

Measuring Exposure to EU-Funded Projects and Spatial Spillovers Using Beneficiary Legal Addresses: A Town-Level Panel for Bulgaria 2014–2026

Extended Abstract

This study develops and examines a town-level spatial panel dataset to assess exposure to European Union (EU) funded project activity and related spatial spillovers across Bulgaria during 2014–2026 years. The analysis is based on a comprehensive set of administrative data on EU funded projects ($N=73,783$), focusing on project initiation events and their spatial diffusion to towns and villages, measured via spatial lag indicators based on beneficiary locations. The geographic unit of the dataset is the legal address of the EU funded project beneficiary organization, rather than the specific physical location at which a project was implemented, therefore, spillover measures capture administrative exposure to EU funding rather than the physical placement of investments and infrastructure.

The dataset includes program identifiers, project proposal numbers, beneficiary characteristics (public vs. private), financial information, project duration, and implementation status. Each project has been geocoded to the legally registered address of the beneficiary organization and then standardized to a single town identifier. Following data cleaning and standardization, the data have been aggregated into a balanced panel of towns by year, spanning 2,302 locations and 13 years of initial project starts.

Empirical analysis is conducted through R in three stages. First, the spatial and temporal aggregation of EU funded project initiations are documented across Bulgarian towns. Second, spatial spillover exposure indicators are calculated via k-nearest neighbor (kNN) spatial weight matrices at the town level and both contemporaneous and one year lagged spatial lag estimates are generated. Finally, spillover exposure is illustrated using spatial maps, Moran-style scatterplots, heatmaps, time series profiles, and distributions.

As descriptive evidence shows, there is significant geographic concentration of EU funded project activity. The capital city of Sofia accounts for approximately a quarter of the

project initiations. Spatial maps clearly show Sofia as a dominant node with both high local project activity and elevated spillover exposure to surrounding towns. Several regional cities (e.g., Plovdiv, Varna, Burgas, and Ruse) demonstrate consistent levels of both project activity and spillover exposure outside of Sofia. The majority of towns and villages appear as having either sporadic or zero project initiations in most years, thereby highlighting the extremely uneven distribution of EU funded initiatives across the territory of Bulgaria.

In addition to extreme geographic concentration of EU funded project activity, temporal patterns also indicate a high degree of programmatic clustering of project initiations, especially in the vicinity of large funding cycles and crisis-related periods. Boxplots of lagged spillover exposure reveal a significant spike in exposure starting in 2020 and continuing through 2026, while exposure is elevated, but quite variable. This pattern is consistent with the rapid expansion of EU funding in response to the COVID-19 pandemic and its subsequent recovery and resilience phases. Density plots show a strong right skew, with a small number of towns experiencing high spillover exposure and most towns experiencing minimal exposure. Because spillover exposure is concentrated in a small number of towns and exhibits a long upper tail, logarithmic transformations are required to obtain interpretable visualizations and stable statistical estimates.

The spatial lag scatter plots reveal the association between local project initiations and lagged spillover exposure. Although some towns have no local project initiations at all, they vary widely in terms of spillover exposure; this variation is largely due to their proximity to other towns which have many projects being initiated. After accounting for extreme outliers in the data set, the fitted regression line indicates no significant evidence of a positive linear association between local project initiations and spillover exposure. These findings suggest that spillover exposure is driven by spatially related administrative and organizational factors rather than local project activity alone.

Time series profiles of specific towns further demonstrate variability in spillover dynamics. Sofia's time series profile demonstrates moderately-stable spillover exposure over time, although it has experienced extremely-high levels of local project initiations. This pattern of spillover exposure may be an indication of the "dampening" effect of spatial weighting. Conversely, Plovdiv and Varna have demonstrated large, spike-like increases in spillover exposure, especially when the number of funds available was at its highest, and then subsequent

declines. The time series patterns of smaller regional centers, such as Ruse and Burgas, have been highly variable; however, the patterns are more likely the result of changes in neighboring towns' spillover exposure, rather than changes in local project initiations. Overall, the observed patterns indicate that spillovers reflect exposure to nearby administrative/organizational activities, rather than simply the geographic location of funded projects.

A heatmap of spillover exposure for the top 40 towns by cumulative exposure, reveals substantial temporal persistence in spillover exposure, with several towns consistently exhibiting high levels of spillover exposure across multiple years. It is also notable that many of these towns are not among the largest urban centers in Bulgaria, which supports the notion that spillover exposure represents regional clustering of beneficiaries and managing authorities, rather than simply the size of a population or economic output. An immediate increase in spillover exposure observed in virtually all of the high-exposure towns in 2020 further supports the hypothesis that the observed increase in spillover exposure in the aftermath of the COVID-19 pandemic represents a systemic increase in EU funding flows, rather than discrete local increases.

The spatial indicators generated in this study are designed to capture the institutional exposure to EU funding flows, including learning effects, administrative spillovers, project management capacity and inter-organizational network effects. It is essential to distinguish between the administrative concentration of funding and the physical placement of infrastructure and therefore the data collected and analyzed in this study are more suited to examining policy diffusion, institutional capacity building and funding ecosystem dynamics, rather than localized treatment effects in the strictest sense.

Additionally, this study provides a completely replicable R-based workflow for creating town-year panels, generating spatial weights, and estimating lagged spillover indicators. The final dataset and codebase provide a flexible foundation for conducting downstream causal analyses, including fixed-effect regressions, event-study designs and spatial econometric models. As an illustration of this flexibility, the study demonstrates how spillover exposure can be decomposed by beneficiary type (public vs. private), enabling researchers to examine whether public and private EU funded projects exhibit distinct spatial diffusion patterns.

In general, this study contributes to the literature on regional science and EU cohesion policy by providing a comprehensive and harmonized town-level panel of EU funded project

activity in Bulgaria, establishing a systematic way to estimate spatial spillover exposure, and establishing the correct interpretation of spillovers when geographic data are based on the legal addresses of the beneficiaries of EU funding rather than the physical locations of the projects. The dataset and diagnostic tools presented in this study provide an essential empirical basis for future studies of the territorial dynamics of EU funding, the spatial organization of administrative capacity and the institutional effects of cohesion policy across regions.