In recent decades, the European Union (EU) has established itself as one of the world's most advanced and coordinated innovation hubs, reflecting a strong commitment to leveraging new technologies to maintain global competitiveness. The EU's success is built upon a dual focus: promoting cutting-edge science while simultaneously bridging regional divides through inclusive growth. Significant policy instruments, such as Horizon Europe and Smart Specialisation Strategies (S3), have been instrumental in customizing innovation support to leverage regional comparative advantages. However, the world in which European businesses operate has become increasingly unstable due to external forces like China's Belt and Road Initiative (BRI). Launched in 2013, the BRI is a state-led global strategy that reconfigures trade routes and technology flows, introducing new uncertainties and competitive pressures for EU firms. This study examines the impact of the BRI on the European innovation ecosystem by utilizing firm-level data from the Community Innovation Survey (CIS) across 12 countries for the 2012–2018 period.

The empirical core of this study relies on firm-level responses from the CIS provided by Eurostat. The final sample focuses on 12 countries that provided consistent data across all survey periods, ensuring the availability of fundamental variables. This geographic selection is strategically significant; most of the sampled nations are members of the "Cooperation between China and Central and Eastern European Countries" (CEEC) Initiative, providing a direct lens into the regions most targeted by Chinese investment and business enhancement efforts. The dataset includes a robust representation of the "17+1" format, alongside major innovators like Germany and maritime hubs like Spain and Portugal, the latter of which are crucial for capturing the impacts of shifting marine transportation costs. By analyzing data from 2014 onwards, the study captures the evolving repercussions of the BRI following its 2013 announcement, mapping how trade cost declines influence R&D expenditure and productivity.

To rigorously evaluate the causal relationship between BRI-induced changes and firm performance, the study addresses the endogenous nature of innovation and export dynamics by constructing an instrumental variable: "Expected Export Volume Changes" (EEVC). Following the methodology of Aghion et al. (2018), the EEVC represents a localized exogenous demand shock. It is calculated by aggregating the expected increase in imports within the destination markets of the sample countries—driven by a reduction in trade costs—while strictly excluding the imports originating from the sample country itself. This ensures the shock is viewed as an external increase in customer demand that cannot be attributed to the domestic producers' own actions.

The construction of the EEVC dataset involves a multi-step integration of three primary sources: CEPII's BACI trade data for 2011, the World Bank's BRI Global Database for sectoral trade cost reductions, and the CIS survey. By calculating the trade volume response to a hypothetical decline in costs and weighting these shocks by the destination market's share in a country's total sectoral exports, the study creates a robust proxy for

the BRI's impact. While these figures were considered for every stage of the MMK model, they are primarily utilized in the initial stage—R&D propensity and expenditure—where they yield the most statistically robust results. This analysis focuses exclusively on the trade of goods, as service sectors exhibit distinct dynamics that fall outside the scope of traditional infrastructure-led trade cost models.

The research is grounded in the Mairesse-Mohnen-Kremp (MMK) framework, an extension of the classic CDM model. This framework structures the relationship between innovation inputs, outputs, and productivity as a sequential chain. A primary methodological contribution of this work is the pioneering integration of spatial dependence into every stage of the MMK structure. To estimate the latent variables within this framework that may not be directly observed due to selection and sample selection biases, this study employs the Heckman selection procedure. While many prior investigations in this field rely on generalized Tobit models, this research prefers the Heckman approach because it allows for a clear differentiation between the selection equation and the outcome equation. This distinction is vital for accurately incorporating the impact of BRI-led trade costs on a firm's initial decision to engage in innovation, a level of detail that Tobit models cannot explicitly provide.

The Heckman procedure recognizes that firms may deliberately omit reporting innovative activities, creating a selection bias that is not merely the result of data censoring. By estimating the probability of a firm being "selected" into the innovative category, the model accounts for these unobserved values. This study specifically utilizes the Heckman two-step procedure rather than Maximum Likelihood Estimation (MLE). This choice is driven by the method's resilience against the non-normality of dependent variables and its superior efficiency with large datasets. Given that the sample sizes in this study consistently exceed 5,000 observations per model, the two-step method effectively avoids the convergence issues often encountered in MLE. To ensure the integrity of the results, potential biases are checked via bootstrapping.

The two-step estimation process begins with a probit model to calculate the Inverse Mills Ratio (IMR). This ratio represents the expected value of the error term in the main equation, essentially serving as a correction factor for the non-zero mean of errors in a non-randomly selected sample. In the second step, the study extends the Heckman procedure by integrating spatial dependence directly into the outcome equation. To achieve this, the study adopts the Generalized Nesting Spatial Model (GNSM), which is the most comprehensive spatial specification available. By utilizing the GNSM, the research simultaneously accounts for spatial lags in the dependent variable, the independent variables, and the error terms. This holistic approach ensures that no hidden spatial dynamics—whether they arise from peer behavior, external shocks, or unobserved regional factors—are neglected.

Integrating these spatial components into the Heckman framework involved specific technical choices to ensure model convergence. Due to the computational complexity of estimating spatial effects with discrete variables, spatial dependence was applied specifically to the second-stage OLS regression, where the IMR from the first stage serves as an explanatory variable to correct for selection bias. To maintain analytical continuity across the three distinct CIS survey waves, the GNSM was applied consistently, even as changes in questionnaire structures required adjustments to the explanatory variables. A focal point of this spatial analysis is the inclusion of spatial lags for the interaction terms between BRI-led trade effects and a firm's market orientation. This allows the study to capture how the combined influence of geopolitical shifts and market focus ripples through geographical and economic neighborhoods.

The empirical findings regarding these spatial dimensions are particularly striking, revealing that the BRI acts as a disruptive force that can invert the traditional benefits of proximity. The analysis confirms the existence of spatial autocorrelation, indicating that the behaviors of nearby firms significantly influence innovation activities. By constructing spatial weight matrices based on both geographical and economic proximity—derived from Eurostat's Figaro input-output tables—the analysis quantifies how the innovative decisions of a focal firm are influenced by the BRI exposure of its "neighbors." In the initial blocks of the MMK framework, the results show that the BRI increases R&D expenditures for domestically oriented firms but decreases their overall tendency to engage in R&D, suggesting an "eliminative effect" where weaker firms withdraw from innovation. Crucially, as a focal firm becomes more proximate to peers oriented toward EU-EFTA or global markets, its own R&D expenditure declines, turning internationally oriented neighbors into a liability under the BRI-induced realignment.

The spatial models consistently outperform non-spatial ones, proving that local and networked interdependencies are critical. In the second block of the model, focusing on turnover from innovative sales, the disruptive capacity of the BRI is underscored by significant sign reversals in spatial coefficients. While pre-BRI models show that proximity to globally oriented firms is positively correlated with innovation output, this relationship is frequently weakened or reversed post-BRI. This implies that the BRI fundamentally alters the nature of innovation spillovers within the EU, potentially fragmenting knowledge-sharing networks previously aligned by common regulatory standards and programs like Horizon Europe. As alternative global markets capture the attention of proximate firms, the effort invested in local knowledge spillovers may be diverted, disrupting the strategic alignment of European firms.

These results carry substantial policy implications for the EU, challenging the assumption that economic integration and regional clustering automatically support innovation under all conditions. They suggest that innovation policy must be redesigned to account for geopolitical realities and global interdependencies. Regional innovation strategies, such

as S3, should no longer be based solely on internal capabilities but must assess the orientation of firm networks and their ability to respond to changing global dynamics. Funding mechanisms should be re-designed to ensure firms feel insured against the effects of global shocks, and policy frameworks should support firms in adapting to exogenous pressures on their innovation capacities.

Furthermore, the research underscores the necessity of an adaptive and outward-looking innovation policy that combines resilience planning with regional development efforts. Identifying systemic vulnerabilities in supply chains and knowledge flows is crucial for solidifying the EU's innovation ecosystem. The findings reinforce warnings raised in recent strategic assessments, including the Draghi Report (2024), which stresses the need to address fragmentation within the EU single market. Without greater coherence and strategic coordination, the EU risks becoming more vulnerable to external shocks and less capable of defending its position in the global innovation hierarchy. The BRI does not merely reshape infrastructure; it reconfigures the foundations of innovation by altering who collaborates, competes, and survives. Recognizing and adapting to these realities is essential for sustaining Europe's competitive edge in the decades to come.