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Fiscal decentralization and Pollution: Institutions Matter

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Fiscal decentralization and Pollution: Institutions Matter

Abstract

We estimate the impact of fiscal decentralization on different indicators of pollution for more than 80 countries from 1970 to 2000. Our cross country estimates show that fiscal decentralization increases pollution. However, higher quality of institutions can limit the destructive environmental effects of decentralization. The empirical results confirm a strand of the literature on decentralization that predicts a "race to the bottom" under federalism. The mitigating effect of good governance can be explained by relative preferences of local and central governments for environmental quality.

JEL classification: C21, H11, H72, Q53, Q56

Key words: decentralization, pollution, environmental quality, institutions

1. Introduction

Decentralization of political and economic power is one of the main topics on agenda of the international organizations such as the World Bank. Around 12% of World Bank projects completed between 1993 and 1997 involved decentralizing responsibilities to lower levels of government (Litvack et al., 1998). A recent World Bank study of 20 representative developing countries reveals that between 1990 and 2006 the World Bank spent 22 billion US dollar, of which 7.4 billion US dollar were aimed specifically at decentralization related activities. Within this period, almost 47% of the 203 World Bank commitments contained decentralization components (Gopal, 2008).[1] Environmental consequences of political and administrative decentralization are subject of an ongoing discussion in academic and governmental circles (e.g. Oates, 2002). Indeed, there is a rich theoretical literature on different effects of decentralization on the provision of public goods such as environmental quality (see, for instance, Peltzman and Tideman 1972; Oates and Schwab, 1988, 1991, and 1996; Cumberland, 1981; List and Mason, 2001; Markusen et al., 1993, 1995). As we will see subsequently (cf. section 2), however, this literature, as it applies to environmental decentralization, is somewhat inconclusive in its results: there are contributions sustaining both the view that decentralization is efficient and that it is inefficient in the provision of environmental quality.

Surprisingly, there is generally still a lack of empirical research on the decentralization-environment nexus: Sigman (2007) has empirically examined the direct effect of decentralization on water pollution around the world. She finds some evidence for increasing effects of decentralization on water pollution (a so called "race to the bottom")[2]. Our aim is to fill the empirical gap in the literature by estimating the effects of decentralization on local and

[1] Part of this increasing importance of decentralization is due to its income growth effects for the economies (for more details on economic growth-decentralization nexus see Thornton, 2007; Iimi, 2005; Stansel, 2005; and Davoodi and Zou, 1998).

[2] Apart from Sigman (2007), Lipscomb and Mobarak (2007) present an empirical study of the effect of decentralization on the environment. However, their analysis focusses on spillover effects in water pollution and is thus only indirectly related to the macroeconomic viewpoint taken in our article.

global pollution indicators. Importantly, we not only consider the direct environmental effect of decentralization but also its conditional effect through the quality of institutions. Generally speaking, the literature has emphasized the direct effect of institutions (e.g., control of corruption, democracy and rule of law) on pollution (see, for example, Panayotou, 1997; Torras and Boyce, 1998; Barrett and Graddy, 2000; Harbaugh et al., 2002; Farzin and Bond, 2006; Li and Reuveny, 2006; Cole, 2007; Bernauer and Koubi, 2009; Leitão, 2010, Damania et al. 2003, Lopez and Mitra 2000, Biswas et al. 2012, Welsch 2004).

Somewhat in contrast with Sigman's (2007) findings, the World Bank Decentralized Environmental Management guideline suggests "*Devolution of power from central to local governments offers the opportunity to tackle local problems in a more sustainable manner*". However, they also emphasize on the role of governance: "*Governments that have operated with a top-down approach may find it difficult to support local-level democratization—a process that will require strong institutions, flexible administrative instruments, effective participatory mechanisms, and empowered local officials and communities*". Adequate capacity building, environmental regulations, and willingness to enforce them are, according to the report, detrimental conditions for a successful performance of decentralization projects. Moreover, most countries in the East Asia and Pacific are said to have initiated decentralization in their environmental issues.[3]

The *joint* effect of decentralization and quality of institutions has, however, been neglected in the decentralization and environmental policy literature. Building on earlier theoretical contributions, this paper develops a hypothesis on the nexus: While decentralization has a detrimental effect on environmental quality ("race-to-the-bottom"), the effect is mitigated by better institutional quality. This view is rationalized by analyzing relative preferences of local governments (resp. populations) for environmental quality. The hypothesis is widely confirmed by our empirical findings. Our main results confirm the "race-to-the bottom", i.e.

[3] For further details see http://go.worldbank.org/U4T2B00M10

they show that direct effect of decentralization on different air and water pollution indicators is strictly expansive. However, this destructive environmental effect of decentralization can be controlled by higher quality of institutions. These findings hold both for local and global pollutants, such as SO2 and CO2.

The rest of the paper is organized as follows. Section 2 presents the review of theoretical discussions on the environmental effects of decentralization and the central hypothesis. Section 3 explains the data and empirical specification. Section 4 presents and discusses the results and Section 5 concludes the paper.

2. Theory of decentralization, governance and quality of environment

In this section we first review the relevant theoretical literature on our topic, including both literature on environmental, decentralization and governance and pollution control. Second, building on the theory reviewed, we derive a hypothesis on the effect of governance on environmental decentralization.

2.1 Environmental decentralization

The theoretical literature on environmental decentralization is very well developed, yet inconclusive in its results. Building on the earlier literature on (fiscal) federalism, it centers on the question whether centralized or decentralized environmental regulation is more efficient. Here, environmental regulation refers to pollution control, so that the question can be rephrased whether a central or regional governments will more efficiently internalize external costs of production, or, alternatively, provide sufficient environmental quality when production is dirty. Importantly, one has to distinguish between local and global pollutants. In the latter case pollutants have effects beyond regional jurisdictions, so that their inhabitants bear only part of the external cost of pollution. As Oates (2002) puts it in his overview article on environmental federalism, "*in such a setting, it seems clear that central determination of environmental standards is in order*." (p. 3). Essentially in this case we observe the tragedy of

the commons: the general public 'good environmental quality' is underprovided by an individual region that fully captures the economic benefit of dirty production, but is only in part exposed to its detrimental effects. Local pollutants are the more intricate and controversial case. From a basic viewpoint, it can be related to the literature of optimal provision of public goods (cf. Wilson 1996): local communities have preferences over prosperity as well as environmental quality, and in a federal democracy, the regional median voter will vote for a legislature that implements a pollution control trading off pollution and economic gain according to his preferences. This is the essence of the Tiebout hypothesis (Tiebout 1956), stating the efficiency of the individual's ability to "vote with his feet", which in the present case amounts to the statement that mobile individuals can efficiently choose their home region according to their individual degree of environmentalism[4]. Note that this line of argument does not purport that decentralization of environmental policy will increase or decrease regional pollution – instead, we should expect larger regional variety of environmental quality in decentralized countries[5]. Yet a systematically lower environmental quality in decentralized countries is still hard to reconcile with this viewpoint: it would suggest that citizens of countries with decentralized environmental regulation have a systematically lower preference for environmental quality than citizens in centralized countries. While being hard to prove or disprove empirically, such a hypothesis seems implausible. In their seminal contribution Oates and Schwab (1988) argue in favor of the **efficiency of decentralized environmental policy**. They formalize the problem by constructing a model of regions that compete for a national stock of capital, that serves as an input into production alongside labor and polluting waste emissions (costless to the firm). The government has direct regulatory control over pollution levels that – by way of production -

[4] For fiscal policy, this viewpoint was elaborated into a theory of fiscal federalism (cf. Oates 1972).
[5] In her international study on water pollution, Sigman (2007) finds indeed some evidence that there is higher interjurisdictional variation in pollution levels in federal than centralized countries.

are, however, relevant both to employment and profitability of the firm[6]. Moreover, the government can raise taxes on capital. In their analysis of competition for capital, the authors find that in a first best setting a median voter would agree to a zero tax on capital and efficient pollution control. Thus an efficient level of both employment and environmental quality can be assured; a result in the spirit of the Tiebout hypothesis. In contrast, when capital taxes are non-zero and thus distortionary for some additional reason[7], a local rational for relaxing environmental standards arises in the mitigation of the fiscal distortion: Competition for capital resources leads to an **inefficient race to the bottom in the provision of environmental quality**. In fact, this line of reasoning is mirrored by a strand of literature on a 'fiscal externality', i.e. distortions of decentral taxation arising either from regional restrictions on the tax base or from strategic behavior of larger regions (cf. Oates 2002, p. 6 ff.). Yet competition for capital need not lead to a race to the bottom, but can also give rise to **Not-In-My-Backyard (NIMBY) policies**, i.e. inefficiently stringent environmental standards. Markusen et al. (1995) present a model with two regions and an imperfectly competitive firm considering a lumpy investment, i.e. due to an industry-specific fix cost, the firm can only invest into one large and dirty plant in one of the two regions. Since it causes pollution deemed excessive by each region the investment it thwarted by both regional governments although a trans-regional cost-benefit analysis would show its overall profitability to the country. Alternatively, Glazer (1999) presents a model of a federal country with two regions, where a strategic choice of local environmental regulation leads to a Nash equilibrium with excessive stringency in comparison to an efficient central state solution.

2.2 Decentralization and governance

Theory does not yield a definitive answer whether environmental decentralization is efficient or not – either a race-to-the-bottom, efficiency or a not-in-my-backyard outcome is

[6] The authors assume constant-returns-to-scale production. Thus the control of pollution can be expressed by controlling the labor-pollution ratio.
[7] Wilson (1996) gives an overview over rationalizations for this assumption (p. 409 ff.).

conceivable depending on the circumstances. Similarly, the theoretical literature is divided on whether decentralization fosters or mitigates weak governance and corruption (cf. Shah, 2006 and Bardhan, 2002). One line of argument, going back to Alexander Hamilton, James Madison and John Jay (1787), emphasizes the multiplication of opportunities for rent extraction by officials after political decentralization or devolution of administrative power.[8] This view is formalized by Shleifer and Vishny (1993) that model government bureaucracies as monopolies selling their "services" to the private sector. Central governments act as a joint monopoly, reducing overall capture in comparison to decentral governments that constitute multiple monopolies. The analysis is challenged by a model by Waller et al. (2002), where higher level officials take a share of the bribes raised by corrupt bureaucrats. In this framework the overall capture across the economy depends on the specific structure of the federal government, including the monitoring process of bureaucracies and general wage-levels, so that the answer to the question for the effect of decentralization on corruption depends on the circumstances. Bardhan and Mookherjee (2000) analyze the determinants of corruption in the democratic process in a federal state. Factors included in their analysis encompass voter awareness, income inequality and lobbying power of specific voter groups. With their formal model they can show that the scope of capture in a centralized versus a federal democracy depends to a large extent on the socioeconomic composition of the regions and voting system across electoral districts. These apparently administrative details of democracy have an important impact on the power of control by the electorate over the dominant party. So their results on the relation of decentralization and corruption are inconclusive as well. Yet in the literature there are also proponents of the hypothesis that decentralization will lower rather than increase state capture. Arikan (2004) presents a model of tax competition. The amount of bribes bureaucrats can raise is directly related to tax

[8] Lessmann and Markwardt (2010) show the importance of monitoring bureaucrats' behavior in marginal effect of decentralization on corruption.

revenues. Whereas in a central system a tendency towards higher taxes fosters higher capture, tax competition between regions in a federal system with decentralized fiscal policy tends to curb overall corruption. The literature on corruption is related to the wider literature on governance that has also analyzed the role of decentralization (cf. Bardhan, 2002). Here the key question is about accountability of officials, i.e. about structures of efficient control. Applying the theory of incomplete contracts, Seabright (1996) highlights the trade-off in the efficiency of decentralization: whereas policy coordination in a central government benefits the electorate, decentral governmental structures allow for a higher level of accountability when judicial control of government is limited and elections are the primary tool of control. This line of argument is related to the concept of "yardstick competition" in federal democracies (Besley and Case 1995): weaknesses in local governance are exposed by competition of jurisdictions (competing for mobile firms and high-skilled labor) only under decentralized structures, whereas centralized structures tend to hide low quality of governance by local envoys.

A further strand of literature is relevant for our analysis: contributions studying the interaction of governance and corruption with environmental quality or policy. Fredriksson and Svensson (2003) present a theoretical model for the relation of corruption, political stability and stringency of environmental policy. Damania et al. (2003) study the impact of corruption on the relation between free trade and environmental policy. Lopez and Mitra (2000) analyze the effect of corruption on the environmental Kuznets curve. Finally, Biswas et al. (2012) study the effect of corruption on pollution in a model with a shadow economy. In all frameworks studied, corruption negatively affects environmental stringency, to a larger or lesser extent depending on the additional factors in the models. This (non-surprising) relationship is confirmed empirically by Welsch (2004), as well as in the empirical sections of Damania et al. (2003) and Biswas et al. (2012).

2.3 Deriving a hypothesis on decentralization, governance and pollution

In this article, we empirically analyze the impact of decentralization on pollution in the presence of bad governance and corruption. At this point, we reflect on the theory reviewed and derive a hypothesis for our empirical analysis. We start with the effect of decentralization on environmental quality. As the theoretical literature presents inconclusive results, we have to take a first look at empirical findings to see whether a race-to-the-bottom, efficiency or a NIMBY situation prevails. Sigman's (2007) (and our own) results suggest that decentralization of pollution control leads to a race-to-the-bottom, so that the corresponding theoretical literature is relevant for us. As we have seen, many contributions spot the decisive role of competition for a national stock of capital as a motivation to lower environmental standards below efficient levels. In Oates and Schwab (1988), the inability to lower capital taxation to the efficient zero level leads to regional governments reducing pollution control instead.

As for the effect of bad governance, we have seen in the discussion of the literature above, that it generally reduces environmental quality. This is to say, the direct effect of bad governance - such as insufficient monitoring systems, lack of coordination between government agencies, corrupt officials neglecting their supervisory duties – is detrimental to environmental quality; the indirect effect of bad governance, i.e. its hampering influence on growth and prosperity, can have a positive effect since poor countries tend to consume less energy[9].

Thus the first two elements of our hypothesis, i.e. the race to the bottom in environmental decentralization and the negative effect of bad governance on environmental quality, follow from the literature in a straightforward manner. In contrast, the answer to the question whether bad governance aggravates or mitigates the race-to-the-bottom in environmental

[9] This explanation works for the initial phase of economic development, the first part of the Kuznets curve, when growth and pollution are positively correlated.

regulation is less obvious. To complete our hypothesis, we use the framework established in the overview article by Wilson (1996). As explained in 2.1, the article sets the problem of pollution control in terms of the optimal provision of the (local) public good, environmental quality. To characterize the race-to-the-bottom, Wilson (1996) rephrases the model by Oates and Schwab (1988). In his framework, output is created from the inputs capital, labor and emissions according to a CRS production function: $Q = F(K, L, E)$. Regional governments regulate emissions by directly controlling the emissions-labor ratio $\alpha = {}^{E}/_{L}$. Regional supply of labor is fixed, whereas firms compete for the national stock of capital. In the absence of distortionary capital taxation, capital supply is efficient and the regional governments provide the efficient level of environmental quality, characterized by the Samuelson rule:

$$\sum_i MB_i = MC, \qquad (1)$$

i.e. the sum of marginal benefits for all members i of a region is equal to the marginal cost of providing the public good, measured by the loss of output due to rising α . A race-to-the-bottom occurs if the regional governments have to use distortionary capital taxation (for some unexplained reason). In that case, pollution control can be modified to encompass this effect:

$$\sum_i MB_i = MC - t\,\Delta K, \qquad (2)$$

where ΔK is the decline in capital supply from tightening the environmental standards and t is the net value of an additional unit of capital to a given jurisdiction[10]. Consequently, environmental standards are set too inefficiently low. This approach captures insufficient pollution control for a local pollutant, for a global pollutant, the tragedy of the commons described above can easily be formulated in the following way:

$$\sum_{i \epsilon R} MB_i = MC, \qquad (3)$$

[10] Compare Wilson (1996), p. 397ff, equations (1) and (7).

with the summation now being over individuals from region R only, while the provision of environmental quality benefits all. Clearly, under these circumstances environmental quality will be undersupplied as only regional, not national benefits are taken into consideration.

How to integrate the notion of bad governance into this framework? Following the literature, bad governance can be understood as a lack of regulatory oversight, due to insufficient monitoring or corruption. In our context, this can be modeled as a further detrimental effect on (official) capital supply: rather than producing according to the environmental standards set by the government, a firm can choose to produce in an inofficial sector and avoid governmental control. For the government, this means an additional cost of environmental regulation: capital is crowded out from the official sector, possibly creating additional pollution in the inofficial sector. This amounts to the following:

$$\sum_i MB_i - MP_{io} = MC - t\,\Delta_k K - \; t\,\Delta_{io} K, \qquad (4)$$

where MP_{io} denotes the marginal reduction of environmental quality due to pollution in the inofficial sector, $\Delta_k K$ the loss of capital due to inefficient tax competition between regions and $\Delta_{io} K$ loss of capital to the inofficial sector. What about the sign of the left-hand-side? Clearly, it depends on the extent of pollution in the inofficial sector that we would expect to use less environmentally friendly technologies than the official sector. It is a plausible assumption, though, that bad governance - while reducing marginal environmental benefits from pollution control – does not entirely undo their effect, i.e. tightening environmental standards will in summa still reduce pollution (and, at the same time, official investment).

What can we learn from the equation above about the relation between decentralization and governance? Under a central government, inefficient tax competition will disappear as capital supply does not increase by a reduction of environmental standards. In terms of the equation above that means that $\Delta_k K$ disappears while the central government is still plagued by bad governance:

$$\sum_i MB_i - MP_{io} = MC - t\,\Delta_{io}K. \quad (5)$$

A comparison of the two formulae yields the following: under a central government higher environmental quality will prevail than under decentralized government, yet better governance can mitigate this trend. Formally, the reason is concavity of individual utility in environmental quality: the lower the value of environmental quality the higher the benefits of an incremental increase and the greater the cost that the electorate (and thus the government) is ready to bear for an improvement. In other words: given the low level of environmental quality under decentralization in a race to the bottom, the improvement of governance is particularly beneficial.

A similar line of reasoning applies to the case of the global pollutant: bad governance adds to the undersupply of the public good environmental quality:

$$\sum_{i\epsilon R} MB_i - MP_{io} = MC - t\,\Delta_{io}K, \quad (6)$$

Yet as governance improves, environmental quality is raised disproportionally. In the empirical part, we will see indeed that the view developed in this reduced form analysis applies to our case.

Thus we have derived a full hypothesis on the effect of decentralization and bad governance on pollution control: bad governance generally has a negative effect of environmental quality, decentralization leads to a race-to-the-bottom, however, the latter effect is mitigated by good governance. We will see that our empirical analysis sustains this view.

3. Data and empirical specification

As we explained earlier, the theoretical literature is not conclusive about the final effect of decentralization on pollution. An overall look at our data shows that there is positive correlation between decentralization and all different transboundary and local pollution (see

Figures 1-3). As we show in estimation results, this positive association survives when we control for other major determinants of pollution. Our main idea is introduction of an interaction term between decentralization indicator and quality of institution index. A higher quality of institutions in a term of rule of law, control of corruption, and political stability can limit the destructive environmental impacts of decentralization.

To test our hypothesis on the long run environmental impacts of decentralization and moderating role of institutions, we use data for more than 80 countries from 1970-2000 in the following cross-country specification:

$$POLLUTION_i = \beta_0 + \beta_1 DEC + \beta_2 INST_i + \beta_3 (DEC_i * INST_i) + \beta_4 X_i + \varepsilon_i \quad (7)$$

We use logarithm of three different pollution indicators averaged from 1970-2000 as our dependent variable: CO2, SO2 and BOD. CO2 emission per capita is an indicator of transboundary pollution while SO2 per capita and BOD per day indicators measure local air and water pollution. The source of CO2 and BOD is the World Bank (2011) and SO2 data are from Smith et al. (2011). Our decentralization measure is the share of sub-national government revenues in the total government (central and sub-national) revenues.[11] The ideal situation was to use a decentralization indicator for the environmental issues, however as Sigman (2007) points out such an index is not available for both practical and conceptual reasons. We follow Sigman (2007) and use the fiscal decentralization for our pollution specification. The source of decentralization data is the World Bank (2001) on the basis of data from the IMF's Government Finance Statistics.

To measure the quality of institutions we use the World Bank governance indicators in the year 1996. These indicators are Government Effectiveness, Control of Corruption, Rule of Law, Regulatory Quality, Political Stability, and Voice and Accountability (Kaufman et al.,

[11] The results are robust using expenditure decentralization indicator. After all, the correlation between revenue and expenditure decentralization in our sample is 0.94.

2010). In order to minimize possible omitted variable bias on the coefficients of our measure of decentralization and its interaction with institutions, we include in the basic regression a number of controls that are standard in the cross-country empirical literature on environmental quality.

One of the most robust determinants of pollution is the income per capita. According to the Environmental Kuznets Curve (EKC) there is an inverted U-shaped relationship between economic development measured by real GDP per capita and air and water quality (Grossman and Krueger, 1995).

This non-linear relationship between economic development and environmental quality has been extensively studied in the literature, for example in Smulders and Bretschger (2000), Kelly (2003), Lieb (2004), Dinda (2004), and Brock and Taylor (2010). Thus, we include the logarithm of real GDP per capita and its square in our specifications. Another determinant of pollution is the urbanization measured as the share of urban population in total population. Urbanization may add to the pollution as it leads to a raise in public and private transportation resulting in higher fossil fuel consumption (Panayotou, 1997).

Figure 1. Logarithm of CO2 per capita and Revenue Decentralization

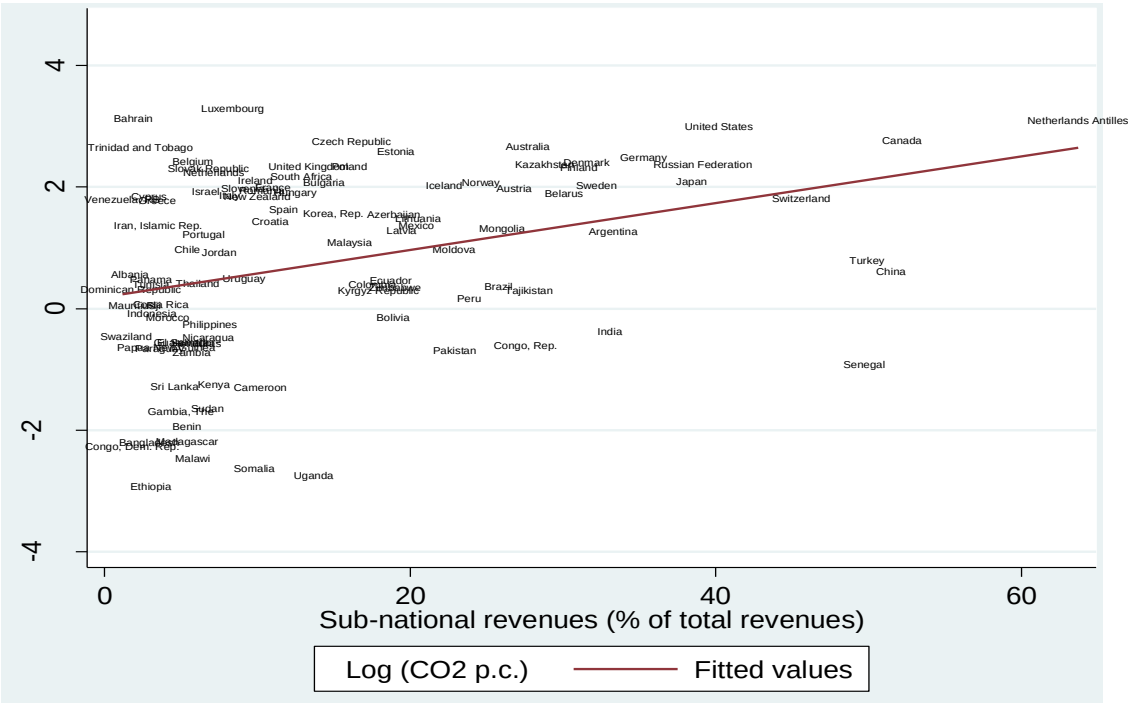


Figure 2. Logarithm of SO2 per capita and Revenue Decentralization

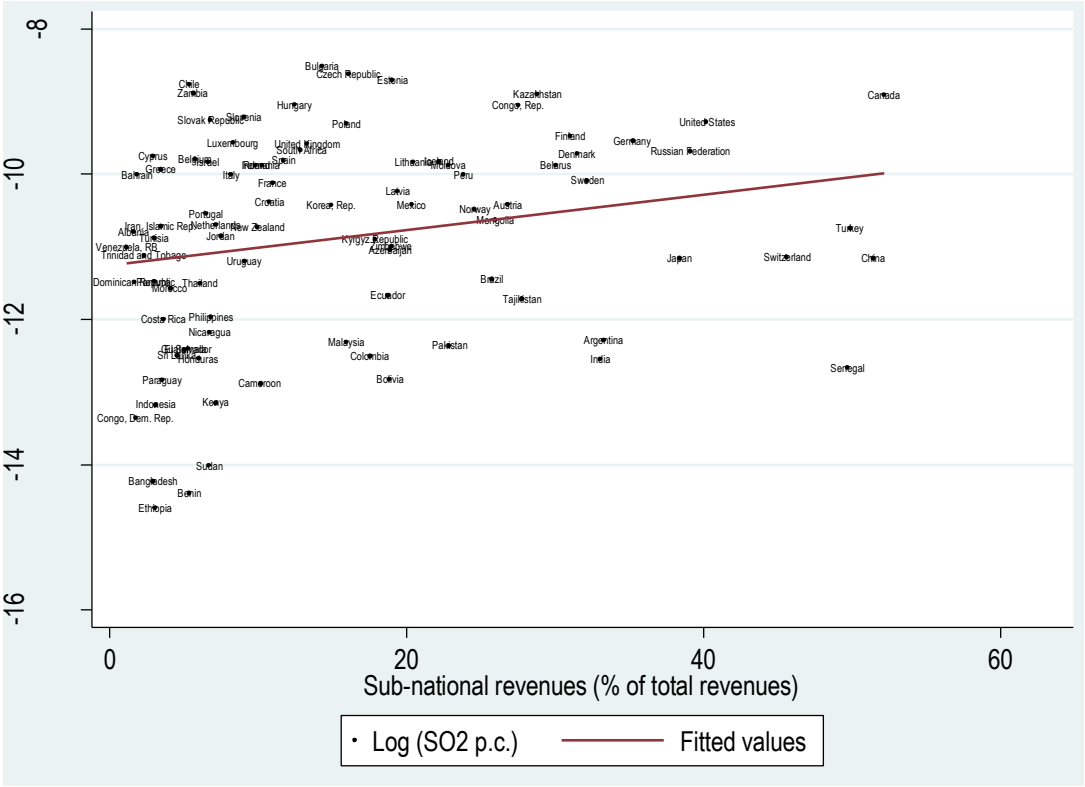
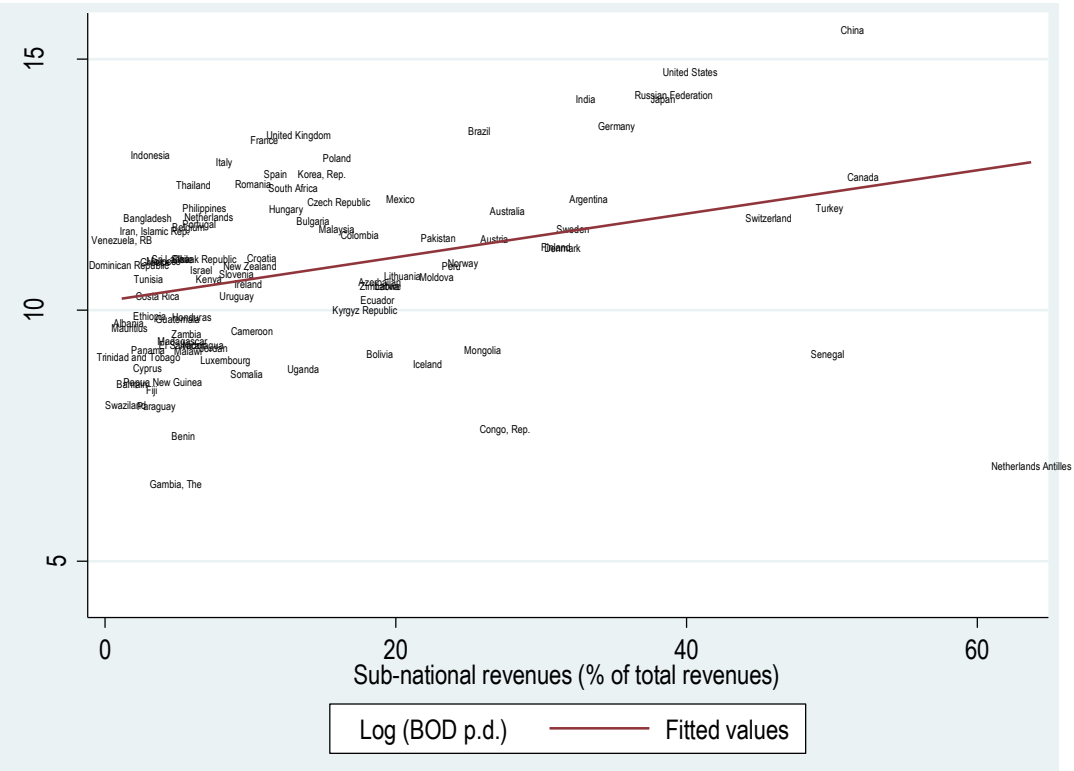


Figure 3. Logarithm of BOD per day and Revenue Decentralization



It also implies a higher density of the means of production, having a further negative impact on the quality of the environment (Cole and Neumayer, 2004). Population density is also another potential factor in explaining the levels of pollution. It is often emphasized that a high population density leads to an unsustainable exploitation of the environment (Hilton and Levinson, 1998). It is often argued that globalization and international trade also affect the quality of environment. Cole (2004) suggests that trade openness may reduce pollution because countries may have easier access to environmentally friendly technologies. However, Pollution Haven Hypothesis also argues the negative effects of higher trade openness for quality of environment. We control for the share of total trade in GDP. Finally, another robust determinant of pollution is the energy efficiency measured as the GDP per unit of energy use. Higher energy efficiency means lower consumption of fuels for a specific unit of production. The source for all control variables is the World Bank (2011). We also include the regional dummies to control for unobserved heterogeneity across our sample. Although many of our variables have annual observation but there is a low within-country variation in particular for our main variables of interest such as fiscal (or political) decentralization and quality of institutions[12]. Thus, we use average values (see Fisman and Gatti, 2002 for the similar approach). Appendix A provides a detailed description of the variables and their sources.

4. Estimation results

Table 1 reports the OLS estimation results based on the equation 1 for more than 80 countries, using the expenditure decentralization measure. Significance of the estimates is based on White-corrected standard errors. Our measure of decentralization enters the regression with a positive and strongly significant sign, indicating that countries with more decentralized revenues have higher local and transboundary pollution. This finding is robust for all specifications. The size effect of decentralization is higher for more local pollution (*SO2* and

[12] This issue is also highlighted by providers of the World Governance Indicators: "*Changes in governance over short year-to-year periods are difficult to measure with any kind of data, and are typically quite small".*

BOD) than more transboundary kind of pollution (*CO2*). Across different specifications, a 1% increase in the revenue decentralization, on average, increases *CO2* emission per capita by 1.44%, *ceteris paribus.* The similar rise in decentralization indicator increases *SO2* and *BOD* pollution by 2.13% and 3.33%, respectively. This robust finding provides some evidence for destructive regulatory competition in the form of "race to the bottom" or the "race to top" in decentralized system. Also the results for the tranboundary pollution (*CO2*) support interjurisdictional free riding. Under free riding; the subnational governments choose higher pollution levels which have more transboundary effects than the national government would choose (Silva and Caplan, 1997). Such patterns are also considered in the United States (Helland and Whitford, 2003; Sigman, 2005; Gray and Shadbegian, 2004) and in Brazil (Lipscomb and Mobarak, 2007).[13] Sigman (2007) also finds an increasing effect of decentralization on water pollution.

We also consider the role of different aspects of governance in pollution-decentralization nexus. We allow for moderating role of institutions in final environmental effect of decentralization which has been ignored in the empirical literature (*inter* in Table 1). We notice that the interaction of institutions and decentralization has a consistent negative effect on both local and transboundary pollution. This negative effect is statically significant in 9 specifications of total 18 models in Table 1. The negative interaction term means that the higher quality of institutions the lower will be the destructive environmental effect of decentralization.

Among different aspects of institutions the following ones proved to have significant moderating effects: Government Effectiveness-gov96*ge*- (for *CO2* and *SO2*), Control of Corruption- *gov96cor*- (for *CO2*), Rule of Law- *gov96rl*- (for *CO2*, *SO2*, and *BOD*),

[13] We find the same increasing and statistically significant effect on pollution indicator by using federalism dummy (the presence of a federalist constitution) from Treisman (2002).

Regulatory Quality- *gov96rq*- (for *CO2*), and Political Stability- *gov96ps*- (for *CO2*, *SO2*, and *BOD*). Voice and Accountability- *gov96va*- shows no statistically significant moderating role.

A number of other variables have been shown to be important explanatory variables in pollution regressions. Population density (*popdesn*) is an important determinant for the local pollution and in particular for the water pollution (*BOD*). Higher openness to trade (*trade*) shows an effective policy to reduce the local pollution while it has an increasing impact on global pollution (*CO2*) as is shown in Pollution Heaven Hypothesis. Increasing energy efficiency (*gdpen*) has a robust negative impact on all indicators of pollution.

We find a significant and robust evidence for the EKC hypothesis, especially for the case of SO2 and CO2 emission. There is an inverted U-shaped relationship between income per capita (*lngdppc*) and pollution. Sub-Sahara dummy (*ssd*) shows a negative effect on CO2 emission while the East Asian dummy (*ead*) has an increasing effect on local pollution indicators. Lower economic output in the Sub-Sahara region should lead to lower environmental pressure.

To sum up, our results show that encouraging developing countries to decentralize their governing systems without paying attention to their institutional background leads to higher environmental degradation. The direct effect of some institutional variables on pollution is positive. Initially this may be puzzling: why higher quality of institutions should have a direct increasing effect of pollution? As mentioned by Cole (2007) higher quality of institutions (lower corruption in his study) can increase environmental stringency, lowering pollution. But it also increases economic output which increases environmental pressure. The final effect depends on strength of these conflicting impacts. Biswas et al. (2012) have also discussed this issue.

The marginal pollution effect of fiscal decentralization can be calculated by examining the following partial derivative on the basis of Eq.7:

$$\frac{\partial(POLLUTION)}{\partial(DEC)} = \beta_1 + \beta_3 * INST \qquad (8)$$

Taking Rule of Law in specifications 7-9 as one of the main aspects of good governance, the marginal impact of 1% increase in the fiscal decentralization on log (*CO2 p.c.*), log (*SO2 p.c.*) and Log (*BOD p.d.*) is:

$$\frac{\partial(\log CO2 p.c.)}{\partial(DEC)} = 0.0163 - 0.0111 * Rule\ of\ Law \qquad (9)$$

$$\frac{\partial(\log SO2\ p.c.)}{\partial(DEC)} = 0.0286 - 0.0176 * Rule\ of\ Law \qquad (10)$$

$$\frac{\partial(\log BOD\ p.d.)}{\partial(DEC)} = 0.0472 - 0.0288 * Rule\ of\ Law \qquad (11)$$

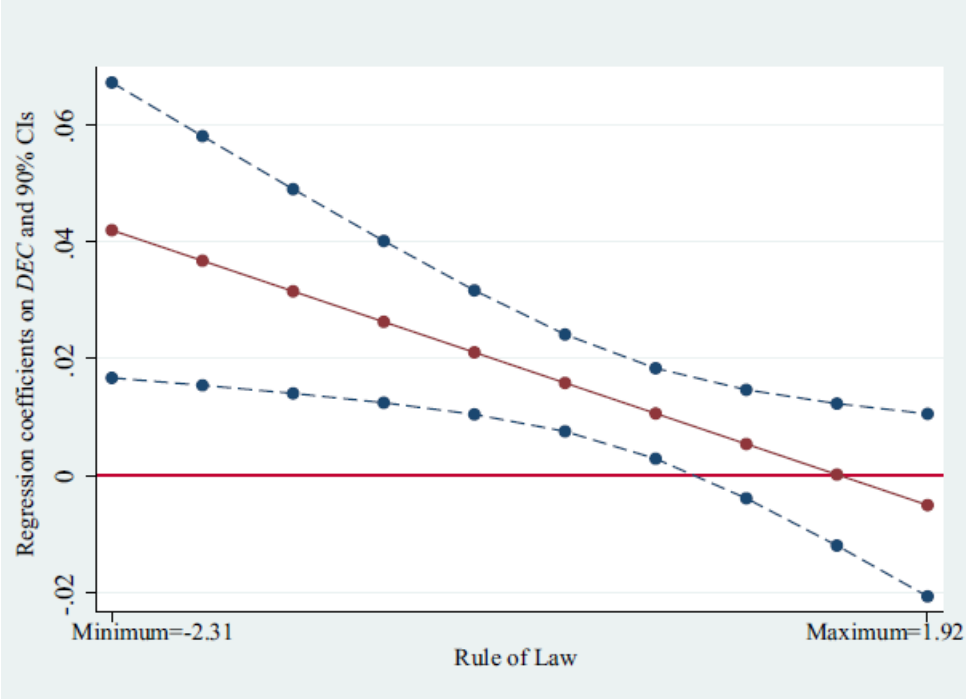
We are also interested in the statistical significance of these marginal effects. Figures 4-6 show the effects of a 1% increase in the fiscal decentralization at different values of rule of law on CO2 emission per capita, SO2 emission per capita and BOD emission per day. The 90% statistical significance of these marginal impacts is also presented. We notice that the final pollution effects of fiscal decentralization are positive (increasing) which is moderated by higher rule of law. The destructive effect of decentralization is stronger for the local pollution (BOD and SO2). These positive effects are statistically significant.

Table 1
OLS cross country estimates. Dependent variable: logarithm of pollution indicator per capita

Models	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	lnco2pc	*lnso2pc*	*lnbodpd*	*lnco2pc*	*lnso2pc*	*lnbodpd*	*lnco2pc*	*lnso2pc*	*lnbodpd*	*lnco2pc*	*lnso2pc*	*lnbodpd*	*lnco2pc*	*lnso2pc*	*lnbodpd*	*lnco2pc*	*lnso2pc*	*lnbodpd*
dec	0.01***	0.01*	0.02**	0.01***	0.01*	0.02**	0.01***	0.02***	0.04***	0.01***	0.02**	0.02*	0.01***	0.02**	0.03***	0.01***	0.01**	0.02**
	(3.57)	(1.90)	(2.16)	(3.50)	(1.81)	(2.28)	(3.21)	(2.68)	(3.50)	(3.84)	(2.15)	(1.88)	(3.69)	(2.47)	(3.60)	(2.97)	(2.06)	(2.39)
inter	-0.01***	-0.01*	-0.01	-0.009***	-0.004	-0.009	-0.01**	-0.01**	-0.02***	-0.01**	-0.01	0.00	-0.01***	-0.01	-0.03***	-0.002	-0.00	-0.005
	(-3.47)	(-1.79)	(-1.28)	(-3.49)	(-0.82)	(-1.20)	(-2.08)	(-2.15)	(-2.72)	(-2.14)	(-1.47)	(0.09)	(-3.04)	(-1.47)	(-3.28)	(-0.90)	(-0.26)	(-0.64)
urban	-0.00	0.00	0.00	-0.00	0.01	0.00	-0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	0.00
	(-1.43)	(0.99)	(0.11)	(-0.96)	(1.54)	(0.14)	(-1.63)	(0.45)	(-0.19)	(-1.11)	(1.01)	(0.18)	(-1.20)	(0.69)	(0.02)	(-0.95)	(1.05)	(0.12)
popdens	-0.00	-0.00	0.00**	-0.00	-0.00	0.002**	0.00	-0.00	0.003***	0.00	-0.00	0.002**	0.00	-0.00	0.003***	0.00	-0.00	0.002**
	(-0.05)	(-1.15)	(2.41)	(-0.02)	(-1.00)	(2.15)	(0.83)	(-0.26)	(2.96)	(0.69)	(-0.68)	(2.33)	(0.77)	(-0.60)	(2.66)	(0.48)	(-0.49)	(2.48)
trade	0.00	0.00	-0.02***	0.002**	0.00	-0.02***	0.00	0.00	-0.02***	0.00	0.00	-0.02***	0.003**	0.007*	-0.02***	0.003**	0.00	-0.02***
	(1.52)	(1.31)	(-6.04)	(2.09)	(1.59)	(-6.14)	(1.58)	(1.31)	(-6.01)	(1.34)	(1.22)	(-5.52)	(2.37)	(1.83)	(-6.47)	(2.33)	(1.60)	(-6.08)
gdpen	-0.25***	-0.19***	-0.19**	-0.2***	-0.18***	-0.18**	-0.25***	-0.16**	-0.23**	-0.24***	-0.18***	-0.18**	-0.25***	-0.16**	-0.24***	-0.25***	-0.18**	-0.20**
	(-10.74)	(-3.05)	(-2.56)	(-10.45)	(-3.02)	(-2.42)	(-8.54)	(-2.29)	(-2.65)	(-9.19)	(-2.77)	(-2.32)	(-9.54)	(-2.47)	(-3.03)	(-9.75)	(-2.61)	(-2.46)
lngdppc	2.9***	3.5***	2.08	2.8***	3.7***	1.3	3.3***	3.8***	2.7*	3.5***	3.7***	2.4	3.4***	3.8***	2.5	3.3***	4.0***	2.5
	(6.39)	(4.37)	(1.50)	(6.37)	(5.09)	(0.92)	(6.30)	(4.32)	(1.74)	(6.38)	(4.09)	(1.51)	(6.82)	(4.12)	(1.55)	(5.93)	(4.57)	(1.59)
lngdppc2	-0.13***	-0.2***	-0.12	-0.12***	-0.22***	-0.06	-0.15***	-0.20***	-0.13	-0.16***	-0.20***	-0.13	-0.15***	-0.20***	-0.12	-0.15***	-0.21***	-0.13
	(-4.37)	(-3.69)	(-1.45)	(-4.36)	(-4.56)	(-0.71)	(-4.48)	(-3.75)	(-1.49)	(-4.80)	(-3.76)	(-1.38)	(-5.09)	(-3.68)	(-1.30)	(-4.29)	(-4.09)	(-1.42)
ssd	-0.82***	-0.2	-0.6	-0.8***	-0.12	-0.6	-0.6***	-0.03	0.34	-0.72***	0.00	-0.28	-0.60***	-0.37	0.11	-0.79***	-0.06	-0.29
	(-4.53)	(-0.35)	(-1.03)	(-4.44)	(-0.21)	(-1.03)	(-2.92)	(-0.08)	(0.60)	(-3.65)	(0.01)	(-0.48)	(-2.79)	(-0.92)	(0.22)	(-3.71)	(-0.10)	(-0.48)
ead	-0.15	-0.72**	1.3***	-0.11	-0.58	1.6***	-0.08	-0.58	1.63***	-0.07	-0.56*	1.65***	-0.06	-0.54	1.71***	-0.12	-0.55	1.66***
	(-1.55)	(-2.14)	(3.73)	(-1.03)	(-1.59)	(3.82)	(-0.67)	(-1.66)	(3.28)	(-0.50)	(-1.69)	(3.50)	(-0.47)	(-1.47)	(3.31)	(-1.08)	(-1.60)	(3.48)
gov96ge	0.21**	0.42**	0.69**															
	(2.35)	(2.03)	(2.63)															
gov96cor				0.14**	0.39**	0.21												
				(2.00)	(2.45)	(0.94)												
gov96rl							0.15*	0.32*	0.45**									
							(1.68)	(1.91)	(2.16)									
gov96rq										0.00	0.22	0.09						
										(0.03)	(0.69)	(0.28)						
gov96ps													0.13*	0.13	0.34			
													(1.69)	(0.84)	(1.51)			
gov96va																-0.03	0.02	0.10
																(-0.42)	(0.14)	(0.41)
N	88	87	82	88	87	82	80	79	75	89	88	83	83	82	77	88	87	82
adj. R-sq	0.91	0.58	0.58	0.91	0.59	0.55	0.89	0.64	0.58	0.90	0.58	0.53	0.90	0.64	0.58	0.90	0.58	0.54

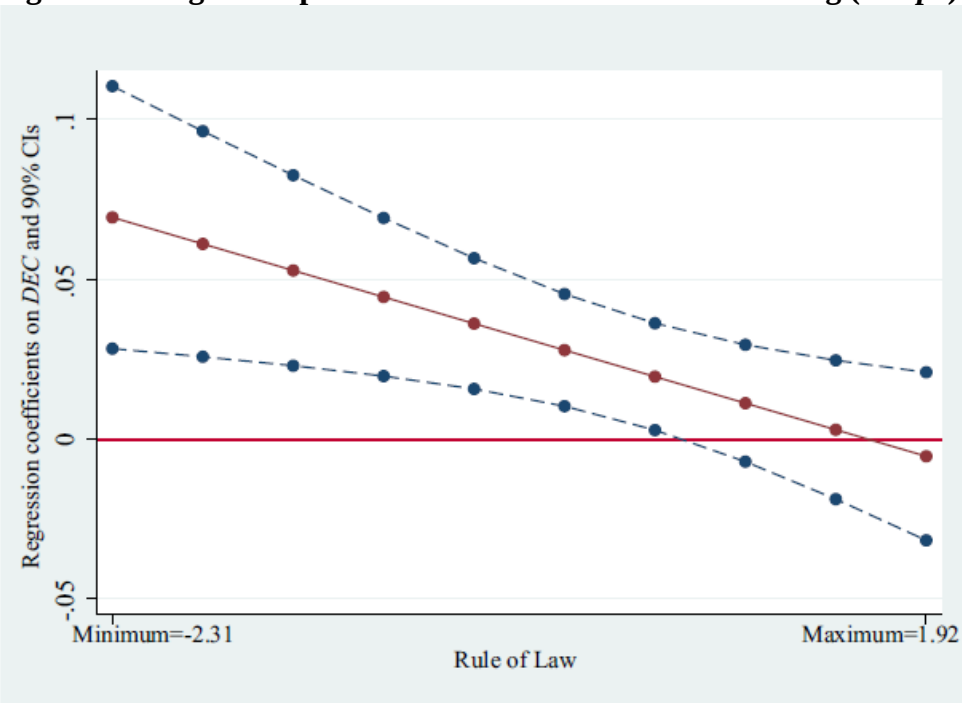
Note: t-statistics are in parentheses. Standard errors are corrected for heteroschedasticity. Constant term is included (not shown).* Statistically significantly different from zero at 90 percent confidence.** Statistically significantly different from zero at 95 percent confidence.*** Statistically significantly different from zero at 99 percent confidence.

Figure 4. Marginal impacts of revenue decentralization on log (*CO2pc*)



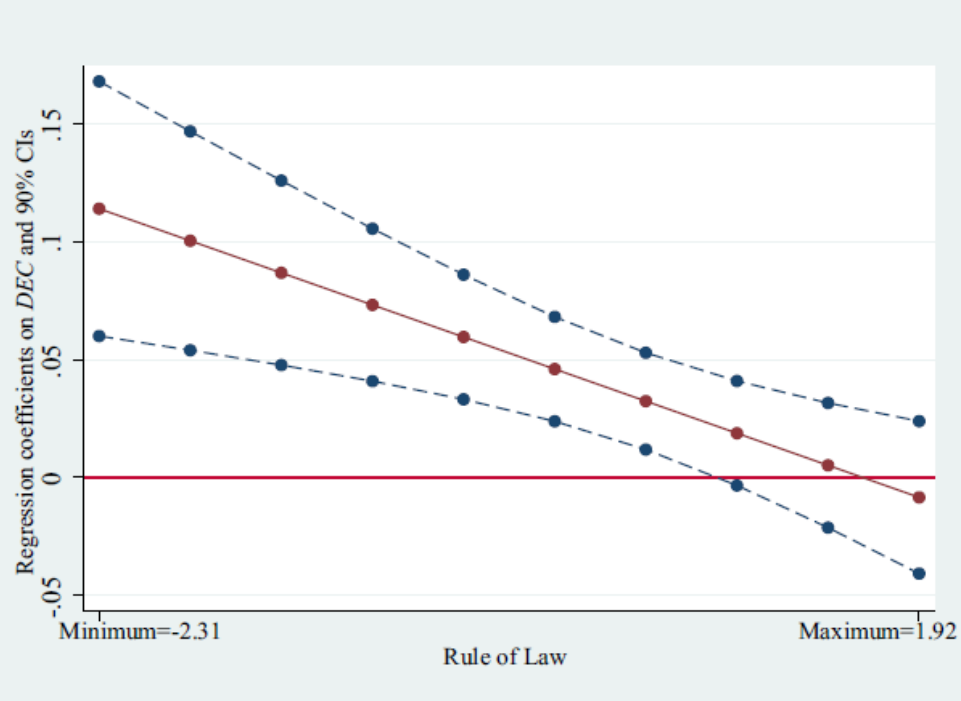
Note: the middle solid line shows the estimated marginal impacts of 1% increase in revenue decentralization on CO2 emission per capita at different levels of rule of law index. The dashed lines show the statistical significance at 90% level.

Figure 5. Marginal impacts of revenue decentralization on log (*SO2pc*)



Note: the middle solid line shows the estimated marginal impacts of 1% increase in revenue decentralization on SO2 emission per capita at different levels of rule of law index. The dashed lines show the statistical significance at 90% level.

Figure 6. Marginal impacts of revenue decentralization on log (*BODpd*)



Note: the middle solid line shows the estimated marginal impacts of 1% increase in revenue decentralization on BOD emission per day at different levels of rule of law index. The dashed lines show the statistical significance at 90% level.

5. Conclusion

In this paper, we have examined the relationship between fiscal decentralization and environmental quality, taking into account the moderating role of institutions. Our hypothesis, built on relative preference for environmental quality of local and central governments, postulates a "race to the bottom" both for local and global pollutants (i. e. decentralization has a detrimental effect on environmental quality) as well as a mitigating effect of institutional quality on this relationship. Empirically, we find a very robust increasing effect of decentralization on different pollution indicators for a more than 80 countries, thereby providing support for the race-to-the-bottom view, also present in part of the literature. We also notice that these destructive environmental effects of decentralization can be limited by increasing the quality of institutions; the finding is robust to controlling for a wide range of potential sources of omitted variable bias. Our research thus suggests some caution with respect to the positive view of decentralization widespread in development policy circles. While a number of political and economic arguments are certainly in favor of such policies, environmental quality can suffer if local governments compete for capital, neglecting concerns of the detrimental effects of pollution. Development policy makers should bear this in mind and concentrate their efforts on good governance to ensure that economic progress does not come at the expense of environmental concerns.

Appendix A. Data description

POLLUTION(lnco2pc,lnso2pc,lnbodpd)	*Lnco2pc* is the logarithm of CO2 emissions (metric tons per capita). *Lnso2pc* is the logarithm of SO2 emission per capita and *lnbodpd* is the logarithm of Organic water pollutant (BOD) emissions (kg per day). Emissions of organic water pollutants are measured by biochemical oxygen demand, which refers to the amount of oxygen that bacteria in water will consume in breaking down waste. This is a standard water-treatment test for the presence of organic pollutants. The source of CO2 and BOD emission is the World Bank (2011) and SO2 data are from Smith et al. (2011). Average values from 1970-2000 are used.
DEC	Fiscal decentralization. Total revenue of subnational (state and local) governments over total revenue by all levels (state, local, and central) of government. Average values from 1970-2000 are used. Source: the data are taken from the World Bank website which is based on Government Finance Statistics Manual 2001 (GFSM 2001). http://www1.worldbank.org/publicsector/decentralization/fiscalindicators.htm#Sources.
INST	Institutional quality. The data are taken from the Worldwide Governance Indicators (WGI) project. We use the data for the year 1996. The WGI measure six broad dimensions of governance: Voice and Accountability (*gov96va*), Political Stability and Absence of Violence/Terrorism (*gov96ps*), Government Effectiveness (*gov96ge*), Regulatory Quality (*gov96rq*), Rule of Law (*gov96rl*), Control of Corruption (*gov96cor*). Source: Kaufmann et al. (2010). More details: http://info.worldbank.org/governance/wgi/resources.htm
inter	Interaction term between each of governance indicators and fiscal decentralization.
urban	Urban population (% of total). Average values from 1970-2000 are used. Source: World Bank (2011).
popdens	Population density (people per sq. km of land area). Average values from 1970-2000 are used. Source: World Bank (2011).
trade	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product. Average values from 1970-2000 are used. Source: World Bank (2011).
gdpen	GDP per unit of energy use is the PPP GDP per kilogram of oil equivalent of energy use. PPP GDP is gross domestic product converted to 2005 constant international dollars using purchasing power parity rates. Average values from 1970-2000 are used. Source: World Bank (2011).
lngdppc	Logarithm of GDP per capita (in constant prices 2000). Average values from 1970-2000 are used. Source: World Bank (2011).

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