Going global, locally? Decentralized environmental expenditure and air quality

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Abstract

Achieving more liveable cities is one of the main goals set by the Sustainable Development Goals (SDGs). According to a recent survey, most subnational governments participate in SDG implementation, especially to achieve environmental goals. Moreover, the public health concerns of COVID-19 have helped to motivate even more cities to improve local air quality. However, despite the importance of intergovernmental cooperation for the success of the SDGs, there is still limited progress at the regional and local levels, due to limited institutional capacity and doubts about electoral consequences of unevenly distributed costs. We use panel data for 2010-2019, covering 217 OECD metropolitan areas, together with consolidated environmental expenditure, and find that subnational public spending on environmental protection is more strongly associated with better municipal air quality than environmental expenditure by general governments. Moreover, environmental spending shows a relationship with reduced air pollution exposure through the mechanism of higher institutional quality.

Keywords: decentralization, air quality, local governance, environmental policy, urban agenda

1 INTRODUCTION: FISCAL DECENTRALIZATION AND AIR QUALITY

Air pollution is one of the main challenges that policymakers are trying to address within the renewed trend towards urban sustainability. In fact, it is directly related to the United Nations' SDG numbers 3 (Good Health and Well-being), 11 (Sustainable Cities and Communities), and 13 (Climate Change). According to the World Health Organization (WHO), 4.2 million premature deaths worldwide in 2016 were related to ambient air pollution due to its links with heart disease, respiratory illness, and the likelihood of cancer (WHO, 2018).

Since WHO air quality guidelines were published in 2005,[1] cities have at their command objective criteria to measure how polluted their air is. Many countries have implemented legally binding air quality goals to tackle this problem and improve citizens' health and quality of life. However, in many cases, these thresholds have not been reached and citizens are exposed to harmful air pollution levels. Therefore, this issue demands the implementation of more creative and ambitious policies by government. Housing and road transport are among the main sources of the particulate matter that pollutes cities. Housing is responsible for over half of 2.5 micron particles (PM2.5), while road transport contributes closer to 10% in cities (EEA, 2021; OECD, 2021).

In contrast with other environmental issues, such as climate change and global warming, air quality has a more local gradient than greenhouse gas (GHG) emissions. This is why local green agendas are of particular relevance to pursue the issue of cleaner air. In this context, the expression in the title, "going global, locally" gains

[1] WHO air quality guidelines were updated in September 2021 to target higher standards (WHO, 2021).

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traction. Already, subnational governments accounted for two-thirds of climate-significant public expenditure in OECD countries (OECD, 2022a).

However, subnational governments – notably regions and cities – are not always given the appropriate incentives to align with internationally and nationally defined green agendas (De Mello and Martinez-Vazquez, 2022). In fact, while legal thresholds and goals for air pollution are set by central governments, it is often localities that are responsible for implementing building, heating, renovation and energy-saving programmes, and municipalities that are responsible for implementing congestion charges and also defining low emission zones (LEZ) to cope with road traffic. These goals could be achieved by following the rationale of ecological fiscal transfers (EFT), that involve intergovernmental vertical grants paid by central governments to subnational entities conditional on the achievement of environmental goals (Ring, 2002; Busch et al., 2021).

We focus on the fiscal side of governance by first exploring whether environmental public expenditure is related to better air quality levels. This is the first step needed to motivate the integration of environmental agendas within intergovernmental fiscal governance frameworks. Although case-study research is available in the field of fiscal decentralization and air quality outcomes, and the topic has been addressed for the Chinese case, where air pollution is an especially pressing issue (He, 2018; Liu, Ding and He, 2019; Guo et al., 2020; Jong et al., 2021), as far as we know, a broader cross-country analysis has not been carried out. Aiming to cover this gap in the literature, we make use of panel data for 217 OECD countries' metropolitan areas for the 2010-19 period. Our results show that higher subnational public spending on the environment is associated with lower PM2.5 exposure rates, a stronger association than that with all-level government environmental expenditure. Indeed, environmental public spending is linked to lower air pollution exposure rates through higher institutional quality. Finally, income per capita and local tree cover are also significant determinants of lower exposure to air pollution in metropolitan areas.

This paper proceeds with the following structure. The next section looks at previous literature on the link between fiscal federalism and environmental issues, particularly air pollution. Following this, the data and methodology are explained in detail. The fourth section presents and interprets the results. Finally, conclusions and policy recommendations are formulated in the last section.

2 FISCAL FEDERALISM AND THE ENVIRONMENTAL AGENDA

The number of decentralized countries and the intensity of their fiscal and financial self-government have increased during recent decades (OECD/KIPF, 2015; OECD, 2019a, 2022a). Multilevel governance is guided by the subsidiarity principle, inspired by Stigler (1957) and Oates (1972), which suggests that policy responsibilities should be attributed to the lowest layer of government possible. This is also the case for environmental policy, which, despite objectives being set

at international and national levels, frequently needs to be implemented at subnational levels. There are several examples of this shared governance framework, which is even more intense in federal and decentralized countries, such as regional responsibility for building renovation, or local urban waste management, traffic congestion containment measures, and urban planning for green spaces and service equipment.

Not by coincidence, due to the increasing salience that environmental policy has gained over recent decades, scholars of federalism have investigated the interactions between multilevel governance and environmental policy. The outcome is a stream of research known as "Environmental Federalism" (Anderson and Hill, 1996; Harrison, 1996; Scheberle, 1997).

If we focus on the public finance aspects of federalism, Martinez-Vazquez (2021) points out the environmental problems that fall within subnational responsibilities. Among them, in terms of direct energy emissions, transport and buildings tend to be regulated and taxed by regional and local governments, while for non-energy emissions, land use and waste management tend to be largely regulated or influenced by SNGs. Martinez-Vazquez identifies expenditure decentralization as the way to promote much faster mitigation policies and highlights inter-jurisdictional spillovers as the main barrier, which could be corrected through intergovernmental fiscal relations tools, in order to determine a compatible set of incentives.

In a related paper, Smoke and Cook (2021) argue that decentralization and environmental reforms are unlikely to be coordinated, despite existing synergies across levels both policy areas, as previous scholars have argued. In addition, they identify a lack of strong theoretical basis and robust empirical evidence as one of the factors hindering progress in defining responsibility allocation across levels of government based on green goals. This mainly driven by the lack of good quality data at the subnational level (see OECD, 2019b). In fact, in an editorial, De Mello and Martinez-Vazquez (2022) set this need near the top of the research agenda as they examine climate change and fiscal policy. One of the main insights from this agenda is the need to carefully assess the costs and benefits of government spending decisions on environmental protection. They call for the reconsideration of several aspects of fiscal federalism arrangements, such as:

- design of dedicated grant and transfer systems,
- assignment of expenditure responsibilities across layers of administration,
- the extent of subnational revenue and borrowing autonomy, including their ability to collect environmental revenue and borrow to promote investment and foster infrastructure adaptation.

De Mello and Jalles (2022) carried out a new study on decentralisation and the environment. Their work provides arguments to reinforce the case for decentralisation as an effective tool to cope with environmental issues since, according to their analysis of World Values Survey data, decentralisation contributes to more

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favourable attitudes towards the environment, even after controlling for personal and household characteristics, as well as country and cohort effects. Furthermore, they find that decentralisation is correlated with higher government spending on green-related programmes and higher green revenues. In a similar line of thinking, some studies suggest that decentralization could increase local fiscal expenditure on environmentally-related areas (Liu and Zhang, 2013). Others also found the same effect, but this time on the share of local expenditure devoted to environmental protection programmes, although the effects of increased expenditure on environmental outcomes are not clear (Millimet, 2003).

Other authors have focused on the relationship between decentralization and policy outcomes (Liu, Ding and He, 2019; Guo et al., 2020). Most of the work focused specifically on the effect of decentralization on air quality has been carried out in China, where this is a pressing problem. Despite the relevance of this literature for this paper, when results and conclusions are compared, the large differences in institutional frameworks should be taken into account. He (2018) shows that fiscal decentralization has no significant effect on environmental pollution, but finds a significant and positive effect on pollution abatement spending and pollutant discharge fees. Some studies have found a U-shaped relationship between fiscal decentralisation and air pollution, depending the degree of decentralisation (Liu, Ding and He, 2019; Hartman and Kwon, 2005; Copeland and Taylor, 2004). For their part, Guo et al. (2020) find that decentralization increases air pollution, with the impact of revenue decentralization being particularly harmful. However, they view this as potentially a China-specific result, based on local incumbents' preferences for economic growth based on political-career promotion possibilities. The institutional element as a mediating variable on the ability of decentralisation to deliver expected policy outcomes has been also explored in Jong et al. (2021), who found that cities with high levels of government quality and local autonomy but low horizontal fragmentation tend to be the most productive.

With particular relevance for our research, He et al. (2018) focused on the influence of regional environmental expenditure on air quality. Their aim was to compute elasticities between fuel tax policy and environmental expenditure, and the air quality index. To do so, they run a regression discontinuity design (RDD) model over a panel data for seven heavily polluted cities in China for the 2007-2015 period. They found that a 1% increase in regional environmental expenditure led to a minor decrease in an air quality index that ranged between 0.01% to 0.09%, depending on the city, while the impact for three other cities was insignificant. This asymmetric effect is also recorded by Cao, Wang and Zhong (2014); Qi, Huang and Wang (2015); and Xu, Zhang and Zhu (2015). Finally, He et al. (2018) suggest that the introduction of a fuel tax, which is used as an identification strategy, improves air quality and reduces the negative effect of environmental public expenditure.

3 ESTIMATING MODEL AND DATA

Following the broad approach of the previous literature, this paper provides initial cross-country estimates for the impact of subnational public expenditure on environmental protection policies, in order to understand whether the case for decentralisation is supported by green-related goals. Following this aim, our model is defined by the following equation:

$$\Delta exppop = \beta_0 + \beta_1 \Delta \ln(envexp)_{t-1} + \beta_2 \Delta EQI + \beta_3 \Delta \ln(envexp) \times \Delta EQI + \Delta X + \Delta \varepsilon$$

The intuition behind the model is that environmental expenditure policies implemented by subnational governments might be correlated with the degree of exposure for the population living in main metropolitan areas to harmful levels of air pollution, termed as *exppop*. This means that higher environmental expenditure should be linked to lower exposure rates. In addition, when exploring the relationship between spending programmes and outcomes, quality of institutions is a key mediating factor, which is why this interaction channel is also considered. In this sense, higher institutional quality should reinforce the exposure reduction effect of environmental expenditure. Finally, other environmental characteristics of metropolitan areas are considered in order to lower potential issues with unobserved factors that could bias estimations. In the following paragraphs we will present in detail the variables included in the model.

The main explanatory variable, *envexp*, stands for consolidated environmental public expenditure in percentage of GDP. We use logarithmic expression of this variable in order to aid its interpretation as a semi-elasticity. As there may be reverse causality concerns in the relationship between environmental expenditure and air pollution exposure, and there is no available instrument for it, we use a one-year lag structure in order to partially address this issue.

In addition, as "institutions matter" (Acemoglu, Johnson and Robinson, 2005), we account for their role by matching and including the European Quality of Government Index (EQI) at the regional level. This composed perception-based index shows the deviation of the quality of government of each region from the mean, and is relevant to this case because the aim of the model is to examine whether institutional elements of environmental protection expenditure are related to lower exposure to poor air quality.

Next, we look at whether the impact of *envexp* depends on the values of *EQI*, to verify if higher quality of government leads to a larger impact of environmental protection expenditure on exposure to air pollution, by interacting both variables. This intermediate mechanism has been broadly explored by previous literature (Butkiewicz and Yanikkaya, 2011; Rodriguez-Pose and Garcilazo, 2013; Arvin, Pradhan and Nair, 2021).

Finally, X is a vector of other explanatory metropolitan-level air quality determinants such as income per capita, population density and two proxies of main sources of air pollution: the residential sector and transport. The residential sector

is proxied through the share of land area covered by trees. Transport is measured by computing the performance gap between car and public transport. The measure makes use of the International Transport Forum's Transport Performance Index (IFT, 2019), which identifies those destinations that can be reached on foot, by bicycle, public transport or car within a certain time (accessibility). It thus measures how many destinations are close by (proximity). We compute performance gaps for cars versus public transport. The larger the gap, the higher the incentive for driving. Therefore, we expect large gaps to be correlated with higher use of cars, and thus, a larger share of population exposed to low air quality.

In addition to its cross-country approach, a key contribution of this paper is that it makes use of consolidated multilevel Classification of the Functions of Government (COFOG) national accounts expenditure data – for the first time. The rest of the variables used are part of the OECD Metropolitan Areas database, except for data capturing institutional elements, where the European Quality of Government Index (Charron, Lapuente and Dijkstra, 2012) has been used, at the regional level. This index, based on surveys answered by more than 120,000 EU citizens across 208 regions is the best available data source to capture subnational institutional quality. It measures three dimensions of governance to help in an understanding of quality of government: service quality, impartiality, and prevention of corruption. Gathering data from these three sources, we have built panel data for the 2010-19 period for 217 metropolitan areas of 22 OECD European Union member countries (table 1), with the dependent variable illustrated in figure 1.

Table 1

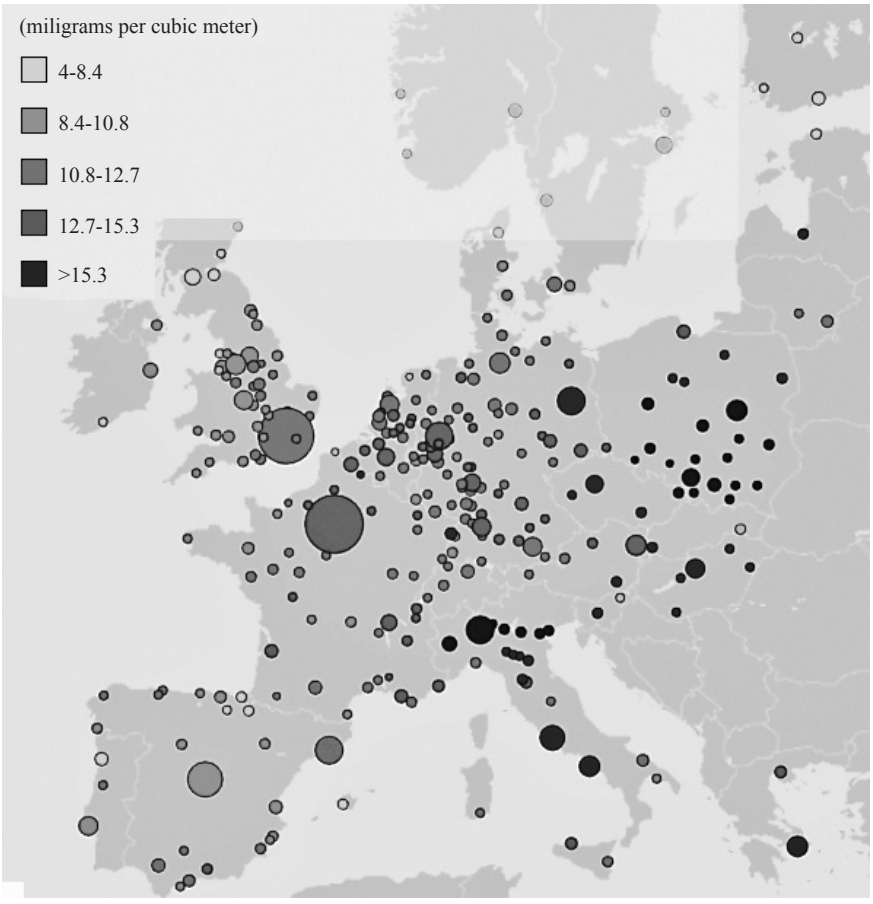
Descriptive variables

Variables	N	Mean	S.d.	Min	Max	Level
Exposure to PM2.5 >10µg/m^3 (% pop.)	1,953	58.07	46.77	0	100	Metropolitan
GG environmental expenditure (% GDP)	2,306	0.887	0.27	1.00e-10	1.7	Country
SNG environmental expenditure (% GDP)	2,306	0.687	0.295	0.0617	1.385	Country
European Quality of Government Index (regional EQI)	1,562	0.244	1.069	-2.230	1.885	Region
GDP per capita (PPP)	2,016	41,067	13,087	10,714	108,069	Metropolitan
Population density	2,299	2,213	1,603	87	12,929	Metropolitan
Tree cover (% of land)	2,343	14.61	15.13	0	66.30	Metropolitan
Transport performance gap	736	2.257	1.069	0.547	6.537	Metropolitan

Note: Main data are consistent with Gilmore and St. Clair (2018) for the United States and Plouin and Allain-Dupré (2018) for remaining OECD member countries, who explained that although more than half of environmental public expenditure is carried out at the subnational level, it does not reach even 1% of total general government expenditure in most cases. Due to data limitations, and particularly lack of disaggregation (OECD, 2019b, 2020), some variables have been considered at higher levels of government, as described in table 1.

Figure 1

Exposure to PM2.5 air pollution in OECD European metropolitan areas



Source: OECD metropolitan areas database (https://regions-cities-atlas.oecd.org/).

As illustrated by figure 1, air pollution is very unevenly distributed across countries, but also across cities within European countries. This reinforces the argument for the relevance of the local agenda to tackle this environmental problem. As a measure of air quality we use exposure to 2.5 micron particulate matter (PM2.5), the smallest and most dangerous size category for public health, according to the WHO (2018). In particular, our dependent variable is the population share of the core of the metropolitan area that is exposed to PM2.5 concentrations higher than 10µg/m^3 (*exppop*), which is the lowest threshold set by the WHO in its 2005 guideline and is the most frequently adopted legal threshold implemented in European countries. In addition, making use of the most critical threshold will allow for larger cross-city and time heterogeneity, strengthening the power of our regressions.

With regards to econometric strategy, we first use the variance inflation factor (VIF) test to reject the existence of multicollinearity. Due to the existence of autocorrelation, we cluster standard errors to make them robust to heteroskedasticity.

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We report our preferred estimates, which correspond to the first differences (FD) model, as suggested by the rejection of the change in the residual as an independent error term. We do so separately for general government environmental protection expenditure, as well as for subnational expenditure in the same COFOG function, both on a consolidated basis.

4 RESULTS

First, subnational public spending on environmental protection is more highly associated with better municipal air quality than environmental expenditure made by all levels of government. First, we look at estimates for subnational consolidated public expenditure on environmental protection, measured as a percentage of GDP. We use this variable as a proxy for the effort made by regions and cities in pursuing nationally assumed commitments with regards to green agendas. Estimates presented in table 2 suggest that metropolitan areas located in countries with larger subnational expenditure on environmental protection policies record smaller shares of their population exposed to low air quality levels. The size of the link is quite relevant, since a one-half standard deviation increase in public expenditure devoted to green policies – a 21% increase – equates to a 4 percentage point decrease in the share of the population exposed to low air quality one year later. Indeed, if one considers the relatively small amounts of spending devoted to this COFOG function by many subnational governments, such an increase in expenditure is not impossible.

Results for general government's environmental expenditure protection are quite similar to the estimates reported in the previous paragraph for general government, although not as robust, since column 4 shows that the effect is not significant when adding controls for the institutional channel interaction and transport performance gap. This is consistent with descriptive statistics for the database in table 1, since countries with larger total green public expenditure are usually those in which subnational expenditure is also higher. This can be explained because regions and cities have primary responsibility in this COFOG policy function (Gilmore and St. Clair, 2018; Plouin and Allain-Dupré, 2018; OECD, 2022a).

Second, environmental spending shows a strengthened link with reduced air pollution exposure through the mechanism of higher institutional quality. The institutional context, that is usually cited as a key prerequisite to have effective policies, also appears to be strongly correlated with a lower share of population exposed to air pollution. The effect ranges from a 0.26 to 0.47 percentage point decrease in the exposure to low quality air as the institutional quality index (regional EQI) increases one percentage point with respect to the average level. For total expenditure iteration, the range is practically the same, meaning that the regional institutional quality factor is as relevant for subnational governments, as for the public sector in general. More importantly, the model suggests that the link between higher expenditure and lower exposure would be reinforced through increased institutional quality. This outcome is shown by the interaction and is also

consistent with previous literature (Butkiewicz and Yanikkaya, 2011; Rodriguez-Pose and Garcilazo, 2013; Arvin, Pradhan and Nair, 2021) that points towards quality of government as a key mediating element between policies and their outcomes.

Table 2

Summary of estimates for the first difference model

Dependent variable: Change in share of population exposed to PM2.5 (Δ exppop)

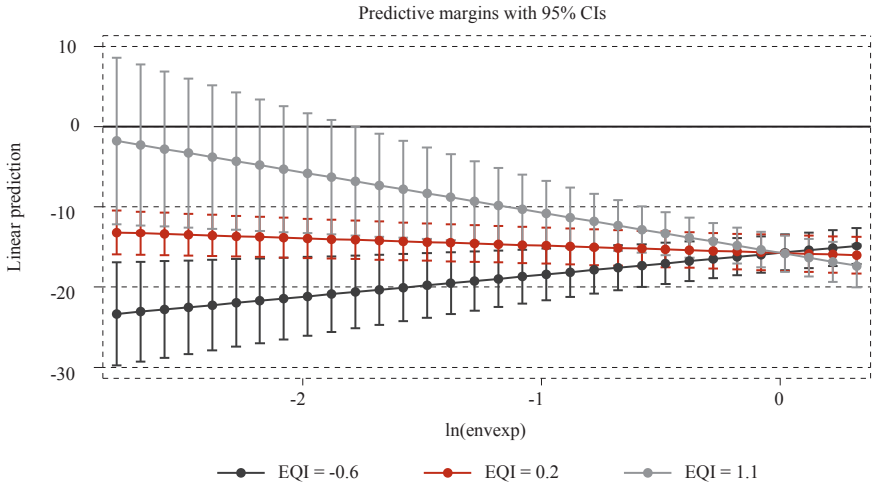
Variable	Subnational government		General government	
	(1)	(2)	(3)	(4)
Δ ln(envexp)$_{t-1}$	-21.28***	-22.12***	-25.82***	-20.72
	(2.293)	(6.947)	(6.210)	(17.33)
Δ regionalEQI	-26.64**	-47.75*	-26.13**	-46.91*
	(11.70)	(23.77)	(11.81)	(24.20)
ln(envexp) * regionalEQI		-4.564**		-7.451***
		(1.699)		(2.353)
Δ GDP per capita	-0.00312***	-0.00275***	-0.00316***	-0.00280***
	(0.000477)	(0.000639)	(0.000470)	(0.000676)
Δ Population density	0.00605	-0.0109	0.000837	-0.00212
	(0.0485)	(0.0601)	(0.0484)	(0.0550)
Δ Tree-cover land share	-26.85***	-25.61	-27.49***	-27.42
	(7.086)	(20.97)	(7.195)	(20.46)
Δ Transport perf. gap.		-1.214		-1.296*
		(0.724)		(0.695)
Constant	-13.60***	-10.68***	-13.59***	-10.61***
	(0.738)	(2.210)	(0.739)	(2.074)
Observations	739	230	739	230
R-squared	0.066	0.091	0.060	0.086

*Note: Robust standard errors in parentheses. Significance *** p<0.01, ** p<0.05, * p<0.1.*

The relevant explanatory power of this interaction can be observed in figure 2, where the correlation between lower air pollution exposure and subnational green expenditure increases for higher levels of institutional quality. Indeed, when institutional quality nears average levels (red line), the "effect" of additional expenditure is almost the same as when expenditure is low or is high. However, when institutional quality is high (grey line), the decreasing pollution exposure "effect" becomes more powerful as expenditure increases. In contrast, when institutional quality is low (black line), additional increases of subnational environmental expenditure become less and less powerful. This interaction effect is thus particularly relevant for lower levels of expenditure, where it becomes less important whether subnational green expenditure is among the highest, based on the European countries represented in our sample.

FIGURE 2

Marginal estimates of exposure to PM2.5 conditional on institutional quality



Finally, income per capita and the extent of tree cover are also significant determinants of lower exposure to air pollution in metropolitan areas. Indeed, estimates for income per capita, population density and share of land covered by trees also yield a negative sign, as expected. However, only income per capita and the tree cover show a significant correlation. In fact, the tree cover share emerges as a very relevant explanatory factor for exposure to low quality air. Accordingly, for an increase of half a percentage point in land covered by trees, 12 percentage points less of the population in metropolitan core areas is exposed to low quality air. These results are in line with literature and policies that point towards the important role that natural space conservation should play to address environmental challenges such as low air quality, but also as natural sink instruments for GHGs (Nowak, Crane and Stevens, 2006; Nowak et al., 2014). Also, cities with higher income per capita show better air quality results, probably due to the increased capacity to use new technologies and of institutions to apply larger and more effective environmental programmes. Indeed, a 1000 euro increase in the GDP *per capita* of a metropolitan area is correlated with a 3 percentage point decrease in share of the population exposed to low quality air. Again, the result is consistent with general government environmental expenditure.

In contrast, estimates for transport performance gap are the opposite sign to expected, since in cities where cars perform comparatively better relative to public transport (larger gap), there is less exposure to low air quality. This could be explained by the fact that these cities, where driving provides more advantages, could be cities with larger suburbs or more dispersed built-up areas. The 30 minute drive considered by the Transport Performance Index could be capturing commutes outside the city centre, which have less effect on the local air pollution exposure index. In addition, model specifications reported in columns 2 and 4 show a loss in sample size due to lower data availability for transport performance. This

loss of sample size could also explain the latter outcome as well as the loss of significance of the tree cover variable. However, the results are consistent with the model specification in columns 1 and 3 regarding the rest of variables.

The estimates are also consistent with previous literature on expenditure and air quality, backing up Nowak, Crane and Stevens (2006) and Nowak et al. (2014). In addition, our results for the long term are also consistent with those of He et al. (2018), who found that a 1% increase in regional environmental expenditure led to a small decrease in air quality index for seven heavily polluted cities in China, while the impact for three other cities was insignificant. This city-dependent effect was also recorded by Cao, Wang and Zhong (2014); Qi, Huang and Wang (2015); and Xu, Zhang and Zhu (2015). He et al. (2018) found that green tax revenue could partly compensate for or reverse the negative impact of decentralized green expenditure on air quality. However, we lack data to replicate the revenue-side of their model.

Finally, it should be kept in mind that these are just initial estimates exploring the association between environmental protection expenditure and air pollution exposure rates. Causality cannot be inferred from the results and future improvements in data availability and quality (OECD, 2019b, 2020b; De Mello and Martinez-Vazquez, 2022), such as metropolitan-level COFOG expenditure could help in improving econometric strategy.

5 CONCLUSIONS

In this paper we made use of a panel data for the 2010-19 period for 217 metropolitan areas of European OECD countries. This paper contributes to the environmental fiscal federalism literature by using cross-country consolidated COFOG expenditure data for the first time. We find that both total and subnational environmental public spending are associated with lower exposure to air pollution, but the link is particularly significant for subnational government intervention. In addition, higher institutional quality also appears to be correlated with lower shares of the population exposed to low air quality. Indeed, environmental public spending shows a stronger link with reduced air pollution exposure rates through higher institutional quality. Finally, higher income per capita and greater tree cover are also significant determinants of lower exposure to air pollution in large cities.

However, these are initial estimates exploring the correlation between environmental protection expenditure and air pollution exposure rates. Future research should explore causality channels, which could be allowed by future improvement in the expenditure data or by making use of unique cross-country events that could serve as identification strategies.

Disclosure statement

No potential conflict of interest was reported by the authors.

REFERENCES

1. Acemoglu, D., Johnson, S. and Robinson, J. A., 2005. Chapter 6 Institutions as a Fundamental Cause of Long-Run Growth. In: *Handbook of Economic Growth Volume 1A*. https://doi.org/10.1016/S1574-0684(05)01006-3
2. Anderson, T. L. and Hill, P. J., 1996. Environmental federalism: thinking smaller. *PERC Policy Series*, No. PS-8.
3. Arvin, M. B., Pradhan, R. P. and Nair, M. S., 2021. Are there links between institutional quality, government expenditure, tax revenue and economic growth? Evidence from low-income and lower middle-income countries. *Economic Analysis and Policy*, 70, pp. 468-489. https://doi.org/10.1016/j.eap.2021.03.011
4. Busch, J. [et al.], 2021. A global review of ecological fiscal transfers. *Nature Sustainability*, 4(9), pp. 756-765. https://doi.org/10.1038/s41893-021-00728-0
5. Butkiewicz, J. L. and Yanikkaya, H., 2011. Institutions and the impact of government spending on growth. *Journal of Applied Economics*, 14(2), pp. 319-341. https://doi.org/10.1016/S1514-0326(11)60017-2
6. Cao, J., Wang, X. and Zhong, X., 2014. Did driving restrictions improve air quality in Beijing. *China Economic Quarterly*, 13(3), pp. 1091-1126.
7. Charron, N., Lapuente, V. and Dijkstra, L., 2012. Regional governance matters: A study on regional variation in quality of government within the EU. *Regional Studies*, 48(1), pp. 68-90. https://doi.org/10.1080/00343404.2013.770141
8. Copeland, B. R. and Taylor, M. S., 2004. Trade, growth, and the environment. *Journal of Economic literature,* 42(1), pp. 7-71.
9. De Mello, L. and Martinez-Vazquez, J., 2022. Climate Change Implications for the Public Finances and Fiscal Policy: An Agenda for Future Research and Filling the Gaps in Scholarly Work. *Economics,* 16(1), pp. 194-198. https://doi.org/10.1515/econ-2022-0026
10. De Mello, L. and Jalles, T. J., 2022. Decentralisation and the environment: Survey-based and cross-country evidence. *REM Working paper series,* No. 0215 - 2022.
11. EEA, 2021. Sources and emissions of air pollutants in Europe. Air quality in Europe 2021. *Report* No. 15/2021.
12. Gilmore, E. A. and St. Clair, T., 2018. Budgeting for climate change: Obstacles and opportunities at the US state level. *Climate policy*, 18(6), pp. 729-741. https://doi.org/10.1080/14693062.2017.1366891
13. Guo, S. [et al.], 2020. Fiscal decentralization and local environmental pollution in China. *International Journal of Environmental Research and Public Health*, 17(22), p. 8661. https://doi.org/10.3390/ijerph17228661
14. Harrison, K., 1996. *Passing the Buck: Federalism and Canadian Environmental Policy*. Vancouver: University of British Columbia Press.
15. Hartman, R. and Kwon, O. S., 2005. Sustainable growth and the environmental Kuznets curve. *Journal of Economic Dynamics and Control*, 29(10), pp. 1701-1736. https://doi.org/10.1016/j.jedc.2004.10.001
16. He, L. [et al.], 2018. A study of the influence of regional environmental expenditure on air quality in China: the effectiveness of environmental policy.

Environmental Science and Pollution Research, 25(8), pp. 7454-7468. https://doi.org/10.1007/s11356-017-1033-8

17. ITF, 2019. Benchmarking Accessibility in Cities: Measuring the Impact of Proximity and Transport Performance. *International Transport Forum Policy Papers*, No. 68.
18. Jong, D. [et al.], 2021. A comprehensive approach to understanding urban productivity effects of local governments: Local autonomy, government quality and fragmentation. *OECD Regional Development Papers,* No. 11. https://doi.org/10.1787/5ebd25d3-en.
19. Liu, A. and Zhang, J., 2013. Fiscal decentralization and environmental infrastructure in China. *The BE Journal of Economic Analysis & Policy*, 13(2), pp. 733-759. https://doi.org/10.1515/bejeap-2013-0082
20. Liu, L., Ding, D. and He, J., 2019. Fiscal decentralization, economic growth, and haze pollution decoupling effects: a simple model and evidence from China. *Computational Economics*, 54(4), pp. 1423-1441. https://doi.org/10.1007/s10614-017-9700-x
21. Martinez-Vazquez, J., 2021. *Adapting Fiscal Decentralization Design to Combat Climate Change.* Washington: World Bank.
22. Millimet, D. L., 2003. Assessing the empirical impact of environmental federalism. *Journal of Regional Science,* 43(4), pp. 711-733. https://doi.org/10.1111/j.0022-4146.2003.00317.x
23. Nowak, D. J. [et al.], 2014. Tree and forest effects on air quality and human health in the United States. *Environmental pollution*, 193, pp. 119-129. https://doi.org/10.1016/j.envpol.2014.05.028
24. Nowak, D. J., Crane, D. E. and Stevens, J. C., 2006. Air pollution removal by urban trees and shrubs in the United States. *Urban forestry & urban greening*, 4(3-4), pp. 115-123. https://doi.org/10.1016/j.ufug.2006.01.007
25. Oates, W. E., 1972. *Fiscal Federalism.* New York: Harcourt Brace Jovanovich.
26. OECD, 2019a. *Making Decentralisation Work: A Handbook for Policy-Makers*. Paris: OECD. https://doi.org/10.1787/g2g9faa7-en
27. OECD, 2019b. Financing climate objectives in cities and regions to deliver sustainable and inclusive growth. *OECD Environment Policy Papers*, No. 17. https://doi.org/10.1787/ee3ce00b-en
28. OECD, 2020. *A Territorial Approach to the Sustainable Development Goals: Synthesis report*. Paris: OECD. https://doi.org/10.1787/e86fa715-en
29. OECD, 2021. *Brick by Brick: Building Better Housing Policies*. Paris: OECD. https://doi.org/10.1787/b453b043-en
30. OECD, 2022a. *Fiscal Federalism 2022: Making Decentralisation Work*. Paris: OECD. http://oe.cd/il/FiscalFederalism
31. OECD, 2022b. *Subnational Government Climate Expenditure and Revenue Tracking in OECD and EU countries*. Paris: OECD. Forthcoming.
32. OECD/KIPF, 2015. *Institutions of Intergovernmental Fiscal Relations: Challenges Ahead.* Paris: OECD.

33. Plouin, M. and Allain-Dupré, D., 2018. *Financing climate objectives in cities and regions to deliver sustainable and inclusive growth. Financing Climate Futures*. Paris: OECD.
34. Qi, W., Huang, H. J. and Wang, S. W., 2015. Traffic restrictions effect on air quality: data integration analysis for Lanzhou City. *In Stat Inf Forum,* 30, pp. 74-81.
35. Ring, I., 2002. Ecological public functions and fiscal equalisation at the local level in Germany. *Ecological Economics*, 42(3), pp. 415-427. https://doi.org/10.1016/S0921-8009(02)00124-6
36. Rodriguez-Pose, A. and Garcilazo, E., 2013. Quality of Government and the Returns of Investment: Examining the Impact of Cohesion Expenditure in European Regions. *OECD Regional Development Working Papers*, No. 2013/12. https://dx.doi.org/10.1787/5k43n1zv02g0-en
37. Scheberle, D., 1997. *Federalism and Environmental Policy: Trust and the Politics of Implementation*. Washington: Georgetown University Press.
38. Smoke, P. and Cook, M., 2022. *Administrative Decentralization and Climate Change. Climate Governance Papers*. Washington: World Bank.
39. Stigler, G. J., 1957. The tenable range of functions of local government. *International Library of Critical Writings in Economics*, 88, pp. 3-9.
40. WHO, 2018. *Burden of disease from ambient air pollution for 2016*. Geneva: World Health Organization.
41. WHO, 2021. *WHO Global air quality guidelines. Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide*. Geneva: World Health Organization.
42. Xu, Y. D., Zhang, J. and Zhu, J. M., 2015. The effect evaluation of the energy: saving emission reduction policies. *Based Diff Chin Air Qual Index J Hei he Univ*, 4, pp. 56-60.