Harmonization...What Else?
The Role for International Regulatory Agreements*

Giovanni Maggi†
Yale University,
FGV/EPGE, and NBER

Monika Mrázová‡
University of Geneva,
CEPR, and CESifo

December 12, 2024

Abstract

We examine the potential role of international agreements on product standards through a stylized model where countries have different regulatory preferences and firms incur fixed costs of regulatory diversity. Overall, our analysis suggests that the common perception of regulatory agreements as playing a key role in promoting harmonization may have been overstated. We show that regulatory harmony can arise even in the absence of an agreement, and that "spontaneous" harmonization may be inefficient, suggesting that the role of regulatory agreements could be to promote regulatory diversity rather than harmonization. Moreover, the role of regulatory cooperation depends in important ways on the pattern of trade: in the presence of intra-industry trade, the potential role of an agreement tends to be more limited, and under some conditions it can only play a coordination role. Finally, through the lens of our model, we examine the "Pop Critique" of regulatory agreements, according to which lobbying by corporate interests may lead to welfare-reducing harmonization. Our analysis lends only limited support to this critique.

*We thank participants in seminars at the University of Nottingham, HEC Paris, Dartmouth, Princeton, SMU, Linz, Drexel, IU, UCD, Georgetown, Bielefeld-Kiel, Yale, University of Geneva, and conferences at EARIE, CESifo, CEPR and LSE for useful comments and discussions. We also thank our discussants Denis Novy, Antoine Bouët and Gonzague Vannoorenberghe for their detailed comments. Monika Mrázová thanks the Swiss National Science Foundation for funding under the SNSF Starting Grant scheme [project # TMSGI1-211445] and the Princeton IES for hosting her as a 2022/23 Kenen Fellow.

†E-mail: giovanni.maggi@yale.edu.

‡E-mail: monika.mrazova@unige.ch

1 Introduction

During the General Agreement on Tariffs and Trade (GATT) era, trade agreements focused on reducing or eliminating traditional trade barriers such as tariffs and quotas. As time passed, the scope of trade agreements, both multilateral and preferential, has broadened to include cooperation on various non-trade issues, including regulatory policies. For example, the World Trade Organization (WTO) included agreements on Technical Barriers to Trade (TBT) and on Sanitary and Phytosanitary Measures (SPS), and more recently, regional agreements like the Comprehensive Economic and Trade Agreement (CETA) between the EU and Canada and the EU-Mercosur agreement have the objective of achieving an even deeper level of regulatory cooperation.

There are many possible shades of regulatory cooperation, but a simple and important form of cooperation in this area is *harmonization* of product standards. Many international organizations and policy practitioners have emphasized the need for harmonization (see for example Lamy (2015, 2016), OECD (2017a), and more recently Letta (2024) and Draghi (2024)). Many of these reports point to a simple efficiency rationale for harmonization: if products need to comply with different regulations across markets, firms will have to incur extra costs of certification, product specifications and information acquisition, and these are generally considered to be fixed costs.[1]

However, regulatory agreements are quite controversial, particularly when it comes to the issue of harmonization. For example, massive protests took place in 2016 in Europe against the CETA agreement. As another example, a European petition against the (now abandoned) Transatlantic Trade and Investment Partnership (TTIP) between the EU and the US gathered three and a half million signatures.[2] While the motivations behind these protests are varied, issues surrounding harmonization have arguably been the most contentious. Two notorious examples are the cases of chlorinated chickens and hormone-treated beef.[3] One of the main concerns expressed by groups opposing harmonization was that corporate lobbies push for harmonization because it serves their interests, at the expense of general welfare (an argument we will refer to as the "Pop Critique").[4] Similar concerns have been raised by some academic economists, for example Rodrik (2018).

Motivated by the observations above, this paper addresses positive and normative questions surrounding the issue of regulatory harmonization. We first focus on the noncooperative choices of product standards, investigating under what conditions noncooperative government behavior leads to regulatory diversity versus "spontaneous" harmonization. We then examine the potential role for international cooperation. In particular, we ask: In what ways – if any – can a regulatory agreement

[1] For example, when discussing the costs of regulatory diversity related to product certification, Lamy (2015) writes: "You pay for this certification once from time to time, and this cost is not related to the volume traded."

[2] See www.theguardian.com/commentisfree/2016/oct/19/people-power-ending-ttip-eu-free-trade-deals-ceta.

[3] See for example the New York Times article from April 26, 2021 entitled "Chlorinated U.S.Chickens Convince British Consumers the Sky Is Falling" (www.nytimes.com/2021/04/25/business/chlorinated-chicken-uk.html)

[4] For example, the Corporate Europe Observatory (2017) expressed this concern in the following terms: "This is why harmonization risks lowering our standards to the lowest common denominator. Again, harmonization was a demand of big business that European trade negotiators included with little changes into the regulatory cooperation chapters of CETA and TTIP."

improve efficiency relative to the noncooperative scenario? Should the agreement push governments to harmonize standards, or rather encourage them to diversify standards? And is an agreement needed to enforce regulatory *cooperation*, or does it play only a *coordination* role in the presence of multiple equilibria? Finally, we examine the impact of lobbying on the regulatory regime: How does lobbying affect the likelihood of harmonization in the noncooperative and cooperative scenarios? And can lobbying lead to welfare-reducing harmonization?

We address these questions through a simple model that focuses on vertical product standards, which are motivated by local consumption externalities.[5] A stricter standard reduces the consumption externality but implies a higher marginal cost. We consider two countries (Home and Foreign) that differ in their valuations of the externality, and as a consequence have different preferred standards. Regulatory diversity is costly: in particular, a firm has to pay a fixed cost per market in order to comply with the local standard, but if both countries impose the same standard the firm pays a single fixed cost.[6] Our basic model focuses on product standards, but we later extend the model to allow for consumption taxes, which are also a natural policy instrument given the presence of consumption externalities.[7] Finally, alongside the sector where regulation is relevant as described above, there is an "outside" numéraire sector where policy does not play a role, and which gives the model essentially a partial-equilibrium structure (e.g. as in Grossman and Helpman (1994)).

We consider two scenarios. The first one is characterized by one-way trade within the non-numéraire sector, and more specifically, we consider a global monopolist that is located in the Home country.[8] The second scenario is characterized by intra-industry trade, and more specifically, we consider a symmetric international duopoly à la Brander and Krugman (1983). As we will highlight shortly, the predictions of the model depend in important ways on whether there is one-way trade or intra-industry trade in the sector of interest.

The broad insights generated by our model can be organized around three themes. First, the model suggests that the harmonization role of regulatory agreements may have been over-emphasized

[5]Our basic model abstracts from global externalities. In section 3.2 we briefly discuss how global externalities may affect our results.

[6]The costs of regulatory diversity are generally considered fixed with respect to volume. Whether or not these costs are fixed also with respect to the distance between the standards depends on the exact nature of these costs. The OECD (2017a) distinguishes three types of costs of regulatory diversity: (i) Information costs (e.g. acquiring information on the different standards); (ii) Specification costs (e.g. extra design costs); (iii) Conformity assessment costs (i.e. costs of product certification). While specification costs, and to a certain extent also information costs, are likely to increase continuously with the distance between standards, conformity assessment costs are likely to vary in a discrete way with the distance between standards: if a firm needs to certify a product to prove compliance with a standard, when standards differ even by a little, the firm will have to certify twice. We note that, according to a survey by OECD (2017b), conformity assessment costs are the most significant costs of regulatory diversity in many sectors: "75% of countries indicated that conformity assessment costs were very significant, whereas less than a third did so for specification costs."

[7]To focus on questions of deep integration, in this paper we only consider policies that do not discriminate between domestic and foreign firms, and in particular, standards and consumption taxes are assumed to be non-discriminatory, and we do not consider tariffs. We note however that in our baseline model, where there are no import-competing firms, a consumption tax is equivalent to a tariff.

[8]This is the simplest (imperfectly competitive) market structure that delivers one-way trade, but we will argue that the main insights extend to oligopoly settings that give rise to one-way trade.

in policy debates. More specifically, we show that harmonization may arise in the noncooperative scenario (we refer to this as "spontaneous harmonization"), and under some conditions this may be inefficient, so the role of regulatory agreements may be to diversify, rather than harmonize, standards.

The second point is that the role of regulatory agreements depends in important ways on whether the sector of interest is characterized by one-way or intra-industry trade. We argue that, in the presence of intra-industry trade, under some conditions there are multiple equilibria in the standard-setting game, and as a consequence regulatory agreements tend to play more of a coordination role. Furthermore, we show that the role of the agreement may be to help governments coordinate on diversified – rather than harmonized – standards.

The third theme is the impact of lobbying. We argue that the Pop Critique as defined above is right in some ways but wrong in others. We show that lobbying pushes toward the regulatory regime – harmony or diversity – that is worse for consumers, and furthermore, if lobbying is strong enough the agreement reduces welfare relative to the noncooperative equilibrium. These results are consistent with the spirit of the Pop Critique, but this is where our model's support for the Pop Critique stops. First, we show that lobbying may push toward diversification, rather than harmonization. Second, lobbying may distort the regulatory regime even in the absence of a regulatory agreement, so the issue is not the agreement *per se*. And third, when the agreement reduces welfare, it is not because lobbying pushes toward harmonization, but because it pushes toward *deregulation*.

Next we describe our main results in more detail.

We start by focusing on the setting with one-way trade. In the noncooperative scenario, if the distance between the countries' regulatory preferences is large relative to the cost of regulatory diversity, the two countries choose diverse standards in equilibrium, but in the opposite case the exporting country spontaneously adopts the importing country's preferred standard. The occurrence of spontaneous harmonization in our model is reminiscent of the so-called "California effect," also known as "Brussels effect," whereby a state or country spontaneously adopts the standards of another state/country (Vogel (1997, 2000), Perkins and Neumayer (2012) and Bradford (2012)). Perhaps interestingly, it is often argued that the exporting country is more likely to adopt the standards of the importing country when the latter has a larger market, but as we will explain below, our model does not support this intuition.

Moving to the role of regulatory cooperation, our first observation concerns the nature of the international policy externalities. When countries set product standards noncooperatively, they do not take into account how their policy choice affects foreign firms' profits. In particular, a government ignores the fact that a stricter standard reduces the foreign firm's operating profits (we will refer to this simply as the "profit externality"), and that by matching the other country's standard it reduces the foreign firm's fixed costs ("matching externality"). Given the matching externality, cursory intuition may suggest that regulatory harmony will be "under-provided" in the noncooperative equilibrium and hence an international agreement will encourage countries to harmonize standards. Perhaps surprisingly, this intuition is not correct. We show that under some circumstances – broadly

speaking, when the countries' *regulatory* preferences are similar but their *fundamental* preferences are not – regulatory harmony arises in the noncooperative equilibrium but the agreement may encourage countries to diversify standards.[9]

While the above result focuses on how the agreement may change the regulatory *regime*, the agreement also changes the *levels* of the standards. The current policy debate typically emphasizes the need for regulatory agreements to tighten environmental and safety standards, but perhaps interestingly, our model highlights an effect that goes in the opposite direction: if parameters are in the region where the California/Brussels effect arises, the agreement loosens standards in both countries, regardless of whether or not it maintains regulatory harmony. What underlies this result is the profit externality exerted by the importing country's standard, together with the fact that under spontaneous harmony the exporting country adopts the stricter standard of the importing country.

We then extend the model to allow for product standards to affect the extensive margin of trade. In this case we show that the agreement can create trade at the extensive margin by harmonizing standards, and characterize the parameter region where this occurs. On the other hand, we show that the agreement can never reduce trade at the extensive margin, even when it promotes diversification.

Next we consider a scenario with intra-industry trade à la Brander and Krugman (1983) featuring two symmetric firms, one in each country. In the noncooperative scenario, a key determinant of the equilibrium regime(s) is again the distance between the countries' preferences relative to the fixed cost of regulatory diversity, but here a new feature is the possibility of multiple equilibria. Specifically, if the above ratio is sufficiently large there is a unique equilibrium with diverse standards, if it is sufficiently small there are multiple spontaneous-harmony equilibria, and if it lies in some intermediate range diversity and harmony equilibria coexist.

When we consider the role for regulatory agreements, a preliminary observation is that in this setting with symmetric intra-industry trade, if the countries' fundamental preferences are similar, also their regulatory preferences are. Thus the diversification motive for an agreement that can arise under one-way trade – namely that the distance between the countries' regulatory preferences may not reflect the distance between their fundamental preferences – is not present here. Nevertheless, it is still true that the agreement may encourage countries to diversify standards, but for a different reason, which can be traced to the interaction between the matching externality and the profit externality. This result is particularly sharp in the case of a linear externality, demand and cost: in this case we find that the agreement can *only* play a diversification role. But there is an important difference relative to the one-way trade setting: here the role of the agreement may be limited to a *coordination* role, because of the possible multiple equilibria in the noncooperative scenario. In particular, the agreement may play a "weak" regime-changing role, in the sense that it may help

[9] In our terminology, countries have similar "fundamental" preferences if their primitive utility functions, and in particular their valuations of the consumption externality, are similar, whereas they have similar "regulatory" preferences if their national-welfare-maximizing standards are similar. The key point is that, if regulatory preferences are similar, so that spontaneous harmony occurs, then fundamental preferences must be dissimilar, because the exporting country cares about the firm's profits while the importing country does not, and hence spontaneous harmony may be inefficient.

countries focus on the efficient regime, and consistently with the discussion above, it may play a weak diversification role. Finally, we find that if the countries' preferences are sufficiently similar and the cost of regulatory diversity is above some critical level, the agreement can at best play a pure coordination role, because the efficient (harmonized) standards constitute a noncooperative equilibrium.

Moving to our key political-economy question, we examine whether lobbying can lead to welfare-reducing harmonization (the Pop Critique). We model lobbying by attaching an extra weight to firm profits in the government's objective (along the lines of Baldwin (1987) and Grossman and Helpman (1994)). We have some good news and some bad news for the Pop Critique. Our first result in support of the Pop Critique is that increasing the strength of the lobby pushes toward the regime – harmony or diversity – that is less preferred by consumers. This is true both in the noncooperative scenario and in the cooperative scenario (in which case what matters is the average world consumer's preference). Underlying this result is the fact that, if a government is indifferent between the two regimes, firms and consumers must have opposite preferences on the regime. The second result that is consistent with the Pop Critique is that, if lobbying is sufficiently strong, regulatory cooperation reduces welfare relative to the noncooperative scenario. This result stems from the fact that lobbying tends to distort cooperative standards more than it distorts noncooperative standards.

However, while there are reasons to be concerned about the impact of lobbying on the regulatory regime, we argue that the Pop Critique is somewhat misdirected in its emphasis on (a) harmonization, and (b) regulatory agreements. First, we show that lobbying may well push *against* harmonization, and in particular this is the case if the two countries' regulatory preferences are not very distant. Second, when lobbying causes the agreement to reduce welfare, it is because it pushes toward looser standards, not because it pushes toward harmonization. And third, lobbying may distort the regulatory regime even absent international agreements, so the problem is not caused by regulatory agreements, but by the distortionary impacts of lobbying more generally.[10]

The final step of our analysis is to examine an extension of the model where governments can use consumption taxes in addition to product standards. We will argue that the availability of consumption taxes makes it more likely that the regulatory agreement plays a harmonization role, and this is especially true in the setting with one-way trade.

Our paper contributes to a small but budding literature on regulatory cooperation. The closest paper to ours is Grossman et al. (2021). This paper is complementary to ours, in that it focuses on different questions and makes very different points. Its main focus is whether market-access-based agreements are sufficient to yield efficiency or whether a deeper integration agreement is needed, in a setting where governments can use trade taxes in addition to product standards and consumption taxes. In their baseline model there is no efficiency rationale for standards, and furthermore there is

[10] An additional result which is at odds with the Pop Critique is that, in the noncooperative scenario, under some conditions lobbying may lead to stricter, rather than looser, standards. This can happen when lobbying leads to a switch from diversity to harmony and the importing country's preferred standard is tighter than the exporting country's, leading the latter to tighten its own standard.

no unilateral rationale for standards if trade taxes are unconstrained. A government is tempted to use standards only as a way to circumvent constraints on trade taxes imposed by a trade agreement, and this motivates their question of whether an "old style" trade agreement is a good idea.[11] At the heart of our paper, on the other hand, are questions surrounding regulatory harmonization, such as whether countries will harmonize standards spontaneously, whether a regulatory agreement should encourage countries to harmonize or diversify standards, and how all of this is impacted by lobbying.

Fischer and Serra (2000) and Suwa Eisenmann and Verdier (2002) examine the protectionist role of standards in the presence of fixed costs of regulatory diversity in a noncooperative scenario, but do not consider the role for international cooperation. Costinot (2008), Maggi and Ossa (2023), Macedoni and Weinberger (forthcoming) and Mei (2024), on the other hand, explore the role for international regulatory cooperation, but in the absence of costs of regulatory diversity, so these papers are largely silent on questions surrounding harmonization.[12] Finally, Parenti and Vannoorenberghe (2024) consider a Ricardian model where firms have a cost advantage in producing at a standard close to their "core competence." They find that, because of this cost of regulatory diversity, cooperation leads to partial convergence of standards, and show that cooperation is most advantageous for countries with moderate differences in regulatory preferences.[13]

The rest of the paper proceeds as follows. Section 2 lays our the basic setup. Section 3 focuses on the setting with one-way trade. Section 4 focuses on the intra-industry trade scenario. Section 5 extends the model to allow for consumption taxes. Section 6 concludes. The Appendix provides proofs of all propositions.

2 The Basic Setup

We consider a model with two countries, Home and Foreign ($*$), and two goods, a numéraire and a non-numéraire good. Each country is populated by citizens with identical preferences. The utility function is separable in the two goods and linear in the numéraire. On the supply side, the numéraire is produced one-for-one from labor, with each country endowed with a large enough quantity of labor, and the non-numéraire good is produced from labor and a specific factor. With this supply

[11] They also consider an extension with consumption externalities, but in this setting they do not consider the governments' noncooperative choice of standards, focusing instead on the comparison between the efficient standards and the standards that firms would choose absent regulations.

[12] Mei (2024) does consider the welfare effect of harmonization in his quantification exercise (which turns out to be small and positive), but as he writes, in his model "the benefit of harmonization is muted to a large extent", since there are no costs of regulatory diversity.

[13] In the public economics literature, Loeper (2011) has some points of contact with our paper. He considers a coordination game between the states of a federation, where policy heterogeneity is costly and states have different policy preferences. Our "matching externality" is reminiscent of his "coordination externality." He examines the noncooperative equilibrium and compare it with a centralized uniform policy. He does not consider the possibility that the efficient policies are diversified, thus his paper cannot speak to the possible diversification role of a federal agreement. Another important difference relative to our paper is that the coordination externality is the only policy externality in his model, whereas in our model, the interaction between the matching externality and the profit externality is at the core of several key results.

and demand structure, it is well known that the numéraire plays the role of an "outside good" and we can focus on the non-numéraire sector in partial-equilibrium fashion. Since this structure is very common in the trade literature (see for example Grossman and Helpman (1994)), we will not introduce explicit notation for the outside good.

The non-numéraire good is vertically differentiated, for example in terms of its environmental friendliness or its safety. As an example, we will sometimes refer to cars that are differentiated in terms of the level of emissions. We index the quality of the good by $e \in [0, \infty)$ (for "emissions"), with a higher e indicating a "dirtier" variety. In what follows we will omit the qualifier "non-numéraire" for this good, as this should not cause confusion.

The dirtiness of the good (e) matters because consumption of the good generates a negative local externality, which is worse if e is higher. We will be more specific about the exact nature of this externality below. Consumers are atomistic and hence ignore the impact of their consumption choices on the externality. We also assume that varieties are indistinguishable in the eyes of consumers, so the demand function depends only on the price of the good. We let $d(p)$ denote the demand function, which we assume symmetric across countries.[14]

Producing a dirtier variety (higher e) is cheaper, and in particular, the marginal cost of the good is constant with respect to quantity but decreasing in e, so we let $c(e)$ denote the marginal cost, with $c'(e) < 0$.

To address the consumption externality, each government chooses an exact product standard for the good sold in the local market. With a slight abuse of notation, we will simply use e as the standard chosen by Home and e^* as the standard chosen by Foreign. We could allow governments to use also caps (e.g. maximum emissions levels), but this would not change our key qualitative results.[15]

We assume that trade taxes are not available. This is meant to capture situations where trade taxes have been largely removed and the focus of international cooperation has shifted from traditional "border" measures that discriminate against imports toward issues of "deep integration." In the same spirit, we assume that standards cannot discriminate against imports (i.e. they conform to "national treatment"), a long-standing rule at the core of the GATT-WTO. We also do not allow for lump-sum transfers to firms. Finally, in our basic model we abstract from consumption taxes, but we will consider them in a later section.[16]

One of our key points will be that the role of regulatory agreements can be quite different depend-

[14]Our main qualitative results do not depend on the assumption of symmetric demand. We briefly discuss the implications of asymmetric market size in subsection 3.2.

[15]As we discuss in subsection 3.1, the game where governments choose exact standards is equivalent to the game where governments can choose both exact standards and caps, in the sense that, for any equilibrium of the latter game, there is an equilibrium of the former game that generates the same outcome.

[16]As a descriptive matter, it is important to note that Pigouvian taxes are often difficult to implement or even infeasible, as argued for example in the case of vehicle emissions by Jacobsen et al. (2023). For this reason we will consider a setting where governments can use product standards and uniform consumption taxes. We also note here that our model abstracts from process standards (which may be motivated by production externalities) or restrictions on the sale of goods produced with certain processes such as child labor (which may be motivated by international "moral" externalities).

ing on the importance of intra-industry trade. To make this point more transparent, we will consider two polar cases: a scenario where trade in the non-numéraire sector is one-way, and a scenario with symmetric firms and two-way trade in the non-numéraire sector. We start with the case of one-way trade.

3 The One-Way-Trade Scenario

In this section we consider a scenario with one-way trade in the non-numéraire sector. The simplest setting that generates one-way trade is one where the non-numéraire good is produced by a single firm, which we assume is located in the Home country. As we will argue later in this section, the main qualitative results of the monopoly model extend to the case in which there are firms in both countries but foreign firms do not export (see footnote 22).

We will consider a simple two-period setting in which governments choose standards (either noncooperatively or cooperatively), and then the firm makes price/quantity decisions for each market.

The firm incurs a fixed cost F for each supplied variety, thus if governments choose the same standard ($e = e^*$) the firm incurs cost F, while if governments choose different standards ($e \neq e^*$), the firm incurs cost $2F$ if it wants to serve both markets.[17] This assumption captures scenarios where regulatory diversity is costly even if standards are relatively similar to each other. This seems like a reasonable approximation, for example, for the costs that a firm must incur to certify that a product conforms to the regulations of the destination market.[18] And as discussed in the Introduction, our fixed cost structure may be a good fit also for costs that a firm must incur to acquire information about the regulations that are in place in each destination market.[19]

We will start by focusing on the benchmark case in which governments maximize welfare, but later we will consider a scenario where the Home government maximizes a politically-adjusted welfare function that attaches an extra weight to the firm's profits.

We first write down the welfare function and then explain each of its components in detail. The

[17] We note that our results do not depend in a knife-edge way on the discontinuity of the cost at zero. For example, if the fixed cost is a function of the distance between the standards, say $f(|e - e^*|)$, our basic model assumes that $f(0) = F$ and $f(|e - e^*|) = 2F$ if $|e - e^*| > 0$, but our qualitative results would be the same if $f(|e - e^*|)$ were continuous but rising sufficiently steeply from F to $2F$ as $|e - e^*|$ increases from zero.

[18] We have in mind that the firm can use a certification agency that both countries have agreed to honor, so if country A and country B have the same product standards, the firm can get certified for both markets with a single submission, whereas if countries have different standards, the firm needs two distinct submissions, even if the standards are relatively similar to each other. In reality, a government can choose a product standard and (one or more) certification agencies that it will honor. Even when countries apply the same standard, if there is no certification agency that both governments agreed to honor, the firm will have to certify the product twice and pay two fixed costs of certification. Our model for simplicity abstracts from this possibility.

[19] It is interesting to contrast our assumption on the cost of regulatory diversity with the corresponding assumption made by Grossman et al. (2021). Using the notation of footnote 17 above, they assume that $f(|e - e^*|)$ is increasing and convex. While we have argued that our specification is a better fit for certification costs, the specification in Grossman et al. (2021) is arguably a better fit for the costs of product specification.

Home country's welfare is given by:

$$\tilde{W}(e,e^*) = \underbrace{CS(e) - \alpha E(e) + \pi(e) + \pi(e^*)}_{W(e,e^*)} - n(e,e^*)F.$$

Note that we use $\tilde{W}$ to denote welfare net of fixed costs, while W denotes welfare gross of fixed costs.

In the expression above, $CS(e)$ denotes consumer surplus (not including the externality) in reduced form, taking into account the effect of e on the monopoly price. Since the marginal cost is decreasing in e, also the monopoly price is decreasing in e and hence CS is increasing in e.

The consumption externality is captured in reduced form by the function $E(e)$. The only structure we impose on $E(e)$ is that it is increasing in e. For example, in the case of car emissions, $E(e)$ could represent the total emissions from the use of cars, equal to the per-car emissions level e times the number of cars $d(p(e))$. Note that in this case $E(e) = ed(p(e))$ is increasing for two reasons: increasing e makes each car more polluting, and leads to a larger consumption of cars, since the monopoly price is decreasing in e.[20] The parameter α captures the importance that the Home country attaches to the externality, and may capture for example the degree to which the country's citizens are environmentally sensitive.

The profits that the firm makes in the Home and Foreign markets (gross of fixed costs) are denoted in reduced form respectively by $\pi(e)$ and $\pi(e^*)$. Note that the profit function $\pi(\cdot)$ is the same for the two markets because the demand function is symmetric across countries.

The number of supplied varieties is denoted by $n(e,e^*)$, so that $n = 1$ if $e = e^*$ and $n = 2$ if $e \neq e^*$. The fixed costs incurred by the firm are therefore given by F if $e = e^*$ and $2F$ if $e \neq e^*$, as discussed above.

Foreign welfare is given by:

$$\tilde{W}^*(e^*) = W^*(e^*) = CS(e^*) - \alpha^* E(e^*).$$

We assume that W^* is single-peaked in e^*. The parameter α^* captures the importance that the Foreign country attaches to the consumption externality.

Before proceeding, we introduce notation for the total surplus arising in each market. The total surplus in the Home market (gross of fixed costs) is denoted in reduced form by $S(e) = CS(e) - \alpha E(e) + \pi(e)$. Note that, in the absence of fixed costs, efficiency would require maximizing this gross surplus function. We assume that S is single-peaked in e. Similarly, the total gross surplus in the Foreign market is defined as $S^*(e^*) = CS(e^*) - \alpha^* E(e^*) + \pi(e^*)$. In what follows, we will often omit the qualifier "gross" when talking about the surplus in a given market.

We define a country's "preferred" standard as the one that maximizes national welfare gross of fixed costs. This is the standard a country would choose if it didn't take into account the costs

[20] In other applications, $E(e)$ may be nonlinear in the consumption level $d(\cdot)$. For example, if e captures the unhealthiness of a product and E is the social damage from a worse level of public health, E could be convex in the amount of consumption $d(\cdot)$ for a given e.

of regulatory diversity. Thus Home's preferred standard is $e_W = \arg\max_e W(e, e^*)$ and Foreign's preferred standard is $e^*_W = \arg\max_{e^*} W^*(e^*)$.

It is important to note that Home's preferred standard is the one that maximizes Home's surplus, $e_S = \arg\max_e S$, while Foreign's preferred standard is stricter than Foreign's surplus-maximizing standard $e^*_S = \arg\max_{e^*} S^*$, because Foreign does not care about the Home firm's profits. This in turn implies that, if the preference parameters are the same, i.e. $\alpha^* = \alpha$, Foreign's preferred standard is stricter than Home's ($e^*_W < e_W$). For future reference, we let $\hat{\alpha}$ be the value of α^* such that $e_W = e^*_W$. Note that $\hat{\alpha} < \alpha$: since Foreign does not care about the firm's profits, for the preferred standard to be the same across countries Foreign needs to care less about the environment than Home.

This leads us to a distinction that will play a key role in what follows: the distance $|\alpha^* - \alpha|$ captures the cross-country difference in *fundamental* preferences, while the distance $|e^*_W - e_W|$ captures the cross-country difference in *regulatory* preferences. As will become clear, the difference in fundamental preferences determines the efficiency benefits of regulatory diversity, while the difference in regulatory preferences will be key in determining the equilibrium regulatory regime (diversity vs. harmony) in the noncooperative scenario. Note that, given the notation introduced above, the distance between regulatory preferences can also be captured by the distance between α^* and $\hat{\alpha}$, so we will often interpret $|\alpha^* - \hat{\alpha}|$ as the distance between regulatory preferences.

3.1 Noncooperative regulatory regime

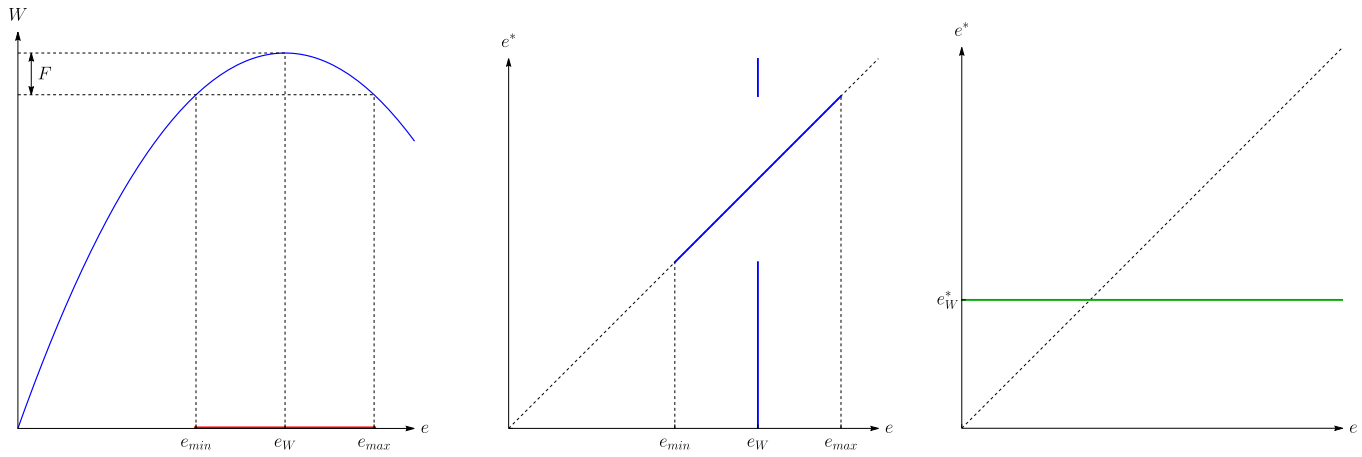
We start by characterizing the governments' choices of standards in the absence of an international agreement. Assuming that governments choose standards simultaneously, we seek to characterize the Nash equilibrium standards, and in particular how they depend on three key parameters: the fundamental preference parameters, α and α^*, and the cost of regulatory diversity, F.

Consider first the choices of the firm given the standards set by the governments. The firms makes two choices: the markets to serve and the price in each market. The firm will serve a market only if it can break even in that market given the product standards chosen by the governments. Initially we will focus on the case in which the break-even condition does not bind for either market, because this allows us to make our main points in a more transparent way, but in Section 3.4 we will allow the break-even condition to bind for the foreign market, so that extensive-margin considerations become relevant. In terms of fundamental parameters, it is easy to see that the break-even conditions are not binding as long as α, α^* and F are not too large.[21]

A key step of the analysis is to characterize the governments' reaction functions. Let us start with the Home government's reaction function, which we define as $R(e^*) = \arg\max_e W(e, e^*)$.

The shape of Home's reaction function, depicted in Figure 1b, is quite intuitive. If e^* is far from

[21] We also assume parameters are such that welfare net of any fixed costs is positive for both countries at the equilibrium standards. If this were not the case, extensive margin considerations could play a role even if the firm's break-even condition is not binding. Again, this requires that α, α^* and F not be too large.



(a) $W(e, e^*)$ for a given e^* (b) Home reaction function (c) Foreign reaction function

Figure 1: Home and Foreign reaction functions

Home's preferred standard e_W, Home finds it optimal to choose e_W. But if e^* is sufficiently close to e_W, then Home finds it optimal to match Foreign's standard, so Home's reaction function follows the diagonal for an interval of e^* around e_W, which we refer to as Home's "tolerance range" and denote $[e_{min}, e_{max}]$. Figures 1a and 1b illustrate how Home's tolerance range can be derived graphically: this range includes all the values of e such that the welfare loss relative to the preferred standard e_W is less than the fixed cost F. Notice that the tolerance range is empty if $F = 0$ and gets larger as F increases.

Foreign's reaction function, which is depicted in Figure 1c, is straightforward: since this country does not care about the firm's profits, clearly its optimal standard is equal to its preferred standard e^*_W regardless of Home's standard.[22]

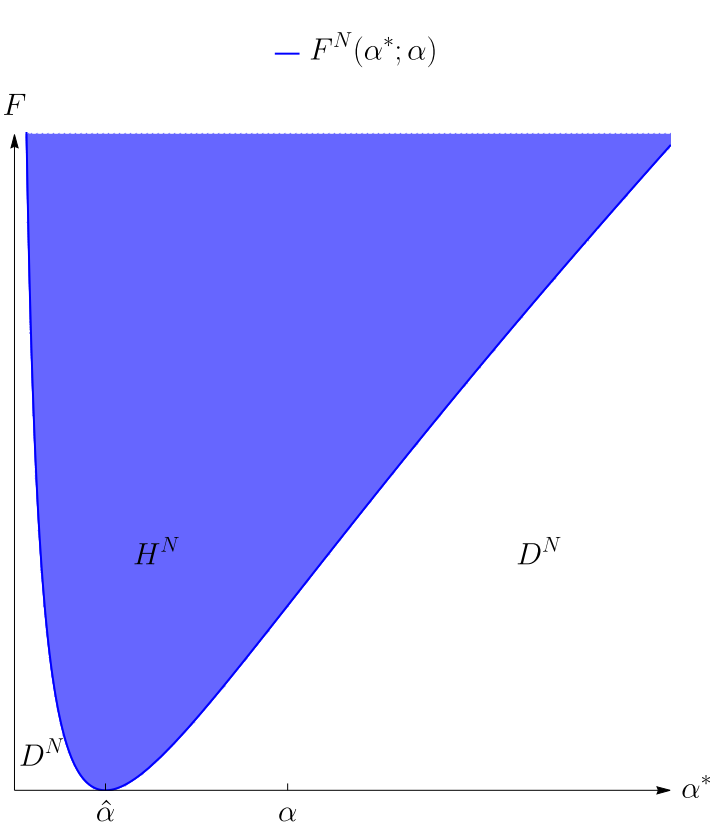
We can now characterize the Nash equilibria of the standard-setting game, by intersecting the two reaction functions described above. First note that there exists a unique Nash equilibrium, as can be easily verified by graphical inspection. We can distinguish between two cases:

(1) The equilibrium standards may be equal, a case that we refer to as the "Harmony" regime. It is easy to see that this is the case when the distance between the countries' preferred standards, $|e^*_W - e_W|$, is small relative to the fixed cost F. In terms of fundamental preference parameters, recalling that $\hat{\alpha}$ is the value of α^* such that $e_W = e^*_W$, this condition is satisfied when $|\alpha^* - \hat{\alpha}|$ is small relative to F. Note that in this case Foreign chooses its preferred standard e^*_W and Home matches it.

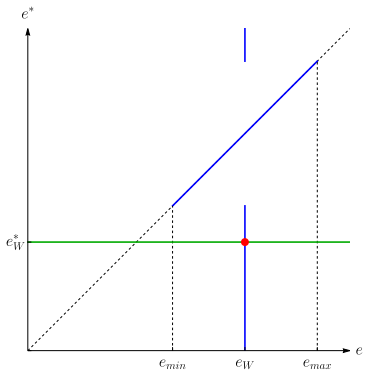
(2) The equilibrium standards may be different, a case that we refer to as the "Diversity" regime. In this case, each government sets its preferred standard (e_W and e^*_W respectively). This occurs when $|\alpha^* - \hat{\alpha}|$ is large relative to F.

Figure 2a illustrates the equilibrium regime in the parameter space (α^*, F) for a fixed level of α.

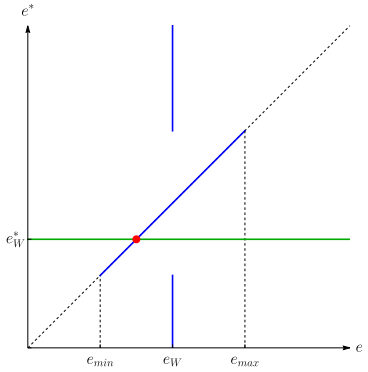
[22]Note that if the model were extended to allow for firms in the Foreign country that only sell locally (perhaps because they have lower productivity than the Home firm), the Foreign reaction function would look similar, because the Home standard would not affect the Foreign government's choice. For this reason, most of our qualitative results in this baseline one-way-trade setting would remain unchanged, as we stated at the outset of this section.



(a) Types of noncooperative equilibria



(b) Diversity equilibrium



(c) Harmony equilibrium

Figure 2: Noncooperative setting of product standards

In the shaded region, where $|\alpha^* - \hat{\alpha}|$ is small relative to F, standards are harmonized. Note that if $F = 0$ the only value of α^* such that standards are harmonized is $\hat{\alpha}$: intuitively, absent fixed costs standards are harmonized only if countries have identical regulatory preferences.

Figures 2b and 2c illustrate the intersection of the two reaction functions for each of the two parameter regions: in the Harmony region, they intersect on the diagonal; in the Diversity region, they intersect at a point off the diagonal where each country chooses its preferred standard.

For future reference, we write down the equation that defines the frontier between the Harmony and Diversity regions. First note that Home's indifference condition between choosing its own preferred standard and adopting Foreign's preferred standard is given by $W(e_W, e^*_W) - F = W(e^*_W, e^*_W)$. Writing Home welfare as $W(e, e^*) = S(e) + \pi(e^*)$ and simplifying, the condition becomes

$$S(e_W(\alpha)) - F = S(e^*_W(\alpha^*)), \tag{1}$$

where the notation emphasizes that e_W and e^*_W depend respectively on α and α^*. Thus spontaneous harmony occurs if $F \geq S(e_W(\alpha)) - S(e^*_W(\alpha^*)) \equiv F^N(\alpha^*;\alpha)$.

It is direct to see from (1) why the spontaneous harmonization region in Figure 2a is U-shaped, so that for a higher level of F harmonization emerges for a larger range of the preference distance $|\alpha^* - \hat{\alpha}|$. There is a simple graphical intuition for this, which can be gleaned from Figure 2c: when F

is larger, Home's tolerance range expands, so the overlap between Home's reaction function and the diagonal expands, and hence the equilibrium will be on the diagonal for a wider range of $|\alpha^* - \hat{\alpha}|$.

The following proposition summarizes the conditions under which spontaneous regulatory harmony emerges in the noncooperative scenario:

Proposition 1. *Under one-way trade: (i) If $|\alpha^* - \hat{\alpha}|$ is small relative to F, governments choose the same standard in equilibrium (spontaneous harmony), with the exporting government adopting the importing government's preferred standard; (ii) If $|\alpha^* - \hat{\alpha}|$ is large relative to F, the noncooperative equilibrium standards differ across countries.*

This proposition states that spontaneous harmony (resp., diversity) emerges when the distance between the two countries' regulatory preferences, which is captured by $|\alpha^* - \hat{\alpha}|$, is small (resp., large) relative to the cost of regulatory diversity F.

Given this result, a natural question is: Do we ever observe spontaneous harmonization in reality? Several anecdotal studies have highlighted cases in which product standards have been harmonized in the absence of regulatory agreements between governments. Examples of such studies are Vogel (1997, 2000) and Perkins and Neumayer (2012). They highlight what has since been labeled the "California effect," that is, a tendency of environmental product standards to ratchet upwards towards levels found in high-regulating states. Relatedly, Bradford (2012) has documented a "Brussels effect," whereby non-EU countries have spontaneously adopted EU standards.[23]

It is also interesting to note that spontaneous harmonization in our model can be in the direction of tighter or looser standards. In Figure 2a, if parameters are in the blue region and $\alpha^* > \hat{\alpha}$, Home tightens its standard in order to match Foreign's preferred standard. Note that the condition $\alpha^* > \hat{\alpha}$ is satisfied provided that Foreign does not care much less than Home about the externality. On the other hand, if parameters are in the blue region and $\alpha^* < \hat{\alpha}$, then Home loosens its standard in order to match Foreign's preferred standard. Interestingly, the former case reflects more closely the California/Brussels effect discussed above.

Another observation concerns the role of market size for the California/Brussels effect. It is sometimes argued that this effect is more likely to arise when the export market is larger, because this implies larger potential profits for exporting firms, and this makes it more attractive for the exporting government to adopt the standard of the destination market (see e.g. Bradford (2012)). Our model, however, offers a qualification to this intuition, at least if the extensive margin is not at play, as assumed here. We can capture an increase in the export market size by scaling up Foreign's demand function. This increases the foreign profit component $\pi(e^*)$ in Home's welfare. But as can be

[23]The California/Brussels effect described by the above studies is sequential, in the sense that one government tightens its standard and then other governments follow suit, but it is not hard to reconcile this feature with a modified version of our model. Suppose that initially standards are harmonized, because parameter values are in the Harmony region, and at some point there is a shock to environmental preferences in Foreign, so that α^* increases. If the increase in α^* is not too large, so that parameter values continue to be in the Harmony region, Foreign will tighten its standard and Home will follow suit. If Home responds to the change in Foreign's standard with a lag, then the policy changes in the two countries will be sequential.

seen from (1), this component does not affect the indifference condition that defines the spontaneous harmony region, simply because foreign profits are not affected by Home's standard. The size of the export market *may* have an impact on condition (1), but through a different channel: it may affect Foreign's preferred standard e_W^*, so it can move it closer or further away from e_W.

More formally, let us scale the Foreign demand function by a factor k, so we write it as $kd(p)$. Suppose also that the externality function takes the multiplicative form $E = eg(kd(p))$, with g an increasing function. As discussed at the outset, this accommodates cases where the consumption externality is nonlinear in consumption. It is easy to show that e_W^* is decreasing (resp., increasing) in k if g is convex (resp., concave), and is independent of k if g is linear. Intuitively, if the externality is convex, increasing the size of the market increases the marginal externality and hence requires a stricter standard. In terms of Figure 2a, depending on the concavity/convexity of E, increasing k may increase or decrease $\hat{\alpha}$, and thus may shift the spontaneous harmony region rightward or leftward. But in either case it is easy to see that, depending on the parameter vector (F, α), increasing k *may* lead to a shift from harmony to diversity. The following remark records this observation:

Remark 1. *(i) If the externality is linear in consumption, increasing the size of the export market has no effect on the regulatory regime; (ii) If the externality is convex (concave) in consumption, increasing the size of the export market makes the Foreign preferred standard e_W^* stricter (looser). In either case, this may lead to a shift from harmony to diversity.*

As Remark 1 highlights, our baseline model does not support the standard intuition that spontaneous harmony is more likely when the export market is larger.[24]

Before proceeding, this is a good juncture to discuss how results would change if governments could choose caps (e.g. maximum emissions levels) rather than exact product standards. The first point is that in our setting, allowing governments to use caps would not change results as long as governments can *also* use exact standards. More specifically, it can be shown that the equilibrium outcome described above remains an equilibrium outcome also in the extended game where governments can use caps and exact standards. Intuitively, consider a government's best response given the other government's choice: clearly, the government can do at least as well with an exact standard as with a cap, for the simple reason that, if a cap induces the firm to supply a variety e' below the cap, the same outcome can be achieved by using an exact standard at e'.

[24]The idea that increasing the size of the export market should make spontaneous harmony more likely is sometimes linked to extensive-margin effects. For example Princen (1999), in discussing the California effect, argues that increasing the size of a market can induce exporting firms to serve that market and at the same time induce the governments of the exporting firms to adopt the standard of the destination market. This idea can be formalized if we extend the model along the lines of Section 3.4. In that setting, if we increase the size of the foreign market while keeping the foreign standard fixed, the extensive margin channel indeed works in favor of spontaneous harmony, consistent with Princen's idea. But if one takes into account that increasing the size of the foreign market affects Foreign's preferred standard, then the extensive-margin channel may work against spontaneous harmony. In particular, one can show that increasing the size of the Foreign market may induce a switch from spontaneous harmony to no-trade. The reason for this is that increasing the size of the Foreign market may lead to a stricter Foreign preferred standard, thus discouraging the Home firm from serving that market.

If governments could use *only* caps, some of the results would be affected. In particular, there could not be spontaneous "downward" harmonization. To see this, recall that in our baseline model, spontaneous downward harmonization occurs when the Home government loosens its standard to match Foreign's standard in order to save on fixed costs. But if the Foreign government can only use a cap, the Home firm may spontaneously choose to sell the cleaner variety in the Foreign market, and thus the Home government may not need to loosen its standard to save on fixed costs.[25] But note that this would be suboptimal for the Foreign government, because allowing the Home firm to sell the cleaner, more expensive variety leads the firm to to sell *only* that variety, which is not desirable for Foreign consumers, hence the Foreign government would prefer to force the Home firm to supply the cheaper variety by using an exact standard, or an emissions floor. Thus assuming that governments can only use caps would be an undue restriction.[26]

3.2 The role of regulatory cooperation

We now consider the potential role for an international agreement. We think of the agreement as a complete and perfectly enforceable contract between the governments, which specifies the standards that maximize the governments' joint welfare $W + W^*$. We will often refer to these as the "efficient" standards. Implicit in this approach are the assumptions that governments bargain efficiently at the international negotiation table, that international lump-sum transfers are available, and that transfers enter linearly in the government's payoffs.[27]

Before we plunge into the analysis, it is useful to examine intuitively the international policy externalities that operate in our setting, since such externalities are key to understanding the role of international agreements. First note that, in this basic model, Home's choice of standard has no impact on Foreign's welfare, so international policy externalities are one-way. Next, how does Foreign's choice of standard affect Home? We can distinguish between two externalities: (i) tightening the Foreign standard e^* reduces the Home firm's operating profits, by increasing its marginal

[25] On the other hand, just as in our baseline model, spontaneous upward harmonization will emerge if Foreign has a stricter regulatory preference than Home but the difference is relatively small. In this case, the Home firm will choose to sell the same (cleaner) variety in both markets even if the Home government's cap is looser than Foreign's. This could be interpreted as a situation where there is "de facto" harmonization but not "de jure" harmonization.

[26] Even in a caps-only game, spontaneous downward harmonization might still arise if we allowed for Foreign local firms that only sell domestically. Intuitively, focus on the parameter region where there is spontaneous downward harmonization in our baseline model: if governments can only use caps, the Foreign government will choose a loose cap, so its local firms will sell the cheaper variety, and as a consequence, the Home firm will be at a cost disadvantage in the Foreign market (since the different varieties look the same in the eyes of the consumers), so the Home government may prefer to loosen its standard to allow its firm to sell the cheaper variety in both markets.

[27] In this paper we do not consider the possibility of a "mutual recognition" agreement. This is an incomplete contract that, rather than specifying the levels of the standards, specifies only that each government has jurisdiction over its own firms. Thus, for example, if the Home government sets a certain standard for its own firms, the Foreign government has to accept that standard if Home firms sell in the Foreign market. While it would be interesting to examine the implications of a mutual recognition agreement, it is easy to show that this type of agreement cannot achieve efficiency. This is true not only in our setting, but in all models of product standards that we are aware of (for example Grossman et al. (2021)). Intuitively, a mutual recognition agreement does not correctly internalize the international externalities from product standards, as the government choosing the standard for its own firm(s) does not consider its effects on the foreign country.

cost: we will refer to this simply as the "profit externality"; (ii) a positive "matching externality": given e, if Foreign chooses a matching standard $e^* = e$ it reduces the Home firm's fixed cost by F. Intuitively, the positive matching externality might suggest that harmonization is "under-provided" in the noncooperative scenario, but as the analysis will reveal, this intuition is not quite correct.

The efficient standards solve:

$$\max_{e,e^*}[\tilde{W}(e,e^*) + \tilde{W}^*(e^*)] = \max_{e,e^*}[S(e) + S^*(e^*) - n(e,e^*)F]$$

To characterize the efficient standards, we start by writing down the standards that would maximize joint welfare in the absence of fixed costs. Recalling that S and S^* denote respectively the surplus in the Home and Foreign market gross of fixed costs, these standards are given by $e_S = \arg\max_e S(e)$ and $e_s^* = \arg\max_{e^*} S^*(e^*)$. Note that $e_S = e_W$ and $e_S^* > e_W^*$: absent fixed costs, the efficient Home standard would coincide with Home's preferred standard, because Home's choice does not exert international externalities, while the efficient Foreign standard would be looser than Foreign's preferred standard, since Foreign does not internalize the effect of its standard on Home's profits.

Of course if $e_S = e_S^*$ these are also the efficient standards, since in this case efficiency can be achieved separately in each market without incurring fixed costs. Let us then consider the tradeoff between harmony and diversity when $e_S \neq e_S^*$. In this case the efficient standards are either (e_S, e_S^*) or (e_H, e_H), where $e_H = \arg\max_e[S(e) + S^*(e)]$. Thus regulatory harmony is efficient if and only if

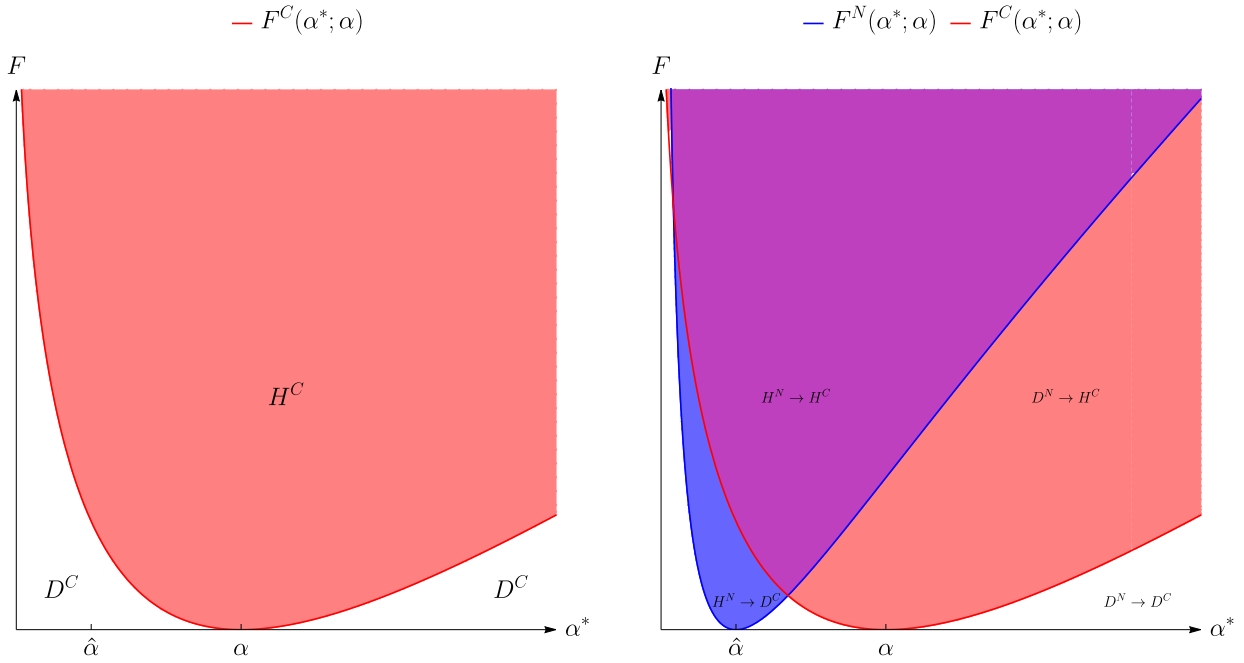
$$F \geq [S(e_S(\alpha)) + S^*(e_S^*(\alpha^*))] - [S(e_H(\alpha,\alpha^*)) + S^*(e_H(\alpha,\alpha^*))] \equiv F^C(\alpha^*;\alpha),$$

where the notation emphasizes the dependence of e_S, e_S^* and e_H on α and α^*. It is intuitive and easy to show that this condition is satisfied when the distance between the countries' *fundamental* preferences $|\alpha - \alpha^*|$ is small relative to the fixed cost F as illustrated in Figure 3a.

We can now combine the results above and compare the cooperative and noncooperative regulatory regimes. Figure 3b illustrates this comparison in (α^*, F) space. In the orange region labeled $D^N \to H^C$, the agreement *harmonizes* standards. Broadly speaking, this is the case if $|\alpha^* - \alpha|$ is small relative to F while $|\alpha^* - \hat{\alpha}|$ is large relative to F. In the blue region labeled $H^N \to D^C$, the agreement *diversifies* standards. Broadly speaking, this is the case when $|\alpha^* - \alpha|$ is large relative to F while $|\alpha^* - \hat{\alpha}|$ is small relative to F. In the remaining regions, the agreement maintains the noncooperative regulatory regime. The following proposition summarizes how the agreement changes the regulatory regime relative to the noncooperative scenario.

Proposition 2. *Under one-way trade, the agreement: (i) harmonizes standards if $|\alpha - \alpha^*|/F$ is sufficiently small and $|\alpha^* - \hat{\alpha}|/F$ is sufficiently large; (ii) diversifies standards if $|\alpha - \alpha^*|/F$ is sufficiently large and $|\alpha^* - \hat{\alpha}|/F$ is sufficiently small.*

According to Proposition 2, the agreement encourages countries to diversify their standards if the distance between their regulatory preferences is small (relative to the fixed cost) while the distance



(a) Efficient regulatory regimes

(b) Role of regulatory agreement

Figure 3: Comparison between cooperative and noncooperative regulatory regimes

between their fundamental preferences is small (relative to the fixed cost), and it encourages countries to harmonize standards in the opposite case.

The most interesting aspect of this result is that regulatory harmony may be "over-provided" at the noncooperative equilibrium, in spite of the positive "matching externality" discussed above. To understand intuitively why an agreement might *diversify* standards, note that spontaneous harmony occurs when countries have similar *regulatory* preferences, but this implies that *fundamental* preferences are dissimilar, because Home cares about the firm's profits and Foreign does not. As a consequence, if spontaneous harmony occurs and fixed costs are sufficiently small, spontaneous harmony can be inefficient.

We can go one step further and explain why the initial intuition – that harmony should be under-provided at the noncooperative equilibrium because of the positive matching externality – is not correct. Recall that, in this setting with one-way trade, Home's choice of standard exerts no externality on Foreign, while Foreign's choice exerts a profit externality and a (potential) matching externality on Home. This implies that Home's noncooperative choice of standard is efficient *conditional on Foreign's standard*, that is, if we fix e^*, Home makes the same choice as the social planner would. Also recall that in the noncooperative scenario matching occurs if and only if Home chooses to adopt Foreign's preferred standard. Now, because of the profit externality, Foreign's preferred standard is too strict. Thus, if Foreign cares less than Home about the externality ($\alpha^* < \alpha$), Foreign's preferred standard may be close enough to Home's preferred standard so that Home chooses to match it when it is not efficient to do so. So the reason why harmony may be over-provided in the noncooperative scenario has to do with the interaction between the matching externality and the

profit externality.[28]

Proposition 2 and Figure 3b focus on the comparison between the cooperative and noncooperative regulatory *regimes*, but it is important to note that, even if the agreement maintains the noncooperative regime, it will change the *levels* of the standards. While the current policy debate typically emphasizes the potential role of regulatory agreements in tightening the levels of environmental and safety standards,[29] our model highlights an effect that goes in the opposite direction. In particular, suppose parameters are in the region where the California/Brussels effect arises (spontaneous harmony with $\alpha^* > \hat{\alpha}$). In this case it is easy to verify that the agreement (weakly) loosens standards in both countries, regardless of whether it maintains regulatory harmony. What underlies this result is the fact that in the spontaneous-harmony equilibrium Home adopts Foreign's preferred standard, which is too strict due to the profit externality.[30] The following remark records this observation:

Remark 2. *If parameters are in the spontaneous-harmony region and $\alpha^* > \hat{\alpha}$ (California/Brussels effect region), the agreement loosens standards in both countries, even if it maintains harmony.*

One possible application of this remark might be the case of non-EU countries exporting to the EU. The model suggests the possibility that non-EU exporters are induced to tighten their standards in order to export to the EU, while it would be more efficient for these countries to stick with their looser preferred standards, and for the EU to loosen its own standards because they are hurting those non-EU exporters.

While Remark 2 focuses on the parameter region where the California/Brussels effect arises, it should be noted that in the parameter region where spontaneous "downward" harmonization arises and the agreement maintains harmony (the part of the purple region in Figure 3b where $\alpha^* < \hat{\alpha}$), the agreement may tighten the common standard. To see this, recall that when there is spontaneous harmony the Home government adopts Foreign's preferred standard e_W^*, so intuitively, if e_W^* is very loose, the efficient level of the common standard (e_H) may be tighter than e_W^*.

It is also important to emphasize that our model abstracts from global externalities, which are relevant in the domain of environmental standards. Intuitively, global externalities would make it more likely that the agreement tightens standards relative to the noncooperative equilibrium. Thus Remark 2 may be interpreted as isolating the implications of the international profit externality in circumstances where the California/Brussels effect arises.

[28]To confirm this point it is useful to note that, if we shut down the profit externality, then harmony would indeed be under-provided in the noncooperative scenario. To see this, consider a fictitious scenario where the operating profits that the firm makes in the Foreign market stay in the pockets of the Foreign government, so that there is no profit externality. Recall that spontaneous harmonization occurs only if Home chooses to adopt Foreign's standard. But the social planner can harmonize by choosing a standard that is half-way between the two preferred standards. So matching looks less attractive from the point of view of Home when making its unilateral choice then from the point of view of the social planner. As a consequence, harmony will be under-provided in the noncooperative scenario.

[29]For example, when discussing regulatory convergence, Lamy (2016) writes: "...And by the way, the only direction we can go is upwards."

[30]More formally, if parameters are in the California/Brussels effect region, in the noncooperative equilibrium both governments choose e_W^*, which is stricter than e_W. If the agreement diversifies standards, it loosens both, since $e_W^* < e_S^*$ and $e_W^* < e_W = e_S$. If it maintains Harmony, the cooperative harmonized standard e_H is a weighted average of the two surplus-maximizing standards, so $e_W^* < e_S^* < e_H < e_S$, so it is looser than Foreign's preferred standard.

3.3 Does lobbying lead to pernicious harmonization?

As discussed in the Introduction, part of the controversy surrounding regulatory harmonization has to do with the role of lobbying. Corporate interest groups have largely supported regulatory harmonization, and the concern expressed by some activist groups, as well as some academic economists, is that harmonization may come at the expense of society at large.[31] In this section we examine how lobbying influences the choice of regulatory regime – Harmony vs Diversity – in the noncooperative and cooperative scenarios, and whether this influence is likely to be detrimental for welfare. As we will show, our model is supportive of the Pop Critique in some ways but not in others.

We capture lobbying in a standard way, by attaching an extra weight γ to the firm's profits in the Home government's objective function (following Baldwin (1987), and in the same spirit as in Grossman and Helpman (1994)). Recalling that the firm's total profits net of fixed costs are given by $\pi + \pi^* - nF$, we write the Home government's objective as $\tilde{\Omega} \equiv \tilde{W} + \gamma(\pi + \pi^* - nF)$. Since there is no firm in the Foreign country, the Foreign government's objective is as before. For future reference, we let e_Ω denote Home's preferred standard under lobbying, that is, the standard that maximizes Home's objective function gross of fixed costs ($\Omega \equiv W + \gamma(\pi + \pi^*)$).

We start by focusing on the impact of lobbying in the noncooperative setting.

3.3.1 Lobbying in the noncooperative scenario

Recall that, absent lobbying (i.e. with $\gamma = 0$), the region of parameters where spontaneous harmony arises in equilibrium is the blue region in Figure 2a. How does lobbying change this parameter region?

We start with a preliminary result that characterizes the conditions under which lobbying makes spontaneous harmony more likely. We let $\tilde{CS}(e) \equiv CS(e) - \alpha E(e)$ denote the consumer surplus net of the externality. This is a measure of consumers' overall well-being. In the following lemma and throughout the section, when we say that increasing γ makes spontaneous harmony "more likely" we mean that, as a result of the increase in γ, the equilibrium regime can switch from diversity to harmony but not vice-versa.

Lemma 1. *For any vector of parameters, an increase in γ makes spontaneous harmony more likely if and only if Home consumers are worse off under harmony than under diversity ($\tilde{CS}(e_W^*) < \tilde{CS}(e_\Omega)$).*

This result can be understood in two steps. The first and more obvious one is that an increase in γ makes spontaneous harmony more likely if and only if the Home firm prefers harmony. The second and less obvious one is that Home firm and Home consumers must have opposite preferences on this policy choice when parameters are such that the Home government is indifferent between harmony and diversity. This follows directly from the fact that the Home government maximizes a weighted sum of consumer surplus and profits, so when the government is indifferent between policy $\mathcal{P}$ and policy $\mathcal{P}'$, if the firm prefers $\mathcal{P}$ the consumers must prefer $\mathcal{P}'$, and vice-versa. The combination of

[31] In the academic literature, this view has been expressed for example by Rodrik (2018).

these two observations implies that, at the indifference point, increasing the weight on the firm (γ) tilts the choice toward policy $\mathcal{P}$ if and only if the consumers are worse off under policy $\mathcal{P}$.

This result can be viewed as partially consistent with the spirit of the Pop Critique, but with an important caveat: lobbying pushes toward the regime that is worse for consumers, but this regime may not be harmony – it may be diversity, as we argue below.

We are now ready to characterize how an increase in γ affects the parameter region where spontaneous harmony occurs, which is the blue region in Figure 2a. Here we consider a small increase in γ starting from $\gamma = 0$, but similar qualitative results apply if we start from a positive value of γ. Note that at $\gamma = 0$ we have $e_\Omega = e_W$, so in light of Lemma 1 we need to compare $\tilde{CS}(e_W^*)$ with $\tilde{CS}(e_W)$ when evaluated at the indifference frontier between harmony and diversity, that is, when $F = F^N(\alpha^*; \alpha)$. For example, if at a given point on this frontier consumers prefer diversity ($\tilde{CS}(e_W^*) < \tilde{CS}(e_W)$), then lobbying breaks the indifference in favor of harmony, so in graphical terms the indifference frontier moves down.

Let us first focus on how α^* affects the condition $\tilde{CS}(e_W^*(\alpha^*)) < \tilde{CS}(e_W(\alpha))$ for a fixed level of α. Observe that $\tilde{CS}(e_W^*(\alpha^*))$ is maximum for $\alpha^* = \alpha$. This is because Foreign maximizes their consumers' well-being, so if $\alpha^* = \alpha$, Foreign's preferred standard is ideal also for Home's consumers. This immediately implies that, if α^* is sufficiently close to α, Home consumers prefer harmony, and hence by Lemma 1 lobbying pushes *against* harmonization.

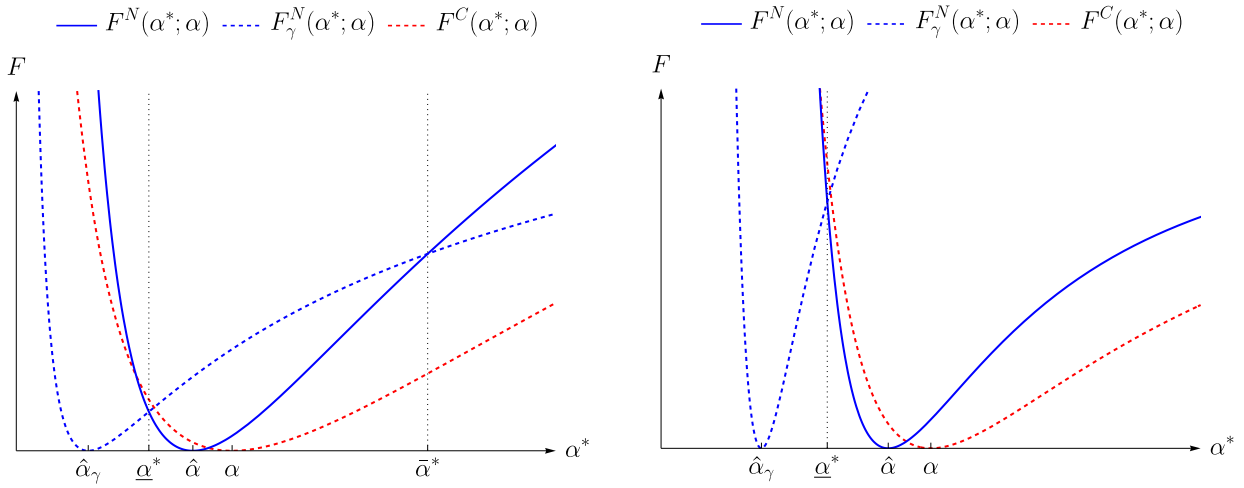
It is also easy to see that if α^* is much lower than α, Foreign's preferred standard is so lenient that Home consumers are better off under Home's preferred standard, and hence by Lemma 1 lobbying pushes in favor of harmonization.

Finally, if α^* is sufficiently higher than α, it is easy to show that Home consumers prefer diversity if and only if $\tilde{CS}(e_W(\alpha)) > 0$. The intuition is that, for a fixed α, as α^* becomes very large e_W^* becomes very strict and $\tilde{CS}(e_W^*)$ goes to zero, so Home consumers are better off under Home's preferred standard if and only if $\tilde{CS}(e_W) > 0$. And given Lemma 1, we can conclude that, when α^* is sufficiently higher than α, lobbying pushes in favor of harmonization if and only if $\tilde{CS}(e_W) > 0$. Note that $\tilde{CS}(e_W)$ *may* be negative: this is possible if the cost function $c(e)$ is steeply decreasing, so that profit considerations make e_W much looser than consumers would like, and α is relatively large.

Figure 4 illustrates the result we just described. In each panel, the solid blue curve is the frontier between diversity and harmony absent lobbying, while the dashed blue curve is the corresponding frontier under lobbying. The red dashed curve is the frontier between diversity and harmony from an efficiency standpoint, and will be considered later. In the figure, $F = F_\gamma^N(\alpha^*; \alpha)$ denotes the frontier under lobbying, and $\hat{\alpha}_\gamma$ denotes the level of α^* such that Home's preferred standard under lobbying ($\gamma > 0$) is equal to Foreign's preferred standard ($e_\Omega = e_W^*$), with $\hat{\alpha}$ denoting $\hat{\alpha}_\gamma$ evaluated at $\gamma = 0$.

Panel (a) focuses on the case $\tilde{CS}(e_W) > 0$: in this case lobbying moves up the frontier when α^* lies in the interval $(\underline{\alpha}^*, \bar{\alpha}^*)$, while the frontier moves down for α^* outside this interval. Panel (b) illustrates the case $\tilde{CS}(e_W) > 0$, where lobbying shifts up the frontier for all $\alpha^* > \underline{\alpha}^*$.

As Figure 4 makes clear, the effect of lobbying on the likelihood of harmonization depends crucially



(a) Case $\tilde{CS}(e_W) > 0$ (b) Case $\tilde{CS}(e_W) < 0$

Figure 4: Effect of lobbying on the noncooperative regime

on Foreign's preference parameter (α^*) relative to Home's (α). Broadly speaking, lobbying can increase the likelihood of spontaneous harmonization only if Home and Foreign have sufficiently different fundamental preferences, while it pushes against harmonization if these preferences are not very distant. It is interesting to note that lobbying is guaranteed to push against harmony precisely when harmony is more likely to be efficient, that is when α^* is close to α.

To further clarify the intuition behind this result, it is useful to think about the Home firm's preferences, recalling that lobbying makes harmony more likely if and only if the firm prefers harmony to diversity. How does the firm feel about this choice? Harmonization affects the firm through two channels, the fixed cost and the marginal cost. The effect through the fixed cost is unambiguous: harmonization lowers the fixed cost, which is good for the firm. The effect through the marginal cost depends on whether Foreign's preferred standard is laxer or stricter than Home's. If it is laxer ($\alpha^* < \hat{\alpha}$), then matching Foreign's standard is even more attractive to the firm because it lowers its marginal cost, and as a consequence, lobbying pushes toward harmonization. In Figure 4 this is reflected in the fact that, if we start from a point on the indifference frontier where $\alpha^* < \hat{\alpha}$, increasing γ from zero pushes down $F^N(\cdot)$.[32] But if Foreign's preferred standard is stricter than Home's ($\alpha^* > \hat{\alpha}$), then matching Foreign's standard raises its marginal cost, so the firm faces a trade-off between the higher marginal cost and the saving in fixed costs. Here Lemma 1 becomes helpful and allows us to determine the effect of lobbying also in this parameter range.

Figure 4 is informative also on how the fixed cost F determines the impact of lobbying on spontaneous harmonization. Cursory intuition might suggest that, if fixed cost considerations are important enough, the firm should prefer harmony to diversity, and therefore lobbying should make spontaneous harmony more likely. However this intuition is not quite correct. If we fix F at a large value and consider the interval of α^* where harmony occurs, this interval expands (set-wise) if $\tilde{CS}(e_W) > 0$

[32] In Figure 4, to make the curves more visible we compare $\gamma = 0$ with a discrete value of γ, but in the limit as γ becomes very small, $F^N(\cdot)$ will go down for any $\alpha^* < \hat{\alpha}$.

(see Figure 4a), and so in our terminology lobbying makes harmony more likely, but this is not true if $\tilde{CS}(e_W) < 0$: in this case, as Figure 4b shows, if we start from a point of indifference with $\alpha^* > \hat{\alpha}$, even if F is very large lobbying will break the indifference in favor of diversity, not harmony.

The results described above extend to an increase in γ starting from any level, as stated in the following proposition.

Proposition 3. *(i) Increasing γ can make spontaneous harmonization more likely only if α^* is sufficiently smaller than α, or if α^* is sufficiently larger than α and $\tilde{CS}(e_\Omega) > 0$. If α^* is sufficiently close to α, increasing γ must make spontaneous harmonization* less *likely. (ii) If F is sufficiently large, increasing γ makes spontaneous harmonization more likely only if $\tilde{CS}(e_\Omega) > 0$.*

Proposition 3 summarizes what we know about the impact of lobbying on the noncooperative regime. It highlights that the initial intuition that lobbying should make spontaneous harmony more likely, especially if the fixed cost F is large, is not accurate. In particular, for a given F lobbying makes spontaneous harmony *less* likely if Home and Foreign have sufficiently similar fundamental preferences, and even if F is very large, lobbying may push against harmonization.

It is important to keep in mind that lobbying affects not only the regulatory regime, but also the levels of the standards. An interesting observation is that, if lobbying causes a switch from diversity to harmony and $\alpha^* > \hat{\alpha}_\gamma$, so that Foreign's preferred standard is stricter (this can happen in Figure 4a if F is large enough), then lobbying leads to a *stricter* standard at Home:

Remark 3. *In the noncooperative scenario, if lobbying induces a switch from diversity to harmony and Foreign's preferred standard is stricter than Home's ($\alpha^* > \hat{\alpha}_\gamma$), then lobbying leads to a stricter standard in Home (and does not change the standard in Foreign).*

The possibility that lobbying leads to stricter regulations is perhaps surprising, and can be understood intuitively as follows: if F is large, lobbying can induce a switch from diversity to harmony, which implies that Home drops its preferred standard and adopts the importing country's preferred standard; thus, if the importing country's preferred standard is stricter, lobbying leads Home to tighten its regulations.

An interesting normative question is whether lobbying tends to distort the noncooperative regulatory regime – i.e. make it more likely that the regime is the "wrong" one – and if so, in what direction. The Pop Critique, at a broad level, expresses a concern that lobbying pushes toward harmonization and this is bad for welfare. Our model, however, offers little support for this specific concern. First, the analysis above and Figure 4 make clear that lobbying may induce a switch from harmony to diversity. Second, let us "stack the deck" in favor of the Pop Critique and consider a parameter vector such that lobbying induces a switch from diversity to harmony: it is easy to see that harmony may well be the efficient regime for that parameter vector. For example, suppose we are in the case of Figure 4a. In this figure, the dotted red curve is the efficiency frontier between harmony and diversity (similar as the red curve in Figure 3a). Consider a point on the noncooperative frontier absent lobbying (solid blue curve) with α^* large enough: for this parameter vector, lobbying

breaks the indifference in favor of harmony, and harmony is in fact the efficient regime. Furthermore, recall from Remark 3 that in this case lobbying leads to a stricter Home standard (with no change in Foreign's standard), and it is easy to show that welfare may go up, with an improvement in both the regulatory regime and the levels of the standards.

Next we turn to the impact of lobbying on the cooperative regulatory regime.

3.3.2 Lobbying in the cooperative scenario

We start with the positive question: does lobbying make it more or less likely that a regulatory agreement between Home and Foreign will specify harmonized standards?

We capture the impact of lobbying on the agreement by assuming that the agreement maximizes the joint politically-adjusted payoff of the two governments, $\tilde{W} + \tilde{W}^* + \gamma(\pi + \pi^* - nF)$.

We let e^*_Ω denote the standard level that maximizes the gross political surplus in the Foreign market, that is $\tilde{W}^* + \gamma\pi^*$. Thus, recalling that e_Ω is the corresponding standard level in the Home market, in the absence of fixed costs the agreement would specify standards (e_Ω, e^*_Ω). These are the cooperative standards under lobbying conditional on the diversity regime. Also, let e^Ω_H denote the standard that maximizes the joint gross political surplus $(\tilde{W} + \tilde{W}^* + \gamma(\pi + \pi^*))$ conditional on standards being harmonized $(e = e^*)$. Clearly then, the regulatory agreement will choose between the pair of standards (e_Ω, e^*_Ω) and the pair of standards (e^Ω_H, e^Ω_H).

We start by stating the analogous result to Lemma 1 for the cooperative scenario.

Lemma 2. *For a given vector of parameters, an increase in γ makes it more likely that the agreement specifies harmonized standards if and only if world consumers are worse off under harmony than under diversity ($\tilde{CS}(e^\Omega_H) + \tilde{CS}^*(e^\Omega_H) < \tilde{CS}(e_\Omega) + \tilde{CS}^*(e^*_\Omega)$).*

The intuition described just after Lemma 1 extends readily to this cooperative setting, with the only difference that, while in the noncooperative setting harmonization boils down to a decision of the Home government whether to adopt Foreign's preferred standard, in the cooperative setting the choice between harmony and diversity is a joint decision of the two governments. But in both cases, the objective function is a weighted sum of profits and consumer well-being, and at a point of indifference between harmony and diversity, increasing γ tilts the decision in favor of harmony if and only if consumers are worse off under harmony.

How does lobbying affect the parameter region where the agreement specifies harmonized standards, relative to the no-lobbying case depicted in Figure 3a?

Intuitively, lobbying does not affect the intercept of the frontier between Harmony and Diversity, which is $\alpha^* = \alpha$. The reason is that, absent fixed costs, the optimal cooperative regime is diversity and so the cooperative standards are (e_Ω, e^*_Ω), which are symmetric if $\alpha^* = \alpha$, regardless of lobbying. But even though lobbying does not affect the qualitative U-shape of the frontier nor its intercept, in general it will affect the exact shape of the frontier for $\alpha^* \neq \alpha$. Lemma 2 tells us that, at a given point on the frontier, lobbying breaks the indifference in favor of harmony if and only if the average

world consumer prefers diversity, but whether or not this is the case turns out to depend on the specifics of the demand and cost functions, $d(p)$ and $c(e)$.

A natural specification to consider is one where the externality is linear in consumption ($E = ed(p)$), and $d(p)$ and $c(e)$ are linear, because in this case the comparative statics effect of increasing γ can be derived analytically. We have a sharp, and perhaps surprising, result:

Proposition 4. *If the externality is linear in consumption ($E = ed(p)$), and $d(p)$ and $c(e)$ are linear, lobbying makes it* less *likely that the agreement specifies harmonized standards.*

We have also examined numerically the case where the externality is linear in consumption, and $d(p)$ and $c(e)$ have constant elasticity. In this case, we find that lobbying can push in favor or against harmonization, depending on the elasticities of the demand and cost functions. Taken together, these results indicate that, according to our model, there is no presumption that lobbying pushes toward harmonization in the cooperative scenario, even if fixed costs are important.

Finally, we ask the following normative question: can regulatory cooperation lower global welfare *relative to the noncooperative equilibrium* in the presence of lobbying? As we argue next, the answer is yes, but importantly, this has little to do with regulatory harmonization *per se*, because it is true regardless of whether standards are harmonized or not.

Intuitively, in this setting with one-way trade, lobbying tends to distort cooperative standards more than noncooperative standards. In the noncooperative scenario, Foreign sticks to its preferred standard regardless of γ, so lobbying affects only the Home standard. In the cooperative scenario, increasing γ leads to deregulation in both countries, with or without harmonization, so lobbying has a worse distortionary impact compared with the noncooperative scenario. If γ is close to zero, cooperation of course still improves welfare (because the agreement must strictly improve welfare if $\gamma = 0$), but if γ is large it decreases welfare. The following remark records this result.

Remark 4. *If γ is sufficiently large, the agreement reduces welfare relative to the noncooperative equilibrium, regardless of whether the agreement harmonizes standards.*

Thus, when lobbying is strong, regulatory cooperation reduces global welfare relative to the noncooperative equilibrium, but the reason is not that lobbying leads to inefficient harmonization. Rather, the main reason why regulatory cooperation reduces welfare when lobbying is strong is that lobbying leads to deregulation, and more so under regulatory cooperation than in the absence of an agreement. Thus, while there are reasons to be worried about the impact of politically-pressured regulatory agreements, the issue is not that lobbying leads to inefficient harmonization, so the concerns expressed by the Pop Critique are somewhat misdirected.

3.4 When the extensive margin matters

Until now, we have restricted our attention to the range of parameters (α, α^*, F) such that the break-even condition for the Home firm is not binding in either market (i.e. $\pi(e) > F$ and $\pi(e^*) > F$

at the equilibrium standards). Here we allow for the possibility that the Home firm may not serve the foreign market, or that standards are set in such a way that the firm just breaks even in the foreign market (so that $\pi(e^*) \leq F$ at the equilibrium standards).[33]

The main question of this section is: what are the implications of regulatory cooperation for the extensive margin of trade, and what role (if any) does harmonization play in this? It is sometimes argued that harmonization agreements can improve trade at the extensive margin, but whether this is true in our setting is not obvious. Note that the question is not whether an exogenous change in regulatory regime – say from diversity to harmony – can induce the home firm to start serving the foreign market, but rather, whether the *endogenous* choice of regulatory regime in the noncooperative scenario may lead to inefficient lack of trade at the extensive margin, hence whether an agreement can improve on this margin. And if this is the case, does the agreement accomplish this through harmonization of standards?

In the previous section we saw that, under some circumstances, harmonization may be "over-provided" in the noncooperative scenario, and thus the agreement may play a diversification, rather than harmonization, role. In light of this, it is not obvious *a priori* whether in the noncooperative scenario there would be insufficient or excessive trade at the extensive margin. For example, in principle it seems conceivable that the agreement might lead to diversification and a reduction of trade at the extensive margin. We now examine this question formally.

In the interest of space, here we abstract from lobbying and focus on the case of welfare-maximizing governments. In what follows we present our analysis in a heuristic way. The formal derivations can be found within the proof of Proposition 5 in the Appendix.

Let us first consider the noncooperative setting of standards. The firm will serve the foreign market if and only if it can break even in that market. If standards are different ($e^* \neq e$), the foreign market will be served if and only if $\pi(e^*) \geq F$, or equivalently $e^* \geq \pi^{-1}(F) \equiv \hat{e}(F)$. On the other hand, if standards are harmonized ($e^* = e$), the foreign market will be served if and only if $2\pi(e^*) \geq F$, or equivalently $e^* \geq \hat{e}(\frac{F}{2})$. We will refer to $\hat{e}(F)$ and $e^* \geq \hat{e}(\frac{F}{2})$ as the "break-even standard" levels under diversity and harmony respectively.

We can think of the foreign government as facing a "participation constraint," which is more severe if standards are not harmonized. Such participation constraint implies that the foreign government's reaction function is not horizontal as in Section 3.1, and may follow the diagonal over a certain range. To see this, suppose Foreign selects its preferred standard e_W^* and Home chooses some standard $e \neq e_W^*$: if the Home firm does not break even in the Foreign market at these standards, Foreign may want to deviate from e_W^* to ensure that the firm breaks even, either by loosening the standard from e_W^*, or by matching the home standard e, thereby reducing the firm's fixed cost.

Meanwhile, the home government's reaction function is the same as in the previous section: just as

[33]Since our main focus in this section is the potential role of the agreement for the extensive margin of trade, we do not consider the possibility that the break-even condition may be binding in the home market. This would increase the taxonomy of possibilities without adding much insight. Thus we are restricting α and F so that $\pi(e_W) \geq F$ and $\tilde{CS}(e_W) \geq 0$, but we are allowing α^* to take any value (except for the restriction that the foreign objective function must be well-behaved).

in Figure 1b, it coincides with the diagonal over a certain range. Intuitively, now both governments may have an incentive to match the other government's standard, but for different reasons. The Home government may benefit from matching Foreign's standard because it reduces the fixed cost of its own firm. The Foreign government, on the other hand, may benefit from matching Home's standard even if it does not care directly about the firm's profits, because this may help ensure that the firm breaks even and serves its market. As a consequence of this new feature, there may now be multiple harmony equilibria in the standard-setting game.

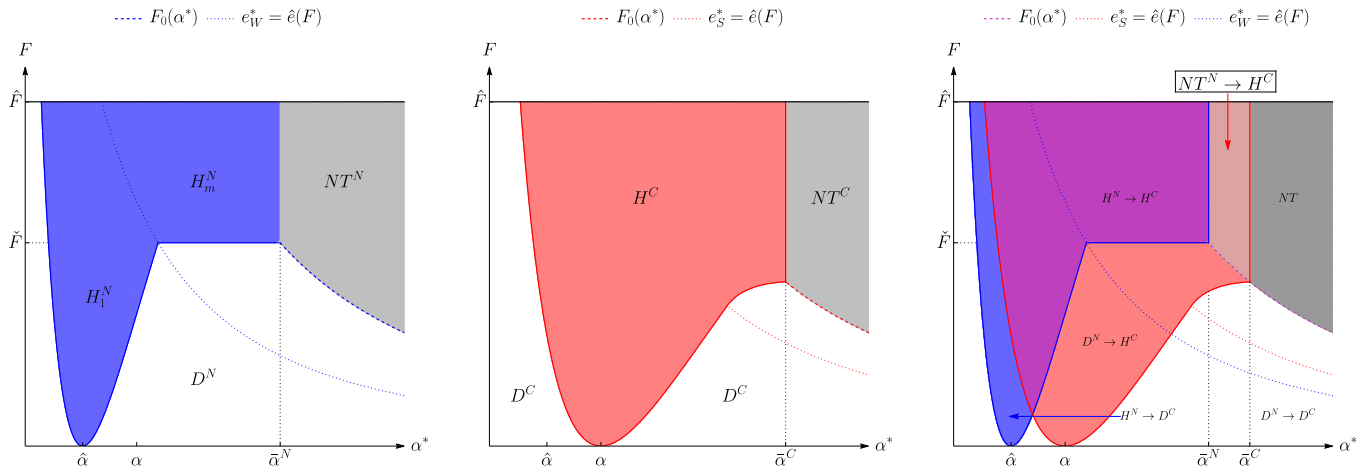
The second new feature implied by the firm's break-even condition is the possibility that the Foreign market is not served at all. Intuitively, this happens when α^* and F are sufficiently large, so that serving the foreign market would impose a significant (additional) fixed cost and the Foreign country's regulatory preference is too strict to satisfy the firm's break-even condition.

Figure 5a illustrates our findings on the Nash equilibrium regimes in the parameter space (F, α^*). In the parameter region denoted H_1^N there is a single harmony equilibrium where Home adopts Foreign's preferred standard, similarly as in the previous section. In the region denoted H_m^N there are multiple harmony equilibria: broadly speaking, this is the case when F is large enough and α^* lies in some intermediate range. In the region denoted NT^N the foreign market is not served in equilibrium: this is the case when both α^* and F are large. And in the remaining region D^N the countries select different standards: more specifically, in the sub-region below the blue dotted line (where $e_W^* \geq \hat{e}(F)$), Home and Foreign choose their preferred standards, while in the sub-region above it Foreign chooses the break-even standard $\hat{e}(F)$ while Home chooses its preferred standard.[34]

Next we examine the cooperative regulatory regime. We continue to assume that the agreement maximizes the joint welfare of the two countries, but now taking into account the firm's break-even constraint. Figure 5b illustrates the cooperative regime as a function of F and α^*. There are two main changes relative to Figure 3b in the previous section. First, the diversity region D^C now includes a sub-region where the break-even condition is binding and hence the foreign standard is set at $\hat{e}(F)$. Second, and more importantly, there is now a parameter region, labeled NT^C, where the break-even condition leads the planner to "drop" the foreign market and only serve the home market. This is the case, broadly speaking, when both α^* and F are large.[35]

[34]Here we briefly explain the shape of the frontiers between the various regions in Figure 5a. The frontier between the unique-harmony region H_1^N and the multiple harmony region H_m^N is defined by the indifference of Foreign between its preferred standard and the break-even standard, $e_W^*(\alpha^*) = \hat{e}(F)$, yielding the downward-sloping blue-dotted curve in Figure 5a. The frontier between the multiple-harmony region H_m^N and the no-trade region NT^N is defined by Home's indifference between having the firm serve only the home market at standard e_W and matching the loosest foreign standard that yields nonnegative Foreign welfare: $S(e_W) = S(e_{max}^*) + \pi(e_{max}^*)$, where e_{max}^* is defined by $W^*(e_{max}^*) = 0$; this condition does not depend on F, hence the frontier is vertical. The frontier between the multiple-harmony region H_m^N and the diversity region D^N is horizontal, since it is defined by the condition $S(e_W) + \pi(\hat{e}(F)) - 2F = S(\hat{e}(F)) + \pi(\hat{e}(F)) - F$, which is independent of α^*. (We note that, if the demand function has a choke price, this horizontal segment may be empty.) Finally, the frontier between the NT^N region and the D^N region is defined by Foreign's indifference between setting its standard at the break-even level and not getting the product at all: $W^*(\hat{e}(F)) = 0$, which implicitly defines $F = F_0(\alpha^*)$, the downward-sloping dashed curve in Figure 5a.

[35]Note that F is truncated at some level $\hat{F}$ in Figure 5b, due to the restriction that the home market is served under the noncooperative and cooperative equilibria. If F were even higher, neither the home market nor the foreign market would be served.



(a) Noncooperative equilibria (b) Cooperative equilibria (c) Role of regulatory agreement

Figure 5: Comparison between cooperative and noncooperative regulatory regimes

Figure 5c overlays the previous two maps in order to highlight how the agreement may change the regime relative to the noncooperative setting. The key finding here is that the NT^C region is entirely contained in the NT^N region, which means that the agreement can create trade at the extensive margin (in the region labeled $NT^N \to H^C$) but can never reduce trade at the extensive margin. It may also be interesting to note that, when the agreement improves the extensive margin, it does so by setting harmonized standards: cooperation cannot improve the extensive margin through diversified standards.

We now explain the logic underlying this finding. The first point is that the boundary between the diversity and no-trade regions is the same under the cooperative and noncooperative scenarios (this corresponds to the curve $F_0(\alpha^*)$ in Figures 5a and 5b). This is because, in both scenarios, this boundary is given by the indifference for foreign welfare between setting the standard at the break-even level and not serving the foreign market: $W^*(\hat{e}(F)) = 0$. The second point is that, if the planner is indifferent between harmony and no trade (this corresponds to the boundary between the regions H^C and NT^C), then there must be no trade in the noncooperative scenario. The broad intuition for this is the following. In the noncooperative scenario, the tradeoff between harmony and no trade boils down to Home's choice between matching the loosest standard that Foreign is willing to accept (e^*_{max}) and not serving the foreign market. On the other hand, the planner chooses between serving both markets at the optimal harmonized standard and not serving the foreign market. In this tradeoff, the planner values harmony more than the Home government because it can optimize the harmonized standard (thus choosing a standard in-between the two countries' preferred standards), whereas the Home government considers matching a standard dictated by Foreign's preferences.[36] The previous arguments together imply that the agreement can only create trade at the extensive margin – in which case it does so by harmonizing standards – while it cannot destroy the extensive

[36]Note that the Home government considers only its own welfare, but foreign welfare is zero both at the standard e^*_{max} and under no trade, so effectively the Home government compares global welfare at e^*_{max} and under no trade.

margin.

Why is it the case that, even if the agreement plays a diversification role, it cannot reduce trade at the extensive margin? Intuitively, recall that the agreement can play a diversification role only if Foreign has more lenient preferences than Home ($\alpha^* < \alpha$), as can be seen in Figure 5c. On the other hand, the possibility that the foreign market may not be served – in the cooperative or noncooperative scenarios – is relevant only if Foreign has stricter preferences than Home ($\alpha^* > \alpha$), so that a tighter standard in the foreign market may induce the firm not to serve that market.

We can now summarize the main points of this section with the following proposition:

Proposition 5. *Under one-way trade, the agreement creates trade at the extensive margin (through harmonization) when α^* lies in some intermediate interval $[\bar{\alpha}^N, \bar{\alpha}^C]$ (where $\bar{\alpha}^N > \alpha$) and F lies in some intermediate interval $[F_0(\alpha^*), \hat{F}]$. The agreement never reduces trade at the extensive margin.*

4 The Intra-Industry-Trade Scenario

Here we revisit our analysis in a simple setting with intra-industry trade. We will show that the presence of intra-industry trade changes some of our conclusions in interesting ways.

The economic structure is the same as in Section 3, with one difference: we now assume two symmetric firms, located in Home and Foreign respectively, which compete à la Cournot in each market. The two countries are hence symmetric in all aspects (size, consumer demand, market structure) except in their fundamental preferences regarding the externality (α and α^* may differ), and the symmetric duopoly will give rise to intra-industry trade à la Brander and Krugman (1983).

As in the one-way trade setting of Section 3, each government sets the product standard for its local market. As mentioned at the outset of the paper, we assume that countries cannot set discriminatory standards, in line with the idea that shallow integration has already been achieved. As a consequence, firms make the same profits in each market: $\pi(e)$ in the Home market and $\pi(e^*)$ in the Foreign market. The Home and Foreign welfare functions can then be written as follows:

$$\tilde{W} = \underbrace{CS(e) - \alpha E(e) + \pi(e) + \pi(e^*)}_{W} - n(e, e^*)F \tag{2}$$

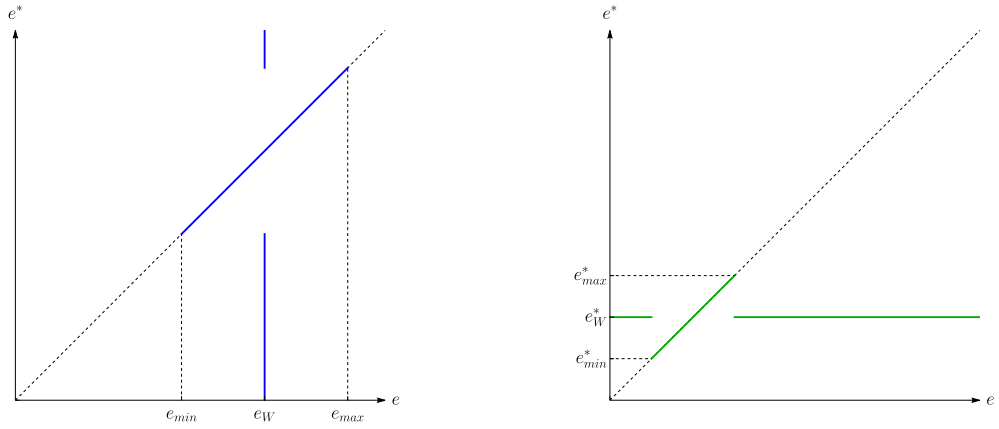
$$\tilde{W}^* = \underbrace{CS(e^*) - \alpha^* E(e^*) + \pi(e^*) + \pi(e)}_{W^*} - n(e, e^*)F \tag{3}$$

For simplicity, we will focus on the parameter region where participation constraints do not bind (this requires α, α^* and F not too large). As before, we define Home's preferred standard as the standard e_W that maximizes W, and Foreign's preferred standard as the standard e^*_W that maximizes W^*.

4.1 Noncooperative standards with intra-industry trade

We start by considering the noncooperative scenario, where governments simultaneously choose product standards to maximize their respective welfare functions, $\tilde{W}$ and $\tilde{W}^*$.

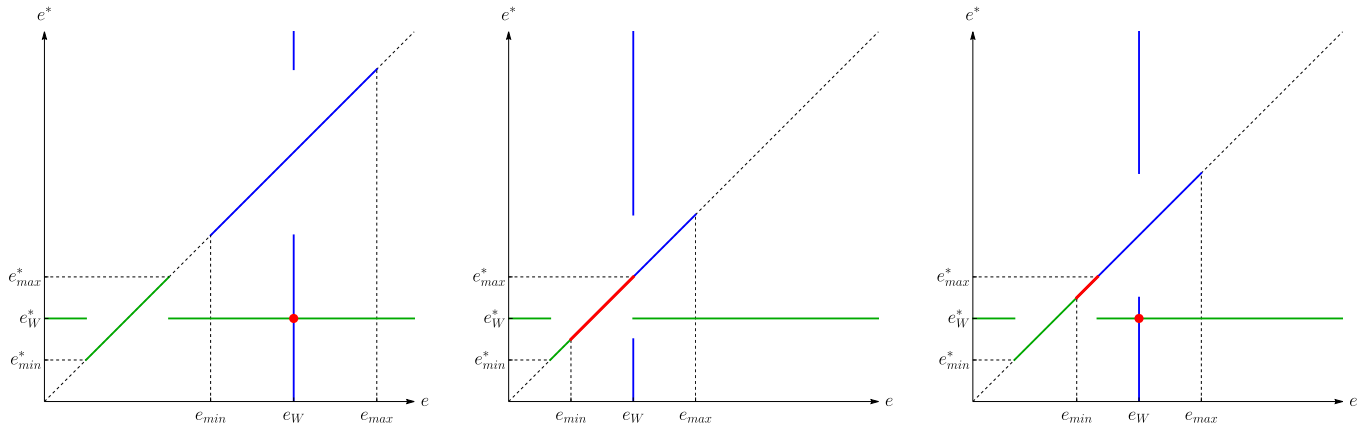
Due to the symmetric market structure, the Home and Foreign governments' reaction functions now have a similar qualitative shape. Home's reaction function in Figure 6a has an identical structure as Home's reaction function in the one-way-trade scenario (illustrated in Figure 1b). Foreign's reaction function in Figure 6b has the same structure as Home's, but shifted, because the difference in fundamental preferences ($\alpha \neq \alpha^*$) implies different preferred standards ($e_W \neq e_W^*$). Figure 6 focuses without loss of generality on the case $\alpha < \alpha^*$.



(a) Home reaction function (b) Foreign reaction function

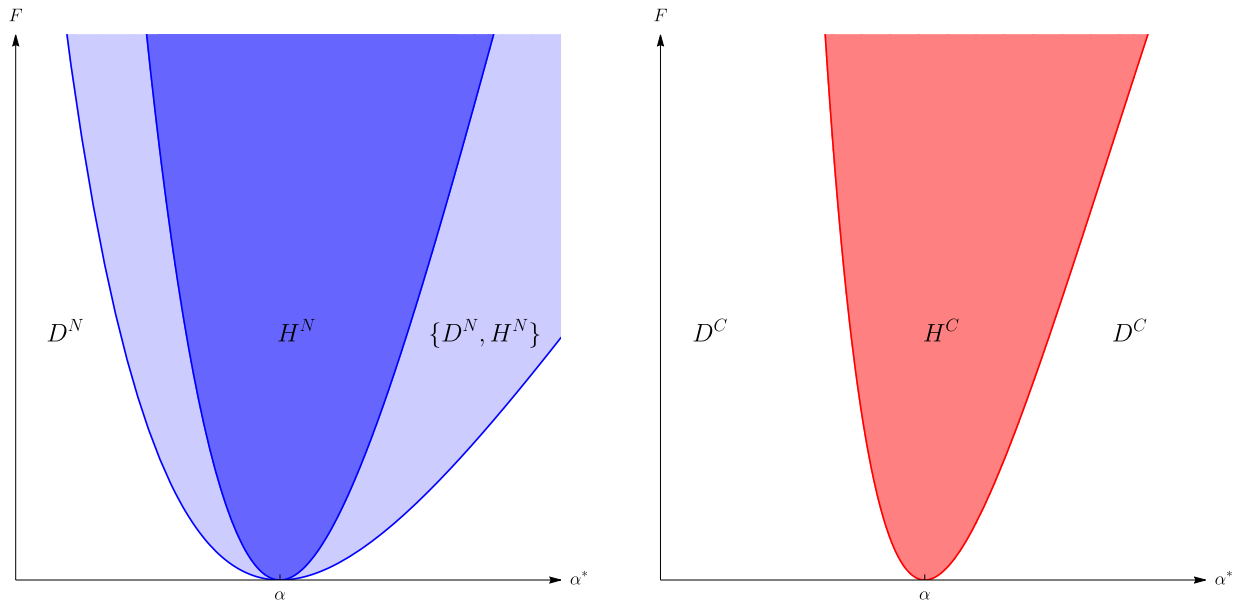
Figure 6: Home and Foreign reaction functions with intra-industry trade and $\alpha < \alpha^*$

We can now characterize the Nash equilibria in (F, α^*) space. As Figure 7 illustrates, there are three possibilities, depending on where the Home and Foreign reaction functions intersect. In Figure 7a, the reaction functions have a unique intersection off the diagonal (the red dot): in this case there is a unique diversity equilibrium, with each country selecting its preferred standard. This



(a) Unique Diversity (b) Multiple Harmony (c) Harmony and Diversity

Figure 7: Types of Nash equilibria with two-way trade



(a) Noncooperative regulatory regimes (b) Efficient regulatory regimes

Figure 8: Regulatory regimes under intra-industry trade

is the case when F is small relative to the preference distance $|\alpha - \alpha^*|$, so that regulatory diversity is not too costly. This corresponds to the parameter region labeled D^N in Figure 8a. In Figure 7b, the two reaction functions overlap on a segment of the diagonal (highlighted in red), thus there are multiple harmony equilibria. This situation arises when F is large relative to the preference distance $|\alpha - \alpha^*|$, so that the Home and Foreign tolerance ranges overlap. This corresponds to the region labeled H^N in Figure 8a. Finally, in Figure 7c the reaction functions have an intersection off the diagonal and also overlap on a segment of the diagonal. In this case, both a diversity equilibrium and multiple harmony equilibria coexist. This situation arises in the parameter region labeled $\{D^N, H^N\}$ in Figure 8a, where the ratio $|\alpha - \alpha^*|/F$ lies in an intermediate range.

We can summarize the analysis above with the following proposition:

Proposition 6. *Under intra-industry trade: (i) for low levels of $|\alpha - \alpha^*|/F$, there are multiple Harmony equilibria; (ii) for intermediate levels of $|\alpha - \alpha^*|/F$, there are Harmony equilibria and a Diversity equilibrium; (iii) for high levels of $|\alpha - \alpha^*|/F$, there is only a Diversity equilibrium.*

In light of this result and Proposition 1, our model predicts that spontaneous harmonization can arise both with one-way-trade and with intra-industry trade, but there are important differences. First, under one-way trade spontaneous harmony arises when the cost of regulatory diversity is large relative to the difference in regulatory preferences ($|\hat{\alpha} - \alpha^*|/F$ relatively small). Under symmetric intra-industry trade, on the other hand, if countries have similar fundamental preferences ($\alpha = \alpha^*$) they also have similar regulatory preferences ($e_W = e_W^*$), and as a consequence, spontaneous harmony arises when the cost of regulatory diversity is large relative to the difference in fundamental preferences ($|\alpha - \alpha^*|/F$ relatively small). The second important difference is that under intra-industry trade there may be multiple equilibria, and in particular: (a) in the parameter region where spontaneous

harmony arises, there is a whole range of equilibrium standard *levels*; and (b) for intermediate levels of $(\alpha - \alpha^*)/F$ both regulatory regimes – Harmony and Diversity – are equilibrium regimes.[37]

4.2 Regulatory cooperation with intra-industry trade

Let us now consider the cooperative scenario, where the standards e and e^* are chosen to maximize the countries' joint welfare $\tilde{W} + \tilde{W}^*$.

Recalling that S and S^* denote the surplus (gross of fixed costs) arising in the home and foreign market respectively, note that the surplus in a given market now includes both domestic and foreign firms' profits in that market, so Home surplus is $S(e) = CS(e) - \alpha E(e) + 2\pi(e)$ and Foreign surplus is $S^*(e^*) = CS(e^*) - \alpha^* E(e^*) + 2\pi(e^*)$. The joint-welfare maximization problem is therefore:

$$\max_{e,e^*}(\tilde{W} + \tilde{W}^*) = \max_{e,e^*}(S(e) + S^*(e^*) - 2n(e,e^*)F)$$

Absent fixed costs, of course Diversity is efficient unless $\alpha = \alpha^*$, and the efficient standards are the surplus-maximizing standards, $e_S = \operatorname{argmax} S(e)$ and $e_S^* = \operatorname{argmax} S^*(e^*)$. Next note that if standards are harmonized, each firm will save one fixed cost, so Harmony is the efficient regime if and only if there exists a standard level e_H such that

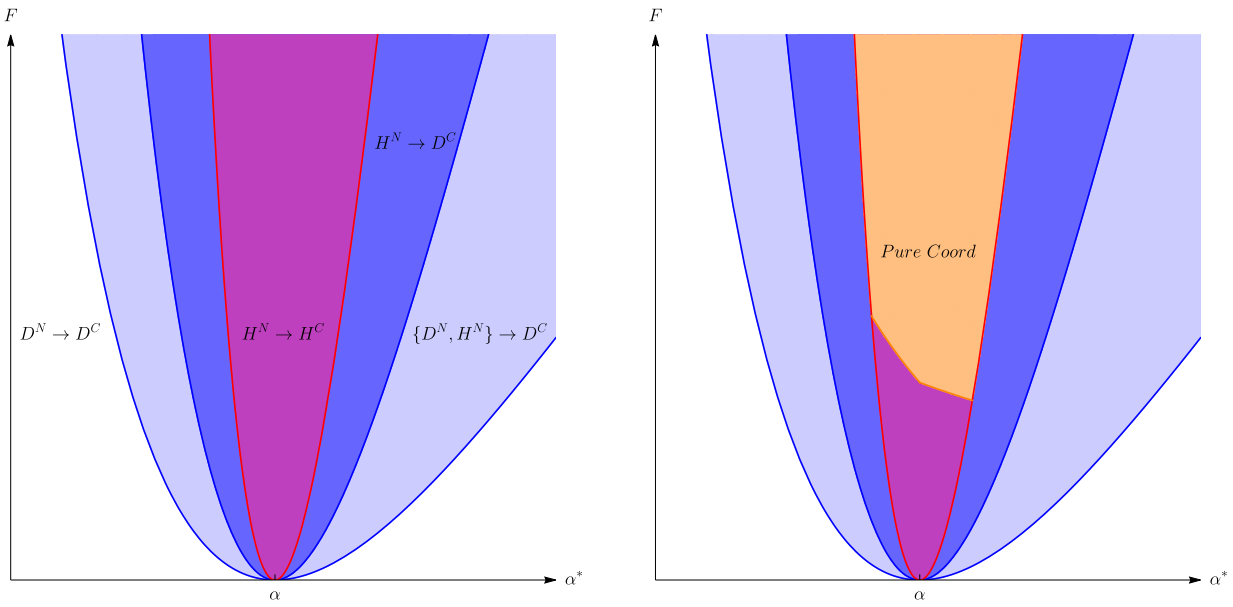
$$S(e_S) + S^*(e_S^*) - 2F \leq S(e_H) + S^*(e_H).$$

It is intuitive and easy to show that Harmony is efficient if and only if the fundamental preference distance $|\alpha - \alpha^*|$ is small relative to the fixed cost F. Figure 8b illustrates how the cooperative regulatory regime depends on the key model parameters, with H^C and D^C denoting the parameter regions where the cooperative regime is respectively Harmony and Diversity.

We can now discuss the potential role for a regulatory agreement under intra-industry trade, by comparing the efficient regulatory regime (Figure 8b) with the noncooperative equilibrium regime(s) (Figure 8a). But first we make some preliminary observations and introduce some new terminology.

Given that for a certain parameter region there are multiple noncooperative equilibria, the possibility arises that the agreement may play a *coordination* role, a possibility that was not present in the baseline one-way-trade setting. We will say that the agreement can play a "weak harmonization" (resp. "weak diversification") role if the efficient regime is Harmony (resp. Diversity) and there are both Harmony and Diversity noncooperative equilibria. On the other hand, we say that the agreement plays a "strong harmonization" (resp. "strong diversification") role if the efficient regime is Harmony (resp. Diversity) and such regime is not a noncooperative equilibrium. We will also ask whether the efficient *levels* of the standards constitute a Nash equilibrium, in which case we say that

[37] The California/Brussels effect discussed earlier – that is, spontaneous "upward" harmonization – can arise in this setting as well, if α^* and α are relatively close, but in this case there will be other equilibrium outcomes as well. Also note that, since firms are symmetric, net trade is zero, so this setting cannot speak to the incentives of a (net) exporting country to adopt the standard of the importing country.



(a) Regime-changing role

(b) Coordination role

Figure 9: Role of regulatory agreement with linear externality ($E = ed(p)$), and linear $d(p)$ and $c(e)$

the agreement can at best play a "pure coordination" role.

Next it is useful to think intuitively through the international policy externalities that arise in this setting. As in the case of one-way trade, there are two international policy externalities, the profit externality and the matching externality, except that now both externalities operate symmetrically in both directions. Thus, given the matching externality, again intuition might suggest that regulatory harmony will be under-provided in the noncooperative scenario and hence the agreement should play a harmonization role (at least in the "weak" sense defined above). Furthermore, in this setting, if the countries' fundamental preferences are similar, also their regulatory preferences are, so the reason for the diversification role of an agreement under one-way trade – namely that the distance between regulatory preferences may not reflect the distance between fundamental preferences – is not present here. Nevertheless, we find again that the agreement may encourage countries to diversify standards, although for a different reason.

The possibility that the agreement plays a diversification role is highlighted very sharply by the case in which the externality is linear in consumption ($E = ed(p)$), and $d(p)$ and $c(e)$ are linear. In this case, we find that the agreement can *only* play a (weak or strong) diversification role, as the following remark states:

Remark 5. *Under intra-industry trade, if the externality is linear in consumption ($E = ed(p)$), and $d(p)$ and $c(e)$ are linear, the H^C region is a strict subset of the H_m^N region, so the agreement can play a (weak or strong) diversification role, but cannot play a harmonization role.*

Figure 9a illustrates the potential regime-changing role of the agreement with linear externality, demand and costs. In the region labeled $\{D^N, H^N\} \to D^C$ the agreement plays a weak diversification

role, and in the region labeled $H^N \to D^C$ the agreement plays a strong diversification role, while for the remaining parameter values the agreement maintains the noncooperative regime.[38]

It is natural to ask: What was missing in the initial intuition? Why can the agreement play a diversification role in spite of the positive matching externality? The answer has to do with the interaction between the matching externality and the profit externality. This can be made clear with the aid of a thought experiment that shuts down the profit externality.

To shut down the profit externality, suppose for a moment that the social planner puts zero weight on the profit that each firm makes on the foreign market, so the social surplus in the Home market is $CS(e) - \alpha E(e) + \pi(e)$ and the social surplus in the foreign market is $CS(e^*) - \alpha^* E(e^*) + \pi(e^*)$.[39] Then it is easy to see that in each market the planner's preferred standard is the same as the local government's preferred standard. Now suppose harmony is a Nash equilibrium regime, so that there is some common standard e_h from which neither government has an incentive to deviate. This means that for each government the gain from deviating to its preferred standard is lower than the fixed cost: $W(e_W, e_W^*) - W(e_h, e_h) < F$ and $W^*(e_W^*, e_W) - W^*(e_h, e_h) < F$. But this implies $[W(e_W, e_W^*) + W^*(e_W^*, e_W)] - [W(e_h, e_h) + W^*(e_h, e_h)] < 2F$, which in turn implies that also the planner has no desire to abandon harmony in favor of diversity. This establishes that, if we shut down the profit externality, the agreement can never play a weak diversification role, and therefore, the possible diversification role of an agreement is due to the interaction between the matching externality and the profit externality.

To understand why the combination of the two externalities can give rise to a diversification role for the agreement, let us drop the fiction above and suppose the planner takes foreign profits into account. The planner prefers diversity if, for any harmonized standard e_H, the gain from deviating to diversity, $[S(e_S) + S^*(e_S^*)] - [S(e_H) + S^*(e_H)]$, is higher than the cost of doing so, $2F$. This may be the case even if harmony is a Nash equilibrium regime, because the social benefit of deviating to diversity is evaluated at different (looser) standard levels than the corresponding benefit for an individual government. And if this is the case, the agreement can play a weak diversification role.

As Remark 5 makes clear, it is even possible that the agreement plays a *strong* diversification role, or in other words, it is possible that diversity is efficient even if diversity is not a Nash equilibrium. Note that diversity is not a Nash equilibrium if either government has an incentive to deviate from its preferred standard and match the other government's preferred standard. Suppose this is the case for Home, so that $W(e_W, e_W^*) - W(e_W^*, e_W^*) < F$. Home's gain from matching the Foreign standard (F) is one-half the planner's gain from harmonizing ($2F$), but its loss from matching the Foreign standard in general can be higher or lower than one-half the planner's loss from harmonization, and in the latter case the agreement has a strong diversification role to play.

We now focus on whether and how the agreement changes the *levels* of the standards. Our first

[38] While the linear specification is a natural one to consider and highlights that there is no presumption in favor of a harmonization role of the agreement, we also examined numerically the case where $d(p)$ and $c(e)$ have constant elasticity and the externality is linear in consumption. In this case, we find that the agreement may play a diversification role or a harmonization role (either in the weak or strong sense), depending on parameter values.

[39] While this does not literally shut down the profit externality, it makes it irrelevant in the objective of the planner.

result is that, in a certain parameter region, the efficient standards are a Nash equilibrium, and thus the agreement can at most play a pure coordination role:

Proposition 7. *Under intra-industry trade, if F is above some critical level and $|\alpha - \alpha^*|$ is sufficiently small, the efficient (harmonized) standards constitute a Nash equilibrium, so the agreement can play at most a pure coordination role.*

The parameter region described in Proposition 7 is labeled "*Pure Coord*" in Figure 9b. Broadly speaking, the agreement can play at most a pure coordination role if the distance between the countries' fundamental preferences is small and F is large. Note that, while the figure is drawn for the case of linear externality, demand and cost, the result of Proposition 7 is valid more generally.

Proposition 7, together with the preceding analysis, highlights a key point: in the presence of intra-industry trade, the potential role of regulatory agreements tends to be more limited, and under some conditions it is limited to a coordination role, helping countries focus on the efficient standards in the presence of multiple equilibria.

Before proceeding, it is useful to discuss whether the multiplicity of Nash equilibria in our model is still present if the cost function does not jump at $e = e^*$. We have examined how results change if our cost function is approximated with a smooth function. In this case, we can show that there are two changes in the results: (a) in the H^N region only one equilibrium survives, where standards are (almost) harmonized, and in the $\{H^N, D^N\}$ region there is a single almost-harmony equilibrium that co-exists with the diversity equilibrium; (b) the efficient standards are never a Nash equilibrium, so the agreement never plays a *pure* coordination role. But aside from these qualifications, our main qualitative insights are still valid. It is also worth recalling from our earlier discussion that, to the extent that certification costs are important, the fixed costs of regulatory diversity are likely to generate a jump in the cost function.

4.3 Lobbying in the intra-industry-trade scenario

Here we briefly revisit the question of how lobbying affects the choice of regulatory regime in the noncooperative and cooperative scenarios, but this time in the setting with intra-industry trade. As in Section 3.3, we capture the political influence of the firm in each country by attaching an extra weight γ to the firm's profits in that country's government objective, and we assume for simplicity that this weight is the same in the two countries.

Our first observation is that the qualitative results regarding the role of a regulatory agreement for a fixed level of γ, and in particular Remark 5 and Proposition 7, are the same as in the case of welfare-maximizing governments (γ=0).

The second observation is that the qualitative results of Section 3.3 regarding the impact of lobbying on the cooperative regime hold also in the setting with intra-industry trade. The reason for this is that the social planner problem is qualitatively similar in the two cases, with the only

difference that in the case of intra-industry trade, global welfare includes the profits of both firms (2π) instead of the profits of a single firm (π).

Thus we only need to revisit the impact of lobbying in the noncooperative scenario. We have analyzed the case where the externality is linear is consumption, and demand $d(p)$ and cost $c(e)$ functions are linear. In this case, we find that increasing γ makes spontaneous harmony less likely, in the sense that it shrinks both the H^N region and the $\{H^N, D^N\}$ region, thus expanding the D^N region. Note that, in this linear case, lobbying makes regulatory harmony less likely both in the cooperative and noncooperative scenarios, thus the counterintuitive possibility that lobbying pushes towards diversity arises more strongly under intra-industry trade than under one-way trade.

Finally, it can be shown that also the result of Remark 4 – that if lobbying is strong enough the agreement reduces welfare relative to the noncooperative equilibrium – extends to this setting.

5 Consumption taxes

In this section we extend the model to allow for consumption taxes. We start with two preliminary remarks. First, while there is a policy debate about the possible benefits of harmonizing consumption taxes, we will not consider these arguments here. The rationale for harmonization that we consider in this paper is based on the costs that regulatory diversity imposes on firms, and these costs are arguably much less important for consumption taxes than for product standards. In this section we assume there is no cost of regulatory diversity for consumption taxes, so there is no rationale for tax harmonization, either in the noncooperative or in the cooperative scenario.

The second remark is that there are two equivalent ways to implement the efficient outcome given the consumption externality. The first one is a quality-dependent Pigouvian consumption tax of the form $t(e)$. For example, if e is the level of emissions from cars, this is a tax that increases with the level of car emissions. The second one is a combination of a product standard (which sets e at the optimal level) and a non-contingent consumption tax (equal to the marginal consumption externality for the optimal variety e). Here we focus on the latter, which is arguably simpler to implement in practice, and more closely reflects the regulatory policies we observe in reality.

We first focus on our basic monopoly setting. We first note that, in this setting, if consumption taxes are available, then trade taxes are redundant: for the Foreign country, a consumption tax is equivalent to a tariff, and for the Home country, there is no reason to use export taxes/subsidies, because the monopolist is already exploiting optimally the Home country's monopoly power in trade.

The first point we will make is that, if consumption taxes are available, each country's preferred standard coincides with the surplus-maximizing standard for that country (recall that we define "surplus" as gross of fixed costs, so the surplus-maximizing standards are not necessarily the efficient standards). The intuition is the following. Recall that in the absence of consumption taxes, Home's preferred standard is the surplus-maximizing one but Foreign's preferred standard is too strict because of the profit externality. If consumption taxes are available, on the other hand, Foreign will use a

consumption tax to extract rents from the Home firm, and as a consequence its unilaterally optimal standard is undistorted.

We now show this point more formally. To streamline the math, we assume here that the externality is linear in consumption. We first show that the surplus-maximizing level of the standard in the Foreign market satisfies $c'(e^*) = -\alpha^*$. With a slight abuse of notation, we write the surplus function for the Foreign market as:

$$S^* = CS(p^*) + (p^* - c(e^*))y^* - \alpha^* e^* y^*, \tag{4}$$

where y^* and p^* are the quantity and price chosen by the Home firm in the Foreign market, and we keep in mind that they depend on the tax and the standard. The FOCs simplify to:

$$S^*_{t^*} = (p^* - c(e^*) - \alpha^* e^*)y^*_{t^*} \tag{5}$$

$$S^*_{e^*} = -(\alpha^* + c'(e^*))y^* + (p^* - c(e^*) - \alpha^* e)y^*_{e^*} \tag{6}$$

From the first equation we get $p^* = c(e^*) + \alpha^* e^*$, and plugging this into the second equation we obtain $c'(e^*) = -\alpha^*$. This equation determines the surplus-maximizing standard. Note that the surplus-maximizing tax is the one that brings the price p^* in line with the marginal cost inclusive of the social cost, $c(e^*) + \alpha^* e^*$, given the surplus-maximizing standard. So the intuitive interpretation of this policy package is that the standard is used to implement the correct quality level of the good, and given this quality level, the tax is used to implement the correct price.

The Foreign government maximizes $W^* = CS(p^*) + t^* y^* - \alpha^* e^* y^*$. The FOCs can be written as:

$$W^*_{t^*} = (t^* - \alpha^* e^*)y^*_{t^*} + (1 - p^*_{t^*})y^* = 0 \tag{7}$$

$$W^*_{e^*} = (t^* - \alpha^* e^*)y^*_{e^*} + (-\alpha^* - p^*_{e^*}) = 0 \tag{8}$$

With a little algebra, it is direct to verify that (i) the unilaterally optimal standard satisfies $c'(e^*) = -\alpha^*$, so it coincides with the surplus-maximizing one, and (ii) the unilaterally optimal tax satisfies $t^* = \alpha^* e^* + (p^*_{t^*} - 1)y^*/y^*_{t^*}$. Note that the first term of the optimal tax is a Pigouvian component (given by the marginal externality evaluated at the efficient standard), and the second term reflects the incentive of the Foreign government to extract rents from the Home firm.

The feature that, if consumption taxes are available, each country's preferred standard coincides with the surplus-maximizing one has a direct implication for the role of a regulatory agreement. In this case it is easy to show that harmony can only be under-provided in the noncooperative scenario, and therefore a regulatory agreement can only have a harmonization role. The intuition is the following. Recall from Section 2 that, in the one-way-trade setting, the reason why the agreement may play a diversification role is that Foreign's preferred standard is distorted, and the Home country may have an incentive to adopt it – leading to spontaneous harmonization – when it is not efficient to do so. Put differently, in the absence of consumption taxes, it is the interaction between the matching

externality and the profit externality that creates a possible diversification role for the agreement. But if consumption taxes are available, profit shifting is achieved through consumption taxes, so the matching externality is the only relevant externality when it comes to the choice of standards, and hence the only possible role of an agreement is to encourage harmonization.[40]

The result above suggests that, in our basic monopoly setting, the role of an agreement depends in part on whether or not consumption taxes are available, and a diversification role is possible only if consumption taxes are constrained. However, there are a few important caveats to this conclusion. The first one is that, if the one-way-trade setting is extended to allow for foreign firms that sell only domestically (because they are much less efficient than the home firm), then Foreign's preferred standard may no longer coincide with the surplus-maximizing standard.[41] The reason is that, while the consumption tax will still be too strict because of the profit externality, the "targeting" feature highlighted above – namely that the consumption tax is used to extract rents from the home firm while the standard is used to maximize local surplus – no longer holds because the consumption tax also affects the local firms, so the Foreign government no longer has a targeted instrument to achieve rent extraction. As a consequence, the Foreign government will distort both the consumption tax and the standard for the purpose of rent extraction. Thus, even if consumption taxes are available, if there are import-competing firms in the foreign market then harmony may be over-provided in the noncooperative scenario, for a similar reason as in our basic model – namely that Home may choose to adopt Foreign's distorted standard.[42]

The second caveat is that, in the setting with symmetric two-way trade, the agreement can still play a diversification role. The reason for this is subtle, and here we provide some broad intuition. Consider an individual government's choice between its preferred standard and some harmonized standard, say e_h. We can think of this choice as follows: given the standard, a government's preferred tax is some function of the standard, say $t^W(e)$; given this schedule, the government's preferred standard maximizes the reduced-form welfare function $W(e, t^W(e))$. When considering whether to adopt the harmonized standard e_h, the government compares the welfare loss of moving from its preferred standard (the maximizer of $W(e, t^W(e))$ to e_h with the benefit of doing so, which is F. What would the planner do if faced with the same choice? The planner would compare F with the loss of surplus incurred by adopting e_h. Following a similar logic as above, this loss of surplus

[40]More formally, recall that spontaneous harmony occurs if and only if Home chooses to adopt Foreign's preferred standard, which recall is the surplus-maximizing standard ($e^*_W = e^*_s$). This is the case if F is larger than the loss of Home welfare when moving from Home's preferred standard to e^*_s. Now recall that Home's welfare is given by Home's surplus plus foreign profits ($S(e) + \pi(e^*)$), and the latter is taken as given by the Home government, so Home makes the same choice as a planner that is constrained to choose between the preferred standard and harmonizing at the level e^*_s. But the planner can do better than that, by choosing a standard that lies between e_s and e^*_s, so the planner's benefit from harmonization is larger than Home's benefit from harmonizing, and hence harmony can only be under-provided in the noncooperative scenario.

[41]Here we are implicitly assuming that firms compete in Cournot fashion and the gap in productivity between the home firm and the foreign local firms is sufficiently large, so that foreign firms will not sell in the Home market.

[42]If trade taxes were available as well, the targeting feature mentioned above would be present even if there are local Foreign firms, because the rent extraction objective would be accomplished entirely by the trade tax. But as discussed at the outset of the section, in this paper we focus on situations where shallow integration has been achieved already, so governments must use non-discriminatory policies, and the focus is on deep integration.

is evaluated by finding the surplus-maximizing tax as a function of the standard, say $t^S(e)$, and considering the reduced-form surplus function $S(e, t^S(e))$. Just as in the monopoly setting, in this symmetric oligopoly setting the maximizer of $W(e, t^W(e))$ coincides with the maximizer of $S(e, t^S(e))$, but the concavity of the two functions in general is different, so the loss of surplus S when moving from the optimal standard to e_h differs from the corresponding loss in W. If $W(e, t^W(e))$ is less concave than $S(e, t^S(e))$, the individual government will have a stronger incentive to adopt e_h than the planner. This is the underlying reason why it is possible that harmony is "over-provided" in the noncooperative scenario.[43]

The final caveat concerns the administrative and political costs associated with consumption taxes.[44] If consumption taxes are costly to implement, the "targeting" feature discussed above again will not hold: consumption taxes will lose effectiveness as a rent-extraction tool, and as a consequence standards will not be set at the efficient level. And with the Foreign government choosing a distorted standard level, the logic of our discussion above suggests again that the agreement may play a diversification role.

6 Conclusion

As trade agreements have become increasingly "deep," extending their reach beyond border policies, the harmonization of product standards has emerged as a contentious issue. In this paper we have examined positive and normative questions surrounding regulatory harmonization, through a stylized model of trade with vertically differentiated products where governments set standards to address local consumption externalities. At the heart of the model is the trade-off between heterogeneous preferences across countries and the fixed costs of regulatory diversity. The overarching message of the paper is that the common perception of regulatory agreements as playing a key role in promoting harmonization may have been over-stated.

First, our analysis shows that regulatory harmony can arise even in the absence of an agreement, as a country's incentives to match another country's standards for cost-saving reasons can lead to "spontaneous" harmonization. However, we also demonstrate that this spontaneous harmonization may be inefficient, suggesting that the role of agreements could in fact be to promote regulatory diversity rather than convergence.

Moreover, we show that the potential contributions of regulatory agreements depend in important ways on the pattern of trade, and in particular on whether trade is inter-industry or intra-industry. In

[43] We have explored the possible diversification role of the agreement in the duopoly setting with a specification where the externality is linear in consumption, the demand curve is linear in price and the cost function is constant-elasticity in the standard. In this case we find that the agreement can play a *weak* diversification role, that is, in a certain parameter region there are spontaneous harmony equilibria but efficiency requires diversification. With this specification we could not find cases where the agreement plays a *strong* diversification role, but we were not able to rule out this possibility in general.

[44] While administrative costs tend to be lower in more advanced countries because their tax systems are more efficient, political costs vary widely depending on the political/institutional setting in each country. In the United States, for example, passing tax-increasing laws is notoriously hard.

the presence of intra-industry trade, the potential role of these agreements tends to be more limited, and under some conditions they can play only a coordination role, helping countries focus on the efficient standards when multiple equilibria exist.

Finally, we have examined the impact of lobbying on the regulatory regime, focusing in particular on the "Pop Critique," according to which lobbying by corporate interests may lead to welfare-reducing harmonization. Our model offers only limited support to the Pop Critique. Lobbying is shown to push toward the regulatory regime – harmony or diversity – that is worse for consumers, both in the cooperative and noncooperative settings. Furthermore, if lobbying is strong enough the agreement reduces welfare relative to the noncooperative equilibrium. However, the model suggests important qualifications to the Pop Critique: first, lobbying may push toward diversification, rather than harmonization; second, when the agreement reduces welfare, it is not because lobbying pushes toward harmonization, but because it pushes toward *deregulation*; and third, lobbying may distort the regulatory regime even in the absence of an agreement, so the problem lies not with the agreement itself, but with the lobbying forces that can shape regulatory policies in suboptimal ways.

Appendix

Proof of Proposition 1. Foreign does not care about the firm's profits, so Foreign always chooses its preferred standard (recalling the assumption that parameters are such that the firm's break-even condition does not matter). Spontaneous harmony occurs when

$$F \geq F^N(\alpha^*;\alpha) \equiv S(e_W(\alpha)) - S(e_W^*(\alpha^*)), \tag{9}$$

where $F^N(\alpha^*;\alpha)$ is the fixed cost at which, given α and α^*, Home is indifferent between keeping its preferred standard and harmonizing at the foreign standard. It is easy to see that, fixing α, F^N is U-shaped in α^*, with a minimum of zero when $\alpha^* = \hat{\alpha}$. Proposition 1 follows immediately.

Proof of Remark 1. The frontier of the spontaneous harmony region is given by

$$F^N(\alpha^*,\alpha) \equiv S(e_W(\alpha)) - S(e_W^*(\alpha^*)). \tag{10}$$

Export profits do not affect this indifference condition, since export profits are not affected by the Home choice of standard. However, an increase in the size of the foreign market may affect the foreign preferred standard $e_W^*(\alpha^*)$ which would in turn affect the indifference condition.

Recall the demand function is $kd(p)$, where k captures the size of the market. Recognizing that the monopoly price is a function of e, we can write demand in reduced form as $kd(e)$. The externality can then be written as $E(e) = eg(kd(e))$, where g is an increasing function. The Foreign objective function is

$$W^*(e,k) = kCS(d(e)) - \alpha^* eg(kd(e)). \tag{11}$$

The Foreign preferred standard $e_W^*(\alpha^*)$ is given by the first-order condition

$$W_e^*(e,k) = kCS'(d(e))d'(e) - \alpha^*(g(kd(e)) + keg'(kd(e))d'(e) = 0. \tag{12}$$

To determine how Foreign's preferred standard depends on k, we need to sign the cross-derivative

$$W_{ke}^*(e,k) = CS'(d(e))d'(e) - \alpha^* g'(kd(e))\left(d(e) + ed'(e)\right) - \alpha^* keg''(kd(e))d(e)d'(e). \tag{13}$$

Substituting from the first-order condition (12) yields

$$W_{ke}^*(e,k) = \alpha^*\left(\frac{g(kd(e))}{k} - g'(kd(e))d(e) - keg''(kd(e))d(e)d'(e)\right). \tag{14}$$

If g is linear in d, the cross-derivative in (14) is zero, so Foreign's preferred standard is not affected by the Foreign market size, and hence the spontaneous harmony region is not affected by the Foreign market size.

If g is convex in d, we have $\frac{g(kd)}{k} \leq g'(kd)d$ and so $W_{ke}^*(e,k) \leq 0$. Thus in this case Foreign's

preferred standard becomes stricter as the size of the Foreign market increases. If g is concave in d, we have $\frac{g(kd)}{k} \geq g'(kd)d$ and so $W^*_{ke}(e,k) \geq 0$. Thus in this case Foreign's preferred standard becomes looser as the size of the Foreign market increases.

Proof of Proposition 2. Cooperative regulatory harmony occurs when

$$F \geq F^C(\alpha^*;\alpha) \equiv S(e_S(\alpha)) + S^*(e^*_S(\alpha^*)) - [S(e_H(\alpha,\alpha^*)) + S^*(e_H(\alpha,\alpha^*))]\,. \tag{15}$$

It is easy to see that, fixing α, F^N is U-shaped in α^*, with a minimum of zero when $\alpha^* = \alpha$. This implies that cooperative harmony occurs when F is sufficiently large compared to $|\alpha^* - \alpha|$. Furthermore, the agreement will harmonize (i.e. change the regime from diversity to harmony) if F is sufficiently large compared to $|\alpha^* - \alpha|$, but not too large compared to $|\alpha^* - \hat{\alpha}|$.

Proof of Lemma 1. Spontaneous harmony under lobbying occurs when

$$F \geq F^N_\gamma = \frac{1}{(1+\gamma)}\left[\Omega(e_\Omega, e^*_W) - \Omega(e^*_W, e^*_W)\right], \tag{16}$$

where to simplify notation we are omitting the arguments α and α^* from the above expression. An increase in γ makes spontaneous harmony more likely if and only if $\frac{\partial F^N_\gamma}{\partial \gamma} \leq 0$.

$$\begin{aligned}\frac{\partial F^N_\gamma}{\partial \gamma} &= \frac{1}{(1+\gamma)^2}\left[(1+\gamma)(\pi(e_\Omega) - \pi(e^*_W)) - (\Omega(e_\Omega, e^*_W) - \Omega(e^*_W, e^*_W)\right] \\ &= \frac{1}{(1+\gamma)^2}\left[\tilde{CS}(e^*_W) - \tilde{CS}(e_\Omega)\right],\end{aligned}$$

so an increase in γ makes spontaneous harmony more likely if and only if $\tilde{CS}(e^*_W) \leq \tilde{CS}(e_\Omega)$.

Proof of Proposition 3. Using Lemma 1, we now characterize how the spontaneous harmony frontier is affected by an increase in γ. We have several cases:

(i) $\alpha^* \leq \hat{\alpha}_\gamma < \hat{\alpha} < \alpha$. In this case we have $e^*_W \geq e_\Omega > e_{\tilde{CS}}$ where $e_{\tilde{CS}} = \operatorname{argmax} \tilde{CS}$. So $\tilde{CS}(e^*_W) - \tilde{CS}(e_\Omega) < 0$, hence consumers prefer diversity while the firm prefers harmony. The intuition for the firm's preference is that, when Foreign is more lenient, the firm prefers harmony because it gets higher operating profits and saves the fixed cost. Hence an increase in γ lowers F^N.

(ii) $\hat{\alpha}_\gamma \leq \alpha^* \leq \alpha$. In this case we have $e_\Omega \geq e^*_W \geq e_{\tilde{CS}}$, so $\tilde{CS}(e^*_W) - \tilde{CS}(e_\Omega) > 0$. Consumers prefer harmony while firms prefer diversity. The intuition for the firm's preference is that harmonization occurs at a stricter standard, which leads to a loss in operating profits, and so to make it worth it, the fixed cost has to increase. Hence an increase in γ increases F^N.

(iii) $\hat{\alpha}_\gamma \leq \alpha \leq \alpha^*$. In this case we have $e_\Omega \geq e_{\tilde{CS}} \geq e^*_W$. e_Ω and e^*_W are on opposite sides of the argmax of $\tilde{CS}$. Here there are two sub-cases:

(iiia) If e_Ω is such that $\tilde{CS}(e_\Omega) < 0$, then for all $\alpha^* \geq \alpha$, $\tilde{CS}(e^*_W) - \tilde{CS}(e_\Omega) > 0$. In this case consumers prefer harmony and the firm prefers diversity for any α^* greater than α, and an increase in γ increases F^N.

(iiib) If e_Ω is such that $\tilde{CS}(e_\Omega) \geq 0$, when α^* is close to α consumers prefer harmony $\tilde{CS}(e_W^*) - \tilde{CS}(e_\Omega) > 0$, so an increase in γ increases F^N. But as α^* increases, $\tilde{CS}(e_W^*)$ decreases and there may be a threshold α^* above which consumers no longer prefer harmony – and hence an increase in γ decreases F^N.

Proof of Lemma 2. Cooperative harmony under lobbying occurs when

$$F \geq F_\gamma^C = \frac{1}{(1+\gamma)} \left[\Omega(e_\Omega, e_\Omega^*) + \Omega^*(e_\Omega^*, e_\Omega) - (\Omega(e_H, e_H) + \Omega^*(e_H, e_H)) \right]. \tag{17}$$

An increase in γ makes cooperative harmony more likely if and only if $\frac{\partial F_\gamma^C}{\partial \gamma} \leq 0$. Calculating the derivative yields

$$\frac{\partial F_\gamma^C}{\partial \gamma} = \frac{1}{(1+\gamma)^2} \left[\tilde{CS}(e_H) + \tilde{CS}^*(e_H) - \left(\tilde{CS}(e_\Omega) + \tilde{CS}^*(e_\Omega^*) \right) \right].$$

So an increase in γ makes cooperative harmony more likely if and only if $\tilde{CS}(e_H) + \tilde{CS}^*(e_H) \leq \tilde{CS}(e_\Omega) + \tilde{CS}^*(e_\Omega^*)$.

Proof of Proposition 4. Let the inverse demand function be denoted by $p(x) = a - bx$ and the marginal cost by $c(e) = c - e$ (where we implicitly assume that parameters are such that $e \leq c$ in equilibrium). The monopolist's profit-maximizing output is then $x = \frac{a-(c-e)}{2b}$. Letting the consumption externality be $E = ex$, we can express the Home surplus function under lobbying as

$$S(e) = CS(e) - \alpha E(e) + (1+\gamma)\pi(e). \tag{18}$$

Plugging in the functions defined above yields

$$S(e) = \frac{(a+e-c)\left((a+e-c)(3+2\gamma) - 4\alpha e\right)}{8b}. \tag{19}$$

Solving for the surplus maximizing standard yields

$$e_S = \frac{(a-c)(3+2\gamma-2\alpha)}{4\alpha - (3+2\gamma)}, \tag{20}$$

where α and γ need to satisfy $\frac{3+2\gamma}{4} < \alpha < \frac{3+2\gamma}{2}$ for the standard to be positive and a maximum.

Similarly, we can solve for harmonized standard that maximizes the global surplus $S + S^*$:

$$e_H = \frac{(a-c)(3+2\gamma-(\alpha+\alpha^*))}{2(\alpha+\alpha^*) - (3+2\gamma)}, \tag{21}$$

where α, α^* and γ need to satisfy $\frac{3+2\gamma}{2} < \alpha + \alpha^* < 3 + 2\gamma$ for the standard to be positive and a maximum.

The condition for the planner's indifference between harmony and diversity can be written as:

$$F^C(\alpha^*;\alpha) = \frac{1}{1+\gamma}\left(S(e_S) + S^*(e_S^*) - S(e_H) - S^*(e_H)\right) \tag{22}$$

$$= \frac{(a-c)^2(3+2\gamma)^2(\alpha-\alpha^*)^2}{4b(1+\gamma)(4\alpha-(3+2\gamma))(4\alpha^*-(3+2\gamma))(2(\alpha+\alpha^*)-(3+2\gamma))}. \tag{23}$$

We can now calculate the elasticity of the frontier F^C with respect to γ:

$$\frac{\partial F^C}{\partial \gamma}\frac{\gamma}{F^C} = \frac{\gamma(1+2\gamma)}{3+5\gamma+2\gamma^2} + 2\gamma\left(\frac{1}{4\alpha-(3+2\gamma)} + \frac{1}{4\alpha^*-(3+2\gamma)} + \frac{1}{2(\alpha+\alpha^*)-(3+2\gamma)}\right).$$

This is positive if α and α^* are such that the second-order conditions for surplus maximization are satisfied. So an increase in γ raises the fixed cost at which the planner is indifferent between harmony and diversity, and hence the cooperative harmony region shrinks.

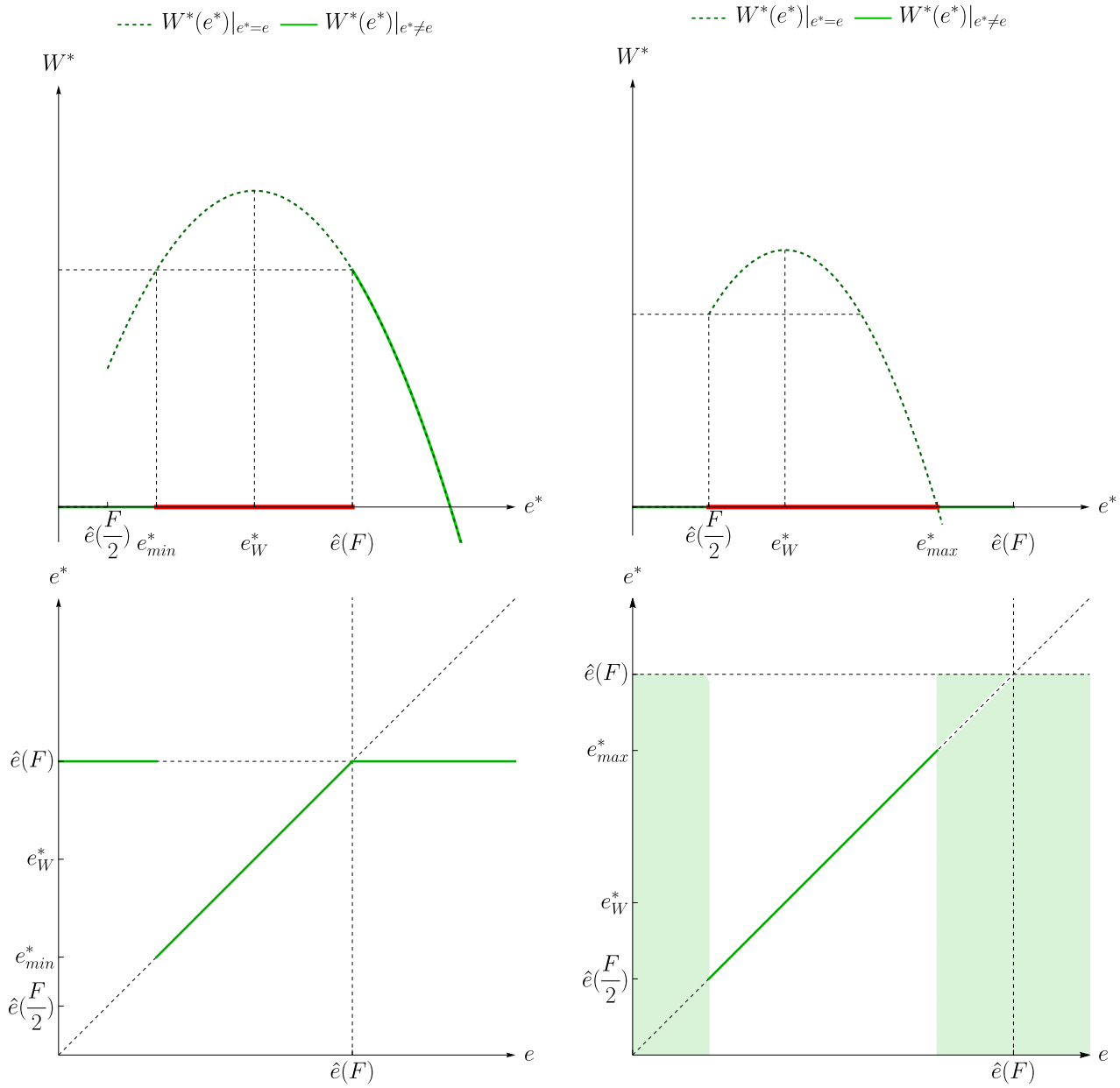
Proof of Proposition 5. We start by characterizing the governments' reaction functions. Given our assumption that the firm's participation constraint does not bind for the Home market (see footnote 33), the Home government's reaction function is clearly the same as in our basic model, so we can focus on the Foreign government's reaction function.

Two possibilities arise. First, if α^* is sufficiently large that Foreign's preferred standard is stricter than the break-even standard ($e_W^* < \hat{e}(F)$), but Foreign still derives positive welfare from consuming the product at the break-even standard ($W^*(\hat{e}(F)) \geq 0$), then Foreign will set $e^* = \hat{e}(F)$ and harmonize for any level of e which yields a higher level of welfare than $W^*(\hat{e}(F))$ as illustrated in Figure 10a.[45] Second, if α^* is so large that foreign welfare is negative at the break-even standard ($W^*(\hat{e}(F)) < 0$), but there exist standard levels $e^* \in (\hat{e}(\frac{F}{2}), \hat{e}(F))$ yielding positive welfare $W^*(e^*) \geq 0$, then Foreign will be willing to harmonize at these standard levels. Outside of this range, Foreign will be indifferent between any standard level inducing the firm not to serve the market as illustrated in Figure 10b.

Using the analysis above and the arguments in footnote 34, one can characterize the parameter regions where the different types of noncooperative equilibria arise, as in Figure 5a. It is also straightforward to show that the parameter regions where each regulatory regime is efficient are as shown in Figure 5b.

To prove that the agreement expands trade at the extensive margin through harmonization and never reduces trade at the extensive margin, we will show that whenever Home is indifferent between spontaneous harmony and no-trade, the planner would always choose harmony.

[45] The harmonized standard needs to be greater than $\hat{e}(\frac{F}{2})$ for the firm to break even in the two markets. Figure 10a focuses on the case in which the minimum standard at which Foreign is willing to harmonize, e_{min}^*, is above $\hat{e}(\frac{F}{2})$, but this need not be the case.



(a) Case: $e^*_W \leq \hat{e}(F)$ and $W^*(\hat{e}(F)) \geq 0$

(b) Case: $e^*_W \leq \hat{e}(F)$ and $W^*(\hat{e}(F)) < 0$

Figure 10: Foreign welfare (top panels) and reaction functions (bottom panels)

The indifference for Home between spontaneous harmony and no-trade (NT) is given by

$$\underbrace{S(e_S) - F}_{NT} = \underbrace{S(e^*_{max}) + \pi(e^*_{max}) - F}_{\text{Harmony at } e^*_{max}} \quad \Rightarrow \quad S(e_S) = S(e^*_{max}) + \pi(e^*_{max}) \tag{24}$$

where e^*_{max} is the standard at which Foreign is just indifferent between consuming the product or not:

$$W^*(e^*_{max}) = 0 \tag{25}$$

Summing (24) and (25) gives

$$S(e_S) + 0 = S(e^*_{max}) + \pi(e^*_{max}) + W^*(e^*_{max}) \quad \Leftrightarrow \quad S(e_S) = S(e^*_{max}) + S^*(e^*_{max}) \tag{26}$$

This indifference condition does not depend on F (the frontier between spontaneous harmony and no-trade is vertical in Figure 5) and uniquely defines the value of $\bar{\alpha}^N$ such that for $\alpha^* > \bar{\alpha}^N$ the foreign market will not be served.

Consider now the planner's condition for indifference between cooperative harmony and no trade

$$S(e_S) = S(e_H) + S^*(e_H). \tag{27}$$

This indifference condition also does not depend on F (the frontier between cooperative harmony and no-trade is vertical in Figure 5) and uniquely defines the value of $\bar{\alpha}^C$ such that for $\alpha^* > \bar{\alpha}^C$, it will be efficient not to serve the foreign market.

If the planner is not constrained by the firm's participation condition, she is choosing e_H optimally, so whenever $S(e_S) = S(e^*_{max}) + S^*(e^*_{max})$, the planner will prefer harmony as $S(e_H) + S^*(e_H) \geq S(e^*_{max}) + S^*(e^*_{max})$. If the planner is constrained by the firm's participation condition, she is choosing $\hat{e}(\frac{F}{2})$ such that $\hat{e}(\frac{F}{2}) \geq e_H$. At the frontier between spontaneous harmony and no-trade, we have $e^*_{max} \geq \hat{e}(\frac{F}{2})$ (otherwise there would not be any scope for spontaneous harmony) and so $S(\hat{e}(\frac{F}{2})) + S^*(\hat{e}(\frac{F}{2})) \geq S(e^*_{max}) + S^*(e^*_{max})$. Hence the planner will also prefer harmony and $\bar{\alpha}^C > \bar{\alpha}^N$.

Proof of Proposition 6. As argued in the main text, both Home's and Foreign's reaction functions include a tolerance interval, i.e. they overlap with the diagonal over a certain range. The width of the tolerance interval increases with F. There are three relevant cases:

(i) When F is small relative to the distance between α and α^*, the tolerance intervals of Home and Foreign are disjoint. The reaction functions have a single intersection off the diagonal at (e_W, e^*_W) and thus we have a unique Diversity equilibrium. This corresponds to the parameter region D^N.

(ii) When F is large relative to the distance between α and α^*, the Home and Foreign tolerance intervals partly overlap on the diagonal and we have multiple Harmony equilibria. This corresponds to the parameter region H^N.

(iii) When F takes intermediate values, the reaction functions partly overlap on the diagonal, and they also intersect off the diagonal. In this case we have multiple Harmony equilibria and also a Diversity equilibrium. This corresponds to the parameter region $\{D^N, H^N\}$.

The frontier between the $\{D^N, H^N\}$ and H^N regions is given by

$$F^{N^I}(\alpha^*; \alpha) = \max\{W^l(e_W) - W^l(e^*_W), W^{l*}(e^*_W) - W^{l*}(e_W)\}, \tag{28}$$

where W^l denotes the local component of welfare ($W^l = CS - \alpha E + \pi$). For $F > F^{N^I}(\alpha^*; \alpha)$, there is no Diversity equilibrium.

The frontier between the D^N and $\{D^N, H^N\}$ parameter regions is given by

$$F^{N^O}(\alpha^*;\alpha) = W^l(e_W) - W^l(e_N), \tag{29}$$

where e_N is the solution to the equation $W^{l*}(e_W^*) - W^{l*}(e_N)$. This is the unique standard level for which the Home and Foreign tolerance intervals just touch. For $F < F^{N^O}(\alpha^*;\alpha)$, there is no Harmony equilibrium.

Proof of Remark 5. Let the inverse demand function be $p = a - b(x_1 + x_2)$ and the marginal cost $c(e) = c - e$ (assuming parameters are such that $e \leq c$ in equilibrium). The Cournot equilibrium outputs in each market are $x_1 = x_2 = \frac{a-(c-e)}{3b}$. Letting the consumption externality in a given country be $E = e(x_1 + x_2)$, we can write the local component of Home welfare (gross of fixed cost) as

$$W^l(e) = CS(e) - \alpha E(e) + \pi(e) = \frac{(a-(c-e))(a-(c-e)-2\alpha e)}{3b} \tag{30}$$

and we can solve for Home's preferred standard:

$$e_W = \frac{(a-c)(1-\alpha)}{2\alpha - 1}, \tag{31}$$

where we need $\frac{1}{2} < \alpha < 1$ to guarantee an interior maximum. The surplus arising in the Home market is

$$S(e) = CS(e) - \alpha E(e) + 2\pi(e) = \frac{2(a-(c-e))(2a-2(c-e)-3\alpha e)}{3b} \tag{32}$$

and the surplus maximizing standard is

$$e_S = \frac{(a-c)(4-3\alpha)}{2(3\alpha - 2)}, \tag{33}$$

where we need $\frac{2}{3} < \alpha < \frac{4}{3}$ to guarantee an interior maximum. Note that, for both restrictions on α to be satisfied, we need $\frac{2}{3} < \alpha < 1$.

Similar expressions hold for the welfare-maximizing and surplus-maximizing foreign standards e_W^* and e_S^* (and for the needed restrictions on α^*).

Finally, we can solve for the harmonized global-surplus-maximizing standard:

$$e_H = \frac{(a-c)(8-3(\alpha+\alpha^*))}{2(3(\alpha+\alpha^*)-4)}, \tag{34}$$

where it can be shown that the restrictions imposed above on α and α^* guarantee an interior maxi-

mum. The planner's condition for indifference between Harmony and Diversity is

$$F^C(\alpha^*;\alpha) = \frac{1}{2}\left(S(e_S) + S^*(e_S^*) - S(e_H) - S^*(e_H)\right) \tag{35}$$

$$= \frac{(a-c)^2(\alpha-\alpha^*)^2}{b(3\alpha-2)(3\alpha^*-2)(3(\alpha+\alpha^*)-4)}. \tag{36}$$

The frontier between the H^N and $\{D^N, H^N\}$ regions is given by

$$F^{NI}(\alpha^*;\alpha) = \max\{W^l(e_W) - W^l(e_W^*), W^{l*}(e_W^*) - W^{l*}(e_W)\} \tag{37}$$

$$= \frac{(a-c)^2(\alpha-\alpha^*)^2}{3b(2\alpha-1)(2\alpha^*-1)} \max\{\frac{1}{2\alpha^*-1}, \frac{1}{2\alpha-1}\}. \tag{38}$$

Without loss of generality, consider the case $\alpha^* > \alpha$. Then

$$F^{NI}(\alpha^*;\alpha) = \frac{(a-c)^2(\alpha-\alpha^*)^2}{3b(2\alpha-1)^2(2\alpha^*-1)}. \tag{39}$$

Consider now the difference

$$F^C - F^{NI} = \frac{(a-c)^2(\alpha-\alpha^*)^2}{3b(2\alpha-1)^2(2\alpha^*-1)(3\alpha-2)(3\alpha^*-2)(3(\alpha+\alpha^*)-4)} d(\alpha,\alpha^*), \tag{40}$$

where

$$d(\alpha,\alpha^*) = 9(2-3\alpha)(\alpha^*)^2 + 3(\alpha(16-\alpha)-10)\alpha^* + 6\alpha(\alpha-4) + 13. \tag{41}$$

This is a second degree polynomial in α^* where the coefficient of the second degree term is negative, so $d(\alpha,\alpha^*)$ is a concave parabola in α^*. If it is positive at the bounds of the admissible region of α^*, then it is positive for all admissible α^* (that is $\frac{2}{3} < \alpha^* < 1$). Evaluating $d(\alpha,\alpha^*)$ at $\alpha^* = \frac{2}{3}$ and $\alpha^* = 1$, we have

$$d(\alpha, \frac{2}{3}) = (2\alpha-1)^2 > 0 \tag{42}$$

$$d(\alpha, 1) = \ = 3\alpha(\alpha-1) + 1 > 0. \tag{43}$$

This implies $F^C - F^{NI} > 0$, so that there is no harmonization role for the agreement.

Proof of Proposition 7. The tolerance interval (the part of the reaction function that overlaps with the diagonal) of both Home and Foreign reaction functions increases with F. It is direct to verify that when F is sufficiently large and $(\alpha-\alpha^*)/F$ is relatively small, the globally efficient standards are harmonized, and the overlap between the Home and Foreign tolerance intervals includes the efficient (harmonized) standards. In other words, one of the Harmony equilibria achieves global efficiency.

References

Baldwin, R. (1987): "Politically Realistic Objective Functions and Trade Policy: PROFs and Tariffs," *Economics Letters*, 24, 287–290.

Bradford, A. (2012): "The Brussels Effect," *Northwestern University Law Review*, 107.

Brander, J. and P. Krugman (1983): "A 'Reciprocal Dumping' Model of International Trade," *Journal of International Economics*, 15, 313–321.

Corporate Europe Observatory (2017): "'Regulatory cooperation': big business' wishes come true in TTIP and CETA," https://corporateeurope.org/sites/default/files/attachments/ceo_regulatory_cooperation_06.1.pdf.

Costinot, A. (2008): "A comparative institutional analysis of agreements on product standards," *Journal of International Economics*, 75, 197–213.

Draghi, M. (2024): "The future of European competitiveness – In-depth analysis and recommendations," https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en.

Fischer, R. and P. Serra (2000): "Standards and protection," *Journal of International Economics*, 52, 377–400.

Grossman, G. M. and E. Helpman (1994): "Protection for Sale," *American Economic Review*, 84, 833–850.

Grossman, G. M., P. McCalman, and R. W. Staiger (2021): "The "New" Economics of Trade Agreements: From Trade Liberalization to Regulatory Convergence?" *Econometrica*, 89, 215–249.

Jacobsen, M. R., J. M. Sallee, J. S. Shapiro, and A. A. van Benthem (2023): "Regulating Untaxable Externalities: Are Vehicle Air Pollution Standards Effective and Efficient?*," *The Quarterly Journal of Economics*, 138, 1907–1976.

Lamy, P. (2015): "The New World of Trade," The Third Jan Tumlir Lecture, https://pascallamyeu.files.wordpress.com/2015/10/jan-tumlir-police-essays-20151.pdf.

——— (2016): "The Changing Landscape of International Trade," The Frank D. Graham Lecture, https://pascallamyeu.files.wordpress.com/2017/02/2016-04-07-lamy-princeton-graham-lecture-final.pdf.

Letta, E. (2024): "Much More Than a Market," https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf.

Loeper, A. (2011): "Coordination in heterogeneous federal systems," *Journal of Public Economics*, 95, 900–912.

Macedoni, L. and A. Weinberger (forthcoming): "INTERNATIONAL SPILLOVERS OF QUALITY REGULATIONS," *International Economic Review*.

Maggi, G. and R. Ossa (2023): "The Political Economy of International Regulatory Cooperation," *American Economic Review (forthcoming)*.

Mei, Y. (2024): "Regulatory Protection and the Role of International Cooperation," *International Economic Review*, 65, 817–850.

OECD (2017a): *International Regulatory Co-operation and Trade: Understanding the Trade Costs of Regulatory Divergence and the Remedies*, OECD Publishing, Paris.

——— (2017b): "Trade Costs in Regulatory Co-operation: Findings from Case Studies," Tech. rep., OECD Publishing.

Parenti, M. and G. Vannoorenberghe (2024): "A Simple Theory of Deep Trade Integration," *Journal of the European Economic Association*, jvae046.

Perkins, R. and E. Neumayer (2012): "Does the 'California effect' operate across borders? Trading- and investing-up in automobile emission standards," *Journal of European Public Policy*, 19, 217–237.

Princen, S. (1999): "The California Effect in the EC's External Relations: A Comparison of the Leghold Trap and Beef-Hormone Issues Between the EC and the U.S. and Canada," Paper prepared for the ECSA Sixth Biennial International Conference Pittsburgh, Pennsylvania.

Rodrik, D. (2018): "What Do Trade Agreements Really Do?" *Journal of Economic Perspectives*, 32, 73–90.

Suwa Eisenmann, A. and T. Verdier (2002): "Reciprocity and the Political Economy of Harmonization and Mutual Recognition of Regulatory Measures," CEPR Discussion Papers 3147, C.E.P.R. Discussion Papers.

Vogel, D. (1997): "Trading up and governing across: transnational governance and environmental protection," *Journal of European Public Policy*, 4, 556–571.

——— (2000): "Environmental regulation and economic integration," *Journal of International Economic Law*, 3, 265–279.