CESifo WORKING PAPERS

6822
2017

December 2017

Housing Environmental Risk in Urban Areas: Cross Country Comparison and Policy Implications

Bruno Chiarini, Antonella D'Agostino, Elisabetta Marzano, Andrea Regoli

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editors: Clemens Fuest, Oliver Falck, Jasmin Gröschl
www.cesifo-group.org/wp

An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: www.CESifo-group.org/wp

CESifo *Working Paper No. 6822*
Category 9: Resource and Environment Economics

Housing Environmental Risk in Urban Areas: Cross Country Comparison and Policy Implications

Abstract

The main aim of this paper is to assess whether there is a statistically significant environmental impact of cities within European countries. Second, starting from the estimated environmental impact of cities within European countries, the paper investigates whether cross-country variation can be explained by macro-economic factors and government policies which can play a role in mitigating such an impact. We start from individual evidence (EU-SILC data) to obtain a measure of the environmental impact of cities within countries, and then correlate the latter with macro variables to explain European heterogeneity. These estimates confirm that the environmental risk for households is particularly perceived in more densely populated urban agglomerations, although the marginal effects are quite heterogeneous between countries. Macroeconomic factors such as inequality, wealth, taxation and public spending on the environment, and macroeconomic constraints such as the public finance disequilibrium produce a strong heterogeneity between countries in determining the marginal effects of urban metropolises on household environmental risk.

JEL-Codes: Q510, Q530, R210, I310, C350.

Keywords: household environmental risk, sustainable cities, bivariate probit model, cross-country heterogeneity.

Bruno Chiarini
University of Naples Parthenope
Italy - 80133 Napoli
chiarini@uniparthenope.it

Antonella D'Agostino
University of Naples Parthenope
Italy - 80133 Napoli
antonella.dagostino@uniparthenope.it

Elisabetta Marzano
University of Naples Parthenope
Italy - 80133 Napoli
elisabetta.marzano@uniparthenope.it

Andrea Regoli
University of Naples Parthenope
Italy - 80133 Napoli
andrea.regoli@uniparthenope.it

1. Introduction

Urbanisation has been a fundamental feature of economic development: over the last two centuries all the countries that have experienced the transition from traditional agricultural economies to market economies have persistently increased urbanisation rates, reduced fertility and achieved an increased growth rate of the per capita output of market sectors (de Vries, 1984; Bairoch, 1988; Zhang , 2002; Galor, 2005; Chiarini and Marzano, 2014).

The importance of cities in economic development is well documented in the literature on economic geography, where agglomeration effects play a crucial role in facilitating the working of the markets: accelerating the distribution of goods, attracting human capital (Glaeser and Resseger, 2010) and creating a favourable business environment.

In the urban economics literature similarly emphasis is attached to the role of production and consumption externalities which favour spatial concentration, conferring an economic advantage on cities although congestion effects may lie at the origin of several negative aspects related to cities (Sato and Yamamoto, 2005).

In recent decades, the role of cities has increasingly assumed a different, and less positive, dimension. While documenting from the mid-20th century the occurrence of urbanisation primarily among the world's poorest countries, Jedwab and Vollrath (2015) suggest that something has been lost in the relationship between income and urbanisation;

In addition, increasingly important concerns about environment quality have led to a wide-ranging debate about the concept of urban sustainability (Button, 2002), witnessed by the fact that in the 2030 Agenda for Sustainable Development, the issue of sustainable cities is listed among the 17 sustainable developments goals adopted in 2015. Achievement of the 2030 Agenda for Sustainable Development goals is a demanding challenge for EU policy makers. With regard to goal 11, promoting sustainable cities, the main actions are related to the Urban Agenda for the EU adopted in 2016 and the 7th Environment Action Programme (European Commission, 2016a).

Achieving sustainable development, and a sustainable city environment within it, calls upon diverse actions at the local, regional, national and international levels. Therefore, the issue of sustainable cities has several possible implications for policy analysis. The problems of the urban environment have to be placed at the forefront, which requires sufficient information and analyses to define measurable indicators and tackle inertia and urban mismanagement responsible for environmental degradation. This aspect is consistent with the target of reducing the adverse per capita environmental impact of cities, and, in a policy perspective, is consistent with the Urban Agenda (UN, 2016) aiming to promote measures that support cleaner cities.

The present paper aims to investigate the issue of urban sustainability in European countries, moving from the concept of "household environmental risk" as measured by self-reported exposure (European Union Statistics on Income and Living Conditions - EU SILC) to environmental risk. For this purpose we tackle the following sequence of interlinked questions.

First, using probit regression analysis on individual data, we investigate the main determinants of "household environmental risk", namely a joint measure of risk of exposure to noise and pollution, and especially the effect exerted upon such exposure by urban environments. Second, starting from the results of the probit regression, we quantify for each European country the effect of the urban environment on "household environmental risk", and use the term "environmental impact of cities" (EIC). Finally, we exploit cross-country variation of the EIC to investigate relevant correlations between EIC and macro-economic factors, for the purpose of supporting policy makers to mitigate it. The methodological innovation lies in the fact that we start from individual evidence from EU-SILC data to obtain a measure of urban sustainability within countries, the environmental impact of cities, and then relate the latter to macro policies.

Estimates from microdata confirm that the environmental risk for families is particularly high in more densely populated urban agglomerations, our EIC effect, although the marginal effects are quite heterogeneous between countries. Moreover, the risk of environmental vulnerability is lower in families with higher socio-economic status (or for those families with more available savings or no credit access restrictions).

As to the correlations between the environmental impact of cities and macro-economic factors, wealth and inequality produce an important impact on the EIC in many countries and constitute a serious constraint, along with the public debt, to an improvement in urban sustainability, producing a somewhat heterogeneous European context. Further, taxation has no efficacy on this phenomenon, suggesting that there are structural, political and cultural elements that prevent a clear effect of the economic transmission channels of taxation on environmental externalities.

The article is organised as follows. In Section 2 we briefly discuss the background and introduce theoretical insights about the EIC indicator. In Section 3 we present data and variables used in the empirical analysis. The methods are described in Section 4. A discussion of results is presented in Section 5 (macro-data and detailed estimates are included in Appendix A). Finally, Section 6 concludes the analysis.

2. Quantifying urban sustainability through the EIC indicator

Measuring the sustainability of an urban environment is a difficult task to accomplish (Whitehead, 2003; Newman, 2006; Williams, 2010). Here we focus on a specific dimension of urban sustainability as defined within the 7th EU Environment Action Programme, which lists, as a priority for sustainable urban planning and design, problems related to air quality and high levels of noise, widely recognized as threats to human health and wellbeing (European Commission, 2016a; Vlahov et al., 2007).

In this article we employ, as a reliable measure of "household environmental risk", the self-reported problems of pollution and noise in residential areas. These measures are widely used in the multidimensional deprivation literature, where housing conditions are an important dimension of deprivation (see for instance, Potsi et al., 2016; Betti et al., 2015). Our research questions are not concerned with deprivation taken in its multidimensional dimension, but on the links between two specific dimensions (exposure to noise and pollution) of environmental deprivation (Nolan and Whelan, 2010) and residence in large cities.

Therefore, this article assumes that these two aspects of an individual’s subjective experience, whether directly or indirectly linked to health (amongst others Babisch, 2000; Bonnefoy, 2007; Navarro et al., 2010; Bilger and Carrieri, 2013), measure "household environmental risk". However, the risks from noise and air pollution are not evenly shared throughout geographical areas and the degree of urbanisation of the area may play a crucial role (Leon, 2008). Using the methodology implemented by Eurostat we classify urban areas using a three-category definition, namely cities/large urban areas, towns and suburbs/small urban areas and rural areas.[2]

In order to build our indicator of the environmental impact of cities, it is necessary to detect all the possible determinants of "household environmental risk" to have a reliable quantification of the impact of the urban environment. In this sense it is important to recall that the self-reported problems of pollution and noise, the dependent variable "household environmental risk", are a dimension of housing conditions, that have to be appropriately modelled from a socio-economic perspective.

In economic terms, housing is a complex good since it summarises several aspects which are hard to model (Galster, 1996): spatial immobility, durability and heterogeneity. These aspects all contribute to generate segmentation in the housing market, and “locational attributes of a dwelling” are among the most relevant ones (Tu, 2006). Within them, environmental characteristics of a dwelling are certainly one aspect of great importance, albeit difficult to measure (Shenassa et al., 2006; Braubach and Fairburn, 2010) .

[2] See http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Degree_of_urbanisation.

All these aspects will be appropriately accounted for in the first stage of the estimation process where explanatory variables employed in the multiple deprivation literature will be integrated by specific regressors to obtain an indicator of the environmental impact of cities comparable across European countries.

Indeed, the availability of extensive comparative data at the individual level as provided in EU-SILC assures an elevated level of comparability of the environmental impact of cities across countries. Therefore, EIC is a good indicator of sustainable cities, of easy comparison between countries, and as such, of interest for policy analysis, helping to understand the best practices to undertake a sustainable cities policy.

3. Data and variables definition

At the individual level the empirical analysis is based on the 2013 wave of the European Union Statistics on Income and Living Conditions (EU-SILC) which offers internationally consistent micro-data on multidimensional aspects of living conditions and income variables with high levels of comparability across European countries. In 2013 the questionnaire of the survey was expanded by adding a module on subjective wellbeing to the standard core survey (Eurostat, 2013). This module also includes specific questions on affective/hedonic characteristics of each individual.

The unit of analysis is the household since environmental deprivation is evaluated at the household level, with reference to the main household residential location. In six out of 32 countries (i.e. the Netherlands, Latvia, Malta, Slovenia, Estonia and Iceland) the data provide no information on our main variables of interest. Hence these countries were not considered in the empirical analysis.

The achieved sample size varies from under 3630 households in Luxembourg to 15703 in Italy (see Table 2). The total sample in this study consists of 184,876 households distributed across the following 26 European countries: Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Cyprus (CY), the Czech Republic (CZ), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (EL), Hungary (HU), Ireland (IE) , Italy (IT) , Lithuania (LT), Luxembourg (LU), Norway (NO), Poland (PL), Portugal (PT), Romania (RO), Serbia (RS), Slovakia (SK), Sweden (SE), Switzerland (CH) and the United Kingdom (UK).

3.1 Household level variables

The response variables are two indicators of environmental risk. They are measured in terms of self-reported problems of pollution and noise where the household lives. We argue that an individual’s perception of pollution or noise may prove to be a better indicator of environmental discomfort than any objective measure (such as pollutant concentrations), since the sensitivity to exposure to environmental risk may differ among individuals (Schmit and Lorant, 2009). In particular, these indicators are expressed by two dummy variables equal to 1 if the household feels it is exposed to the risk of pollution (POLLUTION) or noise (NOISE), and zero otherwise (see Table 1, upper panel).

The key explanatory variable is the degree of urbanisation, namely the character of the area where the household lives. It is measured using the methodology implemented by Eurostat that ensures a high level of comparability between countries[3]. Accordingly, the degree of urbanisation identifies three types of areas: thinly populated areas (rural areas used as a baseline in the econometric model); densely populated areas (cities/large urban areas), measured by the URB1 dummy variable; intermediate density areas (towns and suburbs/small urban areas), measured by the URB2 dummy variable. We assume that there is a positive effect of the degree of urbanisation on the perceived risk of both pollution and noise. That is, a higher degree of urbanisation results in a higher risk of environmental problems. The estimated coefficients for the respective dummy variables allow us to compute the EIC, which will be employed as a response variable in the second step of the econometric analysis (see section 4 for details).

The relationship between the degree of urbanisation and the extent to which households complained about environmental problems is also controlled for other indicators of socio-economic conditions. These variables are often identified in the literature as having an impact on the risk of experiencing deprivation more generally (Nelson 2012) or are well known to have an influence on exposure to pollution and noise (European Commission, 2016b), or are of specific interest in the present analysis since they control for the fact that, according to life-cycle theory, housing services should be determined by lifetime wealth. They are presented in the upper panel in Table 1.

A first group of variables accounts for the economic conditions of the household. Income in this paper is the annual equivalised disposable income of the household (INCOME) and is measured on a continuous scale. In addition, we also control for wealth by introducing income from real and financial assets (RATE_RICH), which is computed as a percentage of the gross disposable income. The inability to afford an unexpected expense is included in the model to capture availability of household savings and the intensity of financial constraints experienced by the household, an aspect of great importance considering that housing represents both an asset and a consumption item; it is a dummy variable that takes the value 1 if the household cannot afford an unexpected expense (D_UNEXP).

[3] Eurostat groups together local administrative units (LAU2) using a double criterion of classification based on geographical contiguity in combination with a minimum population threshold based on population grid square cells of 1 km^2

The durability of housing services means that current income cannot be the only variable to explain housing choice. Indeed, it is often society's poorest who live in the most polluted environments because they are less expensive, and/or because the poorest in society cannot afford to move to a different, healthier environment. For this reason, it is expected that the households that can rely on higher income levels or on higher income shares from real and financial assets as well as households that can afford unexpected expenses are likely to live in the higher quality environments.

In addition, in accordance with the literature on housing economics (see O'Sullivan and Gibb, 2003), to take into account the adjustment cost of changing dwelling, we introduce the tenure status as a further control. It is measured by two dummy variables (abbreviated as HOUSE_PROP1 and HOUSE_PROP2), indicating an outright owner and owner paying a mortgage, respectively, using tenants as the baseline[4]. We expect a negative impact of both these dummy variables on household perception risk of pollution and noise since empirical research at the individual level shows that, on average, homeowners enjoy better housing conditions than tenants (Elsinga and Hoekstra, 2005; Iwata and Yamaga, 2008).

We include in the analysis some household socio-demographic characteristics such as household size, the presence of children and some characteristics of the household reference person (age, educational level and work status) commonly employed in the deprivation literature.[5]

Finally, we also control for the so-called one-source bias (Putrik et al., 2015). Indeed, the perception of pollution and noise can be biased by the personal view of one's own life and surroundings. We mitigated this problem by computing two measures of the average household psychological climate and we include these two indicators in the econometric model as additional variables of control.[6] Thus the individual responses to the indicators "Being happy" and "Feeling calm and peaceful" measured on a scale from 1 ("all of the time") to 5 ("none of the time") are aggregated at the household level by computing the median of the above two indicators at household level and then defining the two dummy variables listed in Table 1.

3.2. Country-level variables

At the country level, the response variable is the environmental impact of cities (EIC), as estimated for every country from household-level data. The salient aspects of the national framework conditions that can explain the cross-country heterogeneity in the response variable were chosen on

[4] It is worth noting that households that state that accommodation is provided free were excluded from the analysis.
[5] The reference person is defined as the major income earner within the household.
[6] That is, an averaged measure computed from the responses of each individual of a particular household to two behavioural variables included in the 2013 EU-SILC ad hoc module on subjective wellbeing.

the basis of theoretical and operational considerations. Specifically, a first block of variables (see Table 1, lower panel) investigates the capacity to create new resources (GDP and GROWTH) and the way in which the economic resources are distributed (GINI). In some circumstances, environmental goods, and the choice to live in an environmentally non-deprived house as well, are luxury goods. In this sense economic prosperity and its distribution may have an important role not only for single households (see the previous step) but also in explaining the sustainability of cities.

Moreover, environmental pressures, to be viewed as sources of air and noise pollution, are accounted for in terms of consumption of petroleum products vs. renewable resources (PETR_REN). We expect that the higher the consumption of petroleum products with respect to the consumption of renewable resources, the worse the environmental conditions, though the relation with the urban/rural dimension is not straightforward.

Finally, we selected some fiscal policy variables: the public debt-to-GDP ratio (DEBT), government expenditure for environmental protection as a share of GDP (EXP_GDP) and environmental taxes (TAX). We are interested in evaluating whether and to what extent government debt constitutes a fiscal policy constraint that prevents resources being allocated at the national level to address exposure to environmental risk in urban areas. The next step is to assess whether different levels of environmental taxes and environmental expenditures amongst countries can be associated with differences in the environmental impact of cities.

The country-level data were extracted from the Eurostat database and are expressed as averages during 2009-2012. The values of these variables for the different countries are shown in Table A1 in the Appendix.

Table 1 Description of micro and macro level variables

Variable	Description	Codes
Micro level variables (Source: EU-SILC 2013)		
Variable	Description	Codes
POLLUTION	Pollution problems	=1 if the household states that it has pollution, grime or other environmental problems in the local area; =0 otherwise
NOISE	Noise problems	=1 if the household states it has noise problems from neighbours or from outside in the local area; =0 otherwise
URB1	Degree of urbanisation	=1 densely populated areas (cities/large urban areas); =0 otherwise
URB2	Degree of urbanisation	=1 intermediate density areas (towns and suburbs/small urban areas) ; =0 otherwise
HOUSE_PROP1	Tenure status	=1 for outright owner; =0 otherwise
HOUSE_PROP2	Tenure status	=1 for owner paying mortgage; =0 otherwise
INCOME	Annual equivalised disposable household income (as a z-score)	
CHILDREN	Presence of children in the household	=1 if at least one children (aged less than 16) is in the household; =0 otherwise
HOUSE_FSIZE	Household size	=1 for large household (4 members or more); =0 otherwise
HAPPY	Happiness status	=1 if the household members are happy most or all of the time (within-household median < 3); =0 otherwise
CALM	Calmness status	=1 if the household members are calm most or all of the time (within-household median < 3); =0 otherwise
D_UNEXP	Inability to face unexpected expenses	=1 if the household cannot afford an unexpected expense; =0 otherwise
RATE_RICH	Income from real and financial activities, as a % of total household income	
EDU	Education level of household reference person	=1 for tertiary education (ISCED level 5 or 6); =0 otherwise
WORK	Work status of household reference person	=1 for employee or self-employed; =0 for unemployed or inactive
AGE	Age (in years) of the household reference person (as a z-score)	
Macro level variables (Source: http://ec.europa.eu/eurostat/data/database)		
Variable	Description	
GDP	Per capita Gross Domestic Product (GDP), in Purchasing Power Standards (PPS)	
GROWTH	Chain-linked volume of GDP, percentage change on previous period, per capita	
GINI	Gini index as a measure of income inequality	
PETR_REN	Energy consumption of total petroleum products, as a % of consumption of renewable energies	
DEBT	Government consolidated gross debt, as a % of GDP	
EXP_GDP	Environmental expenditures, as a % of GDP	
EXP_TOT	Environmental expenditures, as a % of total government expenditure	
TAX	Environmental taxes, as a % of total fiscal burden	

Table 2. Average values of household level variables across countries. Weighted data using cross-sectional weights.

Country	Sample size	POLLUTION	NOISE	URB1	URB2	HOUSE_PROP1	HOUSE_PROP2	CHILDREN	HOUSE_SIZE	D_UN_EXP	EDU	WORK	RATE_RICH	HAPPY	CALM	EQUIVA. INCOME	AGE
AT	5484	0.11	0.20	0.35	0.30	0.32	0.22	0.23	0.20	0.25	0.22	0.67	0.02	0.66	0.70	24912	50.49
BE	5975	0.17	0.18	0.32	0.52	0.34	0.34	0.25	0.19	0.26	0.37	0.60	0.03	0.68	0.56	22614	51.40
BG	3917	0.13	0.10	0.45	0.21	0.94	0.02	0.25	0.29	0.65	0.26	0.66	0.02	0.40	0.48	3549	52.42
CH	7109	0.10	0.17	0.30	0.48	0.05	0.35	0.25	0.20	0.20	0.39	0.75	0.03	0.70	0.65	46596	51.22
CY	3669	0.15	0.26	0.55	0.21	0.62	0.20	0.34	0.35	0.53	0.35	0.78	0.03	0.43	0.40	20662	48.46
CZ	7685	0.16	0.16	0.34	0.33	0.66	0.15	0.25	0.22	0.43	0.18	0.67	0.01	0.53	0.58	8601	51.15
DE	11895	0.23	0.28	0.38	0.41	0.25	0.21	0.19	0.13	0.37	0.31	0.63	0.03	0.59	0.65	21381	52.49
DK	4941	0.06	0.17	0.36	0.21	0.15	0.45	0.25	0.18	0.27	0.34	0.65	0.02	0.79	0.72	29842	50.01
EL	6616	0.27	0.25	0.45	0.13	0.63	0.13	0.25	0.26	0.47	0.26	0.55	0.03	0.27	0.27	9714	53.02
ES	10612	0.10	0.19	0.53	0.23	0.51	0.32	0.28	0.25	0.38	0.32	0.65	0.04	0.60	0.50	16578	51.26
FI	10393	0.08	0.14	0.38	0.28	0.35	0.36	0.23	0.17	0.27	0.37	0.69	0.03	0.80	0.83	25744	50.51
FR	10489	0.11	0.16	0.47	0.20	0.39	0.24	0.26	0.19	0.33	0.28	0.61	0.07	0.64	0.55	24988	52.13
HR	4609	0.07	0.11	0.29	0.28	0.94	0.02	0.26	0.31	0.66	0.20	0.56	0.01	0.56	0.59	5783	53.19
HU	9497	0.14	0.12	0.34	0.31	0.76	0.17	0.25	0.25	0.72	0.24	0.62	0.00	0.56	0.63	5254	52.66
IE	4519	0.05	0.10	0.35	0.25	0.42	0.30	0.36	0.28	0.53	0.42	0.61	0.01	0.79	0.73	22682	49.92
IT	15703	0.17	0.18	0.46	0.39	0.64	0.16	0.24	0.22	0.39	0.15	0.59	0.04	0.51	0.57	18673	54.86
LT	4667	0.16	0.14	0.45	0.10	0.90	0.07	0.24	0.21	0.58	0.31	0.63	0.01	0.50	0.77	5501	52.30
LU	3630	0.12	0.19	0.17	0.37	0.33	0.38	0.29	0.25	0.23	0.28	0.68	0.03	0.74	0.61	40665	49.97
NO	5461	0.08	0.12	0.53	0.17	0.24	0.63	0.30	0.22	0.10	0.35	0.75	0.03	0.73	0.78	46829	49.84
PL	10477	0.10	0.14	0.38	0.25	0.82	0.10	0.29	0.30	0.49	0.27	0.66	0.01	0.70	0.76	6290	51.15
PT	5233	0.15	0.24	0.46	0.28	0.44	0.36	0.31	0.25	0.40	0.19	0.64	0.02	0.57	0.51	10788	51.05
RO	7070	0.17	0.26	0.34	0.24	0.97	0.01	0.30	0.32	0.53	0.17	0.64	0.00	0.34	0.47	2444	51.04
SE	5676	0.09	0.12	0.40	0.31	0.10	0.57	0.28	0.21	0.18	0.36	0.72	0.03	0.74	0.85	28257	50.14
SK	5173	0.14	0.15	0.26	0.28	0.84	0.08	0.28	0.36	0.40	0.21	0.69	0.00	0.55	0.63	7253	50.11
UK	8865	0.08	0.17	0.55	0.31	0.33	0.32	0.26	0.19	0.39	0.39	0.67	0.02	0.69	0.59	21895	50.80
RS	5353	0.18	0.14	0.39	0.28	0.90	0.03	0.26	0.34	0.50	0.24	0.58	0.01	0.52	0.59	3112	53.04

4. Methods

This section describes how we implement theoretically and empirically the issues addressed in the paper. First, we test whether and to what extent the degree of urbanisation of household residential location (measured by the two dummy variables URB1 and URB2 described above) affects "household environmental risk" (measured as household exposure to air pollution and noise). Since air pollution and noise are linked because they often come from the same sources (for example, heavy industry, aircraft, railways and road vehicles), we jointly model the two risks of exposure through a bivariate probit regression. Second, using the estimated regression coefficients of URB1 and URB2, we compute the environmental impact of cities (EIC) effect to make cross-country comparisons. Third, we investigate whether contextual factors at the national level can explain European cross-country differences of the estimated EIC. To this end, we implement linear regression models where the observation unit is the single country and the dependent variable is the EIC effect based on the previous stage estimate. We now briefly explain how we treated these issues in our empirical analysis.

Bivariate probit

The bivariate probit is an extension of the simple probit regression model, where the disturbances of the two equations are assumed to be correlated (Greene, 2012). In other words, it is used when the aim of the analysis is to estimate two dichotomous events jointly. Therefore this model is used empirically for investigating the environmental and socio-economic factors underlying the risk of living in area characterised by both pollution and noise in each country.

The general specification of a bivariate probit would be

$$y_{Pi}^{*} = \boldsymbol{x}_{\boldsymbol{Pi}}^{\prime}\boldsymbol{\beta}_{\boldsymbol{P}} + \varepsilon_{iP} \qquad (1)$$
$$y_{Ni}^{*} = \boldsymbol{x}_{\boldsymbol{Ni}}^{\prime}\boldsymbol{\beta}_{\boldsymbol{N}} + \varepsilon_{iN}$$
$$i = 1 \dots n_j$$

where n_j denotes the sample size in the j[th] country (j=1…J) and y_{Pi}^{*} and y_{Ni}^{*} are continuous latent variables, namely the risk of living in an area with pollution (P) and noise (N) which determines the observed binary outcomes y_{Pi} and y_{Ni} , respectively, through the rule $y_{vi} = 1_{\{y_{vi}^{*}>0\}}$ for v=P,N. Moreover, $\boldsymbol{x}_{\mathrm{v}\boldsymbol{i}}^{\prime} = (\boldsymbol{1}, \boldsymbol{x}_{\mathrm{v}\boldsymbol{2i}}, \dots \boldsymbol{x}_{\mathrm{v}\boldsymbol{Ki}})$ for v=P, N is the i[th] row vector of the $n_j \times K$ model matrix $\mathbf{X}$, which includes variables related to each household i (the list of variables is described in Table 1) and $\boldsymbol{\beta}_{\boldsymbol{P}}$ and $\boldsymbol{\beta}_{\boldsymbol{N}}$ are parameter vectors. These two equations are correlated and were jointly estimated on the assumption that the two error terms $(\varepsilon_{iP}, \varepsilon_{iN})$ have bivariate standard normal distribution:

$$\begin{pmatrix}\varepsilon_{iP}\\ \varepsilon_{iN}\end{pmatrix} \sim N\left(\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}1 & \rho\\ \rho & 1\end{pmatrix}\right)$$

with cumulative distribution function $\Phi_2(\varepsilon_{iP}, \varepsilon_{iN}, \rho)$ where ρ is the correlation coefficient and the error variances are normalized to unity since the parameters in the model can only be identified up to a scale coefficient (Green, 2012). The coefficient ρ is of interest as it measures the covariance in the errors in the two equations. Therefore, the special case ρ= 0 implies the lack of dependence between the risks, namely pollution and noise.

Accordingly, a Likelihood Ratio Test for H0: ρ=0 against H1: ρ≠0 can be used to test whether the correlation coefficient between the errors of the two equations is statistically significant, thus rejecting the hypothesis that the two dependent variables are not jointly determined. The full maximum likelihood estimation procedure is applied by using the software program StataCorp (2015).

Average marginal effects

A country-specific bivariate probit regression was estimated in each country j (j=1..J) using Eq. (1). Let $\widehat{\boldsymbol{\beta}_{\mathbf{P}_{URB1}\mathbf{J}}}$, $\widehat{\boldsymbol{\beta}_{\mathbf{P}_{URB2}\mathbf{J}}}$, $\widehat{\boldsymbol{\beta}_{\mathbf{N}_{URB1}\mathbf{J}}}$ and $\widehat{\boldsymbol{\beta}_{\mathbf{N}_{URB2}\mathbf{J}}}$ be the estimated coefficients from each country-specific estimates j related to the dummy variables URB1 and URB2 respectively for v=P,N.

According to several authors, amongst others, Allison (1999) and more recently Mroz and Zayats (2008), Mood (2010) and Norton (2012), the odds ratios (i.e. exp($\widehat{\boldsymbol{\beta}_{\mathbf{P}_{URB1}\mathbf{J}}}$), $\mathbf{exp}(\widehat{\boldsymbol{\beta}_{\mathbf{P}_{URB2}\mathbf{J}}})$, $\mathbf{exp}(\widehat{\boldsymbol{\beta}_{\mathbf{N}_{URB1}\mathbf{J}}})$ $\mathbf{exp}(\widehat{\boldsymbol{\beta}_{\mathbf{N}_{URB2}\mathbf{J}}})$) cannot be compared across samples even if the models are based on the same explanatory variables because they are affected by unobserved heterogeneity in non-linear models. Accordingly we use the Average Marginal Effects (AME) of the two dummies URB1 and URB2 (Greene, 1996; Hensher and Johnson, 1981) for cross-country comparisons. In particular, even if the bivariate probit model identifies four different possible events, we are only interested in the event ($y_{Pi} = 1$ and $y_{Ni} = 1$), whose probability identifies the joint probability of being exposed to both risks, namely

$$P(y_{Pi} = 1, y_{Ni} = 1) = \phi_2\left(\boldsymbol{x}'_{\boldsymbol{Pi}}\boldsymbol{\beta}_{\boldsymbol{P}}, \boldsymbol{x}'_{\boldsymbol{Ni}}\boldsymbol{\beta}_{\boldsymbol{N}}, \rho\right) \quad (2)$$

Given the estimates for the model components, the average marginal effects, $AMEj,_{URB1}$ and $AMEj,_{URB2}$, express the average effects of URB1 and URB2 on the joint probability given in Eq. (2) respectively, in each country j (j=1….J). Accordingly, $AMEj,_{URB1}$ and $AMEj,_{URB2}$ are our indicators of the environmental impact of cities which, for the sake of simplicity, we indicate as $EIC1_j$ and $EIC2_j$ in the remainder of this paper.

Linear Regression with dependent variable based on estimates

To examine whether contextual factors explain cross-country variation of the EIC effect, we implemented a two-step approach in the same spirit as Lewis and Linzer (2005). Therefore, $EIC1_j$ and $EIC2_j$ estimated in the first step for each country become the dependent variables at the second step. In particular, in the empirical analysis we focus only on the $EIC1_j$ indicator. Accordingly, the $EIC1_j$ indicator was regressed on a set of M country-specific macro-variables (contextual factors) correcting for the error in estimated coefficients from the first step using Feasible Generalized Least Squares (FGLS) methodology[7].

This methodological approach has been applied in several other empirical analyses (see amongst others Guerin et al., 2001; Franzese, 2005; Bono et al., 2017; Borg, 2015) in order to overcome the issue of small sample size due to the available number of countries in many existing data sets. Accordingly, we implemented the two-step approach as a graphical method to describe estimates of cross-country differences from step 1 (Bryan and Jenkins, 2016). In other words, as stressed by Bowers and Drake (2005), we shift the focus of our analysis from inference about repeated samples of a well-defined population to compelling description of patterns within our dataset.

5. Results

5.1 Household environmental risk within countries: testing the role of urbanisation

Tables A2a-A2f in the Appendix show the estimates provided by the bivariate probit regression for each country. The key hypothesis that the correlation of error terms between the two equations is zero is strongly rejected at the 1 percent level of significance, hence supporting the dependence between the two equations. In particular, the correlation coefficient of the country-specific bivariate probit model varies from 0.43 in Denmark to 0.74 in Poland.

Living in urban areas: the environmental impact of cities

It can be noted that the effect of residential housing location has a significant impact on probability of being exposed to the risk of pollution and noise in almost all countries, also controlling for the other covariates. Indeed, the estimated 95% confidence intervals of average marginal effects of URB1 and URB2, our $EIC1_j$ and $EIC2_j$ indicators, in each country presented in Figure 1 clearly do

[7] The two-step procedure was conducted using the edvreg program in Stata 13.0 available from http://svn.cluelessresearch.com/twostep/trunk/edvreg.ado.

not intersect the vertical line fixed at zero in almost all countries. It is clear from the figure that there is also more variability among the countries with respect to $EIC1_j$ compared to $EIC2_j$. Nevertheless, as expected, within each country, living in a city has a greater positive impact on the risk of being exposed to pollution and noise.

The policy implications of such empirical evidence are of great importance insofar as air pollution and noise are among the chief parameters influencing the health of populations, which determine whether a city qualifies as sustainable (European Commission, 2016b). From the figure it emerges that in Mediterranean countries such as Italy and Greece, households living in metropolitan areas are particularly exposed to the risk of pollution and noise, showing a high environmental impact of cities ($EIC1_j$), while northern European countries such as Denmark, Norway and Sweden show much lower values for $EIC1_j$[8]. Along with the above countries, Germany also stands out, a country with a strong tradition of heavy industry, coal mines, steel mills and chemical factories. Another aspect that deserves mention is the concentration of estimated EIC1 in different countries. As we leave the highly populated metropolis, the environmental impact of cities ($EIC2_j$) becomes more concentrated and less intense. In all countries, families in the least populous cities become less exposed to environmental risk. That said, Italy, Germany and Greece maintain their worst position. These estimates confirm, therefore, that environmental risk for families is particularly felt in more densely populated urban agglomerations. For this reason, the cross-country comparison in section 5.2 was restricted to the EIC effect of cities and large urban areas ($EIC1_j$).

The control variables

Focusing on the effect of control variables (see Tables A2a-A2f in the Appendix), further interesting conclusions can be made from a policy viewpoint in each country. First of all, control variables generally explain household environmental risk better in terms of likelihood of being exposed to noise than to air pollution in almost all countries. Nevertheless, the effects that are significantly different from zero go in the same direction in both equations and the coefficients mostly show the expected signs.

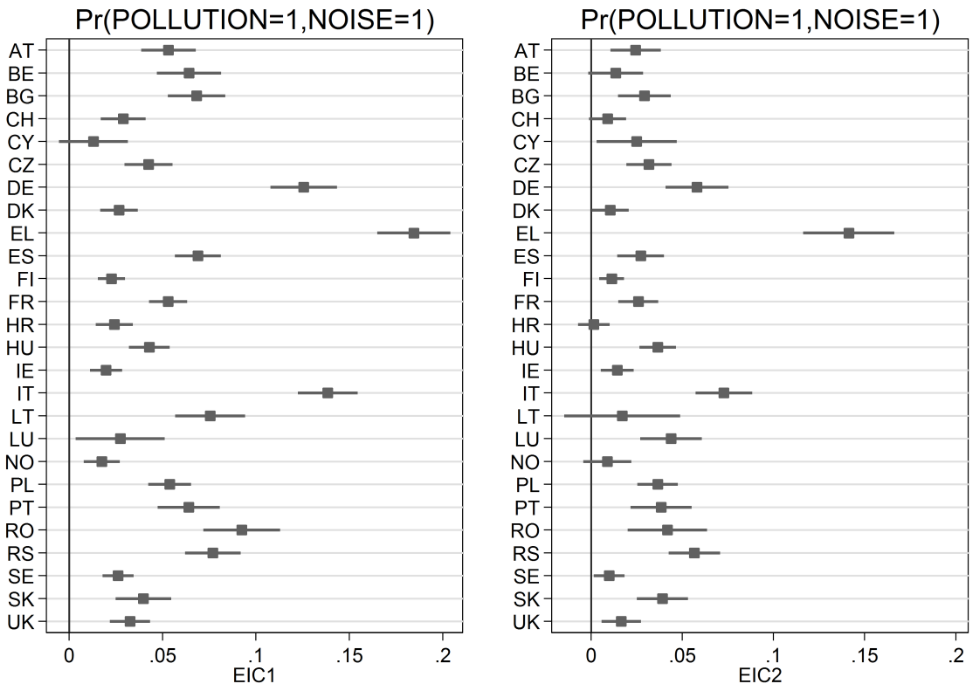
The risk of environmental vulnerability is lower in families with higher socio-economic status since homeowners (whether or not they have a mortgage) have a lower probability of being exposed to both risks than tenants, whereas households that cannot afford unexpected expenses (that is, with lower savings) have a higher risk. This saving capacity may also be due to the ability of households

[8] It is worth noting that we check the robustness of our results against the likelihood that the observed high impacts observed in Italy and in Germany were due to the small sample size in the category chosen as the baseline for urbanisation. These analyses show that even if we merge the towns and small urban areas category with rural areas, these effects still remain high.

to obtain immediate liquidity and hence the willingness of the banking system to provide credit. The impact of saving capacity (or credit constraint) is particularly significant in the economies of the former Soviet bloc (HU, CZ, SK, RS) while it is less marked in northern European countries, and remains significant for many Mediterranean economies (it becomes statistically not significant, at least for pollution, for Greece and Portugal). Our finding therefore confirmed studies suggesting that more deprived communities are more likely to be exposed to air pollution and noise. Furthermore, it is worth noting that current monetary resources, measured by household equivalised disposable income, lose significance in almost all countries when other factors are controlled for. Nevertheless, in some countries (namely NO, FI, AT, LU, UK and IE) the risk of exposure to environmental risks decreases significantly for households with higher incomes which therefore, seem able to mitigate the effects of air pollution and/or noise. Conversely, in other countries (IT, SE, CZ and RS) the more affluent households, other things being equal, seem to be more vulnerable to environmental risks.

The good psychological climate of the household also has a significant and negative effect on household environmental risk. This parameter was introduced into the model by using two indicators at household level that summarise the level of optimism and serenity in the family in order to reduce to some extent the different perceptions of noise and air pollution that people living in different countries can have. It is likely that such psychological effects are related to cultural factors and the households' ability to adapt to difficult situations in different countries. In this case, more traditional families, with significant family ties, are those that show negative effects and are particularly significant in the Mediterranean countries and in the countries of the former Soviet Union.

Figure 1. Estimated environmental impact of cities. Average marginal effect of URB1 ($EIC1_j$), densely populated areas (Panel on the left) and URB2 ($EIC2_j$), intermediate density areas (Panel on the right), on the joint probability given in Eq. (2).



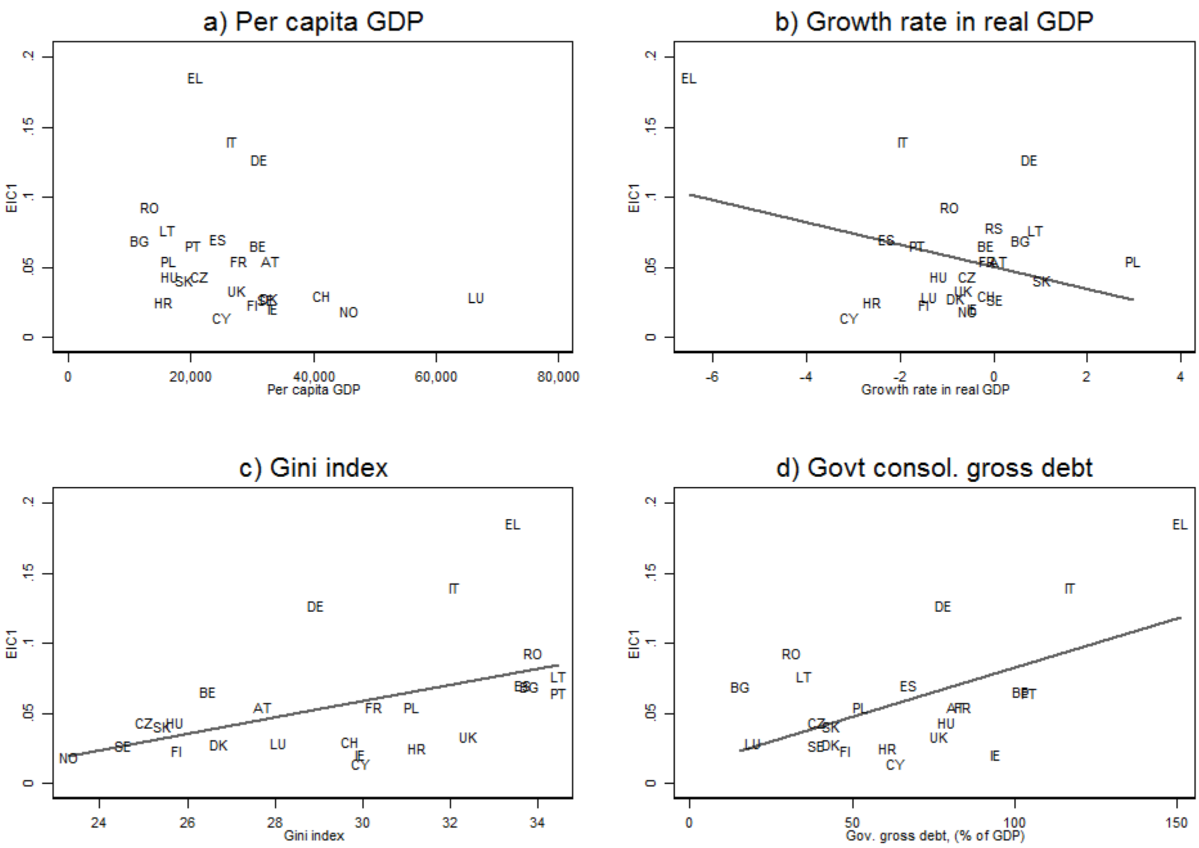
5.2 Cross-country comparisons: assessing the role of macro policies

In this section, moving on from the estimated environmental impact of cities ($EIC1_j$), we investigate whether and - if so - which nationwide policies can exert a significant effect in achieving a sustainable urban environment. Countries with greater wealth or a higher degree of inequality may have different effects in terms of environmental risk for families. Yet the level of environmental spending by different governments or taxation on environmental problems can also help explain the cross-country differences in the estimated $EIC1_j$.

In the following we provide some empirical evidence on the main economic drivers of urban sustainability (including some selected fiscal policy instruments), correlating the estimated environmental impact of cities, as estimated by the average marginal effect of URB1 generated in the first step, with a selection of pertinent macro variables.

As shown by Figure 2a, there is no statistically significant correlation between per capita GDP and the environmental impact of cities. In this regard we attempted different functional forms, but the results do not show a significant relationship. This result seems consistent with the low statistical significance and ambiguous sign found for the coefficient linking disposable income to household environmental risk in the first estimation stage. It is likely that it is the stock of wealth rather than the income flow that affects both household environmental risk and the environmental impact of cities.

Figure 2 – Per capita GDP, Gini index, government debt and estimated environmental impact of cities across European countries

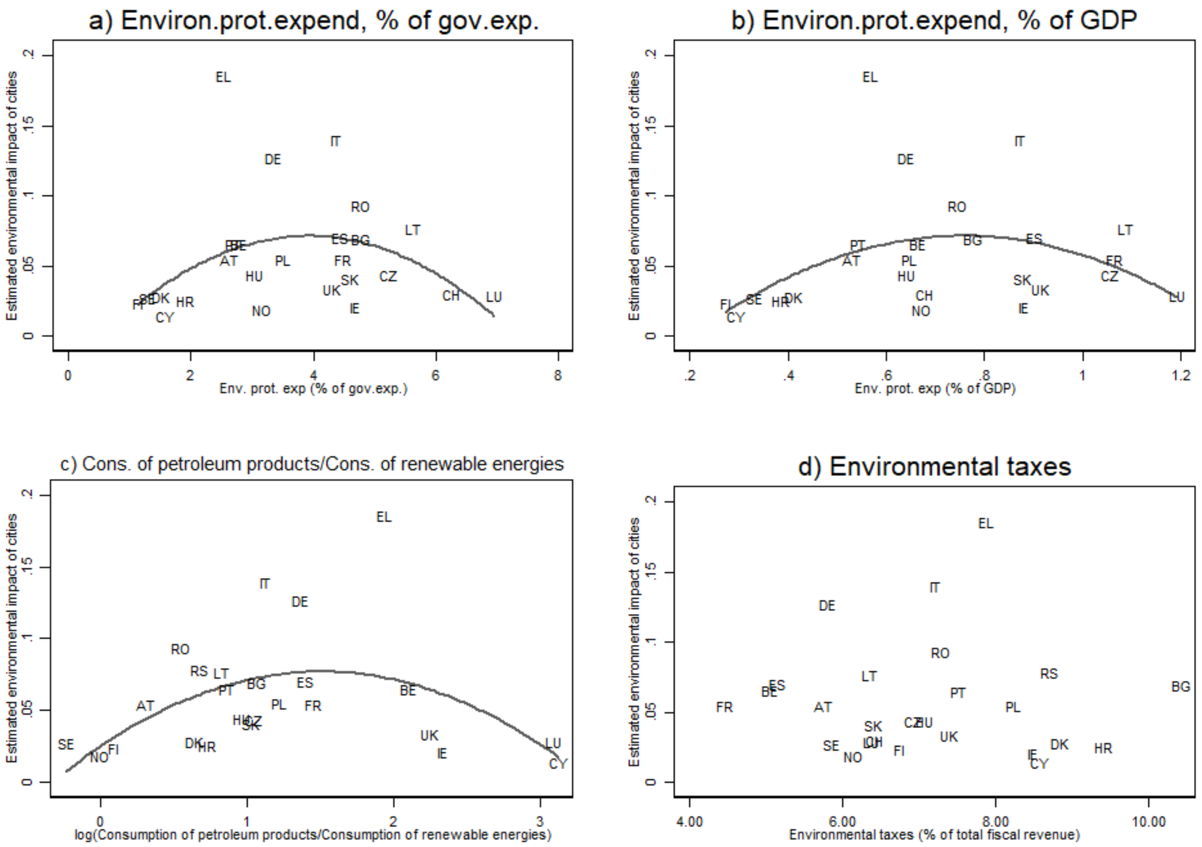


Note: EIC1 is the average marginal effect (AME) of URB1 on the joint probability given in Equation (2).

With regard to the Gini index, Figure 2c suggests that a statistically significant and positive relationship exists between income inequality and environmental impact of cities: higher inequality leads to lower sustainability of urban environments in terms of pollution and noise. The estimated coefficient, which is statistically significant at a 1% significance level, suggests that inequality has negative side effects in terms of urban sustainability. In order to interpret this result, to ascertain the channels through which this effect arises, we can refer to the literature investigating the nexus between emissions and inequality (Jorgenson et al. 2017). In this literature, the use of the Gini index is seen as an appropriate measure of inequality to test the Marginal Propensity to Emit (MPE) hypothesis, suggesting that consumption demand is the key factor to explain the marginal propensity to emit. The sign of the relationship is often negative, with a possible trade-off between equity and emission. Conversely, in our estimates there is no evidence of such a trade-off although the figure shows interesting qualifications for the different countries. Again, at the lowest level of inequality we find the countries of northern Europe, while at the highest level (with maximum impact on urban sustainability) we again find Greece and Italy. Interestingly, the high inequality presented by eastern European countries has a more limited impact in terms of urban sustainability than that showed by Mediterranean countries.

Turning our attention to policy variables, a statistically significant relationship is found between public debt and environmental impact of cities (Figure 2d): countries with a heavy debt burden also have less sustainable cities (see Greece and Italy). This is due to the fact that constraints to fiscal policy originating from high levels of public debt immediately translate into cuts to public spending on the environment. How cities develop and are planned results in outcomes which may be difficult to reverse: substandard quality of urban life and environmental degradation in high density residential areas are characterised by strong irreversibility in the long run. Once such phenomena are started along with inertia and mismanagement, the sunk costs encountered for changing their direction are huge. It is understood that the lack of human and financial resources to be allocated to urban sustainability goes hand in hand with increases in a country's external financial constraints.

Figure 3 – Environmental protection expenditures, energy consumption, environmental taxes and estimated environmental impact of cities across European countries



Note: EIC1 is the average marginal effect (AME) of URB1 on the joint probability given in Equation (2).

This intuition is further reinforced by the evidence provided by Figure 3a, showing that public expenditure on the environment matters for improving urban sustainability, but only when it reaches a threshold (4% of government expenditure, 0.6% of GDP). The last result appears particularly interesting as it draws a bell curve and lends itself to an interpretation defined by multiple equilibria. Indeed, for each level of urban sustainability, we have two opposing situations: countries with a low percentage of public spending on environmental issues and countries with high public spending on the environment. Countries such as Finland, Denmark and Sweden are located to the bottom left of the bell, while countries such as Lithuania, Luxembourg and Switzerland are to the right of the peak, indicating that the latter countries can only have urban sustainability with high public spending on the environment. Finally, Italy, Greece and Germany are well above the maximum point of the bell, indicating that in these countries, spending on the environment alone is not enough to ensure high urban sustainability. The results do not change when we use the ratio between government spending on the environment and GDP as a macro-variable (Figure 3b).

Further evidence of multiple equilibria (and hence a relationship formed by a bell curve) is generated by the relationship between urban sustainability and the logarithm of the ratio between consumption of petroleum products and consumption of renewable energies (Figure 3c). This relationship also shows a distribution across countries along the curve similar to that previously described for government spending on the environment. However, the large consumption of oil products for countries that are to the right of the top of the bell (LU, CY, BE, UK, IE) should be more than offset by high consumption of renewable energy to justify the high level of urban sustainability.

The last macro-variable tested as a source of heterogeneity between countries as to urban sustainability is environmental taxation. Increasing environmental taxes should increase urban sustainability, and hence limit the impact of highly populous metropolises on household perception of environmental risk. However, Figure 3d shows that the relationship is not significant. Even removing the outliers due to Greece and Italy, the relationship appears to be non-existent, meaning that taxation for environmental purposes does not produce the expected effects of the theory.

We are aware that an indicator such as the relationship between revenue from environmental taxation and total tax revenue is a rather gross indicator. Here we are considering a composite variable that includes charges on the emission of nitrogen oxides and charges for industrial water pollution, landfill tax, CO_2 tax, plastic bag levy and a myriad of other environmental taxes which, in principle, should be very precisely aimed at achieving the policy's environmental objectives. Moreover, these objectives are somewhat different among countries. Obviously, it matters greatly what is done with environmental revenues: the greatest gain would come from using them in carefully targeted ways to increase the environmental effectiveness of a given level of eco-taxation. Many countries use them to reduce the most distortionary existing taxes (for instance, income tax rates and payroll taxes). Thus, our measure may be inadequate to capture a clear link between environmental taxation and urban sustainability or, on the contrary, may indicate that there is no real link between tax and objective, since environmental taxation is yet another device used by governments to raise the overall tax burden.

6. Conclusions and policy implications

The empirical analysis carried out in the two estimation stages in this work shows several policy implications, especially for some countries, including Italy, which emerged as very problematic both in the individual analysis of household perception of environmental risk and in the analysis of the macroeconomic determinants of urban sustainability. The estimates show that in Italy and Greece the estimated environmental impact of cities is particularly high and that households living in metropolitan areas are particularly exposed to the risk of pollution and noise. From macro analysis the same countries often report the worst performance of the selected policies in terms of their effects on urban sustainability. Public debt and inequality produce an important effect on the urban environmental problem in many countries and constitute a serious constraint to an improvement in urban sustainability, producing a somewhat heterogeneous European context. Also, taxation has no efficacy on this phenomenon, suggesting that there are structural, political and cultural elements that prevent a clear effect of the economic transmission channels of taxation on environmental externalities.

Turning our attention to policy variables, the statistically significant correlation between public debt and environmental impact of cities has an immediate consequence: in order to pursue the goals of Agenda 2030, countries with a heavy debt burden should be provided with an additional margin of flexibility.

Of course, this study has limitations that can, in turn, be viewed as future lines of research. We are aware that the number of countries used in the second step of our analysis imposes a small sample size. Furthermore, the cross-sectional data limit our findings to a single point in time while a longitudinal approach would allow the dynamic of relationships presented to be studied. Thus, recognizing the importance of this issue, we will extend the present study in a longitudinal perspective in future research, albeit at the cost of losing some of the control variables used in this analysis since they are only available in the EU-SILC 2013 ad-hoc module.

Appendix A

Table A1 - Core variables at the country level

country	GDP	GROWTH	GINI	PETR_REN	DEBT	EXP_GDP	EXP_TOT	TAX
AT	32950	0.1	27.70	1.36	81.88	0.53	2.63	5.75
BE	30775	-0.175	26.45	8.15	101.52	0.66	2.78	5.04
BG	11550	0.55	33.80	2.90	15.23	0.77	4.76	10.42
CH	41425	-0.15	29.70	n.a.	n.a.	0.68	6.26	6.41
CY	25075	-3.1	29.95	22.83	63.42	0.29	1.57	8.57
CZ	21400	-0.575	25.03	2.85	39.15	1.06	5.23	6.93
DE	31075	0.75	28.93	3.88	78.05	0.64	3.34	5.79
DK	32750	-0.8	26.73	1.89	43.45	0.41	1.52	8.85
EL	20850	-6.5	33.45	6.93	151.15	0.57	2.55	7.88
ES	24350	-2.3	33.65	4.05	67.03	0.90	4.43	5.13
FI	29950	-1.5	25.75	1.09	47.80	0.27	1.13	6.73
FR	27675	-0.15	30.25	4.25	83.80	1.06	4.47	4.45
HR	15475	-2.6	31.23	2.08	60.80	0.38	1.92	9.40
HU	16700	-1.175	25.73	2.62	79.30	0.64	3.05	7.07
IE	33475	-0.45	29.95	10.28	94.28	0.88	4.67	8.49
IT	26650	-1.95	32.10	3.07	116.95	0.87	4.36	7.21
LT	16250	0.9	34.48	2.28	35.30	1.09	5.63	6.36
LU	66600	-1.4	28.08	22.05	19.13	1.19	6.95	6.36
NO	45725	-0.575	23.28	0.99	n.a.	0.67	3.15	6.13
PL	16325	2.975	31.13	3.38	52.58	0.65	3.51	8.24
PT	20300	-1.625	34.45	2.36	104.35	0.54	2.70	7.52
RO	13300	-0.95	33.88	1.72	31.15	0.75	4.77	7.28
RS	n.a.	0	n.a.	1.97	n.a.	n.a.	n.a.	8.71
SE	32200	0	24.53	0.79	38.65	0.33	1.29	5.85
SK	19000	1.025	25.43	2.79	43.35	0.88	4.60	6.40
UK	27450	-0.65	32.40	9.48	76.80	0.92	4.31	7.39

Source: http://ec.europa.eu/eurostat/data/database.
n.a.: not available

Table A2a. Bivariate probit estimates

	IT		ES		EL		PT		CY	
	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE
URB1	0.808***	0.737***	0.614***	0.542***	1.001***	0.638***	0.323***	0.494***	0.020	0.163**
	(0.051)	(0.048)	(0.059)	(0.048)	(0.047)	(0.047)	(0.061)	(0.057)	(0.071)	(0.064)
URB2	0.401***	0.414***	0.176**	0.324***	0.877***	0.394***	0.158**	0.348***	0.126	0.181**
	(0.052)	(0.049)	(0.071)	(0.057)	(0.065)	(0.067)	(0.066)	(0.060)	(0.081)	(0.076)
HOUSE_PROP1	-0.096**	-0.161***	-0.004	-0.054	-0.187***	-0.219***	-0.067	-0.186***	0.123	0.073
	(0.044)	(0.044)	(0.073)	(0.063)	(0.063)	(0.062)	(0.070)	(0.064)	(0.091)	(0.080)
HOUSE_PROP2	-0.074	-0.090	-0.117	-0.052	0.069	-0.115	-0.127*	-0.145**	0.338***	-0.008
	(0.056)	(0.055)	(0.075)	(0.063)	(0.078)	(0.079)	(0.074)	(0.068)	(0.107)	(0.097)
INCOME	0.029**	-0.016	0.010	-0.024	0.001	0.019	-0.009	-0.006	0.025	-0.030
	(0.012)	(0.015)	(0.025)	(0.021)	(0.024)	(0.024)	(0.027)	(0.026)	(0.025)	(0.029)
CHILDREN	0.072	-0.034	-0.014	-0.072	-0.162**	-0.100	-0.105	-0.038	-0.097	-0.027
	(0.047)	(0.047)	(0.063)	(0.053)	(0.064)	(0.065)	(0.074)	(0.065)	(0.081)	(0.076)
DHOUSE_FSIZE	0.029	-0.011	0.021	-0.078	0.159***	0.066	0.016	-0.100	0.116	0.026
	(0.046)	(0.045)	(0.058)	(0.051)	(0.061)	(0.062)	(0.073)	(0.064)	(0.073)	(0.069)
D_UNEXP	0.122***	0.161***	0.150***	0.172***	0.092*	0.125***	0.068	0.123**	0.245***	0.089
	(0.035)	(0.035)	(0.053)	(0.044)	(0.048)	(0.046)	(0.054)	(0.051)	(0.063)	(0.059)
AGE	-0.011	0.029	-0.059*	-0.091***	0.075**	0.066**	0.010	-0.006	0.151***	0.114***
	(0.025)	(0.025)	(0.034)	(0.029)	(0.031)	(0.031)	(0.041)	(0.037)	(0.045)	(0.038)
EDU	0.120***	0.119***	0.045	-0.054	0.110**	0.095*	0.084	0.211***	0.039	-0.087
	(0.044)	(0.045)	(0.054)	(0.047)	(0.056)	(0.056)	(0.078)	(0.068)	(0.067)	(0.062)
WORK	-0.065	0.006	-0.063	0.006	0.113*	0.078	-0.044	0.025	0.192**	0.089
	(0.047)	(0.049)	(0.065)	(0.055)	(0.060)	(0.060)	(0.073)	(0.066)	(0.091)	(0.079)
RATE_RICH	0.018	0.025*	0.016	0.026	0.048**	0.048**	-0.017	-0.019	-0.067**	-0.005
	(0.015)	(0.014)	(0.022)	(0.019)	(0.019)	(0.019)	(0.024)	(0.021)	(0.028)	(0.026)
HAPPY	-0.090**	-0.080*	-0.038	-0.023	-0.046	0.122**	0.020	-0.003	0.072	0.001
	(0.044)	(0.043)	(0.052)	(0.044)	(0.064)	(0.060)	(0.058)	(0.056)	(0.072)	(0.064)
CALM	-0.038	-0.053	-0.114**	-0.108**	0.034	-0.170***	-0.080	-0.204***	-0.099	-0.206***
	(0.043)	(0.042)	(0.051)	(0.043)	(0.066)	(0.063)	(0.057)	(0.055)	(0.073)	(0.065)
Constant	-1.449***	-1.329***	-1.640***	-1.179***	-1.296***	-1.009***	-1.114***	-0.901***	-1.515***	-0.832***
	(0.072)	(0.070)	(0.103)	(0.085)	(0.078)	(0.074)	(0.094)	(0.087)	(0.138)	(0.118)
rho	0.73***		0.58***		0.62***		0.52***		0.50***	
N	15703		10612		6616		5233		3669	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2b. Bivariate probit estimates

	DE		AT		FR		BE		LU	
	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE
URB1	0.633***	0.371***	0.480***	0.262***	0.471***	0.437***	0.479***	0.372***	0.121	0.295***
	(0.045)	(0.042)	(0.069)	(0.059)	(0.049)	(0.045)	(0.068)	(0.068)	(0.100)	(0.089)
URB2	0.279***	0.190***	0.231***	0.103*	0.197***	0.257***	0.009	0.173***	0.424***	0.102
	(0.043)	(0.041)	(0.068)	(0.056)	(0.061)	(0.052)	(0.063)	(0.063)	(0.070)	(0.065)
HOUSE_PROP1	0.010	-0.140***	0.128*	-0.087	-0.058	-0.237***	0.128*	-0.133**	0.094	-0.129
	(0.043)	(0.041)	(0.067)	(0.058)	(0.059)	(0.055)	(0.070)	(0.064)	(0.103)	(0.091)
HOUSE_PROP2	-0.116***	-0.224***	-0.036	-0.169**	-0.109*	-0.285***	0.142**	-0.077	0.079	-0.245***
	(0.043)	(0.042)	(0.078)	(0.067)	(0.061)	(0.056)	(0.063)	(0.063)	(0.090)	(0.078)
INCOME	0.004	-0.011	-0.008	-0.052**	0.021	-0.031	-0.017	-0.014	-0.092	-0.180***
	(0.016)	(0.017)	(0.025)	(0.023)	(0.023)	(0.026)	(0.026)	(0.026)	(0.066)	(0.059)
CHILDREN	-0.042	-0.111**	-0.089	-0.189***	0.069	0.112*	0.094	-0.080	-0.101	0.054
	(0.052)	(0.050)	(0.083)	(0.070)	(0.064)	(0.061)	(0.065)	(0.068)	(0.090)	(0.085)
DHOUSE_FSIZE	-0.075	-0.113*	0.129	0.066	0.039	-0.145**	-0.080	-0.148**	0.111	-0.148*
	(0.060)	(0.059)	(0.087)	(0.077)	(0.068)	(0.063)	(0.067)	(0.067)	(0.091)	(0.089)
D_UNEXP	0.123***	0.142***	0.252***	0.172***	0.165***	0.256***	0.278***	0.280***	0.145*	0.103
	(0.037)	(0.036)	(0.064)	(0.056)	(0.050)	(0.046)	(0.060)	(0.059)	(0.084)	(0.075)
AGE	-0.134***	-0.141***	0.050	-0.001	0.076**	-0.047	-0.020	-0.049	0.040	-0.052
	(0.022)	(0.022)	(0.038)	(0.033)	(0.035)	(0.033)	(0.038)	(0.035)	(0.052)	(0.047)
EDU	-0.022	-0.020	-0.032	-0.041	-0.064	-0.061	0.056	-0.004	0.015	-0.021
	(0.033)	(0.032)	(0.064)	(0.055)	(0.054)	(0.047)	(0.052)	(0.051)	(0.085)	(0.075)
WORK	0.061	-0.011	0.089	0.023	0.025	0.030	-0.028	0.160**	0.083	0.022
	(0.042)	(0.042)	(0.079)	(0.069)	(0.065)	(0.061)	(0.072)	(0.067)	(0.105)	(0.093)
RATE_RICH	-0.025	-0.025	0.004	0.001	-0.035	0.016	-0.015	0.005	-0.079*	-0.036
	(0.016)	(0.017)	(0.021)	(0.020)	(0.027)	(0.023)	(0.022)	(0.020)	(0.043)	(0.031)
HAPPY	-0.111***	-0.124***	-0.133**	-0.064	-0.032	0.013	-0.173***	-0.140***	-0.107	-0.091
	(0.034)	(0.034)	(0.058)	(0.051)	(0.055)	(0.049)	(0.055)	(0.054)	(0.082)	(0.074)
CALM	-0.099***	-0.100***	-0.115**	-0.136***	-0.053	-0.204***	-0.056	-0.104**	-0.208***	-0.193***
	(0.036)	(0.035)	(0.058)	(0.052)	(0.051)	(0.047)	(0.050)	(0.050)	(0.073)	(0.066)
Constant	-1.041***	-0.628***	-1.482***	-0.795***	-1.483***	-1.122***	-1.166***	-1.040***	-1.353***	-0.689***
	(0.060)	(0.058)	(0.100)	(0.083)	(0.080)	(0.073)	(0.095)	(0.090)	(0.132)	(0.112)
rho	0.73***		0.58***		0.54***		0.49***		0.71***	
N	11895		5484		10427		5975		3630	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2c. Bivariate probit estimates

	CH		UK		IE	
	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE
URB1	0.217***	0.378***	0.347***	0.359***	0.335***	0.422***
	(0.077)	(0.066)	(0.071)	(0.060)	(0.098)	(0.082)
URB2	0.070	0.115*	0.110	0.295***	0.241**	0.308***
	(0.068)	(0.059)	(0.076)	(0.063)	(0.106)	(0.088)
HOUSE_PROP1	-0.117	-0.133	0.122*	-0.157***	0.148	-0.274***
	(0.104)	(0.095)	(0.073)	(0.056)	(0.118)	(0.098)
HOUSE_PROP2	-0.194***	-0.200***	0.035	-0.186***	0.079	-0.129
	(0.059)	(0.050)	(0.067)	(0.051)	(0.111)	(0.089)
INCOME	-0.033	-0.033	-0.009	-0.042*	0.026	-0.073*
	(0.038)	(0.027)	(0.027)	(0.024)	(0.031)	(0.039)
CHILDREN	-0.067	-0.115	-0.131*	-0.148***	-0.074	-0.025
	(0.088)	(0.075)	(0.076)	(0.056)	(0.107)	(0.089)
DHOUSE_FSIZE	0.035	-0.154*	0.002	-0.032	-0.038	-0.196**
	(0.091)	(0.081)	(0.084)	(0.062)	(0.108)	(0.089)
D_UNEXP	0.284***	0.212***	0.260***	0.191***	0.161*	0.306***
	(0.066)	(0.060)	(0.059)	(0.047)	(0.092)	(0.078)
AGE	0.049	-0.112***	-0.108***	-0.192***	-0.154***	-0.077
	(0.039)	(0.033)	(0.034)	(0.027)	(0.050)	(0.051)
EDU	-0.018	-0.046	0.117**	0.007	0.126	0.178**
	(0.056)	(0.049)	(0.052)	(0.043)	(0.088)	(0.071)
WORK	-0.025	-0.015	-0.110*	-0.036	-0.062	0.022
	(0.079)	(0.071)	(0.063)	(0.052)	(0.095)	(0.086)
RATE_RICH	0.038	0.001	0.033	0.014	-0.026	-0.040
	(0.026)	(0.021)	(0.025)	(0.022)	(0.037)	(0.037)
HAPPY	-0.157***	-0.176***	-0.078	-0.068	-0.083	-0.090
	(0.058)	(0.051)	(0.057)	(0.051)	(0.104)	(0.092)
CALM	-0.141**	-0.173***	-0.106*	-0.132***	-0.256***	-0.175**
	(0.057)	(0.050)	(0.054)	(0.048)	(0.100)	(0.085)
Constant	-1.188***	-0.802***	-1.657***	-1.074***	-1.825***	-1.463***
	(0.102)	(0.091)	(0.102)	(0.081)	(0.156)	(0.129)
rho	0.48***		0.52***		0.58***	
N	6568		8865		4519	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2d. Bivariate probit estimates

	SE		DK		NO		FI	
	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE
URB1	0.415***	0.245***	0.376***	0.392***	0.184***	0.203***	0.328***	0.236***
	(0.069)	(0.062)	(0.080)	(0.076)	(0.066)	(0.059)	(0.055)	(0.052)
URB2	0.178**	0.065	0.121	0.205**	0.127	0.055	0.188***	0.082
	(0.074)	(0.066)	(0.099)	(0.085)	(0.088)	(0.081)	(0.057)	(0.054)
HOUSE_PROP1	-0.292***	-0.139	-0.172	-0.177*	-0.017	-0.028	-0.066	-0.440***
	(0.108)	(0.094)	(0.110)	(0.107)	(0.111)	(0.106)	(0.066)	(0.065)
HOUSE_PROP2	-0.195***	-0.438***	-0.262***	-0.359***	0.091	0.095	-0.129**	-0.387***
	(0.063)	(0.059)	(0.086)	(0.079)	(0.100)	(0.090)	(0.065)	(0.059)
INCOME	0.058**	0.032	-0.015	-0.141	-0.109***	-0.146***	-0.054*	-0.090***
	(0.026)	(0.028)	(0.029)	(0.113)	(0.037)	(0.038)	(0.029)	(0.031)
CHILDREN	0.026	0.132*	0.015	-0.088	-0.113	-0.186**	0.154**	-0.047
	(0.085)	(0.078)	(0.116)	(0.095)	(0.089)	(0.078)	(0.076)	(0.067)
DHOUSE_FSIZE	-0.250***	-0.241***	-0.028	-0.277**	-0.040	-0.173**	-0.108	-0.155**
	(0.093)	(0.084)	(0.128)	(0.122)	(0.094)	(0.083)	(0.078)	(0.075)
D_UNEXP	-0.047	0.211***	0.092	0.274***	0.491***	0.486***	0.083	0.093*
	(0.077)	(0.066)	(0.085)	(0.077)	(0.092)	(0.085)	(0.058)	(0.051)
AGE	-0.097**	-0.136***	-0.024	-0.269***	0.051	-0.082**	0.067*	-0.164***
	(0.039)	(0.033)	(0.046)	(0.041)	(0.039)	(0.034)	(0.035)	(0.030)
EDU	0.120**	0.005	0.102	-0.025	0.071	-0.021	0.036	0.059
	(0.056)	(0.053)	(0.077)	(0.072)	(0.059)	(0.053)	(0.050)	(0.047)
WORK	-0.137*	0.059	0.108	0.049	0.013	-0.071	0.088	0.024
	(0.082)	(0.073)	(0.098)	(0.094)	(0.087)	(0.076)	(0.073)	(0.062)
RATE_RICH	0.005	-0.025	-0.040	-0.003	0.015	0.026	0.022	-0.014
	(0.025)	(0.026)	(0.032)	(0.043)	(0.026)	(0.025)	(0.020)	(0.021)
HAPPY	-0.124*	-0.117*	-0.330***	-0.145	-0.160**	-0.039	-0.010	-0.216***
	(0.070)	(0.063)	(0.108)	(0.106)	(0.075)	(0.066)	(0.068)	(0.060)
CALM	-0.171**	-0.199***	0.146	-0.144	-0.023	-0.043	-0.139*	-0.072
	(0.084)	(0.076)	(0.105)	(0.096)	(0.085)	(0.070)	(0.072)	(0.064)
Constant	-1.170***	-0.903***	-1.607***	-0.879***	-1.538***	-1.246***	-1.501***	-0.765***
	(0.112)	(0.100)	(0.118)	(0.108)	(0.125)	(0.117)	(0.096)	(0.085)
rho	0.45***		0.43***		0.68***		0.44***	
N	5676		5099		5461		10393	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2e. Bivariate probit estimates

	LT		PL		BG		RO	
	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE
URB1	0.564***	0.469***	0.479***	0.357***	0.584***	0.834***	0.440***	0.478***
	(0.072)	(0.070)	(0.052)	(0.048)	(0.074)	(0.084)	(0.062)	(0.053)
URB2	0.060	0.166	0.361***	0.193***	0.077	0.501***	0.168**	0.273***
	(0.134)	(0.122)	(0.054)	(0.049)	(0.087)	(0.097)	(0.067)	(0.057)
HOUSE_PROP1	-0.069	-0.303	-0.225***	-0.294***	0.055	-0.245	-0.436**	-0.481***
	(0.238)	(0.232)	(0.076)	(0.073)	(0.166)	(0.173)	(0.172)	(0.164)
HOUSE_PROP2	0.072	-0.363	-0.295***	-0.412***	0.176	-0.425	-0.502	-0.933***
	(0.290)	(0.291)	(0.097)	(0.095)	(0.259)	(0.267)	(0.319)	(0.291)
INCOME	-0.035	0.013	0.013	0.002	-0.038	-0.089	0.045	0.035
	(0.040)	(0.048)	(0.023)	(0.022)	(0.049)	(0.055)	(0.033)	(0.030)
CHILDREN	0.011	0.018	-0.109*	-0.028	0.095	-0.076	-0.015	0.057
	(0.106)	(0.110)	(0.060)	(0.056)	(0.090)	(0.099)	(0.077)	(0.068)
DHOUSE_FSIZE	0.051	0.062	0.063	-0.065	0.041	0.260***	0.157**	-0.019
	(0.108)	(0.113)	(0.059)	(0.054)	(0.086)	(0.096)	(0.074)	(0.064)
D_UNEXP	0.035	0.105	0.085*	0.082**	0.189**	0.216***	0.148***	0.078*
	(0.074)	(0.075)	(0.045)	(0.042)	(0.074)	(0.082)	(0.052)	(0.047)
AGE	0.142***	0.020	0.001	0.008	-0.078*	-0.011	-0.007	-0.038
	(0.052)	(0.060)	(0.031)	(0.029)	(0.047)	(0.051)	(0.038)	(0.035)
EDU	0.012	-0.090	-0.010	0.049	-0.109	0.088	0.167**	0.219***
	(0.080)	(0.078)	(0.053)	(0.051)	(0.077)	(0.080)	(0.078)	(0.069)
WORK	0.260***	0.026	0.107*	0.017	0.041	-0.028	-0.080	-0.072
	(0.096)	(0.107)	(0.061)	(0.058)	(0.089)	(0.097)	(0.072)	(0.066)
RATE_RICH	-0.077**	-0.051	0.043***	0.056***	-0.019	0.057**	0.009	0.001
	(0.035)	(0.031)	(0.016)	(0.015)	(0.031)	(0.026)	(0.019)	(0.017)
HAPPY	0.035	-0.012	-0.011	-0.097**	-0.002	-0.041	-0.181***	-0.137**
	(0.068)	(0.073)	(0.050)	(0.048)	(0.079)	(0.085)	(0.065)	(0.057)
CALM	-0.142*	-0.092	-0.066	0.041	-0.037	0.079	-0.035	-0.049
	(0.083)	(0.081)	(0.052)	(0.051)	(0.076)	(0.079)	(0.060)	(0.053)
Constant	-1.365***	-1.032***	-1.400***	-1.006***	-1.653***	-1.855***	-0.783***	-0.385**
	(0.256)	(0.256)	(0.102)	(0.095)	(0.192)	(0.208)	(0.181)	(0.173)
rho	0.69***		0.74***		0.55***		0.72***	
N	4667		10477		3916		7005	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2f. Bivariate probit estimates

	HU		CZ		SK		RS		HR	
	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE	POLLUTION	NOISE
URB1	0.382***	0.301***	0.280***	0.259***	0.285***	0.230***	0.416***	0.653***	0.317***	0.343***
	(0.051)	(0.053)	(0.048)	(0.048)	(0.057)	(0.056)	(0.056)	(0.062)	(0.079)	(0.073)
URB2	0.318***	0.263***	0.201***	0.201***	0.296***	0.209***	0.296***	0.489***	-0.054	0.120*
	(0.047)	(0.049)	(0.046)	(0.047)	(0.054)	(0.054)	(0.056)	(0.063)	(0.078)	(0.069)
HOUSE_PROP1	-0.219***	-0.427***	-0.126**	-0.161***	0.053	-0.081	-0.074	0.026	-0.066	-0.058
	(0.075)	(0.073)	(0.052)	(0.053)	(0.088)	(0.083)	(0.092)	(0.099)	(0.173)	(0.151)
HOUSE_PROP2	-0.217**	-0.406***	-0.148**	-0.138*	0.044	-0.040	0.026	0.225	0.177	-0.235
	(0.086)	(0.086)	(0.071)	(0.071)	(0.117)	(0.114)	(0.142)	(0.150)	(0.259)	(0.264)
INCOME	-0.009	-0.080***	0.065***	0.025	-0.013	-0.024	0.103***	0.041	-0.029	0.009
	(0.026)	(0.030)	(0.023)	(0.025)	(0.026)	(0.028)	(0.027)	(0.029)	(0.042)	(0.041)
CHILDREN	0.069	0.012	-0.081	-0.045	-0.091	-0.159**	0.176***	-0.030	-0.147	-0.157*
	(0.060)	(0.060)	(0.060)	(0.062)	(0.064)	(0.066)	(0.063)	(0.068)	(0.106)	(0.095)
DHOUSE_FSIZE	0.002	-0.040	0.008	-0.040	0.067	0.069	0.004	-0.107*	0.135	-0.076
	(0.057)	(0.060)	(0.061)	(0.065)	(0.059)	(0.059)	(0.061)	(0.063)	(0.098)	(0.086)
D_UNEXP	0.191***	0.187***	0.159***	0.144***	0.176***	0.022	0.318***	0.276***	0.053	0.071
	(0.048)	(0.050)	(0.042)	(0.042)	(0.049)	(0.048)	(0.049)	(0.052)	(0.080)	(0.072)
AGE	-0.006	-0.004	-0.016	-0.050	-0.039	0.006	-0.113***	-0.090***	0.015	-0.038
	(0.029)	(0.031)	(0.031)	(0.031)	(0.037)	(0.038)	(0.031)	(0.034)	(0.050)	(0.047)
EDU	0.007	-0.020	-0.084	-0.075	-0.010	0.011	0.022	0.003	0.097	0.041
	(0.053)	(0.055)	(0.053)	(0.055)	(0.058)	(0.060)	(0.059)	(0.061)	(0.089)	(0.083)
WORK	-0.055	-0.023	0.007	-0.072	-0.093	-0.090	-0.175***	-0.042	0.042	-0.014
	(0.058)	(0.061)	(0.064)	(0.064)	(0.079)	(0.080)	(0.063)	(0.066)	(0.104)	(0.091)
RATE_RICH	-0.070***	-0.007	0.035**	0.057***	0.012	0.004	0.021	-0.005	0.008	0.018
	(0.026)	(0.030)	(0.016)	(0.018)	(0.022)	(0.022)	(0.020)	(0.027)	(0.031)	(0.025)
HAPPY	-0.114**	-0.139***	-0.070	-0.053	0.028	-0.120**	0.119**	0.105*	0.072	-0.007
	(0.049)	(0.048)	(0.051)	(0.052)	(0.055)	(0.058)	(0.056)	(0.060)	(0.098)	(0.082)
CALM	-0.061	-0.042	-0.118**	-0.125**	-0.128**	-0.058	-0.148***	-0.166***	-0.124	0.045
	(0.050)	(0.048)	(0.051)	(0.052)	(0.056)	(0.059)	(0.055)	(0.059)	(0.098)	(0.083)
Constant	-1.148***	-0.984***	-0.990***	-0.929***	-1.228***	-0.904***	-1.223***	-1.607***	-1.565***	-1.306***
	(0.099)	(0.101)	(0.079)	(0.077)	(0.110)	(0.109)	(0.112)	(0.122)	(0.208)	(0.171)
rho	0.63***		0.66***		0.72***		0.58***		0.55***	
N	9497		7685		5173		5353		4606	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3. Regression FGLS - URB1 POLLUTION NOISE

	Y variable									
X variable	EIC1	log(EIC1)	EIC1	EIC1	EIC1	EIC1	EIC1	EIC1	EIC1	EIC1
GDP	-0.000									
	(-1.53)									
log(GDP)		-0.652*								
		(-2.05)								
log(GDP)			-0.029							
			(-1.43)							
GROWTH				-0.008						
				(-1.71)						
GINI					0.006**					
					(2.68)					
DEBT						0.001***				
						(2.99)				
EXP_GDP							34.508*			
							(2.07)			
EXP_GDP^2							-2275.163*			
							(-1.97)			
EXP_TOT								4.872**		
								(2.10)		
EXP_TOT^2								-62.052*		
								(-2.06)		
log(PETR_REN)									0.068**	
									(2.65)	
[log(PETR_REN)]^2									-0.023**	
									(-2.74)	
TAX										-0.001
										(-0.17)
_cons	0.085***	3.502	0.353	0.051***	-0.114*	0.013	-0.060	-0.025	0.025	0.064
	(4.11)	(1.09)	(1.70)	(5.98)	(-1.79)	(0.74)	(-1.07)	(-0.61)	(1.51)	(1.53)
N	25	25	25	26	25	23	25	25	25	26
R^2	0.092	0.155	0.082	0.108	0.238	0.299	0.166	0.167	0.256	0.001

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

References

Alkire S., Apablaza M., E. Jung (2014), Multidimensional poverty measurement for EU-SILC countries, *Oxford Poverty & Human Development Initiative* (OPHI)

Alkire S. and Foster J. (2011) Counting and multidimensional poverty measurement*, Journal of Public Economics*, 95, 476-487.

Allison, P. D. (1999). Comparing logit and probit coefficients across groups. *Sociological Methods and Research*, 28, 186–208.

Bairoch, P. (1988), Cities and Economic Development, University of Chicago Press. Chicago.

Babisch, W. (2000) 'Traffic noise and cardiovascular disease – epidemiological review and synthesis', *Noise and Health*, Vol. 8, 9–32.

Betti G. Gagliardi F., Lemmi A. and V. Verma (2015). Comparative Measures of Multidimensional Deprivation in the European Union, *Empirical Economics, 49*, 1071-1100.

Bilger, M., Carrieri, V. 2013. Health in the cities: When the neighborhood matters more than income, *Journal of Health Economics* 32, 1-11.

Bonnefoy X., 2007, Inadequate housing and health: an overview, *Int. J. Environment and Pollution*, Vol. 30, pp.

Bono F., Cracolici M.F., Cuffaro M., 2017 A Hierarchical Model for Analysing Consumption Patterns in Italy Before and During the Great Recession Soc Indic Res, 134, 421–436

Borg, 2015 Housing Deprivation in Europe: On the Role of Rental Tenure Types. Housing, Theory and Society, 32, 73–93.

Bowers J. and Katherine W. Drake. 2005 EDA for HLM: Visualization when Probabilistic Inference Fails, Political Analysis (2005) 13:301–326

Bossert W., Chakravarty S.R., D'Ambrosio C., 2103 Multidimensional Poverty and Material Deprivation with Discrete Data, *The Review of Income and Wealth*, 59, 29-43.

Braubach M., Fairburn J. , 2010, Social inequities in environmental risks associated with housing and residential location—a review of evidence, *European Journal of Public Health*, 20, 36–42.

Bryan M.L., Jenkins S. P., 2016, Multilevel Modelling of Country Effects: A Cautionary Tale *European Sociological Review*, Volume 32, Issue 1, 1 February 2016, 3–22

Button K. (2002), City management and urban environmental indicators, Ecological Economics 40, 217–233.

Cappellari, L. and Jenkins, S.P. (2007), Summarizing multiple deprivation indicators, in Jenkins, S.P. and Micklewright, J. (Eds), *Inequality and Poverty Re-examined*, Oxford University Press, Oxford.

Chiarini B., E. Marzano, 2014, Urbanization and growth: why did the splendor of the Italian cities in the sixteenth century not lead to transition?, *CESifo Working Paper* No. 5038, October 2014

De Vries, J. (1984), *European Urbanisation 1500-1800*, Harvard University Press, Cambridge MA

Elsinga, M. and J. Hoekstra. 2005. "Homeownership and Housing Satisfaction." *Journal of Housing and the Built Environment* 20, 401-424.

Eurostat (2013), *EU-SILC Description of Target Variables: Cross-sectional and Longitudinal*. Luxembourg: Publications Office of the European Union.

European Commission (2016)a, Key European action supporting the 2030 agenda and sustainable development goals, Commission staff working document, COM (2016) 739 final.

European Commission (2016)b, Links between noise and air pollution and socioeconomic status, Science for Environment Policy, IN-DEPTH REPORT 13.

Franzese, R. J. (2005). Empirical strategies for various manifestations of multilevel data, *Political Analysis*, 13, 430–446.

Galor, O. (2005), Unified growth theory, in Aghion P. and Durlauf S. (eds.), *Handbook of Economic Growth*, North-Holland, Elsevier Science. Amsterdam.

Galster, G. (1996) William Grigsby and the analysis of housing submarkets and filtering. Urban Studies, 33 (10), 1797–1806.

Glaeser, E. L. , Resseger M. G. (2010), The Complementarity between Cities and Skills, Journal of Regional Science , 50(1) (2010): 221 - 2 44 .

Guerin, D., Crete, J., Mercier, J. (2001). A multilevel analysis of the determinants of recycling behavior in the European Countries, *Social Science Research*, 30, 195–218.

Greene, W. H., (1996), Marginal Effects in the Bivariate Probit Model NYU Working Paper No. EC-96-11. Available at SSRN: https://ssrn.com/abstract=1293106

Greene, W.H. (2012), *Econometric Analysis*, Prentice Hall, New York, NY, USA.

Hensher, D., and L. Johnson (1981), *Applied Discrete Choice Modelling*, New York:.John Wiley and Sons.

Iwata, S., Yamaga H. (2008), Rental Externality, Tenure Security, and Housing Quality, *Journal of Housing Economics* 17, 201-211.

Jedwab R. and Vollrath D. (2015) Urbanization without growth in historical perspective, *Explorations in Economic History*, vol. 58, issue C, 1-21.

Leon, D.A. (2008) Cities, urbanization and health, *International Journal of Epidemiology* 37, 4-8.

Lewis, J.B. and Linzer, D.A. (2005) Estimating Regression Models in Which the Dependent Variable Is Based on Estimates, *Political Analysis,* 13, 345–364

Mood, C. (2010), Logistic Regression: Why We Cannot Do What We Think We Can Do, and What We Can Do About It, *European Sociological Review*, Volume 26, Issue 1, 67–82,

Navarro, C., Ayala, L., Labeaga, J. M. 2010. Housing deprivation and health status: evidence from Spain. *Empirical Economics* 38, 555-582.

Nelson, Kenneth. 2012. "Counteracting Material Deprivation: The Role of Social Assistance in Europe." *Journal of European Social Policy* 22, 148-163.

Newman P.(2006). The environmental impact of cities, *Environment and Urbanization,* 18(2); 275-295.

Nolan B. and C. T. Whelan, (2010), Using Non-Monetary Deprivation Indicators to Analyze Poverty and Social Exclusion: Lessons from Europe?, *Journal of Policy Analysis and Management*, 29, 305-325. Special Issue on Poverty Measurement,

O'Sullivan T. and K. Gibb (2003)(eds.), *Housing Economics and Public Policy*, Blackwell Science, Oxford.

Potsi, A., D'Agostino, A., Giusti, C., Porciani, L. (2016). Childhood and capability deprivation in Italy: a multidimensional and fuzzy set approach. *Quality & Quantity, 50*, 2571-2590.

Putrik P., de Vries Nanne K. , van Amelsvoort K. J, Kunst A. E , van Oers H Jansen M (2015), Living Environment Matters: Relationships Between Neighborhood Characteristics and Health of the Residents in a Dutch Municipality, *Journal of Community Health*, 40, 47–56.

Sato Y. and Yamamoto K. (2005), Population concentration, urbanization, and demographic transition, *Journal of Urban Economics*, 58, 45-61.

Schmit, C., Lorant, V. (2009). Noise nuisance and health inequalities in Belgium: a population study. *Archives of Public Health*. 67(2): 52. DOI:10.1186/0778-7367-67-2-52.

Shenassa E., Liebhaber A, Ezeamama A (2006), Perceived safety of area of residence and exercise: a pan-European study, 163, 1012-7.

StataCorp. (2015), *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP.

Terraneo, M. (2016), A longitudinal study of deprivation in European countries, International Journal of Sociology and Social Policy, 36, 379-409.

Tu Y., 2006 Segmentation, Adjustment and Disequilibrium, in O'Sullivan T. and Gibb K. (ed. by) *Housing Economics and Public Policy*, Blackwell Science, Oxford.

UN, 2016, Draft outcome document of the United Nations Conference on Housing and Sustainable Urban Development (Habitat III), A/CONF.226/4.

Whitehead M. (2003), (Re)analysing the sustainable city: nature, urbanization and the regulation of socio-environmental relations in the UK, *Urban studies*, 40(7), 1183-12.06.

Williams K. (2010) Sustainable cities: research and practice challenges, *International Journal of Urban Sustainable Development*, 1:1-2, 128-132, DOI:10.1080/19463131003654863

Wooldridge, J. M. (2010 Econometric Analysis of Cross Section and Panel Data, MIT Press, Cambridge, UK, 2010.

Zhang J. (2002), Urbanisation, population transition, and growth, *Oxford University Press*, 54, 91-117.