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All Policies Are Glocal: International Environmental Policy Making with Strategic Subnational Governments

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National governments have intensified their attempts to create international institutions in various policy fields such as the environment, finance and trade. At the same time, many subnational policy makers have begun to duplicate international efforts by setting their own, stricter policies while others remain inactive or enact more lax regulation. This 'glocalization' of policy creates a complex and potentially costly patchwork system of regulations. To shed light on this phenomenon, this article analyzes the interaction between subnational and national governments within a game-theoretic model of international treaty negotiations. The glocalization of regulatory policy can be understood as an attempt by subnational policy makers to strategically constrain or empower national governments in international negotiations. The study finds that the shadow of international treaty formation gives rise to within-country and cross-country policy balancing dynamics that may explain some of the subnational policy polarization that is currently observable in many countries. The article specifies the conditions under which these dynamics occur, spells out empirically testable hypotheses and identifies possible theoretical extensions.

Survey evidence suggests that citizens want their governments to do more to combat global challenges such as climate change and environmental degradation and that they largely agree on which types of environmental agreements they find desirable.[1] While many national governments have intensified their attempts to strike international policy deals to address global problems, such policies have also proliferated at the subnational level. Subscribing to the slogan 'think globally, act locally', subnational policy makers increasingly create environmentally relevant policies that aim to reduce air pollution, conserve natural resources and protect the climate. Examples range from local public transport policies (for example, the share of electric buses used for public transport or regulations on the number of cars allowed to enter specific areas), public employment (for example, subsidies for employees using public transport to commute to work instead of their own car), to regional building codes (for example, requiring new buildings to meet specific energy efficiency standards). National governments even seem to encourage such subnational policy making. The UK national government emphasizes that when it comes

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[1] Polling results based on representative surveys in nineteen nations, including developed and less developed countries. The sample includes China, Egypt, France, Germany, Great Britain, India, Indonesia, Kenya, Mexico, Nigeria, Turkey, Ukraine, USA, Poland, Russia and other countries (see www.worldpublicopinion.org/pipa/articles/btenvironmentra/631.php, accessed 15 March 2011). See also Bechtel and Scheve 2013; Yeager, Laron, Krosnick, and Tompson 2011.

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to climate change, 'local authorities are free to decide how best to address these challenges and take advantage of any opportunities'.[2] In the United States, some subnational governments have even made pledges to achieve a specific reduction in greenhouse gas (GHG) emissions to express their long-term dedication to climate policy.[3] Even in a particularly centralized political system like France, subnational governments still enjoy considerable room to implement their own environmentally relevant policies.[4]

While some scholars explicitly recommend bottom-up initiatives to more effectively address global warming,[5] we argue that the proliferation and polarization of environmentally relevant policies at subnational levels (for example, cities, municipalities or states) illustrates a broader phenomenon in international politics: international co-operation occurs in a world in which subnational authorities can set their own regulations in many policy fields. Ever since Robert D. Putnam[6] introduced the 'two-level games' idea, scholars in international relations have recognized that domestic political constraints exert considerable influence on international negotiations.[7] The empirical reality of subnational environmental policy shows that in some settings, such as regulatory policy formation, these domestic constraints may form endogenously in response to both the expected results of international policy-making efforts and the national and subnational factors that influence these efforts. However, the extant literature offers little systematic theory to explain these interactions.

We examine the relationships between international co-operation and subnational policy making within a game-theoretic model. This model allows us to (1) explore the strategic implications of subnational policy for national policy choices and international treaties in multilevel systems and (2) specify the conditions under which subnational policies affect treaty negotiations. Thereby, we identify the conditions under which we should observe specific patterns of subnational policy choices that result from strategic behavior in the shadow of the formation of international institutions. The results show that strategic policy balancing is one of the key mechanisms that may explain subnational policy choices in the presence of national and international policy making.

Anecdotal evidence highlights the potential linkages between subnational, national and international policy. For example, commentators agree that California's Global Warming Solutions Act of 2006, which aims to reduce climate emissions by 20 percent by 2020, 'is leading the United States in promulgating policies to reduce greenhouse gas (GHG) emissions' and attempts 'to inspire and encourage coordinated actions by other western states and adjacent Canadian provinces and to align the state with leading policies being adopted in the European Union'.[8] According to Governor Schwarzenegger:

> The world's national governments cannot make the progress that is needed on global climate change alone, they need the help of cities, states, provinces and regions in enacting real climate solutions. California has shown that a subnational policy maker can lead the way to national change.[9]

[2] UK Department for Environment, Food and Rural Affairs 2010.

[3] For example, according to Lutsey and Sperling (2007), 53 percent of Americans live in a state or a city that has a target for greenhouse gas emission reductions.

[4] Bodiguel and Buller 1994.

[5] Kahn 2006; Urpelainen 2009; Victor 2011.

[6] Putnam 1988.

[7] Chapman 2009; Milner 1997.

[8] Mazmanian, Jurewitx, and Nelson 2008, 400–1.

[9] California Office of the Governor, 'Gov. Schwarzenegger Urges World Leaders to Embrace Subnational Leadership in Climate Change Fight', 15 December 2009, available at http://gov.ca.gov/press-release/14034.

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In our general model, two national governments engage in international treaty negotiations. National governments' ideal points and subnational policy patterns jointly determine their preferred international treaty. If many subnational policy makers – provincial governments, city councils, municipal policy makers, etc. – select ambitious policies, national governments that choose lax national and international policies face higher costs: informational benefits, co-ordination failure, inconsistent regulations, costly delay and loss of economies of scale generally favor a harmonization of policies across different (international, national and subnational) levels.[10] This allows subnational policy makers to influence international treaty negotiations by either enacting ambitious policies or strategically lagging behind to prevent progress at the national and international levels. We examine how (and under what conditions) this type of interdependence affects strategic domestic policy making as well as international negotiation outcomes. More precisely, the model allows us to explore how heterogeneity in policy preferences, the number of subnational policy makers, concerns about international treaty outcomes and bargaining power affect international agreements and subnational policy making in multilevel systems.

The comparative statics of our model predict interesting, and often counterintuitive, types of policy balancing and specify the conditions under which they occur. The predictions we derive pertain to both subnational policies and international treaty outcomes. In equilibrium, ambitious subnational policy makers over-regulate, while lagging subnational policy makers under-regulate to strategically achieve a more favorable international treaty. Moreover, the model predicts two novel classes of strategic policy dynamics, which we term within-country and cross-country policy balancing. To our knowledge, previous research has not yet identified these types of strategic policy balancing. By analyzing the linkages between subnational, national and international environmental policy making we provide a theoretical foundation for the growing literature on policy formation in multilevel systems in the context of international policy making efforts[11] and extend research on two-level games[12] that explores when and how domestic politics affect international relations.

INTERNATIONAL POLICY MAKING AND DOMESTIC POLITICS

Thomas C. Schelling's celebrated 'paradox of weakness'[13] holds that a strong domestic opposition may enable an international negotiator to extract greater concessions from her opponent. Ever since this important discovery, scholarship in international relations has acknowledged the impact of domestic factors on international negotiations. Putnam[14] introduces a non-formal 'two-level' game that examines how domestic and international politics interact. The model has two periods. In the first period, two negotiators bargain over an international agreement. In the second period, a domestic actor, typically the legislature, can choose whether or not to ratify the treaty that resulted from international negotiations in Period 1. This may enable the chief negotiator to exploit the strength of being weak: a domestic ratification constraint allows her to successfully demand a more favorable deal by pointing out that less attractive bargains will fail to find domestic support. Greater domestic constraints may therefore constitute a bargaining advantage in

[10] Harstad 2007; Urpelainen 2010.
[11] Betsill and Bulkeley 2004; Meyer and Konisky 2007.
[12] Chapman 2009; Putnam 1988; Tarar 2001.
[13] Schelling 1960.
[14] Putnam 1988.

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international negotiations, a hypothesis that has been termed the *Putnam* or *Schelling conjecture*.

This model has inspired a large number of theoretical and empirical studies.[15] Some have examined whether the Schelling conjecture applies if the chief negotiator can hold an ideal point that diverges from that of her domestic constituents[16] and in cases in which both countries involved in bilateral bargaining face domestic ratification constraints.[17] Other, more specific contributions argue that elections,[18] public opinion[19] and divided government[20] influence success in international bargaining through their effect on the probability of domestic ratification in various policy fields such as trade, security and European integration. The key insight of these models is that domestic actors can, directly or indirectly, shape negotiation outcomes at the international level. We build on this result and examine the case of subnational policy makers. Our findings highlight that domestic actors anticipate the effects of their own behavior on treaty negotiations. This anticipation allows them to strategically adjust their behavior to shape the treaty that national governments ultimately negotiate. As such, the model contributes to the literature on two-level games by focusing on the strategic implications of interactions between the international, national and subnational levels.

INTERNATIONAL POLICY MAKING WITH STRATEGIC SUBNATIONAL POLICY MAKERS

We examine the national and international effects of strategic policy formation at the subnational level. Throughout, we analyze games of complete information, with no uncertainty about preferences and ideal points. To simplify, we assume that there are only two national governments. We do not attempt to construct a multilateral negotiation game, because the dynamics of coalition formation would greatly complicate the solution of the game. This limitation notwithstanding, we believe a simple two-player game can offer insights into how subnational policy makers strategically shape their national policy makers' negotiation positions and the ultimate outcome.

First, we analyze a benchmark two-level game in the spirit of Putnam's original model, in which subnational actors are non-strategic, that is, pure price takers. Secondly, we allow subnational policy makers to choose their regulatory policies, possibly in expectation of or response to international co-operative efforts in the same policy field. By comparing these outcomes, we can analytically isolate the effects of strategic subnational behavior. We define a subnational policy maker as any type of subnational jurisdiction with policy-making authority. Examples are provincial governments, city councils, municipal policy makers or state parliaments. We do not restrict the term 'subnational' to refer exclusively to a specific level between very local and national authorities. Subnational policy makers can be thought of as governing various jurisdictions below the national level.[21]

[15] Chapman 2009; Iida 1993; Mo 1994; Milner and Rosendorff 1997; Schneider and Weitsman 1996; Tarar 2001; Voeten and Brewer 2006.
[16] Mo1994.
[17] Tarar 2001.
[18] Morrow 1991; Schneider and Weitsman 1996; Smith and Hayes 1997.
[19] Bechtel and Tosun 2009; Chapman 2009;Voeten and Brewer 2006.
[20] Milner and Rosendorff 1997.
[21] More generally, subnational actors may be viewed as any type of subnational interest that has preferences for outcomes of international negotiations and actions at their disposal that may have an impact on the distribution of the costs and benefits arising from regulatory policy decisions.

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As we model subnational policy makers, we assume they have at least some, possibly small, interest in international negotiations. Even if subnational policy makers do not fully internalize the global public goods that co-operation produces, this does not imply that they have no preferences regarding the outcomes of international co-operation and the resulting international treaties. First, because some constituencies may prefer multilateralism, electoral accountability induces policy makers to also promote international co-operative efforts. For example, if Californians prefer global climate co-operation, then California's governor has an incentive to enact policies that presumably promote such co-operation. Secondly, international treaties can produce private costs and benefits for concerned actors. For example, the Kyoto Protocol would impose a carbon price on the United States. Thus states that produce a lot of coal would suffer from the Kyoto Protocol. Conversely, states with a lot of potential for solar and wind energy would benefit. This provides incentives for subnational policy makers to care about the international bargains that are struck between national governments.

Our model focuses on situations in which international co-operation between countries with multilevel systems can address a negative externality or provide a global public good. Subnational policy in each country can be set by various actors, for example provincial governments, municipalities or cities.[22] We use this general model to examine how subnational policy makers select such policies in view of the expected international negotiations between national governments. While the model is intended to be general, for concreteness we use environmental politics as an illustrative example throughout the formal analysis.

The Baseline Model: International Diplomacy with Non-strategic Subnational Policy Makers

Following Putnam's original framework, we consider a stylized world with two countries $C \in \{A, B\}$. Each country has two subnational policy makers and one national government. Although considering only two countries is a simplification, we retain this feature of the model for at least two reasons. First, it helps to achieve a minimum degree of comparability between the original benchmark model and our own theory. Secondly, focusing on only two countries appears interesting and empirically relevant since if only two of the world's major GHG emitters such as the United States, India, China, Russia or India were to agree on reducing their emissions, this would have significant effects on the world's climate. Thirdly, in the literature on global climate policies, some advocate that a small set of more ambitious countries should move forward with emission reductions, as this can give rise to positive spillover effects on other countries' climate policy choices.[23] Thus even if we consider smaller emitters, we may think of two countries that could potentially negotiate an ambitious environmental agreement.

The sequence of moves is as follows. First, subnational units simultaneously choose their policies. Secondly, national governments observe these policies and negotiate an international deal. Subsequently, pay-offs are realized. Several reasons justify this sequence of moves. First, international climate negotiations take place only about once a year. Secondly, the real windows of opportunity for progressive treaties appear even less frequently. In fact, the status quo in global climate policy has been subject to few

[22] Birch and Wachter 2008; Kahn 2006; Victor 2011.
[23] Victor 2011.

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significant changes in recent years, which gives subnational policy makers considerable room to implement their own policies. For example, previous work on the enactment of renewable portfolio standards (RPS) in the United States finds that Minnesota enacted the first RPS in 1994, and by 2002 ten states had done so.[24] Even though the United States had not ratified the Kyoto Protocol, and negotiations for a genuinely global climate treaty had not even begun, many states moved forward. By 2007, twenty-nine states had adopted an RPS. Thirdly, most scholars agree that there is little reason to expect a major shift in global climate policy anytime soon. Against the background of sticky global climate policy with a slowly moving status quo, subnational policy makers have time and opportunities to engage in local policies that are environmentally relevant. Fourthly, recent work[25] further highlights the importance of bottom-up initiatives by subnational units in the field of environmental and climate policy. In sum, a theory in which subnational policy makers move first seems the most realistic and relevant approach to modeling the dynamics of local and global environmental policy-making efforts.

A subnational policy maker holds an ideal policy $\theta \in \Theta = \mathrm{R}$. There is one 'brown' ($b$) and one 'green' ($g$) type of subnational unit in each country; the colors refer to these actors' policy bliss points in the sense that $b < g$. Thus a green type (g) prefers a more stringent or ambitious policy level than a brown subnational unit (b). We use the environmental referent for clarity, but we could equally well use such labels as 'high-regulating' versus 'low-regulating', or 'aggressive' versus 'cautious', depending on the specific policy field. We consider extensions in which we allow for an arbitrary number of subnational policy makers and asymmetry in their numbers below.

We allow the national government to take into account the subnational domestic policy structure, that is, the patterns of subnational policy decisions, when setting its own policy and when engaging in international negotiations. Our model then enables us to explore how this interdependence affects subnational policy making and the outcomes of international bargaining. Which specific mechanisms may lead national governments to take into account subnational policy patterns? We can identify three reasons why national governments should negotiate at the international level with an eye toward the subnational policies already in place in their own country. First, according to the empirical literature, subnational policy choices significantly shape the costs and benefits of national public policy decisions. Lutsey and Sperling evaluate the effects of decentralized climate change policies on GHG emissions in the United States and conclude that 'efforts of states and cities are so pervasive at this point that future federal policy will benefit by adopting the most popular and best functioning GHG mitigation programs'.[26] This conclusion suggests that, secondly, subnational policy choices have an informational value since local authorities are typically the first to detect the need for (and experience the consequences of) regulatory policy. Subnational environmental policy programs then provide information to the national government about the necessity and effects of regulatory policy.[27] Thus states tend to lead policy innovation and development because they can more rapidly react to changing conditions and have superior information about the public policy preferences of domestic constituencies.

[24] Lyon and Yin 2010.
[25] Birch and Wachter 2008; Kahn 2006;Victor 2011.
[26] Lutsey and Sperling 2007, 683.
[27] Schaffer 2011.

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Thirdly, domestic policy preferences can help national governments that adjust their own policies to these patterns in international negotiations, as this creates a more unified and coherent bargaining stance. National leaders can refer to the policies of their subnational entities during international negotiations, pointing out that because of these domestic configurations, they can only accept a bargaining outcome that does not interfere with subnational policy patterns. Thus the pattern of subnational policy choices may potentially influence the national policy maker's preferred policy and thereby the outcome of international negotiations. However, the conditions and types of strategic policy choices that result from such interdependencies remain to be explored. We start filling this gap in the literature.

Since the national government of a country C also makes policy decisions with an eye toward its domestic subnational policy patterns, we model its own ideal point in the negotiations, z_C, as reflecting both its own preferred policy y_C and the mean subnational policy $\bar{x}_C$ in country C. More formally, $z_C = \frac{y_C + \bar{x}_C}{2}$, where, in a world with one brown and one green subnational unit in C, $\bar{x}_C = \frac{g+b}{2}$. Thus z_C measures the average de facto policy in C that is a mixture of national and subnational policy decisions. Substantively, the use of the mean value implies that the national government puts equal weight on its own and the subnational preferences. The national government has an initial preference for the level of regulation, but it also incurs, for reasons outlined above, a cost for negotiating treaties that deviate from subnational policies. Therefore, the national government prefers a point between its own initial target regulation and the mean preference of the subnational policy makers. This simple formulation does not account for potentially complex bargaining between national and subnational policy makers, but it does allow actors' preferences on both levels to shape treaty outcomes. This means, for example, that the US federal government would not completely ignore the domestic costs of policy change in different states.[28] This conceptualization of environmental policy choices *can* be interpreted to mean that all actors choose policies on the same environmental policy dimension, but does not need to. Alternatively, one might imagine that each actor chooses policy levels on different dimensions of environmental policy – for example, subnational governments choose environmental safety regulations for local firms or increase the energy efficiency of local public transport, national governments set automobile emission targets and international negotiations decide on broad CO_2 emission levels – but that these dimensions are reducible to a (potentially implicit) underlying environmental protection or climate policy dimension $\Theta \subseteq \mathrm{R}$.

To achieve a higher degree of generality, we do not restrict the set of policies from which policy makers can choose. Applied to a specific political system, the institutional setting may suggest imposing such a restriction, for example, that subnational policy makers' policy choices cannot fall below or above a certain constitutional or national threshold. However, there is no need to restrict our theory to this variant of the model, which merely constitutes a special case of the model we develop. Rather, we formalize the original Putnam model and do not impose any prior restriction on the policy set that

[28] At this point we abstract away from size differences between subnational units that may affect how strongly national governments take them into account when setting policy. Intuitively, smaller subnational units may matter less than larger ones. One could model this by interpreting Z_C as a size-weighted mean, where the weights would reflect relative differences in subnational influences. Due to the linearity of such a functional form, the substantial predictions from our model, which uses the simple average, would remain intact.

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subnational policy makers can choose from. Moreover, it is straightforward that this special case would, by construction, limit the room for strategic policy making by subnational authorities. We elaborate on this further in the online appendix.

The national government's utility function depends on its preferred policy and the international treaty, because the national government's domestic constituents will evaluate this outcome. Formally, we define the utility function as

$$U_C = -(T - z_C)^2, \tag{1}$$

where T denotes the international treaty outcome and z_C is the national government's preferred policy. This utility function reflects the idea that each national government wants the international outcome to be as close to its preferred policy as possible. In line with standard spatial models of politics and Putnam's framework, we assume that T is a convex combination of the national governments' policies and that the bargaining range is non-empty. The treaty outcome may be interpreted as the result of a Rubinstein-Stahl alternating offers bargaining with infinite horizon, as long as offers can be made fast enough.

A subnational policy maker θ in country C holds the utility function

$$U_{C,\theta} = -(x_{C,\theta} - \theta)^2, \tag{2}$$

where $x_{C,\theta}$ denotes the subnational policy in country C set by a θ-type policy maker. In our benchmark model, a subnational policy maker will maximize its utility by setting $x^*_{C,\theta} = \theta$. This choice of policy is clearly non-strategic, as the subnational policy maker does not choose the subnational policy in a way that anticipates the subsequent international treaty negotiation outcome.

Given this benchmark model, countries will agree on the treaty $T^* = \frac{z_A + z_B}{2}$ and given our definition of the national governments ideal policy, $z_C = \frac{y_C + (\frac{g+b}{2})}{2}$, we can rewrite the resulting treaty as $T^* = \frac{1}{4}(b + g + y_A + y_B)$. In this model, subnational policies remain unaffected by the expectation of international treaty negotiations. Although they feed into the international treaty outcome, subnational policy makers do not take into account that their own policy choices, and those of other subnational units in A and B, may matter for international treaties through their impact on national policy choices.

According to this benchmark model, the effect of subnational policies on international negotiations is direct. The national government surveys the set of subnational policies and tries to achieve a negotiation outcome that is close to the country's average subnational policy. Since the average subnational policy is also the average ideal policy among subnational policy makers, the national government merely collects the preferences of non-strategic actors when forming a bargaining position in international negotiations.

Strategic Subnational Policy Makers

The baseline model ignores the sequential nature of policy making and views subnational actors as mere price takers. This means that subnational policy makers disregard how their own policy choices may affect treaty outcomes through their impact on national policy choices. We now relax this assumption while trying to maintain as many features of the baseline model as possible. We start by assuming that a subnational policy maker θ in country C holds the following utility function:

$$U_{C,\theta} = -(x_{C,\theta} - \theta)^2 - \beta_\theta(T - \theta)^2, \tag{3}$$

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where the weight $\beta_\theta \in (0,1)$ indicates how much a subnational policy maker takes into account the difference between the policy set by the international treaty and its own ideal policy. Technically, the subnational policy maker is simultaneously minimizing two loss functions along the same dimension. In the environmental case, for instance, international policy may have more power to mitigate the adverse effects of global environmental problems, such as climate change, than a subnational government's own policy. The weighting factor β_θ may also be interpreted as an exposure factor that captures how much changes in international policy affect subnational policy makers. In the initial set-up of the model, we set β_θ to 1, and consider extensions below.

Let us first examine a situation with equally powerful national governments in which each government brings its own national policy to the international negotiations. This constitutes a strong simplification that we find acceptable because our focus is on strategic subnational policy making. Power asymmetries in international bargaining are straightforward to include, however, and we will do so when considering extensions to our initial set-up below.

We start at the international negotiations stage to solve for the unique subgame-perfect equilibrium to this game.[29] Given power symmetry, the outcome of the international negotiations is $T^* = \frac{z_A + z_B}{2} = \frac{\bar{x}_A + y_A + \bar{x}_B + y_B}{2}$. A green subnational policy maker in country A then chooses the optimal subnational policy to maximize her utility (Equation 3). With four subnational policy makers, such choices induce a system of four first-order conditions. All subnational policy makers' utility functions are strictly concave in the choice variables, so solving this system of equations produces a unique equilibrium, in which $x^*_{A,g}$ equals

$$arg\,max_{x_{A,g}}\, U_{A,g} = \frac{1}{272}(297g - 9b - 8y_A - 8y_B). \tag{4}$$

Since the set-up is symmetric, Equation 4 also characterizes the optimal subnational policy for a green subnational policy maker in country B. Let us focus on a green subnational policy maker to illustrate how policy choices – and the ideal points of the other actors – affect its optimal subnational policy. The optimal subnational policy depends on four factors: the subnational policy maker's own ideal policy, the brown subnational policy maker's ideal policy, and the ideal points of the national government in countries A and B. For a green subnational policy maker, its own ideal policy plays the most important role, as can be seen from the coefficient on g in Equation 4. In this sense, g represents a push factor, since the greener its ideal policy, the higher the optimal subnational policy. Its optimal subnational policy, however, decreases in all other three variables, which represent pull factors. A green subnational policy maker will choose a lower policy level if brown subnational policy makers and the national governments in A and B prefer higher policies.

This solution already illuminates some of the complex interactions in international policy making, and how these relate to subnational policy choices. Most importantly, Equation 4 highlights the role of strategic policy making on the part of subnational policy makers in the context of policy spillover effects. At the national and global levels, subnational policy makers strategically choose their policies to support or counteract choices by other political actors. Even if we assume that the resulting international treaty will override any existing subnational policy decisions, there would still be an incentive

[29] For the formal solution, see the Appendix.

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for subnational authorities to engage in strategic policy making as long as national governments are not completely ignorant of these regulatory decisions within their own country.

EXTENSIONS: ASYMMETRIC BARGAINING POWER, EXPOSURE AND THE NUMBER OF SUBNATIONAL POLICY MAKERS

In the previous section, we solved a simple baseline model to identify strategic considerations that influence subnational policy formation: green subnational policy makers strategically over-regulate to 'pull' the treaty outcome up, while brown subnational policy makers under-regulate to bring it down. We now extend the model to investigate how changes in exogenous parameter values influence policy outcomes across levels. We explore the role of three key factors: bargaining power, exposure to international policy outcomes and the number of subnational policy makers. These extensions produce several comparative static results that provide a foundation for empirical hypothesis testing.

Asymmetric Bargaining Power

So far, we have assumed that the two national governments 'split the difference' in treaty negotiations. In reality, however, one country may have greater bargaining power. To investigate this issue, we now use a modified treaty outcome expression:

$$T^* = z_A + z_B = p\left(\frac{\bar{x}_A + y_A}{2}\right) + (1-p)\left(\frac{\bar{x}_B + y_B}{2}\right). \tag{5}$$

In this function, $p \in (0,1)$ measures the bargaining power of country A relative to country B. As p increases, so does the ability of country A to dictate the terms of the treaty.[30]

Bargaining power p and national preferences y_A,y_B notwithstanding, the game is still symmetric. Consequently, we can focus on subnational policy makers in country A without loss of generality. Solving the augmented model yields subnational equilibrium policies $x^*_{A,b}$, $x^*_{A,g}$. The mathematical expressions are somewhat complex, so they are relegated to the Appendix. However, the basic insights of the simple symmetric model remain intact. Subnational policy makers in each country not only consider their own ideal points, but also understand that they can influence the international treaty by strategically selecting their subnational policies.

How does the bargaining power of country A change the subnational policies $x^*_{A,b}$ and $x^*_{A,g}$? To answer this question, each equilibrium strategy must be differentiated with respect to country A's bargaining power p. For the resulting proposition, the critical values V^*_b, V^*_g play a key role.[31] These values constitute cut-off points that determine changes in bargaining power have a positive or negative effect on the subnational policies that green and brown policy makers set. Thus we need to investigate cases depending on the alignment of preferences between different actors.

[30] The parameter p could be derived from the Nash bargaining solution (Nash 1950) or a Rubinstein bargaining game (Rubinstein 1982) with time preferences as the key parameter.

[31] Since these values have somewhat complex expressions, we have moved them to the Appendix to simplify the exposition.

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PROPOSITION 1 (Bargaining Power): An increase in country A's bargaining power p causes an increase in the optimal policy of green subnational authorities, $x^*_{A,g}$, if and only if $b > V^*_g$ and a decrease in the optimal policy of brown subnational authorities $x^*_{A,b}$, if and only if $g < V^*_b$.

Proof: see Appendix. ■

Table 1 summarizes the full set of analytical results. Depending on the exact preference configuration, different scenarios arise in which an increase in country A's bargaining power triggers specific patterns of optimal policy choices. We focus on the most interesting configuration of preferences, which is the 'Conflict' scenario (first row in Table 1). In this case, green subnational policy makers in each country are aggressive enough, and thus push for an ambitious international treaty. Therefore a shift in bargaining power from country B to country A, measured as an increase in p, will make the brown policy maker more aggressive in country A. It will therefore set an even more lax policy. Thus greater national bargaining power increases the incentive to shape the international treaty through a strong commitment to a brown policy under these conditions. An increase in national bargaining power raises the stakes, and hence strengthens the relative importance of strategic under-regulation. Similarly, the green policy maker responds to an increase in national bargaining power by over-regulating, so as to shift the negotiation balance toward an increasingly ambitious treaty. In other scenarios, subnational policy makers in country A respond to an increase in their countries' bargaining power toward the other country by both resorting to strategically green policies – that is, environmental policies that are more strict than what they would implement in the absence of international diplomacy.

Analytically, we are interested in how the cut-offs V^*_b and V^*_g vary. Sections A.2 and A.3 in the Appendix report the corresponding mathematical analysis. In the most interesting scenario, the effect of increasing country A's bargaining power is always more likely to decrease $x^*_{A,b}$ and increase $x^*_{A,g}$, thus inflating brown subnational policies and deflating green ones, when national government A's preference y_A for regulation grows. This follows from country A demanding over-regulation in any case, so the need to influence its own position through subnational action falls for green subnational policy makers but increases for brown subnational policy makers. Thus subnational policy makers behave strategically, especially when their own national government is hostile.

By contrast, country B's preferences y_B have an ambiguous effect on the cut-off. If country B is powerful, so that $p < 1/2$, then the effect is identical to that of country A. But if country B is weak, so that $p > 1/2$, then the effect is the opposite. This counterintuitive result stems from the indirect interdependence between the subnational levels. If country B is powerful, an increase in p can be thought of as a shift of responsibility from subnational policy makers in country B to subnational policy makers in country A. But if country B is already weak, then an increase in y_B has a positive impact because a green policy maker in country A also increases its efforts to influence treaty outcomes, and this triggers a race between green and brown subnational policy makers to affect the international bargain.

These results show that changes in bargaining power may have a complex effect on subnational policies. An intense struggle over the international treaty between green and brown policy makers in combination with an increase in bargaining power leads subnational authorities to adopt extreme policies. But if the struggle is not intense, exactly

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TABLE 1 *The Effects of Bargaining Power on Subnational Policy Making*

Scenario	Configuration		Effect on subnational policies			
			In country A		In country B	
			Brown ($x_{A,b}$)	Green ($x_{A,g}$)	Brown ($x_{B,b}$)	Green ($x_{B,g}$)
Conflict	$g < V_b^*$	$b < V_g^*$	−	+	+	−
Green	$g > V_b^*$	$b < V_g^*$	+	+	−	−
Brown	$g < V_b^*$	$b > V_g^*$	−	−	+	+
Reverse	$g > V_b^*$	$b > V_g^*$	+	−	−	+

Note: the table shows the direction of the effect of an increase in the bargaining power of country A on subnational policy choices in each country, conditional on the location of the ideal points of brown (b) and green (g) national governments units relative to the critical values V_b^* and V_g^*.

the opposite may occur, as subnational policy makers in powerful countries can expect that the international negotiations will produce an outcome that is close to their ideal points even if they fail to adopt extreme subnational policies.

This latter mechanism seems to help better understand multilevel environmental policy dynamics in federal systems. For example, about half of all Americans live under some form of subnational climate policy to reduce emissions, while the other half has decided to do comparably little or nothing to mitigate global warming.[32] It is exactly in such circumstances, under an intense struggle over the broad contours of national policy, that countries with substantial bargaining power should experience starkly diverging subnational policies. Thus our model partly sheds light on why many US states have not done anything to mitigate global warming, while others, notably California and the Northeastern alliance of ten states for the Regional Greenhouse Gas Initiative, are substantially reducing emissions.[33] Equally notable, these dynamics are consistent with the fact that the United States has not been particularly enthusiastic about climate co-operation. One might intuitively expect that subnational policy makers have strong incentives to act when an international treaty seems feasible. However, our results show that high-regulating policy makers have the strongest incentives to influence their national government if it is hostile to international co-operation.

Importance of International Treaty Outcomes to Subnational Policy Makers

The initial set-up allows subnational policy makers to hold different ideal policies, but it assumes that they care as much about international bargains as they care about their own subnational policy choices. Several factors can influence how much subnational policy makers care about international policies, however. For example, some environmental problems (climate change, ozone depletion) are more global than others (waste management, water conservation), so an environmental treaty will be more important than a subnational environmental policy. In other cases, subnational policy makers may also care more or less strongly about the international policy outcomes to the extent they are affected by the resulting trade and investment patterns.

[32] Lutsey and Sperling 2007.
[33] Rabe 2004.

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To examine the effects of such variation across co-operation problems, we now allow subnational policy makers to attach varying weights to the international treaty. We explore how this affects their subnational policy choices.[34] More precisely, we explore how an increase in exposure to (or concerns about) international policies affects strategic policy making at the subnational level. To simplify the problem, let $\bar{y}$ denote the symmetric mean ideal policy of national governments. Consider brown subnational policy makers first.

PROPOSITION 2 (International Exposure and Brown Subnational Policy Choices): Let $D_b^* := \frac{24b - 8g + b\beta_b - g\beta_g}{8}$. If $\bar{y}\ D_b^*$, an increase in exposure of a brown subnational policy maker, $\beta_{C,b}$, increases the optimal policy for a brown policy maker. If $\bar{y}\ D_b^*$, an increase in exposure decreases the optimal subnational policy.

PROOF: see Appendix. ■

Proposition 2 implies that an increase in exposure to the effects of international policy can move the optimal policy of brown policy makers in two directions. If average ideal policies fall below the threshold D_b^*, higher exposure will induce brown subnational authorities to implement a higher policy. But if the average policy preferred by national governments exceeds the critical value, brown policy makers will strategically set lower subnational policies. The threshold varies as a function of the difference between brown and green ideal policies at the subnational level. The threshold will increase as the green policy maker's preferred subnational policy increases, and will decrease as the brown policy maker's ideal policy gets greener. Since the set-up is still symmetric with respect to subnational policy makers in *A* and *B*, this result holds for all brown policy makers, irrespective of whether they belong to country *A* or *B*.

PROPOSITION 3 (Exposure and Green Subnational Policy Choices):Let $D_g^* := \frac{24g - 8b - b\beta_b + g\beta_g}{8}$. An increase in exposure of a green subnational policy maker, $\beta_{C,g}$, increases the optimal subnational policy for a green policy maker if $\bar{y} > D_g^*$, and decreases the optimal subnational policy if $\bar{y} < D_g^*$.

PROOF: see Appendix. ■

Exposure to the effects of international policy can again move the subnational optimal policy of brown policy makers in two directions. The direction depends on how 'green' national governments are, on average, in relation to the ideal point heterogeneity that characterizes subnational policy makers. The threshold D_g^* decreases (increases) if the policy preferred by brown (green) policy makers increases. Differences in the international orientation of subnational policy maker types give rise to interesting patterns of strategic subnational policies (see Table 2).

These results suggest that subnational policy makers often justify climate policies by highlighting their vulnerability to global warming. According to standard public goods theory, such concerns should be largely irrelevant, because no individual subnational

[34] We ignore the degenerated case in which the subnational policy maker only cares about its own subnational policy ($\beta_\theta = 0$).

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TABLE 2 *The Effects of Exposure to International Treaty Outcomes on Subnational Policy Making*

National preferences		Effect on subnational policies	
		$x_{C,b}$	$x_{C,g}$
$\bar{y} > D_b^*$	$\bar{y} > D_g^*$	+	−
$\bar{y} > D_b^*$	$\bar{y} < D_g^*$	+	+
$\bar{y} < D_b^*$	$\bar{y} > D_g^*$	−	−
$\bar{y} < D_b^*$	$\bar{y} < D_g^*$	−	+

Note: the table shows the direction of the effect of an increase in exposure to international treaty outcomes on subnational policy choices. $\bar{y}$ denotes the mean ideal policy preferred by national governments. D_b^* and D_g^* denote thresholds as defined in Propositions 2 and 3.

policy maker can change the rate of global warming in the absence of co-operation with others. If some subnational policy makers believe their leadership efforts can change national policies, however, vulnerability to climate change creates a strategic incentive to nonetheless select more ambitious subnational policies.

Multiple Subnational Policy Makers

In the initial set-up we restricted the number of subnational policy makers to two. In reality, multilevel political systems have more than two subnational policy makers, particularly if we consider large countries whose environmental policy choices may have global effects on the environment. We now consider an extension of the model with an arbitrary, finite number of subnational policy makers. To make the model even more general, we relax the assumption that the number of green subnational policy maker types equals the number of brown subnational policy makers, and we allow for different numbers of brown and green policy makers in the two countries A and B. Since the number of certain subnational policies changes the measure of subnational policy patterns, $\bar{x}_C$, the model now allows for a situation in which there might be effective strength in numbers.

To study how this affects policy makers' strategic policy decisions at the subnational level, we have to introduce some additional notation. Let $M_C \in N$ denote the number of subnational policy makers in country C, and $M_{C,\theta}$ is the number of θ-type subnational policy makers in C. To find the optimal subnational policy, we need to consider the outcome of international negotiations separately for each subnational policy maker type. For concreteness, we focus on subnational policy makers in country A.[35] We express the number of green subnational policy makers in terms of the total number of subnational policy makers and the number of brown policy makers, that is, $M_{A,g} = M_A - M_{A,b}$. For a brown subnational policy maker in country A, the international treaty outcome is given by $T_{A,b}$, a modified treaty expression that can be found in Section A.5 of the Appendix. Treaty outcomes for green policy makers and country B are characterized analogously.

We are interested in whether and how the number of brown and green subnational policy makers in A and B affect public policy at the subnational level. Therefore, we first

[35] Because the setup is symmetric, the results hold for both countries.

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solve for the optimal subnational policy. We explore how the optimal policy of a brown subnational policy maker in country A reacts to an increase in the number of brown subnational authorities and an increase in the number of green policy makers by partially differentiating the optimal policy with respect to $M_{A,b}$ and $M_{A,g}$.

The subnational optimal policy is $x^*_{A,b}$, a relatively complex mathematical expression that can be found in Section A.5 of the Appendix. First, we note that according to this expression, the policy choice by a brown subnational policy maker in A now depends on the total number of subnational policy makers and the number of brown and green subnational policy makers in both country A and country B. Therefore the distribution of brown and green subnational policy makers in both countries affects strategic policy decisions at the subnational level. This transboundary interdependence follows from national governments bringing subnational policy choices to international treaty negotiations, thereby indirectly connecting their domestic arenas.

How does the number of brown and green policy makers impinge on a subnational policy maker's optimal policy choice? To answer this question, we hold the total number of subnational policy makers in country A, namely M_A, constant. Specifically, how do optimal subnational policies change if one brown policy maker is replaced by a green policy maker? We find that

$$\frac{\Delta x^*_{A,b}}{\Delta M_{A,b}} - \frac{\Delta x^*_{A,b}}{\Delta M_{A,g}} = \frac{(g-b)(4M_A+1)M_B}{4M_A^2(M_B+M_A(1+16M_B))}, \tag{6}$$

and that similar changes in the other country prompt

$$\frac{\Delta x^*_{B,b}}{\Delta M_{B,b}} - \frac{\Delta x^*_{B,b}}{\Delta M_{B,g}} = \frac{(g-b)(4M_B+1)M_B}{4M_B(M_B+M_A(1+16M_B))}. \tag{7}$$

Since $(g - b) > 0$, the expressions in Equations 6 and 7 are positive. Thus, a brown subnational policy maker will set a greener policy if the proportion of other brown subnational policy makers in either country increases. The reason is that as the number of brown subnational policy makers increases, their collective ability to influence the international treaty negotiations grows. Thus each individual brown policy maker has fewer incentives to strategically manipulate the treaty, and so they all focus more on reducing the distance between their subnational policies and ideal points.

The result is identical for green subnational policy makers. If the number of brown subnational policy makers increases, greens have greater incentives to choose aggressive subnational policies to compensate for the loss of collective bargaining power in the international treaty negotiations. We summarize this as follows:

PROPOSITION 4 (Multiple Subnational Policy Makers): If a green (brown) subnational policy maker is replaced in either country by a brown (green) subnational policy maker, all subnational policy makers select a greener (browner) policy.

PROOF: The effects of replacing one policy maker with another of the opposite color (Equations 6 and 7) can be derived from the equilibrium analysis of the model (see Appendix). To characterize the sign of the effect, see the main text for $x_{A,b}$. The proof for $x_{A,g}$ is analogous. By symmetry, all results hold for $x_{B,b}$,$x_{B,g}$. ■

Applied to environmental policies, this logic implies that subnational policy choices may ultimately feature the following balancing dynamics: if the number of brown

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subnational policy makers increases, perhaps due to the increased production of fossil fuels or energy-intensive manufacturing goods, green policy makers elsewhere have an incentive to respond by ramping up their regulatory efforts. Conversely, if some subnational policy makers become greener, the brown policy makers will respond by doing even less to protect the environment. In view of this observation, it may not be surprising that the greening of certain constituencies in Europe and the United States has not created enough momentum to allow their leaders to form an alliance for a comprehensive international environmental treaty.

EXTENSIONS AND EMPIRICALLY FALSIFIABLE IMPLICATIONS

To facilitate subsequent empirical research and falsification attempts, we summarize the most important empirical predictions and offer some ideas for operationalizing key concepts. Some of the hypotheses we state rely on extensions of the basic model. Due to space constraints, we can only provide informal statements and intuitive arguments for these. The online appendix discusses these extensions along with possible limitations.

Our first prediction is that subnational policy makers in each country will attempt to affect international negotiations by strategically setting their own subnational policies higher or lower than they would without such negotiations. Such strategic behavior is sequentially rational because it moves the international bargain toward their own ideal point. If subnational units prefer a less strict international agreement than their own government prefers – assuming that the foreign government's ideal outcome is more strict – it will set even lower subnational regulations.

This causal mechanism should, for example, prevail in the case of bargaining between two countries where subnational policy makers in one country have the authority to set their own policies in that policy field, but not in the other country. In this scenario, subnational policy makers' behavior in terms of policy making should help to explain the international bargain. We focus on low-regulating (brown) subnational policy makers, that is, governments that prefer a relatively low level of (international) regulation. The same logic holds for subnational policy makers that prefer higher levels of regulations than national governments. This gives rise to several strategic balancing dynamics, which the following hypotheses summarize.

HYPOTHESIS 1 (Strategic Subnational Policy Making and the International Bargain): An increase in the number of low-regulating subnational policy makers decreases the level of policy set by the international agreement.

The analogous hypothesis holds for high-regulating subnational policy makers. While this hypothesis would also follow from a non-strategic model that does not involve strategic interaction, its full implication becomes apparent when compared to the prediction of our non-strategic (Putnam) benchmark model. With strategic subnational units, the decrease in the international policy that results from an increase in the number of low-regulating subnational units is greater than in the benchmark model. Both hypotheses seem broadly consistent with the evolution of climate negotiations, for example. Europe's willingness to engage in climate co-operation has steadily increased as policy makers across multiple levels – from municipalities to provinces and nation states – have enacted climate and clean energy policies.[36] The US position has, by contrast,

[36] Schreurs and Tiberghien 2007.

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fluctuated considerably. To explain differences in the negotiation behavior of US and European national governments, our model points to this heterogeneity in subnational policy preferences in the United States and Europe. The available literature documents high variation in subnational policies across localities in Europe and the United States.[37] Many US cities have joined the US Mayors' Climate Protection Agreement to initiate local environmental protection efforts that ultimately induce national and international policy change.[38] However, many other cities seem to hold conservative environmental policy preferences. We expect this domestic distribution of subnational policy preferences to be a useful predictor of national policy choices and international bargains.

The following two hypotheses concentrate on the effects of changes in national-level preferences with respect to the international bargain on public policy decisions at the subnational level:

HYPOTHESIS 2 (Within-country Subnational Policy Balancing): An increase in the international outcome preferred by the national government decreases the level of policy set by the low-regulating subnational policy maker.

HYPOTHESIS 3 (Cross-country Subnational Policy Balancing): An increase in the international outcome preferred by the national government in the foreign country decreases the level of policy set by the low-regulating subnational policy maker.

These hypotheses provoke the question of how to measure policy makers' preferences and when to classify them as green or brown. We can think of several possibilities. Research can use the increasingly nuanced measures of parties' ideal policies based on a coding of party manifestos,[39] quantitative text analyses[40] or expert judgments.[41] Current research on party competition and parties' ideal policies also provides ideal point estimates of subnational parties on various issue dimensions.[42]

Strategic balancing does not stop at national borders, or occur solely in response to national governments' policy choices. Rather, subnational policy makers in both countries know that they engage in strategic policy balancing. Thus changes in the distribution of high- and low-regulating governments at the subnational level in either country will influence subnational policies in both countries. We again focus on the low-regulating subnational policy makers, since an analogous hypothesis straightforwardly follows for high-regulating subnational policy makers.

HYPOTHESIS 4 (Policy Balancing and Domestic Subnational Policy Makers): An increase in the number of high-regulating subnational policy makers in a country decreases the level of policy set by the low-regulating subnational policy maker in that country.

Clearly, nothing in our theory limits this mechanism to take place only within a country. International bargaining links subnational policy levels in all countries

[37] Andonova and Mitchell 2010; Kern and Bulkeley 2009.
[38] Schaffer 2011.
[39] Budge et al. 2001.
[40] Laver, Benoit, and Garry 2003.
[41] Benoit and Laver 2006.
[42] Bäck et al. 2010.

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participating in the negotiations, which gives rise to transboundary strategic subnational policy:

HYPOTHESIS 5 (Policy Balancing and Foreign Subnational Policy Makers): An increase in the number of high-regulating subnational policy makers in the foreign country decreases the level of policy set by the low-regulating subnational policy maker.

Hypotheses on the Role of Bargaining Power Imbalances

The model also generates hypotheses on how bargaining asymmetries affect subnational policy making and international treaty formation. We again restrict attention to a set-up in which low-regulating subnational policy makers prefer an outcome that is lower than their national government's preferred agreement and assume that the foreign national government would like to strike a relatively high-regulating bargain. We have to additionally qualify these predictions because the theory suggests power asymmetries to moderate the incentive to strategically over- or under-regulate, which gives rise to conditional relationships. The hypotheses also specify the critical conditions that must be met in order for the prediction to follow from the formal model. Although this makes the hypotheses more complex, precisely identifying these conditions constitutes one of the key strengths of formal modeling and may also make these predictions more fruitful for future empirical research.

HYPOTHESIS 6 (Low Power Imbalances): An increase in a country's relative bargaining power increases the level of policy chosen by low-regulating subnational policy makers if high-regulating subnational policy makers prefer sufficiently high levels of environmental regulation.

Suppose high-regulating subnational policy makers are relatively aggressive, and push hard for a stringent treaty. Under relatively symmetric bargaining capabilities, low-regulating subnational policy makers strategically under-regulate to prevent their national government from conceding too much in the negotiations. As this government becomes more powerful, the need to do so decreases and the low-regulating subnational policy makers shift their policies toward their bliss policy θ.[43] The converse, of course, applies to high-regulating subnational policy makers. An interesting implication of this observation pertains to China's rising importance in international regulatory politics. As China's bargaining power increases, subnational policy makers with an interest in stringent regulation may choose to increase their efforts in Europe and the United States. If strategic considerations play a role in policy formation, then a power shift in favor of China will amplify the strategic value of subnational policies in other industrialized countries.

CONCLUSION

Many of the most pressing global challenges cannot be solved without international co-operation. The observable co-operation between governments to address, for example, environmental issues such as air pollution, global warming or biodiversity loss may vary in degree and resolution. Yet national governments' efforts to regulate the global

[43] Recall that a subnational actor's type refers to its policy bliss point. See Equation 2.

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commons at least indicate some awareness of the fact that transboundary challenges need to be addressed through transboundary political action. At the same time, however, we observe a proliferation of subnational environmental regulation directed toward global environmental problems, despite the presumably negligible direct effect of these subnational efforts on the global environment.

Our theory views this phenomenon as the result of strategic subnational policy makers acting prior to international policy efforts, which we have studied in a stylized world with two countries, each consisting of a national government and several subnational policy makers with different policy preferences. In each country subnational policy makers have either a preference for low policies (brown subnational policy makers) or prefer relatively strict policies (green subnational policy makers). Subnational policy makers set a policy observed by the national government. The national governments then engage in international bargaining over an international treaty. The negotiations result in a treaty that sets a policy at the international level.

We have examined how bargaining power, exposure to international outcomes and the number of subnational policy makers affect strategic subnational policy making in the shadow of international negotiations and the resulting international bargain. First, the results suggest that exposure to international treaty outcomes can affect subnational policy decisions in two opposite ways. If average ideal policies fall below a certain threshold, higher exposure induces brown subnational policy makers to implement a higher level of policy. But if the average policy preferred by national governments exceeds a critical value, subnational policy makers strategically set lower policies.

Secondly, given a minimum level of conflict over the international treaty, green and brown subnational policy makers react to increased bargaining power by adopting more extreme public policies. If the struggle remains mild, subnational policy makers in powerful countries can expect that the international negotiations will produce an outcome close to their ideal points even if they fail to adopt extreme subnational policies. Thirdly, if the number of brown subnational policy makers increases, their policy choices will receive more weight in the international negotiations, and this provides an incentive to implement a greener policy to ensure that the treaty outcome will not fall below what brown policy makers actually prefer.

These stylized dynamics illuminate some of the complex interactions and patterns of policy formation at the subnational level, where policy decisions may be understood as cross- and within-country balancing dynamics by strategic subnational authorities that aim to counterbalance other actors' policy influences. The model suggests that parallel policy changes may arise through strategic policy changes intended to offset policy relevant shifts in, for example, the number of subnational policy makers that shares the same ideal policy. Moreover, international negotiations – and the transboundary nature of many regulatory problems – link subnational policy decisions in different countries, giving rise to transboundary policy-balancing efforts in the shadow of international negotiations. Although we have used environmental politics to motivate our model and illustrate some of its results, the vast literature on global governance suggests that the theory has the potential to extend to many other policy fields, for example international labor standards, food safety, consumer protection policies, and the regulation of services and patents.

We have analyzed a model that allows for subnational units with different ideal points to implement policies that reflect strategic considerations pertaining to national and international regulatory efforts. Yet this model has abstracted away from explicitly

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modeling electoral considerations and the role of interest groups.[44] However, we acknowledge that subnational policy makers may respond to their constituencies, and campaign contributions could lead them to deliver policy favors to special interest groups. Similarly, our model focuses on policy formation. Examining the effectiveness of subnational policies would require an extended version of the model we have analyzed. Finally, while we have assumed perfect information, subnational actors may exploit information asymmetries to derail international negotiations. We leave it to subsequent research to integrate arguments about the formation of policy makers' ideal points, policy effectiveness and the existence of information asymmetries into the model we have presented here.

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[44] The online appendix provides a more detailed discussion of a large number of extensions and several limitations.

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1 APPENDIX

A.1 Equilibrium Analysis

This is an extensive form game with complete information. A subgame-perfect Nash equilibrium of the game is a set of actions by green and brown subnational policy makers that are best responses, given the other type of subnational governments and the international treaty.

We solve for the subgame-perfect Nash equilibrium (SPNE) of the game for an arbitrary (but finite) number of subnational policy makers in each country by backward induction. Recall that subnational governments move first, and that national governments will then negotiate a treaty. Thus we can find the SPNE by first characterizing the international treaty and then solve for the optimal subnational policy choices given the treaty outcome.

The international treaty is given by

$$T^* = z_A + z_B = \left(\frac{\bar{x}_A + y_A}{2}\right) + \left(\frac{\bar{x}_B + y_B}{2}\right). \tag{8}$$

We directly generalize this to a setting with more than two subnational governments. Let $M_{C,b}$ denote the number of brown subnational policy makers in country C. Let M_C denote the total number of subnational policy makers in country C. Thus$M_C - M_{C,b}$ is the number of green subnational policy makers in country C. In the equilibrium analysis, we allow β_θ to obtain any value for generality.

Without loss of generality, let us focus on a green government in country A and rewrite the treaty from the perspective of a green subnational government in country A:

$$T^*_{A,g} = \frac{1}{2}\left(\frac{x_{A,b}M_{A,b} + x_{A,g} + x_{A,g}(M_A - M_{A,b} - 1)}{M_A} + y_A + \frac{x_{B,b}M_{B,b} + x_{B,g}(M_B - M_{B,b})}{M_B} + y_B\right), \tag{9}$$

where $x_{A,g}$ is the equilibrium policy set by other green governments in country A. Reversing the subscripts A and B yields the treaty from the perspective of a green government in country B. An analogous expression can be derived for brown policy makers in each country.

We now need to solve for the policy $x_{A,g}$ that maximizes the subnational policy maker's utility. The first-order condition with respect to the choice variable is

$$-2(x_{A,g} - g) - 2\beta_g(T - g)\frac{\partial T(\cdot)}{\partial x_{A,g}} = 0. \tag{10}$$

To solve for the explicit value of the equilibrium in the main model, simply let $M_A = M_B = 2$, $M_{A,g} = M_{B,g} = 1$ and choose b,g. Insert b,g into the four first-order conditions and find the equilibrium values using matrix inversion or Cramer's rule. This yields the best response in the main text. That is, $x^*_{A,g} = \frac{1}{272}(297g - 9b - 8y_A - 8y_B)$ (see Equation 4). The best responses for brown subnational actors can be derived analogously. This set of best responses constitutes the subgame-perfect Nash equilibrium of this game.

A.2 Equilibrium Subnational Policies Under Asymmetric Bargaining Power

To obtain the equilibrium of the asymmetric bargaining power game, use Expression 5 for the treaty outcome. This gives the following utility function for a subnational policy maker:

$$U_{C,\theta} = -(x_{C,\theta} - \theta)^2 - \beta_\theta\left(p\left(\frac{\bar{x}_A + y_A}{2}\right) + (1 - p)\left(\frac{\bar{x}_B + y_B}{2}\right) - \theta\right)^2. \tag{11}$$

In equilibrium, the following first-order condition must hold for the brown and green subnational policy makers in both countries:

$$-2(x_{C,\theta} - \theta) - \beta_\theta(T - \theta)\frac{\partial T(\cdot)}{\partial x_{C,\theta}} = 0. \tag{12}$$

This yields a system of four equations that can be solved for a unique equilibrium, given that there are exactly four unknowns, by inverting the matrix describing the linear system.

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For a brown subnational policy maker in country A, this yields

$$x^*_{A,g} = \frac{(gp(-9-2(-1+p))]}{16(33+2(-1+p)p)^2} + \frac{b(528+p(25+2p(15+p)))}{16(33+2(-1+p)p)^2} + \frac{16p(-py_A+(-1+p)y_B)}{16(33+2(-1+p)p)^2}. \tag{13}$$

For a green subnational policy maker in country A, we have

$$x^*_{A,g} = \frac{(bp(-9-2(-1+p))]}{16(33+2(-1+p)p)^2} + \frac{g(528+p(25+2p(15+p)))}{16(33+2(-1+p)p)^2} + \frac{16p(-py_A+(-1+p)y_B)}{16(33+2(-1+p)p)^2}. \tag{14}$$

The expressions for country B are symmetric with respect to A,B,p.

A.3 Proof of Proposition 1

To obtain Equations 14 and 13, proceed as described in the equilibrium analysis of the asymmetric bargaining power game above. This yields a full characterization of the equilibrium behavior of the game.

To obtain the critical values, we first need to obtain $\frac{\partial x^*_{A,b}}{\partial p}$ and $\frac{\partial x^*_{A,g}}{\partial p}$. The sign of the relevant derivative changes as the critical value is crossed. To do this, differentiate Equations 14 and 13 with respect to p to obtain $\frac{\partial x^*_{A,b}}{\partial p}$ and $\frac{\partial x^*_{A,g}}{\partial p}$, respectively. These are given by:

$$\frac{\partial x^*_{A,b}}{\partial p} = \frac{b(1881+4p(-33+p(22+(-2+p)p)))}{16(33+2(-1+p)p)} + \frac{g(-297-4p(-33+p(46+(-2+p)p)))}{16(33+2(-1+p)p)} + \frac{32(-33+p)py_A+528(-1+2p)y_B}{16(33+2(-1+p)p)} \tag{15}$$

$$\frac{\partial x^*_{A,g}}{\partial p} = \frac{b(1881+4p(-33+p(22+(-2+p)p)))}{16(33+2(-1+p)p)} + \frac{g(-297-4p(-33+p(46+(-2+p)p)))}{16(33+2(-1+p)p)} + \frac{32(-33+p)py_A+528(-1+2p)y_B}{16(33+2(-1+p)p)} \tag{16}$$

Begin with the brown policy maker. Here, Equation 15 gives $\frac{\partial x^*_{A,b}}{\partial p}$. Setting it to zero and solving for g, we obtain V^*_b:

$$V^*_b = \frac{b(1881+4p(-33+p(22+(-2+p)p)))+32(-33+p)py_A+528(-1+2p)y_B}{297+4p(-33+p(46+(-2+p)p))}. \tag{17}$$

Now verify by inspecting $\frac{\partial x^*_{A,b}}{\partial p}$ that whenever the value of g is lower (higher) than this, the derivative is strictly positive (strictly negative).

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Proceed similarly for the green policy maker, so as to obtain V_g^*:

$$V_g^* = \frac{g(1881 + 4p(-33 + p(22 + (-2 + p)p))) + 32(-33 + p)py_A + 528(-1 + 2p)y_B}{297 + 4p(-33 + p(46 + (-2 + p)p))}. \quad (18)$$

■

A.4 Proof of Propositions 2 and 3

The equilibrium analysis of the main model applies. Consider brown subnational policy makers. The optimal subnational policy is:

$$x_{C,b}^* = \frac{8b(32 + \beta_g) + \beta_b(32b - 8g - 8y_A - 8y_B + (b - g)\beta_g)}{8(32 + \beta_b + \beta_g)}. \quad (19)$$

Differentiating with respect to β_b yields

$$\frac{\partial x_{C,b}^*}{\partial \beta_b} = \frac{(32 + \beta_g)(24b - 8g - 8y_A - 8y_B + (b - g)\beta_g)}{8(32 + \beta_b + \beta_g)}. \quad (20)$$

Recall that $D_b^* = \frac{24b - 8g + b\beta_b - g\beta_g}{8}$ and $\bar{y} = \frac{y_A + y_B}{2}$. Now consider the following two cases:

1. Suppose $\bar{y} > D_b^*$. This is equivalent to $24b - 8g - 8y_A - 8y_B + (b - g)b_g > 0$. Since $\beta_g > 0$, the numerator in Equation 20 is positive as well. Because β_g and β_b are both positive, the denominator is always positive. Thus $\frac{\partial x_{C,b}^*}{\partial \beta_b}$ will be positive.
2. Suppose $\bar{y} < D_b^*$. It follows that $24b - 8g - 8y_A - 8y_B + (b - g)\beta_g < 0$. Since $\beta_g > 0$, the numerator in Equation 20 will be negative. We already know that the denominator is always positive. Therefore $\frac{\partial x_{C,b}^*}{\partial \beta_b}$ will be negative.

The proof for green subnational policy makers proceeds analogously. ■

A.5 Multiple Subnational Policy Makers

The equilibrium analysis of the main model given in this Appendix is provided for an arbitrary number of subnational policy makers in each country, so it applies to this extension. The treaty expression from the perspective of a brown subnational policy maker b in country A is now

$$T_{A,b} = \frac{1}{4}\left(\frac{x_{A,b} + \tilde{x}_{A,b}(M_{A,b} - 1) + x_{A,g}(M_A - M_{A,b})}{M_A} + y_A + \frac{x_{B,b}M_{B,b} + x_{B,g}(M_B - M_{B,b})}{M_B} + y_B\right), \quad (21)$$

where $\tilde{x}_{A,b}$ denotes the subnational policy choices by other brown subnational policy makers in country A. Reversing the subscripts A and B in Equation 21 yields the treaty from the perspective of a brown government in country B.

The optimal subnational policy for a brown policy maker in country A is

$$\begin{aligned} x_{A,b}^* &= \frac{(g - b)M_B^2(M_{A,b} + M_A(4M_{A,b} - 1)}{4M_A^2M_B(M_B + M_A(16M_B + 1))} \\ &+ \frac{4bM_A^3M_B(1 = 16M_B) + M_A^2}{4M_A^2M_B(M_B + M_A(16M_B + 1))} \\ &+ \frac{\left((g - b)(M_{B,b} + M_B(4M_{B,b} - 1) + 4M_B^2(5b - 2g - y_A - y_B)\right)}{4M_A^2M_B(M_B + M_A(16M_B + 1))}. \end{aligned} \quad (22)$$

To examine changes in this expression, simply let M_A remain constant but increase or decrease the value of $M_{A,b}$ by exactly one.

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