Policy Alteration: Rethinking Diffusion Processes when Policies have Alternatives

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Abstract

Most analyses of policy interdependence operate under the assumption that international policy networks can be observed by focusing on the diffusion of one policy across countries. Consequently, if a focal policy is not adopted from one country to the next, researchers usually claim that interdependence is weak and diffusion may have not occurred. In this article we take issue with this argument and challenge the notion that diffusion processes and interdependence entail the *same* policy diffusing. We posit that national governments, which are usually confronted by a bundle of diffusing policies instead of one unique policy, are often pressed to implement the policy adopted in neighboring countries. At the same time, the decision makers' incentive to implement this instrument may rely on whether the domestic government is more or less dependent on foreign resources and, thus, the policy preferences of foreign constituents. We hold that, conditional on a neighbor's pressure to adopt a policy, choosing an alternative policy is more likely to occur in countries that are relatively less dependent on economic flows, where governments have more political leeway to model policy diffusion into their strategic advantage. We trace this alteration mechanism using two studies of environmental policy diffusion across space and time. Our analyses suggest that considering only one diffusing policy although alternatives are implemented risks underestimating policy interdependence, as well as biasing inference on the scope of policy diffusion.

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In a context of global interdependence, public policymaking is a challenging task. Government officials are forced to carefully weigh policy options in order to understand how an instrument may produce domestic winners and losers, especially in a democratic context in which electoral success depends on policy choices (Rodrik, 1997; Iversen and Cusak, 2000). Simultaneously, decision makers are sensitive to other countries' choices and need to consider policies implemented in the international networks their country belongs to (Simmons et al., 2006; Shipan and Volden, 2008).

A government can reject the adoption of an internationally diffusing policy because of domestic concerns. However, rejecting a policy instrument is not equivalent to rejecting the policy's objective altogether, especially when countries are faced with an externality that needs to be addressed. In many cases, governments may have an alternative policy at their disposal to target the same policy objective, but with different political ramifications, leading to a subtler kind of policy spill-over. Yet, a large share of diffusion research usually concentrates on incentives for adoption of *one* particular policy instrument, disregarding the substantial implications that alternative policies may have for diffusion processes. As some recent work indicates (Pelc, 2011; Rickard, 2012), neglecting the set of similarly targeted policies may bias inference. If researchers fail to consider policy alternatives, they run the risk of incorrectly estimating the overall effect of interdependence. Underestimating interdependence results in overestimating domestic or systemic factors (Franzese and Hays, 2008). Thus, researchers may find no diffusion when in fact states' policy choices are interdependent.

This article explores the conditions under which countries may respond to the same international policy influences by choosing an alternative policy instrument. We theoretically consider the relation between governments' incentives for policy adoption and the implementation of alternative diffusing policies borrowing from works on the local implementation of global practices (Halliday and Carruthers, 2009) and the literature on conditional diffusion (Martin, 2009; Neumayer and Plümper, 2012; Chaudoin et al., 2015), which suggest when and why states may not copy policies from one another. At the same time, we draw on lessons from the embedded liberalism research (Hays et al., 2005; Brooks and Kurtz, 2012; Wibbels, 2006) to understand which domestic factors should likely condition policy coupling across countries.

Our theory suggests that choosing alternative diffusing policies is a rational political choice driven by a government's incentive to compete with other countries while accepting domestic constraints and the need to respond to a diffusing policy demand. We claim that this policy alteration depends on the location where policies are implemented, as home governments may strategically choose alternative policies based on how much they know about the policy abroad and the extent of policy externalities. The impact of neighbors' policies, we argue, is mediated by the home country's reliance on international economic flows, such as capital movements and credit circulation. High economic flows can force a home government to accept the regulatory interests of foreign investors, while low economic flows allow the government to take more isolated decisions. Thus, we predict that if a policy is implemented in a neighboring country, a government with lower economic flows has more leeway to implement its alternative policy to minimize domestic adjustment costs.[1] This is in contrast to the choice of governments with higher economic flows, which have less liberty to deviate from policy conformity if the diffusing policy at hand is implemented in a neighboring country.

To illustrate our argument, we consider one policy sphere where reactions to a common externality are evident and alternative policy reactions are discernible. We focus on cross-national environmental policymaking in Western countries. In this policy area, all governments are in principle interested in addressing a global externality, e.g. air pollution, but national decision makers can provide the public good with a number of politically different policies. Following our theory, spatial contiguity should make the environmental policy adopted by bordering countries more salient than the policy adopted by distant countries. For example, a green policy implemented in the geographical proximity should increase the pressure on a government to adopt that identical policy given that these policies are complements and that contact between two governments increases the pressure to harmonize environmental regulation (Perkins and Neumayer, 2012; Vogel, 1995). At the same time, decision makers should assess the material and political costs of this policy choice, such as expenses for pollution mitigation or rising unemploy-

[1]As we discuss below, countries with lower economic flows may implement the alternative policy to avoid onerous domestic costs or reap fortuitous benefits, such as attracting foreign firms willing to relocate as a consequence to the policy abroad.

ment in energy-intensive sectors, compared to an alternative policy. Following our theoretical framework, we expect that in countries with high international economic flows, which are often tied to international environmental standards (Vogel, 1995), governments have less liberty to reject diffusing environmental policies. So, on average, these governments should give in to the international pressure to adopt their neighbor's environmental policy instrument. By contrast, in more economically isolated countries, governments can prioritize domestic protection over conforming to diffusing regulations while still responding to the larger need of abating pollution (Dechezleprêtre et al., 2015). Decision makers should then have more leeway in choosing a functionally similar but structurally different environmental policy. Specifically, we expect that a country's adoption of a diffusing environmental policy vis-à-vis its alternative depends on a country's closeness to the source country of policy implementation combined with the level of domestic dependence on international economic flows. As we will discuss, this hypothesis can be adjusted to whether the alternative policies under consideration are considered substitutes or complements to each other.

To empirically test our hypothesis, we make use of two different sets of data in which green taxes are treated as the focal diffusing policy. Analyzing two separate datasets serves to show the robustness of our argument in this policy area, and also highlights how alternative policy adoption materializes when policies are substitutes or complements. We first employ the dataset of green taxation used by Ward and Cao (2012), to which we add a policy that is often evoked in the public discussion of green taxes, namely environmentally relevant subsidies. We show that green taxes follow adoption patterns that are dependent on the level of economic flows of the country that adopts them and on where the subsidy policy is implemented. Specifically, we find that, given low levels of economic flows, governments are more likely to implement green taxes if their proximate neighbors have previously implemented a green subsidy. Vice versa, countries with high levels of economic flows are more likely to adopt taxes if the close neighbors have implemented the same policy. The results confirm our prediction that countries adjust their policy choices based on how far they are from other implementing countries and how constrained they are by external capital flows.

In a second step, we present an original study of two climate change policies – namely carbon-related taxes and carbon trading allowances – diffusing in Europe in 2000-2010. We show that these two policies also vary in terms of adoption across time and space, and while countries with high levels of economic flows react to neighbors implementing either type of carbon policy by adopting the same policy, countries with lower levels of economic flows are less likely to adopt the neighbors' focal policy. This finding provides additional evidence that governments strategically pursue the environmental policy that is most suitable to their domestic motivations and geographic considerations.

Our results provide a new perspective on environmental policymaking in the globalized era. In addition, the article makes several contributions to international and comparative politics research. First, our findings suggest that alternative policies have important effects on policy adoption, and that ignoring them may bias the inference on the overall extent of international interdependence. Consequently, we offer a potential explanation for the failure to detect policy spill-overs when cross-border interdependence is complex. Additionally, our theoretical angle informs important debates on the new politics of interdependence and the complex interactions in international relations (Chaudoin et al., 2015; Oatley, 2011). In line with recent analyses of the adaptation of globalization in developed countries (Farrell and Newman, 2015), our evidence indicates that regulatory disagreements may cause nuanced layering of regulatory instruments. Furthermore, our argument provides support to the claim that governments can maintain domestic policy control under conditions of international interdependence (Cao et al., 2007; Rickard, 2012; Shipan and Volden, 2006).

Theoretical Framework

Rethinking the Logic of Policy Diffusion

We first present an argument for why countries may be more likely to choose policy alternatives when multiple policies are diffusing. In order to elaborate our logic of policy alteration, we first introduce the basic logic of policy diffusion. In a classical policy diffusion scenario, government officials usually assess the impact that the policy of other countries will have on their own jurisdictions. So, if country i adopts a new policy x that may affect country j, policy makers in the latter have to decide how to behave regarding this new instrument. Standard diffusion theory posits the set of possible actions as a binary distribution of 'adopt' or 'not adopt' the policy, or – for policy levels – 'more' or 'less' of the policy. Subsequently, researchers then model the conditions under which country j is more or less responsive to the diffusing policy.

These conditions can be international and domestic in nature. With respect to international drivers of policy diffusion, many researchers point to geographic proximity, for instance a shared border (Brinks and Coppedge, 2006; Gleditsch and Ward, 2006; Mukherjee and Singer, 2010).[2] At the same time, a number of studies focus on more domestic mechanisms of common policy choices, such as structural pressures to compete for capital assets (Swank, 2006) and political disagreements on free–market reforms (Elkins and Simmons, 2004). While these works have greatly contributed to the understanding of policy interdependence, most of them neglect alternative policies to the instrument they focus on, de facto assuming that these have null effects on the adoption of the focal policy. This assumption seems puzzling because interrelated policies are often invoked in the debate that justifies policy choice. Precisely because policy alternatives may be implemented instead of, or in combination with, the focal diffusing policy, interdependence may be subtler than classical diffusion theory may suggest. Thus, it is up to debate whether considering the different policy options in a diffusion scenario may be necessary to fully understand the scope of policy diffusion.

This concern has stimulated a number of studies that highlight how, in a context of diffusion, policies may not be simply copied or rejected. Along these lines, conditional diffusion researchers have suggested that jurisdictions may have different sensitivities to a common external policy pressure. Consequently, the implementation of a diffusing policy may be adapted to domestic political circumstances (Basinger and Hallerberg, 2004; Martin, 2009; Gilardi, 2010; Neumayer and Plümper, 2012). National legal contexts may also intermediate the absorption of diffusing regulation. For example, Halliday and Carruthers (2009) suggest that, as local jurisdictions confront a new diffusing policy, decision makers may accept some particular features

[2] Of course, closeness need not be expressed in terms of physical vicinity. Beck et al. (2006), for example, use both trade flows and capital distances to establish different connections between countries. In a similar vein, cultural similarity has been identified as a policy diffusion mechanism.

of a policy package and reject others. This is in line with the insight from the varieties of capitalism literature, which discusses how institutional variations may determine a government's preferred economic policy over another. For example, Kurtz and Brooks (2008) show that the diffusion of Keynesian demand-side fiscal policies may create variations in policy adoption because national institutions may have ways to intercede in macroeconomic processes through supply-side economic interventions.

Our argument aligns with these strands of the diffusion literature as we contend that the implementation of diffusing policies will vary according to conditions at the domestic level (Neumayer and Plümper, 2012). We agree that there may be coherent alternatives to the path of policy diffusion that do not preclude interdependence but may involve competition or learning (Braun and Gilardi, 2006; Volden et al., 2008). Consequently, despite consistent pressure that should push governments into adopting similar policies, policy convergence may occur in more complex ways than classical diffusion theory would expect (Brooks and Kurtz, 2012; Kurtz and Brooks, 2008). At the same time, our argument departs from this body of works in two significant ways. First, our argument indicates that complex diffusion patterns do not only entail the domestic accommodation of a diffusing policy, but also the consideration of separate policies that are functionally similar yet politically different from the focal policy. We specifically concentrate on the links between two policies that belong to the same policy sphere but are not necessarily part of the same policy package. Hence, we focus on varying levels of diffusion when a larger set of policy options are considered – and not just when one policy proposal is examined.[3] Second, while our argument evokes a number of traditional conditions for why a country may choose alternative policies, a crucial element of our theory is that the direction of policy alteration is determined by the relation between the two policies. That is, we argue that whether the alternative policies are complements or substitutes will also affect policy choices. Thus, our argument sheds light on how heterogenous jurisdictions may be connected by different policies that are themselves interdependent.

[3] While policies may have more than two alternatives, we believe focusing on two policies should be sufficient to explicate the dynamics of policy alteration. Furthermore, from an empirical standpoint we think that tracing one alternative instrument together with a focal policy may be enough to avoid omitted variable bias without risking model overspecification.

Explaining Diffusion Processes when Policies have Alternatives

To depict our logic, we describe the payoffs of adopting diffusing policies from the point of view of a government. We assume the government to be a unified rational actor whose objective is to maximize support in order to stay in power. Furthermore, we assume that the decision maker should choose to implement a policy based on political considerations. In the presence of only one diffusing policy, she should be interested in pursuing that policy if it increases the likelihood that she may remain in office. For example, in the case of a developed democracy confronted with a diffusing public policy, the decision maker would accept that policy if the majority of her constituents were interested in seeing that instrument implemented domestically, which in return would increase the probability that she will be re-elected in office. This also assumes that the decision maker is able to balance the preference of the median voter and the interest of private stakeholders. In the case of public good provision, she would implement a diffusing policy that provides the public good to the point that the private interests are not penalized in a way that would decrease overall support.

According to traditional diffusion research, there are a number of factors that may affect these considerations and ultimately lead the decision maker to accept or refuse the diffusing policy. On the domestic side, government ideology and industrial lobbying are examples of determinants of decision makers' positions on a diffusing policy. Internationally, regional learning, trade relations and the influence of international organizations may equally affect the likelihood of policy adoption. The relative relevance of these factors depends on the policy area. Nonetheless, it is reasonable to expect that, when a decision maker is confronted only with one diffusing policy, some of these mechanisms will consistently be in place. For example, the geography of policy implementation should frequently matter, for neighbors are usually more attentive to each other's behavior (Gleditsch and Ward, 2006). Similarly, democracies are more likely to mimic each other as they often abide to the same policy demand (Starr, 1991).

We claim that the described decision making process significantly changes once we allow for two functionally similar but structurally different policies to be considered. Not everything differs, of course: even in a context in which policies have alternatives, the decision maker still faces pressure to react to externalities as in the case of one diffusing policy. However, the number of ways in which the incumbent can satisfy the electorate increases as more policy options become available. Thus, the decision maker now has the possibility to implement a different policy that functionally addresses the same initial requirement but may produce different political returns. More specifically, the decision maker can opt for the alternative policy to the one that she observes being implemented in other jurisdictions if doing so benefits her and her constituents.

We argue that decision makers will be more likely to implement alternative policies to the diffusing policy if a number of conditions hold. Firstly, as the new varieties of diffusion research suggest, subtle reactions to policy diffusion depend on where global policies are diffused from and where they are received (Wibbels, 2006). This implies that policy alteration should be linked to the *geographic distance* of implementing countries. Presumably, government officials in two close countries have intertwined preferences that would lead to similar policy choices. For instance, two countries sharing a border may often engage in a certain level of regulatory harmonization (Franzese and Hays, 2006). Furthermore, due to regional interests and cross-border relations, these countries may have constituents with similar preferences who would probably demand a similar policy adoption (Gerber and Gibson, 2009). By contrast, two countries that are further away from each other should be less exposed to the externalities of each other's policy choice, and the decision makers of insular countries should feel less pressure to adopt a diffusing policy, everything else constant. Consequently, geographic considerations may influence the capability of a government to consider deviating from policies observed abroad.

While the political geography of policy diffusion should matter for alternative policy choices, geography by itself constitutes only the international lenses through which decision makers assess the potential benefits of alternative policies. Evidently, domestic considerations should mediate how a diffusing policy is assessed in a country. For example, decision makers could consider alternative policy options based on party ideology, because some alternative policies may be preferred by left-leaning voters while others may be more embraced by conservative voters. However, partisanship is not likely to generate the same effects across all types of countries. As Kurtz and Brooks (2008, 249) note, one should not assume that policy outcomes follow seamlessly from partisan preferences, because whether governments follow their partisan goals depends on a number of contextual factors, e.g. the strength of labor organizations. Thus, for the sake of keeping our argument as generalizable as possible, we focus on more systemic domestic considerations that could influence the decision makers' policy adoption.

We argue that a country's domestic constraints related to its level of *international economic integration* should mediate the extent to which a decision maker may choose alternative policies based on the policy implemented in neighboring countries. In particular, a country's exposure to international capital movements should influence the degree to which a government has leeway in adopting internationally diffusing policies at home. To clarify, consider first the effect of capital mobility when policies do not diffuse. Capital movement entails a decision maker's contacts with foreign private actors, such as multinational companies. These contacts are usually attractive if they come at low domestic costs. So, if capital movement increases domestic economic performance at the cost of no reform or policy adoption, then the decision maker should welcome further capital flows without any restriction (Globerman and Shapiro, 2002). Yet, governments may also have to address questions of regulatory harmonization and policy integration.

Governments in countries with high economic flows should be more willing to adjust to diffusing policies compared to countries with low economic flows, because the former care about the access to capital at the cost of linking it to internationally diffusing regulations (Hays et al., 2005). This entails that high capital mobility countries may be more constrained to accept diffusing policies. We conjecture that countries with high economic flows should be especially prone to adopt a foreign policy if it is implemented in a geographically close country. For example, a country with high capital mobility may be more likely to learn coping mechanisms to a foreign policy from neighboring countries that have implemented it (Blonigen et al., 2007). Moreover, close countries with high economic flows are more likely to share political and legal approaches to policy adjustment, so learning from neighbors seems a feasible choice for these governments (Dreher et al., 2013).

Vice versa, government officials of countries with low economic flows should face lower pressure to adjust to policies from abroad, given the relatively smaller dependence on the policy regime of foreign investors. Hence, in this type of country, decision makers have more leeway to respond to diffusing policies with policy alteration. Surely in the case in which a diffusing policy requires onerous domestic adjustments, the government of a country with low economic flows may try to avoid that particular policy. Yet, this does not necessarily mean that the country does not implement any policy. Rather, the government may implement an alternative policy that responds to the general policy need while protecting the interests of the home country. Alternatively, the government may choose a different policy to reap political benefits, for example from attracting the losers from that onerous diffusing policy. This alternative outcome should be particularly prominent for low economic flows countries that observe neighbors adopting a focal policy, because these countries do not need to converge on the regional policy equilibrium and have a costless incentive to compete with others (Plümper et al., 2009). In sum, countries with high levels of economic integration should adjust to the policies of neighbors by adopting the same policy, while less economically integrated countries should have more liberty to deviate from the trend of proximate countries, and can implement alternative instruments.

The testable implication of our argument is that countries at different levels of international economic integration should be differently sensitive to policy diffusion depending on where the policies are adopted. Before turning to the area of environmental policy, we should clarify how 'alternative' policies can be identified. Evidently, the choice to adopt any policy instruments depends on the framing of domestic politics (Jacoby, 2000). In this article, we keep with the notion that alternative policies are strategic complements or substitutes that simultaneously emerge in the public discourse across several countries (Franzese and Hays, 2008). That is to say, the *rate of substitution* of the alternative policies should affect policy implementation. The rate of substitution depends on the properties of each policy as well as their relative importance for a government. For example, a government may decide to either adopt a diffusing policy x or opt for an alternative policy y. From a theoretical perspective, it is possible that the two alternative policies are mutually exclusive substitutes of which governments may adopt either one or the other, but not both. Decision makers may then substitute adoption of policy x for the adoption of policy y, and vice versa, e.g. when one policy is deemed sufficient to achieve a desired policy goal. However, in a perhaps more realistic scenario, the two alternatives may also be substitutable by degree. Decision-makers may then adopt a level of policy x *and* a level of policy y. This does not necessarily affect the rate of substitution, but allows decision makers to take advantage of situations in which *complementary* effects of two policies generate higher utility than mere substitution.[4] To better illustrate the implications of substitutable and complementary effects of policies, we discuss these dynamics together with the empirical applications below.

Application: Environmental Policies in Advanced Democracies

Environmental degradation is an important source of cross-national policy diffusion, because a country's pollution has international consequences and states should adapt to each other's policies to decrease environmental risks. Although mitigation is expensive, most governments in developed democracies seek to address pollution, because failure to act may have electoral consequences. Hence, domestic decision makers regularly discuss environmental options to agree on an efficient policy at a politically affordable price.

One of the traditional measures to abate pollution is *green taxation*. An environmental tax is an excise tax targeted at environmental pollutants and goods whose production increases pollution. Green taxes are often implemented in developed democracies with large welfare states that feature market progressive executives or strong green parties. Moreover, a big obstacle to green tax implementation is the coalition of industrial polluters, especially firms that lag behind the clean technologies needed to lower the environmental costs of production. Hence, a green tax that sustains economic performance but also generates the revenue to compensate the domestic losers of mitigation can be adopted across a diverse number of countries (Stavins, 2008).

[4] To be sure, whether an alternative policy y is seen as a substitute or complement to a focal policy x by policy-makers is not only dependent on the properties of a policy, but also on the context of implementation. That is, in two different contexts, the same policy can be seen as a substitute or a complement to an alternative policy.

In practice, not all countries are complaisant with green taxes, or at least not at all times.[5] In fact, policy makers can alternatively address environmental degradation by choosing policies to either substitute or substantiate green taxes or enhance their effect. We focus on two alternatives to green taxation that are often considered in public debates. The first policy is a *green subsidy*. Environmentally motivated subsidies are grants and soft loans given to polluters willing to cut pollution. Sometimes green subsidies are directly linked to taxes, because executives earmark a green fee and later redistribute the revenue as an endowment. However, the links between subsidies and taxes are not always explicit, and often a subsidy scheme may exist without the implementation of a tax.[6] Moreover, subsidies have different political implications when compared to taxes, and may shape governments' strategic considerations accordingly (Rickard, 2012). In the environmental area, subsidies may be linked to trading fees, which means that governments allocate green subsidies not upon collection of green taxes but based on international trading considerations. Similarly, policy makers can prefer a green subsidy to a tax because the former preserves the status quo of firms that threaten to relocate under the tax, while it increases political support among subsidized polluters.[7]

The second alternative policy to a green tax is an *abatement credit allowance*. This policy usually involves a fixed quantity of permits that polluters exchange among themselves in an abatement 'market'. The permit price plays a role analogous to a tax: firms with high costs of reducing pollution buy permits that let them continue to pollute, while those that can cut pollution at lower costs will do so and then sell their unused permits. Tradable credit schemes however have specific distributional effects, and therefore present different payoffs to policy makers in comparison to green taxes. They can be particularly useful if government officials have a weak control of bureaucracy or if monitoring tax collection is more costly than providing credits. Moreover, allowances can be instrumental if they are given away to critical polluters

[5]For example, in 2012 Australia agreed to a fixed-price carbon tax, but in November 2013 the executive scrapped the carbon tax and voted in favour of an emission trading scheme.

[6]To illustrate, all recent German environmental subsidies are categorized as capital investment grants, and none represents a direct tax reduction (OECD 2015).

[7]Surely long and large subsidies risk inflating fiscal debts. However, assuming an increasing consumer preference for clean products, subsidies may pay off in terms of increasing green exports and trade.

with competitive advantages in the global economy (Victor and House, 2006).[8] Together with green taxes and environmental subsidies, the trading of pollution allowances belongs to the set of environmental instruments available to each domestic government when pollution becomes a salient public policy. We expect policy makers to assess the advantages of implementing either of these instruments in the ways that we describe below.

Environmental Policy Adoption with Alternative Policies

In a context of international interdependence, proximate developed countries should easily learn about each other's environmental practices and should quickly adjust to them. Thus, we expect that the higher the distance between two countries, the lower the likelihood that the green policy introduced in one country will influence the other. This expectation is in line with the literature that points to the importance of learning in the international diffusion of environmental practices, given that most governments are pressed to respond to domestic demands for environmental public goods (Busch and Jörgens, 2005; Holzinger et al., 2011).

We also expect that environmental policy diffusion should be deeply intertwined with competition for economic resources, and that internal cost considerations could constrain the adoption of international environmental policies (Tews et al., 2003). Tracing this to the effect of capital flows, decision makers in countries with high volumes of foreign capital should have incentives to pursue tighter regulation to emulate the stringent standards of countries they may depend on. By contrast, countries that depend on fewer economic flows may have incentives to diversify their policy options and adopt more opportunistic responses to policy diffusion. Following this logic, countries should adopt diffusing environmental policies as a function of the interaction of the geographic distance from other implementing countries and the home country's level of international economic flows.

Note however that policy adoption should also vary as a function of the relationship between the alternative policies and the context of implementation. That is, if diffusing policy x

[8] Of course, if a government has a weak bureaucracy, then it may not want to implement a system that requires careful monitoring of thousands of polluters. At the same time, if credits are cheap and easy to allocate, allowances may also constitute a form of subsidy. Then again, credits are not necessarily linked to taxes and may be handled as a separate type of policy.

is the alternative of policy y, either may be decreased or increased based on whether x and y are substitutes or complements conditional on contextual factors. Figure 1 sketches hypotheses with regard to what would occur to policy diffusion when we vary geographic distance to foreign implementation, level of international economic flows, and substitutability of the alternative policy. To provide an intuition for the policy outcome under these three factors, let us expand on each of the hypotheses that is contained in one quadrant of Figure 1.

SUBSTITUTES

If foreign country i adopts x, then in home country j:

	$W^x \downarrow$	$W^x \uparrow$
$EI\uparrow$	1.1 $x\uparrow$ — $y\downarrow$	1.2 $x\downarrow$ — $y\uparrow$
$EI\downarrow$	1.3 $x\downarrow$ — $y\uparrow$	1.4 $x\uparrow$ — $y\downarrow$

COMPLEMENTS

If foreign country i adopts x, then in home country j:

	$W^x \downarrow$	$W^x \uparrow$
$EI\uparrow$	2.1 $x\uparrow$ — $y\uparrow$	2.2 $x\downarrow$ — $y\downarrow$
$EI\downarrow$	2.3 $x\downarrow$ — $y\downarrow$	2.4 $x\uparrow$ — $y\uparrow$

Figure 1: *Theoretical expectations.* The table shows policies a home government should hypothetically adopt as geographical distance from implementation of policy x (W^x) and economic integration in international capital flows (EI) vary. Note that x and y refer to policies with equivalent functional purposes.

First consider the scenario on the left side of Figure 1 in which two green policies are substitutes. Governments can trade off one of these policies against the other. In the absence of diffusion, a country should choose one of two substitute policies based on domestic rationales. By contrast, in the presence of diffusion, a country may choose the first policy adopted by the neighbors at the cost of the other. We expect that this should be especially the decision for countries with high level of economic flows (quadrant 1.1), as these should be especially sensitive to foreign policies from proximate investors and donors. In reverse, a country that is located far away from the place where a policy is first implemented is less likely to be involved in the diffusion of that policy, hence increasing the likelihood for the substitute policy to be implemented (1.2).

Now consider a less economically integrated country and the emanating theoretical expectations. In a context in which neighboring countries may be adopting one of two substitutable policies, decision makers in this country should react as if these policies constitute opportunities to seek international gains and further compete in the global economy. For example, if neighbouring countries adopt a green tax, policy makers may adopt subsidies to attract the polluting firms willing to relocate because of the neighbour's tax. So, if two policies are substitutes, governments in countries with fewer international capital flows should differentiate policies compared to their neighbors and choose the *alternative* policy of *close* countries (1.3). Vice versa, we expect that governments have low incentives to increase the level of the alternative policy when diffusing policies are far away (1.4). In other words, the implementation of a policy in distant countries decreases the level of the substitute policy in a country with low economic flows.

Now let us turn to diffusing policies that are complements, which is to say that governments can adopt them simultaneously because the policies reinforce each other. In the case of a country with high global capital flows, we hypothesize that the adoption of either policy in a neighboring country should incentivize the government to adopt both instruments, as either can be used to reach further harmonization with foreign capital investors, assuming they are proximate (2.1). Vice versa, a policy adopted in distant countries should decrease the direct pressure to quickly adjust to the new policy regime, and the decision maker should be less likely to adopt either policy (2.2). Once again, we expect the policy outcomes to be different for countries with fewer capital flows. In these countries, the decision maker has strategic reasons to adopt the *alternative* policy of *distant* countries because it faces smaller costs from deviating from the neighbors' trends. For example, if a neighbor implements a new green tax in conjunction with a subsidy, a less economically integrated country has an incentive to *decrease* both policies, for example, to attract foreign companies willing to relocate.[9] Vice versa, deci-

[9]This may look more like 'free-riding', but it really just implies that the country is more likely to adopt an alternative policy from distant countries, *ceteris paribus*.

sion makers who observe the complementary policies being implemented in *distant* countries can show policy initiative and adopt that same policy. A subsidy for clean technologies, for example, may attract distant firms while allowing the government to claim the provision of public good. So, we expect that in less economically integrated countries the implementation of complementary policies in close countries should decrease the likelihood that either is implemented at home (2.3). By contrast, the implementation in distant countries should increase the adoption of either policy (2.4).

Research Design, Data and Empirical Analyses

We test our argument in the environmental area with two separate statistical analyses. For both analyses we employ spatial econometric models of policy diffusion, which allow us to effectively specify the geography-based considerations of our theory (Neumayer and Plümper, 2012; Gilardi, 2016). Our first test (case 1) expands on the study of green taxes put forward by Ward and Cao (2012). Specifically, we explore how environmental subsidy adoption affects green tax diffusion in OECD countries from 1995 to 2004. For our second study (case 2), we collected data on climate change policies in the peripheral European countries to trace how carbon allowances may have influenced levels of carbon-related taxes in the years 2000-2010. Together, these two studies present evidence that certain countries consistently exploit policy alteration, especially if their domestic dependence on international economic flows interacts with the distance to other implementing countries.

The two analyses also indicate how the dynamics of policy alteration may vary if the policies under consideration are related to each other as either substitutes or complements. Although there may be reasons for why environmental taxes, subsidies and allowances should complement or substitute each other in developed democracies, we do not attempt a theoretical expectation on whether these specific policies are more likely to be complements or substitutes, and we allow the data to show us the relations between the selected policies in the samples we study. Thus, our sole assumption is that the rate of substitution of these policies varies within and across countries.

Case 1: Green Taxation in OECD Countries

We first test our argument against a published dataset that is directly linked to our argument of policy alteration in the environmental area. We use the framework proposed in Ward and Cao (2012, W&C), where the authors evaluate the diffusion of green taxes in OECD countries between 1995 and 2004. W&C identify a number of domestic and international factors that presumably affect a government's decision to raise green taxes. Using uniparametric and multiparametric spatiotemporal autoregressive models (Hays et al., 2010), the authors find that green tax burdens are influenced by the positions of legislative medians, the power of the energy-producing sector, and international networks generated through trade and environmental intergovernmental organizations. While W&C do not find evidence for tax competition, they note that not all countries show a consistent pattern in tax coordination, possibly because alternative 'affinities between states' condition the adoption of green taxes.

We re-assess W&C's findings in light of alternative policy choices, focusing in particular on green subsidies (OECD 2015). Green subsidies comprise renewable energy grants, clean technology support and environmental soft loans, most of which exist within a subsidy scheme that is separate from environmental taxes. If our hypothesis is correct, decision makers should adjust their level of green taxes compared to how closer countries are implementing subsidies, and these adjustments should vary across countries with high and low economic flows.

Environmental Taxes and Subsidies Data

To measure *green taxes* we use the original W&C variable that captures revenues from fees that the OECD deems to be environmentally relevant. The green tax per capita is denominated in constant U.S. dollars and is available for 25 OECD members.[10] Notably, green taxes vary across time and across countries. Although they are generally lower in poorer countries, some post-Communist countries significantly raised them in the early 2000s, reaching double the tax levels of environmentally ambitious nations such as New Zealand. Similarly, while policy coordination in the European Union has facilitated an increase in green taxes in Western

[10] The panel is unbalanced as some countries such as Iceland and Turkey have no complete series.

European countries, the tax base is still relatively low in rich countries like the United States and Canada.

To measure *green subsidies*, we collected the net financial value (amount of grants, soft loans and guarantees) of all environmentally motivated subsidies provided in a given year in the same 25 OECD countries.[11] We standardized the figures weighing them by constant GDP per capita. The highest levels of subsidies range above 15,000 USD per capita (500 million USD) in countries like Switzerland and the UK in the early 2000s. However, subsidies also reached high values in other countries, for example the United States during the later years of the Clinton administration when the government invested in green energy and renewable technology. Note that the data contains missing values, thus we perform linear interpolations and use the estimated means of ten simulated values to avoid listless deletion.[12]

It is worth noting that green subsidies are often implemented before or separately from green taxes. For example, Denmark and Germany established a national subsidy for wind turbine electricity in the 1980s, years before a substantively related tax.[13] Subsidies also have an inverse relationship with taxes in some states but not in others. For example, while in Sweden green taxes and environmental subsidies followed parallel trends, in Turkey they have not. More importantly, the descriptive statistics suggest that geographically close countries react to other policies of neighboring countries. To illustrate, consider countries in Central Europe (Figure 2). According to our theory, these countries should be sensitive to each other's policies, but at the same time their sensitivities should vary by their dependence on economic flows. Relatedly, the data show that high capital flows countries like Austria and Germany have had similar long-term trends with respect to green policies: taxes increased due to more stringent environmental policies within the European Union, and subsidies to GDP were mostly low. However, bordering Eastern countries behaved differently. The Czech Republic adopted ambitious tax targets and increased its per capita rate even earlier than Austria. By contrast, Poland, which is equally influenced by EU policies, substantially raised subsidies in the 2000s.

[11] Database on instruments used for environmental policy, `http://www2.oecd.org/ecoinst/queries/Default.aspx`.

[12] The proportion of missing–at–random data is thirty percent. To infer the missing values, we use a standard repeated-imputation Bayesian simulation.

[13] Moreover, the EU has increased carbon–related subsidies issuance by 30% in the past twenty years without yet accomplishing a harmonized carbon tax (Holzinger et al., 2011).

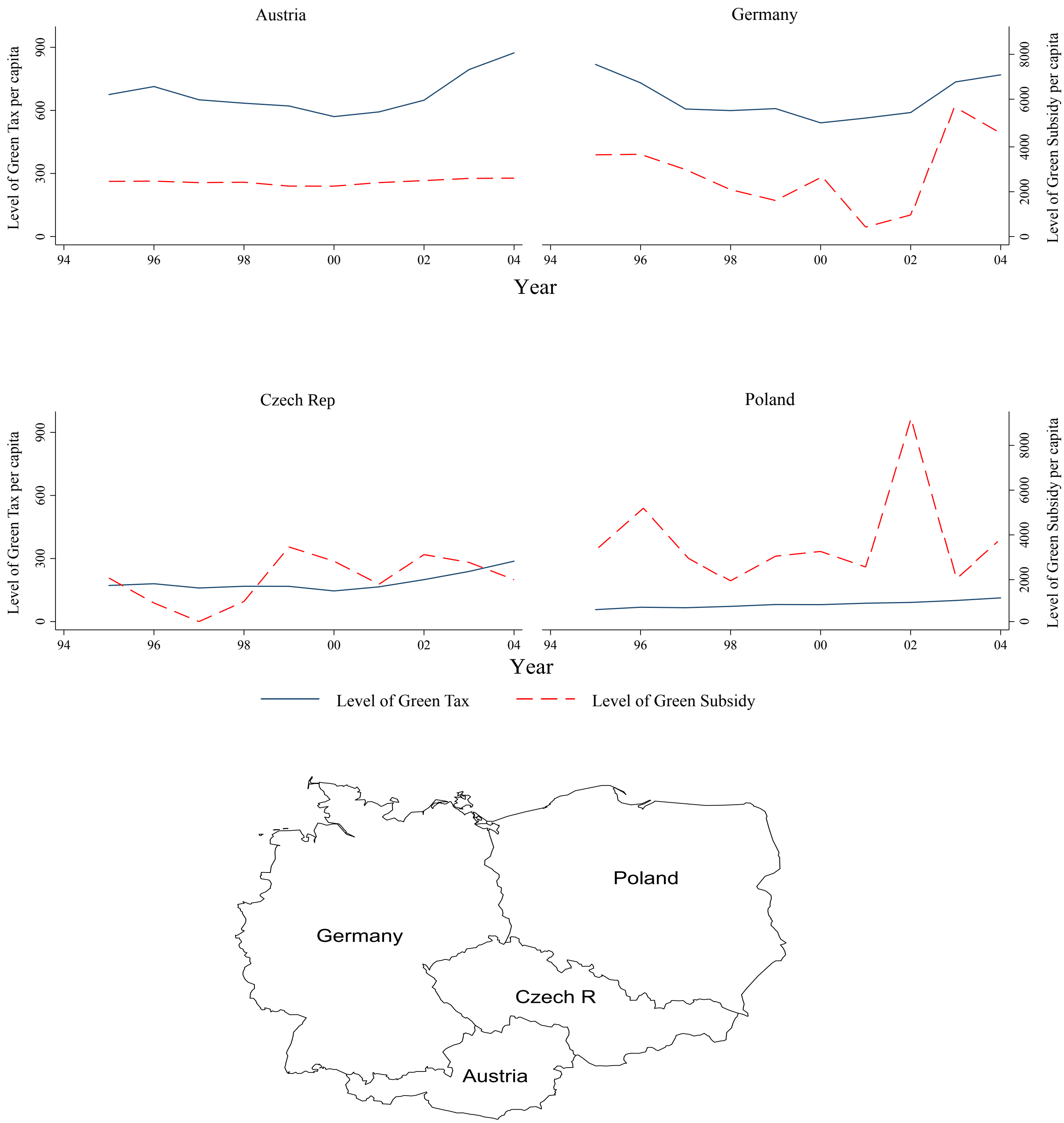

Figure 2: *Green Taxes and Green Subsidies, 1995–2004:* Policy Level Trends for Selected OECD Countries.

The patterns in the Czech Republic and Poland reflect in part an Eastern European reaction to Western stimuli for reform and regulatory measures (Andonova et al., 2007). We think they also importantly echo our theory. On the one hand, the Czech government decided to pursue more stringent green policies, possibly because it was preparing for EU membership. Along these lines, anecdotal evidence confirms that in order to show good environmental practice, the Czech government raised the cost of gasoline at the rate of the Austrian neighbors.[14] By contrast, the Polish government decided to increase energy subsidies as European leaders were due to finalize the EU 2030 green framework, possibly to incentivize German mining firms to relocate.[15] To verify whether this sort of policy coupling underlines the trends in green taxation in the OECD countries, we now move to estimate the partial effects of alternative policies distributed across space.

Independent Variables and Estimation Strategy

Following W&C, we test our hypothesis with a spatiotemporal autoregressive model (Franzese and Hays, 2007). This model can appropriately estimate mechanisms of policy interdependence across space. Moreover, it allows us to calculate the effects of endogenous spatial lags with important temporal structures, which one may assume if countries adjust their budgetary cycles in reaction to the ones of other countries. We also expect spatial lags to be often highly related, so we use a multiparametric version of the spatiotemporal autoregressive model (Hays et al., 2010).[16] As our main dependent variable, *Green tax*, is continuous, we can work in a framework of linear correlations. The specification of our linear multiparametric spatiotemporal autoregressive (M-Star) model is:

$$Green\ tax_{i,t} = \varphi\ Green\ tax_{i,t-1} + \mathbf{X}_{i,t}\beta + \rho\mathbf{W}_i\mathbf{Z}_{i,t} + \rho\mathbf{W}_i Green\ tax_{i,t} + \rho\mathbf{W}_i Green\ subsidy_{i,t-1} + \rho\mathbf{W}_i Green\ subsidy_{i,t-1} \times Economic\ flows + \varepsilon_{i,t} \qquad (1)$$

[14] In 2013, the rate of 1 liter of gasoline in Prague was 1:0.95 compared to Austria.

[15] Responding To Climate Change. 2014. *Europe spends 10 Billion Euros a year on coal subsidies*. `http://www.rtcc.org/2014/10/13/europe-spends-e10bn-a-year-on-coal-subsidies/`.

[16] Spatiotemporal models can solve bias problems that ordinary least squares (OLS) encounter if errors are not serially independent. However, OLS estimation is often unbiased if one applies a one-year time lag to the spatial lags and includes temporally lagged dependent variable (Franzese and Hays, 2008). Our model addresses these potential sources of bias, so OLS is less of an issue for the analyses in the paper.

where *Economic flows*$_{i,t}$ also belongs to the subset of variables denoted by $\mathbf{X}_{i,t}$. In this specification, *Green tax*$_{i,t-1}$ is the autoregressive temporal lag that absorbs within-country idiosyncratic variation (Ward and Gleditsch 2008). $\mathbf{X}$ is a battery of domestic factors presented in W&C, while the connectivity matrices $\mathbf{W}$ capture the effects of international factors $\mathbf{Z}$, identified in W&C. The parameter $\epsilon_{k,i,t}$ is the error term. We first discuss the domestic and international variables that, keeping with W&C's original model, we include in our specification. We then move to the central predictors of our model, namely $\mathbf{W}_i$*Green subsidy*$_{i,t-1}$ and its interaction with *Economic flows*.

Our econometric model of green tax diffusion distinguishes several domestic and international explanatory variables. The domestic variables include the *left–right position* of national legislators and their *environmental position* (Klingemann et al., 2006), as well as a dummy if *green party* members are elected to the lower house. An indicator of *energy production* as kilograms of CO2 emitted per dollars of GDP (WDI, 2012) is added to proxy the power of polluting lobbying sectors. Similarly, in our effort to mirror W&C, we estimate the coefficients of *GDP per capita* and *unemployment* and their respective squared terms (WDI, 2012), as well as *income tax* as a percentage of GDP (WDI, 2012) in order to capture the effects of wealth and fiscal pressure on green taxes. Crucially for our argument, we operationalize the *International Economic Flows* with the index of globalization (Dreher, 2007) employed in W&C. This measure ranges from 0 to 100 and captures the effect of foreign direct investment and cross-national portfolio investments on green taxes.[17]

Regarding the international variables in the model, we make use of W&C's same connectivity matrices, $\mathbf{W}$, which are of the form $NT \times NT$ with $TN \times N$ submatrices along the block diagonal, and are multiplied with the dependent variable to generate the spatial lags.[18] W&C's model includes the following lags: $\mathbf{W}$*geographic distance*, which measures the green tax

[17]The Dreher indicator, which is available in Ward and Cao's dataset, is derived from a principal components analysis of data on a nation's foreign direct investment, portfolio investment and income payments to foreign nationals. Table 1 of Dreher (2007) suggests that foreign investment flows have the biggest weight in this index. Hence, we are confident that this measure of international economic flows captures the impact of foreign investors referred in our theoretical discussion.

[18]The authors row standardize to allow the sum of each row to be 1. Consequently, the estimated values of the spatial coefficient, ρ, reflect the average influence of other countries' geographical location.

lag over the distance in kilometers between national capital cities (Ward and Gleditsch 2008); $\mathbf{W}$*dyadic trade*, which is the green tax weighted by the bilateral trade flows from one country to another (Barbieri et al., 2009); and $\mathbf{W}IGOs$, which is the green tax proportional to the shared memberships in environmental international organizations (Ingram et al., 2005). We implement these lags in our analysis as well. However, note that we estimate the geography lag not only for green taxes but also for *subsidies*, which is central to our theoretical argument.

Specifically, we propose the spatial lag $\mathbf{W}$*geographic distance* $*$ *green subsidy*$_{t-1}$, which represents the average subsidy level across geographically connected countries. The OECD sample in W&C includes proximate European countries as well as distant countries such Japan, Australia and New Zealand, which are further than 15,000 km away from most Western capitals. To avoid that these long distances may distort our spatial lag of interest, we calculate the $\mathbf{W}$*geographic distance* $*$ *green subsidy*$_{t-1}$ lag for countries whose relative distance is less than 1,000 kilometers (Cao, 2010).[19] We multiply this matrix to the one-year lag of taxes not only to avoid simultaneity bias (Beck et al., 2006; Franzese and Hays, 2007), but also to capture the strategic dynamics suggested by our theory, i.e. that domestic decisions should strategically follow foreign decisions. The matrix is row standardized to stay consistent with W&C and hold their assumption about the influence of geographic distances.[20]

Our baseline M-Star model does not include country fixed effects because the specification already contains the temporally lagged dependent variable, and together with fixed effects this may generate simultaneity bias. However, including the country dummies to capture idiosyncratic national characteristics in policy adoption does not change our main findings, as we show below. One may also worry that, because green taxes and environmentally motivated subsidies represent two endogenous policy choices faced by the same national government at each point in time, the correct model should comprise a system of simultaneous equations where the error

[19]This means we assign zeros for the cells of the geography matrix where the countries are more than 1,000 km distant. Evidently, the matrix with all distances generates a much more sparsely distributed spatial lag on geographic distance, as we discuss below. Note that spatially lagging the green tax on our more constrained matrix of geographic distance does not affect our main results.

[20]Row standardization is consistent with the assumption that a country is influenced by its neighbours and the importance of each neighbour is related to its relative distance (Elhorst, 2003). This assumption in contrast with Plümper and Neumayer (2010), who argue that each unit's influence measured as a proportion of the other units is not always appropriate. For our purposes, it is reassuring that our results are not altered by the row-standardization choice, as we note below.

terms are assumed to be correlated. To respond to this concern, in additional analyses we employ a simultaneous equation model with two structural equations. Each structural equation has *green tax* or *green subsidy* as its own dependent variable and the same explanatory variables denoted in Equation (1) but the spatial and temporal lags of the dependent variable. We gauge the simultaneous equations using three-stage least squares (3SLS), which is an estimator that combines a two-stage estimation of endogenous structural equations with seemingly unrelated regressions.[21] As we will discuss, the 3SLS models show that our baseline estimations are robust, thus supporting our inferences on policy alteration.

Results

Broadly put, our theory suggests that, conditional on international economic flows, a government's adoption of a green policy should vary as a function of where it observes other decision makers implementing alternative policies. Additionally, our argument predicts the policy choices of close countries based on the relation of the policies under consideration. Precisely because it is useful to understand the relation between green tax and subsidy in our dataset, our first empirical specification estimates W&C's model of green taxes to which we only add green subsidy as a covariate.

Column 1 in Table 1 reports the coefficients of this first model. In line with W&C's results, we find that GDP has an inverted-U shape relationship with green taxes, while higher income taxes are linearly associated with higher green policy levels. We also find that left-wing governments tend to raise green taxes compared to conservative governments. We do not find a statistically significant effect of executives' environmental positions, and the actual economic flows have a negative coefficient but the confidence intervals include zero. The coefficient of the temporal lag indicates that previous green tax levels are important predictors of today's

[21] Three-stage least squares produce estimates from a three-step process. First, instrumented values for all endogenous variables are considered similarly to the first step in a two-stage least squares approach. Second, estimates are calculated on the basis of the residuals from a 2SLS estimation of each structural equation. Finally, a generalized least squares estimation is performed using the covariance matrix of the second stage and the instrumented values in place of the right-hand-side endogenous variables. Like 2SLS, the 3SLS approach assumes that the instrumental variables are relevantly correlated with the independent variables and uncorrelated with the error term. We model *unemployment* and *GDP per capita*, their respective squared terms, *energy production* and the country fixed effects as the predetermined exogenous variables that identify each equation, respectively.

Table 1: *Green Taxes and Green Subsidies in OECD countries: The Effect of Alternative Policy Levels*

	M-Star models of Green Tax (1)	(2)	(3)
Green tax$_{t-1}$	0.90***	0.87***	0.90***
	(0.025)	(0.025)	(0.025)
Green subsidy$_{t-1}$	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Energy production	-10379	-10421	-2030
	(18879)	(19336)	(19111)
GDP per capita	-0.005**	-0.001	-0.004*
	(0.002)	(0.002)	(0.002)
GDP per capita sq.	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)
Unemployment	4.62	4.35	4.13
	(4.82)	(5.05)	(4.94)
Unemployment sq.	-0.34	-0.27	-0.30
	(0.22)	(0.23)	(0.23)
Income tax per capita	0.18***	0.16***	0.18***
	(0.045)	(0.046)	(0.044)
Left-right position	-1.38***	-1.68***	-1.34***
	(0.44)	(0.44)	(0.43)
Environmental position	0.86	-7.66	-0.82
	(8.47)	(8.66)	(8.52)
Environmental position sq.	-0.78	0.12	-0.52
	(0.81)	(0.84)	(0.82)
Green party	-3.76	-6.76	-1.14
	(12.1)	(12.4)	(12.0)
Actual economic flows	-0.16	0.19	-0.76
	(0.39)	(0.38)	(0.49)
ρ: $\mathbf{W}$*geographic distance**Green tax	-0.081	0.137*	-0.037
	(0.082)	(0.070)	(0.084)
ρ: $\mathbf{W}$*IGOs**Green tax	0.43***	0.006**	0.36***
	(0.10)	(0.003)	(0.10)
ρ: $\mathbf{W}$*dyadic trade**Green tax	0.12	0.39***	0.17*
	(0.087)	(0.061)	(0.089)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$		-0.16	-0.14
		(0.11)	(0.12)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows			0.003*
			(0.001)
Intercept	-234.7***	-319.0***	-225.6***
	(67.3)	(67.2)	(69.2)
σ	67.1***	68.6***	66.3***
	(3.11)	(3.18)	(3.07)
N	233	233	233
Log-likelihood	-1312.3	-1317.4	-1308.9
χ^2	5926.5	5654.8	6082.5

Dependent variable is Green Tax Levels. The table reports linear M-Star coefficients. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

green taxes, while the negative (though insignificant) coefficient of the spatial lag indicates that countries are less responsive to more distant countries' green tax levels. Moreover, we find that the spatial lag on environmental IGOs and, to a lesser extent, international trade relations induce interdependence on green taxes, as suggested by the positive ρ coefficients. In addition, Model 1 shows that the subsidy variable has a negative coefficient that approaches statistical significance. This suggests that national green subsidies have inverse effects on green taxes, and that in our sample these two policies may be used as substitutes to each other.

Moving to a specification that integrates the influence of alternative policies implemented abroad, Model 2 shows the effect of the spatiotemporal lag of subsidies on geographical distance, keeping everything else constant. The results stay largely unvaried, beside the spatial lag of green tax on geographical distance: the ρ becomes positive, hinting at the sensitivity of this parameter to the inclusion of the subsidy variable. More importantly, the $\mathbf{W}$*geographic distance* $*$ *green subsidy*$_{t-1}$ coefficient is negative and borders statistical significance. This suggests that geographical distances with respect to green subsidies tend to decrease green tax levels. Put differently, close neighbors that increase a subsidy may weakly decrease a country's likelihood to implement high green taxes, possibly because they put pressure on a domestic government to accept their policy. But does this effect vary if one considers whether the country is more or less dependent on international economic flows?

In Model 3 we test this conjecture by integrating the interaction between economic flows and the spatial lags of green subsidies. We find that the variable $\mathbf{W}$*geographic distance*$*$*Green subsidy*$_{t-1}$ multiplied by *actual economic flows* is positive and statistically significant. This suggests that, given high levels of economic flows, countries that observe neighbors implement more green subsidies in line with the principle of substitution are less likely to raise green taxes. By contrast, given low levels of economic flows, countries that see neighbors implement subsidies are more likely to raise green taxes. In essence, this finding indicates that, while high capital flows countries often implement the policy of their proximate countries, low capital flows countries are more likely to deviate from this trend. Thus, the evidence confirms that governments in less economically integrated countries do respond to the pressures to adopt a green policy by employing the alternative to a neighbor's instrument.

The interaction effect in Table 1 is illustrated in Figure 3. The plots show how economic flows affect green tax levels at different values of the spatial lag of green subsidies on geographic distances. When economically integrated countries are geographically proximate to countries that spend as much as 2000 dollars per capita on subsidies, their governments can be expected to raise taxes up to 650 dollars per capita. However, green taxes are on average below 600 dollars per capita if the spatial connection dissipates, which supports our proposition that high economic flows countries are more likely to adjust to a neighbor's policy mix. By contrast, less economically integrated countries that are connected to neighbors with subsidies amounting to 2000 dollars are more likely to have tax levels around 650 dollars, and are more likely to increase taxes if the spatial connection dissipates.

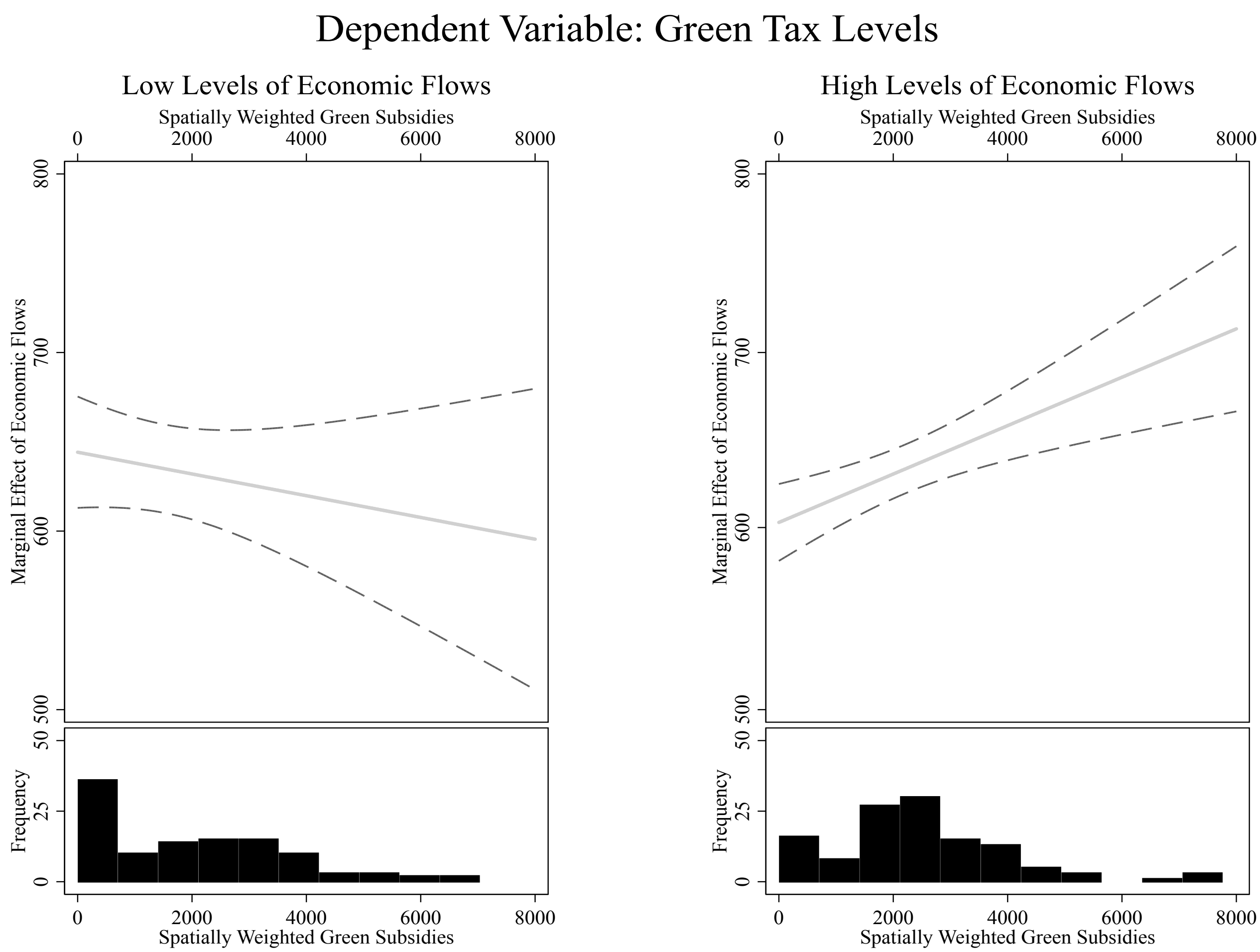

Figure 3: *Effects of Economic Flows and Spatially Lagged Green Subsidies on Green Taxes.* This figure is based on Model 3 from Table 1. The upper plots illustrate the marginal effects (solid line) and the 90% confidence interval (dashed line) of the spatial clustering of subsidies on the level of green taxes conditional on international economic flows. The histograms show the spatially lagged subsidies of countries above and below the mean value of the economic flows distribution.

The findings are robust to a number of sensitivity tests that we report in the Appendix. Our results are virtually unaltered if we run a spatial lag OLS model, and they are different in magnitudes but qualitatively identical if we do not row-standardize our main connectivity matrix. As we noted above, we also ran 3SLS estimations. In the 3SLS procedure, we endogenize the effects of the two alternative policies, including their respective spatial lags.[22] The results reported in the Appendix show that there is a positive and significant link between green taxes and the spatial lag of green subsidies interacted with economic flows. While we do not report this mechanism for the subsidy equation where the interaction is insignificant, this finding does not affect the implication that green taxes are influenced by other countries' subsidy levels.

Finally, one may wonder whether our inferences are limited by the choice to constrain the connectivity matrices to the 1,000 km, and how the results would change if we considered all distances across the observed OECD members, at the cost of bifurcating the sample between Europe, North America and distant countries in the Pacific Ocean. The results from these additional estimations show that leveraging the entire range of geographic distances in the connectivity matrices overturns the multiplicative coefficients. Specifically, the additional results indicate that countries with high economic flows are more likely to choose high taxes if they are more proximate to countries with higher subsidies (and thus lower taxes), while low economic flows countries are more likely to choose taxes if proximate countries implemented lower subsidies (and thus higher taxes). There are two ways to interpret the dissimilarity between this finding and the main results in Table 1. One is that, while within the distances of the constrained geography matrix these policies are substitutes, they may actually be complements across the world. Another way to think about these results is to consider how the observations of the most insular countries may influence the model. We find that at the top of the $\mathbf{W}\textit{geographic distance} * \textit{green subsidy}_{t-1}$ distribution are most distant countries like Australia and New Zealand. Furthermore, Japan, which has implemented very high levels of

[22] In the full form, each of the two structural equations has each of the two policies – *green taxes* or *green subsidies* – in the left-hand side, while the right hand-side includes the autoregressive temporal lag, the independent domestic variables and the vectorized international variables in Equation (1). Additionally, we include the $\mathbf{W}\textit{geographic distance} * \textit{green subsidy}_{t-1}$ if the outcome is green tax, otherwise $\mathbf{W}\textit{geographic distance} * \textit{green subsidy}_{t-1}$ if the outcome is green subsidies, and we add the interaction between the spatially weighted alternative policy and actual economic flows.

environmental subsidies, is at the bottom of the *economic flows* variable. These distributional characteristics suggest the most insular OECD countries that we dropped in our main analyses may be choosing policies in idiosyncratic ways precisely because of their insularity. So, even if the results that account for all geographical distances were true, our argument still holds in its generality, as more and less economically integrated countries show different reactions to other countries' alternative policies channeled through space.

Case 2: Carbon Policies in the Greater European Area

We have shown evidence supporting our theory based on the relationship between green taxes and environmentally motivated subsidies in OECD countries. Here we propose a second empirical study that provides an additional test of our argument. Our second study focuses on alternative instruments that are often evoked together in debates of climate change mitigation. Specifically, we investigate the relation between carbon-related taxes and carbon trading allowances in what we call the Greater European Area, a region at the border of the 'core' fifteen members of the EU (EU15) between 2000 and 2010. In the course of the 2000s, cap-and-trade in this region generated much debate on its costs and benefits compared to taxes. Since the European Union Emission Trading System (EU ETS) was adopted in 2003, non-EU15 countries have differed in the speed and levels in which they implemented either carbon taxes or carbon trading. For example, in 2002 the Slovenian government noted that "the introduction of an emission permits market is a measure that may contribute to reducing the total costs of emission reductions [...]. An interesting alternative to the emission permits market is the introduction of trade in exemptions as part of carbon (CO2) tax.'[23] Following our argument, we explore whether countries in the Greater European Area have preferred alternatives to their neighbours' policies conditional on their international economic integration.

[23] Slovenia's First National Report to the UNFCCC, p. 40. http://unfccc.int/resource/docs/natc/sloenc1.pdf.

Carbon Policy Data

To study the choice of alternative climate policies in the Greater European Area in the 2000s, we focus on seventeen countries: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Iceland, Latvia, Lithuania, Malta, Norway, Poland, Romania, Slovakia, Slovenia, Switzerland, and Turkey. We select these countries because at some point between 1950 and 2010 each expressed interest in EU membership, so we can assume that these countries are all exposed to the carbon policy options discussed in Europe at the time. However, for these countries climate policies were not strictly top-down imposed, but they rather represent an outcome of domestic decisions.[24]

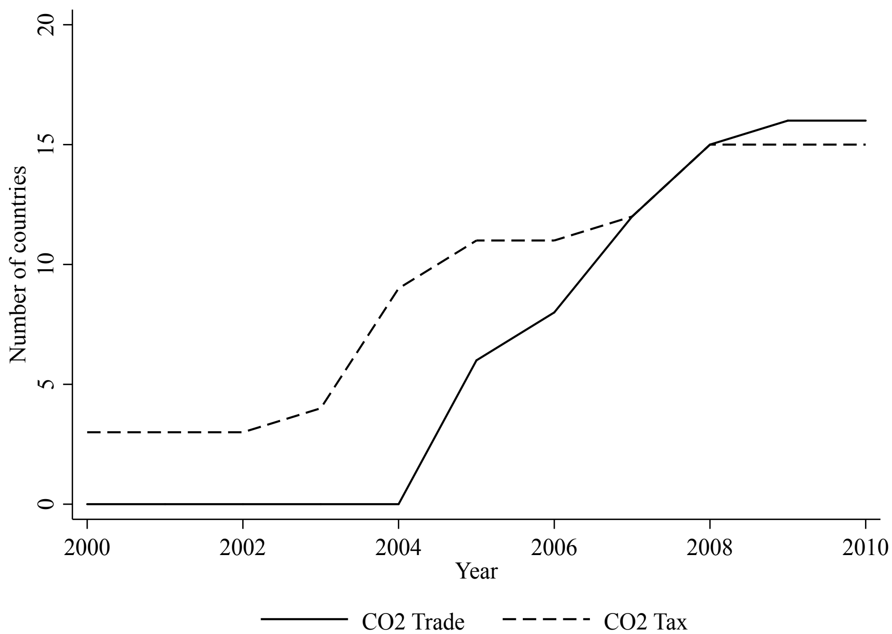

Figure 4: *Adoption of carbon policies, 2000-2010*: This figure shows the cumulative number of European neighborhood countries that adopted carbon taxes (dotted line) and carbon trading registries (solid line) across time.

Plotting the number of countries implementing a tax or a CO2 trade registry through time, Figure 4 shows that the adoption of both policies picked up in the course of the 2000s. However, because we are interested in continuous indicators of taxes and allowances for our econometric analyses, we collected data for the levels of these two variables. To measure *carbon*

[24]We exclude Albania, Morocco and Serbia, because we see too many missing values on their basic covariates. Moreover, these three countries do not meet the minimum threshold of $5000 GDP per capita, which we believe to be required for a credible climate policy, in line with the cost of policy implementation in the Stern Review.

taxes, we use the value of 'energy taxes on fossil fuel content' as percentage of GDP per capita, which we collected from the European Commission's 'Country Chapters' reports.[25] While this is not a straight-up carbon tax, it is the closest regulation of carbon-based fuels from CO2-generating polluters observed in Europe. Over these years, we find that Norway has had the most consistently high fossil fuel–related taxes, while Estonia and Slovenia have had the lowest tax levels, below 80 dollars per capita.[26]

Carbon allowances are considered the alternative to carbon taxes, and we measure them by the amount of tradable carbon credits countries possessed in each year since the establishment of a national carbon trading registry. Carbon allowances are equivalent to the volume of prevented or mitigated carbon emissions. More precisely, one allowance unit is calculated as one tonne of CO2.[27] The original data comes from the European Commission's Community Independent Transaction Log (CITL), which was set up following the 2003 European Union emission trading directive. This directive requested an adoption of the carbon trading policy by all EU countries, including new members. At the same time, several conditions were granted to new member states that could consequentially slow down the policy adoption.[28] These conditions were effectively used by a number of the countries in our sample. Romania and Bulgaria, for example, started operating its trading platform later than previously agreed.

For our measurement, we use the yearly deflated allowances reported in Abrell et al. (2011), which are the CITL national allowances minus the national verified emissions (i.e. the emissions for which most allowances are used at the source). Allowance volumes are more informative than the simple adoption of a carbon trading registry or auction. However, they are reflective of economic activity, so they need to be adjusted by gross domestic output. Consequently, we weigh the allowances by per capita GDP. Our carbon allowances variable is at zero levels

[25]See the European Commission's Tax Structures page, `http://ec.europa.eu/taxation_customs/taxation/gen_info/economic_analysis/tax_structures/article_6047_en.htm`, and at the Commission's Taxation Data archive, `http://ec.europa.eu/taxation_customs/taxation/gen_info/economic_analysis/data_on_taxation/index_en.htm`.

[26]In our analyses we normalize the tax distribution to address the fact that the tax distribution is sparse and there are many zeros. However, the results are qualitatively identical if we use the original scale.

[27]Different types of allowances exist, but the older one is the European Union allowance unit.

[28]For example, article 9 of the EU directive mentions that states can"issue allowances valid for a five-year period beginning in 2008 to persons in respect [...] to emission reductions made by those persons on their national territory during a three-year period beginning in 2005." Similarly, articles 11 and 12 give a lot of flexibility in terms of identifying the operators to monitor the emissions and enforcing penalties to infringements.

for most countries between 2000 and 2003, at which point the EU passed the Greenhouse Gas Emission Allowance Trading Scheme Directive, thereby incentivizing neighbouring countries to open auction houses and registries for emission trade at their discretion.[29] In 2010, allowances averaged the value of 1543 over the 17 sampled countries. To illustrate, they were at 11471 in Poland and 7248 in Romania. The time-country variation is also noticeable. For example, Iceland has had no carbon taxes nor has it issued allowances per capita.[30] Hungary in 2008 opened its first carbon trade registry but also established low tax levels.[31] Similarly, Romania has been slow at adapting emission trading, but by 2007 it reached the highest levels of allocation.[32] Maps in the Appendix further illustrate the rates of adoption across the two policies.

Key Variables and Estimation Strategy

Following our theory, we expect the international distribution of carbon allowances to be an influential determinant of the diffusion of carbon taxes, especially for less economically integrated countries that have more leeway to adopt the alternative policy. In line with the models employed above, we test our hypothesis with multiparametric spatiotemporal lag (M-Star) models. The full specification of our linear M-Star model is:

$$\begin{gathered} CO2\ tax_{i,t} = \varphi\ CO2\ tax_{i,t-1} + \mathbf{X}_{i,t}\beta + \rho\mathbf{W}_i CO2\ tax_{i,t} + \rho\mathbf{W}_i CO2\ allowances_{i,t-1} + \\ \rho\mathbf{W}_i CO2\ allowances_{i,t-1} \times Economic\ flows + \varepsilon_{i,t} \qquad (2) \end{gathered}$$

where *Economic flows*$_{i,t}$ also belongs to a subset of variables denoted by $\mathbf{X}_{i,t}$. As per our previous discussion, in the right-hand side we include the autoregressive temporal lag and a battery of domestic variables, $\mathbf{X}$, to gauge the effects of other national determinants of carbon tax levels (see Table 2). We include *GDP per capita* and its squared term (WDI, 2012) to

[29] The 2009 revised Directive governing the EU ETS decided to introduce a harmonised EU-wide approach to the allocation of greenhouse gas emission allowances to installations covered by the system. However, in the period of our analysis all allowances are calculated by national governments, which had freedom of allocation.

[30] European Commission 2013. `http://ec.europa.eu/enlargement/pdf/key_documents/2013/package/brochures/iceland_2013.pdf`. Accessed 17 March 2014.

[31] `http://www.unicreditanduniversities.eu/uploads/assets/CEE_BTA/Dora_Fazekas.pdf`.

[32] Reuters 2013. `http://www.reuters.com/article/2011/08/28/us-romania-co-idUSTRE77R0W920110828`. Accessed 17 March 2014.

control for the nonlinear income effects on carbon taxes. Similarly, because pollution may be a relatively low priority for citizens in the early stages of development but becomes a higher priority as they become better off, we include *CO2 per capita* and its square term (WDI, 2012). *Energy production* is the national production of energy in kilotons of oil equivalent divided by real GDP (WDI, 2012), and captures the power of energy intensive sectors and energy producers. For the political variables, we add a measure of *government effectiveness* (-2 to 2), which is a composite index of the coverage provided by public services, the quality of civil service and its independence from political pressures (WDI, 2012). Furthermore, we include the executive's *left-right position* as measured by the Database of Political Institutions.[33]

Evidently, the carbon policies in the sampled countries are not independent from those of the EU, not least because EU members often negotiate policy adoptions with neighboring countries on a bilateral basis, especially if the admission to the Union is foreseeable. On the one hand this is to our advantage, because it means that we can use the strong regional role played by the EU to see how our countries delayed or accelerated their preferred policies. At the same time, the role of EU conditionality has to be taken into account. Consequently, in our regressions we include a dummy for *EU integration*, where 1 stands for whether a country at point t was integrated in the Union, and 0 otherwise. More importantly for our analysis, we introduce the variable *EU economic flows* to measure the dependence that a country has from capital exchanges with the European Union. More specifically, we sum the balance of trade of each of the selected countries, where lower values stand for a lower exchange.[34]

To capture the effects of international interdependence, the connectivity matrices $\mathbf{W}$ are again calculated using the distance between capital cities.[35] $\mathbf{W}$*geographic distance***CO*2 *tax* is the spatial lag of the response variable. By contrast, $\mathbf{W}$*geographic distance***CO*2 *allowances* is the spatial lag of the alternative policy, which we expect to have a significant effect on CO2 taxes across countries. We lag this by one year, to estimate causal effects of the geographical

[33]Ideally we would want to measure the legislative medians as estimated by the Comparative Manifesto Projects, but some of our countries are not yet coded in that database.

[34]This data can be found at the Eurostat webpage (`http://epp.eurostat.ec.europa.eu/`) and at the European Commission Trade portal (`http://ec.europa.eu/trade/`).

[35]In additional estimations we also operationalized spatial ideological distances, but the results remain substantively unchanged.

Table 2: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
CO2 tax	129.8	154.9	0	676.7	187
CO2 tax (normalized)	18.5	22.3	0	100	187
CO2 allowances	847.8	2471.8	0	18556.0	187
GDP per capita	18076	18503	1612	93157	187
CO2 per capita	8.9	3.1	3.7	16.1	187
EU integration	0.4	0.5	0	1	187
Left-right position	2.1	0.8	1	3	187
EU economic flows	-0.01	0.092	-0.38	0.45	187
Energy production	-1692	51416	-209867	74513	180
Government effectiveness	0.9	0.6	-0.4	2.2	170

distribution of CO2 trading on the adoption of carbon taxes. Note that we row-standardize **W** to stay consistent with the previous specification, but also because the countries under consideration are clustered closely to each other and we are not concerned of 'washing away' spatial variance through standardization. We expect the spatial lag of carbon allowances to interact with the EU economic flows measure, because countries more integrated with the EU should adopt carbon trade together with carbon taxes especially if they are close to the EU 'border.' By contrast, countries that are less integrated should have more incentives to adopt carbon taxes if they are far away from the EU.

Results

Before testing the full specification in Equation (2), Column 1 in Table 3 reports the results of a model of CO2 taxes that only includes the domestic variables, the spatial lag of the dependent variable, and the within-country carbon trading allowances. In this model, the temporal lag's coefficient explains much of the variation in CO2 taxes, and indicates that the previous year's levels significantly increase carbon taxes in the present year. Income does not have an important effect, nor does it have an exponential relationship with CO2 taxes in our sample. By contrast, CO2 emissions are correlated with the carbon taxes both linearly and in a U-shape relationship. Although executive ideology is not statistically significant, government effectiveness and EU integration are linked to carbon tax levels. Specifically, government effectiveness decreases the level of carbon taxes, indicating that countries with weak public services and dysfunctional administrations may be less likely to adopt more complex and bureaucratic policies. Moreover, once a country is admitted to the EU it is more likely to increase CO2 taxes. Note also that learning from neighbouring countries does not drive the levels of carbon taxes, as shown by the coefficient of the spatial lag of carbon taxes, which is negative but not statistically significant.

Altogether, this model suggests there are domestic motivations driving carbon taxes in EU neighbours, and that these are not necessarily based on whether other countries have adopted carbon taxes. Moreover, we find that, keeping everything else constant, the levels of carbon allowances have a positive and statistically significant influence on carbon taxes, and that countries involved in carbon trading are more likely to raise the level of carbon taxes. We interpret this as evidence that carbon taxes and carbon trading are complementing policies, and that carbon allowances may precede carbon taxes as a country builds its environmental portfolio (notice that *CO*2 *allowances* is lagged by one year).

We then move to test whether the international diffusion of carbon allowances may affect national levels of carbon taxes by introducing the spatial lag of carbon allowances. The results in Model 2 show that the coefficient ρ for $\mathbf{W}$*geographic distance*CO2 Allowances*$_{t-1}$ is not significant but is negative, indicating that a country that is geographically distant from another country that has invested in carbon trading has lower pressure to implement carbon taxes. Moving to the full M-Star model (Equation 2), in Model 3 we calculate the coefficients of the spatial lag of carbon taxes, the spatial lag of carbon allowances, and the interaction of the spatial lag of carbon allowances with the indicator of economic integration. The ρ coefficient of $\mathbf{W}$*geographic distance*CO2 Tax* is negative but remains statistically insignificant. *EU economic flows* produces a positive coefficient and reaches statistical significance, which indicates that more integrated countries are more likely to raise carbon taxes. More importantly for our argument, we find that the coefficient for $\mathbf{W}$*geographic distance*CO2 Allowances*$_{t-1}$ conditional on EU economic flows is negative and statistically significant. The interpretation of this finding is that more economically integrated countries that border countries involved in carbon trading are more likely to adopt the complementing policy, carbon taxes (and, plausibly, carbon trading as well). By contrast, less economically integrated countries that border countries involved in carbon trading are less likely to adopt carbon taxes, the focal policy.

Table 3: *Carbon Taxes in the Greater European Area and The Conditional Spatial Effect of Carbon Allowances*

	M-Star models of CO2 Tax		
	(1)	(2)	(3)
CO2 Tax_{t-1}	0.750***	0.750***	0.750**
	(0.053)	(0.053)	(0.052)
CO2 Allowances_{t-1}	0.001*	0.001*	0.001*
	(0.000)	(0.000)	(0.000)
Energy production	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
GDP per capita	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
GDP per capita sq.	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
CO2 per capita	2.95*	2.96*	3.27**
	(1.68)	(1.68)	(1.65)
CO2 per capita sq.	-0.140*	-0.140*	-0.153*
	(0.083)	(0.083)	(0.082)
Government effectiveness	-6.47*	-6.48**	-6.72**
	(3.37)	(3.37)	(3.31)
Left-right position	-0.689	-0.652	-0.976
	(0.901)	(0.901)	(0.893)
EU integration	9.10***	9.10***	10.26***
	(2.29)	(2.29)	(2.29)
EU economic flows	7.22	7.22	26.73*
	(15.04)	(15.04)	(16.67)
ρ: $\mathbf{W}$*geographic distance*CO2 Tax*	-0.168	-0.168	-0.205
	(0.155)	(0.155)	(0.154)
ρ: $\mathbf{W}$*geographic distance*CO2* $\textit{Allowances}_{t-1}$		-0.001	-0.001
		(0.001)	(0.002)
ρ: $\mathbf{W}$*geographic distance*CO2* $\textit{Allowances}_{t-1}$ $\times$ EU economic flows			-0.032**
			(0.013)
Intercept	-6.23	-6.16	-5.98
	(8.01)	(7.99)	(7.84)
σ	8.74***	8.74***	8.57***
	(0.48)	(0.48)	(0.47)
N	163	163	163
Log-likelihood	-584.8	-584.7	-581.7
χ^2	838.9	840.2	879.3

Dependent variable is CO2 Tax Levels. The table reports linear M-Star coefficients. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

This result is illustrated in the two-dimensional plots in Figure 5. In the scenario of countries with high economic integration (*high levels of economic flows*), the countries that feel the geographic pressure of close countries with CO2 allowances are likely to have high carbon taxes, like in the case of Norway. The effects decrease and fade away as these countries become more insular, as in the case of Iceland. The opposite is true for less economically integrated countries (*low levels of economic flows*). Here the countries that are closer to countries with CO2 allowances are more likely to have low carbon taxes (and, in the logic of complementarity, carbon allowances), like in the case of Slovenia. Vice versa, being weakly linked through space with CO2 allowances makes it more likely that these countries will raise carbon taxes, *ceteris paribus*. Again, this is in line with our logic, as less economically integrated states choose differently than their close neighbors, especially if these have implemented sophisticated policies and if the alternative creates domestically beneficial opportunities, like attracting foreign firms or subsidizing domestic businesses.[36]

Note that our results are robust to running an OLS spatial lag model and to not row-standardizing the geography **W** connectivity matrix (see Appendix). We also ran the same type of 3SLS models described in the previous section, and find that there is a negative and significant link between carbon taxes and the spatial lag of carbon allowances interacted with economic flows. We find the same type of relationship for the allowances equation where the interaction between the spatial lag of carbon taxes and economic flows is also negative and statistically significant. This finding bolsters our conclusion that the geographic diffusion of climate change mitigation is driven by the domestic and international considerations behind both policies. Finally, one may wonder whether other variables that affect key actors' preferences towards different policies may interact with the spatial lag of the alternative policies. Our data seem to suggest that this could be an alternative hypothesis to study within our general argument: for example, we find that the spatial lag of carbon allowances differently affects countries with left and right government ideology. Future work may expand our theory to explore these additional patterns that explain how countries accept alternative diffusing policies when

[36]This was the case of many Eastern European countries investing in cap-and-trade. See `http://www.theguardian.com/environment/2012/nov/20/europe-emissions-trading`.

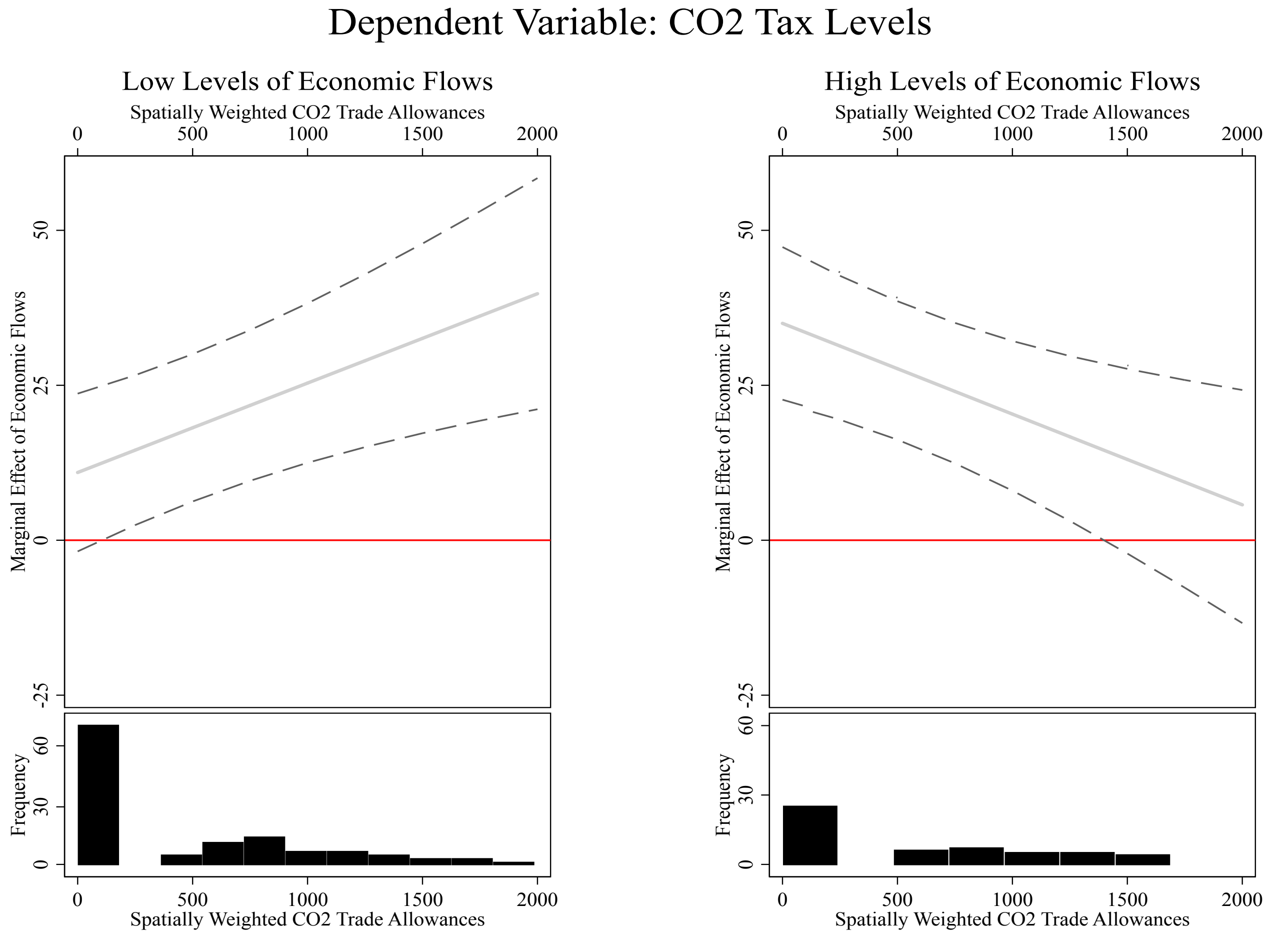

Figure 5: *Effects of Economic Flows and Spatially Lagged Carbon Allowances on Carbon Taxes.* This figure is based on Model 3 from Table 3. The upper plots illustrate the marginal effects (solid line) and the 90% confidence interval (dashed line) of the spatial clustering of carbon allowances on the level of carbon taxes conditional on international economic flows. The histograms show the spatially lagged carbon allowances of countries above and below the mean value of the economic flows distribution.

domestic considerations, other than the political constraints linked to economic integration, are imminent and salient.

Conclusion

Most analyses of policy diffusion operate under the assumption that international policy interdependence can be observed by focusing on the diffusion of one policy across jurisdictions. Yet, policy diffusion does not need to entail only one policy instrument, as governments often draw from several policies that may be diffusing simultaneously. This implies that policy interdependence may link countries in complex ways, as recent contributions on the politics of globalization and interdependence have indicated (Rudra, 2008; Oatley, 2011; Farrell and Newman, 2014; Chaudoin et al., 2015). Following this line of research, in this article we posit that national governments are sensitive to the geographic implementation of a bundle of diffusing policies, and that these policies may substitute or complement each other. Furthermore, we argue that the sensitivity to the spatial distribution of alternative policies is mediated by whether a country is dependent on international economic flows and may cause what we call policy alteration.

We test our argument with two empirical analyses that focus on environmental policies. Our spatial econometrics models suggest that geographic distance to implementing countries and domestic constraints based on the dependence on international capital flows generate incentives to adopt alternative policies. Specifically, we find that policy alteration is more likely to occur in countries that are relatively less dependent on economic flows and where governments consequently enjoy more political leeway to shape processes of policy diffusion to their strategic advantage. More generally, our findings suggest that by restricting the analysis on only one focal policy, researchers risk underestimating the overall degree of international interdependence. Thus, to avoid biased inference, it is important to integrate the logic of policy alteration into diffusion analyses when alternative policies are identifiable and when governments can be expected to strategically choose from a set of policy instruments. Further work may build on our framework and test its validity by replicating our study in another policy field, exploring the interaction of alternative policies with other key domestic factors such as industrial lobbying and pressure from various societal groups, and using new techniques that allow the estimation of spatial models for endogenous policies.

Finally, beyond opening a dialogue with the literature on policy diffusion and environmental politics, our study speaks to more general debates in the field of international relations. We provided evidence for how domestic decision makers learn from and react to the policies enacted in foreign countries. Therefore, our study may be useful to discuss hurdles of globalization in different domestic contexts, adding on to the embedded liberalism hypothesis. Moreover, our analysis supports the varieties of capitalism literature in pointing that government decisions in such diverse areas as foreign policy and diplomacy, foreign aid and immigration imply that governments have to weigh and choose among different policy instruments, taking into account both domestic and international constraints.

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Policy Alteration: Rethinking Diffusion Processes when Policies have Alternatives

Appendix

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The robustness checks discussed in the article are illustrated in the following tables and figures:

- Figure A.1 illustrates the relation between alternative policies in a context of diffusion.
- Table A.1 – A.7 refer to additional analyses for our first empirical study (Case 1).
  - Table A.1 reports the results from an OLS model of green tax
  - Table A.2 is an OLS model of green tax with a **W***geographic distance**Green subsidy $_{t-1}$ matrix that is not row-standardized.
  - Table A.3 reports additional M-STAR results controlling for EU membership.
  - Table A.4 reports the results from the 3SLS estimations of the two structural equations for *Green tax* and *Green subsidies*.
  - Table A.5 reports the results from the 3SLS estimations of two structural equations for *Green tax* and *Green subsidies* where GDP is calculated in absolute terms.
  - Table A.6 reports the results from M-Star and OLS models where the connectivity matrices are calculated across all distances, respectively.
  - Table A.7 reports the 3SLS estimations of two structural equations for *Green tax* and *Green subsidies* where the connectivity matrices are calculated across all distances.
- Figure A.2 – A.4 illustrate the interaction effects for our first empirical study (Case 1).
  - Figure A.2 refers to the interaction reported in Table 1.
  - Figure A.3 and Figure A.4 refer to the interactions reported in Table A.6.
- Figure A.5 and Figure A.6 map the sample and the two carbon policies of the second empirical study (Case 2).
- Table A.8 – A.10 report the results from robustness tests for our second empirical study (Case 2).
  - Table A.8 reports the results from an OLS model of carbon tax
  - Table A.9 reports the 3SLS estimations of two structural equations for carbon tax and carbon allowances
  - Table A.10 reports the results from the M-Star model where **W***geographic distance** Carbon allowances $_{t-1}$ is interacted with the *Left-right ideology* measure.

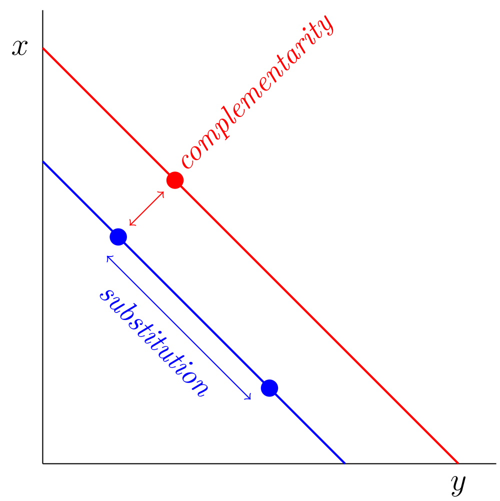


Figure A.1: *Effects of Different Types of Alternative Policies*: The figure shows the relation between two ideal alternative policies x and y that are substitutable by degree. Decision-makers may adopt a level of policy x *and* a level of policy y, while still keeping with the idea of substitution according to which governments may adopt more x *compared* to y (or vice versa).

Table A.1: *Green Taxes and Green Subsidies in OECD countries: The Effect of Alternative Policy Levels*

	OLS models of Green Tax		
	(1)	(2)	(3)
Green tax$_{t-1}$	0.90***	0.90***	0.89***
	(0.026)	(0.026)	(0.026)
Green subsidy$_{t-1}$	-0.173	-0.226	-0.226
	(0.170)	(0.170)	(0.170)
Energy production	-9829.4	-9463.5	-1604.8
	(19608.6)	(19500.4)	(19955.1)
GDP per capita	-0.0051*	-0.0046	-0.0041
	(0.0029)	(0.0029)	(0.0029)
GDP per capita sq.	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)
Unemployment	4.58	1.70	3.33
	(5.00)	(5.21)	(5.27)
Unemployment sq.	-0.34	-0.22	-0.27
	(0.23)	(0.24)	(0.24)
Income tax per capita	0.17***	0.18***	0.18***
	(0.047)	(0.047)	(0.047)
Left-right position	-1.40***	-1.44***	-1.41***
	(0.45)	(0.45)	(0.45)
Environmental position	0.064	-4.11	-2.75
	(8.83)	(8.96)	(8.95)
Environmental position sq.	-0.72	-0.26	-0.35
	(0.85)	(0.87)	(0.86)
Green party	-3.98	-4.95	-5.00
	(12.6)	(12.5)	(12.5)
Actual economic flows	-0.085	-0.12	-0.65
	(0.40)	(0.40)	(0.51)
ρ: $\mathbf{W}$*geographic distance**Green tax	-0.048	-0.008	-0.008
	(0.089)	(0.090)	(0.090)
ρ: $\mathbf{W}$*IGOs**Green tax	0.41***	0.37***	0.34***
	(0.11)	(0.11)	(0.11)
ρ: $\mathbf{W}$*dyadic trade**Green tax	0.15	0.16*	0.18*
	(0.094)	(0.094)	(0.094)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$		0.071*	-0.017
		(0.035)	(0.15)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows			0.003*
			(0.001)
Intercept	-272.5***	-266.9***	-240.8***
	(74.1)	(73.8)	(75.0)
N	231	231	231
R-squared	0.96	0.96	0.96

Dependent variable is Green Tax Levels. The table reports linear OLS coefficients. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: *Green Taxes and Green Subsidies in OECD countries: Unstandardized Green Subsidy Spatial Matrix*

	OLS models of Green Tax		
	(1)	(2)	(3)
Green tax$_{t-1}$	0.404***	0.406***	0.407***
	(0.046)	(0.046)	(0.046)
Green subsidy$_{t-1}$	-0.00141	-0.00143	-0.000166
	(0.0014)	(0.0018)	(0.0019)
Energy production	-177898.5*	-197374.5**	-165970.1*
	(92133.3)	(95125.7)	(96295.9)
GDP per capita	-0.0194*	-0.0260*	-0.0221
	(0.012)	(0.014)	(0.014)
GDP per capita sq.	0.0000**	0.0000**	0.0000**
	(0.0000)	(0.0000)	(0.0000)
Unemployment	24.94***	24.98***	27.28***
	(7.39)	(7.43)	(7.52)
Unemployment sq.	-0.915***	-0.919***	-1.012***
	(0.26)	(0.26)	(0.27)
Income tax per capita	0.917***	0.898***	0.950***
	(0.12)	(0.12)	(0.12)
Left-right position	-0.789	-0.796	-0.817
	(0.51)	(0.51)	(0.51)
Environmental position	14.31*	14.21*	15.42**
	(7.42)	(7.45)	(7.45)
Environmental position sq.	-1.845**	-1.830**	-1.932***
	(0.74)	(0.74)	(0.74)
Green party	21.82*	21.18*	20.19
	(12.3)	(12.4)	(12.3)
Actual economic flows	-2.106***	-2.027***	-2.673***
	(0.76)	(0.77)	(0.86)
ρ: $\mathbf{W}$*geographic distance**Green tax	-0.653***	-0.666***	-0.630***
	(0.16)	(0.16)	(0.17)
ρ: $\mathbf{W}$*IGOs**Green tax	0.589***	0.586***	0.562***
	(0.18)	(0.18)	(0.18)
ρ: $\mathbf{W}$*dyadic trade**Green tax	0.307*	0.321*	0.309*
	(0.16)	(0.16)	(0.16)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$		0.00000038	-0.00000481
		(0.00000031)	(0.0000029)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows			0.00000053*
			(0.00000032)
Intercept	-227.0	-159.8	-216.4
	(215.2)	(227.8)	(229.3)
σ			
N	231	231	231
R-squared	0.98	0.98	0.98
Log-likelihood	-1199.7	-1189.5	-1187.8

Dependent variable is Green Tax Levels. The table reports linear OLS coefficients. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Fixed effects included.

Table A.3: *Green Taxes and Green Subsidies in OECD countries: The Effect of Alternative Policy Levels (Controlling for EU Membership)*

	M-Star models of Green Tax		
	(1)	(2)	(3)
Green tax$_{t-1}$	0.89***	0.86***	0.89***
	(0.025)	(0.027)	(0.027)
Green subsidy$_{t-1}$	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Energy production	-11091	7581	25042
	(26576)	(27227)	(27393)
GDP per capita	-0.006**	-0.002	-0.006*
	(0.002)	(0.002)	(0.003)
GDP per capita sq.	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)
Unemployment	1.80	2.06	1.03
	(5.40)	(5.59)	(5.41)
Unemployment sq.	-0.24	-0.19	-0.19
	(0.24)	(0.24)	(0.23)
Income tax per capita	0.19***	0.18***	0.20***
	(0.047)	(0.048)	(0.046)
Left-right position	-1.26***	-1.58***	-1.20***
	(0.45)	(0.45)	(0.44)
Environmental position	0.07	-8.21	-1.42
	(8.47)	(8.66)	(8.49)
Environmental position sq.	-0.66	0.20	-0.41
	(0.81)	(0.83)	(0.82)
Green party	-0.83	-4.37	2.53
	(12.3)	(12.6)	(12.3)
EU membership	21.7	18.2	26.3
	(18.9)	(19.5)	(19.2)
Actual economic flows	-0.22	0.14	-0.91
	(0.39)	(0.38)	(0.50)
ρ: $\mathbf{W}$*geographic distance**Green tax	-0.049	0.163*	0.001
	(0.086)	(0.074)	(0.087)
ρ: $\mathbf{W}$*IGOs**Green tax	0.43***	0.006**	0.36***
	(0.10)	(0.003)	(0.10)
ρ: $\mathbf{W}$*dyadic trade**Green tax	0.10	0.37***	0.15*
	(0.088)	(0.062)	(0.089)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$		-0.16	-0.13
		(0.11)	(0.11)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows			0.003*
			(0.001)
Intercept	-218.0***	-305.0***	-201.1***
	(68.5)	(68.6)	(70.9)
σ	66.8***	68.5***	65.9***
	(3.11)	(3.17)	(3.05)
N	233	233	233
Log-likelihood	-1311.6	-1316.9	-1307.9
χ^2	5926.5	5680.1	6138.9

Dependent variable is Green Tax Levels. The table reports linear M-Star coefficients. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: *Green Taxes and Green Subsidies in OECD countries: 3SLS Models*

	Tax (1)	Subsidy (2)	Tax (3)	Subsidy (4)
Green tax$_{t-1}$	0.964***	0.564	0.973***	0.533
	(0.025)	(1.100)	(0.027)	(1.161)
Green subsidy$_{t-1}$	-0.003	0.551***	-0.010	0.565***
	(0.005)	(0.059)	(0.007)	(0.061)
Income tax per capita	0.092	-0.013	0.112**	-1.139
	(0.056)	(1.586)	(0.057)	(1.741)
Left-right position	-1.288***	-1.861	-1.561**	24.418
	(0.489)	(16.139)	(0.676)	(22.531)
Environmental position	-0.118	-470.580	-29.543*	-169.430
	(8.876)	(300.0)	(16.562)	(500.312)
Environmental position sq.	-0.741	30.6	1.670	15.8
	(0.845)	(29.844)	(1.537)	(48.617)
Green party	2.905	-4.023	-8.668	175.563
	(12.204)	(39.767)	(17.337)	(515.771)
Actual economic flows	0.199	-22.848*	-0.419	-27.756
	(0.485)	(13.339)	(0.807)	(20.441)
ρ: **W***geographic distance**Y	0.023	-0.035	-0.103	-0.063**
	(0.096)	(0.029)	(0.129)	(0.031)
ρ: **W***IGOs**Y	0.427***	0.126***	0.523***	0.146 ***
	(0.103)	(0.037)	(0.126)	(0.038)
ρ: **W***dyadic trade**Y	0.073	-0.036**	0.128	-0.038**
	(0.078)	(0.017)	(0.086)	(0.018)
ρ: **W***geographic distance**Green subsidy $_{t-1}$	0.011		-0.721**	
	(0.053)		(0.338)	
ρ: **W***geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows			0.009**	
			(0.004)	
ρ: **W***geographic distance**Green tax $_{t-1}$		0.648		0.154
		(1.170)		(3.503)
ρ: **W***geographic distance**Green tax $_{t-1}$ $\times$ Actual economic flows				0.006
				(0.042)
Intercept	-328.889***	2053.667	-225.968**	1713.840
	(72.577)	(1318.059)	(104.722)	(1680.600)
N	231	231	231	231
R-squared	0.96	0.36	0.96	0.36

The table reports the coefficients for 3SLS linear models. The dependent variables for each set of equations are Level of Green Tax and Level of Green Subsidy, respectively. Standard errors in parentheses. The endogenous variables are GPD per, capita, GDP per capita squared, Unemployment, Unemployment squared, and Energy Production (fixed effects included). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

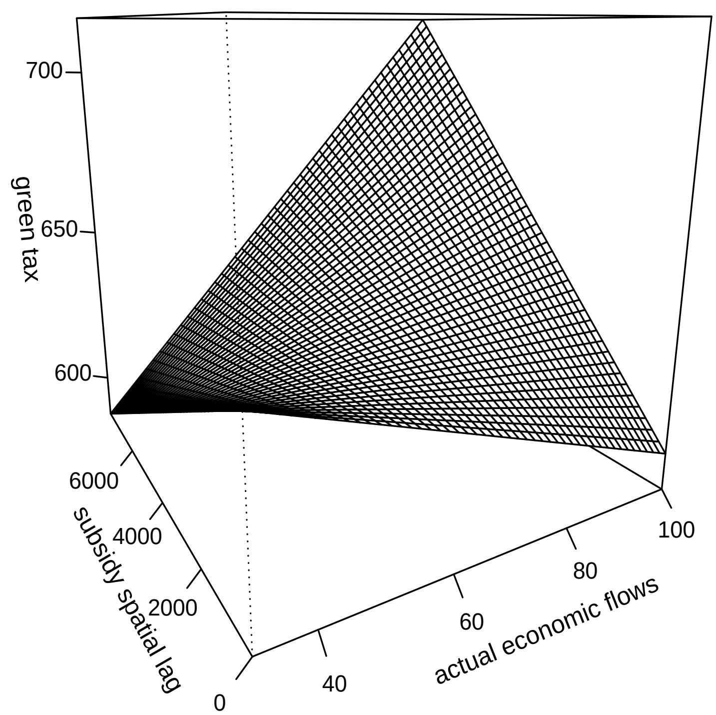


Figure A.2: *Effects of Spatial Clustering of Subsidies on the Level of Green Taxes Conditional on Level of International Economic Integration.* This figure is based on the interaction of Model 3 in Table 1.

Table A.5: *Green Taxes and Green Subsidies in OECD countries: 3SLS Models with Subsidy per Absolute GDP*

	Tax (1)	Subsidy (2)	Tax (3)	Subsidy (4)
Green tax$_{t-1}$	0.950***	0.002***	0.945***	0.003***
	(0.025)	(0.001)	(0.027)	(0.001)
Green subsidy$_{t-1}$	0.776	0.235***	0.840	0.205***
	(5.313)	(0.065)	(6.515)	(0.067)
Income tax per capita	0.099**	0.000	0.133**	-0.001
	(0.049)	(0.001)	(0.056)	(0.001)
Left-right position	-1.256***	0.005	-1.799***	0.016
	(0.477)	(0.009)	(0.674)	(0.013)
Environmental position	3.223	0.170	-14.313	-0.158
	(8.839)	(300.005)	(14.751)	(0.281)
Environmental position sq.	-0.949	0.022	0.463	0.029
	(0.870)	(0.017)	(1.485)	(0.027)
Green party	2.407	0.379*	-23.761	0.623
	(12.415)	(0.228)	(18.741)	(0.297)
Actual economic flows	0.092	0.006	0.327	0.014
	(0.428)	(0.008)	(0.514)	(0.012)
ρ: $\mathbf{W}$*geographic distance**Y	0.029	-0.035	-0.025	0.000
	(0.094)	(0.029)	(0.109)	(0.000)
ρ: $\mathbf{W}$*IGOs**Y	0.458***	0.126***	0.428***	0.000**
	(0.102)	(0.037)	(0.106)	(0.000)
ρ: $\mathbf{W}$*dyadic trade**Y	0.074	-0.036**	0.173*	0.000
	(0.082)	(0.017)	(0.094)	(0.000)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$	0.067*		-0.716*	
	(0.040)		(0.411)	
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows			0.009*	
			(0.005)	
ρ: $\mathbf{W}$*geographic distance**Green tax $_{t-1}$		-0.003***		0.154
		(0.001)		(3.503)
ρ: $\mathbf{W}$*geographic distance**Green tax $_{t-1}$ $\times$ Actual economic flows				0.000
				(0.000)
Intercept	-357.409***	-0.411	-344.616**	-0.690
	(68.036)	(0.872)	(73.946)	(0.967)
N	231	231	231	231
R-squared	0.96	0.28	0.96	0.28

The table reports coefficients for 3SLS linear models. The dependent variables for each set of equations are Level of Green Tax and Level of Green Subsidy by absolute GDP. Standard errors in parentheses. The endogenous variables are GPD per capita, GDP per capita sq., Unemployment, Unemployment sq., Energy Production (fixed effects included). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: *Green Taxes and Green Subsidies in OECD countries: The Effect of Alternative Policy Levels Across All Distances*

	OLS models of Green Tax			*M-Star models of Green Tax*		
	(1)	(2)	(3)	(4)	(5)	(6)
Green tax$_{t-1}$	0.41***	0.41***	0.41***	0.41**	0.41***	0.41***
	(0.046)	(0.046)	(0.046)	(0.041)	(0.041)	(0.041)
Green subsidy$_{t-1}$	-1.197	-1.104	-0.978	-0.012	-0.010	-0.009
	(1.387)	(1.401)	(1.390)	(-0.012)	(0.013)	(0.012)
Energy production	-198671**	-202924**	-227340**	-177734**	-184954**	-210051**
	(94571)	(95125)	(95000)	(-83309)	(83543)	(83273)
GDP per capita	-0.026*	-0.027**	-0.026*	-0.020*	-0.021**	-0.021**
	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)	(0.01)
GDP per capita sq.	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment	24.9***	24.6***	23.3***	25.4***	24.8***	23.6***
	(7.41)	(7.45)	(7.41)	(6.68)	(6.70)	(6.64)
Unemployment sq.	-0.918***	-0.908***	-0.866***	-0.94***	-0.92***	-0.88***
	(0.262)	(0.263)	(0.261)	(0.24)	(0.24)	(0.23)
Income tax per capita	0.897***	0.898***	0.880***	0.95***	0.95***	0.93***
	(0.121)	(0.121)	(0.120)	(0.11)	(0.11)	(0.11)
Left-right position	-0.792	-0.794	-0.819	-0.84*	-0.84*	-0.87*
	(0.508)	(0.510)	(0.505)	(0.46)	(0.46)	(0.45)
Environmental position	14.24*	14.62*	15.06**	14.9**	15.5**	15.8**
	(7.44)	(7.49)	(7.43)	(6.71)	(6.73)	(6.66)
Environmental position sq.	-1.828**	-1.848*	-1.877**	-1.90***	-1.92***	-1.94***
	(0.741)	(0.744)	(0.737)	(0.67)	(0.67)	(0.66)
Green party	21.24*	20.81*	17.55	22.7**	21.9**	18.6*
	(12.31)	(12.37)	(12.35)	(11.1)	(11.1)	(11.1)
Actual economic flows	-2.022***	-2.001**	-0.650	-2.18***	-2.14***	-0.79
	(0.769)	(0.772)	(1.001)	(0.69)	(0.69)	(0.89)
ρ: $\mathbf{W}$*geographic distance**Green tax	-0.666***	-0.636***	-0.609***	-0.584***	-0.539***	-0.518***
	(0.164)	(0.175)	(0.174)	(0.134)	(0.142)	(0.141)
ρ: $\mathbf{W}$*IGOs**Green tax	0.588***	0.559***	0.506***	0.612***	0.562***	0.510***
	(0.181)	(0.190)	(0.190)	(0.157)	(0.164)	(0.164)
ρ: $\mathbf{W}$*dyadic trade**Green tax	0.318*	0.307*	0.322*	0.186	0.178	0.197
	(0.164)	(0.166)	(0.165)	(0.133)	(0.134)	(0.133)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$		-0.003	0.004*		-0.053	0.378**
		(0.006)	(0.002)		(0.052)	(0.189)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows			-0.002**			-0.006**
			(0.001)			(-0.003)
Intercept	-155.74	-135.07	-206.05	-204	-170.3	-237.1
	(226.73)	(230.76)	(231.22)	(191.9)	(194.7)	(194.6)
σ				41.7***	41.7***	41.3***
				(1.94)	(1.94)	(1.92)
N	231	231	231	231	231	231
R-squared	0.98	0.98	0.98			
Log-likelihood				-1202.3	-1201.8	-1199.1
χ^2				15602.3	15627.9	15997.6

This table reports coefficients from linear models where the spatial lag is calculated across all distances (see text for more details). Dependent variable is Green Tax Levels. Models 1-3 report coefficients from an OLS specification, while Models 4-6 report coefficients from a multiparametric spatiotemporal autoregressive (M-Star) specification. Standard errors in parentheses. Fixed effects not reported for brevity. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.7: *Green Taxes and Green Subsidies in OECD countries: 3SLS Models of Alternative Policies Across All Distances*

	Tax (1)	Subsidy (2)	Tax (3)	Subsidy (4)	Tax (5)	Subsidy (6)
Green tax$_{t-1}$	1.00***	0.001	0.99***	0.001	0.99***	0.001
	(0.026)	(0.001)	(0.029)	(0.001)	(0.030)	(0.001)
Green subsidy$_{t-1}$	-4.17	1.00***	-6.11*	1.00***	-6.84*	1.00***
	(2.936)	(0.111)	(3.309)	(0.113)	(3.511)	(0.115)
Income tax per capita	0.072	-0.001	0.092	0.000	0.090	-0.001
	(0.050)	(0.002)	(0.056)	(0.002)	(0.059)	(0.002)
Left-right position	-1.244**	0.002	-0.820	0.001	-0.983*	0.001
	(0.480)	(0.019)	(0.544)	(0.019)	(0.579)	(0.019)
Environmental position	-3.047	-0.167	3.663	-0.171	2.162	-0.182
	(8.836)	(0.329)	(9.985)	(0.329)	(10.573)	(0.332)
Environmental position sq.	-0.571	0.012	-0.491	0.012	-0.379	0.012
	(0.843)	(0.032)	(0.943)	(0.032)	(0.998)	(0.032)
Green party	1.082	-0.006	-4.068	-0.024	-11.976	0.006
	(12.253)	(0.457)	(13.75)	(0.463)	(14.92)	(0.469)
Actual economic flows	0.123	0.002	-0.003	0.001	10.30**	-0.096
	(0.449)	(0.015)	(0.502)	(0.017)	(4.408)	(0.117)
ρ: $\mathbf{W}$*geographic distance**Y	0.045	0.000	0.116	0.000	0.002	0.000
	(0.096)	(0.000)	(0.108)	(0.000)	(0.124)	(0.000)
ρ: $\mathbf{W}$*IGOs**Y	0.454***	0.001***	0.065	0.0001***	0.082	0.0001***
	(0.104)	(0.000)	(0.139)	(0.000)	(0.147)	(0.000)
ρ: $\mathbf{W}$*dyadic trade**Y	0.036	-0.0004*	-0.051	-0.0004*	-0.028	-0.0004*
	(0.079)	(0.0002)	(0.090)	(0.0002)	(0.096)	(0.0002)
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$			-0.010***		0.027*	
			(0.002)		(0.016)	
ρ: $\mathbf{W}$*geographic distance**Green subsidy $_{t-1}$ $\times$ Actual economic flows					-0.0005**	
					(0.0002)	
ρ: $\mathbf{W}$*geographic distance**Green tax $_{t-1}$				-0.001		-0.014
				(0.005)		(0.016)
ρ: $\mathbf{W}$*geographic distance**Green tax $_{t-1}$ $\times$ Actual economic flows						0.0002
						(0.0002)
Intercept	-334.6***	-2.3	159.3	-1.7	-623.0*	5.3
	(70.4)	(1.6)	(125.2)	(3.5)	(358.1)	(9.0)
N	233	233	233	233	233	233
R-squared	0.96	0.16	0.96	0.16	0.96	0.16

The table reports 3SLS linear coefficients. The dependent variables for each set of equations are Level of Green Tax and Level of Green Subsidy. Standard errors are in parentheses. The endogenous variables are GPD per capita, GDP per capita squared, Unemployment, Unemployment squared, and Energy Production (fixed effects included).
$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

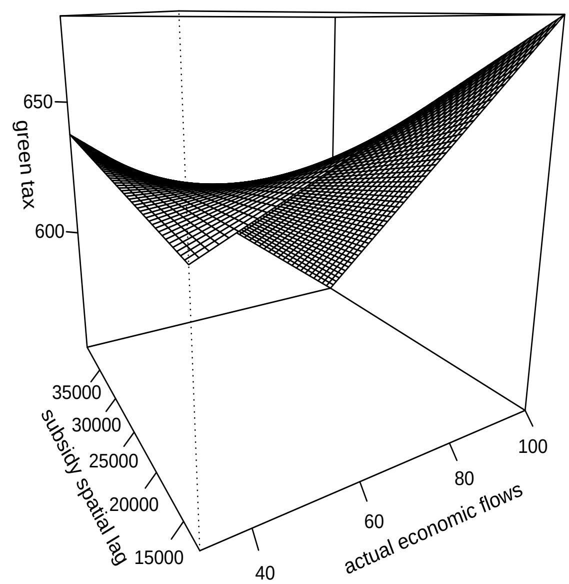


Figure A.3: *Effects of Spatial Clustering of Subsidies on Green Taxes Conditional on International Economic Flows.* This figure is based on the interaction of Model 3 in Table A.6. The spatial lag for green subsidies is calculated across all distances.

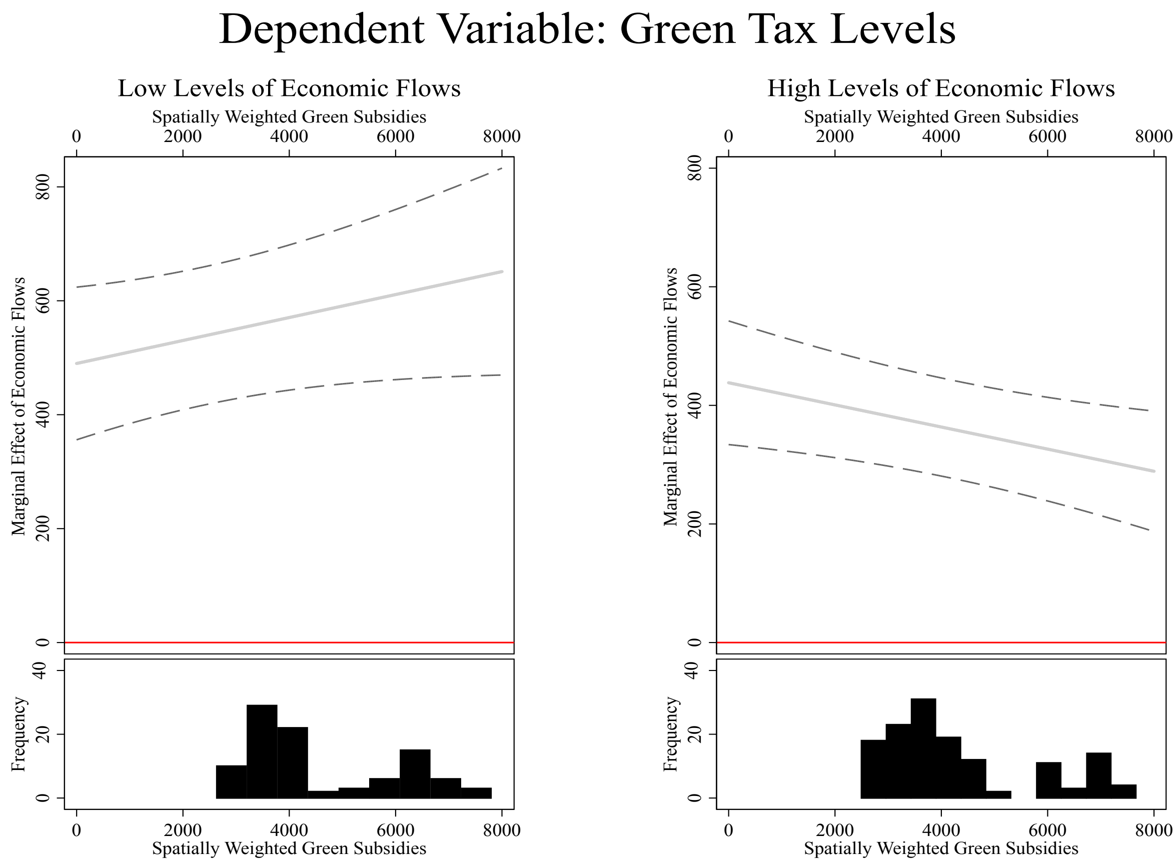
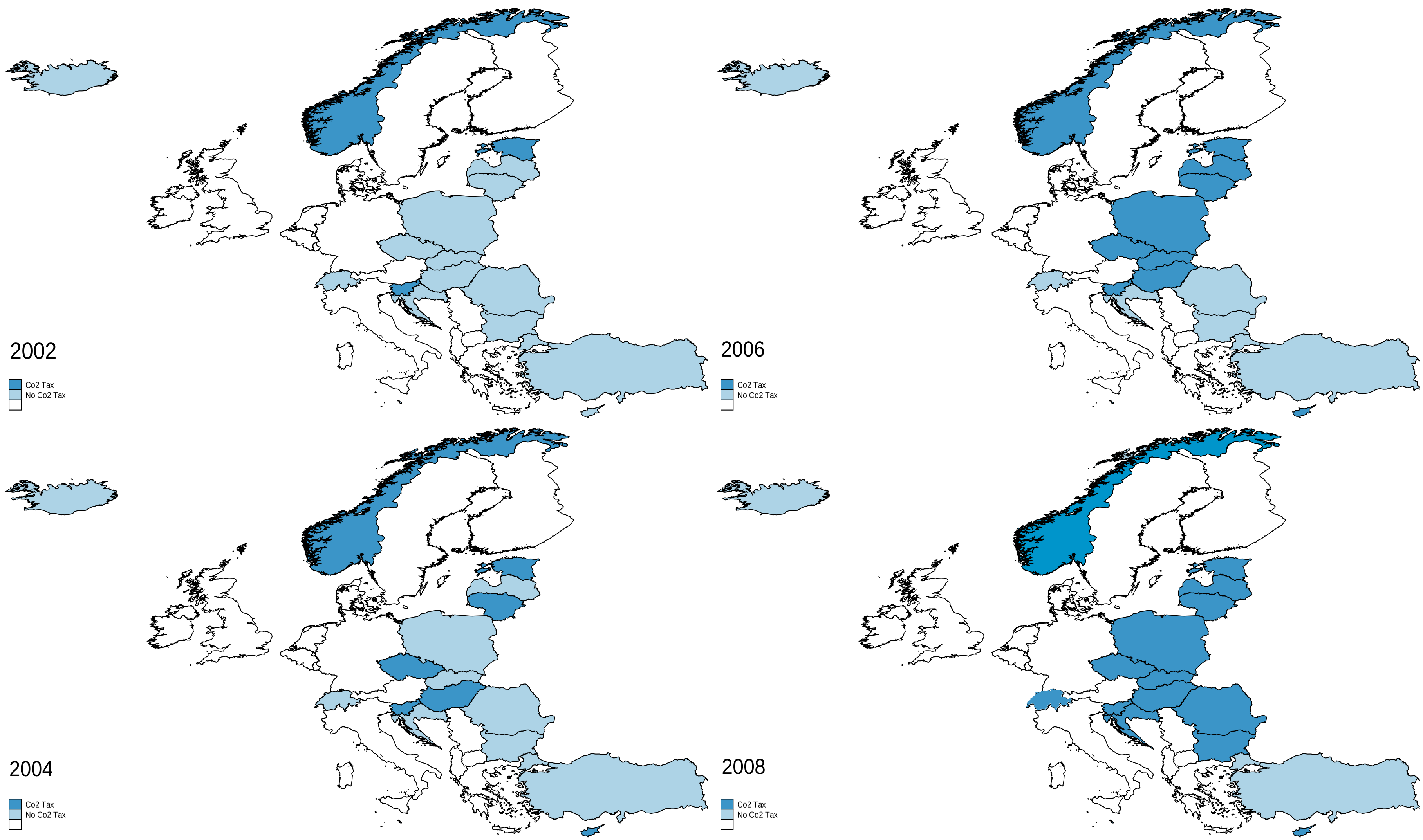


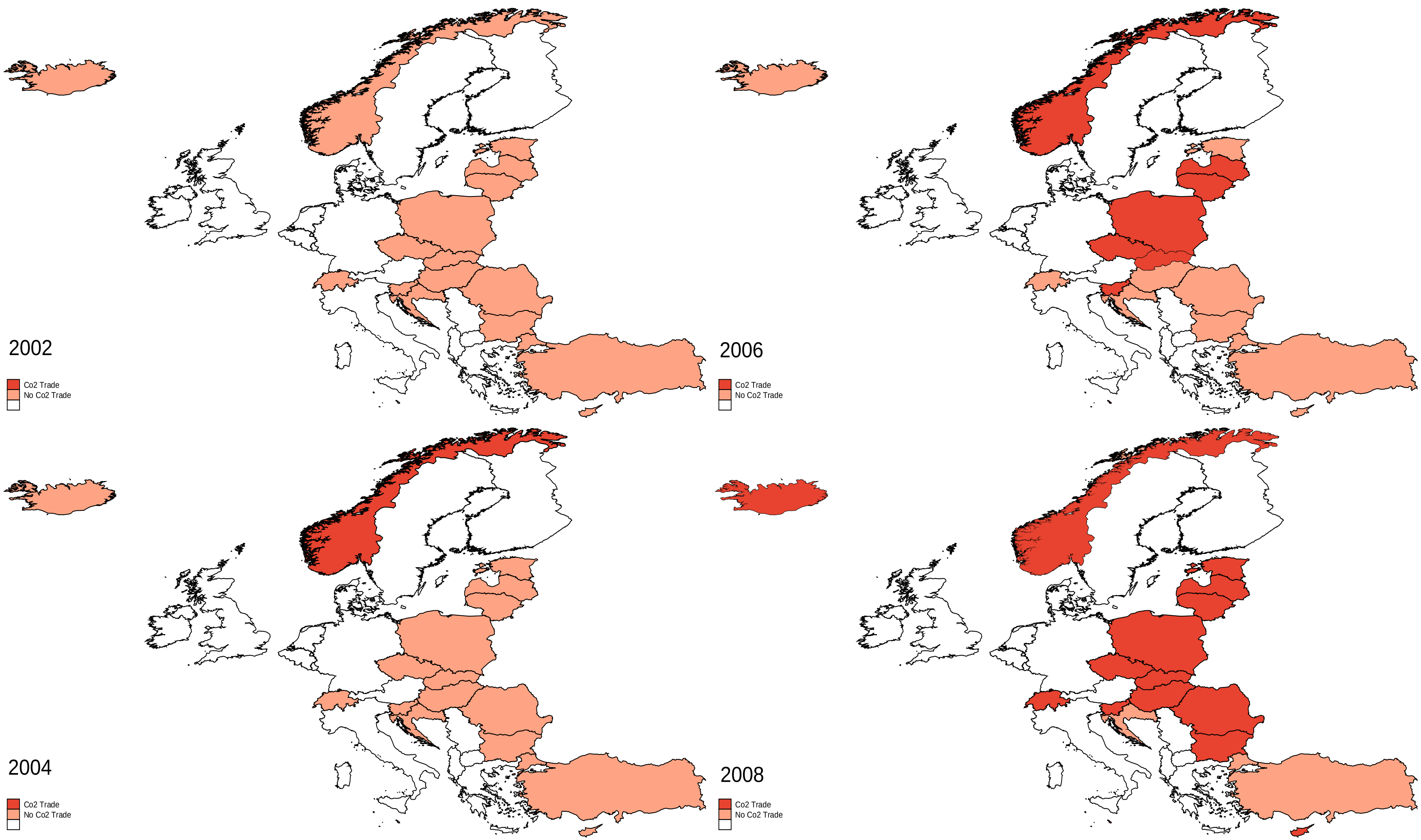
Figure A.4: *Effects of Spatial Clustering of Subsidies on Green Taxes Conditional on International Economic Flows.* This figure is based on the interaction of Model 6 in Table A.6. The spatial lag for green subsidies is calculated across all distances.

Figure A.5: *Carbon tax implemention in European countries across time and space*



In colour countries under consideration (sample). Darker colours indicate carbon tax implementation.

Figure A.6: *Carbon trading in European countries across time and space*



In colour countries under consideration (sample). Darker colours stand for opening of verification agency/carbon trading registry.

Table A.8: *Carbon Taxes in the Greater European Area and The Conditional Spatial Effect of Carbon Allowances*

	OLS models of CO2 Tax		
	(1)	(2)	(3)
CO2 Tax_{t-1}	0.751***	0.755***	0.761***
	(0.056)	(0.056)	(0.055)
CO2 Allowances_{t-1}	0.0007*	0.0006	0.0006
	(0.0004)	(0.0004)	(0.0004)
Energy production	-0.001	-0.001	-0.001
	(0.000)	(0.001)	(0.001)
GDP per capita	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
GDP per capita sq.	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
CO2 per capita	2.93*	2.98*	3.57*
	(1.75)	(1.75)	(1.73)
CO2 per capita sq.	-0.139	-0.142	-0.168*
	(0.088)	(0.087)	(0.087)
Government Effectiveness	-6.87*	-6.75*	-7.42**
	(3.60)	(3.59)	(3.54)
Left-right position	-0.656	-0.648	-0.875
	(0.938)	(0.935)	(0.924)
EU integration	9.31***	8.87***	10.66***
	(2.44)	(2.46)	(2.52)
EU economic flows	6.61	6.89	28.12
	(15.73)	(15.69)	(17.63)
ρ: $\mathbf{W}$*geographic distance***CO2 Tax*	-0.002	-0.000	-0.001
	(0.001)	(0.002)	(0.002)
ρ: $\mathbf{W}$*geographic distance***CO2* $\textit{Allowances}_{t-1}$		-0.003	-0.004*
		(0.002)	(0.002)
ρ: $\mathbf{W}$*geographic distance***CO2* $\textit{Allowances}_{t-1}$ $\times$			-0.037**
EU economic flows			(0.015)
Intercept	-6.01	-6.87	-7.87
	(8.35)	(8.35)	(8.21)
N	163	163	163
R-squared	0.84	0.84	0.85

Dependent variable is CO2 Tax Levels. The table reports linear (OLS) coefficients. Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: *CO2 Tax and CO2 Allowances in Europe: 3SLS Models*

	Tax (1)	Allowances (2)	Tax (3)	Allowances (4)	Tax (5)	Allowances (6)
CO2 Tax_{t-1}	0.604***	23.125	0.632***	31.54*	0.693***	25.08
	(0.094)	(16.96)	(0.109)	(17.26)	(0.1042)	(17.66)
CO2 $Allowances_{t-1}$	0.002**	0.440***	0.002	0.400***	0.001	0.407***
	(0.001)	(0.103)	(0.001)	(0.104)	(0.001)	(0.105)
Energy production	-0.001*	0.004	-0.0001	0.008	0.000	0.013*
	(0.000)	(0.006)	(0.0000)	(0.006)	(0.000)	(0.007)
GDP per capita	0.000	0.007	0.0003	0.052	-0.0001	-0.004
	(0.000)	(0.051)	(0.0003)	(0.060)	(0.0003)	(0.066)
GDP per capita sq.	0.000	0.000	0.000	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CO2 per capita	2.934	561.0	3.09	489.00	4.882**	713.5*
	(1.91)	(352.4)	(2.07)	(352.07)	(2.02)	(368.2)
CO2 per capita sq.	-0.144	-24.7	-0.1517	-21.11	-0.228**	-31.2*
	(0.095)	(17.7)	(0.103)	(17.63)	(0.099)	(18.3)
Government effectiveness	-5.675	-799.9	-5.513	-1406.5*	-8.312**	-1479.5*
	(3.954)	(652.2)	(4.286)	(793.6)	(4.093)	(798.7)
Left-right position	-1.40	74.5	-1.31	142.8	-1.68	57.4
	(1.116)	(189.9)	(1.2088)	(193.4)	(1.1240)	(198.5)
EU integration	10.14***	724.9	8.42**	1112.0*	14.67***	1993.2***
	(2.647)	(476.2)	(3.7934)	(581.5)	(4.1003)	(703.5)
EU economic flows	6.574	-1472.1	7.30	-2340.9	70.50**	6909.4
	(17.081)	(3120.9)	(18.40)	(3167.0)	(27.25)	(5199.6)
ρ: $\mathbf{W}$*geographic distance**Y	-0.001	-0.165	0.005	0.361	-0.001	0.470
	(0.002)	(0.352)	(0.009)	(0.550)	(0.008)	(0.554)
ρ: $\mathbf{W}$*geographic distance***CO2* $Allowances_{t-1}$			-0.013		-0.007	
			(0.017)		0.016	
ρ: $\mathbf{W}$*geographic distance***CO2* Tax_{t-1}				-0.007		-0.012**
				(0.005)		(0.006)
ρ: $\mathbf{W}$*geographic distance***CO2* $Allowances_{t-1}$ × EU economic flows					-0.112***	
					(0.038)	
ρ: $\mathbf{W}$*geographic distance***CO2* Tax_{t-1} × EU economic flows						-0.070**
						(0.031)
Intercept	-4.6320	-2515.9	-7.9583	-1950.1	-10.1	-2280.9
	(9.2672)	(1658.9)	(11.2247)	(1691.4)	(10.4)	(1708.2)
N	163	163	163	163	163	163
R-squared	0.83	0.48	0.81	0.49	0.82	0.48

The table reports 3SLS linear coefficients. The dependent variables for each set of equations are Level of Green Tax and Level of Carbon Allowance, respectively. Standard errors are in parentheses. The endogenous variables are GPD per capita, GDP per capita squared, CO2 per capita, CO2 per capita, Energy production and Government effectiveness.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: *CO2 Tax and CO2 Allowances in Europe: The effect of government ideology*

	M-Star model of CO2 Tax
CO2 Tax$_{t-1}$	0.75***
	(0.053)
CO2 Allowances$_{t-1}$	0.0007*
	(0.0004)
Energy production	-0.000
	(0.000)
GDP per capita	0.0002
	(0.0002)
GDP per capita sq.	0.000
	(0.000)
CO2 per capita	2.72
	(1.67)
CO2 per capita sq.	-0.13
	(0.083)
Government Effectiveness	-5.97*
	(3.35)
Left-right position	-1.98*
	(1.16)
EU Integration	8.64***
	(2.28)
EU economic flows	11.1
	(15.1)
ρ: $\mathbf{W}$*geographic distance***CO2 Tax*	-0.12
	(0.16)
ρ: $\mathbf{W}$*geographic distance***CO2 Allowances*$_{t-1}$	-0.006*
	(0.004)
ρ: $\mathbf{W}$*geographic distance***CO2 Allowances*$_{t-1}$ $\times$ Left-right position	0.003*
	(0.001)
Intercept	-2.49
	(8.17)
σ	8.65***
	(0.48)
N	163
Log-likelihood	-583.2
χ^2	859.6

This table reports coefficients from a linear multiparametric spatiotemporal autoregressive (M-Star)specification. Dependent variable is CO2 Tax Levels. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.