highlights the role of the incompleteness of policy instruments in motivating international agreements. If governments could use a complete set of policies, including efficient redistribution policies such as targeted lump-sum transfers, regulatory policies would be undistorted in the noncooperative scenario, and the only possible role for international agreements would be to address terms-of-trade manipulation by large countries, so there would be no rationale for agreements in a world of small countries. This continues to be true even if lump-sum transfers are not available, if production subsidies (a second-best instrument to redistribute income to producer groups) are available.[10] But if governments cannot even use second-best redistribution policies (production subsidies), this introduces a new rationale for international agreements: governments will seek international regulatory agreements as a way to manipulate world prices and transfer income more effectively to their producer groups.[11]

Before plunging into the analysis, we discuss briefly the related literature.

There is a sizable literature on shallow agreements in the presence of lobbying pressures. The pioneering models in this literature are Grossman and Helpman (1995a) and Bagwell and Staiger (1999, 2001). It is worth noting that in these models governments can use export subsidies, and as a consequence there is no counter-lobbying by importing-competing and exporting interests in the negotiation of tariffs. But there are several models within this broad family where such counter-lobbying does take place because export subsidies are restricted: see for example Grossman and Helpman (1995b), Levy (1999), Ornelas (2005, 2008), Bagwell and Staiger (2011), Ludema and Mayda (2016), Nicita et al (2018) and Lazarevski (2020).

We note that most of the above models adopt the same government objective functions to predict and evaluate trade policy choices, thus they cannot address the question of whether trade agreements benefit special interests at the expense of society.[12] In our working paper version we examine this question through a model of shallow agreements that shares many

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[10]Thus the incompleteness of policy instruments (in the sense that first-best policies are not available) is a necessary but not sufficient condition for international agreements to play a role in a world of small countries.

[11]The same is true if governments cannot use efficient policies to address domestic externalities. For example, if the only motive for policy intervention is correcting local consumption externalities and governments can only use second best instruments such as product standards, but not consumption taxes, then governments will use international agreements to improve the efficiency of product standards. See Section 2, where we consider both the case where consumption taxes are not available and the case where they are.

[12]Notable exceptions are Grossman and Helpman (1995b) and Ornelas (2005, 2008), who discuss whether politically-viable regional trade agreements are likely to cause more trade diversion or creation, and thus whether they are likely to increase or reduce welfare.

features with the models mentioned above, except that we assume a continuum of small countries in order to abstract from terms of trade manipulation motives and emphasize the role of lobbying in the shaping of trade agreements. There we show that a shallow agreement increases global welfare relative to the noncooperative equilibrium, provided it does not lead to large import subsidies.

The literature on the political economy of deep integration is very thin, and we are not aware of any model that examines the welfare impacts of politically-pressured deep agreements. Nevertheless there are papers in the literature that have points of contact with our model of regulatory cooperation. For example, a recent paper by Grossman et al. (2021) considers the optimal design of international agreements in a setting where governments can choose product standards as well as trade and domestic taxes. The questions they address are very different from ours, however. Among other things, they focus on the tradeoff between harmonization and regulatory diversity in a setting of monopolistic competition and fixed costs of standards compliance, an issue that is not a focus of our paper.[13]

The paper proceeds as follows. Section 2 examines international agreements on product standards. Section 3 focuses on the case of process standards. Section 4 extends the model to the case of large countries. Section 5 offers concluding comments. The Appendix provides all the proofs that are not contained in the main text.

2   Product Standards

The welfare implications of international regulatory agreements depend crucially on whether the agreement focuses on product standards or on process standards. To put these contrasting implications in sharp relief, we examine two separate models, one that focuses only on product standards and one that focuses only on process standards.

To focus sharply on the effects of deep integration, we consider a scenario where shallow integration has already occurred, so that policies cannot discriminate against imports. Thus we assume that trade taxes are not available, and standards are non-discriminatory (i.e. satisfy "national treatment").

In line with most political-economy models of trade policy (for example Grossman and Helpman, 1994), we assume away production subsidies.[14] In our basic model we also abstract

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[13]Other papers that examine international regulatory agreements from a purely economic perspective are Costinot (2008), Mei (2021), Parenti and Vannoorenberge (2021), and Campolmi et al (2022). See also Maggi and Ossa (2021) for a survey that discusses this literature in more detail.

[14]If production subsidies were available, producer lobbies would focus their efforts on production subsidies,

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from consumption taxes, but we will later extend the model to allow for this additional policy instrument.

We start by focusing on product standards, which are defined as restrictions on the characteristics of products sold in a given country. Examples include emissions standards for automobiles, safety standards for children's toys, or health standards for meat products. As mentioned in the Introduction, product standards have played a key role in a number of recent international negotiations, and have been at the center of some of the most well-known controversies regarding deep agreements.

2.1 Setup

We consider a perfectly competitive world with a continuum of countries. Assuming that countries are small allows us to focus more sharply on the role of lobbying in the shaping of deep agreements. Here and throughout, we normalize the mass of countries to one. In section 4 we will extend the model to allow for large countries.

There are $\mathcal{G} + 1$ goods which can be costlessly traded. Good 0 is the numeraire. The numeraire good is produced one-for-one from labor. We assume that in each country there is positive production of the numeraire good in equilibrium, so the wage is equal to one everywhere.

Good $g \in \mathcal{G}$ is produced from labor and a sector-specific input whose returns in country i we denote by π_{ig}. Hotelling's lemma implies that $y_{ig}(p_{ig}) = \pi'_{ig}(p_{ig})$, where y_{ig} is country i's supply of good g.

Each non-numeraire good comes in a continuum of varieties, indexed by their "dirtiness" $e_g \in [0, \infty)$. For example, e_g may index the amount of emissions generated by a car. Cleaner goods are more costly: in country i, producers have to incur an abatement cost $\phi_{ig}(e_g)$ in terms of the numeraire good for each unit of variety e_g they produce. We assume $\phi_{ig}(e_g)$ is strictly positive for all e_g, decreasing and convex, with $\lim_{e_g \to \infty} \phi_{ig}(e_g) = 0$ and $\lim_{e_g \to 0} \phi_{ig}(e_g) = \infty$.[15]

Consuming a dirtier good (higher e_g) generates a negative local externality. For concreteness we will focus on environmental externalities. But alternative interpretations are also possible, for example health-care externalities caused by the consumption of unsafe prod-

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not on regulations, since the former are more efficient redistribution tools, thus it would be hard to explain the influence of lobbies on regulations, just as it would be hard to explain the influence of lobbies on trade policies.

[15] We note that our results go through also if $\phi_{ig}(0)$ is finite, as long as it is large enough.

ucts. The consumption externality will provide a potential welfare rationale for product standards.

Each consumer is atomistic and ignores the impact of its consumption choices on the externality. Furthermore we assume that varieties are indistinguishable in the eyes of consumers.

In each country i there is a unit mass of citizens with the following quasi-linear preferences:

$$U_i = c_{i0} + \sum_{g \in \mathcal{G}} [u_{ig}(c_{ig}) - E_{ig}], \tag{1}$$

where c_{i0} denotes country i's consumption of the numeraire good, c_{ig} denotes country i's consumption of good g, the subutility function $u_{ig}(\cdot)$ satisfies the usual properties $u'_{ig}(\cdot) > 0$ and $u''_{ig}(\cdot) < 0$, and E_{ig} is the consumption externality that the consumer takes as exogenous and which we will specify shortly.

Letting p^c_{ig} denote the consumer price of good g in country i, utility maximization implies $p^c_{ig} = u'_{ig}(c_{ig})$, which can be inverted to yield the demand function $c_{ig} = d_{ig}(p^c_{ig})$.

The indirect utility associated with the utility function above is given by $V_i = Y_i + \sum_{g \in \mathcal{G}} [S_{ig}(p_{ig}) - E_{ig}]$, where Y_i is income and $S_{ig}(p_{ig}) \equiv u_{ig}(d_{ig}(p_{ig})) - p_{ig}d_{ig}(p_{ig})$ is consumer surplus.

As will become clear below, in each country i there will be a single variety of good g that is consumed in equilibrium, say variety e_{ig}. Assuming that consuming one unit of variety e_{ig} generates e_{ig} units of pollution, the total amount of pollution is then $e_{ig}d_{ig}(p^c_{ig})$. In the case of cars, this would be the total amount of emissions from cars in country i. The disutility caused by a unit of pollution for the representative consumer in country i is assumed to be constant and denoted by a_{ig}, so the local externality associated with consumption of variety e_{ig} can be written as $E_{ig} = -a_{ig}e_{ig}d_{ig}(p^c_{ig})$. The parameter a_{ig} can be interpreted as an environmental-preference parameter, capturing how strongly country i feels against pollution.

Each government i chooses emission standards $\{e_{ig}\}_{g \in \mathcal{G}}$ for products sold in its own market.[16] These can be interpreted as emission *caps*, because in this setting a cap is always binding, due to the fact that producing cleaner products is more costly and varieties are indistinguishable in the eyes of consumers.

Note that a product standard is a second-best policy, because given the variety e_{ig} selected by the government, consumers do not internalize the consumption externality. One way to

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[16]See footnote 4 for a discussion of our definition of product standards as "destination specific" restrictions.

implement the first best is to combine a product standard with a consumption tax. At the end of this section we will argue that, if both instruments were available, our conclusions would get strengthened.

Since there are no trade costs, producer arbitrage ensures that producers get the same price net of abatement costs in any market where they sell. And since each individual country is small, its choice of standards cannot affect the net price received by its producers. Letting p_g denote the producer price net of abatement costs, the price faced by consumers in country i is therefore $p_{ig}^c = p_g + \phi_i(e_{ig})$. We will often refer to the net producer price p_g as the "world" price.[17] Thus, if an individual country i tightens its standards, the associated cost falls entirely on its consumers.[18]

The feature that the incidence of product standards falls entirely on domestic consumers will make our results sharper, but it does not drive our main qualitative results: as we will show in section 4, if countries are large the incidence of product standards is shared between consumers and producers, but our key results continue to hold.

We can now write down an expression for welfare. Total income in country i consists of labor income, which is equal to one, and producer surplus $\sum_{g \in \mathcal{G}} \pi_{ig}$, thus aggregate indirect utility can be written as $V_i = 1 + \sum_{g \in \mathcal{G}} (\pi_{ig} + S_{ig} - a_{ig} e_{ig} d_{ig})$. We can abstract from the first term in V_i and define country i's welfare as:

$$W_i = \sum_{g \in \mathcal{G}} W_{ig} = \sum_{g \in \mathcal{G}} \left[\pi_{ig}\left(p_g\right) + S_{ig}\left(p_g + \phi_i(e_{ig})\right) - a_{ig} e_{ig} d_{ig}\left(p_g + \phi_i(e_{ig})\right) \right]. \tag{2}$$

Governments are subject to lobbying pressures, so their objective function does not coincide with welfare. In the same spirit as Grossman and Helpman (1994, 1995a), we assume that lobbies represent the groups of specific-factor owners, and we capture the influence that lobbies have on the government by assuming that government i attaches extra weights $\gamma_{ig} \geq 0$

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[17]This is the net price that producers of each country can get if they sell anywhere in the world, and also the price that consumers of a country would pay if that country imposed no standard at all ($e_{ig} = \infty$).

[18]Note that, in our setting with constant returns, there is no cost in producing different varieties for different markets. In the Conclusion we will discuss how results might change if there are fixed costs of adapting a product to a country's local standard. At this juncture it is also worth highlighting the role of the assumption that abatement costs are paid in terms of the outside good. This feature is convenient because it implies that a product standard acts like a consumer tax (except that it affects the pollution level directly and does not generate revenue). An alternative assumption would be that the abatement cost is paid in terms of some non-numeraire good (possibly the same good that the standard is applied to), but this would lead to a less tractable model, because e would then directly affect profits, and we would not be able to apply a simple arbitrage logic to link the prices of different varieties in different markets, and use a notion of "world price" to connect such prices. In other words, with our specification, if two countries choose two different standards, we can still think of the two varieties as the same good with different local prices. This convenient feature would be lost if abatement costs were paid in terms of some other good.

to the producer surplus in the various sectors.[19] Thus government i maximizes:

$$\Omega_i = W_i + \sum_{g \in \mathcal{G}} \gamma_{ig} \pi_{ig} \tag{3}$$

A remark is in order on the difference between our "positive" government objective (3) and our "normative" criterion (2). We have adopted a utilitarian definition of welfare (just as in the Grossman-Helpman model) because it is the simplest and most natural one in this transferrable-utility environment, but we have in mind a broader interpretation: if we assigned different Pareto weights to different groups in our welfare criterion, our government objective would reflect these welfare weights plus the "bias" γ_{ig} introduced by lobbying. What really matters for our results is that producer groups get more weight in the government objective than in the welfare criterion.

2.2 Noncooperative product standards

In the noncooperative scenario, each government unilaterally chooses product standards to maximize $\Omega_i = \sum_{g \in \mathcal{G}} \Omega_{ig}$, taking world prices and other countries' standards as given. Since each country is small relative to the rest of the world, it takes world prices as given. This problem is separable across goods, so we can focus on a single good g. Thus each government i solves:

$$\max_{e_{ig}} \Omega_{ig} = \left(1 + \gamma_{ig}\right) \pi_{ig} \left(p_g\right) + S_{ig} \left(p_g + \phi_{ig}(e_{ig})\right) - a_{ig} e_{ig} d_{ig} \left(p_g + \phi_{ig}(e_{ig})\right).$$

To rely on a first-order approach we assume that the optimal unilateral standards are nonprohibitive. This is guaranteed as long as the externality parameters a_{ig} are not too large.[20] Straightforward algebra reveals that the first-order condition implies:

$$e_{ig} = \frac{1}{\sigma_{ig}} \left(\frac{1}{a_{ig}} + \frac{1}{\phi'_{ig}}\right) \quad \text{for all } i, \tag{4}$$

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[19] This formulation of a government's objective is similar as in Baldwin (1987), and can be viewed as a reduced-form version of the government objectives in Grossman and Helpman's (1994) model. In this model, γ_{ig} depends on government i's valuation of welfare relative to campaign contributions and on the share of country i's population that is represented by some lobby. Also note that this model of lobbying implicitly assumes that labor-owners or consumers at large are not able to get politically organized, since these are large and dispersed economy-wide groups, so it is more difficult for them to overcome collective action problems.

[20] A prohibitive standard is one that chokes off consumption. Depending on whether the demand function has a choke price, the prohibitive level of the standard may be zero or positive. In either case, it is easy to see that the optimal level of e_{ig} must be nonprohibitive if $a_{ig} = 0$, and by continuity the same is true if a_{ig} is sufficiently small. Also note that $e_{ig} = \infty$ can never be optimal in our setting, as long as the a_{ig} parameters are strictly positive, because this implies an infinite cost of the externality.

where $\sigma_{ig} \equiv -\frac{d'_{ig}}{d_{ig}} > 0$ denotes the demand semi-elasticity.

The market clearing condition can be written as:

$$\int_i y_{ig}(p_g) = \int_i d_{ig}(p_g + \phi_{ig}(e_{ig})). \tag{5}$$

The noncooperative equilibrium product standards and world price for good g solve equations (4) and (5). We assume that such solution exists and is unique, and denote it $\left(\{e^N_{ig}\}, p^N_g\right)$.[21]

The formula for the noncooperative product standards in (4) is intuitive. A country's standard is tighter when the externality weight a_{ig} is higher, as one would expect. When demand is more elastic (higher σ_{ig}), the price increase caused by a tighter standard leads to a larger reduction in consumption and hence pollution, thus the optimal standard is tighter. And it is also intuitive that, if the marginal abatement cost is lower (so that ϕ'_{ig} has a smaller negative value), the optimal standard is tighter.

Also note that the strength of lobbies (γ_{ig}) does not affect the noncooperative product standards. The reason is that the incidence of product standards is entirely on domestic consumers, so this instrument cannot be used to help domestic producers. This feature, which depends on the small-country assumption, is extreme and makes our results sharp, but does not drive our qualitative results, as will become clear later.

2.3 Cooperative product standards

In the cooperative regime, governments set standards to maximize their joint payoff $\Omega \equiv \int_i \Omega_i = \sum_{g \in \mathcal{G}} \int_i \Omega_{ig}$ taking into account the impact of product standards on world prices.[22] This problem is again separable across industries, so it suffices to maximize Ω_g. Thus cooperative product standards solve:

$$\max_{\{e_{ig}\}, p_g} \Omega_g = \int_i \left[\left(1 + \gamma_{ig}\right) \pi_{ig}(p_g) + S_{ig}(p_g + \phi_{ig}(e_{ig})) - a_{ig} e_{ig} d_{ig}(p_g + \phi_{ig}(e_{ig})) \right] \tag{6}$$

$$\text{s.t.} \int_i y_{ig}(p_g) = \int_i d_{ig}(p_g + \phi_{ig}(e_{ig}))$$

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[21] As we show in Appendix A, a simple sufficient (but not necessary) condition on the fundamentals that guarantees the existence and uniqueness of the noncooperative equilibrium is that the demand semi-elasticities σ_{ig} do not increase too much with the price.

[22] We are implicitly assuming that countries have access to international transfers (in terms of the numeraire good). Given that governments have many ways to compensate each other in the context of trade negotiations, this assumption seems reasonable, but in any case it is not essential to our main qualitative results.

As in the noncooperative scenario, we assume that the optimal standards are nonprohibitive (which again is ensured if the a_{ig} parameters are not too large), so we can rely on a standard Lagrangian approach. Letting λ_g denote the Lagrange multiplier, it is direct to verify that the cooperative standards and world price for good g satisfy the following conditions (we suppress the arguments of all functions for simplicity):

$$e_{ig} = \frac{1}{\sigma_{ig}} \left(\frac{1}{a_{ig}} + \frac{1}{\phi'_{ig}} \right) + \frac{\lambda_g}{a_{ig}} \quad \text{for all } i \tag{7}$$

$$\lambda_g = \frac{\int_i \left(\gamma_{ig} y_{ig} + a_{ig} e_{ig} \sigma_{ig} d_{ig} \right)}{\int_i \left(\varepsilon_{ig} y_{ig} + \sigma_{ig} d_{ig} \right)} > 0$$

$$\int_i y_{ig} = \int_i d_{ig},$$

where $\varepsilon_{ig} \equiv \frac{y'_{ig}}{y_{ig}} > 0$ denotes the semi-elasticity of supply. We assume there exists a unique solution to the system of first order conditions above.[23]

The main difference between the noncooperative and cooperative product standards is the presence of the multiplier λ_g in equation (7). Note that $\lambda_g > 0$ even if $\gamma_{ig} = 0$, thus the agreement changes standards for both political and environmental reasons, a finding that we explore more thoroughly below. For now, just notice that all producers have a common interest in loosening product standards, since they all benefit from the resulting increase in the world price.

Also note that, since the demand semi-elasticities σ_{ig} in general depend on prices, and the agreement changes prices, we cannot immediately infer from equations (4) and (7) whether the agreement loosens or tightens standards.[24] We investigate this question next.

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[23]It is natural to ask whether there are restrictions on the fundamentals that ensure the uniqueness of a stationary point. Addressing this question from an analytical standpoint is hard, so we turned to a numerical approach to investigate the shape of the objective function in a two-country world. More specifically, letting $p_g(\mathbf{e}_g)$ denote the market-clearing world price as a function of the standards, the objective function can be written as $\Omega_g(\mathbf{e}_g, p_g(\mathbf{e}_g))$. For the abatement cost function we considered a constant-elasticity specification, and for the demand and supply functions we considered three alternative specifications: constant semi-elasticity, constant elasticity, and linear. In each case we explored the shape of $\Omega_g(\mathbf{e}_g, p_g(\mathbf{e}_g))$ for a large number of parameter configurations. Consistent with our assumptions, we focused on parameter values such that the optimal standards are nonprohibitive (i.e. where the a_{ig} parameters are not too large). For all parameter configurations we examined, we found the objective function to always have a unique interior maximum. A final observation is that, while the case of two countries is convenient because it allows for a visual inspection of the shape of the objective function, it seems reasonable to expect similar findings with a larger number of countries, because the cooperative objective function is the joint government payoff, and so its structure is similar regardless of the number of countries. This is clearly true, for example, if countries are symmetric, because in this case the joint payoff is the same regardless of the number of countries the world is divided into.

[24]To simplify some of the proofs, we make the technical assumptions that the semi-elasticities σ_{ig} and ε_{ig} are bounded above and bounded away from zero.

2.4 What does the agreement do?

We now examine how the agreement changes product standards relative to the noncooperative equilibrium. Here we take a heuristic approach, relegating the formal arguments to the appendix.

We start with a local argument. Let us consider the international externalities caused by a change in product standards starting from the noncooperative equilibrium. Suppose a positive measure of countries loosens their standards. This pushes up the world price by boosting demand.[25] How does this affect the joint payoff of all governments? Differentiating the joint government payoff Ω_g with respect to the world price p_g and evaluating the expression at the noncooperative standards (4), we obtain:

$$\frac{\partial \Omega_g}{\partial p_g}|_{NE} = \int_i \left(\gamma_{ig} y_{ig} + a_{ig} e^N_{ig} \sigma_{ig} d_{ig} \right) > 0 \tag{8}$$

The first term is positive and captures the beneficial effect of an increase in the world price for producers worldwide. The second term is also positive and is due to the fact that an increase in the world price reduces consumption and thereby mitigates the local environmental externality in all countries. Thus the aggregate international externality from loosening product standards is positive for two reasons, a political one and an environmental one. It is this externality that the international agreement internalizes, as reflected in formula (7).

Having argued that, when starting from the noncooperative equilibrium, the aggregate international externality from loosening product standards is positive, one can then show that the "best local agreement" entails increasing e_{ig} for all countries, where the best local agreement is defined as the local change in product standards that achieves the steepest rate of improvement in the objective starting from noncooperative standards. Intuitively, if we marginally loosen standards in a group of countries starting from noncooperative levels, this causes a first-order positive externality on the other countries (as we argued above), while the loss for the countries loosening their standards is second-order, because they were starting from unilaterally-optimal levels, therefore the joint payoff Ω_g increases.

The next question is whether the local result above holds also globally. We can show that the globally optimal agreement loosens all product standards at least if one of the

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[25] To see this, differentiate the market clearing condition to get $dp_g = \frac{\int_i d'_{ig}\phi'_{ig} de_{ig}}{\int_i (y'_{ig} - d'_{ig})}$. Noting that each term of the integral in the numerator has the same sign as de_{ig}, it follows that if any subset of countries loosens their standards, the world price goes up.

following sufficient conditions are satisfied: (i) demand semi-elasticities σ_{ig} do not increase too much with the price, or (ii) countries are not too asymmetric, or (iii) lobbying pressures are sufficiently strong. We emphasize that these are three alternative sufficient conditions, and none of them is necessary.[26]

Here and throughout the paper, we consider proportional changes in all political parameters γ_{ig}, by letting $\gamma_{ig} = \gamma_g \cdot \nu_{ig}$ (with $\nu_{ig} > 0$ for all i, g) and varying the scaling factor γ_g. So when we say that lobbying pressures are sufficiently strong we mean that γ_g is sufficiently large.

The following proposition summarizes the positive effects of the equilibrium agreement. The proof of this and all subsequent propositions can be found in Appendix B.

Proposition 1 *The equilibrium agreement loosens all product standards, at least if demand semi-elasticities σ_{ig} do not increase too steeply with the price,* or *countries are not too asymmetric,* or *the strength of lobbying γ_g is sufficiently high.*

Our model thus yields a sharp result: international cooperation on product standards leads to de-regulation. The intuition behind this result is that, if a group of countries loosen their product standards, the world price goes up because demand increases, and this in turn generates two externalities on other countries: it benefits producer lobbies (political externality) and it mitigates local pollution (environmental externality).

Note that, while in our setting the purpose of an international agreement is to deal with international externalities that travel through world prices, there is a fundamental difference between the motives behind an agreement in our model and in the standard terms-of-trade theory. In our model, the purpose of an agreement is not to prevent individual countries from manipulating world prices, because individual countries are small. Rather, the agreement is motivated by lobbying pressures and by environmental externalities. In Section 4 we will extend the model to the case of large countries, where terms-of-trade motivations for an agreement are also present.

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[26]To understand intuitively the role of the sufficient condition on σ_{ig}, compare the formulas for the non-cooperative and cooperative standards, (4) and (7). Cooperation has a direct effect and an indirect effect on the standard levels. The direct effect is captured by the fact that the positive quantity λ_g enters the latter formula but not the former. This pushes toward looser standards, which in turn pushes up the world price. This price change may have an indirect effect through σ_{ig}, but this is guaranteed not to outweigh the direct effect if σ_{ig} does not increase too steeply. Next notice that, as γ_g becomes very large, so does λ_g, and this is an alternative way to guarantee that the indirect effect cannot undo the direct effect. Finally, if countries are symmetric, the cooperative problem becomes effectively one-dimensional (choosing a symmetric standard), and in this case the assumption that the cooperative objective is single-peaked is sufficient to ensure that the local result holds also globally.

2.5 Is it good for welfare?

Recall from the discussion above that there are two motives for an agreement on product standards: a political reason and an environmental reason. Letting $\Delta_g \equiv W_g^A - W_g^N$ denote the (positive or negative) welfare change caused by the agreement relative to the noncooperative equilibrium, the political motive pushes Δ_g down, since lobbying pressures distort product standards in the cooperative scenario but not in the noncooperative scenario. The environmental motive, on the other hand, pushes Δ_g up: intuitively, if lobbying pressures were absent the agreement would be motivated just by welfare considerations, and hence Δ_g would be positive.

We illustrate the welfare implications of the agreement intuitively by focusing on the case in which countries are symmetric, and later we extend the result to the case of asymmetric countries. The key argument for the case of symmetric countries can be illustrated with the help of Figure 1.[27]

Figure 1: Product Standards
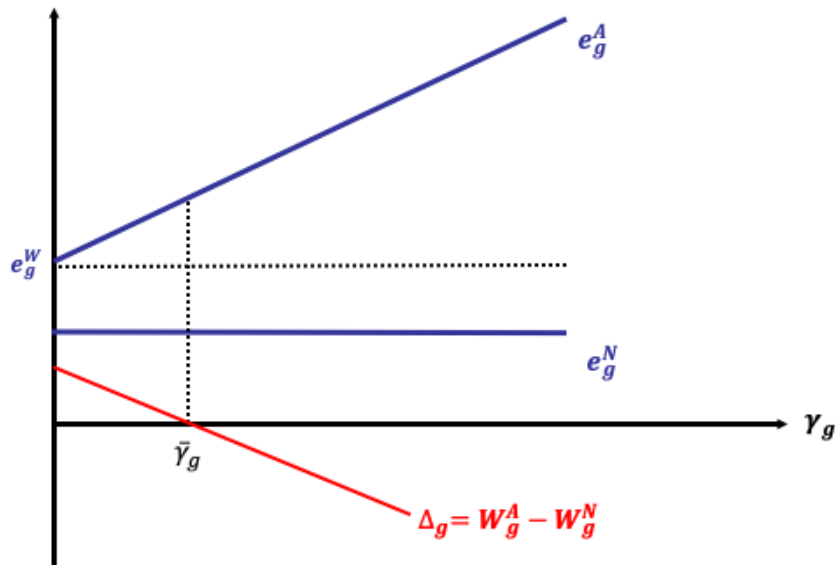
This figure draws the noncooperative standards e_g^N and the cooperative standards e_g^A as functions of the political-economy parameter γ_g. It also shows the welfare-maximizing standards e_g^W and the welfare gain from the agreement, $\Delta_g = W_g^A - W_g^N$.

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[27] The key features of Figure 1 are proved in Appendix B, within the proof of Proposition 2. In what follows we provide an intuitive explanation.

First note that the noncooperative standards do not depend on γ_g and are tighter than the welfare-maximizing standards $(e_g^N < e_g^W)$.[28] Intuitively, starting from the noncooperative equilibrium, loosening standards in a group of countries has a positive welfare externality on other countries, because it increases the world price and in turn mitigates the local consumption externalities in other countries. As a consequence, noncooperative standards are too tight from the welfare point of view.

The cooperative standards e_g^A coincide with e_g^W for $\gamma_g = 0$ and are increasing in γ_g. Intuitively, stronger lobbying pressures lead to looser cooperative standards because producers worldwide benefit from a rise in the world price.

The welfare gain from the agreement (Δ_g) is of course positive at $\gamma_g = 0$, but is decreasing in γ_g and it becomes negative as γ_g crosses a critical value $\bar{\gamma}_g$. Intuitively, as γ_g increases, cooperative standards get looser and looser, and at some point the implied welfare distortion exceeds the welfare distortion in the over-tight noncooperative standards.

The result illustrated above for the case of symmetric countries extends to the case of asymmetric countries, albeit in a slightly weaker version. As before, we vary all political parameters proportionally by a scaling factor γ_g. In general it is not guaranteed that there is a unique value of γ_g for which $\Delta_g = 0$ as in Figure 1, but we can prove the following:

Proposition 2 *Cooperation on product standards increases global welfare if γ_g is sufficiently low, and decreases global welfare if γ_g is sufficiently high.*

In our model international cooperation on product standards leads to de-regulation. If lobbying pressures are weak, such de-regulation is mild and actually increases welfare, because non-cooperative standards are too tight from the welfare point of view, but if lobbying pressures are strong, the agreement leads to excessive de-regulation and damages welfare.

A key mechanism that underlies the result of Proposition 2 is that international cooperation induces "co-lobbying" by producers across countries: loosening product standards in any group of countries is in the interest of all producers world-wide, since they all share a common interest in boosting the world price. Because of this feature, international cooperation intensifies the impact of lobbying on regulations relative to the noncooperative scenario. In our small-country setting, this mechanism is made sharper by the fact that lobbying has zero impact in the noncooperative scenario, but as we will see in Section 4 the same logic

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[28]This is an immediate corollary of Proposition 1, since the welfare-maximizing standards coincide with the cooperative standards when $\gamma_g = 0$.

applies in a large-country setting where lobbying has an impact also in the noncooperative scenario.[29]

2.6 Product standards and consumption taxes

We now return to a question raised earlier: how would our results change if consumption taxes were available?

Note that one way to implement the welfare optimum is to combine product standards with consumption taxes. To derive the optimal combination of product standards and consumption taxes, first note that such combination must be equivalent to the Pigouvian emission-contingent tax schedule $t_{ig}(e_{ig}) = a_{ig}e_{ig}$; this is the tax that internalizes the consumption externality for a given variety e_{ig}. Given this tax schedule, consumers will buy only the variety with the lowest consumer price. Since the incidence of abatement costs falls on consumers, the consumer price in the presence of the Pigouvian emission-contingent tax is $p_g + \phi_{ig}(e_{ig}) + a_{ig}e_{ig}$. Thus the variety that consumers will buy is defined by the first order condition $\phi'_{ig}(e_{ig}) = -a_{ig}$. This is the first-best variety. Thus the first best can be implemented by the product standard $e_{ig}^{fb} = \phi'^{-1}(-a_{ig})$ and the corresponding Pigouvian consumption tax $t_{ig}^{fb} = a_{ig}e_{ig}^{fb}$.

A key point is that, since countries are small, this combination of product standard and consumption tax $(e_{ig}^{fb}, t_{ig}^{fb})$ maximizes not only global welfare, but also unilateral welfare. And given that lobbying is immaterial for unilateral policies, since product standards and consumption taxes cannot affect local producer surplus, these are the noncooperative equilibrium policies regardless of the lobbying parameters γ_{ig}. It is then an immediate corollary that the cooperative policies must decrease welfare relative to the noncooperative policies.[30]

Thus the availability of consumption taxes makes the conclusion more pessimistic: inter-

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[29] The logic of co-lobbying can be further understood with the following thought experiment. Suppose that, rather than increasing all the political parameters γ_{ig}, we increase them only for a group of countries (say group A), while holding constant the parameters of the remaining countries (group B), and think about how this affects cooperative standards. It is easy to show that increasing the strength of lobbying in group A leads to looser cooperative standards not only for group A but also for group B, at least if the political parameters γ_{ig} in group A become large enough. As we will see in the next section, this effect will be reversed in the case of process standards, which is characterized by counter-lobbying: there, increasing the strength of lobbying in group A will tend to loosen cooperative standards in group A while tightening those in group B.

[30] It is direct to verify that the cooperative taxes and standards are respectively given by $t_{ig}^A = a_{ig}\phi'^{-1}(-a_{ig}) - \frac{\int_i \gamma_{ig}y_{ig}}{\int_i \varepsilon_{ig}y_{ig}}$ and $e_{ig}^A = \phi'^{-1}(-a_{ig})$. Note that lobbying distorts only the consumption taxes (downwards), not the standards. The reason is that, conditional on consumption taxes and product standards being the only available instruments, lowering the consumption tax while keeping the variety e_{ig} at the first-best level is the least distortionary way to increase the world price.

national cooperation on product standards in this case is bad for welfare as long as there is any lobbying, and the welfare loss is worse if lobbying pressures are stronger. At the same time, however, it is important to keep in mind that our model abstracts from potentially important motives for international agreements, such as the presence of large countries or international pollution externalities, which can change the sign of the welfare effect of the agreement (Δ_g). The result that is arguably more robust and we wish to emphasize is not about the sign of Δ_g, but rather, the prediction that Δ_g tends to decrease with γ_g: increasing the power of lobbies tends to decrease the welfare gains, or increase the welfare losses, from the agreement.

A final observation concerns the rationale for international agreements. In our setting governments cannot use production subsidies to transfer income to producer groups. If production instruments were available, in the noncooperative scenario each government would address their political-economy concerns by using production subsidies, and would address local externalities efficiently by using consumption taxes and standards (as highlighted above), and as a consequence there would be no role for international agreements. But absent production subsidies, governments resort to international regulatory cooperation to manipulate world prices, as a way to transfer income to producer groups. Note also that *a fortiori* there would be no role for international agreements if governments could make lump sum transfers to their producers, since this would be a more efficient redistribution policy than production subsidies. Thus our setting highlights a new rationale for international agreements: if governments cannot use first-best or even second-best redistribution policies (i.e. lump sum transfers or production subsidies), they distort regulatory policies to make producer groups richer, and they do so in concert through international agreements.[31]

3 Process standards

We now turn our attention to international agreements on process standards, which are defined as restrictions on production processes that take place on domestic soil. Examples include environmental regulations for factories and safety standards for workers. As discussed above, process standards of this kind have been an important focus of many deep agreements in recent history.

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[31]It is important to note that, if countries are large, there is always a classic terms-of-trade rationale for an international agreement, even if governments can use a complete set of policy instruments. In such a setting, the incompleteness of policy instruments creates an *additional* rationale for international agreements.

To provide a welfare rationale for process standards we allow for local production externalities. To make our points in the most transparent way, in this section we focus on a setting where process standards are the only policy instruments and production externalities are the only market failures.

3.1 Setup

We now assume that each good g is homogenous but can be produced with a continuum of technologies $z_g \in [0, \infty)$, indexed by their "dirtiness." Dirtier production processes are cheaper: producers in country i incur a per-unit abatement cost $\varphi_{ig}(z_g)$ in terms of the numeraire good if they use technology z_g. We assume, in analogy with the case of product standards, that $\varphi_{ig}(z_g)$ is strictly positive for all z_g, decreasing and convex, with $\lim_{z_g \to \infty} \varphi_{ig}(z_g) = 0$ and $\lim_{z_g \to 0} \varphi_{ig}(z_g) = \infty$.[32]

From the point of view of an individual producer, aside from the abatement cost all technologies are identical.

Production generates a negative externality, which is worse for dirtier processes (higher z_g). For concreteness we will focus on pollution externalities as our running example. Since each producer is atomistic and hence does not take into account the pollution externality, the supply of good g in country i depends only on the local producer price p_{ig}^p, and will be denoted $y_{ig}(p_{ig}^p)$.

As will become clear, a single technology is used in equilibrium in each country i, say technology z_{ig}. Producing y_{ig} units with technology z_{ig} generates local pollution $z_{ig}y_{ig}$. This could be for example the amount of emissions from factories in country i. The disutility caused by a unit of pollution to the representative consumer of country i is constant and denoted by b_{ig}, so the local externality is given by $-b_{ig}z_{ig}y_{ig}(p_{ig}^p)$.[33]

Each country i chooses emission standards $\{z_{ig}\}_{g \in \mathcal{G}}$ for production activity that takes place on domestic soil. These can be interpreted as emission caps, since caps are always binding; recall that adopting a cleaner technology is costly and does not directly benefit an individual producer.

Due to consumer arbitrage, the consumer price is the same across the world, and we denote it by p_g. This can be interpreted as the "world" price in this setting. The producer price net of abatement costs, on the other hand, is $p_{ig}^p = p_g - \varphi_{ig}(z_{ig})$. Thus, if an individual

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[32]Our results extend to the case in which $\varphi_{ig}(0)$ is finite, as long as it is large enough.

[33]As in the previous section, we are implicitly assuming that the disutility from pollution enters utility in a separable way.

country i tightens its process standards, the associated cost falls entirely on its producers. Note the contrast with the case of product standards, where the cost of tighter standards falls on consumers.

Government i's objective can be written as:

$$\Omega_i = \sum_{g \in \mathcal{G}} \left[(1 + \gamma_{ig}) \pi_{ig} \left(p_g - \varphi_{ig}(z_{ig}) \right) + S_{ig} \left(p_g \right) - b_{ig} z_{ig} y_{ig} \left(p_g - \varphi_{ig}(z_{ig}) \right) \right],$$

Note that, just as in the case of product standards, process standards are second-best policies, because given the process z_{ig} producers do not internalize the production externality.

3.2 Noncooperative process standards

In the noncooperative scenario, government i chooses the process standard in sector g according to:

$$\max_{z_{ig}} \Omega_{ig} = \left(1 + \gamma_{ig} \right) \pi_{ig} \left(p_g - \varphi_{ig}(z_{ig}) \right) + S_{ig} \left(p_g \right) - b_{ig} z_{ig} y_{ig} \left(p_g - \varphi_{ig}(z_{ig}) \right) \quad (9)$$

As in the previous section, we assume that the optimal unilateral standards are nonprohibitive. This assumption is satisfied as long as the b_{ig} parameters are not too large. It is easy to verify that the first-order conditions imply

$$z_{ig} = \frac{1}{\varepsilon_{ig}} \left(\frac{1 + \gamma_{ig}}{b_{ig}} + \frac{1}{\varphi'_{ig}} \right) \quad \text{for all } i, \quad (10)$$

The market clearing condition can be written as:

$$\int_i y_{ig} \left(p_g - \varphi_{ig}(z_{ig}) \right) = \int_i d_{ig} \left(p_g \right). \quad (11)$$

The noncooperative equilibrium process standards and world price for good g solve equations (10) and (11). We assume that the solution to this system of equations exists and is unique, and denote it $\left(\{ z_{ig}^N \}, p_g^N \right)$.[34]

A key difference between product and process standards can already be noted from (10): unlike the case of product standards, unilateral process standards *are* influenced by lobbies. The reason is that the process standard adopted by country i directly affects the local producer price, so to the extent that local producers have political power, they will push for

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[34] A sufficient (but not necessary) condition on the fundamentals that guarantees the existence and uniqueness of the noncooperative equilibrium is that the supply semi-elasticities ε_{ig} do not decrease too much with the price. This claim is proved in Appendix A.

looser standards.[35] Also note that, intuitively, a country's standards are tighter when the externality weights are higher, when the marginal abatement cost is lower and when supply is more elastic.

3.3 Cooperative process standards

In the cooperative scenario, governments maximize their joint payoff taking into account the effect of process standards on world prices. Thus cooperative process standards in sector g solve:

$$\max_{\{z_{ig}\}, p_g} \Omega_g = \int_i \left[\left(1 + \gamma_{ig}\right) \pi_{ig} \left(p_g - \varphi_{ig}(z_{ig})\right) + S_{ig}\left(p_g\right) - b_{ig} z_{ig} y_{ig} \left(p_g - \varphi_{ig}(z_{ig})\right) \right] \quad (12)$$

$$\text{s.t.} \quad \int_i y_{ig} \left(p_g - \varphi_{ig}(z_{ig})\right) = \int_i d_{ig}\left(p_g\right)$$

As in the noncooperative scenario, we assume that the optimal standards are nonprohibitive, so that we can rely on a standard Lagrangian approach.[36] It is easy to check that the cooperative process standards and world price for good g satisfy the following conditions (omitting the arguments of the various functions for simplicity):

$$z_{ig} = \frac{1}{\varepsilon_{ig}} \left(\frac{1 + \gamma_{ig}}{b_{ig}} + \frac{1}{\varphi'_{ig}} \right) - \frac{\lambda_g}{b_{ig}} \quad \text{for all } i \quad (13)$$

$$\lambda_g = \frac{\int_i y_{ig} \left(\gamma_{ig} - b_{ig} z_{ig} \varepsilon_{ig}\right)}{\int_i \varepsilon_{ig} y_{ig} + \int_i \sigma_{ig} d_{ig}}$$

$$\int_i y_{ig} = \int_i d_{ig},$$

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[35]Note that, if we increase the local producers' power γ_{ig} all else equal, z_{ig}^N gets looser, but if we increase producer powers in all countries at the same time, the world price will go down, and this may in turn affect the supply elasticity ε_{ig}. This will dampen or reinforce the impact on z_{ig}^N, depending on whether ε_{ig} increases or decreases with the price.

[36]Relative to the case of product standards, where standards can be prohibitive only if the externality weights are large, here there is an additional possibility that may give rise to prohibitive process standards, namely the presence of large cross-country asymmetries, especially in the political parameters γ_{ig}. To see this, suppose lobbying is very strong in a group of countries (say group A) and very weak in another (say group B). Then cooperative standards may be prohibitive for group B, because tightening standards in this group of countries raises the world price, so it benefits producers in group A at the expense of group B. This is a manifestation of "counter-lobbying" in international negotiations, which we discuss further below. A sufficient condition that rules out prohibitive process standards is that the b_{ig} parameters are not too large and countries are not too asymmetric.

where λ_g denotes the Lagrange multiplier. We assume there exists a unique solution to the system of first order conditions above.[37]

The key difference between noncooperative and cooperative process standards is the presence of the multiplier λ_g in equation (13). Note that λ_g is positive if $\gamma_{ig} > b_{ig}z_{ig}\varepsilon_{ig}$ for all i. This suggests that the agreement will tighten standards if lobbying pressures are sufficiently strong, and loosen standards if lobbying pressures are sufficiently weak. Intuitively, the agreement changes process standards for both political and environmental reasons, as in the case of product standards, but these two forces now push in opposite directions: the political motive pushes for a tightening of standards, because this would increase the world price and hence benefit all producers, while the environmental motive pushes for a loosening of standards, because this would decrease the world price and hence reduce production and pollution.

The intuition offered just above, however, does not take into account the fact that the expression for λ_g depends on the optimal standards z_{ig} themselves (as well as the supply elasticities, which in general depend on prices). Thus we need to go a bit deeper with the analysis.

3.4   What does the agreement do?

To examine how the agreement changes process standards, we start by considering the international externalities caused by a change in process standards when starting from the noncooperative equilibrium. If a positive measure of countries tightens their standards, this reduces supply and hence pushes up the world price.[38] How does this affect the joint payoff of all governments? Differentiating the joint government payoff Ω_g with respect to p_g and evaluating at the noncooperative standards, we obtain:

$$\frac{\partial \Omega_g}{\partial p_g}|_{NE} = \int_i \left(\gamma_{ig} y_{ig} - b_{ig} z_{ig}^N \varepsilon_{ig} y_{ig} \right) \tag{14}$$

The first term of (14) is positive and is due to the political externality exerted by the increase in the world price. The second term is negative and is due to the fact that a higher

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[37] As in the case of product standards, we used numerical methods to investigate under what conditions the objective function has a unique interior maximum, focusing on a two-country world. We followed an analogous approach to the one described in footnote 23, and again we restricted our attention to parameter values such that the optimal standards are nonprohibitive. For all parameter configurations we examined, the objective function always had a unique interior maximum.

[38] To see this, differentiate the market clearing condition to get $\frac{\int_i y'_{ig} \varphi'_{ig} dz_{ig}}{\int_i \left(y'_{ig} - d'_{ig} \right)}$. Noting that each term of the integral in the numerator has the opposite sign as dz_{ig}, it follows that if a positive measure of countries reduce their z's, the world price goes up.

world price stimulates supply, thus increasing pollution world-wide. Intuitively, if lobbying pressures are sufficiently strong the net externality should be positive, thus the agreement should tighten standards relative to the noncooperative equilibrium, while if lobbying pressures are sufficiently weak, the net externality should be negative, so the agreement should loosen standards.

We can confirm this intuition, in the following sense. Consider a proportional change in the political parameters, by letting $\gamma_{ig} = \gamma_g \nu_{ig}$ and varying the scaling factor γ_g (as in the previous section). First, it is obvious that if γ_g is small enough then $\frac{\partial \Omega_g}{\partial p_g}|_{NE} < 0$. Next note that, in the limit as $\gamma_g \to \infty$, the problem becomes equivalent to maximizing $\int_i \nu_{ig} \pi_{ig}$, and the derivative of this function with respect to p_g is clearly positive. It is then a small step to conclude, using a similar logic as in the previous section, that the best local agreement loosens all standards if γ_g is sufficiently small and tightens all standards if γ_g is sufficiently large.

If γ_g is large, we are able to show that the local result above holds globally, without need for any additional condition. If γ_g is small, we can show that the local result is guaranteed to hold globally if the supply semi-elasticities ε_{ig} do not decrease too much with the price *or* countries are not too asymmetric (these are two alternative sufficient conditions, neither of which is necessary).[39] The following proposition summarizes:

Proposition 3 *(i) The equilibrium agreement loosens all process standards for sufficiently small γ_g, at least if countries are not too asymmetric or the supply semi-elasticities ε_{ig} do not decrease too much with the price; (ii) The equilibrium agreement tightens all process standards for sufficiently large γ_g.*

Thus the model predicts that international cooperation on process standards leads to deregulation if lobbying is weak, but tightens regulations if lobbying pressures are strong. One way to interpret this result is that, when lobbying is strong, the non-cooperative equilibrium entails a "race to the bottom," and the agreement acts to counter-balance this tendency. But note that what drives the cooperative tightening of standards is the influence of producer groups themselves.

It may also be interesting to note that, even though the nature of the international externalities exerted by process standards is quite different relative to the case of product

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[39] The intuition behind these sufficient conditions is similar to the corresponding conditions for the case of product standards: see footnote 26.

standards examined in the previous section, if governments maximize welfare ($\gamma_g = 0$) then the agreement loosens standards in both cases. To understand this feature, note that (i) in the case of process standards the externality from an increase in the world price is negative, as can be seen from (14), while in the case of product standards it is positive, as can be seen from (8); but (ii) the world-price impact of tightening standards is also reversed: tightening product standards raises local consumer prices, hence reduces local demand and puts downward pressure on world prices; while tightening process standards reduces local producer prices, hence reduces local supply and puts upward pressure on world prices. Thus the sign of the overall international externality generated by a tightening of standards is the same in both cases. Formally (and with a slight abuse of notation) we can write the overall international externality in the case of process standards as $\frac{\partial \Omega}{\partial p} \frac{\partial p}{\partial z}$, where the change in z applies to a positive measure of countries. Given the observations above, if $\gamma_g = 0$ then $\frac{\partial \Omega}{\partial p} < 0$ and $\frac{\partial p}{\partial z} < 0$, thus $\frac{\partial \Omega}{\partial p} \frac{\partial p}{\partial z} > 0$. In the case of product standards, on the other hand, $\frac{\partial \Omega}{\partial p} > 0$ and $\frac{\partial p}{\partial e} > 0$, thus $\frac{\partial \Omega}{\partial p} \frac{\partial p}{\partial e} > 0$.

We are now ready to address the question of how international cooperation on process standards affects global welfare.

3.5   Is it good for welfare?

We start by describing briefly our main result and its underlying logic. We will show that the equilibrium agreement increases welfare if γ_g is sufficiently small or sufficiently large, and may decrease welfare for intermediate values of γ_g. The starkest difference with respect to our earlier result for product standards is the fact that, when political pressures are strong (γ_g large), a deep agreement is bad for welfare in the case of product standards, while it is good for welfare in the case of process standards. The fundamental reason for this difference is that the interests of producers around the world are no longer aligned when it comes to process standards, since each producer lobby prefers weak regulations at home and strict regulations abroad. As a result, the agreement now brings about counter-lobbying, thereby diluting the overall effect of lobbying on process standards.

We now illustrate in more detail the logic behind our result. We start by focusing on the special case in which countries are symmetric and the semi-elasticities of supply and demand are constant, and then we extend the result to the more general case. We illustrate our arguments with the help of Figure 2.[40]

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[40]The key features of Figure 2 are proved in Appendix B, within the proof of Proposition 4.

Figure 2: Process Standards
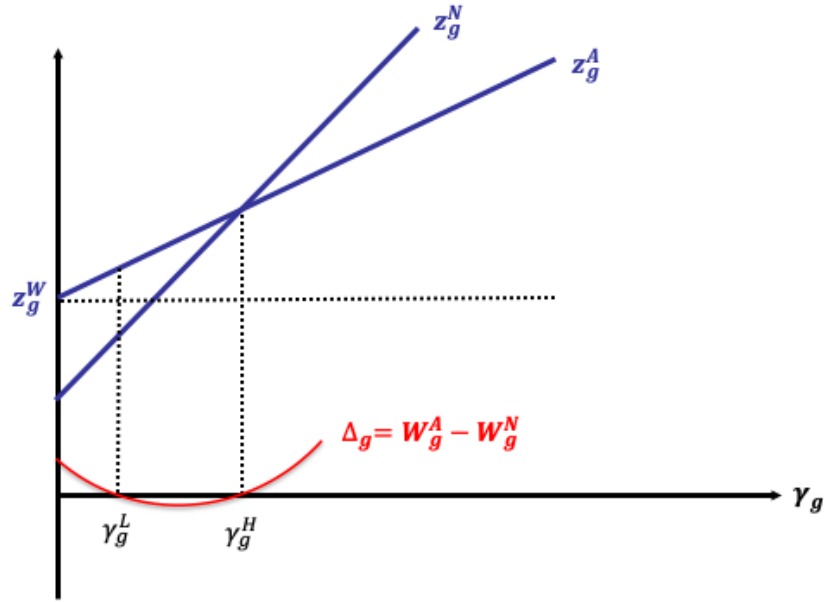
This figure shows the noncooperative standards z_g^N, the cooperative standards z_g^A and the welfare maximizing standards z_g^W as functions of γ_g, as well as the welfare change from the agreement, $\Delta_g = W_g^A - W_g^N$.

Absent lobbying pressures $(\gamma_g = 0)$, noncooperative process standards are too tight from the welfare point of view $(z_g^N < z_g^W)$, since governments do not internalize the negative international externality caused by tightening standards. As γ_g increases, noncooperative standards become looser, since loosening standards unilaterally benefits local producers. The cooperative standards z_g^A coincide with the welfare-maximizing standards z_g^W when $\gamma_g = 0$ and are also increasing in γ_g.[41] However, the z_g^A schedule is flatter than the z_g^N schedule, since in the cooperative scenario governments internalize the negative political terms-of-trade externality from loosening standards, and such externality becomes stronger as γ_g increases. This captures the counter-lobbying intuition we mentioned earlier: looser domestic standards harm the interests of producers abroad, thus cooperation moderates the loosening of standards that is brought about by increases in lobbying pressures.[42]

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[41]Recall that the equilibrium producer price given a symmetric standard z_g is $p_g - \varphi_g(z_g)$. It is easy to show that the marginal effect of a change in z_g on the world price p_g is less than $\varphi_g'(z_g)$, thus a symmetric loosening of standards benefits producers.

[42]To further clarify the logic of counter-lobbying, consider the following thought experiment (analogously to the case of product standards, see footnote 29). Suppose we increase the strength of lobbying γ_{ig} for a

The welfare change from the agreement (Δ_g) is of course positive at $\gamma_g = 0$, but more interestingly, it must be positive again for γ_g large enough. The latter statement follows from the fact that if γ_g is large enough then $z_g^N > z_g^A > z_g^W$, together with the assumption that welfare has a unique stationary point (given by z_g^W). Furthermore, Δ_g must be negative for an intermediate range of γ_g (in Figure 2 the interval between γ_g^L and γ_g^H), because the noncooperative standards coincide with the welfare-maximizing standards for a critical value of γ_g. Thus the welfare change from the agreement is non-monotonic, being positive if lobbying pressures are low or high, but negative when lobbying pressures are intermediate.[43]

The result illustrated just above generalizes to the case of asymmetric countries and variable semi-elasticities, albeit in a slightly weaker version. The only change is that in general there may or may not be an intermediate range of γ_g for which the agreement decreases welfare. In order to state the more general result, we consider as usual a proportional change in all political parameters γ_{ig}, with γ_g denoting the scaling factor:

Proposition 4 *Cooperation on process standards increases global welfare if γ_g is sufficiently low or sufficiently high, and may decrease global welfare for intermediate values of γ_g.*

As discussed above, the result that the equilibrium agreement increases global welfare when lobbying is strong enough contrasts sharply with the case of product standards, and the basic reason is that international negotiations bring about counter-lobbying between the domestic producers of a given country and the producers in the remaining countries.

It is worth emphasizing a subtle aspect of the result in Proposition 4: in spite of the countervailing-lobbying effect, the agreement may decrease welfare for an intermediate range of lobbying pressures (and as noted above, this intermediate range of γ_g is guaranteed to exist if countries are symmetric). The intuition is the following: if governments are welfare-maximizers ($\gamma_g = 0$), noncooperative standards are too tight, so a moderate amount of political pressures makes noncooperative standards more efficient, and there is a critical level of γ_g that makes them exactly efficient ($z_g^N = z_g^W$ in Figure 2). Clearly, then, for γ_g close to this critical level the agreement must be bad for welfare.

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group of countries (group A), while holding them constant for the remaining countries (group B). It is easy to show that this now loosens cooperative standards for group A but tightens them for group B, at least in the limit when the political parameters γ_{ig} in group A become very large.

[43]Note that, while lobbying pressures are always detrimental for welfare if they are strong enough (both in the noncooperative and cooperative scenarios), a *moderate* amount of lobbying may increase welfare in the noncooperative scenario. This is clear from Figure 2: when $\gamma_g = 0$ non-cooperative standards are too tight from the welfare point of view, thus a moderate amount of lobbying pushes them closer to their efficient levels. This provides an important qualification to the general intuition that international agreements tend to increase welfare if they dilute the influence of lobbies on policy-making. See also footnote 3 above.

It is also interesting to compare the impact of the power of lobbies on the welfare change from the agreement (Δ_g) with the case of product standards. Recall that, in the case of product standards, increasing the power of lobbies reduces Δ_g (see Figure 1). Here the answer is different and more subtle, as Figure 2 suggests: increasing the power of lobbies initially worsens the welfare impact of the agreement, but this effect is reversed as the power of lobbies becomes large.[44]

A final observation concerns the link between the notion of counter-lobbying and the welfare impact of the agreement. In our setting the presence of counter-lobbying plays a key role for the result that the agreement improves welfare when lobbying is strong, but this link is not automatic and may not hold in other policy settings. With reference to Figure 2, the presence of counterlobbying implies that the $z_g^A(\gamma_g)$ schedule increases more slowly than the $z_g^N(\gamma_g)$ schedule, but the $z_g^A(\gamma_g)$ schedule is still increasing, because a symmetric loosening of standards benefits all producers. In other words, increasing γ_g affects the noncooperative and cooperative standards in the same direction. It is this feature, in conjunction with counterlobbying, that leads to the conclusion that the agreement increases welfare for γ_g large enough. But it is not hard to imagine settings characterized by counter-lobbying where γ_g has opposite effects on the noncooperative and cooperative policies, and if this is the case the agreement can decrease welfare when γ_g is large. Thus our results should be interpreted as applying to settings where lobbying pressures affect the noncooperative and cooperative policies in the same direction.

4   Large Countries

We now extend our analysis to the case of large countries. To this end, we replace our assumption that there is a continuum of small countries with the assumption that there are N large countries. Otherwise, we leave our setup unchanged.

The key implication of this modification is that *individual* countries now have market power in world markets and are thus able to manipulate world prices. As one would expect, this shows up in the formulas for noncooperative standards but leaves the formulas for cooperative standards essentially unchanged. Note that countries were able to *jointly*

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[44]The reader might wonder how our results on process standards would change if we allowed for production taxes. But recall that if production subsidies (i.e. negative production taxes) were available, lobbies would focus only on production subsidies, thus the model would have nothing to say about the impact of lobbying on regulations. For this reason we follow most of the literature in assuming away production taxes/subsidies. See also footnote .

control world prices even in our baseline model, and indeed this was the reason they pursued international agreements.

In what follows we summarize and discuss our results at an intuitive level, relegating the formal analysis to Appendix C.

We begin with the case of product standards. Defining imports $m_{ig} \equiv d_{ig} - y_{ig}$, it is easy to show that the formulas for noncooperative and cooperative product standards become respectively:

$$e_{ig}^N = \frac{1}{\sigma_{ig}} \left(\frac{1}{a_{ig}} + \frac{1}{\phi_{ig}'} \right) + \frac{\lambda_{ig}^N}{a_{ig}} \text{ for all } i, \tag{15}$$
$$\text{where } \lambda_{ig}^N = \frac{\gamma_{ig} y_{ig} + a_{ig} e_{ig}^N \sigma_{ig} d_{ig} - m_{ig}}{\sum_i \left(\varepsilon_{ig} y_{ig} + \sigma_{ig} d_{ig} \right)}$$

and

$$e_{ig}^A = \frac{1}{\sigma_{ig}} \left(\frac{1}{a_{ig}} + \frac{1}{\phi_{ig}'} \right) + \frac{\lambda_g^A}{a_{ig}} \text{ for all } i, \tag{16}$$
$$\text{where } \lambda_g^A = \frac{\sum_i \left(\gamma_{ig} y_{ig} + a_{ig} e_{ig}^A \sigma_{ig} d_{ig} \right)}{\sum_i \left(\varepsilon_{ig} y_{ig} + \sigma_{ig} d_{ig} \right)}.$$

The key difference relative to our baseline model is the Lagrange multiplier λ_{ig}^N in the formula for noncooperative standards (15). Note that the Lagrange multiplier λ_g^A in the formula for cooperative standards (16) is the sum of the noncooperative Lagrange multipliers, since $\sum_i m_{ig} = 0$, except that they are evaluated at different standards. This illustrates that individual countries now leverage their market power in a similar way as all countries do combined, with the key difference that individual countries only care about the effects of world price changes on their own economy.

It is instructive to begin the discussion by focusing on the special case of symmetric countries. In this case, there is no trade in equilibrium and thus no incentive to manipulate the terms-of-trade. This allows us to isolate a first new effect: since unilateral changes in standards now affect world prices, they now affect consumers *and* producers. Recall that in the baseline model, unilateral changes in product standards only affected consumers.

To understand the shared incidence of product standards, suppose a country unilaterally loosens its product standards. Just as in our baseline model, this reduces local consumer prices by reducing abatement costs. But now it also increases local (as well as foreign) producer prices, since the resulting boost to local consumption pushes up world prices. Hence, the incidence of a unilateral change in product standards is now shared between consumers

and producers. In fact, if the world-price effect is strong, it is even possible that the incidence falls more on producers than on consumers. A key implication of this is that the strength of lobbies now does affect noncooperative product standards, as evidenced by the fact that the political parameter γ_{ig} now enters the corresponding formula through λ_{ig}^N. Recall that in the baseline model there was no lobbying in the noncooperative equilibrium, since the incidence of unilateral changes in product standards was entirely on consumers.

In spite of the new effect just highlighted, in this symmetric case the main qualitative results of our baseline model are preserved, regardless of the way in which the incidence of product standards is shared between consumers and producers. In particular, at the positive level, the equilibrium agreement still loosens all product standards, and at the normative level, it is still true that the equilibrium agreement increases welfare if lobbying is sufficiently weak and decreases welfare if lobbying is strong enough.

To gain intuition, consider the following local argument, in analogy to our discussion in Section 2. Suppose that, starting from the noncooperative equilibrium, country i slightly loosens its standard e_{ig}. This pushes up the world price, and the implied change in the joint payoff of the remaining countries (denoted Ω_g^{-i}) is easily shown to be:

$$\frac{\partial \Omega_g^{-i}}{\partial p_g}|_{NE} = (N-1)\left(\gamma_g y_g + a_g e_g^N \sigma_g d_g\right) > 0$$

Thus, just as in our baseline model, if countries are symmetric the international externality from loosening a standard is positive, because it is composed of a positive political externality and a positive environmental externality. In particular, the political externality is positive because loosening product standards in country i benefits not only producers in country i but also producers in the rest of the world, so the interests of all producer lobbies are aligned. As a consequence, the agreement leads to de-regulation. Furthermore, at the normative level, it is intuitive that if γ_g is large enough such de-regulation is excessive and decreases welfare.

The case of symmetric large countries thus highlights that the main insights of our baseline model do not depend on the incidence of product standards, but rather on the feature that loosening product standards generates positive political and environmental externalities.[45]

We now turn to the case in which countries are asymmetric and trade in equilibrium. This introduces a second new effect, namely that unilateral changes in standards affect the

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[45]Note that the incidence of standards does matter for how lobbying affects noncooperative standards. For example, the feature that in the small-country model lobbying does not affect noncooperative product standards *is* due to the fact that the incidence of product standards falls entirely on consumers. But the direction in which the agreement changes standards relative to the noncooperative levels, as well as the associated welfare impact, does not.

terms-of-trade. As a result, import-competing countries now have an incentive to tighten product standards, other things equal, in order to reduce the world price and thus improve their terms-of-trade at the expense of exporting countries. Conversely, exporting countries now have an incentive to loosen product standards, other things equal, in order to increase the world price and thus improve their terms-of-trade at the expense of import-competing countries. The key implication is that the international agreement now also addresses the issue of terms-of-trade manipulation, in addition to the political and environmental world-price externalities familiar from the analysis above.

A local argument again goes a long way in illustrating the implications of the terms-of-trade motive. As above, suppose country i loosens its standard (e_{ig}) starting from the noncooperative equilibrium. The increase in the world price caused by this change has the following impact on the joint payoff of the remaining countries:

$$\frac{\partial \Omega_g^{-i}}{\partial p_g}|_{NE} = \sum_{j \neq i} \left(\gamma_{jg} y_{jg} + a_{jg} e_{jg}^N \sigma_{jg} d_{jg} \right) + m_{ig} \tag{17}$$

The best local agreement loosens country i's standard if and only if the expression above is positive. The sum on the right-hand side captures the political and environmental externalities familiar from the baseline model, which push toward a cooperative loosening of product standards. The term m_{ig} captures the terms-of-trade motive for the agreement: for importing countries, this reinforces the de-regulation brought about by the agreement, while for exporting countries it reduces de-regulation and may even overturn it, in which case the agreement tightens an exporting country's standards.

If lobbying forces are sufficiently strong, intuitively political motives swamp terms-of-trade motives. Indeed we can show that if the political parameters γ_{ig} are sufficiently large, the globally optimal agreement loosens all product standards and damages welfare, just as in the small-country model. Thus the results of our baseline model are robust to the presence of large countries if political economy forces are strong enough.

We now turn to the model of process standards. In this large country setting, the noncooperative and cooperative process standards can be expressed respectively as:

$$z_{ig}^N = \frac{1}{\varepsilon_{ig}} \left(\frac{1 + \gamma_{ig}}{b_{ig}} + \frac{1}{\varphi_{ig}'} \right) - \frac{\lambda_{ig}^N}{b_{ig}} \text{ for all } i, \tag{18}$$

$$\text{where } \lambda_{ig}^N = \frac{y_{ig} \left(\gamma_{ig} - b_{ig} z_{ig}^N \varepsilon_{ig} \right) - m_{ig}}{\sum_j \left(\varepsilon_{jg} y_{jg} + \sigma_{jg} d_{jg} \right)}$$

and

$$z_{ig}^A = \frac{1}{\varepsilon_{ig}}\left(\frac{1+\gamma_{ig}}{b_{ig}} + \frac{1}{\varphi'_{ig}}\right) - \frac{\lambda_g^A}{b_{ig}} \text{ for all } i, \qquad (19)$$

$$\text{where } \lambda_g^A = \frac{\sum_j y_{jg}\left(\gamma_{jg} - b_{jg}z_{jg}^A\varepsilon_{jg}\right)}{\sum_j \left(\varepsilon_{jg}y_{jg} + \sigma_{jg}d_{jg}\right)}$$

Just as in the case of product standards, the key difference relative to our baseline model is the Lagrange multiplier in the formula for noncooperative standards, which captures the fact that individual countries now have market power in the world market.

First note how an individual country's influence on world prices changes the incidence of process standards. If country i tightens its standards, domestic producers lose from the increase in abatement costs, but the world price increases as a consequence of the supply reduction, and this means that the incidence of the standard is now shared between consumers and producers: the stronger is the world-price effect, the more the incidence is shifted onto consumers. Also note how this changes the impact of lobbies on unilateral standards. Recall that lobbies already cared about unilateral changes in process standards in the small-country setting, but now they care less strongly, because the impact of a unilateral change in process standards on producers is now mitigated by the world-price effect.

Following a similar logic as above, it is easy to see that in the benchmark case of symmetric countries, the qualitative results of our baseline model are preserved, in spite of the changed incidence of process standards: in particular, if lobbying is strong enough, the equilibrium agreement tightens process standards and increases welfare. Intuitively this is because the basic logic of counter-lobbying highlighted in the small-country model is still present.

We next focus on the case in which countries are asymmetric and trade in equilibrium. Suppose country i tightens its standard (z_{ig}) starting from the noncooperative equilibrium. This increases the world price and impacts the joint payoff of the remaining countries according to the following:

$$\frac{\partial \Omega_g^{-i}}{\partial p_g}\Big|_{NE} = \sum_{j \neq i} y_{jg}\left(\gamma_{jg} - b_{jg}z_{jg}^N\varepsilon_{jg}\right) + m_{ig} \qquad (20)$$

The best local agreement tightens country i's process standard if and only if the expression above is positive. The sum on the right hand side captures the political and environmental externalities, which push in opposite directions, just as in the small-country case, and the term m_{ig} captures the terms-of-trade motive for the agreement.

Focus first on the case in which lobbying pressures are weak, so the political parameters γ_{ig} are small. In this case, recall that absent trade the agreement would loosen all process standards. But if there is trade, for exporting countries the terms-of-trade effect pushes in the same direction (toward de-regulation), while for importing countries it pushes in the opposite direction and may lead to a tightening of standards.

If the political pressure parameters γ_{ig} are large enough, intuitively the political externality dominates and hence $\frac{\partial \Omega_g^{-i}}{\partial p_g}|_{NE} > 0$, thus the best local agreement tightens all process standards. We can show that, under a regularity condition, this local result holds also globally, and at the normative level the equilibrium agreement increases welfare, just as in our baseline model.[46]

5 Conclusion

In this paper we have examined the positive and normative effects of international regulatory agreements that are negotiated under lobbying pressures from producer groups. Our analysis suggests that these effects depend critically on whether the interests of producers in different countries are aligned or in conflict. The former situation tends to occur for product standards, while the latter tends to occur for process standards. We have shown that, if lobbying forces are strong enough, international cooperation on product standards leads to excessive de-regulation and decreases welfare, while in the case of process standards it leads to tighter regulations and increases welfare.

To make our points more transparent we have considered two separate models, one focused only on product standards and one focused only on process standards. In our working paper version we consider an integrated model that allows for both types of regulations and for externalities both on the consumption side and on the production side. In that extended setting we find that most of our qualitative results hold, with two qualifications. At the positive level, the equilibrium agreement changes product standards and process standards in opposite directions, and in particular, if the strength of lobbying is above a certain threshold then product standards are loosened and process standards are tightened, while the opposite is true if the strength of lobbying is below such threshold. And at the normative level, we find that when lobbying pressures are strong, the agreement decreases welfare if the relative

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[46]The restriction under which we can show that the local result holds globally is that γ_{ig} and ε_{ig} are not too dissimilar across countries. Note that the key difference between the formulas for the noncooperative and cooperative standards, (18) and (19), lies in the difference between λ_g^A and λ_{ig}^N. In Appendix C we show that the restriction mentioned above ensures that $\lambda_g^A > \lambda_{ig}^N$ when the γ_{ig} parameters are sufficiently large.

importance of production externalities versus consumption externalities is small – since in this case product standards play a dominant role relative to process standards – while it increases welfare in the opposite case.

There are several further extensions of our model that would be interesting to explore in future research.

Our model assumes perfect competition. While a competitive model seems like a natural place to start for exploring the questions we are interested in, the presence of imperfect competition may affect some of our qualitative results and may open up further interesting questions. One such question concerns the role of firm heterogeneity and how this might affect the alignment of producer interests across borders. For example, in our competitive setting all producers in the world benefit from a relaxation of (non-discriminatory) product standards in any given country, and this is true regardless of asymmetries in supply parameters, but this is no longer obvious in the presence of imperfect competition: in particular, it is conceivable that tightening a (non-discriminatory) standard may increase the profits of more productive firms at the expense of less productive ones, even though it increases abatement costs for all firms. Whether or not this is the case is likely to depend on the specifics of the market structure and on the extent of cross-firm differences in abatement cost elasticities, and it would be interesting to investigate the conditions under which this would happen.

We have abstracted from fixed costs of compliance with product standards. Such fixed costs are undoubtedly relevant in reality and often mentioned as a rationale for harmonization of standards. How the presence of such fixed costs might change the welfare impact of regulatory agreements that are negotiated under lobbying pressures is an important question, but again, this would require a model with imperfect competition, which is outside the scope of this paper. Second, we have not considered horizontal standards. Note that the notions of co-lobbying and counter-lobbying, which are central in our model, are intrinsically vertical notions (do lobbies agree on tightening versus loosening standards), so they would not apply to a setting of horizontal standards, and hence one would have to entirely revisit the question of whether lobbying has a more distortionary effect on cooperative policies or on unilateral policies.

Another important question that we have not addressed in this paper is the role of global supply chains. Intuitively, in the presence of global supply chains, the welfare effects of regulatory cooperation would depend on where regulations hit along the supply chain. For example, consider vertical product standards. The interests of producer lobbies around the

world are likely to be aligned when it comes to standards on final products, so regulatory cooperation will strengthen the impact of lobbies on regulations. But this would not necessarily be true for standards on intermediate products, because in this case the interests of upstream and downstream lobbies worldwide would be in conflict, so an agreement may dilute the overall influence of lobbies.

In the debate on the welfare effects of deep integration, the role of multinational enterprises is often mentioned as one of the reasons for concern. A natural question therefore is whether or not the multinational nature of production tends to worsen the welfare impacts of deep integration. Our perfect-competition setting cannot speak to the role of multinational firms, since there is no meaningful notion of firms in such a setting, so this is another desirable direction of extension of our model.

We have focused on global agreements, but it would be interesting to explore the welfare impacts of regional agreements when such agreements are negotiated under lobbying pressures. While there is a large literature that examines the welfare impacts of regional agreements of the "shallow" kind, including a few models where such agreements are negotiated under political pressure (e.g. Grossman and Helpman, 1995b, and Ornelas, 2005), the literature has paid little attention so far to the welfare impacts of regional regulatory cooperation.

Finally, it would be important to examine the welfare impacts of international cooperation in other salient areas of deep integration, such as foreign investment and intellectual property rights. The cleavages between special interests across country borders are clearly issue-area specific, but our conjecture is that the basic logic outlined above will continue to apply – namely, that international negotiations tend to enhance welfare if the interests of lobbies around the world are aligned, while they tend to reduce welfare if the interests of lobbies across borders are in conflict, at least if lobbies are sufficiently powerful.

6 Appendix

6.1 Appendix A

Claim: If σ_{ig} does not increase too steeply with the price, then (i) there exists a unique noncooperative equilibrium, and (ii) it satisfies the system (4)+(5).

Proof: We begin by showing that there exists a unique solution to the first-order condition $e_{ig} = \frac{1}{\sigma_{ig}\left(p_g + \phi_{ig}(e_{ig})\right)}\left(\frac{1}{a_{ig}} + \frac{1}{\phi'_{ig}(e_{ig})}\right)$ for any p_g, which must then correspond to the unique maximum of the associated objective function Ω_{ig} given that we assume away corner solutions. Recall that ϕ_{ig} is decreasing and convex, so ϕ'_{ig} is negative and increasing, hence $\frac{1}{\phi'_{ig}}$ is negative and decreasing. Also note that our assumptions imply $\frac{1}{\phi'_{ig}(0)} = 0$ and $\lim_{e_{ig}\to\infty}\frac{1}{\phi'_{ig}(e_{ig})} = -\infty$. Next note that, if σ_{ig} is weakly decreasing in the price, it is weakly increasing in e_{ig} and hence $\frac{1}{\sigma_{ig}\left(p_g + \phi_{ig}(e_{ig})\right)}$ is weakly decreasing in e_{ig}. So in this case the left-hand side of the equation above is a line with slope 1 and the right-hand side is a decreasing function that starts positive and goes to minus infinity, hence the equation above has a unique solution. Next note that, for the first-order condition to have a unique solution, it suffices that the right-hand side not increase in e_{ig} with slope steeper than (or equal to) one, and this is satisfied as long as σ_{ig} does not increase too steeply with the price, hence the claim.

Next we show that there exists a unique solution to the system (4)+(5), which must then correspond to the unique noncooperative equilibrium. The argument just above implies that the unilateral optimum given p_g is a well defined function $e_{ig}(p_g)$. Plugging this into the market clearing condition gives $\int_i y_{ig}(p_g) = \int_i d_{ig}\left(p_g + \phi_{ig}(e_{ig}(p_g))\right)$. We now show that the consumer price $p_g^c \equiv p_g + \phi_{ig}(e_{ig}(p_g))$ increases weakly with p_g. Given this, the left-hand side is increasing in p_g and the right-hand side is decreasing in p_g, so there is a unique solution.

Differentiating p_g^c yields

$$\frac{dp_g^c}{dp_g} = 1 + \phi'_{ig}\frac{de_{ig}}{dp_g}$$

Differentiating the first order condition (4), it is direct to verify that

$$\frac{de_{ig}}{dp_g} = \frac{\frac{-\sigma'_{ig}}{\sigma_{ig}}e_{ig}}{1 + \frac{\phi''_{ig}}{\sigma_{ig}\phi'^2_{ig}} + \frac{\sigma'_{ig}\phi'_{ig}e_{ig}}{\sigma_{ig}}}$$

and hence

$$\frac{dp_g^c}{dp_g} = \frac{1 + \frac{\phi''_{ig}}{\sigma_{ig}\phi'^2_{ig}}}{1 + \frac{\phi''_{ig}}{\sigma_{ig}\phi'^2_{ig}} + \frac{\sigma'_{ig}\phi'_{ig}e_{ig}}{\sigma_{ig}}}$$

Since $\phi'_{ig} < 0$ and $\phi''_{ig} > 0$ by assumption, $\frac{dp^c_g}{dp_g}$ is positive as long as σ'_{ig} is not too large and positive, hence the claim. QED

Claim: If ε_i does not decrease too steeply with the price, then (i) there exists a unique noncooperative equilibrium, and (ii) it satisfies the system (10)+(11).

Proof: We begin by showing that there exists a unique solution to the first-order condition $z_{ig} = \frac{1}{\varepsilon_{ig}\left(p_g - \varphi_{ig}(z_{ig})\right)}\left(\frac{1+\gamma_{ig}}{b_{ig}} + \frac{1}{\varphi'_{ig}(z_{ig})}\right)$ for any p_g, which must then correspond to the unique maximum of the associated objective function Ω_{ig} given that we rule out corner solutions. Recall that φ_{ig} is decreasing and convex, so φ'_{ig} is negative and increasing, hence $\frac{1}{\varphi'_{ig}}$ is negative and decreasing. Also note that our assumptions imply $\frac{1}{\varphi'_{ig}(0)} = 0$ and $\lim_{z_{ig}\to\infty} \frac{1}{\varphi'_{ig}(z_{ig})} = -\infty$. Next note that, if ε_{ig} is weakly increasing in the price, it is weakly increasing in z_{ig} and hence $\frac{1}{\varepsilon_{ig}\left(p_g - \varphi_{ig}(z_{ig})\right)}$ is weakly decreasing in z_{ig}. So in this case the left-hand side of the equation above is a line with slope 1 and the right-hand side is a decreasing function that starts positive and goes to minus infinity, hence the equation above has a unique solution. Next note that, for the first-order condition to have a unique solution, it suffices that the right-hand side not increase in z_{ig} with slope higher than (or equal to) one, and this is satisfied as long as ε_{ig} does not decrease too steeply with the price, hence the claim.

Next we show that there exists a unique solution to the system (10)+(11), which must then correspond to the unique noncooperative equilibrium. The argument just above implies that the unilateral optimum given p_g is a well defined function $z_{ig}(p_g)$. Plugging this into the market clearing condition gives $\int_i y_{ig}\left(p_g - \varphi_{ig}(z_{ig}(p_g))\right) = \int_i d_{ig}(p_g)$. We now show that the producer price $p^p_g \equiv p_g - \varphi_{ig}(z_{ig}(p_g))$ increases weakly with p_g. Given this, the left-hand side is increasing in p_g and the right-hand side is decreasing in p_g, so there is a unique solution.

Differentiating p^p_g yields

$$\frac{dp^p_g}{dp_g} = 1 - \varphi'_{ig}\frac{dz_{ig}}{dp_g}$$

Differentiating the first order condition (10), it is direct to verify that

$$\frac{dz_{ig}}{dp_g} = \frac{-\frac{\varepsilon'_{ig}z_{ig}}{\varepsilon_{ig}}}{1 + \frac{\varphi''_{ig}}{\varepsilon_{ig}\varphi'^2_{ig}} - \frac{\varepsilon'_{ig}\varphi'_{ig}z_{ig}}{\varepsilon_{ig}}}$$

and hence

$$\frac{dp^p_g}{dp_g} = \frac{1 + \frac{\varphi''_{ig}}{\varepsilon_{ig}\varphi'^2_{ig}}}{1 + \frac{\varphi''_{ig}}{\varepsilon_{ig}\varphi'^2_{ig}} - \frac{\varepsilon'_{ig}\varphi'_{ig}z_{ig}}{\varepsilon_{ig}}}$$

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Since $\varphi'_{ig} < 0$ and $\varphi''_{ig} > 0$ by assumption, $\frac{dp^c_g}{dp_g}$ is positive as long as ε'_{ig} is not too large and negative, hence the claim. QED

6.2 Appendix B

Proof of Proposition 1: We first establish that the best local agreement increases e_{ig} for all i. This follows from two observations. The first one is that Ω_g is increasing in each e_{ig} when evaluated at the noncooperative standards. To see this, differentiate Ω_g to get:

$$
\begin{aligned}
d\Omega_g &= \int_i \frac{\partial \Omega_{ig}}{\partial e_{ig}} de_{ig} + \frac{\partial \Omega_g}{\partial p_g} dp_g \\
&= \int_i \frac{\partial \Omega_{ig}}{\partial e_{ig}} de_{ig} - \frac{\partial \Omega_g}{\partial p_g} \int_i \frac{\sigma_{ig} d_{ig} \phi'_{ig}}{\int_j (\varepsilon_{jg} y_{jg} + \sigma_{jg} d_{jg})} de_{ig}
\end{aligned}
$$

where we have differentiated the market clearing condition to write down the expression for dp_g. Note that $\frac{\partial \Omega_{ig}}{\partial e_{ig}} = 0$ for all i at the noncooperative equilibrium and recall from the main text that $\frac{\partial \Omega_g}{\partial p_g} > 0$ at the noncooperative equilibrium. Furthermore $-\int_i \frac{\sigma_{ig} d_{ig} \phi'_{ig}}{\int_j (\varepsilon_{jg} y_{jg} + \sigma_{jg} d_{jg})} de_{ig}$ has the same sign as de_{ig}, hence the claim. The second observation is that, since the gradient of Ω_g at the noncooperative standards $\mathbf{e}^N_g$ is positive for all standards, it follows that the direction of steepest ascent of the objective Ω_g starting from $\mathbf{e}^N_g$ entails loosening all of the standards.

Next we show that this local result holds globally if (i) countries are sufficiently close to symmetric, or (ii) demand semi-elasticities σ_{ig} do not increase too much with the consumer price, or (iii) the political parameters γ_{ig} are sufficiently large.

(i) Suppose countries are symmetric. Under our assumptions $\Omega_g(\mathbf{e}_g, p_g(\mathbf{e}_g))$ has a unique peak, which is symmetric. Letting $\Omega_g(e_g, p_g(e_g))$ denote the joint government payoff given a common standard e_g, also this function clearly has a single peak, which we denote e^A_g.

We know from the local argument in the main text that $\frac{d\Omega_g}{de_g}|_{NE} > 0$. Given that $\Omega_g(e_g, p(e_g))$ is single-peaked, it follows immediately that $e^A_g > e^N_g$, where e^N_g is the symmetric noncooperative standard. A continuity argument can then be used to extend this result to the case where countries are sufficiently close to symmetric.

(ii) Let $(\hat{e}_{ig}(\kappa_g), \hat{p}_g(\kappa_g))$ denote the solution to the following system:

$$
e_{ig} = \frac{1}{\sigma_{ig}(p_g + \phi_{ig}(e_{ig}))}\left(\frac{1}{a_{ig}} + \frac{1}{\phi'_{ig}(e_{ig})}\right) + \frac{\kappa_g}{a_{ig}} \quad \text{for all } i
$$

$$
\int_i y_{ig}(p_g) = \int_i d_{ig}(p_g + \phi_{ig}(e_{ig}))
$$

Note that κ_g is a parameter that "connects" the noncooperative equilibrium with the cooperative solution: when $\kappa_g = 0$ the solution of the above system is the noncooperative equilibrium, and when $\kappa_g = \lambda_g > 0$ the solution of the above system coincides with the cooperative solution.

Given σ_{ig}, the first equation implicitly defines a unique value of e_{ig}, since the left-hand side is a line with slope one and the right-hand side is a decreasing function that starts positive and goes to minus infinity, given our assumptions on $\phi_{ig}(\cdot)$. We denote such solution by $e_{ig} = f_{ig}\left(\sigma_{ig}\left(p_g + \phi_{ig}\left(e_{ig}\right)\right), \kappa_g\right)$ and rewrite the above system as:

$$e_{ig} = f_{ig}\left(\sigma_{ig}\left(p_g + \phi_{ig}\left(e_{ig}\right)\right), \kappa_g\right) \text{ for all } i$$

$$\int_i y_{ig}\left(p_g\right) = \int_i d_{ig}\left(p_g + \phi_{ig}(e_{ig})\right)$$

Recall from Appendix A that if $\kappa_g = 0$ then this system has a unique solution, provided σ_{ig} does not increase too steeply. It is easy to show that the same is true for any $\kappa_g > 0$. Also, it is easy to verify that $\frac{\partial f_{ig}}{\partial \kappa_g} > 0$ and $\frac{\partial f_{ig}}{\partial \sigma_{ig}} < 0$. Differentiating the system we obtain:

$$\frac{d\hat{e}_{ig}}{d\kappa_g} = \frac{\frac{\partial f_{ig}}{\partial \sigma_{ig}}\sigma'_{ig}}{1 - \frac{\partial f_{ig}}{\partial \sigma_{ig}}\sigma'_{ig}\phi'_{ig}}\frac{d\hat{p}_g}{d\kappa_g} + \frac{\frac{\partial f_{ig}}{\partial \kappa_g}}{1 - \frac{\partial f_{ig}}{\partial \sigma_{ig}}\sigma'_{ig}\phi'_{ig}}$$

$$\frac{d\hat{p}_g}{d\kappa_g} = -\frac{\int_i \sigma_{ig}d_{ig}\phi'_{ig}\frac{d\hat{e}_{ig}}{d\kappa_g}}{\int_i \left(\varepsilon_{ig}y_{ig} + \sigma_{ig}d_{ig}\right)}$$

Plugging the first equation into the second one and solving for $\frac{d\hat{p}_g}{d\kappa_g}$, this yields

$$\frac{d\hat{p}_g}{d\kappa_g} = -\frac{\int_i \sigma_{ig}d_{ig}\frac{\frac{\partial f_{ig}}{\partial \kappa_g}\phi'_{ig}}{1 - \frac{\partial f_{ig}}{\partial \sigma_{ig}}\sigma'_{ig}\phi'_{ig}}}{\int_i \varepsilon_{ig}y_{ig} + \int_i \sigma_{ig}d_{ig}\frac{1}{1 - \frac{\partial f_{ig}}{\partial \sigma_{ig}}\sigma'_{ig}\phi'_{ig}}}$$

Clearly, $\frac{d\hat{p}_g}{d\kappa_g} > 0$ as long as σ_{ig} does not increase to steeply. This in turn immediately implies $\frac{d\hat{e}_{ig}}{d\kappa_g} > 0$. Thus, as we move from the noncooperative solution to the cooperative solution, $\hat{e}_{ig}$ increases for all i. We can conclude that $e_{ig}^A > e_{ig}^N$ for all i.

(iii) We first argue that, if $\gamma_g \to \infty$ for all i, then $e_{ig}^A \to \infty$ for all i. This follows from the fact that, in the limit as $\gamma_g \to \infty$ for all i, the cooperative standards must maximize $\int_i \nu_{ig}\pi_{ig}(p_g)$, and this implies $e_{ig}^A \to \infty$ for all i. More concretely, suppose by contradiction that, as $\gamma_g \to \infty$ for all i, the optimal standards e_{ig}^A converge to some finite levels $\bar{e}_{ig}$ for a positive measure of countries. Then clearly there exist large enough values of γ_g such that the optimal standards for these countries are looser than $\bar{e}_{ig}$.

Finally, recalling that e_{ig}^N is independent of γ_g, we can conclude that the agreement loosens all standards if γ_g is sufficiently large. QED

Proof of Proposition 2: Before proving the more general result stated in Proposition 2, we focus on the case of symmetric countries and prove the stronger result illustrated in Figure 1.

(i) We show that, if countries are symmetric, there exists a cutoff value $\bar{\gamma}_g$ such that $\Delta_g > 0$ for $\gamma_g < \bar{\gamma}_g$ and $\Delta_g < 0$ for $\gamma_g > \bar{\gamma}_g$.

We begin by characterizing e_g^N, e_g^W, and e_g^A as functions of γ_g. It is immediate that $\frac{de_g^N}{d\gamma_g} = 0$, $\frac{de_g^W}{d\gamma_g} = 0$, and that $e_g^A = e_g^W$ for $\gamma_g = 0$.

Next we show that e_g^A is increasing in γ_g. Let $\tilde{\Omega}_g(e_g, \gamma_g) \equiv \Omega_g\left(e_g, p\left(e_g\right), \gamma_g\right)$ (with a slight abuse of notation we have emphasized the dependence of Ω_g on γ_g), and note that $\frac{d^2\tilde{\Omega}_g}{de_g d\gamma_g} = \frac{y_g d_g' \phi_g'}{y_g' - d_g'} > 0$. Thus $\tilde{\Omega}_g$ is supermodular in e_g and γ_g, and hence by standard supermodularity arguments it follows that $\frac{de_g^A}{d\gamma_g} > 0$.

We now turn to characterizing W_g^N and W_g^A as functions of γ_g. Note that $\frac{de_g^N}{d\gamma_g} = 0$ implies $\frac{dW_g^N}{d\gamma_g} = 0$ and $\frac{de_g^A}{d\gamma_g} > 0$ implies $\frac{dW_g^A}{d\gamma_g} < 0$, since e_g^A maximizes welfare when $\gamma_g = 0$ and global welfare is single-peaked in e_g by assumption. It follows that $\frac{d\Delta_g}{d\gamma_g} < 0$.

The final step is to show that $\Delta_g < 0$ for sufficiently large γ_g. Recalling from the proof of the previous proposition that $\lim_{\gamma_g \to \infty} e_{ig}^A = \infty$, it is clear that $\lim_{\gamma_g \to \infty} W_g^A = -\infty$, so there must exist some $\bar{\gamma}_g$ such that $\Delta_g < 0$ for $\gamma_g > \bar{\gamma}_g$.

(ii) We now allow for asymmetric countries. Recall that we define $\gamma_{ig} = \gamma_g \nu_{ig}$ and vary γ_g. With asymmetric countries, it is still trivially true that $\Delta_g > 0$ for $\gamma_g = 0$, and thus also for sufficiently low γ_g. Moreover, it is also still true that $\lim_{\gamma_g \to \infty} e_{ig}^A = \infty$ for all i and thus $\Delta_g < 0$ for sufficiently large γ_g. What is no longer guaranteed in the case of asymmetric countries is that there exists a unique cutoff value $\bar{\gamma}_g$. QED

Proof of Proposition 3: In the main text we established that $\frac{\partial \Omega_g}{\partial p_g}\big|_{NE}$ is positive if γ_g is large enough and negative if γ_g is small enough. Using a similar argument as in the proof of Proposition 1, it is easy to argue that the best local agreement tightens all process standards if γ_g is large enough and loosens all process standards if γ_g is small enough.

Now we show that this local result holds globally under the conditions stated in Proposition 3.

(i$_a$) Suppose countries are symmetric. Under our assumptions, $\Omega_g\left(\mathbf{z}_g, p_g\left(\mathbf{z}_g\right)\right)$ has a unique peak, which is symmetric. Let z_g^A denote the symmetric cooperative standard. Let

$\Omega_g(z_g, p_g(z_g))$ denote the joint government payoff given a common standard z_g. Also this function clearly has a single peak at z_g^A.

We know from the local argument in the main text that $\frac{d\Omega_g}{dz_g}|_{NE} > 0$ for small enough γ_g. Given that $\Omega_g(z_g, p(z_g))$ is single-peaked, it follows immediately that $z_g^A > z_g^N$ for small enough γ_g, where z_g^N is the symmetric noncooperative standard. A continuity argument can then be used to extend this result to the case where countries are sufficiently close to symmetric.

(i_b) We now show that the globally optimal agreement loosens all standards for small enough γ_g, as long as ε_{ig} does not decrease too steeply.

It suffices to show the result for $\gamma_g = 0$. Note that in this case $\lambda_g < 0$.

Let $(\hat{z}_{ig}(\kappa_g), \hat{p}_g(\kappa_g))$ denote the solution to the following system:

$$z_{ig} = \frac{1}{\varepsilon_{ig}(p_g - \varphi_{ig}(z_{ig}))}\left(\frac{1}{b_{ig}} + \frac{1}{\varphi'_{ig}(z_{ig})}\right) - \frac{\kappa_g}{b_{ig}}$$

$$\int_i y_{ig}(p_g - \varphi_{ig}(z_{ig})) = \int_i d_{ig}(p_g)$$

As in the case of product standards, when $\kappa_g = 0$ the solution of the above system is the noncooperative equilibrium, and when $\kappa_g = \lambda_g < 0$ it coincides with the cooperative solution. Given ε_{ig}, the first equation implicitly defines a unique value of z_{ig}, since the left-hand side is a line with slope one and the right-hand side is a decreasing function that starts positive and goes to minus infinity, given our assumptions on $\varphi_{ig}(\cdot)$. We denote such solution by $z_{ig} = f_{ig}(\varepsilon_{ig}(p_g - \varphi_{ig}(z_{ig})), \kappa_g)$ and rewrite the above system as:

$$z_{ig} = f_{ig}(\varepsilon_{ig}(p_g - \varphi_{ig}(z_{ig})), \kappa_g)$$
$$\int_i y_{ig}(p_g - \varphi_{ig}(z_{ig})) = \int_i d_{ig}(p_g)$$

Recall from Appendix A that if $\kappa_g = 0$ then this system has a unique solution, provided ε_{ig} does not decrease too steeply. It is easy to show that the same is true for any $\kappa_g > 0$. Also, it is easy to verify that $\frac{\partial f_{ig}}{\partial \kappa_g} < 0$ and $\frac{\partial f_{ig}}{\partial \varepsilon_{ig}} < 0$. Differentiating the system we obtain:

$$\frac{d\hat{z}_{ig}}{d\kappa_g} = \frac{\frac{\partial f_{ig}}{\partial \varepsilon_{ig}}\varepsilon'_{ig}}{1 + \frac{\partial f_{ig}}{\partial \varepsilon_{ig}}\varepsilon'_{ig}\varphi'_{ig}}\frac{d\hat{p}_g}{d\kappa_g} + \frac{\frac{\partial f_{ig}}{\partial \kappa_g}}{1 + \frac{\partial f_{ig}}{\partial \varepsilon_{ig}}\varepsilon'_{ig}\varphi'_{ig}}$$

$$\frac{d\hat{p}_g}{d\kappa_g} = \frac{\int_i \varepsilon_{ig}y_{ig}\varphi'_{ig}\frac{d\hat{z}_{ig}}{d\kappa_g}}{\int_i(\varepsilon_{ig}y_{ig} + \sigma_{ig}d_{ig})}$$

Plugging the first equation into the second one and solving for $\frac{d\hat{p}_g}{d\kappa_g}$, this yields

$$\frac{d\hat{p}_g}{d\kappa_g} = \frac{\int_i \varepsilon_{ig} y_{ig} \varphi'_{ig} \frac{\frac{\partial f_{ig}}{\partial \kappa_g}}{1 + \frac{\partial f_{ig}}{\partial \varepsilon_{ig}} \varepsilon'_{ig} \varphi'_{ig}}}{\int_i \sigma_{ig} d_{ig} + \int_i \varepsilon_{ig} y_{ig} \frac{1}{1 + \frac{\partial f_{ig}}{\partial \varepsilon_{ig}} \varepsilon'_{ig} \varphi'_{ig}}}$$

Clearly, $\frac{d\hat{p}_g}{d\kappa_g} > 0$ as long as ε_{ig} does not decrease too steeply with the price. This in turn immediately implies $\frac{d\hat{z}_{ig}}{d\kappa_g} < 0$. Thus, as we move from the noncooperative solution ($\kappa_g = 0$) to the cooperative solution ($\kappa_g < 0$), $\hat{z}_{ig}$ increases for all i. We can conclude that $z_{ig}^A > z_{ig}^N$ for all i.

(ii) We now argue that the globally optimal agreement tightens all standards if γ_g is large enough. In fact we will show a stronger result, namely that $z_{ig}^N - z_{ig}^A \to \infty$ as $\gamma_g \to \infty$ for all (except possibly a zero measure of) countries, a result that we will use in the next proof below.

First recall from equation (13) that $z_{ig}^A = \frac{1}{\varepsilon_{ig}} \left(\frac{1 + \gamma_{ig}}{b_{ig}} + \frac{1}{\varphi'_{ig}(z_{ig}^A)} \right) - \frac{\lambda_g}{b_{ig}}$, where the multiplier is given by $\lambda_g = \frac{\int_i y_{ig} (\gamma_{ig} - b_{ig} z_{ig}^A \varepsilon_{ig})}{\int_i \varepsilon_{ig} y_{ig} + \int_i \sigma_{ig} d_{ig}}$. Substituting the first equation into the second and rearranging yields

$$\lambda_g = -\frac{\int_i y_{ig} \left(1 + \frac{b_{ig}}{\varphi'_{ig}(z_{ig}^A)} \right)}{\int_i \sigma_{ig} d_{ig}}$$

Second, note that $\lim_{\gamma_g \to \infty} z_{ig}^N = \infty$. To see this, recall from (10) that $z_{ig}^N = \frac{1}{\varepsilon_{ig}} \left(\frac{1 + \gamma_{ig}}{b_{ig}} + \frac{1}{\varphi'_{ig}(z_{ig}^N)} \right)$. Given the assumption that ε_{ig} is bounded, the right hand side of the above expression goes to infinity as $\gamma_{ig} \to \infty$, unless $\frac{1}{\varphi'_{ig}(z_{ig}^N)} \to -\infty$. But given our assumptions on the abatement cost function, the latter can happen only if $z_{ig}^N \to \infty$, thus the claim follows.

Now suppose by contradiction that $z_{ig}^N - z_{ig}^A$ stays bounded (or goes to $-\infty$) for a positive measure of countries, say group A. Then $\lim_{\gamma_g \to \infty} z_{ig}^A = \infty$ for group A, since $\lim_{\gamma_g \to \infty} z_{ig}^N = \infty$. This implies that $\varphi'_{ig}(z_{ig}^A) \to 0^-$ for group A. Also, for these countries y_{ig} is clearly bounded away from zero, so $y_{ig} \left(1 + \frac{b_{ig}}{\varphi'_{ig}(z_{ig}^A)} \right) \to -\infty$ for group A. Furthermore, recalling the assumption that σ_{ig} is bounded, $\int_i \sigma_{ig} d_{ig}$ stays bounded, and therefore $\lim_{\gamma_g \to \infty} \lambda_g = \infty$. Keeping in mind that λ_g is the same for all countries, and using the formulas for the noncooperative standards (10) and cooperative standards (13), it is easy to see that $z_{ig}^N - z_{ig}^A$ must then go to infinity for all countries, thus contradicting the premise.

We can conclude that $z_{ig}^N - z_{ig}^A \to \infty$ as $\gamma_g \to \infty$ for all (except possibly a zero measure of) countries. QED

Proof of Proposition 4: We separate this proof into two parts. First, we focus on the case with symmetric countries and constant semi-elasticities and prove the result illustrated in Figure 2. Then we turn to the general case and prove the result stated in proposition 4.

(i) We first focus on the case of symmetric countries and constant semi-elasticities and prove the result illustrated in Figure 2, and namely that there exist critical levels $\gamma_g^L < \gamma_g^H$ such that the agreement increases welfare if $\gamma_g < \gamma_g^L$, decreases welfare if $\gamma_g \in \left(\gamma_g^L, \gamma_g^H\right)$, and increases welfare again if $\gamma_g > \gamma_g^H$.

We begin by showing that the schedules $z_g^N(\gamma_g)$ and $z_g^A(\gamma_g)$ are both increasing, and that $z_g^N(\gamma_g)$ crosses $z_g^A(\gamma_g)$ only once and from below. Differentiating equations (10) and (13) yields

$$\frac{dz_g^N}{d\gamma_g} = \frac{1}{\varepsilon_g b_g}\left(1 + \frac{\varphi_g''(z_g^N)}{\varepsilon_g \varphi_g'^2(z_g^N)}\right)^{-1}$$

$$\frac{dz_g^A}{d\gamma_g} = \frac{1}{\varepsilon_g b_g}\left(1 + \frac{\varphi_g''(z_g^A)}{\varepsilon_g \varphi_g'^2(z_g^A)} + \frac{\varphi_g''(z_g^A)}{\sigma_g \varphi_g'^2(z_g^A)}\right)^{-1}$$

where we have used the fact that $y_g = d_g$ under symmetry. Since $\varphi_g'' > 0$, it follows that $\frac{dz_g^N}{d\gamma_g} > 0$ and $\frac{dz_g^A}{d\gamma_g} > 0$. Next recall from the previous proposition that $z_g^N(0) < z_g^A(0)$ and $z_g^N(\infty) > z_g^A(\infty)$, so $z_g^N(\gamma_g)$ must cross $z_g^A(\gamma_g)$ at least once and from below. Finally note that, at any point where the two schedules cross, it must be $z_g^A = z_g^N$, and hence using the expressions above $\frac{dz_g^N}{d\gamma_g} > \frac{dz_g^A}{d\gamma_g}$. This immediately implies that $z_g^N(\gamma_g)$ crosses $z_g^A(\gamma_g)$ only once and from below.

We are now ready to show that there exist cutoffs $\gamma_g^L < \gamma_g^H$ such that $\Delta_g > 0$ if $\gamma_g < \gamma_g^L$ or $\gamma_g > \gamma_g^H$ and $\Delta_g < 0$ if $\gamma_g \in \left(\gamma_g^L, \gamma_g^H\right)$.

With reference to Figure 2, let γ_g^M denote the value of γ_g such that the noncooperative standard is efficient, that is $z_g^N = z_g^W$, and let γ_g^H denote the value of γ_g such that $z_g^N = z_g^A$.

Clearly, we have $\Delta_g > 0$ at $\gamma_g = 0$, $\Delta_g < 0$ at $\gamma_g = \gamma_g^M$, and $\Delta_g = 0$ at $\gamma_g = \gamma_g^H$. Note also that W_g is increasing in z_g for all $z_g < z_g^W$ and decreasing in z_g for all $z_g > z_g^W$, given that z_g^W maximizes W_g and W_g is single-peaked in z_g.

For all $\gamma_g \in \left[0, \gamma_g^M\right)$, clearly $\frac{dW_g^A}{d\gamma_g} < 0$ and $\frac{dW_g^N}{d\gamma_g} > 0$, and hence $\frac{d\Delta_g}{d\gamma_g} < 0$, so there exists a critical value γ_g^L between 0 and γ_g^M such that $\Delta_g > 0$ for $\gamma_g \in \left[0, \gamma_g^L\right)$ and $\Delta_g < 0$ for $\gamma_g \in \left(\gamma_g^L, \gamma_g^M\right]$. Moreover, it is clear that $\Delta_g < 0$ for all $\gamma_g \in \left[\gamma_g^M, \gamma_g^H\right)$, given that $z_g^W \leq z_g^N \leq z_g^A$ and W_g is increasing in z_g for all $z_g < z_g^W$. And finally, $\Delta_g > 0$ for all $\gamma_g > \gamma_g^H$, given that $z_g^W \leq z_g^A \leq z_g^N$ and W_g is decreasing in z_g for all $z_g > z_g^W$.

(ii) We now turn to the general case allowing for asymmetric countries. Recall our scaling convention $\gamma_{ig} = \gamma_g \nu_{ig}$ and consider the limit cases $\gamma_g = 0$ and $\gamma_g \to \infty$. It is still (trivially) true that $\Delta_g > 0$ for $\gamma_g = 0$ and thus also for sufficiently low γ_g. What remains to be shown is that cooperation on process standards increases global welfare if γ_g is sufficiently high.

From the expression for welfare, it follows immediately that

$$\lim_{\gamma_g \to \infty} W_g^N = \lim_{\gamma_g \to \infty} \int_i \left[\pi_{ig} \left(p_g^N - \varphi_{ig} \left(z_{ig}^N \right) \right) + S_{ig} \left(p_g^N \right) - b_{ig} z_{ig}^N y_{ig} \left(p_g^N - \varphi_{ig} \left(z_{ig}^N \right) \right) \right]$$

Recall from the proof of Proposition 3 that $\lim_{\gamma_g \to \infty} z_{ig}^N = \infty$ for all i. Note that therefore $\lim_{\gamma_g \to \infty} W_g^N = -\infty$, since $\pi_{ig} \left(p_g^N - \varphi_{ig} \left(z_{ig}^N \right) \right)$, $S_{ig} \left(p_g^N \right)$, and $y_{ig} \left(p_g^N - \varphi_{ig} \left(z_{ig}^N \right) \right)$ converge to some finite levels as $\gamma_g \to \infty$.

Similarly,

$$\lim_{\gamma_g \to \infty} W_g^A = \lim_{\gamma_g \to \infty} \int_i \left[\pi_{ig} \left(p_g^A - \varphi_{ig} \left(z_{ig}^A \right) \right) + S_{ig} \left(p_g^A \right) - b_{ig} z_{ig}^A y_{ig} \left(p_g^A - \varphi_{ig} \left(z_{ig}^A \right) \right) \right]$$

For each country, we need to consider two possibilities: z_{ig}^A may go to infinity, or it may stay bounded (possibly at the prohibitive level). The latter possibility cannot be ruled out because there may be a group of countries with much lower ν_{ig} than other countries, and "counter-lobbying" by more powerful countries may push the standards in this group to get tighter. Letting $\mathcal{F}_g^B$ denote the (possibly empty) subset of countries for which z_{ig}^A stays bounded as $\gamma_g \to \infty$, we can write

$$
\begin{aligned}
\lim_{\gamma_g \to \infty} \Delta_g \;\equiv\;& \lim_{\gamma_g \to \infty} \left(W_g^A - W_g^N \right) \\
=\;& \lim_{\gamma_g \to \infty} \int_{i \in \mathcal{F}_g^B} \left(W_{ig}^A - W_{ig}^N \right) \\
&+ \lim_{\gamma_g \to \infty} \int_{i \notin \mathcal{F}_g^B} \left[\left(\pi_{ig} \left(p_g^A - \varphi_{ig}(z_{ig}^A) \right) + S_{ig}(p_g^A) \right) - \left(\pi_{ig} \left(p_g^N - \varphi_{ig}(z_{ig}^N) \right) + S_{ig}(p_g^N) \right) \right] \\
&+ \lim_{\gamma_g \to \infty} \int_{i \notin \mathcal{F}_g^B} \left[b_{ig} z_{ig}^N y_{ig} \left(p_g^N - \varphi_{ig}(z_{ig}^N) \right) - b_{ig} z_{ig}^A y_{ig} \left(p_g^A - \varphi_{ig}(z_{ig}^A) \right) \right]
\end{aligned}
$$

The first term of the sum above goes to ∞, since z_{ig}^A stays bounded for $i \in \mathcal{F}_g^B$ and hence W_{ig}^A also stays bounded for these countries, while $\lim_{\gamma_g \to \infty} W_{ig}^N = -\infty$. The second term stays bounded, since clearly p_g^A and p_g^N both stay bounded. The third term goes to ∞ since $y_{ig} \left(p_g^N - \varphi_{ig} \left(z_{ig}^N \right) \right)$ and $y_{ig} \left(p_g^A - \varphi_{ig} \left(z_{ig}^A \right) \right)$ stay bounded and $\lim_{\gamma_g \to \infty} \left(z_{ig}^N - z_{ig}^A \right) = \infty$ as established in the proof of Proposition 3. We can conclude that $\lim_{\gamma_g \to \infty} \Delta_g = \infty$. QED.

6.3 Appendix C

We start with the model of product standards. We first prove the claims made in the main text about the positive effects of the globally optimal agreement:

Proposition 1': The equilibrium agreement loosens all product standards, provided that (i) countries are not too asymmetric, or (ii) the political parameters γ_{ig} are sufficiently large.

Proof: Result (i) can be established following similar steps as in the proof of Proposition 1(i). The first step is to show that the best local agreement loosens standards. Next, if countries are symmetric the problem is effectively one-dimensional, and using the assumption that the objective function is single-peaked one can show that the local result holds globally. And finally, the result can be extended by continuity if countries are sufficiently close to symmetric.

Next we focus on result (ii). As usual, we let $\gamma_{ig} = \gamma_g \nu_{ig}$ and consider the limit as $\gamma_g \to \infty$. It is easy to check that the first-order conditions associated with the noncooperative and cooperative problems can be written as $f_{ig}(e_{ig}, \mathbf{e}_{-ig}) + \lambda_g^N(e_{ig}, \mathbf{e}_{-ig}) g_{ig}(e_{ig}, \mathbf{e}_{-ig}) = 0$ and $f_{ig}(e_{ig}, \mathbf{e}_{-ig}) + \lambda_g^A(e_{ig}, \mathbf{e}_{-ig}) g_{ig}(e_{ig}, \mathbf{e}_{-ig}) = 0$, where $f_{ig}(e_{ig}, \mathbf{e}_{-ig}) \equiv -d_{ig}\phi'_{ig} - a_{ig}d_{ig}\left(1 - e_{ig}\sigma_{ig}\phi'_{ig}\right)$ and $g_{ig}(e_{ig}, \mathbf{e}_{-ig}) \equiv -d_{ig}\sigma_{ig}\phi'_{ig}$, and the arguments $(e_{ig}, \mathbf{e}_{-ig})$ emphasize that all endogenous variables in general depend on all the standards. Note that, as we increase e_{ig}, the left-hand side has to cross zero once and from above in both cases, given our assumption that the noncooperative and cooperative problems each have a unique interior solution.

We first establish that $\lim_{\gamma_g \to \infty} e_{ig}^N = \infty$ and $\lim_{\gamma_g \to \infty} e_{ig}^A = \infty$ for all i. This follows immediately from the above first-order conditions combined with the fact that $\lambda_g^N(e_{ig}, \mathbf{e}_{-ig})$ and $\lambda_g^A(e_{ig}, \mathbf{e}_{-ig})$ are linearly increasing in γ_g for given standards $(e_{ig}, \mathbf{e}_{-ig})$, as is easy to see from equations (15) and (16).

We now establish that $\lim_{\gamma_g \to \infty}\left(e_{ig}^A - e_{ig}^N\right) > 0$ for all i. This follows from two observations. First, $\lambda_g^A(e_{ig}, \mathbf{e}_{-ig}) - \lambda_{ig}^N(e_{ig}, \mathbf{e}_{-ig}) \to \infty$ for any $(e_{ig}, \mathbf{e}_{-ig})$ as $\gamma_g \to \infty$, as is easy to establish by combining the expressions for λ_{ig}^N and λ_g^A from equations (15) and (16) to $\lambda_g^A(e_{ig}, \mathbf{e}_{-ig}) - \lambda_{ig}^N(e_{ig}, \mathbf{e}_{-ig}) = \frac{\sum_{j \neq i}\left(\gamma_{jg}y_{jg} + a_{jg}e_{jg}\sigma_{jg}d_{jg}\right) + m_{ig}}{\sum_j\left(\varepsilon_{jg}y_{jg} + \sigma_{jg}d_{jg}\right)}$. Second, as γ_g becomes large and thus e_{ig}^N and e_{ig}^A become large, the standards of countries $j \neq i$ only have a negligible impact on the first-order conditions for country i, so we can write them as $f_{ig}(e_{ig}) + \lambda_g^N(e_{ig}) g_{ig}(e_{ig}) = 0$ and $f_{ig}(e_{ig}) + \lambda_g^A(e_{ig}) g_{ig}(e_{ig}) = 0$. To see this note that, as e_{ig}^N and e_{ig}^A become large, the equilibrium price and thus d_{ig} and y_{ig} converge to their unregulated levels, and recall the assumption that σ_{ig} and ε_{ig} are bounded above and bounded away from zero. These two observations together immediately imply the result. QED

Next we prove the claim made in the main text regarding the welfare impact of the equilibrium agreement:

Proposition 2': Suppose all political parameters are scaled by a factor γ_g. Cooperation on product standards increases global welfare if γ_g is sufficiently low, and decreases global welfare if γ_g is sufficiently high.

Proof: It is immediate that cooperation on product standards increases global welfare if $\gamma_g = 0$ and hence also if γ_g is sufficiently low. We now show that the agreement decreases global welfare if γ_g is sufficiently high.

From the expression for welfare, it follows immediately that

$$
\begin{aligned}
W_g^A - W_g^N \;=\; & \sum_i \left[\pi_{ig}\left(p_g^A\right) - \pi_{ig}\left(p_g^N\right) \right] \\
& + \sum_i \left[S_{ig}\left(p_g^A + \phi_{ig}\left(e_{ig}^A\right)\right) - S_{ig}\left(p_g^N + \phi_{ig}\left(e_{ig}^N\right)\right) \right] \\
& - \sum_i a_{ig} \left[e_{ig}^A d_{ig}\left(p_g^A + \phi_{ig}\left(e_{ig}^A\right)\right) - e_{ig}^N d_{ig}\left(p_g^N + \phi_{ig}\left(e_{ig}^N\right)\right) \right]
\end{aligned}
$$

Recalling from the previous proof that $\lim_{\gamma_g \to \infty} e_{ig}^N = \infty$ and $\lim_{\gamma_g \to \infty} e_{ig}^A = \infty$, this implies

$$
\begin{aligned}
\lim_{\gamma_g \to \infty} \left(W_g^A - W_g^N\right) \;=\; & \sum_i \left[\pi_{ig}\left(\tilde{p}_g\right) - \pi_{ig}\left(\tilde{p}_g\right) \right] \\
& + \sum_i \left[S_{ig}\left(\tilde{p}_g\right) - S_{ig}\left(\tilde{p}_g\right) \right] \\
& - \sum_i a_{ig} d_{ig}\left(\tilde{p}_g\right)\left(e_{ig}^A - e_{ig}^N\right) \\
\;=\; & -\sum_i a_{ig} d_{ig}\left(\tilde{p}_g\right)\left(e_{ig}^A - e_{ig}^N\right),
\end{aligned}
$$

where $\tilde{p}_g$ is the unregulated world price, i.e. the solution to $\sum_i y_{ig}\left(p_g\right) = \sum_i d_{ig}\left(p_g\right)$. Hence, $\lim_{\gamma_g \to \infty}\left(W_g^A - W_g^N\right) < 0$ if $e_{ig}^A > e_{ig}^N$ for all i, which is true for sufficiently large γ_g, as shown above. QED

We now turn to the model of process standards. We start by proving the claims made in the main text about the positive effects of the globally optimal agreement:

Proposition 3': (i) The equilibrium agreement loosens all process standards for sufficiently small γ_g, provided countries are sufficiently symmetric; (ii) The equilibrium agreement tightens all process standards for sufficiently large γ_g, as long as ν_{ig} and ε_{ig} are not too dissimilar across countries.

Proof: Result (i) can be established following similar steps as in the proof of Proposition 3, part (i$_a$). We therefore focus on result (ii). As usual, we decompose $\gamma_{ig} = \gamma_g \nu_{ig}$ and consider the limit $\gamma_g \to \infty$.

It is easy to check that the first-order conditions associated with the noncooperative and cooperative problems can be written as $f_{ig}\left(z_{ig}, \mathbf{z}_{-ig}\right) + \left(\gamma_{ig} - \lambda_{ig}^N\left(z_{ig}, \mathbf{z}_{-ig}\right)\varepsilon_{ig}\right)g_{ig}\left(z_{ig}, \mathbf{z}_{-ig}\right) = 0$ and $f_{ig}\left(z_{ig}, \mathbf{z}_{-ig}\right) + \left(\gamma_{ig} - \lambda_g^A\left(z_{ig}, \mathbf{z}_{-ig}\right)\varepsilon_{ig}\right)g_{ig}\left(z_{ig}, \mathbf{z}_{-ig}\right) = 0$, where $f_{ig}\left(z_{ig}, \mathbf{z}_{-ig}\right) \equiv -y_{ig}\varphi'_{ig} - b_{ig}y_{ig}\left(1 - z_{ig}\varepsilon_{ig}\varphi'_{ig}\right)$, $g_{ig}\left(z_{ig}, \mathbf{z}_{-ig}\right) \equiv -y_{ig}\varphi'_{ig}$, and the arguments $\left(z_{ig}, \mathbf{z}_{-ig}\right)$ emphasize that all endogenous variables in general depend on all the standards. Note that, as we increase z_{ig}, the left-hand side has to cross zero once and from above in both cases, given our assumption that the noncooperative and cooperative problems each have a unique interior solution.

We first establish that $\lim_{\gamma_g \to \infty} z_{ig}^N = \infty$ for all i. This follows from the above first-order condition for noncooperative standards combined with the fact that the expression for $\gamma_{ig} - \lambda_{ig}^N\left(z_{ig}, \mathbf{z}_{-ig}\right)\varepsilon_{ig}$ is linearly increasing in γ_g for given standards $\left(z_{ig}, \mathbf{z}_{-ig}\right)$. To see this, note that we can use equation (18) to rewrite $\gamma_{ig} - \lambda_{ig}^N\varepsilon_{ig} = \gamma_{ig}\frac{\sum_{j \neq i}\varepsilon_{jg}y_{jg} + \sum_j \sigma_{jg}d_{jg}}{\sum_j\left(\varepsilon_{jg}y_{jg} + \sigma_{jg}d_{jg}\right)} + \frac{b_{ig}z_{ig}\varepsilon_{ig}y_{ig} + m_{ig}}{\sum_j\left(\varepsilon_{jg}y_{jg} + \sigma_{jg}d_{jg}\right)}\varepsilon_{ig}$.

We next show that $\lim_{\gamma_g \to \infty} z_{ig}^A = \infty$ for all i provided that γ_{ig} and ε_{ig} are not too dissimilar across countries. This follows from the above first-order condition for cooperative standards combined with the fact that the expression for $\gamma_{ig} - \lambda_g^A\left(z_{ig}, \mathbf{z}_{-ig}\right)\varepsilon_{ig}$ is linearly increasing in γ_g for given standards $\left(z_{ig}, \mathbf{z}_{-ig}\right)$. To see this, note that we can use equation (19) to rewrite $\gamma_{ig} - \lambda_g^A\varepsilon_{ig} = \gamma_g\frac{\sum_j \sigma_{jg}d_{jg}}{\sum_j\left(\varepsilon_g y_{jg} + \sigma_{jg}d_{jg}\right)} + \frac{\sum_j b_{jg}z_{jg}\varepsilon_g y_{jg}}{\sum_j\left(\varepsilon_g y_{jg} + \sigma_{jg}d_{jg}\right)}\varepsilon_g$, upon imposing $\gamma_{ig} = \gamma_g$ and $\varepsilon_{ig} = \varepsilon_g$ for all i.

We now establish that $\lim_{\gamma_g \to \infty}\left(z_{ig}^N - z_{ig}^A\right) > 0$ for all i. This follows from two observations. First, $\lambda_g^A\left(z_{ig}, \mathbf{z}_{-ig}\right) - \lambda_{ig}^N\left(z_{ig}, \mathbf{z}_{-ig}\right) \to \infty$ for any $\left(z_{ig}, \mathbf{z}_{-ig}\right)$ as $\gamma_g \to \infty$, as is easy to establish by combining the expressions for λ_{ig}^N and λ_g^A from equations (18) and (19) to $\lambda_g^A\left(z_{ig}, \mathbf{z}_{-ig}\right) - \lambda_{ig}^N\left(z_{ig}, \mathbf{z}_{-ig}\right) = \frac{\sum_{j \neq i}y_{jg}\left(\gamma_{jg} - b_{jg}z_{jg}\varepsilon_{jg}\right) + m_{ig}}{\sum_j\left(\varepsilon_{jg}y_{jg} + \sigma_{jg}d_{jg}\right)}$. Second, as γ_g becomes large and thus z_{ig}^N and z_{ig}^A become large, the standards of all countries $j \neq i$ only have a negligible impact on the first-order conditions of country i so that we can write them as $f_{ig}\left(z_{ig}\right) + \left(\gamma_{ig} - \lambda_{ig}^N\left(z_{ig}\right)\varepsilon_{ig}\right)g_{ig}\left(z_{ig}\right) = 0$ and $f_{ig}\left(z_{ig}\right) + \left(\gamma_{ig} - \lambda_{ig}^A\left(z_{ig}\right)\varepsilon_{ig}\right)g_{ig}\left(z_{ig}\right) = 0$. To see this, note that the equilibrium price and thus d_{ig} and y_{ig} converge to their unregulated levels as $z_{ig}^A \to \infty$ and $z_{ig}^N \to \infty$, and recall the assumption that σ_{ig} and ε_{ig} are bounded above and away from zero. These two observations together immediately imply the result. QED

Finally, we prove the claim made in the main text regarding the welfare impact of the

equilibrium agreement:

Proposition 4': Cooperation on process standards increases global welfare if γ_g is sufficiently low. It also increases global welfare if γ_g is sufficiently high, as long as ν_{ig} and ε_{ig} are not too dissimilar across countries.

Proof: It is immediate that the agreement increases global welfare if $\gamma_g = 0$ and hence also if γ_g is sufficiently low. We now show that the agreement increases global welfare also if γ_g is sufficiently high, as long as ν_{ig} and ε_{ig} are not too dissimilar across countries.

From the expression for welfare, it follows immediately that

$$
\begin{aligned}
W_g^A - W_g^N &= \sum_i \left[\pi_{ig} \left(p_g^A - \varphi_{ig} \left(z_{ig}^A \right) \right) - \pi_{ig} \left(p_g^N - \varphi_{ig} \left(z_{ig}^N \right) \right) \right] \\
&\quad + \sum_i \left[S_{ig} \left(p_g^A \right) - S_{ig} \left(p_g^N \right) \right] \\
&\quad - \sum_i b_{ig} \left[z_{ig}^A y_{ig} \left(p_g^A - \varphi_{ig} \left(z_{ig}^A \right) \right) - z_{ig}^N y_{ig} \left(p_g^N - \varphi_{ig} \left(z_{ig}^N \right) \right) \right]
\end{aligned}
$$

Recalling from the previous proof that $\lim_{\gamma_g \to \infty} z_{ig}^N = \infty$ and $\lim_{\gamma_g \to \infty} z_{ig}^A = \infty$ as long as the political parameters γ_{ig} and the supply semi-elasticities ε_{ig} are not too dissimilar across countries, this implies

$$
\begin{aligned}
\lim_{\gamma_g \to \infty} \left(W_g^A - W_g^N \right) &= \sum_i \left[\pi_{ig} \left(\tilde{p}_g \right) - \pi_{ig} \left(\tilde{p}_g \right) \right] \\
&\quad + \sum_i \left[S_{ig} \left(\tilde{p}_g \right) - S_{ig} \left(\tilde{p}_g \right) \right] \\
&\quad - \sum_i b_{ig} y_{ig} \left(\tilde{p}_g \right) \left(z_{ig}^A - z_{ig}^N \right) \\
&= - \sum_i b_{ig} y_{ig} \left(\tilde{p}_g \right) \left(z_{ig}^A - z_{ig}^N \right),
\end{aligned}
$$

where $\tilde{p}_g$ is the unregulated world price, i.e. the solution to $\sum_i y_{ig} \left(p_g \right) = \sum_i d_{ig} \left(p_g \right)$. Hence, $\lim_{\gamma_g \to \infty} \left(W_g^A - W_g^N \right) > 0$ if $z_{ig}^A < z_{ig}^N$ for all i, which is true for sufficiently large γ_g, as long as the political parameters γ_{ig} and the supply semi-elasticities ε_{ig} are not too dissimilar across countries, as follows from the previous proposition. QED

References

[1] Bagwell, K. and R. Staiger. 1999. "An Economic Theory of GATT." *American Economic Review* 89(1): 215-248.

[2] Bagwell, K. and R. Staiger. 2001. "Domestic Policies, National Sovereignty, and International Economic Institutions." *Quarterly Journal of Economics* 116(2): 519-562.

[3] Bagwell, K. and R. Staiger. 2011. "What Do Trade Negotiators Negotiate About? Empirical Evidence from the WTO." *American Economic Review* 101(4): 1238-73.

[4] Baldwin, R. 1987. "Politically Realistic Objective Functions." *Economics Letters* 24(3): 287-290.

[5] Blanchard, E. 2010. "Reevaluating the Role of Trade Agreements: Does Investment Globalization Make the WTO Obsolete?" *Journal of International Economics* 82: 63-72.

[6] Blanchard, E., C. Bown and R. Johnson. 2018. "Global Value Chains and Trade Policy." Mimeo.

[7] Campolmi, A., H. Fadinger, and C. Forlati. 2022. "The Design of Trade Agreements Under Monopolistic Competition." Mimeo.

[8] Costinot, A. 2008. "A Comparative Institutional Analysis of Agreements on Product Standards." *Journal of International Economics* 75(1): 197-213.

[9] Drazen, A. and N. Limao. 2008. "A Bargaining Theory of Inefficient Redistribution Policies." *International Economic Review* 49(2): 621-657.

[10] Grossman, G. and E. Helpman. 1994. "Protection For Sale." *American Economic Review* 84(4): 833-50.

[11] Grossman, G. and E. Helpman. 1995a. "Trade Wars and Trade Talks." *Journal of Political Economy* 103(4): 675-708.

[12] Grossman, G. and E. Helpman. 1995b. "The Politics of Free Trade Agreements." *American Economic Review* 85(4): 667-690.

[13] Grossman, G., P. McCalman and R. Staiger. 2021. "The "New" Economics of Trade Agreements: From Trade Liberalization to Regulatory Convergence?" *Econometrica* 89(1): 215-249.

[14] Lazarevski, G. 2020. "Lobbying for Trade: Why Countries Enter into Trade Agreements." Mimeo.

[15] Levy, P. 1999. "Lobbying and International Cooperation in Tariff Setting." *Journal of International Economics* 47: 345-370.

[16] Ludema, R. and A. Mayda. 2013. "Do Terms-of-Trade Effects Matter for Trade Agreements? Theory and Evidence from WTO Countries." *Quarterly Journal of Economics* 128(4): 1837-1893.

[17] Maggi, G. 2019. "Anti-lobbying Gains from International Agreements." Mimeo.

[18] Maggi, G. 2014. "International Trade Agreements," in G. Gopinath, E. Helpman and K. Rogoff (eds.), The Handbook of International Economics, vol. 4, Elsevier.

[19] Maggi, G. and R. Ossa. 2021. "The Political Economy of Deep Integration." *Annual Review of Economics* 13: 19-38.

[20] Maggi, G. and A. Rodriguez-Clare. 1998. "The Value of Trade Agreements in the Presence of Political Pressures." *Journal of Political Economy* 106(3): 574-601.

[21] Maggi, G. and A. Rodriguez-Clare. 2007. "A Political Economy Theory of Trade Agreements." *American Economic Review* 97(4): 1374-1406.

[22] Mei, Y. 2021. "Regulatory Protection and the Role of International Cooperation." Mimeo.

[23] Mitra, D. 2002. "Endogenous Political Organization and the Value of Trade Agreements." *Journal of International Economics* 57(2): 473-485.

[24] Nicita, A., M. Olarreaga, and P. Silva. 2018. "Cooperation in WTO's Tariff Waters?" *Journal of Political Economy* 126(3): 1302-1338.

[25] Ornelas, E. 2005 "Rent Destruction and the Political Viability of Free Trade Agreements." *Quarterly Journal of Economics* 120(4): 1475-1506.

[26] Ornelas, E. 2008. "Feasible Multilateralism and the Effects of Regionalism." *Journal of International Economics*, 74(1): 202-224.

[27] Parenti, M. and G. Vannoorenberghe. 2021. "A Simple Theory of Deep Integration." Mimeo.

[28] Rodrik, D. 2018. "What Do Trade Agreements Really Do?". *Journal of Economic Perspectives* 32(2): 73-90.

[29] Young, A. 2016. "Not Your Parents' Trade Politics: The Transatlantic Trade and Investment Partnership Negotiations". *Review of International Political Economy* 23(3): 345-378.

[30] Young, A. 2017. "Intergovernmental Policy Makes Transnational Politics? The Unusually Transnational Politics of TTIP". *Cambridge Review of International Affairs* 30(5-6): 527-548.