

URBAN SPATIAL STRUCTURE AND ENVIRONMENTAL EMISSIONS: A SURVEY OF THE LITERATURE AND SOME EMPIRICAL EVIDENCE FOR ITALIAN NUTS-3 REGIONS

Abstract

This paper addresses the relationship between urban spatial structure and emissions. Within this general aim, the major contributions of the paper are twofold. Firstly, we review the most relevant literature in the topic and the possible causal links between spatial structure and emissions. Then, we empirically assess those links by studying the case of Italy.

By surveying the most relevant literature, we discuss the concept of spatial structure by focusing in particular on two main aspects of urban and regional spatial structure: dispersion and polycentricity. The first refers to the extent to which economic activities are spatially concentrated in centres or, conversely, evenly dispersed across space. Nowadays, urban dispersion, or urban sprawl, has become one of the most relevant issues in land use, because it may involve a sub-optimal use of land with many potential pressures on physical systems. The second aspect of spatial structure, polycentricity, refers to balanced hierarchical relationships among centres in a spatial system, occurring when most of economic activity is evenly distributed across centres of comparable size, rather than concentrated in a main centre. Both aspects of dispersion and polycentricity are briefly presented, together with some indexes that can be applied to measure their measure.

Then, the paper summarises the possible causal links between spatial structure and emissions. The literature that was surveyed highlights several mechanisms through which spatial structure can play a relevant role in affecting emissions. Amongst other dimensions, transport and house heating represent the most relevant dimensions in which spatial structure can affect emissions. In particular, we focus on private road transport, which is largely dependent on residential and working locations, and private house heating. For each aspect we review some of the most relevant literature.

The survey provides the framework to explore the empirical evidence for Italy concerning CO₂ and PMs emissions originating from private transport and house heating. Hence, the paper describes the Italian empirical evidence of the topic by presenting some figures about CO₂ and PMs emission trends and the contribution made by road transport and linked to modal choices, which have been argued to be related to spatial structure. This section also shows figures on residential heating emissions in Italy, which show an increasing trend.

Then, the paper reports the main results from the empirical analysis that we carried out by taking into account Italian NUTS-3 level regions (*province*) as analytical units. We studied the links between spatial structure in Italian provinces and emissions by performing a regression analysis, considering respectively private road transport (cars and motorbikes) and residential heating, within the causal framework sketched in the first part of the paper which involve a series of control variables. For each dimension we regressed environmental impact in terms of CO₂ and PMs emissions, for years 1990, 2000 and 2006. Regarding residential heating, our results show that urban dispersion affects positively PMs emission in all periods considered. With reference to road transport, we found that, while in 1990 sprawl is not significant, in the later period data suggest that both sprawl and polycentricity increase CO₂ emissions. PMs are positively affected by polycentricity, with a low evidence for the role of sprawl. Hence, to sum up, our results support the

idea that compact and dense urban regions may reduce emission from private motorised transport. Conversely, the role of polycentricity is opposite to what is usually thought: however, this does not need to be interpreted that polycentricity increases environmental pressure. However it is a strong evidence that polycentricity alone does not reduce emissions. Actually, polycentricity might facilitate planning and long-term development policies oriented towards the reduction of private vehicles flows, and hence emissions, between centres. To verify this hypothesis one would need additional control variables, such as proxies for the quality of the public transport or for the degree of multifunctional land use, which were not available for our case study: this calls for further analysis in the topic.