DISCUSSION PAPER SERIES

IZA DP No. 7831

Environmental Federalism: A Survey of the Empirical Literature

Daniel L. Millimet

December 2013

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

Environmental Federalism: A Survey of the Empirical Literature

Daniel L. Millimet
Southern Methodist University
and IZA

Discussion Paper No. 7831
December 2013

IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

IZA Discussion Paper No. 7831
December 2013

ABSTRACT

Environmental Federalism: A Survey of the Empirical Literature*

Environmental federalism refers to the debate over the 'optimal' level of government at which to delegate environmental policymaking. Although this issue receives widespread attention across the globe, opinions run the gamut. The diversity of views plays out in practice as well as different federations have 'resolved' the issue differently. With the United States alone, environmental authority has oscillated between periods of relatively greater centralized and decentralized control. This article seeks to accomplish two objectives in order to advance the literature. The first objective is to provide a brief overview of the two primary theoretical frameworks – Tiebout (1956) and models of interjurisdictional competition – used to explore the effects of the decentralization of policy decisions such as taxes, expenditures, environmental standards, etc. The reason for doing so is to illuminate the issues that play a fundamental role in conclusions regarding the 'optimal' allocation of environmental authority. The second objective is to then provide a comprehensive survey of the relevant empirical literatures. By doing so, the goal is to limit the scope of the debate over environmental federalism moving forward, as well as make clear where the gaps in empirical knowledge exist.

JEL Classification: H77, Q58

Keywords: environmental regulation, federalism, Tiebout, interjurisdictional competition

Corresponding author:

Daniel L. Millimet
Department of Economics
Southern Methodist University
Box 0496
Dallas, TX 75275-0496
USA
E-mail: millimet@smu.edu

* Portions of this Article were prepared while the author was an Adjunct Professor, Department of Economics, Queensland University of Technology. The author would like to thank Per Fredriksson, Arik Levinson, and participants at the LEC-PERC Workshop on Environmental Federalism at the Case Western Reserve University School of Law.

INTRODUCTION

Bednar (2011, p. 270) defines federalism as a "system of government characterized by semiautonomous states in a regime with a common central government" where "government authority is allocated between levels of government." Gordon (1983, p. 567) notes that within a federal system "each unit of government decides independently how much of each type of public good to provide, and what types of taxes, and which tax rates, to use in funding the public goods." While many countries contain a federal political system, the 'optimal' allocation of authority across levels of government is the subject of constant research and debate. While much of this research and debate focuses on fiscal policy (taxation and expenditures), the allocation of authority over environmental decision-making within a federal political system has also been discussed, deliberated, and agonized over for decades. The puzzle concerning the 'optimal' allocation of environmental authority across levels of government is commonly referred to as environmental federalism.

Although the issue of environmental federalism receives widespread attention across the globe, there is no resolution in sight. Even some of the most prominent researchers in this area have a diverse set of beliefs. Gordon (1983, p. 584) concludes: "Competition among communities should lead to greater efficiency and innovation. However, this paper has shown the many ways in which decentralized decision-making can lead to inefficiencies, since a local government will ignore the effects of its decisions on the utility levels of nonresidents… In light of these costs arising from lack of coordination, it may be preferable to have the central government take responsibility for particular activities, in spite of the lost diversity." Oates (2002a, p. 22) states: "My own sense is that where environmental quality is basically a local public good, the case for the setting of environmental standards at an appropriately decentralized level of government is quite compelling. At the same time, one can envision an essential informational and guidance role for the central authority." Wilson (1999, p. 298) concludes: "As such, competition among governments has both good and bad aspects, the importance of which vary across the attributes of the goods and services that the governments provide. This assessment suggests a role for intervention by a central authority, but both political considerations and information problems should be carefully addressed." Adler (2005, p. 138) states: "In sum, there is a strong case for a general presumption in favor of decentralization – a presumption that can be overcome in any specific policy context by demonstrating the need for federal intervention." Levinson (2003, p. 103) writes: "The conclusion must be that under most practical circumstances, local environmental authority will lead to inefficient regulations."

The diversity of views concerning the appropriate allocation of environmental authority also plays out in practice as different federations have 'resolved' the issue differently. For example, the well-known Principle of Subsidiarity emanating from the Maastricht Treaty of 1992 constitutionalizes the delegation of environmental authority by dictating that centralized action is only allowed in situations where policy objectives cannot be sufficiently achieved through decentralized action (Revesz 1997). This is consistent with the so-called Decentralization Theorem put forth in Oates (1972, p. 54): "[I]n the absence of cost-savings from the centralized provision of a [local public] good and of interjurisdictional externalities, the level of welfare will always be at least as high (and typically higher) if Pareto-efficient levels of consumption are provided in each jurisdiction than if any single, uniform level of consumption is maintained across all jurisdictions." In contrast, the delegation of authority is not constitutionalized in the US except insofar as decentralized policymaking is not allowed to interfere with interstate commerce

(Revesz 1997). As a result, environmental authority in the US has oscillated between periods of relatively greater centralized and decentralized control.[1]

Given this backdrop, the objectives of this article are twofold. The first objective is to provide a very brief summary of the main theoretical models put forth in the literature. The reason for doing so is to illuminate the issues that play a fundamental role in conclusions regarding the 'optimal' allocation of environmental authority. The second objective is to then provide a comprehensive survey of the relevant empirical literatures for the first time in the legal literature. By doing so, the goal is to limit the scope of the debate over environmental federalism moving forward, as well as make clear where the gaps in empirical knowledge exist.

ENVIRONMENTAL FEDERALISM IN THEORY

The two primary theoretical frameworks used to explore the effects of the decentralization of policy decisions such as taxes, expenditures, environmental standards, etc. derive from Tiebout (1956) and the literature on interjurisdictional competition.

The Tiebout model highlights the positive side of decentralization as jurisdictions compete for mobile residents in such a way that yields outcomes that are efficient. As laid out in Revesz (1992), the model relies on seven assumptions. First, individuals are perfectly mobile across jurisdictions and have heterogeneous preferences over jurisdictional attributes. Second, individuals have perfect knowledge concerning the attributes of all jurisdictions, which include the 'head' tax levied on residents and the level of public goods and services provided. Third, there exist a large number of jurisdictions. Fourth, employment does not affect individual residential choice as income is derived via dividends. Fifth, there are no interjurisdictional externalities. Sixth, every jurisdiction has a (known) optimal size where the average cost of services provided is minimized. Seventh, jurisdictions below their optimal size seek to attract new residents. Brueckner (2004, p. 133) provides a concise summary of the model: "Tiebout argued that, in attempting to attract residents, fiscally autonomous subnational governments will tailor public spending to suit individual preferences, leading consumers to sort across jurisdictions according to their demand for public goods. With each individual able to exactly fulfill his or her demand in some jurisdiction, the economy achieves a market-like outcome in the provision of public goods." Thus, under the assumptions of the model, this market-like outcome is efficient.

In contrast, the interjurisdictional competition framework nests both the positive and negative sides of decentralization as jurisdictions compete for mobile resources, typically taken as capital. Dating back at least to Oates (1972), the framework has led to a variety of theoretical models. The model of Oates and Schwab (1988) provides a useful starting point in the literature.

Oates and Schwab (1988) find that it is possible for decentralized environmental authority to be efficient even with interjurisdictional competition for capital. However, this result requires numerous assumptions. First, individuals are homogeneous and immobile across jurisdictions. Second, capital is perfectly mobile across jurisdictions, seeking to maximize after-tax returns, and all production profits are earned locally. Third, capital has perfect knowledge concerning the attributes of all jurisdictions, which includes the tax rate on capital and level of public goods and services provided. Fourth, there exist a large number of jurisdictions that take the after-tax return on capital as given. Fifth, there are no interjurisdictional externalities. Sixth, governments maximize the (known) social welfare of their jurisdiction. Oates (1999, p. 1135) summarizes this model, stating that "the invisible hand works in

[1] Vig (1984, 1994), Vig and Kraft (1984), and Elliott et al. (1985) provide early histories of environmental policymaking in the United States.

much the same way as in the private sector to channel policy decisions in individual jurisdictions into an efficient outcome from a national perspective."

In sum, the Tiebout and interjurisdictional competition frameworks provide a definitive answer to the environmental federalism debate under certain assumptions. Failure of these assumptions, however, may reverse this conclusion. For example, Oates (1999, p. 1136) stresses the limitations of his earlier work, stating: "The problem is that these models make some strong assumptions… [V]iolations of any of these conditions can lead to distorted outcomes." Indeed, many theoretical models have extended the Oates and Schwab (1988) model by relaxing various assumptions, finding that decentralized environmental policymaking with interjurisdictional competition may lead to environmental standards that are inefficiently stringent or lax.[2] Thus, the central takeaway message from this lengthy theoretical literature is eloquently provided in Oates (1999, p. 1136):

> "The theoretical literature thus generates some diverse findings on this issue. There seem to be some basic efficiency-enhancing aspects of interjurisdictional competition, but there are clearly a range of 'imperfections' that can be the source of allocative distortions. The real issue here is the magnitude of these distortions. Are we dealing with minor deviations from efficient outcomes-or does such competition produce major welfare losses? The pure theory can't help us much in answering this question."

The debate, then, over environmental federalism cannot be settled using theory alone. The range of possible *theoretical* outcomes can only be limited by an *empirical* understanding of the magnitudes of any violations of the various assumptions invoked in the Tiebout and interjursidictional competition frameworks. Surprisingly, a comprehensive review of what is known and unknown does not exist to my knowledge. The result is that the debate over environmental federalism focuses too much on anecdotal evidence and intuition, and not enough on empirical facts. The remainder of the paper seeks to remedy this by assessing our current knowledge of the "imperfections" alluded to above by Oates.

Prior to continuing, several comments are warranted. First, while violation of any of the assumptions noted above may cause decentralized environmental policymaking to be inefficient, this does not imply that centralized policymaking is efficient (or even less inefficient). Thus, interest lies in not just the validity of the prior assumptions, but also the contrast in social welfare under local versus central environmental authority as neither system is likely to yield the efficient outcome in practice.[3] Such differences will be discussed in the next section when possible.

Second, environmental 'policy' or 'regulation' is not a homogeneous concept. There are important sources of heterogeneity across environmental issues (e.g., air pollution, water pollution, hazardous waste disposal, and energy), across stages of environmental policy (e.g., scientific research, standard setting, measurement, and enforcement), and across environmental instruments (e.g., emissions taxes, cap-and-trade, subsidies, and command-and-control). In all likelihood there is no single answer to the question of 'optimal' allocation of environmental authority across levels of government. Differences may arise across specific environmental issues or stages of the policy process. Moreover, certain policy instruments may not be available to all levels of governments. Such differences will also be emphasized when possible in the remainder of the article.

---

[2] Dijkstra & Fredriksson (2010) provide an excellent survey of this literature.

[3] The alternative to decentralized policymaking need not be complete centralization. A third option based on regional policymaking may be possible. In the interests of limiting the scope of the discussion, the distinction between regional and central policymaking is ignored. See Oates (2002a), Dinan and Tawil (2003), and Adler (2005) for some discussion of regional environmental policymaking.

Finally, the quest to understand the 'optimal' level of government at which to assign environmental authority depends on, among other things, one's definition of 'optimal.' Economists often equate optimality with efficiency, which requires the equating of marginal social costs and benefits in all locations. Others may wish to incorporate equity or political considerations into the notion of optimality.[4] Still others may consider the 'optimal' allocation of governmental authority as that which maximizes environmental quality. As evidenced by the theoretical discussion above, the structure of this article is guided by the factors affecting the efficiency of policymaking in theoretical models. That said, the efficient outcome is generally unknown, making the "first-best policy … typically impracticable" (Banzhaf and Chupp 2012, p. 449). Thus, empirical evidence regarding the impact of local versus central control is often expressed in terms of the level or variance of environmental quality or the resulting nature of the political process. Adler (2007, p. 71) stresses this point, stating: "[W]hile it is common to suggest that more environmental regulation is better than less regulation, it is not always clear that greater levels of environmental regulation are always welfare enhancing. The optimal level of environmental regulation in a given context may be greater than current levels, but it may also be lower if the costs of a given level of regulation exceed the benefits."

ENVIRONMENTAL FEDERALISM IN PRACTICE

This section discusses the empirical literature relating to several of the assumptions invoked in the Tiebout and interjursidictional competition frameworks. First, the empirical literature on the mobility of capital and individuals is examined. Second, preference heterogeneity is assessed. Third, the importance of interjurisdictional externalities is evaluated. Fourth, political economy issues are examined. Finally, issues related to policy instruments are discussed.

RESOURCE MOBILITY

The Tiebout framework has as its linchpin the perfect mobility of individuals. The interjurisdictional competition framework has its linchpin the perfect mobility of capital. Here, I review the empirical evidence on the mobility of these two resources, starting first with individual mobility.

Population Mobility

Efficiency in the Tiebout model requires the population to be perfectly mobile across jurisdictions in order for individuals to sort within communities that choose policies aligned with their preferences. Molloy et al. (2011, p. 173) write: "The notion that one can pick up and move to a location that promises better opportunities has long been an important part of the American mystique." Clearly, however, individuals are not perfectly mobile. Revesz (1992, p. 1237) states: "[M]uch of the legal literature has dismissed as unrealistic the assumption of perfect mobility by individuals. There may, indeed, be substantial transaction costs in exiting one jurisdiction and moving to another, particularly in a world in which individuals have jobs and do not live solely on dividend income." That said, how mobile are individuals? And, does mobility differ across socioeconomic groups?

Long (1991) presents evidence on residential mobility in the US and other countries in the 1970s and 1980s. Defining mobility as simply changing residential address, he finds that the US has the second highest one-year residential mobility rate at 17.5% (behind New Zealand) and the third highest five-year residential mobility rate at 46.4% (behind Canada and Australia) in the early 1980s among the

[4] Inman and Rubinfeld (1997) provide a nice discussion of some of these issues.

handful of countries analyzed. However, changing residences within a jurisdiction is not the type of mobility envisioned in the Tiebout model. Upon further examination, Long reports that roughly 60% of one- and five-year residential mobility is due to moves within the same county; roughly 80% is due to moves within the same state. Thus, very little internal migration crosses jurisdictional boundaries that might entail significant changes in the provision of environmental quality.

Molloy et al. (2011) provide a more current, in-depth analysis of internal migration in the US. The crux of their analysis points to an interesting puzzle: despite having one of the highest rates of internal migration in the world, US internal migration has declined since roughly 1980. Despite this decline, internal migration rates in the US are still among the highest in the world. Specifically, five-year, cross-state migration rates in the US fell from 9.9% of the population in 1980 to 8.9% in 2000. Five-year, cross-county migration rates declined from 19.8% in 1980 to 18.6% in 2000. Molloy et al. (2011, p. 180-1) state: "This decrease marks a noticeable departure from the longer-run trend as migration shows a secular rise from 1900 to 1990... Not only are migration rates lower in levels than at any point in the post-war period, they have also entered a period of continuous decline that is longer than any recorded in the twentieth century."

Beyond simply documenting rates of internal migration, several studies have assessed the determinants of migration and destination choice. Among different socioeconomic groups, the largest differences in migration rates appear across education levels and homeownership status. For example, Molloy et al. (2011) estimate the annual interstate migration rate for individuals with at least a college degree to be 2.1% over the period 2001-2010 in comparison to only 1.2% for high school graduates and 1.0% for high school dropouts.[5] Similarly, the migration rate for renters is 3.5%, but only 0.9% for homeowners. Surprisingly, there is little difference in migration rates by race or income status over this period.

Barro et al. (1991), Borjas et al. (1992), and Davies et al. (2001), among others, investigate the role of economic factors on migration decisions. Barro et al. (1991) document a statistically significant, but small, effect of per capita income differentials on interstate migration. Davies et al. (2001) use a different statistical technique and obtain larger effects. Specifically, the authors find that a one standard deviation increase in the ratio of the unemployment rate at a potential destination state to one's current state reduces the likelihood of migration to that destination by about 19%. Similarly, a one standard deviation increase in the ratio of per capita income at a potential destination state to one's current state increases the likelihood of migration to that destination by about 16%. Finally, Borjas et al. (1992) find that workers migrate to maximize their relative standard of living. In particular, high skilled workers move to states where the return to skill is high (and, hence, income inequality is greater), while low skilled workers move to states where the return to skill is low (and, hence, income inequality is lower).

To my knowledge, there is little empirical evidence on the role of environmental quality in explaining internal migration decisions. Barro et al. (1991) explore US interstate migration rates from 1900-1987. To proxy for environmental amenities, the authors include an independent variable measuring the average number of days requiring heating. This is admittedly an extremely crude proxy for environmental amenities. Nonetheless, the authors find it to be a meaningful determinant of net migration rates into US states. Similarly, Kahn (2000) explores the role of smog – measured as days per year exceeding the Clean Air Act one-hour standard for ozone – only county-level population growth in California between 1980 and 1994. He finds that a county experiencing a ten-day decline in the number of "high ozone" days over this time period registered a 7.8% increase in population on average.

[5] Rosenbloom and Sundstrom (2004) also document a historically positive association between education and the propensity to migrate internally in the US.

Banzhaf and Walsh (2008) undertake a detailed analysis using more spatially disaggregate data than these prior studies. The authors use data from California over the period 1990 to 2000. The authors divide urban areas of the state into mutually exclusive half-mile diameter circles. They then assess the relationship between changes in pollution and changes in population and mean household income over this period. Toxicity-weighted air emissions from the TRI are used as the measure of pollution. The results support the role of environmental amenities in household location decisions. Specifically, locations with the average level of emissions in 1990, as opposed to no emissions in 1990, experienced about a 12 percentage point reduction in the population growth rate between 1990 and 2000. The average location experiencing an increase in emissions over the time period suffered a 6.9 percentage point reduction in the population growth rate. The average location experiencing a decline in emissions witnessed a 6.3 percentage point increase in the population growth rate.

Lastly, Konisky (2010), in perhaps tangentially related research, finds that better educated individuals are more likely to favor federal control over most environmental issues, including local issues such as protecting community drinking water. If the higher mobility rates of the better educated documented in Molloy et al. (2011) are related to environmental issues, one might expect the reverse to be true.

In sum, labor mobility is relatively high in the US compared to many other developed countries, and there exists some evidence that location decisions are impacted by environmental amenities at a very spatially disaggregate level. But, mobility is on a "historically unprecedented" downward trajectory in the US (Molloy et al. 2011, p. 194). Whether this low (and declining) mobility invalidates the Tiebout assumption, or simply reflects a population close to equilibrium where most individuals are currently residing in communities that maximize their utility is not clear. Moreover, whether the "threat" of migration exists and is sufficient to satisfy the assumptions of the Tiebout model is equally unclear.[6]

However, three facts work against the Tiebout model. First, migration patterns appear to be strongly related to employment, not the provision of public goods. Second, the survey evidence in Konisky (2010) indicates that more mobile segments of the population are more likely to favor federal authority over even local environmental issues. Finally, the fact that mobility rates are significantly lower for the less educated runs the risk that jurisdictions do not compete for residents of this type, but instead focus on the competition for more mobile, educated residents. If so, the Tiebout model would predict that the preferences of lower educated residents will be ignored. Provision of even purely local goods, such as drinking water, may not reflect the preferences of all residents. Bednar (2011, p. 274) states: "If only a categorical portion of the population is immobile – the poor or ethnic minorities – then outcomes are even worse; governments compete for the wealthiest and are free to ignore these minority categories."

Capital Mobility

The empirical literature on capital mobility is much more extensive. Not only are there a number of studies assessing the impact of taxation on the location of industrial activity, but there are many studies focused solely on the impact of environmental regulation on the location of industrial activity. In the interest of relative brevity, I focus solely on the latter and start with the survey article of Jaffe et al. (1995). Jaffe et al. (1995) survey the literature at the time on the effects of the early period of

[6] The "threat" of migration is analogous to the notion of contestable markets. In that case, a market with few firms may achieve the competitive equilibrium if the "threat" of entry exists due to (i) a lack of entry and exit barriers, (ii) no sunk costs, and (iii) complete access to the same technology by both incumbents and new entrants (Baumol 1992).

environmental regulation in the US (post-1970) on country-level competitiveness.[7] To measure competitiveness, the authors focus on empirical studies examining trade patterns, both generally and specifically in pollution-intensive industries, domestic firm location decisions, and foreign direct investment (FDI). Jaffe et al. (1995, p. 157-8) summarize the literature, concluding: ''Overall, there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness, however that elusive term is defined… [S]tudies attempting to measure the effect of environmental regulation on net exports, overall trade flows, and plant-location decisions have produced estimates that are either small, statistically insignificant, or not robust to tests of model specification." Surveying the literature at roughly the same time, Levinson (1999, p. 32) similarly notes that "the empirical literature suggests that … economic activity does not respond significantly to the different taxes and regulations in competing jurisdictions."

However, there are a number of statistical problems that plagued these early empirical studies. In their concluding remarks, Jaffe et al. (1995) discuss the issue of measuring environmental stringency in practice. Environmental regulation is a complex concept which does not lend itself to precise measurement. Regulations differ across pollutants and depend not just on legislation (*de jure* regulation) but also enforcement (*de facto* regulation). Reliance on poor proxies for environmental regulation – referred to as measurement error in the econometric literature – might explain the lack of meaningful effects found in these early studies. A second problem with this early literature is that the results lacked a convincing causal interpretation. As Jaffe et al. (1995, p. 146) note: "[T]he choice of a new plant location is obviously a complex one… Hence, isolating the effect of environmental regulations on the decision will inevitably be difficult." In particular, the choice of environmental stringency in a particular jurisdiction may be endogenous to the level (or expected level) of economic activity, or may be correlated with other location-specific attributes that determine the location of economic activity but are unobserved by the researcher.

The empirical literature beginning in the late 1990s addresses these criticisms. As noted in Jepppesen et al. (2002), this "second wave" of studies has consistently found meaningful, detrimental effects of environmental regulation on industrial activity. Brunnermeier and Levinson (2004, p. 38) conclude: "The early literature based on cross-sectional analyses typically tended to find that environmental regulations had an insignificant effect on firm location decisions. However, several recent studies that use panel data to control for unobserved heterogeneity, or instruments to control for endogeneity, do find statistically significant pollution haven effects of reasonable magnitude. Furthermore, it does not appear to matter whether these studies look across countries, industries, states, or counties, or whether they examine plant location, investment, or international trade patterns."

One branch of this second wave of studies uses the spatial and temporal variation in US county-level environmental regulation induced by the Clean Air Act (CAA) to address the question of capital mobility. Specifically, beginning in 1972, every US county is designated as either in attainment or out of attainment (nonattainment) of the federally designated standard for each of the criteria air pollutants established under the statute. Counties that are in nonattainment are subject to more stringent regulation. Thus, nonattainment status is synonymous with greater regulatory stringency.

Henderson (1996) uses data on the ozone attainment status of urban counties over the period 1978-1987, along with data on the number of establishments in each county during each year from the County Business Patterns, to examine the effects of the more stringent regulations imposed in nonattainment counties. He focuses on five pollution-intensive manufacturing industries: industrial organic chemicals, petroleum refining, miscellaneous plastics, plastic materials and synthetics, and blast

[7] See also Engel (1997).

furnace and primary steel. The results indicate that counties in attainment over the prior three years contain 7-10% more establishments than other counties.

Henderson (1997) revisits the same data using a different statistical methodology and focusing on a binary indicator of the presence of at least one establishment in a county during a given year in the pollution-intensive industries studied. He finds that the probability of a given industry being located in a county increases by at least 19% in four of the five industries considered after a county switches from nonattainment to attainment.

Becker and Henderson (2000) continue this line of inquiry, using plant-level data over the period 1963-1992 for the industrial organic chemicals, miscellaneous plastic products, metal cans and barrels, and the wood furniture sectors. The data come from the Longitudinal Research Database, administered by the Center for Economic Studies of the US Census Bureau. The results are in line with the prior studies; nonattainment status reduces the expected number of new plant births by 26-45%. However, the authors find that new plants locating in nonattainment counties are initially larger in size (relative to new plants locating in attainment areas). This size discrepancy disappears after roughly ten years.

Greenstone (2002) builds on this research by examining 1.75 million plant-level observations over the period 1967-1987, obtained from the Census of Manufactures, to assess the separate impacts of carbon monoxide, ozone, sulfur dioxide, and total suspended particulate nonattainment status across all counties in the US. With such rich data, the author is able to identify the effect of nonattainment status on plants in sectors deemed to be high emitters of each of the four criteria pollutants using only the temporal variation within plants, controlling for industry- and county-level unobserved attributes in an unrestricted way. The results indicate that over the period 1972-1987, nonattainment counties (relative to in attainment counties) lost roughly 600,000 jobs, $37 billion in capital stock, and $75 billion in output in 1987 dollars.

In a series of paper by List and co-authors, the impacts of ozone nonattainment status on county-level industrial activity in New York State are examined over the period of 1980 to 1990. Annual data on new plant births by domestic and foreign firms, as well as plant relocations, are provided by the Industrial Migration File maintained by the New York State Department of Economic Development. List et al. (2003a) focus on plant relocations and find that being in nonattainment costs a county roughly 0.50 fewer relocating plants in pollution-intensive sectors per year relative to being in attainment. Given that the average county in the sample only receives about 0.2 relocating plants per year, this represents a sizeable decrease. List et al. (2003b) analyze new plant births using similar statistical techniques. Here, the authors find even larger effects; nonattainment counties lose out on approximately one new pollution-intensive plant per year relative to being in attainment. The average county in the sample obtains 0.4 new plant births per year. Finally, List et al. (2004) revisit the data on new plant births, distinguishing between new plant births by foreign and domestic firms. The authors find that the prior deterrent effects of nonattainment status on new plant births is driven entirely by domestically-owned plants; foreign-owned plants are unresponsive to spatial variation in environmental regulatory costs due to differences in ozone attainment status.

The other branch of this second wave of the empirical literature on the effects of environmental regulation on the location of industrial activity analyzes patterns of international trade and FDI (the so-called pollution haven hypothesis). The criticisms of the early literature are particularly worrisome when examining the effects of cross-country differences in environmental regulation. First, one needs a consistent measure of environmental regulation across multiple countries. Second, one needs extensive data on country (or industry) characteristics otherwise any association between environmental stringency and the patterns of global trade or investment may simply reflect unobserved attributes of countries (or industries) correlated with both regulation and the location of industrial activity. The

traditional econometric approach used to overcome measurement error in the proxy for environmental regulation and unobserved, country-level heterogeneity is the method of instrumental variables. While not all studies employing instrumental variables are necessarily sound (due to the use of weak or potentially invalid instruments), I focus only on studies that employ this technique as the alternative – such as cross-sectional or fixed effects estimation – is not likely to produce causal estimates of the impacts of environmental regulation in my view (due to the requirement that all independent variables in such models be strictly exogenous).

The first set of studies focus on patterns of FDI. Xing and Kolstad (2002) assess the pattern on US outbound FDI in six manufacturing sectors across 22 host countries using data from 1985 and 1990. As a proxy for environmental regulation, the authors utilize sulfur dioxide (SO_2) emissions. The authors find more lax regulation (as measured by higher SO_2 emissions) leads to greater US investment in two pollution-intensive industries: chemicals and primary metals. There is no meaningful effect for the other, less pollution-intensive, sectors considered.

Fredriksson et al. (2003) examine the impact of environmental stringency on US inbound FDI across the 48 contiguous states for the period 1977-1986. To measure environmental regulation, the authors utilize an index based on the ratio of actual pollution abatement expenditures incurred by plants located in the state to the predicted level of expenditures based on the state's industrial composition. The results indicate a meaningful deleterious effect of stringency on inbound FDI. For example, the effect of a one standard deviation in stringency in California in 1984 is predicted to lower employment in the foreign-owned chemical plants by 6%, or 2500 jobs.

Cole and Elliott (2005) analyze the patterns of US outbound FDI in Brazil (Mexico) across 31 (36) industries from 1989-1994. The authors' goal is to disentangle the effects of environmental regulatory costs – measured by industry-level pollution abatement costs per unit of value added – on firm behavior from the effects of endowments of physical capital. Specifically, the authors contend that since many pollution-intensive sectors are also capital-intensive, the benefit to firms from more lax environmental standards in less developed countries may be offset by lower levels of physical capital in these same countries. Brazil and Mexico, the authors argue, are relatively well endowed with physical capital but have lax environmental standards, thus making it more likely that investment in these countries will be more sensitive to environmental costs. Indeed, the authors find evidence supporting the claim that sectors experiencing relatively high environmental regulatory costs in the US do invest more in each country.

Cole and Fredriksson (2009) utilize data on inbound FDI to 13 OCED and 20 less developed countries over the period 1982-1992. The proxy variable for environmental regulation is the allowable lead content in gasoline. The results point to a sizeable, deleterious effect of environmental regulation on the amount of inbound FDI enjoyed by a country. For example, a one standard deviation increase in the authors' measure of regulation leads to a roughly 0.6 standard deviation reduction in a country's stock of FDI.

Kellenberg (2009) focuses on effects of country-level environmental stringency on the value added of majority-owned US affiliates in 50 countries across nine industries over the period 1999-2003. To measure environmental policy, Kellenberg uses data from the Global Competitiveness Report (GCR) on the stringency and enforcement of environmental regulations. The GCR creates separate indices related to stringency and enforcement based on survey responses elicited from executives. The results point to a meaningful effect of environmental regulation on the location of production abroad by majority-owned US affiliates. Specifically, for the 20 countries that experienced the largest increase in economic activity by majority-owned US affiliates over the sample period, 7% of this increase is attributable to more lax environmental policies in these countries.

Finally, Millimet and Roy (2011) analyze the pattern of inbound FDI across the 48 contiguous US states from 1977-1994 (omitting 1987) using recently developed econometric techniques designed for situations where valid instrumental variables are difficult to envision. The measure of state-level environmental regulation is identical to that used in Fredriksson et al. (2003). The authors find an adverse impact of environmental regulation on the amount of FDI locating in a state for the pollution-intensive chemical sector, but no effect on the level of FDI for manufacturing as a whole.

The second set of studies focus on patterns of international trade. Cole and Elliot (2003) examine the impact of environmental regulation on the net exports of 60 countries in four pollution-intensive sectors in 1995. The sectors studied include iron and steel, chemicals, pulp and paper, and non-ferrous metals. Two measures of environmental stringency are employed. The first is an index based on country reports concerning environmental policies and enforcement compiled under United Nations Conference on Environment and Development guidelines. The second is a proxy variable computed using information on the energy intensity of production. The authors find no effects of environmental stringency on net exports, but they do find effects on the composition of trade; stricter regulation leads to a greater fraction of trade that is inter-industry.

Several studies utilize US industry-level measures of environmental costs based on pollution abatement expenditures to assess the impact of regulation on industry-level measures of US imports or exports. Ederington and Minier (2003) analyze data on the net imports of 374 US industries over the period 1978-1992 (omitting 1979 and 1987). The authors find extremely large effects of environmental costs on net imports. Specifically, they find that a 1% increase in pollution abatement costs results in a 30 percentage point increase in net imports scaled by the total value of US shipments in the industry. Similarly, Cole et al. (2005) analyze the effect of environmental costs on US net exports across 94 industries over the same time period. The authors also control for the human and physical capital intensity of sectors, finding a detrimental effect of environmental costs on net exports. However, the magnitude of the effect is much smaller than that due to human or physical capital considerations. Finally, Levinson and Taylor (2008) examine US net imports from Mexico and Canada across 132 industries over the period from 1977-1986. The authors also find a large, adverse effect of environmental costs on domestic production. For example, net imports increased by $601 million (in 1982 US dollars) for the average industry in the sample over this period; $79 million of this increase is attributable to the rise in pollution abatement costs. Among the 20 industries in the US that experienced the largest rise in pollution abatement costs, the numbers are $595 million and $453 million, respectively.

The final two studies utilize data across several countries. Jug and Mirza (2005) analyze the import patterns of 12 countries in the EU15 and export patterns of 19 countries from the EU15 and Central and Eastern Europe across nine industries over the period 1996-1999. Environmental regulation is measured using data from the Eurostat Environmental Expenditures and Environmental Taxes database on total current expenditures related to environmental protection activities for all manufacturing. The results indicate a meaningful, negative effect of environmental stringency on domestic production, with the results of greater magnitude for Eastern Europe.

Mulatu et al. (2010) utilize data on 16 industries across 13 countries to assess the role of environmental regulation on the share of production in each industry that occurs in each country. The objective is to determine if countries with relatively more stringent regulation are responsible for a greater share of production in pollution-intensive sectors over the period from 1990 to 1994. The country-level measure of regulation is given by the Environmental Sustainability Index (collected in 2001) developed by the World Economic forum, Yale Center for Environmental Law, and Center for International Earth Science Information Network at Columbia University. As with the prior studies, the

findings point to significantly greater domestic production in pollution-intensive industries in countries with lax regulation.

In sum, second generation studies – utilizing better data and (potentially) improved statistical approaches to identify the causal effect of environmental policy – have consistently documented a meaningful effect of environmental stringency on the location of economic activity. That said, these findings must be interpreted carefully. First, environmental costs are a small fraction of the total production costs for most industrial sectors. Thus, the effects documented in the literature typically apply to only the most pollution-intensive industries. For the vast majority of industries, environmental costs are a small fraction of overall costs and location decisions are dominated by other factors. For example, Henderson and Millimet (2007) allow for heterogeneous effects of more stringent environmental policy on the amount of foreign investment and find the effects to be negative for some locations and positive for others. Overall, Henderson and Millimet (2005) find no overall effect of environmental stringency on the Gross State Product of US states.

Second, the effects estimated by econometric models are *ceteris paribus* effects. In other words, they indicate the impact of more stringent environment regulation "with other things the same" or "with all other things being held constant." In practice, other important determinants of the location of economic activity are not held fixed such as a location's endowment of physical and human capital. This fact is highlighted by the analyses of Ederington et al. (2004), Levinson (2010), and Grether et al. (2012). In the first two of these studies, the authors show that the rate of increase in total US imports has risen faster over the past few decades than the rate of imports of pollution-intensive goods. As such, the pollution content of US imports has fallen over a period where US regulatory stringency has increased markedly. Grether et al. (2012) analyze the pollution content of imports across 48 countries and find that environmental standards play a small role in the overall pattern of trade. In this vein, Cole and Elliott (2005, p. 541) conclude: "We do not suggest that pollution havens are widespread."

Finally, while the studies I have focused on make use of instrumental variables or fixed effects strategies an attempt to isolate the causal effect of environmental regulation, not all identification strategies are convincing in my view. I discuss some of this in my prior research (e.g., Millimet and Roy 2011) and so I have not rehashed such arguments here. Nonetheless, readers should be cognizant that simply because researchers employ panel data fixed effects or instrumental variables methods does not mean that such strategies produce credible inferences.

PREFERENCE HETEROGENEITY

The Tiebout framework relies on heterogeneous individuals sorting themselves across communities offering different combinations of taxes and public goods. In equilibrium, the policies of each community will reflect the preferences of its homogeneous residents. The literature on environmental federalism, and fiscal federalism more generally, has long touted the ability of communities to synchronize policy choices with individual preferences as the primary advantage of decentralized policymaking. Gordon (1983, p. 582) states: "One of the key advantages of decentralization is the resulting diversity of policies." Oates (1999, p. 1120) writes: "The hope is that state and local governments, being closer to the people, will be more responsive to the particular preferences of their constituencies…" Adler (2005, p. 138) asserts that "localized control of environmental policy will produce environmental measures that are more likely to reflect the preferences and needs of those who will be most affected by them."

In practice, the advantages to decentralized policymaking depend on three factors: (i) the extent of preference heterogeneity in the population, (ii) the degree to which individuals act on such

preferences to sort themselves into homogeneous communities, and (iii) the ability of local governments to better respond to community preferences than the central government. I discuss the empirical evidence on each in turn.

For the purposes of evaluating the benefits of decentralization, empirical evidence on the extent of heterogeneous preferences over environmental issues is scant. Several papers utilize survey or voting data to examine associations between socioeconomic characteristics and preferences. Elliott et al. (1997) use data from the General Social Survey, administered by the US National Opinion Research Center, to analyze public attitudes toward environmental spending over the period 1974 to 1991 (omitting 1979 and 1981). The authors find that liberalism, lower age, being female, being non-white, urban status, education, and income are positively associated with preferences for environmental spending. However, one is not able to discern how much overall variation in preferences exists, nor how much of this variation is explained by these attributes

Israel and Levinson (2004) and Lorenzoni and Pidgeon (2006) undertake similar analyses using individual-level, cross-country data. Israel and Levinson utilize data spanning 33 countries from the World Values Survey during the mid-1990s. Consistent with the prior study, the authors find that lower age, being female, education, and income are positively associated with willingness to pay for environmental improvements. However, the vast majority of the variation in willingness to pay (72%) is explained by the country one resides in, not by the socioeconomic attributes included in the analysis. As such, over two-thirds of the international variation in willingness to pay occurs across countries, with the rest representing within-country variation.

Lorenzoni and Pidgeon (2006) discuss data collected by the European Opinion Research Group in 2002 across EU15 member states on individual concerns regarding climate change. The authors report the percentage of survey respondents in each country reporting that they are "very worried" about climate change. The percentages varied from about 21% in The Netherlands to about 64% in Greece. When asked about concern over future trends in climate change, the percentage responding "very much" or "quite a lot" varied from roughly 48% in the Netherlands to roughly 85% in Greece and Italy. Thus, there is variation in concern over climate change both within and across countries.

Kahn and Matsusaka (1997) examine county-level voting on 16 environmental ballot initiatives in California spanning 1970 to 1994. The authors report the county with the lowest and highest fraction of votes in favor of each ballot initiative. For example, Proposition 1986-65 that sought to restrict the release of chemicals into drinking water sources received 32.7% votes in favor in the least favorable county and 63.0% votes in favor in the most favorable county. Other ballot measures yielded greater variation. Votes in favor of Proposition 1990-130 that sought to ban clear-cutting of forests and authorize a $742 million bond issue to buy forest land ranged from 15.3% in the least favorable county to 70.7% in the most favorable county. This is indicative of significant variation in preferences across counties. Kahn and Matsusaka further find that much of this cross-county variation is explained by differences in per capita income, urban status, education, and per capita income derived from specific industries (construction, farming, forestry, and manufacturing).

Rather than relying on survey response data, several papers utilize information on home values and environmental amenities (or disamenities) to assess the demand for environmental quality. Zabel and Kiel (2000) combine data from the American Housing Survey, the US Census Bureau, and the EPA across four cities (Chicago, Denver, Philadelphia, and Washington, D.C.) from 1974-1991 to estimate household-level marginal willingness to pay for air quality by relating local air quality to home values. The authors then examine the association between household characteristics and this value. In contrast to the results above, Zabel and Kiel find lower marginal willingness to pay for nonwhites and no meaningful association with gender.

Brasington and Hite (2005) utilize data on home sales across six metropolitan areas in Ohio (Akron, Cincinnati, Cleveland, Columba, Dayton, and Toledo) in 1991 to first estimate the implicit price of distance from the nearest environmental hazard and then examine the effect of price, income, and other attributes on the demand for distance from the nearest environmental hazard. The authors find a small, negative (positive) price (income) elasticity of demand for distance from the nearest environmental hazard. Carruthers and Clark (2010) follow the strategy in Brasington and Hite (2005) and examine data on home sales in King County, Washington in 2004. The authors obtain similar results in terms of the price and income elasticity of demand for distance from the nearest environmental hazard.

The second factor affecting the advantages to decentralization relates to the degree to which individuals act on variation in environmental preferences to sort themselves into homogeneous communities. The preceding studies on preferences over environmental quality provide little evidence in this regard. With the exception of Kahn and Matsusaka (1997), studies using survey responses or voting behavior are geographically aggregated. Thus, while preferences vary across individuals, there is no information concerning the level of variation in the total population versus the level of variation in a single community. Kahn and Matsusaka, however, do provide evidence of significant variation in voting behaviors across California counties driven by differences in income and industrial composition.

Studies utilizing housing prices to infer something about the willingness to pay for environmental amenities or how the prices of environmental amenities affect its demand also fail to provide insights into the amount of overall variation in preferences or whether preferences are more homogeneous at the city level than at the state or country level. Lastly, the empirical evidence on population mobility discussed earlier indicates that residential location choices, at least in the US, are driven primarily by employment prospects.

The final factor impacting the advantages to decentralized policymaking pertains to the ability of local governments to better respond to community preferences than the central government. If preferences concerning the environment do vary across individuals and individuals do sort into homogeneous communities, both of which are far from certain, are local policymakers better able to align environmental policies with these preferences? While this is typically asserted, as evidenced by some of the quotes above, there is no evidence to support this contention. Wilson (1999, p. 277) states "[W]e do not have a good understanding of how information asymmetries occur between different levels of government, and what exact form these asymmetries take. Rather, we have vague ideas, such as the understanding that local officials know more because they are 'closer to the people.'… [I]t seems difficult to justify why the central authority cannot easily obtain the information that is assumed absent."

In sum, the empirical evidence regarding preference heterogeneity and its implications on environmental federalism is limited and incomplete. While it seems likely that preferences do vary, perhaps much of this variation is across countries. The main drivers of within-country variation are income, education, and industry. Because these attributes are easily observed, Wilson's point about central governments being as capable as localities of understanding local preferences is valid. That said, it is not clear that communities are particularly homogeneous with respect to these attributes. For example, in terms of income, the level of income inequality in 1999 across all households in the US was 0.463 as measured by the Gini coefficient, a common measure of inequality.[8] The Gini coefficient ranges from zero to one, where zero indicates perfect equality (all households have identical incomes) and one indicates perfect inequality (one household possesses all income). The corresponding state-level Gini coefficients ranged from 0.402 (Alaska) to 0.499 (New York). County-level Gini coefficients are available pooling data from 2006-2010. Here, the Gini coefficients vary from 0.207 (Loving, TX) to

[8] See http://www.census.gov/hhes/www/income/data/historical/state/state4.html (accessed on 11 September 2013).

0.645 (East Carroll Parish, Louisiana), while the Gini coefficient for the US as a whole was 0.467 over this time period. Among the 25 most populous counties in the US, the Gini coefficients range from 0.417 (Suffolk County, New York) to 0.601 (New York County, NY).[9] This suggests that there is not much sorting at the state or county level according to income, which is a strong predictor of environmental preferences. In any event, much more research is needed on the extent of preference heterogeneity and, more importantly, whether individuals sort themselves such that localities within a country are less heterogeneous than the country as a whole.

INTERJURSIDICTIONAL EXTERNALITIES

Efficiency of decentralized policymaking in both the Tiebout and interjurisdictional competition frameworks requires local governments to internalize all externalities. A lengthy empirical literature has emerged assessing the practical relevance of spillovers across jurisdictions. This is crucial because the failure of local governments to internalize all externalities is often cited as the main argument against decentralized policymaking. For example, Engel (1997, p. 285) writes: "The interstate spillover rationale is the classic economic efficiency argument that federal intervention is necessary to prevent the environmental, social, and economic losses that accrue when air and water pollution originating in one state are carried by natural forces into other states. States from which the pollution originates have little incentive to curb interstate pollution because they benefit from having the harmful effects of pollution externalized while they enjoy the economic benefits of the polluting activity." Sigman (2003, p. 117) notes that the size of "spillovers across jurisdictions …. is a central question in the literature on the problem of assigning functions to different levels of government." Adler (2005, p. 140) states: "The strongest case for federal involvement comes in the context of interstate spillovers." Hall (2008, p.50) writes: "One of the foundational justifications for the federalization of environmental law is the problem of interstate environmental harms." Dijkstra and Fredriksson (2010, p. 320) state: "Transboundary pollution is a standard and well-known reason for preferring centralized environmental policy making …" Esty (1996, p. 625) notes: "While a few environmental harms (some waste problems, for example) are geographically localized, many forms of pollution (surface water contamination and most air pollutants, for example) spread across the land. Because state boundaries often do not fully encompass airsheds and watersheds, interjurisdictional externalities arise."

The empirical literature can be categorized by the type of externality considered. The first category I will refer to as resource externalities. This is the case where the actions of one jurisdiction affect the resource quantity or quality available to other jurisdictions. The second category is referred to as pecuniary externalities in Wilson (1999). This refers to situations where the actions of one jurisdiction affect prices in other jurisdictions. A final category of externalities is denoted by Wilson as fiscal externalities. This is the case where the policy choices of one jurisdiction have effects on the policy choices of other jurisdictions through strategic policymaking.[10]

Resource Externalities

[9] See http://www.census.gov/prod/2012pubs/acsbr10-18.pdf (accessed on 11 September 2013).

[10] The policy choices in one location may impact prices in neighboring location as well. Thus, pecuniary and fiscal externalities do overlap. However, I invoke the distinction that pecuniary externalities occur even absent a behavioral response from neighboring governments, whereas fiscal externalities explicitly require a policy response by neighboring jurisdictions.

The empirical literature on resource externalities focuses on whether jurisdictions fail to consider the effects of their actions on the quality or quantity of a resource available in other jurisdictions. Transboundary pollution is the canonical example. With transboundary pollution, one jurisdiction fails to consider the full environmental consequences of its actions as some of the costs – typically in terms of greater air or water pollution – fall outside one's jurisdiction. Another type of spillover may occur when resources are shared across multiple jurisdictions. Common examples of such shared resources are watersheds, fisheries in the ocean, and endangered species that are present in multiple jurisdictions.

Murdoch et al. (1997) examine emissions of sulphur and nitrogen oxides in 25 European countries during the 1980s. The authors explore the reductions in these types of emissions achieved after the formulation of the 1979 Convention on Long-Range Transboundary Air Pollution (LRTAP). In particular, the authors are motivated by the fact that mandated reductions for sulfur were more likely to be met than for nitrogen oxides (NO_x). In an attempt to understand this, the authors investigate the importance of transboundary spillovers in explaining cross-country variation in emissions reductions achieved under LRTAP. Specifically, the authors estimate separate econometric models for the two types of emissions and incorporate two measures of spillovers as independent variables in the model. The first measure captures the fraction of a country's emissions that stay within its own borders. The second measure captures the amount of emissions originating outside of one's own jurisdiction that ends up in one's jurisdiction. Since sulfur emissions are less likely to spill across jurisdictional boundaries, if these variables are meaningful (in a statistical and economic sense) determinants of emissions, then externalities not only play an important role in determining emissions, but also help explain the disparate trends in sulfur and nitrogen oxide emissions in Europe over this time period. The results point to a very meaningful effect of the second measure of spillovers: as the amount of emissions entering one's jurisdiction from other countries declines, a country's own emissions rise. The authors interpret this finding as indicative of free-riding behavior by countries. However, the first measure is found to have at best a weak statistical relationship with emissions.

Kahn (1999) examines the importance of transboundary pollution using data at the county-level from the US. Specifically, he assesses the impact of manufacturing activity in one's own county, as well as adjacent counties, on ambient concentrations of total suspended particulates (TSP). The data are from 1977, 1982, and 1987, thus spanning a period during which manufacturing activity experienced large declines. However, the spatial and temporal variation in this decline allows Kahn to assess its impact on own and neighboring county air quality. The results suggest that manufacturing activity in adjacent counties has meaningful effects on a county's own ambient concentrations. For example, a one standard deviation increase in a county's own activity in the primary metal industry raises ambient concentrations of TSP by 3.5%. A one standard deviation increase in activity in the primary metals industry in a county's adjacent neighbors raises a county's own ambient concentrations of TSP by 1.1%. For other industries Kahn considers, the discrepancy between the effects of a county's own activity and that of its neighbors is even smaller. A one standard deviation increase in activity in the stone, clay, and glass industry in a county's adjacent neighbors raises a county's own ambient concentrations of TSP by 4.1%.

Sigman (2002, 2005, 2013) investigate pollution in rivers in order to assess the empirical relevance of transboundary spillovers. Specifically, Sigman (2002) uses international data on water quality obtained from monitoring stations on rivers administered by the United Nations' Global Environmental Monitoring System Water Quality Monitoring Project (GEMS/Water). The data span 291 river monitoring stations across 49 countries over the period 1979-1996. Water quality is measured using biochemical oxygen demand (BOD). The results are consistent with free-riding behavior by countries. Pollution is meaningfully higher at upstream locations (i.e., locations before a river flows into another country), as well as in rivers that form the political border between two countries. Interestingly,

these effects apply predominantly to non-European Union (EU) countries. Thus, institutional arrangements within the EU are hypothesized to limit the extent of free riding in terms of river pollution.

Sigman (2005) undertakes a similar analysis with US data obtained from the National Stream Quality Accounting Network, administered by the US Geologic Survey. The data come from 501 monitoring stations and span the period from 1973 to 1995. Sigman uses changes in the "authorization" or "primacy" status of neighboring states under the Clean Water Act to assess the extent of upstream states to free ride on their downstream neighbors. Since the statistical procedure only utilizes temporal variation within states arising from changes in authorization status, the results are more likely to capture the causal effect of decentralized control. Measuring water pollution using the EPA's water quality index based on five major pollutants (dissolved oxygen, fecal coliform, total suspended solids, phosphorous, and nitrogen), the results indicate a 4% reduction in water quality at sites downstream from an authorized state. In addition, rivers forming the border between states suffer a 6% reduction in water quality if at least one state is authorized.

Sigman (2013) continues to examine pollution levels in rivers at the international level using data from GEMS/Water spanning 47 countries over the period 1979-1999. Two measures of pollution are examined: BOD and fecal coliform. Compared to BOD, fecal coliform is considered to more of a local pollutant. In contrast to the above studies, here Sigman assesses the impact of decentralization, defined at the country-level, on the level of and subnational variation in pollution. Decentralization is either measured using a binary indicator for a federalist system, or as a continuous measure of the ratio of subnational government expenditures to total government expenditures (net of any intergovernmental transfers). The most convincing results, in my view, that utilize only temporal variation in the continuous measure of decentralization suggest a harmful effect of decentralization on BOD but not fecal coliform. Moreover, decentralization is also found to increase the subnational variation in both BOD and fecal coliform, consistent with a tailoring of decentralized policies to local preferences.

Other papers pursue a similar strategy to Sigman (2002, 2005) and assess the impact of proximity to political boundaries on pollution. Helland and Whitford (2003) use reported emissions by US establishments from the Toxic Release Inventory (TRI) spanning 1987-1996 to determine if emissions are higher from establishments located in counties that border neighboring states (either any border or only along the eastern edge). The results point to significantly higher air and water emissions in establishments located on any border, and effects even larger among establishments located on eastern borders. Interestingly, the results point to greater spillovers when the authors allow for the possibility that establishments located in border counties may systematically differ in unobserved dimensions from other establishments.

Gray and Shadbegian (2004) utilize data on 409 US pulp and paper mills, from 38 states, over the period 1985-1997. The authors examine plant-level air emissions of particulates (PM10) and SO_2 and water emissions of BOD and total suspended solids. The importance of spillovers is measured by assessing the sensitivity of a plant's emissions to the distance to the nearest state or Canadian border, as well as by the marginal benefits to reductions in air and water emissions enjoyed by neighboring jurisdictions. For plants located within 50 miles of the Canadian border, only BOD emissions are higher than other plants further from the Canadian border; SO_2 emissions are lower (attributable to the focus on acid rain near the US-Canadian border). The results also suggest that plants reduce their emissions by less when the marginal benefits from such reductions are enjoyed by neighboring jurisdictions. For example, the authors find that out-of-state benefits to a reduction in sulfur dioxide emissions have only one-third the impact of in-state benefits.

Lipscomb and Mobarak (2011) assess pollution in rivers at upstream and downstream locations in Brazil. The authors analyze quarterly data on BOD levels from several hundred monitoring stations

spanning 1990-2007. The importance of spillovers on pollution levels are investigated by measuring the distance of each station from its nearest upstream and downstream border. While generally such distances may be endogenous, Brazil frequently redraws its jurisdictional boundaries allowing the authors to exploit only the temporal variation in the distance of a given station to its nearest borders. Lipscomb and Mobarak find meaningful evidence that spillovers matter. As the distance to the nearest downstream border falls from ten to nine kilometers, say, pollution increases by 1.3%; pollution rises by 1.9% as distance falls from one kilometer to zero (i.e., at the actual border). Thus, BOD levels rise at an increasing rate as the river approaches its downstream border. In further analysis, the authors examine pairs of station monitors and find that BOD levels at the downstream monitor, relative to BOD levels at the upstream monitor, are 3.1% higher per jurisdictional boundary that the river crosses between the two stations.

In more recent work, Hatfield and Kosec (2013) exploit variation in the number of counties spanned by US metropolitan areas to determine if areas divided across more counties experience greater pollution. Because division into multiple jurisdictions may not be random, the authors exploit jurisdictional boundaries caused by the presence of rivers in order to isolate the causal effect of the number of jurisdictions on pollution. Pollution is measured using the average of the EPA's Air Quality Index over the years 1999-2002, as well as the ambient concentrations of several individual pollutants. Finally, the authors also examine the effect of increasing the number of jurisdictions within a metropolitan area on drinking water quality using data from the EPA's Safe Drinking Water Information System database. Since drinking water is a local good, the authors do not expect to find any effect of jurisdictional boundaries on this outcome. The results indicate a sizeable effect of increasing the number of counties within an area on air pollution. For example, changing a metropolitan area from being entirely contained in one county to split among two counties is found to worsen air quality by half a standard deviation and add an additional 13 days per year where the air is considered unhealthy. Moreover, Hatfield and Kosec find that a similar increase from one to two counties within a metropolitan area increases the concentrations of carcinogenic pollutants by 19-250% (depending on the pollutant). However, the authors find no effect on drinking water quality, consistent with their results being driven by interjurisdictional externalities.

Kahn et al. (2013) assess river pollution in China, taking advantage a unique natural experiment. Using data from 2004-2010, the authors assess relative pollution levels at internal versus border locations. Beginning in 2005, the central government began monitoring local compliance with environmental targets related to the chemical oxygen demand (COD) of rivers. Compliance became a criterion upon which the political promotion of local officials is based. As a result, prior to 2005, local officials had little incentive to reduce river pollution near jurisdictional boundaries. After 2005, this is no longer the case for officials seeking promotion. However, other pollutants besides COD are not a part of the promotion criteria. Using pollution data from 499 river monitoring stations located in China's seven major rivers, the authors find that the 2005 change reduced COD levels. Moreover, the decline was greater at border locations, consistent with significant transboundary pollution prior to 2005. Finally, the authors find no impact of the promotion criteria on other measures of pollution.

Banzhaf and Chupp (2012) and Perino and Talavera (2013) pursue very different strategies for assessing the importance of interjurisdictional externalities. Banzhaf and Chupp (2012) present a detailed simulation model of the US electricity sector, incorporating NO_x and SO_2 emissions. They then compare the level of welfare achieved under a first-best policy whereby each state fully internalizes all transboundary pollution damages, a second-best uniform policy across all states, and the decentralized case where each states acts only in its best interest. The results indicate that social welfare is only 0.2% lower under the second-best uniform policy compared to the first-best policy. However, the

decentralized case with self-interested states results in a 31.5% reduction in social welfare. This discrepancy does not arise due to a lack of preference heterogeneity across states. Rather, the welfare cost of ignoring such heterogeneity under the second-best uniform policy is swamped by the welfare cost of failing to internalize the pollution externalities. Evidence of the magnitude of the externality is further provided in Chupp (2011). He illustrates for two states, Arizona and North Carolina, that the in-state marginal benefit per ton of SO_2 reduction is only about one-fourth the marginal benefit to the nation as a whole. Banzhaf and Chupp (2012, p. 2012) conclude that "inter-state spillovers are simply more important that [*sic*] inter-state heterogeneity in this application."

Lastly, Perino and Talavera (2013) assess the determinants of state sulfur emissions rate standards prior to the Acid Rain Program in 1995. In particular, the authors are interested in the relative importance of the internal costs and benefits of reduced emissions versus the external benefits on the state emissions standard. The state sulfur standard is measured by pounds of SO_2 per million British thermal units (MMBtu). The marginal cost of a more stringent standard is proxied by the transportation costs incurred to import low-sulfur coal from Wyoming. Finally, internal and external benefits to emissions reductions are measured by the state's own acidity of rainwater and the average acidity of rainwater in northeastern states (for states located in the Midwest). The results indicate that marginal abatement costs and internal and external benefits all matter in a statistical sense. However, the effect of a state's own acidity is more than 20 times larger than the effect of the acidity of rainwater in the northeast.

Rather than focusing on pollution, several empirical studies test for the presence of spillover effects on enforcement of environmental regulations. Gray and Shadbegian (2004), in the study of 409 paper and pulp establishments in the US discussed previously, also examine determinants of the number air and water pollution inspections and enforcement actions. The results are generally weaker than those reported above pertaining to emissions. Nonetheless, the authors find some evidence that air pollution enforcement actions are higher against establishments near the Canadian border (consistent with the lower SO_2 emissions found in the analysis), but fewer water pollution inspections take place against such plants.

Gray and Shadbegian (2007) use emissions data on 521 US manufacturing plants from 1997, where all plants are located within 50 miles of the center of three cities located near state borders (St. Louis, Cincinnati, and Charlotte). The primary purpose of the study is to examine the effect of prior environmental enforcement – against either oneself (so-called specific deterrence) or against other plants within ten miles (so-called general deterrence) – on subsequent plant-level emissions. However, a very interesting finding emerges: inspections of other plants within ten miles reduces a plant's own emissions of air toxics (obtained from the TRI), as long as those other plants are located within the same state. Inspections of other nearby plants, but located in another jurisdiction, fail to produce any general deterrent effect. In this case, the lack of a spillover across jurisdictional boundaries reduces welfare. If enforcement were instead the responsibility of a higher level of government, each inspection would result in a greater reduction in emissions through general deterrence.

More recently, Konisky and Woods (2010) assess the impact of proximity to jurisdictional borders on plant-level enforcement actions. Data on state-led enforcement actions – inspections, total punitive actions, and formal punitive actions – under the US CAA over the period 1990-2000 are aggregated to the county-level are used to determine if counties on state or international borders are subject to less enforcement. The results indicate an approximate 25% and 50% reduction in the count of inspections in counties bordering Canada and Mexico, respectively, but no meaningful effect of bordering other states.

In a follow-up study, Konisky and Woods (2012) utilize data from the EPA's Integrated Database for Enforcement Analysis to assess the determinants of enforcement actions – compliance monitoring and punitive actions – against roughly 6,400 facilities regulated under the US Clean Water Act over the period 1995-2005. The importance of spillovers is assessed by examining whether a facility that discharges its effluent into an interstate river or a multi-state watershed is the subject of less enforcement action. The authors also assess, among other things, the impact of distance to the nearest downstream state from the point where a facility's effluent likely enters a river. Konisky and Woods fail to find any evidence consistent with fewer enforcement actions being taken against firms more likely to be responsible for transboundary pollution. Thus, the empirical studies to date assessing the spatial and temporal variation in enforcement behavior indicate less free-riding than those assessing pollution directly. Understanding the source(s) of this difference is necessary.

The final set of papers examining the empirical relevance of resource externalities assess the impact of decentralized decision-making on the exploitation of shared resources. McWhinnie (2009) analyzes data on the global exploitation status of various fish stock according to the Food and Agriculture Organization (FAO) in 1994 and 2002. Specifically, the FAO designates each fish stock in each of 15 regions as underexploited, moderately exploited, fully exploited, overexploited, depleted, or recovering. The author then examines whether the number of countries that report catching a given fish in a given region and year help predict the exploitation status of the fish stock. McWhinnie finds that exploitation is increasing in the number of countries accessing the fish stock. For example, if the fish stock is shared by two countries rather than one, it is 9% more likely to be overfished and 19% more likely to be depleted. If the fish stock is shared by five countries rather than one, it is 36% more likely to be overfished and 82% more likely to be depleted.

Burgess et al. (2012) is similar to Hatfield and Kosec (2013) in that they explore the impact of dividing a given geographic area into a larger number of jurisdictions on the environment. However, here the authors examine the impact of the number of administrative jurisdictions in a given Indonesian province on the rate of deforestation over the period 2001-2008. The results indicate a nearly 4% increase in the annual rate of deforestation if an additional district is formed within a province. Burgess et al. (2012, p. 1751) conclude that their analysis provides a "counterexample to those who argue that decentralization of control over natural resources in weakly governed tropical environments should enhance their conservation."

Pecuniary Externalities

The second category of externalities includes pecuniary externalities. This refers to situations where jurisdictions ignore the ramifications of their actions on prices in other areas. However, empirical evidence regarding pecuniary externalities is rare. One source of pecuniary externalities, in theory, is referred to as tax exporting and dates back at least to Gordon (1983).[11] This refers to localities levying excessive taxes in situations where at least a portion of the tax bill is paid by nonresidents (e.g., hospitality taxes). In the context of environmental regulation, the idea is referred to as environment importing and can arise in either of two ways. First, a jurisdiction may enact excessive regulation if producers of polluting goods are located in other jurisdictions as long as the costs cannot be passed fully

[11] Another type of pecuniary externality is what Hall (2008) refers to as psychological externalities. This is the case where resources within one jurisdiction are valued by residents of another jurisdiction. Unique natural elements, such as Old Faithful, are primary examples. Destruction of such resources by the jurisdiction in which the resource is located can be thought of as imposing a pecuniary externality on residents of other jurisdictions as the price of utilizing (or visiting) the resource becomes infinite.

onto consumers located in the jurisdiction. Second, a jurisdiction where the pollution-generating production of goods occurs may enact excessive regulation if producers are able to pass at least a portion of the regulatory costs onto consumers in other jurisdictions.

Anecdotal evidence of the first type behavior is found in Elliott et al. (1985). The authors provide a historical account of the development of the Motor Vehicle Air Pollution Control Act of 1965. This was the first statute to provide the US federal government with regulatory power over air pollution. The legislation was supported by the automobile industry, not because it favored reducing pollution, but rather because several states had adopted or were in the process of adopting stringent regulations regarding automobile emissions. Since the production of automobiles is geographically concentrated in a few areas, the costs of these regulations were born predominantly by nonresidents. Thus, prior to the passage of the federal statute, states were "importing" a cleaner environment at the expense of nonresidents. Moreover, history is repeating itself as states are once again pursuing regulations on automobile emissions for the purposes of achieving greenhouse gas (GHG) reductions. Rabe (2011, p. 502) writes: "Still another state economic development incentive may relate to policy opportunities that, in effect, will shift most of the compliance costs to other jurisdictions. California's alliance with other states pursuing vehicle emissions reductions can be considered through this lens, as none of these jurisdictions host large vehicle manufacturing sectors that might be jeopardized through aggressive transition toward lower-emission vehicles… In turn, some of the proponent states were actively developing next-generation vehicle technology within their boundaries that might receive a boost through a regulatory burden imposed on conventional vehicles generally manufactured elsewhere."

McAusland and Millimet (2013) provide indirect evidence of environmental importing by subnational jurisdictions. The authors use data on trade among US states, among Canadian provinces, and between US states and Canadian provinces from 1997 and 2002 to explore the effect of intra- and international trade on emissions reported in the TRI for the US and the Canadian National Pollutant Release Inventory (NPRI). McAusland and Millimet show theoretically that environmental regulation should become more stringent as trade increases because the resulting higher prices on locally-produced goods are passed on to consumers in other jurisdictions. Moreover, because environmental regulation in the US and Canada is a mix of centralized and decentralized control, the effect on regulatory stringency should be stronger when higher prices are passed onto foreign consumers. Thus, the theoretical model predicts that international trade should result in greater reductions in emissions than intranational trade. Consistent with the idea of environment importing, this is what the authors find.

Chakrovorty et al. (2008) provide additional evidence of price spillovers due to decentralized environmental policymaking. The authors examine the effect of clean fuel programs permitted under the US CAA. Under the Act, states are permitted to implement their own clean fuel program for gasoline in an effort to reduce air pollution. The result is a proliferation of clean fuel blends; at least 15 different fuel specifications are in use, combined with three different octane levels, yielding more than 45 unique blends. Chakravorty et al. examine the temporal and spatial variation in wholesale gasoline prices across states over the period 1995-2002 due to the required usage of so-called "boutique fuels." Specifically, the authors estimate not only the direct effect on prices due to requirement of a cleaner gasoline blend, but also the indirect effect of market segmentation. In other words, as the type of fuel required in one state becomes more distinct from the type of fuel required in neighboring states, prices should rise due to greater demands placed on refineries.[12] The results confirm not only that the market segmentation effect is important, but that it is nearly as important as the direct cost effect. If a state changes from no gasoline regulation to a clean fuel (of the type considered in the analysis) for the entire

[12] This is related to the general argument concerning uniform product standards as a rationale for centralization. See Oates (2002a), Adler (2005), and Dalmazzone (2006) for general discussions.

state, wholesale gasoline prices are expected to rise by 16%. On the other hand, if a state transitions from requiring the same fuel as its neighbors to a completely unique blend not used by any of its neighbors, wholesale gasoline prices are expected to rise by at least 14%. To the extent that states do not take into account the higher prices occurring elsewhere when a state decides to require a unique fuel blend and thus increases its "regulatory distance" from its neighbors, decentralization in this case will lead to excessive heterogeneity in fuel blends.

In sum, the empirical evidence suggests that localities ignore interjurisdictional externalities related to transboundary pollution and resource exploitation and these externalities entail significant welfare loss. The evidence is less convincing when enforcement of environmental regulations is examined. However, the inability of the general deterrent effect of local enforcement to cross political boundaries is noteworthy. Finally, some evidence exists suggesting that localities ignore the impact of their policies on the prices paid and the profits earned by nonresidents. More empirical evidence on the prevalence of tax exporting (or environment importing) is needed.

Fiscal Externalities

The final category of externalities is referred to as fiscal externalities, a holdover from the fiscal federalism literature. However, Wilson (1999) defines fiscal externalities more broadly as instances where the policy choices of one jurisdiction have effects on the policy choices of other jurisdictions through strategic policymaking. Thus, the presence of such externalities violates the assumptions required for decentralized policymaking to be efficient just as in the case of resource or pecuniary externalities. Konisky (2009, p. 406) writes: "The economic efficiency results emerge from local regulators making decisions solely based on intrajurisdictional, not interjurisdictional, factors."

Brueckner (2003) provides an excellent introduction to the notion of strategic interactions between governments. Such interactions may arise for three reasons. First, jurisdictions are, or are perceived to be, in competition for mobile resources. Second, policies in one jurisdiction lead to spillovers (e.g., transboundary pollution) that alter the payoffs to different policies in other jurisdictions. Third, voters may judge the performance of policymakers through interjurisdictional comparisons, thereby creating a situation referred to as yardstick competition.

Before discussing the existing empirical evidence on strategic interaction, three comments are warranted. First, all three sources of strategic interaction are empirically equivalent in that each predicts that the policy choices of one jurisdiction depend on the choices of other jurisdictions. Thus, without more information, differentiating among the underlying causes is not possible. Second, whether strategic interactions occur or not depends on policymaker perceptions. For example, if resources – people or capital – are immobile, but policymakers mistakenly believe that resources are mobile, then strategic interactions may occur. However, if resources are mobile but policymakers naively assume they are not, then strategic interactions may be absent. Thus, the question of whether governments act strategically is fundamentally distinct from the question of resource mobility (and, similarly, the presence of actual spillovers or yardstick competition).[13] Third, strategic interaction is not synonymous with a race-to-the-bottom. In theory, strategic interaction may lead to decentralized policies that are

[13] For example, Esty (1996, p. 573) states: "While economists downplay fears of a race to the bottom, politicians cannot escape the image, in Ross Perot's memorable words, of a 'giant sucking sound' as U.S. factories and jobs go down the drain to jurisdictions with more lax environmental standards and lower compliance costs." Oates (2002a, p. 16) writes: "In fact, irrespective of the actual facts on the location decisions in polluting industries, whether officials use environmental regulations for competitive purposes depends largely on perceptions. If policymakers *think* that these regulations matter, then they may well craft environmental legislation in the light of their objectives for economic development. Perceptions matter here." (italics in original).

inefficiently lax or inefficiently stringent (referred to as a race-to-the-top).[14] That said, one of the most common justifications given for centralization of environmental policymaking is fear over a race-to-the-bottom. Engel (1997, p. 274) states: "Of the numerous theoretical rationales used to justify federal environmental regulation, perhaps the most broadly compelling is the argument that without such regulation, states would engage in a welfare-reducing 'race-to-the-bottom' in environmental standard-setting." List and Gerking (2000, p. 453) argue that "in a second-best world in which initial distortions are present, locally determined environmental regulations are likely to be suboptimal when jurisdictions compete with each other to attract capital." Konisky (2007, p. 853) states: "A principal objection to decentralization of environmental regulatory authority to subnational governments in federal systems is the concern that it will result in a 'race-to-the-bottom.'"

The empirical literature on strategic interaction can be parsed into two strands. The first examines the impact of decentralization on pollution levels directly, using temporal variation in the level of centralization. The second directly estimates so-called spatial reaction functions to determine if policy choices in one jurisdiction are affected by the choices of other jurisdiction. A subset of this group pushes the analysis further in an attempt to determine if strategic interaction, to the extent it exists, is consistent with a race-to-the bottom or a race-to-the top.

Within the first strand, several empirical papers have used President Ronald Reagan's swift devolution of many aspects of environmental policy – referred to as new federalism – as a natural experiment from which to form indirect inferences concerning the race-to-the-bottom hypothesis.[15] List and Gerking (2000) utilize state-level data on pollution abatement expenditures by manufacturing industries obtained from the *Annual Survey of Manufactures* over the period 1973-1990, as well as state-level emissions data on SO_2 and NO_x from the EPA over the period 1929-1994. The objective is to determine if there were shifts in the levels of these variables in the mid-1980s after controlling for other potential determinants of abatement and emissions. In terms of abatement expenditures, the authors find mixed evidence as expenditures were found to increase in some sectors and decrease in others. There is no evidence that emissions worsened after the early 1980s and some evidence that SO_2 emissions declined.

Millimet and List (2003) and Millimet (2003) use the same data as in List and Gerking (2000) but apply alternative econometric techniques. In contrast to List and Gerking, Millimet and List compare the entire distribution of emissions and abatement expenditures across states before and after President Reagan's new federalism policies. This allows the authors to investigate the possibility of finer changes in these variables that may have been overlooked in List and Gerking. Millimet and List find stronger evidence of a reduction in emissions and increase in abatement efforts in the 1980s. Millimet (2003), in contrast to the prior papers, allows for the determinants of emissions and abatement to have differential effects over time and then tests for any residual effect of President Reagan's new federalism policies. He finds little meaningful association between the decentralization of the 1980s and emissions, but does find a positive association with abatement expenditures.

Fomby and Lin (2006) perform a similar analysis. The authors use time series data on aggregate emissions in the US of SO_2, NO_x, and volatile organic compounds (VOCs) from 1940-1998 to test for a structural break where the possible date of any break is unknown. The results point to structural breaks for all three pollutants (where the breaks represent the start of downward trends). However, the breaks occur in the late 1960s or 1970s, corresponding to beginning of the environmental movement in the US. There is no meaningful evidence of further breaks during the Reagan era.

[14] Engel (1997, p. 346) refers to the implication of strategic interaction as simply a "race to inefficiency," highlighting the irrelevance of whether the race is actually to the top or the bottom if one simply cares about efficiency.
[15] Millimet (2003) provides a detailed description of the changes implemented.

Related to Fomby and Lin (2006) is the analysis in Bulte et al. (2007). Here, the authors examine a related, but distinct, question. In particular, the authors are interested in whether emissions levels are converging across states over time and whether such convergence accelerated after the 1970s. Thus, the authors are not concerned with the Reagan era *per se*, but rather the general era of relative federal involvement in environmental policymaking beginning in 1970. Data on SO_2 and NO_x from the EPA over the period 1929-1999 are examined. The results indicate that emissions were converging across some states prior to 1970, and then across many more states after 1970. While it is not obvious if this analysis offers much guidance regarding the realization of a race-to-the-bottom, the results are consistent with federal involvement since 1970s leading to more homogeneity across states.

Finally, Potoski (2001) and Chang et al. (2014) address another related, but distinct, question. Potoski (2001) assesses whether US states have chosen to adopt air quality standards in excess of that required by the federal government. Data come from the State Air Pollution Control Survey conducted in 1998. 38 states responded to the survey. Eleven of the 38 states indicate that the state standard exceeds the EPA's ambient air quality standards for at least one of the six criteria pollutant. Eight states reported adopting new source performance standards that are more stringent than required by the EPA. Potoski (2001, p. 339) interprets this as "no evidence of a race to the bottom." Oates (2002a, p. 13) is less optimistic. He writes that "with a couple of minor exceptions … environmental authorities have not adopted standards for these pollutants that are more stringent than the federal standards." That said, Oates does not interpret this as evidence of a race-to-the-bottom; he explains this by the "*extraordinarily* stringent" federal standards (italics in original).

Chang et al. (2014) examine state applications for "authorization" or "primacy" status under the US Clean Water Act (CWA) and the Resource Conservation and Recovery Act (RCRA). As of 2002, 45 states have authorization under the CWA; 48 states have authorization under the RCRA. The authors explore the determinants of how quickly states were authorized in the two cases. The results indicate that states with more "green" preferences – measured by the average League of Conservation Voters environmental scores for a state's US senators and representatives – authorize significantly sooner. Chang et al. (2014, p. 49) infer that "states seek authorization in order to adopt stricter rather than weaker environmental policies than the federal government."

The preceding studies do not suggest a race-to-the-bottom. However, they do not shed any light on whether decentralization leads to an efficient outcome or to a race-to-the-top. Levinson (2003, p. 97) states: "The important question is more subtle than whether emissions go up or down. It is whether interjurisdictional competition and the Reagan decentralization caused regulations to be laxer than if they had been set by a welfare maximizing central planner." Thus, the second strand of the literature tests for evidence of strategic policymaking by jurisdictions. Brueckner (2003) provides an excellent, general overview of the theoretical and empirical literature concerned with strategic interactions between governments. Not only does he provide an introduction to the spatial econometric techniques employed to test for strategic behavior, but he also discusses studies examining other policy areas such as welfare benefits and taxation.[16] Thus, I focus exclusively on papers looking at environmental issues.

Murdoch et al. (1993) use data on public recreation expenditures per acre of recreation land across 85 communities in the Los Angeles metropolitan area in 1987. The authors are motivated by the question of whether communities free-ride by reducing own expenditures when neighboring expenditures increase. Instead, they find the opposite; own expenditures increase by roughly $1000 if neighboring expenditures increase by $2500. This is consistent with a model of yardstick competition or competition for mobile households.

[16] Subsequent research, in Millimet and Rangaprasad (2007), Millimet and Collier (2008), and elsewhere, test for the presence of strategic interactions in US educational policymaking as well.

Brueckner (1998) tests for strategic interaction using an index of growth controls across 173 California cities in 1988. The index reflects the number of measures adopted that are designed to constrain population or construction growth. Brueckner finds meaningful evidence of positive strategic interaction: more stringent growth controls in a city lead to more stringent controls in neighboring jurisdictions.

Fredriksson and Millimet (2002a) test for strategic interaction across the 48 contiguous states using two measures of environmental regulation over the period 1977-1994 (omitting 1987). First, as in Fredriksson et al. (2003), the authors use an index based on the ratio of actual pollution abatement expenditures incurred by plants located in the state to the predicted level of expenditures based on the state's industrial composition. Second, they utilize state-level abatement expenditures scaled by state manufacturing output. The results indicate strong, positive effects of neighboring environmental stringency on a state's own environmental stringency. Furthermore, the authors explore whether the results are consistent with a race-to-the-bottom or a race-to-the-top by allowing for asymmetric responses to neighboring policies. Specifically, Fredriksson and Millimet allow for the possibility that states may respond differently to changes in neighboring states depending on whether one is currently more or less stringent than one's neighbors. The results are consistent with a race-to-the-top as states are responsive only to changes in neighboring policy if one is initially less stringent than one's neighbors.

Fredriksson and Millimet (2002b), Fredriksson et al. (2004), and Levinson (2003) extend this study in different directions. Fredriksson and Millimet (2002b) test for a particular pattern of strategic interaction, referred to as the "California effect." Specifically, the authors test for the presence of abnormally large spillovers from California's environmental policy choices to other states. The results do not indicate a special role of California in the degree of cross-state strategic interaction. Fredriksson et al. (2004) extend the model in Fredriksson and Millimet (2002b) to allow for cross-policy strategic interactions. In other words, in contrast to earlier models of strategic interaction, the authors do not estimate a model that restricts the response of one jurisdiction to policy changes in another jurisdiction to be limited to the same policy (i.e., a state need not respond to changes in environmental regulation in neighboring states by only adjusting its environmental regulation). Specifically, the authors estimate a model that allows for the possibility that environmental, tax, and expenditure policies are jointly determined and thus any policy may respond to changes in neighboring states. Environmental regulation is measured as in the prior studies, tax policy is measured using data on tax effort obtained from the Advisory Commission on Intergovernmental Relations, and expenditures is measured using data on total general expenditures obtained from the *Compendium of State Government Finances*. The results provide strong evidence of not only cross-state strategic interactions within policy arenas, but also across arenas. This is consistent with the empirical fact that states utilize a package of incentives in an attempt to attract capital.

Levinson (2003) extends this work in an interesting direction. First, he combines the spatial models of strategic interaction with the natural experiment concerning President Reagan's decentralization to see if cross-state strategic interaction accelerated during the Reagan era. He finds little meaningful evidence that the extent of strategic policymaking changed after 1981; states act strategically in both periods. Second, Levinson tests for the presence of strategic interaction in the setting of hazardous waste disposal tax rates across states over the period from 1989-1995. He finds strong evidence of strategic interaction beginning in 1992, after the Supreme Court ruled that states are not able to levy different rates depending on whether the waste originated in- or out-of-state.

Woods (2006) and Konisky (2007, 2009) test for cross-state strategic interaction using measures of environmental enforcement. Woods (2006) examines state enforcement of environmental regulation

in the surface-mining industry. Enforcement is measured using the number of violations and cessation orders issued by a state in a year scaled by the number of mines in the state. The data for the 23 states that had primary enforcement authority for this industry are obtained from the *Office of Surface Mining Annual Report* for the period 1987 to 1999. The results, first and foremost, indicate the presence of strategic interaction; state enforcement depends on how one's own past enforcement levels compare to one's neighbors. However, the results are counter to Fredriksson and Millimet (2002a) in that states are found to only respond to their neighbors if the neighbors are relatively lax in terms of enforcement.

Konisky (2007, 2009) use state-level data on inspections and punitive actions taken under the CAA, CWA, and RCRA from 1985-2000. The data are obtained from the EPA's Integrated Database for Enforcement Analysis. The results in Konisky (2007) affirm those in prior studies; a 10% increase in neighboring enforcement activity leads to a 5-15% increase in a state's own enforcement activity. Konisky (2009) extends the analysis by allowing for asymmetric responses depending on whether or not a state is considered economically susceptible. However, he finds that states are equally likely to engage in strategic policymaking regardless of their current level of economic vulnerability.

Davies and Naughton (2013) utilize a similar econometric framework but assess country-level decisions to ratify any of 110 multilateral environmental agreements (MEAs) containing explicit environmental targets or requirements. The data contain 139 countries spanning the period 1980-1999. The results provide meaningful evidence of strategic interaction in environmental policymaking at the country level; a 10% increase in the number of treaties participated in by one's neighbors raises one's own participation by about 1.5%. Furthermore, the analysis reveals that this strategic interaction is driven by countries – OECD and non-OECD alike – reacting to ratifications by other OECD countries. This result is consistent with the asymmetric results in Fredriksson and Millimet (2002a) in that OECD countries are likely to be more environmentally stringent on average.

Two final studies on strategic interaction in environmental policymaking merit attention. Engel (1997) and Konisky (2008) explore the possibility of strategic policymaking not by estimating a spatial econometric model, but rather by directly surveying state environmental managers in the US. Engel surveyed 80 state environmental regulators in 1996. Engel (1997, p. 340-1) summarizes the findings: "[T]he possibility that industry might relocate or site a new plant elsewhere is something of a concern to the environmental regulators in many states, and affects policymaking in some manner in most states." However, the survey responses do not yield much guidance as to whether such strategic behavior is more in line with a race-to-the-bottom or race-to-the-top."

Konisky (2008) surveyed senior managers in state environmental agencies in 2005. The survey was mailed to 1,459 officials; the response rate was roughly 34%. In contrast to Engel (1997), the sample size is larger and contains career managers rather than political appointees. Several findings are noteworthy. First, only about 10% of the respondents indicated that they were "not sure" how enforcement in their state ranked relative to other states. Second, more than 60% responded that other states' actions influenced their own state's actions; over 10% indicated it has a significant effect. Third, while the more than 70% of the respondents indicated their belief that environmental regulations are a "fairly important" or "very important" factor in firm location decisions, this ranked lower than their perceived importance of transportation, labor costs and quality, proximity to customers or markets, taxes, and proximity to natural resources or raw materials. That said, almost 60% responded that concerns over the impact on industry played a "fairly important" or "very important" role in the discouragement or opposition to adoption of a more stringent environmental standard. More than 25% said that concern over the impact on industry played a "fairly important" or "very important" role in the decision to allow or advocate allowing greater emissions or discharges.

In sum, the evidence concerning the presence of strategic policymaking in the environmental arena is much stronger than the evidence concerning the influence of environmental policymaking on firm location or industry competitiveness. One possible explanation for this apparent contradiction is that politicians are not economically rational. Engel (1997, p. 352) discusses the possibility that "state regulators are simply not aware of the evidence demonstrating the unimportance of environmental standards to firm location." However, she goes on to argue that it is more plausible that "environmental regulators … are responding to different incentives" as they are "subject to politically rational, but not always economically rational, political pressures to accommodate industry with the use of less stringent environmental standards" (p. 353). Consistent with the notion that politicians are responding to political incentives, evidence indicates that states favor uniform environmental standards. Engel (1997, p. 344) writes: "[S]tates strive to mimic the standards of other states – activity that is at least consistent with the hypothesis that states act strategically when establishing environmental standards. On average, environmental regulators agreed 'strongly' with the proposition that their state's standards be of about the same stringency as the standards of neighboring states." Thus, yardstick competition may be a more likely explanation for strategic behavior than "economically irrational" resource competition. Regardless of the source, the empirical evidence of strategic interaction in environmental policymaking at the city, state, and national level is convincing.

Before turning to the next section, there is an additional issue regarding strategic policymaking that merits discussion. The preceding studies test for horizontal strategic interaction in an environmental context. Here, horizontal refers to the fact that the governments being examined are at the same level. Vertical interactions, on the other hand, may arise due to fiscal externalities spanning different levels of government when each possesses some regulatory power over the same base.[17] While unexplored in the environmental context, this issue is a potentially salient one moving forward given increasing reliance on a system of cooperative federalism in the US and elsewhere. For example, Esty (1996) discusses arrangements whereby the US federal government sets minimum standards and allows states the possibility of exceeding these standards if desired. Williams (2011, p. 1092) states: "In recent years, cases in which state governments chose to override federal environmental regulation with tighter regulations of their own have become increasingly common, even for pollutants that have substantial spillovers across states." In other situations, it may be that the federal government sets standards related to some environmental issues (e.g., US ambient air quality standards for criteria pollutants), but states settle other environmental issues (e.g., hazardous waste disposal taxes).[18] Thus, federal and state governments can be seen as both taxing the same industrial base. Goulder and Stavins (2011, p. 253) write: "The coexistence of state and federal policies raises questions about their interactions. Problems arise when state and federal policies overlap."

To my knowledge, there is no formal empirical evidence regarding the nature of any strategic interactions between subnational and national governments in the context of environmental policy.[19]

[17] Specifically, externalities arise because each level of government fails to account for that fact that its taxes reduce the size of the tax base available to other levels. Wilson (1999) provides a nice survey of the literature.

[18] Related to this, Alm and Bahnzaf (2012, p. 182) state that "multiple instruments are often used for a single pollution problem in a single country."

[19] Cutter and DeShazo (2007) and Chang et al. (2014) are tangentially related. Both assess situations where a higher level of government must agree to delegate environmental authority to lower level governments. Chang et al. (2014), discussed earlier, focuses on the decision to authorize states under the CWA and RCRA. Cutter and DeShazo (2007) examine the implementation of authorization under the RCRA in California in the early 1990s. Specifically, once California received authorization from the federal government, the state assigned authority over implementation to counties. Cities could then petition for authorization from their county. The analysis shows that cities that petition for and were granted authorization

Thus, if there is indeed a push for something akin to the cooperative federalism described in Esty (1996), this is an area in desperate need for both theoretical and empirical research. However, as a starting point, there are several studies looking at vertical policy interactions in tax setting.

Besley and Rosen (1998), Devereux et al. (2007), and Fredriksson and Mamun (2008) examine the case of gasoline and cigarette taxation in the US. Besley and Rosen (1998) utilize data over the period 1975-1989. The results indicate that states increase their gasoline and cigarette taxes by roughly three cents per each ten cent increase in the corresponding federal tax rate. Devereux et al. (2007) analyze data over the period 1977-1997. They obtain weaker results for cigarette taxes, but continue to find a positive effect of federal gasoline tax rates on state tax rates. However, Fredriksson and Mamun (2008) revisit the issue of cigarette taxation using data from 1975-2001. The authors find no meaningful effect. When focusing on data from 1982-2001, the results indicate that states reduce their taxes by about five cents per each ten cent increase in the federal tax rate. The authors attribute this difference to the additional years of data from the Reagan era of new federalism, as well as the addition of various independent variables to control for political economy issues.

Goodspeed (2000) uses data across 13 OECD countries from 1975 to 1984 to test if local income tax rates are affected by national income tax rates. Local tax rates are measured by total local personal income tax revenue scaled by gross national product (GNP). National tax rates are measured by total federal and state income tax revenue scaled by GNP. Thus, states are lumped together with the central government. He obtains a negative effect of national tax rates on local tax rates; the estimates imply an elasticity of about -0.5.

Esteller-Moré and Solé-Ollé (2001) assess the impact of US federal tax rates on state personal income and general sales taxes. The data cover the 41 states with an income tax from 1987-1996. Tax rates are measured as state or federal income tax revenue scaled by personal income. State tax rates are also measured by the sum of state income and general sales tax scaled by personal income. The results are consistent with Besey and Rosen (1998). Specifically, a 10% increase in the federal tax rate leads to about a 1% increase in state income tax rates and a 2% increase in state income plus general sales tax rates.

Hayashi and Boadway (2001), Andersson et al. (2004), and Brülhart and Jametti (2006) undertake similar analyses using Canadian, Swedish, and Swiss data, respectively. Hayashi and Boadway (2001) focus on business taxation and define the provincial business tax rate as corporate income tax revenues scaled by corporate profits earned in the province. The federal rate is obtained similarly using federal corporate income tax revenues. The data cover the period 1963-1996. Contrary to the prior study on the US, the results indicate that provinces respond to higher federal tax rates by substantially reducing their own rates. Andersson et al. (2004) study local (municipality) and regional (county) personal income tax rates from 1981-1990. Again, the results indicate that local tax rates are reduced in response to higher regional tax rates. Brülhart and Jametti (2006) examine local (municipality) and regional (canton) tax rates in select years spanning the period 1985-2001. Here, the results indicate higher local tax rates in response to an increase in regional tax rates; the elasticity is around 0.3.

Thus, the empirical evidence to date appears to confirm the existence of vertical tax externalities in federations. However, whether strategic policymaking leads to inefficiently high or low taxation is unclear and may vary across locations and the type of tax considered. Theoretically, the effects of vertical tax competition on efficiency have been shown to depend crucially on the order of moves and the political objectives of the different levels of government, which is the subject of the next section.

---

increased enforcement efforts. However, it is not likely that authorization of other cities, had it occurred, would have resulted in the same increase; authorized cities are not a random draw.

Wilson (1999, p. 290) concludes: "Clearly, the best case for efficiency will occur when the federal government is benevolent and is able to move first, so that it can influence the behavior of the state governments." However, significant research is needed that incorporates the peculiarities of cooperative federalism with regards to environmental regulation into existing theoretical and empirical models of vertical interactions.

POLITICAL ECONOMY

Both the Tiebout and interjurisdictional competition frameworks make strong assumptions concerning the behavior of governments. The Tiebout model assumes that communities adjust policies optimally to attract (or repel) residents. The interjurisdictional competition model assumes that governments maximize a (known) social welfare function. In practice, there are several reasons why decentralized policymakers may not behave in this fashion. First, as posited in so-called Leviathan models of government behavior, policymakers may seek to maximize the size of the local tax base rather than social welfare. Second, lobbying behavior or explicit corruption may induce policymakers to deviate from socially optimal policies. Third, individuals may abstain from participation in the political process. Fourth, policymakers may aim to maximize social welfare but make mistakes. Mistakes may arise either due to imperfect scientific knowledge or the so-called winner's curse. A final reason, in the context of the Tiebout model, for local governments possibly deviating from the assumed behavior pertains to differential mobility rates across population segments discussed earlier. Thus, I do not revisit this issue here.

Before discussing the empirical literatures with regard to these issues, it is important to reiterate that what is relevant for the debate over environmental federalism is not simply whether local policymakers stray from socially optimal decisions, but rather how any such deviations compare to political economy distortions at the federal level.

Leviathan

Leviathan models suppose that governments seek to maximize tax revenues rather than social welfare. As such, tax rates (in this case, any revenue-generating environmental instrument) are set inefficiently high. Wilson (1999) notes that capital mobility limits the ability of policymakers to behave in this manner; capital can move to avoid excessively high taxes. Because capital may be less mobile across countries than within countries, the federal government may be more capable of acting like a Leviathan. Thus, decentralization is predicted to result in lower tax rates as rates move towards the efficient level. However, Wilson goes on to state that if decentralized policymakers behave strategically, as discussed in the prior section, then capital mobility may lead to a race-to-the-bottom in which decentralized tax rates are inefficiently low and less than what would be set by the federal government. As a result, Leviathan and race-to-the-bottom models both predict that decentralized tax rates will be lower than those set by the central government. In the former (latter) case, this reduction entails a movement toward (away from) the socially optimal level.

This theoretical result implies that obtaining empirical evidence supporting or refuting the Leviathan model is difficult. One can certainly assess the empirical associations between the relative power of the top tier of government (referred to as "centralism"), the extent of competition among lower tiers of government (referred to as "fragmentation"), and policy outcomes.[20] However, whether the results support or refute the Leviathan model is unknown without knowledge of the efficient tax rate.

[20] See Zax (1989).

Evidence of smaller public sectors in decentralized economies is consistent with, but not proof of, the Leviathan model.

Aside from the difficulties arising from the unobservability of the efficient level of taxation, the empirical literature must also confront data issues surrounding the proper measurement of decentralization, as well as the possible endogeneity of decentralization. In light of the numerous difficulties testing the Leviathan model empirically, I do not provide a detailed survey of the existing literature. Oates (1989) provides an early survey. Cowley and Sobel (2011) is a recent addition to the literature and provide a more current literature review. The authors state that the "previous literature has examined local, state, and international data and has found mixed results" (Cowley and Sobel 2011, p. 6). Thus, empirical support for the Leviathan model, particularly in the context of environmental issues, is an open question.

Lobbying and Corruption

Aside from government preferences over tax revenues, policies may also deviate from socially optimal levels due to lobbying influence or corruption. Esty (1996) argues that industry lobby groups enjoy an advantage over environmental lobby groups at the local level due to the fact that they are better funded and thus able to cover numerous jurisdictions. Revesz (2001) hypothesizes that the reverse may be true because of the typical grass-roots nature of environmental groups. Fredriksson and Gaston (2000) posit a theoretical model where capital has no incentive to lobby at the local level if it is mobile; it can simply relocate if policies are not to its liking. Thus, environmental lobbying is offset by capital mobility, not industry lobbying, at the local level. However, with centralized policymaking, both environmental and industry groups have an incentive to lobby (if capital is not mobile across national borders). In terms of corruption, theoretical arguments are also ambiguous. For example, Weingast (1995) argues that decentralization limits corruption through interjurisdictional competition. However, Shleifer and Vishny (1993) hypothesize that access to the same "bribe" base (as opposed to tax base) will result in greater levels of corruption due to vertical externalities. Note, this argument does not make the case for greater corruption at the federal or local level, but rather it is a system of simultaneous policymaking at multiple levels that results in greater corruption than either a purely centralized or decentralized system.

The empirical evidence on lobbying and corruption is just as mixed as the theoretical arguments. One strand of the literature addresses this issue indirectly by examining specific policy examples to ascertain whether the outcome was influenced by political motives. Hird (1990) and Cropper et al. (1992) examine particular instances of EPA behavior; thus, the findings shed some light on political influences within federal environmental decision-making.

Hird (1990) examines EPA outlays under Superfund. Under the program, abandoned hazardous waste sites are evaluated and given a Hazard Ranking System (HRS) score. If the HRS score exceeds a certain threshold, the site is added to the National Priorities List (NPL). Hird obtains data on 799 sites on the NPL as of December 31, 1988 from the Superfund data collection system (CERCLIS). He examines determinants of the number of NPL sites per state, the length of time spanned between when a site was initially "proposed" and when its status became "final," total expenditures on a site as of 1988, and planned future expenditures by the EPA on a site. The empirical model assesses whether political variables related to the committee assignments of a state's US senators and representatives influence these allocation outcomes after controlling for other attributes of a site such as its HRS score. The results indicate that having senators or representatives from a state on key Senate and House subcommittees may influence the total number of sites on the NPL in a given state and how quickly a

site progresses to "final" status. However, these political variables have no meaningful influence on the level of current or future expenditures at a given site.

Cropper et al. (1992) analyzes EPA decisions concerning cancer-causing pesticides between 1975 and 1989. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the EPA was required to reregister the 600 active ingredients appearing in various pesticides. If the ingredient was found to pose a significant risk to humans or animals, the EPA was to conduct a special review to weigh the benefits and costs of the reregistration of the ingredient. Over the time period studied, a special review was completed for 37 ingredients. Of these, 19 involved ingredients used to treat food crops and found to cause cancer in laboratory animals. For each of these ingredients, the EPA made separate decisions for each type of crop to which it is applied. In total, 245 ingredient/crop combinations were decided upon by special review; 96 were banned. Controlling for cancer risk as well as economic importance, the authors assess whether public comments submitted to the EPA during the review process by environmental groups, industry groups, and academics affected the outcome. The results do indicate that the cancellation decisions were affected by the existence of public comments by each of the three groups; comments by environmental groups (industry groups and academics) raised (lowered) the probability of cancellation. While the magnitude of the effect of environmental groups was larger than the corresponding effect of industry groups, the combined effect of industry groups and academics was greater.

Hays et al. (1996) and Helland (1998) undertake similar analyses at the state-level. Hays et al. (1996) examine cross-state variation in the Green Policy Index, which is a function of the existence of 50 different environment-related policies and the extent of commitment to 17 environmental programs common to all states. The index is computed based on data from 1987-1991. Among the various determinants of the index considered, Hays et al. include a measure of environmental pressure – state membership in environmental groups as a fraction of the population – and industry pressure – fraction of state employment in the manufacturing sector. Surprisingly, the results indicate a positive association between both environmental and industry pressure and the index. The latter could represent a failure of the statistical analysis to identify the causal effect of industry pressure on environmental policy.

Helland (1998) uses data from the EPA's Performance Compliance Database to assess inspections, violations, and effluent discharge at 232 pulp and paper mills across 30 states under the CWA from 1989-1993. Enforcement of the CWA is either the responsibility of regional EPA offices or states; 70% of the sample is under state control. With the set of potential determinants of inspections, violations, and effluent discharges, the authors include local environmental pressure – measured by the share of the state population belonging to the Sierra Club – and economic pressure – measured by the size of the plant and the local unemployment rate. The results indicate state responsibility for enforcement is associated with a lower probability of inspection and higher effluent discharge. Greater environmental pressure is associated with a higher probability of a plant being inspected, lower probability of a plant being in violation, and lower effluent discharge. Plant size, particularly in areas of high unemployment, is associated with a higher probability of a plant being inspected and a lower probability of a plant being in violation.

Joskow and Schmalensee (1998) investigate the role of politics in the SO_2 tradeable allowances program created under the 1990 CAA Amendments to combat acid rain. Specifically, the authors investigate whether political variables help explain the allocation of allowances across electric utilities. The outcome examined is the difference between the actual allowances allocated to a given utility and the expected allocation derived under different "objective" allocation rules. Political variables considered include measures of the political "clout" of the state in which the utility belongs (e.g., whether it is considered a swing state, has a competitive Senate or gubernatorial election, and its number

of electoral votes) and the committee assignments of its US senators and representatives. The authors find some evidence that states with greater political clout fared better in terms of allocations. That said, Joskow and Schmalensee (1998, p. 81) conclude: "If anything, the resulting allocation of Phase II allowances appears more to be a majoritarian equilibrium than one heavily weighted toward a narrowly defined set of economic or geographical interests. It is not strongly consistent with the predictions of standard models of interest group politics or of congressional control."

Another strand of the literature explicitly investigates the link between (fiscal) decentralization and corruption. As is the case in the empirical literature testing the Leviathan model, studies in this area must confront data issues surrounding the proper measurement of decentralization, the potential endogeneity of decentralization, as well as the proper measurement of corruption.

Several studies use cross-country data and measure federalism using a discrete measure of federal structure. Treisman (2000) analyzes country-level data on perceived corruption obtained from Transparency International (TI) from 1996-1998. The index is based on a combination of surveys of businesses, local populations, economic risk analysts, and country experts. Federalism is measured using a simply binary indicator. The number of countries covered varies by year, ranging from 52 in 1997 to 85 in 1998. The results indicate that federal structures have a meaningful, positive association with corruption holding constant the level of economic development and democratic history of a country.

Gerring and Thacker (2004) investigate corruption across 125 countries using a measure developed elsewhere that combines several sources of data from the late 1990s. Federalism is measured on a three-point scale (non-federal, semi-federal, and federal). The results are in line with Treisman (2000), indicating a positive association between federalism and corruption. Interpreting the findings as causal, the results suggest that moving from a federal to a unitary system would move, say, Nigeria from the seventh most corrupt country to number 46 or the US from the 108th most corrupt country to number 119. The authors (p. 319) conclude: "[N]ational bureaucracies are large and interdepartmental transfers tend to be frequent. It is more difficult to maintain clientelistic networks under such circumstances… Following Madison, largeness of size and heterogeneity of constituency may be seen as conducive to more transparency, more publicity and more anti-corruption efforts generally, at least in so far as these may stem from the dynamics of political competition."

Bohara et al. (2004) analyze corruption across roughly 90 countries using the World Bank Institute Governance Research Indicator to measure corruption in 1996, 1998, and 2000. Federalism is measured using a simply binary indicator. No statistically meaningful association between federalism and corruption is found.

Other studies in the literature utilize continuous measures of decentralization to reflect the degree to which countries are decentralized in practice. Fisman and Gatti (2002a) analyze corruption across 59 countries. Corruption is measured using an index provided by the *International Country Risk Guide*. Decentralization is measured as the subnational share of total government spending obtained from the International Monetary Fund. The data are averaged over the years available from the period 1980-1995. In contrast to Treisman (2000), the authors find a meaningful, negative association between fiscal decentralization and corruption (and no association between a constitutional measure of federal structure and corruption).

Gulsun Arikan (2004) use corruption data from TI for about 40 countries in 1998 along with several measures of corruption: per capita number of local jurisdictions, per capita number of local and intermediate jurisdictions, share of subnational government employment, and the share of subnational government expenditures. The results suggest a negative, but only weakly statistically significant association between decentralization and corruption. The author (p. 192) concludes: "The empirical

results are not particularly strong, but they offer tantalizing evidence that corruption may indeed be lower in countries where the extent of fiscal decentralization is high."

Fan et al. (2009) investigate the same issues except using firm-level data. The World Business Environment Survey interviewed business managers from over 9000 firms across 80 countries in 1999-2000. Managers were asked about the frequency and amount of bribes paid. The primary measure of decentralization used captures the number of tiers of government within a country. The results indicate a meaningful association between this measure of decentralization and the frequency and amount of bribes. For example, adding an additional tier of government is associated with a 2.6 percentage point increase in the probability that a manager reports "always needing to make informal payments to get things done" (Fan et al. 2009, p. 24). In addition, the subnational share of government employment is positively associated with the frequency and amount of bribes. Interestingly, the association between government tiers and the frequency of bribes is only statistically meaningful for less developed countries once the sample is split by level of development. However, subnational share of government employment remains positively associated with corruption in both subsamples. Thus, the lack of association between government tiers and corruption among developed countries may reflect a lack of variation in this subsample.

Lastly, Fisman and Gatti (2002b), Fredriksson and Vollebergh (2009), and Brollo et al. (2013) investigate two complementary questions. Fisman and Gatti (2002b) and Brollo et al. (2013) explore a different type of relationship between fiscal decentralization and corruption. Specifically, each assesses the impact of federal transfers on the behavior of subnational governments. Fisman and Gatti (2002b) utilize state-level data from the US to investigate whether greater federal transfers – yielding a divergence between state-level revenue generation and expenditures – results in greater corruption by state officials. Federal transfers are interpreted as inducing a "soft budget constraint" at the state level. Data on state-level corruption comes from the *Report to Congress on the Activities and Operations of the Public Integrity Section for 1987* and measures the annual number of public officials (from any level of government) convicted in a state for abuse of public office from 1976-1987. This is then scaled by population or public sector employment in the state. The fiscal variable of interest is the share of state and local expenditures financed by federal transfers. The results indicate a meaningful, positive association between the softness of the state budget constraint and corruption.

Brollo et al. (2013) exploit discontinuities in the size of transfers from the federal government to municipalities in Brazil arising from deterministic allocation rules related to municipality population. Using data from 2001-2008, the authors assess the impact of transfers in non-election years on local corruption and the "quality" of individuals seeking local office (i.e., municipal mayor). Corruption is measured using municipal audit reports prepared by an independent body, the *Corregedoria Geral da União*, under Brazil's anti-corruption program. Candidate quality is measured by education. The results indicate that a 10% increase in transfers results in at least a 6% increase in corruption, a 7% increase in the probability of an incumbent being reelected, and a 6% reduction in the college graduation rates of an incumbent's opponents.

Fredriksson and Vollebergh (2009) assemble data from 11 industrial sectors across 12 OECD countries over the period from 1982 to 1996. Instead of assessing the impact of decentralization on the level of corruption, the authors explore whether a given level of corruption has a larger impact on environmental policy in decentralized countries. Environmental policy is measured at the sector level within each country and is proxied by the aggregate physical energy units used per unit of value added. Corruption is measured using data from TI. The findings indicate a positive association between corruption and energy intensity (i.e., environmental laxity) in unitary countries. There is no meaningful association between corruption and energy intensity with federal structures. The authors attribute this

finding to the fact that corrupt political officials have less power to influence policy outcomes in decentralized systems.

In sum, the empirical literature on lobbying and corruption in federal systems is inconclusive for a few reasons. First, the difficulty of dealing with the potential endogeneity of the presence of a federal structure or the level of fiscal decentralization makes it unlikely that the results discussed here have a causal interpretation. Second, from the perspective of environment federalism, the debate is not over the choice between a federal and a unitary system, but rather the delegation of environmental authority within a federation. Unfortunately, studies using binary measures indicating a federal structure or a continuous measure of the number of government tiers offer little guidance on whether the federal or local level is responsible (or both) for the positive association between corruption and non-unitary systems. Finally, while studies assessing continuous measures of fiscal decentralization – such as the share of subnational government expenditures – are more helpful, the results are mixed and seem to depend on characteristics of the budget at the local level.

Political Participation

Besides the potential for decentralization to affect the level of lobbying or corrupt activity, it also has the potential to affect individual participation in the political process. Decentralized policymaking is often advocated on the grounds that individual participation is greater at the local level. Oates (1999, p. 1138) summarizes this view: "The basic presumption here is that more decentralized political systems are conducive to increase citizen impact on political outcomes and political participation." Bednar (2011, p. 274-5) states: "Democratic outcomes improve with higher participation, and participation is boosted when one's vote is likely to be pivotal, which is more likely in smaller-scale elections." However, a trade-off may exist if participation leads to policies that are not socially efficient when the electorate is relatively uninformed.

In the interest of brevity, I do not conduct a thorough review of the empirical literature – located predominantly within the political science field – on political participation. Rather, I refer the interested reader to Horiuchi (2001) who provides an excellent review. Specifically, Horiuchi begins by stating that American and European political scientists claim, contrary to the statements above, that subnational elections have lower voter turnout than national elections in most democracies. However, the author goes on to state that the opposite is true in select countries such as Australia, Canada, Finland, France, India, Italy, Northern Ireland, Spain, and Switzerland. Horiuchi posits that political participation depends on the likelihood that one's vote affects the electoral outcome and the ability of the electoral outcome to influence policy decisions. Thus, even if it is the case that subnational political participation is lower in many democracies, this might change with greater decentralization as local policymakers become more influential. That said, devolution of environmental policymaking alone may be insufficient to affect political participation decisions at the local.

Knowledge

The final political economy issue that may impact a government's implementation of social welfare-maximizing policies concerns knowledge. In the absence of any other distortions, the ability of any government to maximize social welfare rests first and foremost with the government's knowledge of the true social welfare function. There are at least two reasons why, in the context of environmental federalism, governments may inadvertently maximize the wrong social welfare function. First, the scientific basis of the social welfare function (e.g., the so-called damage functions for different

environmental hazards) may be incorrect. Second, governments may over-value the acquisition of capital due to the so-called winner's curse.

There is little empirical research, to my knowledge, related to environmental federalism and scientific knowledge. However, due to potential economies of scale and the incentive for jurisdictions to free ride, many advocate that scientific research be centralized regardless of the extent of decentralization of actual policymaking. For example, Esty (1996, p. 573) states: "Sound environmental policies depend on good science, which, in turn, requires a level of investment in sophisticated technical analysis that many smaller jurisdictions are in no position to make." On the other hand, Adler (2005, p. 147) espouses concern that the "over-centralization of scientific research may increase the risks of political manipulation of science." Future work into the objectivity of scientific research conducted at various levels of government appears warranted. Moreover, it may be fruitful to consider a decentralized system of scientific research that overcomes the incentive to free ride through the creation of something akin to a patent system. For example, in the context of policy innovation (discussed below), Rose-Ackerman (1980, p. 615) states: "However, there is a more innovative way to encourage low-level governments to search for new ways of doing things. The central government might institute a system of prizes awarded to governments after they have come up with new ideas. Prizes could be a function of a jurisdiction's own activities or could be awarded only if the jurisdiction happened to generate the best project."

There is also little empirical research, to my knowledge, related to environmental federalism and the so-called winner's curse.[21] The winner's curse refers to the fact that when multiple agents bid for a single good with an uncertain value based on unbiased, agent-specific forecasts of the good's true value, the agent with the highest bid frequently ends up disappointed either because the bid exceeds the value of the good (resulting in a net loss) or because the value is less than presumed (resulting in a smaller net gain than envisioned).

The winner's curse is relevant to the environmental federalism debate because it suggests that in the presence of multiple jurisdictions bidding for mobile capital (through environmental standard setting) in order to maximize social welfare, the winning jurisdiction may set the environmental standard too low and suffer from the winner's curse. As such, decentralized policymaking, resulting in multiple jurisdictions competing for mobile, lumpy capital investments, may induce inefficiently low environmental standards even if all jurisdictions seek to maximize social welfare and have unbiased forecasts concerning the social value of attracting capital.

Much of the empirical evidence in support of the winner's curse is typically obtained by laboratory experiments conducted by economists. Some behaviors in the field have also been shown to be consistent with the winner's curse. In the interest of brevity, the reader is referred to Thaler (1988) and Charness and Levin (2009) for reviews of the literature. In sum, there is ample evidence that the winner's curse is a frequent outcome not only in the laboratory, but also in practice. While fully rational agents should be able to eliminate the winner's curse, the evidence suggests that that agents possess only "bounded rationality" and do not recognize the difference between the unconditional expected value of the good and the expected value of the good conditional on submitting the highest bid.

The potential for the winner's curse to apply to jurisdictional bidding for capital is very real. Engel (1997, p. 319) states: "To entice new plants within their borders, or to prevent their existing plants from leaving, states offer firms lucrative packages consisting of a dizzying array of economic incentives." That said, the only study to my knowledge that relates directly to interjurisdictional competition for capital is Greenstone and Moretti (2004). The authors utilize data collected from various issues of *Site Selection* over the period 1982-1993. Each issue details the siting decision of so-

[21] Thaler (1988) provides an early overview of the topic.

called "million dollar plants." In particular, the winning county is listed along with one or two runner-up counties. This enables Greenstone and Moretti to compare the county that won the new plant to counties that merited final consideration but ultimately lost out on the plant. While the size of any inducements offered by the winning and losing counties is not known, the authors examine relative changes in property values across winners and losers to estimate the welfare gains experienced by winning counties. The findings indicate that property values increased by roughly 1.1 to 1.7%, indicating that winning counties experienced a net gain due to the attraction of the plants. Thus, at least this study concludes that the (stronger version of the) winner's curse – the winner suffering a net reduction in welfare – does not seem to characterize jurisdictional competition for large capital investments.

In sum, there are numerous political economy issues that play a role in the debate over environmental federalism. Unfortunately, the empirical evidence is less clear cut than on other issues discussed in this article. Empirical studies of the Leviathan model suffer from the empirical equivalence of Leviathan and interjurisdictional competition models; both predict lower tax rates in decentralized settings. Distinguishing between the two requires knowledge of the socially efficient tax rate, which is not an easy task. Empirical studies of the Leviathan model, as well as of the effects of decentralization on lobbying and corruption, suffer from the proper measurement of decentralization and difficulty in dealing with the potential endogeneity of institutional arrangements. As such, the results of existing studies should not be interpreted in a causal manner. Finally, there is limited evidence on whether decentralization of environmental policymaking induces greater political participation and leads to inefficient decisions due to the winner's curse. Nor is there much empirical evidence concerning the optimal structure regarding scientific research.

POLICY INSTRUMENTS

The Tiebout and interjurisdictional competition frameworks invoke assumptions concerning the ability of jurisdictions to implement a "full range of needed tax and regulatory instruments" to obtain efficient outcomes (Oates 2002a, p. 6). Similarly, Dalmazzone (2006, p. 467) states that "governments must be … in conditions to avail themselves of the best suited among expenditure, tax, and environmental policy instruments." I briefly discuss two final issues – laboratory and bottom-up federalism – factoring into the debate over environmental federalism under this umbrella. Laboratory, or horizontal, federalism refers to policy replication by other subnational governments once one subnational government discovers a "successful" policy. Bottom-up, or vertical, federalism refers to policy adoption by the federal government after "successful" demonstration of the policy at the subnational level.

Laboratory Federalism

One of the virtues of decentralized policymaking is the ability of jurisdictions to experiment with new policies, thereby developing potentially new and welfare-improving policy instruments.[22] This notion is commonly referred to as laboratory federalism. Oates (1999, p. 1132) states that "a federal system may offer some real opportunities for encouraging such experimentation and thereby promoting 'technical progress' in public policy." Adler (2005, p. 137) refers to the ability of states to act as "environmental 'laboratories.'" Bednar (2011, p. 273) writes that "subnational governments" have the opportunity to become "laboratories of democracy." Of course, this notion dates back at least to Justice

[22] Shobe and Burtraw (2012) provide an excellent introduction to many of the issues.

Brandeis' well-known statement: "It is one of the happy incidents of the federal system that a single courageous State may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments without risk to the rest of the country."[23]

Direct empirical evidence on the value of experimentation in decentralized settings is limited given the difficulty of question involved. There is a lengthy literature on the diffusion of policies across jurisdictions, exemplified, in part, by the literature discussed above on horizontal and vertical externalities in policymaking. However, this does not shed much light on the development or evaluation of experimental policies in decentralized versus centralized settings. Thus, early explorations into this issue were entirely theoretical.

The seminal study in this area is Rose-Ackerman (1980). She explored the incentives that local politicians have to undertake risky experimentation. Three conclusions are of interest. First, secure incumbents have little incentive to experiment and risk undermining their re-election prospects. Instead, they can choose to free-ride off experiments conducted elsewhere. Second, local politicians may have an incentive to experiment even if their local position is secure if they aspire to federal office and are credited by the electorate for developing innovative local policies. Kostogiannis and Schwager (2006) provide additional theoretical support for this point. Finally, wasteful duplication of experiments at subnational levels may arise due to a failure to coordinate among jurisdictions and the desire for all politicians to implement the policy with the greatest chance for success.

Strumpf (2002) focuses on the incentives for jurisdictions to free-ride. If innovative policies can be easily replicated, then there is no advantage to being the first-mover unless there are political gains of the type discussed in Rose-Ackerman (1980). Strumpf (2002, p. 208) states: "Because successful policy experiments are eventually emulated, they have a public good component. Experiments benefit not just the innovating government but also potential imitators, and so local governments have an incentive to free-ride off their neighbors. Alternatively, a central government should take this learning externality into account when it is deciding whether to consider a policy experiment." Similarly, Galle and Leahy (2009, p. 1333) writes: "Innovations in government produce positive externalities for other jurisdictions. Theory therefore predicts that local government will tend to produce a lower than optimal amount of innovation, as officials will prefer to free ride on innovation by others". That said, Strumpf assesses conditions under which free-riding is more likely to occur.[24] He predicts that the level of policy experimentation will be relatively greater under centralization as the number of subnational jurisdictions increases and as the similarity of these jurisdictions increases (specifically, as the welfare effects of different policies become more highly correlated across locations).[25] Callander and Harstad (2013) expand on this point, documenting that jurisdictions may opt for a less-than-ideal policy if this policy is less useful to other jursidictions. Incentives to do so are greater the more similar are jurisdictions.

Interestingly, the potential for subnational free-riding is often used to justify centralization of scientific research, but is often omitted in the environmental federalism literature when discussing local policy innovation. On the one hand, Galle and Leahy (2009, p. 1337) state that "any number of scholars of federalism routinely argue that experimentation is a reason to favor decentralized government, generally acknowledging RA [Rose-Ackerman] with a 'but see' footnote and at most a few sentences of explanation." On the other hand, Dalmazzone (2006, p. 464-5) writes that "the generation and diffusion" of scientific research related to environmental problems is a "task that is generally assigned, in theory as in the real world, to the central level of government" as these are "activities that benefit

[23] *See* New State Ice Co. v. Liebmann, 285 U.S. 262, 311 (1932).
[24] See also Galle and Leahy (2009, p. 1360-1).
[25] Cai and Treisman (2009) examine similar issues theoretically while allowing for centralized experimentation to entail non-uniform policies.

everyone and that tend to be subject to important economies of scale." However, while these positions may seem a bit contradictory at first glance, they may not be inconsistent. Galle and Leahy (2009) argue that policies that are transparent and cheap to copy are the most susceptible to free-riding. This may be a more apt description of scientific research than subtle policy components of environmental regulation. Moreover, local policymakers may be more likely to receive credit for policy innovations than the advancement of scientific knowledge. Rabe (2008, p. 107) notes that state-led initiatives regarding climate change may be due to the fact that "some states have consciously chosen to be 'first movers,' often taking bold steps with the explicit intent of trying to take national leadership roles on climate policy."

In terms of empirical research, the questions that can be addressed are a bit more limited as direct assessments of whether centralization leads to more or less policy experimentation are difficult to conceptualize. Volden (2006) examines whether states emulate successful policies implemented in other states. Emulation of successful policies by other jurisdictions addresses is a necessary but not sufficient condition for policy experimentation to be a benefit to decentralization. The author examines the specific case of the Children's Health Insurance Program (CHIP) over the period from 1998 to 2001. Specifically, Volden looks at amendments to particular aspects of each state's CHIP program to see if these changes are driven in part by the design of other states' CHIP programs that were successful in reducing the proportion of uninsured children in poor households. The results indicate that states are more likely to emulate design choices from states that achieved past success. However, this is only the case if these design choices do not necessarily result in higher costs.

Rabe (2008, 2011) and Cale and Reams (2013) provide anecdotal evidence in support of greater policy experimentation at the subnational level in the US in the case of GHG reductions targets. Specifically, Cale and Reams note that 17 states adopted GHG reduction targets between 1998 and 2008 despite the federal government never ratifying the Kyoto Protocol. Rabe (2008) documents that 22 states, representing roughly half the US population, adopted at least two of eight climate change policies over roughly this same time period.[26]

In sum, the theoretical literature indicates that the relationship between decentralization and policy experimentation is not straightforward.[27] Whether policy innovation is greater at the subnational level depends on the level of fragmentation at the subnational level, the degree of heterogeneity across jurisdictions, the level of transparency and replicability of local policies, the incentives of policymakers, and the extent to which politicians can claim credit for successful policies. Goulder and Stavins (2011, p. 256) states: "The case for state-level experimentation needs to be considered carefully: why the laboratories should be at the state, rather than national, level is not clear, and – in any event – there is some question regarding whether state authorities will allow their 'laboratory' to be closed after the experiment has been completed and the information delivered." In light of this, it is not surprising that Galle and Leahy (2009, p. 1339) conclude that "the question whether innovation adds to the allure of decentralized government is a highly nuanced one, not to be resolved in a footnote or an aside." Unfortunately, empirical evidence on this issue is limited and likely to remain so given the difficulty in designing appropriate statistical tests of the underlying hypothesis.

[26] The eight policies include renewable electricity mandates or portfolio standards, carbon taxes, renewable fuel mandates or equivalent programs that mandate expanded use of biofuels, carbon cap-and-trade programs, statewide emissions reduction targets, mandatory reporting of carbon emissions, formal participation as a co-plaintiff in the 2007 Supreme Court case on carbon dioxide regulation, and adoption of the carbon emission standards for vehicles enacted by California.

[27] Callander and Harstad (2013, p. 34) state that "the prominence of policy experimentation in policy and popular discourse has not been matched by development of a formal understanding of the underlying phenomenon."

Bottom-Up Federalism

Another potential virtue of decentralization is the notion of bottom-up federalism. Shipan and Volden (2006) use this term to denote vertical policy diffusion from subnational jurisdictions to the federal level. This question is distinct question from the prior discussion of vertical externalities in policymaking as that literature focuses exclusively, to my knowledge, on the effects of federal policies on state choices.

Empirical evidence on the importance of bottom-up federalism is extremely limited. Oates (1999) provides anecdotal evidence in the context of the creation of a SO_2 permit trading scheme in the US. Oates (1999, p. 1132-3) writes: "More recently, in the area of environmental policy, the experience in a number of states with their own forms of Emissions Trading was an important prelude to the adoption, in the 1990 Clean Air Act Amendments, of a national trading program in sulfur allowances to address the problem of acid rain. Without this experience in a number of states, I seriously doubt that policy-makers would have been willing to introduce such a new and unfamiliar policy measure as tradeable emissions rights on a national scale. More generally, since the dawn of the nation, programs successfully developed at the state level have often provided models for subsequent federal programs." More generally, Bednar (2011, p. 273) suggests that "subnational involvement in national policymaking may also help to overcome bureaucratic inertia." Rabe (2008, p. 106) states: "In many instances, early state policy engagement has provided models that were ultimately embraced as national policy by the federal government. This has been evident in a range of social policy domains, including health care and education, and can either result in federal preemption that obliterates earlier state roles or a more collaborative system of shared governance."

Shipan and Volden (2006) address this issue more formally by examining state and local adoptions of antismoking laws in the US over the period from 1975 and 2000. Conceptually, the authors argue that greater adoptions by cities within a state may spur state action due to a snowball effect or it may reduce the likelihood of state action due to a "pressure valve" effect. Data on state antismoking laws comes from the State Cancer Legislative Database maintained by the National Cancer Institute. Data on city-level laws comes from the Local Tobacco Control Ordinance Database compiled by the American Nonsmokers' Rights Foundation. The results indicate no meaningful effect of local laws on state propensity to adopt antismoking laws on average. However, further analysis reveals that local laws reduce (raise) the probability of state adoption in states with low (high) values of legislative professionalism. That said, in terms of magnitude, it seems that horizontal policy diffusion across states is more salient than bottom-up considerations.

CONCLUSION

Theoretical models used to frame the environmental federalism debate – based on the Tiebout and interjursidctional competition models – highlight several issues that play a salient role in the efficiency of decentralized environmental policymaking: resource mobility, preference heterogeneity, interjursidctional externalities, political economy concerns, and policy instrument choice. The objective of this article has been to provide a reasonably thorough, yet concise, survey of what we do and do not know, empirically-speaking, concerning these various issues. While a complete accounting of the magnitudes of the "imperfections," as suggested by Oates (1999) in the Introduction, is beyond the scope of the current article (and perhaps any article), I believe several preliminary conclusions can be drawn.

First, environmental concerns play, at best, a small role in explaining patterns of resource mobility. Population mobility seems relatively low in most developed countries and is declining in the US. Moreover, mobility seems to be driven predominantly by economic, as opposed to environmental, factors. That said, there is some evidence that environmental amenities may affect residential location choices along the "spatial" margin (i.e., across very spatially disaggregate neighborhoods). However, whether the lack of overall population mobility reflects immobility or convergence to some spatial equilibrium is unclear. Moreover, whether the "threat" of mobility is sufficient to yield an efficient, market-like outcome as in contestable markets is also unclear. The impact of differential mobility rates, particularly by education, on the efficiency of decentralization is also unclear. Capital, while perhaps relatively more mobile, appears to be influenced by environmental regulation only in a few, highly pollution-intensive sectors. Other factors such as taxes and endowments of physical and human capital seem to play more important roles.

Second, the empirical evidence suggests that preferences over environmental issues are heterogeneous, particularly across political ideologies, income levels, and sectors of employment. However, variation in preferences is much greater across countries than within countries. Moreover, it is not clear that individuals sort themselves across jurisdictions according to environmental preferences. Lastly, there is no empirical evidence to support the (intuitive) notion that subnational jurisdictions are better able to act on community preferences than the central government.

Third, the empirical evidence concerning the importance of interjursidictional externalities is compelling, particularly as it relates to transboundary pollution and strategic policymaking. The limited, but persuasive evidence, on environment "importing" is also noteworthy. One issue in this literature that gives me some pause is the fact that externalities are less informative in understanding the spatial distribution of enforcement than emissions and effluent discharge. Moreover, it is also noteworthy that there exists limited evidence on whether strategic policymaking is due to a race-to-the-top or a race-to-the-bottom.

Fourth, the empirical evidence regarding political economy issues is less convincing and informative owing to limited data availability and the difficulty of dealing with the endogeneity of decentralization. Further empirical analysis is needed along several lines, such as the efficacy of environmental and industry lobbying, the propensity for policymakers to engage in corrupt activity, and political engagement by the populous at different levels of government. Furthermore, evidence regarding the empirical relevance of the winner's curse in the competition for capital and the optimal institutional structure for promoting scientific research is required. Finally, significantly more empirical investigation is needed to assess the arguments concerning laboratory and bottom-up federalism in order to move these arguments beyond mere speculation.

REFERENCES

Adler, J.H. (2005), "Jursidictional Mismatch in Environmental Federalism," *NYU Environmental Law Journal*, 14, 130-178

Adler, J.H. (2007), "When is Two a Crowd? The Impact of Federal Action on State Environmental Regulation," *Harvard Environmental Law Review*, 31, 67-114

Alm, J. and H.S. Banzhaf (2012), "Designing Economic Instruments for the Environment in a Decentralized Fiscal System," *Journal of Economic Surveys*, 26(2), 177-202

Andersson, L., T. Aronsson, and M. Wikström (2004), "Testing for Vertical Fiscal Externalities," *International Tax and Public Finance*, 11, 243-263

Banzhaf, H.S. and B.A. Chupp (2012), "Fiscal Federalism and Interjurisdictional Externalities: New Results and an Application to US Air Pollution," *Journal of Public Economics*, 96, 449-464

Banzhaf, H.S. and R.P. Walsh (2008), "Do People Vote with Their Feet? An Empirical Test of Tiebout's Mechanism?" *American Economic Review*, 98(3), 843-863

Barro, R.J. and X. Sala-i-Martin (1991), "Convergence Across States and Regions," *Brookings Papers on Economic Activity*, 1991(1), 107-182
Baumol, W.J. (1982), "Contestable Markets: An Uprising in the Theory of Industry Structure," *American Economic Review*, 72(1), 1-15
Becker, R. and V. Henderson (2000), "Effects of Air Quality Regulations on Polluting Industries," *Journal of Political Economy*, 108(2), 379-421
Bednar, J. (2011), "The Political Science of Federalism," *Annual Review of Law and Social Science*, 7, 269-288
Besley, T.J. and H.S. Rosen (1998), "Vertical Externalities in Tax Setting: Evidence from Gasoline and Cigarettes," *Journal of Public Economics*, 70, 383-398
Bohara, A.K., N.J. Mitchell, and C.F. Mittendorff (2004), "Compound Democracy and the Control of Corruption: A Cross-Country Investigation," *Policy Studies Journal*, 32(4), 481-489
Borjas, G.J., S.G. Bronars, and S.J. Trejo (1992), "Self-Selection and Internal Migration in the United States," *Journal of Urban Economics*, 32, 159-185
Brasington, D.M. and D. Hite (2005), "Demand for Environmental Quality: A Spatial Hedonic Analysis," *Regional Science and Urban Economics*, 35(1), 57-82
Brollo, F., T. Nannicini, R. Perotti, and G. Tabellini (2013), "The Political Resource Curse," *American Economic Review*, 103(5), 1759-1796
Brueckner, J.K. (1998), "Testing for Strategic Interaction Among Local Governments: The Case of Growth Controls," *Journal of Urban Economics*, 44, 438-467
Brueckner, J.K. (2003), "Strategic Interaction Among Governments: An Overview of Empirical Studies," *International Regional Science Review*, 26(2), 175-188
Brueckner, J.K. (2004), "Fiscal Decentralization with Distortionary Taxation: Tiebout vs. Tax Competition," *International Tax and Public Finance*, 11(2), 133-153
Brülhart, M. and M. Jametti (2006), "Vertical Versus Horizontal Tax Externalities: An Empirical Test," *Journal of Public Economics*, 90, 2027-2062
Brunnermeier, S. and A. Levinson (2004), "Examining the Evidence on Environmental Regulations and Industry Location," *Journal of Environment & Development*, 13, 6-41
Bulte, E., J.A. List, and M.C. Strazicich (2007), "Regulatory Federalism and the Distribution of Air Pollutant Emissions," *Journal of Regional Science*, 47(1), 155-178
Burgess, R., M. Hansen, B.A. Olken, P. Potapov, and S. Sieber (2012), "The Political Economy of Deforestation in the Tropics," *Quarterly Journal of Economics*, 127(4), 1707-1754
Cai, H. and D. Treisman (2009), "Political Decentralization and Policy Experimentation," *Quarterly Journal of Political Science*, 4(1), 35-58
Cale, T.M. and M.A. Reams (2013), "Influences on Adoption of Greenhouse Gas Reduction Targets among US States, 1998-2008," *Open Journal of Political Science*, 3(1), 39-43
Callander, S. and B. Harstad (2013), "Experimentation in Federal Systems," NBER Working Paper No. 19601, October.
Carruthers, J.I. and D.E. Clark (2010), "Valuing Environmental Quality: A Space-Based Strategy," *Journal of Regional Science*, 50(4), 801-832
Chakravorty, U., C. Nauges, and A. Thomas (2008), "Clean Air Regulation and Heterogeneity in US Gasoline Prices," *Journal of Environmental Economics and Management*, 55, 106-122
Chang, H.F., H. Sigman, and L.G. Traub (2014), "Endogenous Decentralization in Federal Environmental Policies," *International Review of Law and Economics*, 37, 39-50
Charness, G. and D. Levin (2009), "The Origin of the Winner's Curse: A Laboratory Study," *American Economic Journal: Microeconomics*, 1(1), 207-236
Chupp, A.B. (2011), "Environmental Constituent Interest, Green Electricity Policies, and Legislative Voting," *Journal of Environmental Economics and Management*, 62, 254-266
Cole, M.A. and R.J.R. Elliott (2003), "Do Environmental Regulations Influence Trade Patterns? Testing Old and New Trade Theories," *World Economy*, 26, 1163-1189
Cole, M.A. and R.J.R. Elliott (2005), "FDI and the Capital Intensity of 'Dirty' Sectors: A Missing Piece of the Pollution Haven Puzzle," Review of Development Economics, 9, 530-548
Cole, M.A., R.J.R. Elliott, and K. Shimamoto (2005), "Why the Grass Is Not Always Greener: The Competing Effects of Environmental Regulations and Factor Intensities on US Specialization," *Ecological Economics*, 54, 95-109
Cole, M.A. and P.G. Fredriksson (2009), "Institutionalized Pollution Havens," *Ecological Economics*, 68, 1239-1256
Cropper, M.L., W.N. Evans, S.J. Berardi, M.M. Ducla-Soaresand, and P.R. Portney (1992), "The Determinants of Pesticide Regulation: A Statistical Analysis of EPA Decision Making," *Journal of Political Economy*, 100(1), 175-197

Crowley, G.R. and R.S. Sobel (2011), "Does Fiscal Decentralization Constrain Leviathan? New Evidence from Local Property Tax Competition," *Public Choice*, 149, 5-30
Cutter, W.B. and J.R. DeShazo (2007), "The Environmental Consequences of Decentralizing the Decision to Decentralize," *Journal of Environmental Economics and Management*, 53, 32-53
Dalmazzone, S. (2006), "Decentralization and the Environment," in E. Ahmad and G. Brosio (eds.) *Handbook of Fiscal Federalism*, Cheltenham: Edward Elgar, 459-477
Davies, P.S., M.J. Greenwood, and H. Li (2001), "A Conditional Logit Approach to U.S. State-to-State Migration," *Journal of Regional Science*, 41(2), 337-360
Davies, R.B. and H.T. Naughton (2013), "Cooperation in Environmental Policy: A Spatial Approach," *International Tax & Public Finance*, forthcoming
Devereux, M.P., B. Lockwood, and M. Redoano (2007), "Horizontal and Vertical Indirect Tax Competition: Theory and Some Evidence from the USA," *Journal of Public Economics*, 91, 451-479\
Dijkstra, B.R. and P.G. Fredriksson (2010), "Regulatory Environmental Federalism," *Annual Review of Resource Economics*, 2, 319-339
Dinan, T. and N. Tawil (2003), "Resolving Environmental Externalities with Regional Decisionmaking: Controlling Ground–Level Ozone," *National Tax Journal*, 56(1), 123-138
Ederington, J., A. Levinson, and J. Minier (2004), "Trade Liberalization and Pollution Havens," *Advances in Economic Analysis and Policy*, 4, Article 2
Ederington, J. and J. Minier (2003), "Is Environmental Policy a Secondary Trade Barrier? An Empirical Analysis," *Canadian Journal of Economics*, 36, 137-154
Elliott, E.D., B.A. Ackerman, and J.C. Millian (1985), "Toward a Theory of Statutory Evolution: The Federalization of Environmental Law," *Journal of Law, Economics, & Organization*, 1(2), 313-340
Elliott, E., B.J. Seldon, and J.L. Regens (1997), "Political and Economic Determinants of Individuals' Support for Environmental Spending," *Journal of Environmental Management*, 51(1), 15-27
Engel, K.H. (1997), "State Environmental Standard-Setting: Is There a 'Race' and Is It 'To the Bottom'?" *Hastings Law Journal*, 48, 271-398
Esteller-Moré, A. and A. Solé-Ollé (2001), "Vertical Income Tax Externalities and Fiscal Interdependence: Evidence from the US," *Regional Science and Urban Economics*, 31, 247-272
Esty, D.C. (1996), "Revitalizing Environmental Federalism," *Michigan Law Review*, 95(3), 570-653
Fan, C.S., C. Lin, and D. Treisman (2009), "Political Decentralization and Corruption: Evidence from Around the World," *Journal of Public Economics*, 93, 14-34
Fisman, R. and R. Gatti (2002), "Decentralization and Corruption: Evidence Across Countries," *Journal of Public Economics*, 83(3), 325-345
Fisman, R. and R. Gatti (2002), "Decentralization and Corruption: Evidence from U.S. Federal Transfer Programs," *Public Choice*, 113(1-2), 25-35
Fomby, T.F. and L. Lin (2006), "A Change Point Analysis of the Impact of 'Environmental Federalism' on Aggregate Air Quality in the United States: 1940-1998," *Economic Inquiry*, 44(1), 109-120
Fredriksson, P.G. and N. Gaston (2000), "Environmental Governance in Federal Systems: The Effects of Capital Competition and Lobby Groups," *Economic Inquiry*, 38(3), 501-514
Fredriksson, P.G., J.A. List, and D.L. Millimet (2003), "Corruption, Environmental Policy, and FDI: Theory and Evidence from the United States," *Journal of Public Economics*, 87, 1407-1430
Fredriksson, P.G., J.A. List, and D.L. Millimet (2004), "Chasing the Smokestack: Strategic Policymaking With Multiple Instruments," *Regional Science and Urban Economics*, 34, 387-410
Fredriksson, P.G. and K.A. Mamun (2008), "Vertical Externalities in Cigarette Taxation: Do Tax Revenues Go Up in Smoke?" *Journal of Urban Economics*, 64, 35-48
Fredriksson, P.G. and D.L. Millimet (2002a), "Strategic Interaction and the Determination of Environmental Policy Across US States," *Journal of Urban Economics*, 51, 101-122. Reprinted in R.N. Stavins and A. Pratt (eds.), *The Political Economy of Environmental Regulation*, 2004.
Fredriksson, P.G. and D.L. Millimet (2002b), "Is there a 'California Effect' in US Environmental Policymaking?" *Regional Science and Urban Economics*, 32, 737-764
Fredriksson, P.G. and H.R.J. Vollebergh (2009), "Corruption, Federalism, and Policy Formation in the OECD: The Case of Energy Policy," *Public Choice*, 140, 205-221
Galle, B. and J. Leahy (2009), "Laboratories of Democracy? Policy Innovation in Decentralized Governments," *Emory Law Journal*, 58(6), 1333-1400
Garcia-Valiñas, M.A. (2007), "What Level of Decentralization is Better in an Environmental Context? An Application to Water Policies," *Environmental and Resource Economics*, 38(2), 213-229

Gerring, J. and S.C. Thacker (2004), "Political Institutions and Corruption: The Role of Unitarism and Parliamentarism," *The British Journal of Political Science*, 34, 295-330
Goodspeed, T.J. (2000), "Tax Structure in a Federation," *Journal of Public Economics*, 75, 493-506
Gordon, R.H. (1983), "An Optimal Taxation Approach to Fiscal Federalism," *Quarterly Journal of Economics*, 98(4), 567-586
Goulder, L.H. and R.N. Stavins (2011), "Challenges from State-Federal Interactions in US Climate Policy," *American Economic Review*, 101(3), 253-257
Gray, W.B. and R.J. Shadbegian (2004), "'Optimal' Pollution Abatement – Whose Benefits Matter, and How Much?" *Journal of Environmental Economics and Management*, 47, 510-534
Gray, W.B. and R.J. Shadbegian (2007), "The Environmental Performance of Polluting Plants: A Spatial Analysis," *Journal of Regional Science*, 47(1), 63-84
Gray, W.B. and J.P. Shimshack (2011), "The Effectiveness of Environmental Monitoring and Enforcement: A Review of the Empirical Evidence," *Review of Environmental Economics and Policy*, 5(1), 3-24
Greenstone, M. (2002), "The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures," *Journal of Political Economy*, 110(6), 1175-1219
Greenstone, M. and E. Moretti (2004), "Bidding for Industrial Plants: Does Winning a 'Million Dollar Plant' Increase Welfare?" MIT Department of Economics WP No. 04-39
Grether, J.-M., N.A. Mathys, and J. de Melo (2012), "Unravelling the Worldwide Pollution Haven Effect," *Journal of International Trade and Economic Development: An International and Comparative Review*, 21(1), 131-162
Gulsun Arikan, G. (2004), "Fiscal Decentralization: A Remedy for Corruption?" *International Tax and Public Finance*, 11, 175-195
Hall, N.D. (2008), "Political Externalities, Federalism, and a Proposal for an Interstate Environmental Impact Assessment Policy," *Harvard Environmental Law Review*, 32, 49-94
Hatfield, J.W. and K. Kosec (2013), "Local Environmental Quality and Inter-Jurisdictional Spillovers," unpublished manuscript, Stanford University
Hayashi, M. and R. Boadway (2001), "An Empirical Analysis of Intergovernmental Tax Interaction: The Case of Business Income Taxes in Canada," *Canadian Journal of Economics*, 34(2), 481-503
Hays, S.P., M. Esler, and C.E. Hays (1996), "Environmental Commitment among the States: Integrating Alternative Approaches to State Environmental Policy," *Publius: The Journal of Federalism*, 26(2), 41-58
Helland, E. (1998), "Environmental Protection in the Federalist System: The Political Economy of NPDES Inspections," *Economic Inquiry*, 36, 305-319
Helland, E. and A.B. Whitford (2003), "Pollution Incidence and Political Jurisdiction: Evidence from the TRI," *Journal of Environmental Economics and Management*, 46, 403-424
Henderson, V. (1996), "Effects of Air Quality Regulation," *American Economic Review*, 86(4), 789-813
Henderson, V. (1997), "The Impact of Air Quality Regulation on Industrial Location," *Annales d'Economie et de Statistique*, 45, 123-137
Henderson, D.J. and D.L. Millimet (2005), "Environmental Regulation and US State-Level Production," *Economics Letters*, 87, 47-53
Henderson, D.J. and D.L. Millimet (2007), "Pollution Abatement Costs and Foreign Direct Investment Inflows to U.S. States: A Nonparametric Reassessment," *Review of Economics and Statistics*, 89(1), 178-183
Hird, J. (1990), "Superfund Expenditures and Cleanup Priorities: Distributive Politics or the Public Interest?" *Journal of Policy Analysis and Management*, 9(4), 455-483
Horiuchi, Y. (2001), "Turnout Twist: Higher Voter Turnout in Lower-Level Elections," PhD Dissertation, MIT, Department of Political Science
Hutchinson, E. and P.W. Kennedy (2008), "State Enforcement of Federal Standards: Implications for Interstate Pollution," *Resource and Energy Economics*, 30, 316-344
Inman, R.P. and D.L. Rubinfeld (1997), "Rethinking Federalism," *Journal of Economic Perspectives*, 11(4), 43-64
Israel, D. and A. Levinson (2004), ""Willingness to Pay for Environmental Quality: Testable Empirical Implications of the Growth and Environment Literature," *Contributions to Economic Analysis and Policy*, 3(1), Berkeley Electronic Press. Reprinted in S. Tiezzi and C. Martini (eds.) *Is the Environment a Luxury?* Routledge, 2014.
Jaffe, A.B., S.R. Peterson, P.R. Portney, and R. Stavins (1995), "Environmental Regulation and the Competitiveness of US. Manufacturing," *Journal of Economic Literature*, 33(1), 132-163
Jeppesen, T., J.A. List, and H. Folmer (2002), "Environmental Regulation and New Plant Location Decisions: Evidence from a Meta-Analysis," *Journal of Regional Science*, 42(1), 19-49
Joskow, P.L. and R. Schmalensee (1998), "The Political Economy of Market-Based Environmental Policy: The U.S. Acid Rain Program, " *Journal of Law and Economics*, 41(1), 37-84

Jug, J. and D. Mirza (2005), "Environmental Regulations in Gravity Equations: Evidence from Europe," *World Economy*, 28, 1591-1615
Kahn, M.E. (1999), "The Silver Lining of Rust Belt Manufacturing Decline," *Journal of Urban Economics*, 46, 360-376
Kahn, M.E., P. Li, and D. Zhao (2013), "Pollution Control Effort at China's River Borders: When Does Free Riding Cease?" NBER Working Paper No. 19620, November
Kahn, M.E. and J.G. Matsusaka (1997), "Demand for Environmental Goods: Evidence from Voting Patterns on California Initiatives," *Journal of Law and Economics*, 40(1), 137-174
Kellenberg, D.K. (2009), "An Empirical Investigation of the Pollution Haven Effect with Strategic Environment and Trade Policy," *Journal of International Economics*, 78, 242-255
Konisky, D.M. (2007), "Regulatory Competition and Environmental Enforcement: Is There a Race to the Bottom?" *American Journal of Political Science*, 51(4), 853-872
Konisky, D.M. (2008), "Regulator Attitudes and the Environmental Race to the Bottom Argument," *Journal of Public Administration Research and Theory*, 18(2), 321-344
Konisky, D.M. (2009), "Assessing U.S. State Susceptibility to Environmental Regulatory Competition," *State Politics and Research Quarterly*, 9(4), 404-428
Konisky, D. (2010), "Public Preferences for Environmental Policy Responsibility," *Publius: The Journal of Federalism*, 41(1), 76-100
Konisky, D.M. and N.D. Woods (2010), "Exporting Air Pollution? Regulatory Enforcement and Environmental Free Riding in the United States," *Political Research Quarterly*, 63(4), 771-782
Konisky, D.M. and N.D. Woods (2012), "Environmental Free Riding in State Water Pollution Enforcement," *State Politics and Research Quarterly*, 12(3), 227-251
Kostogiannis, C. and R. Schwager (2006), "On the Incentives to Experiment in Federations," *Journal of Urban Economics*, 60, 484-497
Kruger, J., W.E. Oates, and W.A. Pizer (2007), "Decentralization in the EU Emissions Trading Scheme and Lessons for Global Policy," RFF DP 07-02, February
Levinson, A. (1997), "A Note on Environmental Federalism: Interpreting Some Contradictory Results," *Journal of Environmental Economics and Management*, 33(3), 359-366
Levinson, A. (1999), "NIMBY Taxes Matter: The Case of State Hazardous Waste Disposal Taxes," *Journal of Public Economics*, 74(1), 31-51
Levinson, A. and M.S. Taylor (2008), "Unmasking the Pollution Haven Effect," *International Economic Review*, 49(1), 223-254
Levinson, A. (2003), "Environmental Regulatory Competition: A Status Report and Some New Evidence" *National Tax Journal*, 56(1), 91-106
Levinson, A. (2010), "Offshoring Pollution: Is the United States Increasingly Importing Polluting Goods?" *Review of Environmental Economics and Policy*, 4(1), 63-83
Levinson, A. (2011), "Comments on Alm and Banzhaf 'Designing Economic Instruments for the Environment in a Decentralized Fiscal System.'" at http://joesonlineconference.files.wordpress.com/2011/11/alm-banzhaf-commentary-levinson.pdf
Lipscomb, M. and A.M. Mobarek (2011), "Decentralization and the Political Economy of Water Pollution: Evidence from the Re-drawing of County Borders in Brazil," unpublished manuscript, Yale University
List, J.A., E.H. Bulte, and J.F. Shogren (2002), "'Beggar Thy Neighbor:' Testing for Free Riding in State-Level Endangered Species Expenditures," *Public Choice*, 111, 303-315
List, J. and C. Co (2000), "The Effects of Environmental Regulations on Foreign Direct Investment," *Journal of Environmental Economics and Management*, 40(1), 1-20
List, J.A. and S. Gerking (2000), "Regulatory Federalism and Environmental Protection in the United States," *Journal of Regional Science*, 40(3), 453-471
List, J.A., W.W. McHone, and D.L. Millimet (2003a), "Effects of Air Quality Regulation on the Destination Choice of Relocating Plants," *Oxford Economic Papers*, 55, 657-678
List, J.A., W.W. McHone, and D.L. Millimet (2004), "Effects of Environmental Regulation on Foreign and Domestic Plant Births: Is There a Home Field Advantage?," *Journal of Urban Economics*, 56, 303-326.
List, J.A., D.L. Millimet, W.W. McHone, and P.G. Fredriksson (2003b), "Effects of Environmental Regulations on Manufacturing Plant Births: Evidence from a Propensity Score Matching Estimator," *Review of Economics and Statistics*, 85, 944-952. Reprinted in R. Brooks, N.O. Keohane, and D.A. Kysar (eds.), *Economics of Environmental Law*, Edward Elgar Publishing, 2008. Reprinted in K. Segerson (ed.), *The Economics of Pollution Control*, Edward Elgar Publishing, 2011.

Long, L. (1991), "Residential Mobility Differences among Developed Countries," *International Regional Science Review*, 14(2), 133-147
Lorenzoni, I. and N.F. Pidgeon (2006), "Public Views on Climate Change: European and USA Perspectives," *Climatic Change*, 77, 73-95
McAusland, C. and D.L. Millimet (2013), "Do National Borders Matter? Intranational Trade, International Trade, and the Environment," *Journal of Environmental Economics and Management*, 65, 411-437
McWhinnie, S.F. (2009), "The Tragedy of the Commons in International Fisheries:An Empirical Examination," *Journal of Environmental Economics and Management*, 57, 321-333
Millimet, D.L. (2003), "Assessing the Empirical Impact of Environmental Federalism." *Journal of Regional Science*, 43, 711-733
Millimet, D.L. and T. Collier (2008), "Efficiency in Public Schools: Does Competition Matter?" *Journal of Econometrics*, 145, 134-157
Millimet, D.L. and J.A. List (2003), "A Natural Experiment on the 'Race to the Bottom' Hypothesis: Testing for Stochastic Dominance in Temporal Pollution Trends," *Oxford Bulletin of Economics and Statistics*, 65, 395-420
Millimet, D.L. and V. Rangaprasad (2007), "Strategic Competition Amongst Public Schools," *Regional Science and Urban Economics*, 37, 199-219
Millimet, D.L. and J. Roy (2011), "Three New Tests of the Pollution Haven Hypothesis When Environmental Regulation is Endogenous," IZA DP 5911
Molloy, R., C.L. Smith, and A. Wozniak (2011), "Internal Migration in the United States," *Journal of Economic Perspectives*, 25(3), 173-196
Mulatu, A., R. Gerlagh, D. Rigby, and A. Wossnik (2010), "Environmental Regulation and Industry Location in Europe," *Environmental and Resource Economics*, 45, 459-479
Murdoch, J.C., M. Rahmatian, and M.A. Thayer (1993), "A Spatially Autoregressive Median Voter Model of Recreation Expenditures," *Public Finance Quarterly*, 21(3), 334-350
Murdoch, J., T. Sandler, and K. Sargent (1997), "A Tale of Two Collectives: Sulfur Versus Nitrogen Oxides Emission Reduction in Europe," *Economica*, 64, 281-301
Oates,W.E. (1972), *Fiscal Federalism*. New York: Harcourt Brace Jovanovich
Oates, W.E. (1989), "Searching for Leviathan: A Reply and Some Further Reflections," *American Economic Review*, 79(3), 578-583
Oates, W.E. (1999), "An Essay on Fiscal Federalism," *Journal of Economic Literature*, 37(3), 1120-1149
Oates, W.E. (2002a), "A Reconsideration of Environmental Federalism," in J.A. List and A. de Zeeuw (eds.) *Recent Advances in Environmental Economics*, Cheltenham: Edward Elgar, 1-32
Oates, W.E. (2002b), "Fiscal and Regulatory Competition: Theory and Evidence," *Perspektiven der Wirtschaftspolitik*, 3(4), 377-390
Oates, W.E. and P.R. Portney (2003), "The Political Economy of Environmental Policy," in K.-G. Mäler and J.R. Vincent (eds.) *Handbook of Environmental Economics*, Vol. 1, Cheltenham: Edward Elgar, 325-354
Perino, G. and O. Talavera (2013), "The Benefits of Spatially Differentiated Regulation: The Response to Acid Rain by U.S. States Prior to the Acid Rain Program," *American Journal of Agricultural Economics*, forthcoming
Potoski, M. (2001), "Clean Air Federalism: Do States Race to the Bottom?" *Public Administration Review*, 61(3), 335-343
Rabe, B.G. (2008), "States on Steroids: The Intergovernmental Odyssey of American Climate Policy," *Review of Policy Research*, 25(2), 105-128
Rabe, B.G. (2011), "Contested Federalism and American Climate Policy," *Publius: The Journal of Federalism*, 41(3), 494-521
Revesz, R.L. (1992), "Rehabilitating Interstate Competition: Rethinking the 'Race-to-the-Bottom' Rationale for Federal Environmental Regulation," *NYU Law Review*, 67, 1210-1254
Revesz, R.L. (1997), "Federalism and Environmental Regulation: Lessons for the European Union and the International Community," *Virginia Law Review* 83(7), 1331-1346
Rose-Ackerman, S. (1980), "Risk Taking and Reelection: Does Federalism Promote Innovation?" *Journal of Legal Studies*, 9(3), 593-616
Rosenbloom, J.L. and W.A. Sundstrom (2004), "The Decline and Rise of Interstate Migration in the United States: Evidence from the IPUMS, 1850–1990," in A. Field (ed.) *Research in Economic History*, Vol. 22, Amsterdam and San Diego: Elsevier, JAI, 289-325
Shipan, C.R. and C. Volden (2006), "Bottom-Up Federalism: The Diffusion of Antismoking Policies from U.S. Cities to States," *American Journal of Political Science*, 50(4), 825-843
Shleifer, A. and R.W. Vishny (1993), "Corruption," *Quarterly Journal of Economics*, 108(3), 599-617

Shobe, W.M. and D. Burtraw (2012), "Rethinking Environmental Federalism in a Warming World," *Climate Change Economics*, 3(4), 1-33
Sigman, H. (2002), "International Spillovers and Water Quality in Rivers: Do Countries Free Ride?" *American Economic Review*, 92, 1152–1159. Reprinted in J. Geoghegan and W. Gray (eds.), *Spatial Aspects of Environmental Policy*, Ashgate Publishing, 2006.
Sigman, H. (2003), "Letting the States Do the Dirty Work: State Responsibility for Federal Environmental Regulation," *National Tax Journal*, 56, 107–122
Sigman, H. (2005), "Transboundary Spillovers and Decentralization of Environmental Policies," *Journal of Environmental Economics and Management*, 50, 82-101
Sigman, H. (2013), "Decentralization and Environmental Quality: An International Analysis of Water Pollution Levels and Variation," *Land Economics*, forthcoming
Strumpf, K.S. (2002), "Does Government Decentralization Increase Policy Innovation?" *Journal of Public Economic Theory*, 4(2), 207-241
Thaler, R.H. (1988), "Anomalies: The Winner's Curse," *Journal of Economic Perspectives*, 2(1), 191-202
Tiebout, C.M. (1956), "A Pure Theory of Local Expenditures," *Journal of Political Economy*, 64(5), 416-424
Treisman, D. (2000), "The Causes of Corruption: A Cross-National Study," *Journal of Public Economics*, 76(3), 399-458
Volden, C. (2006), "States as Policy Laboratories: Emulating Success in the Children's Health Insurance Program," *American Journal of Political Science*, 50(2), 294-312
Weingast, B.R. (1995), "The Economic Role of Political Institutions: Market-Preserving Federalism and Economic Development," *Journal of Law, Economics, and Organization*, 11(1), 1-31
Williams III, R.C. (2012), "Growing State-Federal Conflicts in Environmental Policy: The Role of Market-Based Regulation," *Journal of Public Economics*, 96, 1092-1099
Wilson, J.D. (1999), "Theories of Tax Competition," *National Tax Journal*, 52(2), 269-304
Woods, N.D. (2006), "Interstate Competition and Environmental Regulation: A Test of the Race-to-the-Bottom Hypothesis," *Social Science Quarterly*, 87(1), 174-189
Xing, Y. and C.D. Kolstad (2002), "Do Lax Environmental Regulations Attract Foreign Investment?" *Environmental and Resource Economics*, 21, 1-22
Zabel, J.E. and K.A. Kiel (2000), "Estimating the Demand for Air Quality in Four U.S. Cities," *Land Economics*, 76(2), 174-194
Zax, J.S. (1989), "Is There a Leviathan in Your Neighborhood?" *American Economic Review*, 79(3), 560-567