Sovereign Credit Risk Among Belt Road Initiative Countries and Its Impact on Financing Decisions

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Abstract

In an increasingly interconnected global economy, sovereign credit risk has become a vital factor influencing financial stability and macroeconomic resilience. How sovereign risk propagates across sectors and countries constitutes an important research question. This research examines the dynamics of sovereign credit risk among Belt and Road Initiative (BRI) countries using credit default swap (CDS) data from 2010 to 2021. Through three empirical studies, this work addresses the main drivers of sovereign risk, focusing on sustainable development, economic integration, and geopolitical influences in shaping risk transmission and financial resilience.

The first study investigates the impact of environmental, social, and governance (ESG) factors on sovereign credit risk connectedness. It reveals that BRI countries with stronger environmental performance exhibit lower risk exposure to other nations within the interconnected sovereign CDS network. Bilateral trade and foreign direct investment (FDI) are also identified as key channels through which risk is transmitted, with geographical distance emerging as a dominant explanatory factor in shaping sovereign risk spillovers within the context of BRI. These findings emphasize the significance of ESG strategies not only for sustainable development but also for enhancing the resilience of financial systems to external shocks. Policymakers are encouraged to value the ESG factors in policy design to manage debt vulnerability better and facilitate

long-term financial stability.

The second study employs a time-varying-network-model to investigate the causal impact of joining the BRI on the risk transmission between China and BRI member countries. This study finds increased risk spillovers from China to BRI countries post-BRI-membership, with foreign direct investment and Chinese exports identified as key channels. These findings underscore the need for effective policy measures to manage sovereign risk and balance the economic benefits and financial vulnerabilities associated with BRI participation. This study contributes to the growing literature on the economic and financial effects of the BRI by providing empirical evidence of sovereign credit risk dynamics within the network. It emphasizes the importance of sovereign risk networks as a critical metric for assessing economic interconnectedness and exposure to risks among BRI countries as they deepen their cooperation with China.

The third study explores the impact of geopolitical tensions, the U.S.-China trade war, on the sovereign risk dynamics within the BRI network. The study reveals a system-wide trend of decentralization in sovereign risk connectedness among BRI countries. However, this decentralization is disrupted when geopolitical competition between China and the United States intensifies. The increased economic conflicts between these two major nodes in the network leads to more significant risk spillovers between China and BRI countries. This feedback loop illustrates how geopolitical conflicts can exacerbate sovereign risk transmission, creating a two-way risk contagion channel that reshapes the financial risk network structure. The main results imply greater financial integration may also increase the risk of adverse contagion in the event of a large negative shock. This paper highlights the growing importance of geopolitical risk management in ensuring financial stability, particularly for economies heavily concentrated on major trade and investment partners.

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Chapter 1

Introduction

1.1 Background

In the increasingly interconnected global economy, sovereign credit risk has become a critical determinant of financial stability and macroeconomic resilience. The global financial system operates as a complex network where countries and financial institutions are interconnected through trade, investment, and various regional cooperation. The structural characteristics of these networks profoundly shape the dynamics of risk transmission. Evidence from network theory highlights that centralized and asymmetrical financial networks are more susceptible to cascading effects during crises (Acemoglu et al., 2012). The shocks originating in systemically important nodes, such as nations with extensive trade linkages or financial entities deeply embedded in global capital flows, would propagate widely and destabilize peripheral economies in the interconnected global financial networks (Acemoglu et al., 2016; Allen and Babus, 2009; Elliott et al., 2014). This interconnectedness has exacerbated the significance of monitoring systemic vulnerabilities, as small disruptions can amplify large-scale risks and cause substantial contagion effects.

Economic globalization promotes financial integration by strengthening the trade and financial channels (Stiglitz, 2010). Meanwhile, it causes the transmission of credit risks among countries as financial markets become increasingly interconnected (Ballester et al., 2019). It shows that occurrences within a single economy are likely to induce cascade effects through financial networks. This background highlights the vulnerability that a particular country may experience as a consequence of the financial distress experienced by another nation. The Belt and Road Initiative (BRI) launched by China in 2013 is a representative measure of economic globalization. The BRI involves over 140 countries and aims at enhancing economic connectivity and cooperation across Asia, Europe, and Africa (Chen and Lin, 2020; Baniya et al., 2020). It has transformed the network of international trade, investment, and regional collaboration, significantly impacting the BRI member countries.

Sovereign credit risk reflects the likelihood of a country defaulting on debt obligations, which can trigger significant disruptions in domestic and international financial markets. Historical crises, such as the 2008 global financial crisis and the 2010–2012 European sovereign debt crisis, have demonstrated how the interconnectedness of sovereign risk can lead to cascading failures across countries and sectors (Diebold and Yılmaz, 2014; Alter and Beyer, 2014; Ballester et al., 2019). These crises revealed the importance of understanding risk transmission mechanisms and the structural vulnerabilities of sovereign risk networks. Despite its critical importance, most studies on sovereign risk networks focus on developed economies. Recently, emerging markets have played an increasingly significant role in global economic growth and financial integration (Bostanci and Yilmaz, 2020; Hilscher and Nosbusch, 2010). BRI countries, which include many low- and middle-income nations, operate under entirely different economic, financial, and institutional conditions. These countries tend to have higher debt burdens, weaker governance structures, and greater susceptibility to external shocks (Bandiera and Tsiropoulos, 2020). While the BRI presents significant opportunities for economic development, it also raises critical questions about the risks associated with deepening economic interconnectedness between China and BRI-participating countries.

1.2 Motivation and research questions

Literature treats network structure as exogenous (Acemoglu et al., 2015; Glasserman and Young, 2016; Nier et al., 2007) that is, remains stable when subjected to shocks, but this assumption becomes problematic if the network structure is endogenously influenced by the shocks it experiences. The BRI creates a unique setting to analyze how a policy shock reshapes the sovereign credit risk network. The structural changes in trade and investment patterns induced by the BRI may alter the dynamics of risk propagation across countries. However, existing literature neglects how policy-induced networks affect the pattern of risk spillover.

The BRI has been criticized for exacerbating debt vulnerabilities among BRI-participating countries. BRI is concentrated on infrastructural advancements, with a significant dependence on extensive debt financing. Research by Bandiera and Tsiropoulos (2020) highlights that many BRI countries have experienced rising debt-to-GDP ratios, leading to concerns about debt sustainability and rising vulnerability to financial distress. Hurley et al. (2019) finds that the average levels of private and public sector external debt in 35 BRI countries have markedly increased since the Initiative's launch in 2013, and 23 BRI countries have been identified as highly vulnerable to debt distress with

BRI-related financing. High debt burdens can heighten systemic risk within the sovereign risk network, particularly if a single node, China, acts as the primary creditor. Existing research lacks a comprehensive analysis of how these debt vulnerabilities influence the broader financial stability within the context of BRI network.

Furthermore, as environmental, social, and governance (ESG) factors become more prominent in the evaluation of sovereign credit risk (Pineau et al., 2022; Anand et al., 2023), countries that integrate sustainability into their economic development strategies are likely to benefit from lower borrowing costs and reduced financial risk. However, there is limited empirical evidence to address how governance and environmental risks amplify or mitigate the transmission of sovereign risk within the network. This issue is closely related to the financial network within the context of the BRI, where large-scale infrastructure investments raise concerns about environmental sustainability and long-term debt financing (Mengdi and Wang, 2021; Wong and Downes, 2024; Bandiera and Tsiropoulos, 2020).

This thesis addresses key gaps in the literature by providing critical insights into the evolving dynamics of sovereign risk networks within the BRI framework. The following three research questions are explored in the subsequent chapters: (i) How do country-specific factors, including ESG performance, influence the transmission of sovereign credit risk within the BRI network? (ii) Does participation in the BRI increase the spillover of sovereign risk between China and its BRI partners, and what are the mechanisms driving this transmission? (iii) What are the system-wide dynamics of the sovereign risk network among BRI countries, and does the trade tension between China and the U.S. alter the structure of this network?

1.3 Thesis structure

This thesis is structured across three studies addressing different aspects of sovereign credit risk networks within the BRI framework.

The first study examines the role of ESG factors in sovereign credit risk connectedness. It investigates how the sustainable performance of BRI countries affects their exposure to sovereign risk within the interconnected sovereign credit risk network. The findings demonstrate that BRI countries with stronger environmental performance exhibit lower risk exposure to other nations, highlighting the critical role of sustainability in mitigating risk spillovers and enhancing financial stability. Additionally, bilateral trade and foreign direct investment (FDI) are identified as significant channels of risk transmission, with geographical distance emerging as a dominant factor in shaping sovereign risk spillovers. This chapter underscores the importance of incorporating ESG factors in policy design to reduce debt vulnerability and promote long-term financial stability.

The second study utilizes a time-varying network model to explore the causal impact of BRI membership on risk transmission between China and BRI countries. The analysis reveals that BRI participation increases the risk spillover from China to BRI countries, with foreign direct investment and Chinese exports as key channels for this transmission. As BRI countries engage more closely with China through international trade and investment, they concentrate their economic links with China. The lack of diversification in trade and investment channels can make countries more susceptible to China's economic fluctuations, such as changes in export demand or shifts in economic policy. These findings highlight the importance for BRI countries to manage sovereign risk due to increasing economic integration and trade reliance on China.

The third study investigates the influence of geopolitical tensions, particularly the U.S.-China trade war, on sovereign risk dynamics within the BRI network. The study finds a system-wide decentralization trend in sovereign risk connectedness among BRI countries, exacerbated by escalating geopolitical competition between China and the U.S. It finds that the economic distance can be shortened through new trade routes, which enhance the accessibility of local information and encourage global competition. The economic decoupling between China and the U.S. results in greater risk spillovers, highlighting how geopolitical conflicts can exacerbate sovereign risk transmission. This chapter confirms China's role in influencing global risk dynamics and the economic distance—decentralization link associated with the dynamics of sovereign risk networks. The main findings emphasize the growing importance of geopolitical risk management in ensuring financial stability, particularly for countries heavily reliant on major trade and investment partners.

Each study in this thesis contributes to the understanding of sovereign risk transmission within the BRI framework. The main findings offer insights into the influence of non-financial factors, including sustainable performance, economic integration, and geopolitical competition, on shaping financial stability and economic resilience.

1.4 Contribution of the thesis

By adopting the methodology outlined in Diebold and Yılmaz (2014) and using sovereign credit default swaps (CDS) as a proxy for sovereign credit risk, this research examines the time-varying patterns of sovereign CDS networks from 2010 to 2021. The Difference-in-Differences (DiD) approach is a critical tool to assess how policy-induced economic integration through the BRI contributes to the growing interconnectedness of financial networks. This methodology also provides empirical evidence on the causal impact of the BRI on risk spillovers, identifying key transmission channels such as international trade and investment. Furthermore, this study explores the role of sustainable performance, particularly ESG factors, in mitigating sovereign risk connectedness.

This research expands on the literature examining the relationship between network structure and shock transmission by offering empirical evidence on how a policy shock, the BRI, can lead to structural changes in the sovereign risk network. First, it contributes to the study of the determinants of sovereign credit risk by assessing the causal effect of BRI membership on sovereign risk spillovers. The findings show that trade and FDI with China are key channels for sovereign risk transmission, with China acting as a net risk transmitter to BRI countries. Second, it adds to the literature on the impact of ESG factors on sovereign credit risk. The main results confirm that country-level ESG performance plays a key role in mitigating risk spillovers, highlighting the broader implications of sustainability for financial stability. Third, this research extends the literature on evaluating the increased vulnerabilities of BRI countries to Chinese economic shocks during global trade tensions. The findings offer valuable policy insights for countries to understand the importance of geopolitical risk management as an integral component of financial stability strategies.

Chapter 2

The determinants of sovereign risk connectedness: Does ESG matter for sovereign risk connectedness?

[1]

[1] Declaration of original contribution: This chapter is based on original research conducted by the author. All contributions to data collection, analysis, and interpretation are the author's own. The content has been published: Zhao, P. (2025). The impact of ESG on sovereign risk spillover: evidence from belt and road countries. Applied Economics Letters, 1–5. https://doi.org/10.1080/13504851.2025.2486718.

2.1 Introduction

Sovereign credit risk is essential for assessing a country's economic stability in the global financial network. The interconnected nature of sovereign risks underscores the importance of addressing them constructively across borders and sectors, especially in the context of economic globalization (Tamakoshi and Hamori, 2013; Cuadros-Solas and Salvador Muñoz, 2021; Bratis et al., 2020). Understanding the factors that affect the connectedness of risks between countries has become a critical issue.

Previous research on sovereign credit risk connectedness highlighted the influence of global factors (Srivastava et al., 2016; Gilchrist et al., 2022) and the macroeconomic fundamentals in transmitting sovereign risks among countries (Debarsy et al., 2018; Bostanci and Yilmaz, 2020). The indirect effects of a change in the macroeconomic variables of a country can affect the sovereign CDS spreads of the neighboring countries through geographical distance, trade linkages and financial linkages (Kışla and Önder, 2018; Ismailescu and Kazemi, 2010; Bostanci and Yilmaz, 2020). Recently, a new stand of literature confirms the correlations between corporate sustainable performance and financial risk transmission across sectors and sovereigns (Wang et al., 2024; Bax et al., 2024), as environmental concerns and geopolitical issues become pressing worldwide.

Unlike prior studies focusing on firm-level ESG performance or sector-specific ESG impacts on financial stability, this paper examines the impact of sustainability on sovereign credit risk at the country level. While previous studies have focused on the European or Arab region, this study examines the sovereign-level ESG in BRI countries that have diverse ESG practices that differ greatly by region and stage of development. This variation provides a valuable opportunity to explore how different aspects of ESG affect cross-border sovereign risk transmission in a way that has not been fully explored in previous literature.

This paper offers the first examination of sovereign credit risk connectedness determinants within the BRI context. In particular, the study focuses on the impact of country-level sustainable performance on sovereign credit risk connectedness. Given the diversity of economic fundamentals and political systems of the BRI countries, the vulnerability of one country may have significant connectedness effects on another. This paper provides a time-varying measure of pairwise sovereign risk connectedness using sovereign credit default swap (CDS) data from 2010 to 2021, estimating directional pairwise risk connectedness among 42 sovereigns through forecast error variance decomposition (FEVD) in a vector autoregressive (VAR) model.

The main findings confirm the substantial impact of BRI countries' sustainable performance on sovereign credit risk connectedness. In Particular, BRI countries with better environmental performance generate less connectedness to others and are less exposed to the risk of other countries in the interconnected sovereign CDS network. This paper also confirms that both bilateral trade and bilateral foreign direct investment(FDI) are key contributors to pairwise sovereign risk connectedness. A negative correlation was identified between bilateral distance and pairwise directional sovereign risk spillovers. Meanwhile, the indicator of distance provides better explanatory power than trade and investment variables. Overall, the principal results underscore the strength of environmental development and governance structure on a country's ability to manage its debt vulnerability. Therefore, countries are encouraged to develop effective ESG-related strategies to promote the financial system's resilience and economic development's sustainability. This study highlights the influence of non-financial determinants of sovereign risk connectedness in the global financial network, considering key sustainability themes at the sovereign level.

The rest of the paper is organized as follows: Section 2 specifies hypotheses development. Section 3 details the data used in our empirical analysis. Section 4 presents the methodology employed to construct directional sovereign risk connectedness measures and evaluate country-level ESG performance. Section 5 discusses the main empirical results, and Section 6 concludes with policy implications.

2.2 Hypotheses Development

ESG practices have been widely regarded as potential stabilizing factors for both firms and countries, potentially reducing their susceptibility to external economic shocks. Prior studies underscore the relevance of ESG in risk dynamics but focus mainly on corporate contexts. These findings, however, neglect sovereign-level ESG impacts in interconnected global risk networks. By integrating the network theory and contagion theory with ESG factors, this study could explore how governance, environmental policies, and social stability in one country can mitigate or amplify sovereign risk spillovers to neighbouring countries.

This study is grounded in two theoretical frameworks. Network theory emphasizes the interconnectedness of financial systems and how structural linkages influence risk transmission across the financial networks (Allen and Babus, 2009). Financial contagion theory underscores how economic shocks originating in one country propagate across interconnected economies through multiple transmission channels (Allen and Gale, 2000). These theories suggest that countries with stronger ESG practices can mitigate cross-border risk transmission by enhancing systemic resilience.

Empirical evidence supports this theoretical foundation. At the corporate level, robust ESG performance is associated with reduced financial risk (Athari, 2024; Wang et al., 2024). Sovereign-level studies link climate vulnerabilities and governance instabilities to higher borrowing costs and debt distress (Bax et al., 2024). Naifar (2024) finds that environmental policy uncertainty exacerbates contagion risks, particularly in climate-vulnerable countries, while strong governance frameworks enhance institutional credibility and mitigate volatility (Chebbi et al., 2024). Gelpern et al. (2023) indicates that BRI financing amplifies debt vulnerabilities in BRI-participating countries and exposes participants to climate-related risks and socio-political instabilities (Wang, 2023). Given the financial interconnectedness and ESG heterogeneity among BRI countries, this paper proposes the following hypotheses:

H1: Sovereign ESG performance reduces sovereign risk spillovers within the BRI network.

H2: Enhanced environmental practices reduce sovereign risk spillovers.

H3: Improved social policies reduce sovereign risk spillovers.

H4: Stronger governance frameworks mitigate sovereign risk spillovers.

2.3 Data descriptions

The sovereign credit risk is proxied by the 5-year sovereign CDS spread data sourced from Markit. The full sample includes 42 sovereigns with continuous data from 2010 to 2021. The empirical analysis uses the log differences of CDS spreads because CDS spreads themselves have a unit root, but the hypothesis of a unit root is strongly rejected for the difference of log sovereign CDS spreads[2]. The sovereign CDS spread comprehensively mirrors factors such as interest rate variations and movements in the liquidity of sovereign debt prices. The CDS spreads provide a more accurate measure of credit risk than bond yields, which are also used in literature as a proxy for sovereign credit risk. Firstly, CDS contracts are standardized products with pre-specified and fully documented credit derivatives agreements (Augustin, 2018). In contrast, bond terms and conditions are heterogeneous and depend on various features, including maturity, issue amount and coupon structure. Secondly, CDS markets are typically less influenced by liquidity effects than bond markets. Longstaff et al. (2011) finds that a large proportion of bond spreads is related to measures of bond-specific liquidity such as bid-ask differentials. Thirdly, CDS spreads provide a timelier market-based indicator of credit risk, as empirical studies show that CDS markets lead bond markets in the price discovery process (Blanco et al., 2005).

Appendix B presents the summary statistics of country-specific macroeconomic factors used in the empirical analysis. Data are sourced from different online databases. First, the measurement of ESG performance in this study employs PIMCO's proprietary ESG scoring model to assign an ESG score to each sovereign. The World Bank sovereign ESG dataset provides a list of ESG indicators at the country level. Second, bilateral trade flows, a metric drawn from the IMF's Direction of Trade Statistics (DOTS). Third, bilateral investment flows are sourced from the IMF's Coordinated Portfolio Investment Survey (CPIS). Fourth, geopolitical distance is measured by the The 'Weighted Distance' metric is sourced from the GeoDist database and employs city-level data to encompass the spatial distribution of the population within each nation. Control variables include country-specific GDP, inflation, unemployment, cur-

[2]Table A.1 in Appendix shows unit root test results.

rent account balance, debt-to-GDP ratio, and political stability index, which are sourced from the World Bank Open Data.

2.4 Methodology

2.4.1 Estimation of pairwise sovereign risk connectedness

This study uses the connectedness index developed by Diebold and Yılmaz (2014), which is based on assessing the forecast error variance decomposition (FEVD) from a Vector Autoregression (VAR) model to obtain an estimate of the underlying network. This method provides a variance decomposition matrix that shows how the forecast error variance of each variable is explained by the shocks to all variables in the system. The matrix can be linked to a weighted directed network where each variable is a node, and the variance decomposition values represent the strength and direction of the edges between the nodes. One concern of using financial time series, especially at daily frequency, is the satisfaction of the orthogonality assumption. The generalized FEVD of VAR does not require a particular causal ordering among the variables. In comparison with other methods, the Cholesky VAR model relies on a recursive ordering of the variables. If the true causal relationships are not in line with the assumed ordering, the results will be problematic; the Granger Causality test does not quantify the contribution of each shock to forecast error; the Impulse Response Function (IRF) does not provide information on the relative importance of each shock, but only traces the dynamic effects after a shock.

The first step in implementing the method is estimating a covariance stationary N-variable VAR(p) model[3] as follows:

$$\mathbf{x}_t = \textstyle\sum_{l=1}^{p} \Phi_l \mathbf{x}_{t-l} + \varepsilon_t, \tag{2.1}$$

where $\mathbf{x}_t = (x_{1,t}, x_{2,t}, \cdots, x_{N,t})$ is a vector of log differences of SCDS spreads for N countries at time t. Φ_l is the $N \times N$ l-th autoregressive parameter matrix, in which ϕ_{ijl} represents the effect of the l-lagged value of variable j on the current value of variable i. $\varepsilon_t \sim (0, \Sigma)$ is a vector of independently and identically distributed disturbances. The coefficient matrices are derived from the corresponding moving-average representation

$$\mathbf{x}_t = \textstyle\sum_{l=0}^{\infty} A_l \varepsilon_{t-l}, \tag{2.2}$$

where

$$A_l = \Phi_1 A_{l-1} + \Phi_2 A_{l-2} + \cdots + \Phi_p A_{l-p}. \tag{2.3}$$

Note that A_0 is an identity matrix and A_l is a zero matrix for $l < 0$.

The generalized FEVD of equation (4.1) forms a weighted network that summarizes the pairwise connectedness among the elements of $\mathbf{x}_t$. The (i, j)th element of the H-step-ahead FEVD matrix is defined as:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \Sigma e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \Sigma A_h' e_i\right)} \tag{2.4}$$

where e_i is the selection vector with one as the ith element and zeros otherwise, A_h is h-step moving average coefficient matrix, Σ is the covariance matrix for the error vector ε and σ_{jj} is the standard deviation of the error term for the jth equation. Since the sum of the entries of each row in the variance decomposition

[3]Wooldridge test for residual autocorrelation in panel VAR model shows no first order autocorrelation (p-value=0.306).

matrix is not equal to 100, we apply the row-sum normalization to obtain:

$$\tilde{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N} \theta_{ij}(H)} \tag{2.5}$$

Hence, by construction, $\sum_{j=1}^{N} \tilde{\theta}_{ij}(H) = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H) = N$. Hence, the directional pairwise risk connectedness from country j to country i is measured by $\tilde{\theta}_{ij}(H)$.

2.4.2 Estimation method

Elastic Net is applied to estimate the VAR model. In estimating the VAR model, the number of parameters to be estimated increases quadratically with the number of countries included in the regression. We use the elastic net (EN) Estimation to address this issue, which nests together the Least Absolute Shrinkage and Selection Operator (LASSO) regression and Ridge regression. The LASSO regression introduces L1 penalty terms to the cost function, effectively shrinking coefficients to absolute zero if estimating them does not substantially reduce the in-sample prediction error. It is crucial to recognize that penalized VAR estimation with LASSO confronts the issue of introducing bias in Estimation due to the selection of penalty parameters, a process often guided by data-driven strategies such as cross-validation. Ridge regression incorporates L2 penalty terms into the cost function, pushing coefficients closer to zero (though not reaching zero) and minimizing their impact on the training data. The Elastic Net regularization technique combines both L1 (LASSO) and L2 (Ridge) penalties in the linear regression model (Zou and Hastie, 2005). This method simultaneously encourages sparsity (some coefficients are precisely zero) through the L1 penalty and handles multicollinearity by grouping correlated predictors through the L2 penalty. The EN-regularized estimator for variable i minimizes:

$$\hat{\Phi}_i^{\mathrm{EN}} = \arg\min_{\phi_{ijl}} \left(\sum_{t=p+1}^{T} \left(x_{i,t} - \sum_{l=1}^{p} \sum_{j=1}^{N} \phi_{ijl} x_{j,t-l} \right)^2 + \lambda \sum_{l=1}^{p} \sum_{j=1}^{N} \left[\alpha |\phi_{ijl}| + (1-\alpha) \phi_{ijl}^2 \right] \right) \quad (2.6)$$

The EN estimation has two tuning parameters, the shrinkage coefficient λ and selection coefficient $\alpha \in [0, 1]$. The estimator is equivalent to LASSO when $\alpha = 1$ and Ridge when $\alpha = 0$. Following Bostanci and Yilmaz (2020), this paper opts for a VAR model order of 3, indicating the number of lags of the endogenous variable included, and sets a 10-day forecast horizon. The tuning parameters in elastic net Estimation consist of α, which is fixed at 0.5, and the value of λ is determined through a 10-fold cross-validation procedure[4].

2.4.3 Country-level Sustainably Performance

This study utilizes thirty-seven ESG indicators available for full sample analysis, obtained from the World Bank Sovereign ESG Dataset as shown in Table B.3. Employing PIMCO's proprietary ESG scoring model, the aggregate ESG score is the average of three sub-pillar z-scores in a given year t for given sub-component indicators m of a pillar p. Firstly, for each sovereign i in year t, the z-score of each indicator m is

$$Z_{m,i,t} = \frac{X_{m,i,t} - \overline{X}_{m,t}}{\sigma_{m,t}} \quad (2.7)$$

$X_{m,i,t}$ is the raw score of each indicator for sovereign i in year t. $\overline{X}_{m,t}$ and $\sigma_{m,t}$ are the cross-sectional mean and standard deviation of $X_{m,i,t}$ for each ESG indicator respectively.

[4] Figures A.1 and A.2 in Appendix A display the results of the sensitivity analyses conducted on the VAR lag order selection and the tuning parameter α in the Elastic Net estimation, respectively. The findings demonstrate that variations in these parameters show limited influence on the connectedness index, confirming the robustness and stability of the estimation strategy.

Secondly, the equal weights are assigned to the z-scores of all underlying indicators $Z_{m,i,t}$ to obtain three ESG sub-pillar z-scores:

$$Z_{p,i,t} = \frac{\sum Z_{m,i,t}}{N_p} \tag{2.8}$$

The total number of indicators N_p for each ESG pillar p is 19 indicators for Environmental, 7 indicators for Social and 11 indicators for Governance. [5]

The aggregate ESG score $Z_{i,t}$ for each sovereign i in year t is the weighted average of three sub-pillar z-scores:

$$Z_{i,t} = \frac{\sum Z_{p,i,t}}{3} \tag{2.9}$$

2.5 Result and discussion

This section discusses the impact of four varieties of macroeconomic variables on the direction of pairwise risk connectedness. Panel data regressions over the full sample using the two-way fixed effects (TWFE) model take the following form:

$$\tilde{\theta}^H_{ij,t} = \beta_0 + \beta_1 Z_{i,t} + \beta_2 Z_{j,t} + \gamma_1 X_{i,t} + \gamma_2 X_{j,t} + \alpha_{i,j} + \tau_t + \varepsilon_{ij,t} \tag{2.10}$$

where $\tilde{\theta}^H_{ij}$ is average pairwise connectedness from country j to country i. The main regressor includes ESG scores[6], bilateral trade flows, bilateral investment

[5]details are presented in Appendix Table B.3.

[6]In analyzing ESG sub-pillars' effects, the aggregate ESG scores are substituted by three sub-pillars' scores $Z_{p,i,t}$ and $Z_{p,j,t}$.

flows and distance. $Z_{j,t}$ represents the proxy of regressors related to risk-transmitting country j and $Z_{i,t}$ for risk-receiving country i respectively[7]. $X_{i,t}$ and $X_{j,t}$ denote a set of control variables, including GDP, inflation, current account balance, unemployment, index of political stability, and government debt to GDP ratio. All data run at an annual frequency. All regressions control for the country pair fixed effects $\alpha_{i,j}$ and time fixed effects τ_t.

2.5.1 Impact of country's sustainable performances

The main results presented in Table 2.1 underscore the significant influences of ESG factors on pairwise risk connectedness. All model specifications consistently show negative correlations between ESG performance and pairwise sovereign risk connectedness.

Impact of Aggregate Sovereign ESG Practices

The aggregate ESG scores for risk-transmitting country j and risk-receiving country i negatively correlate with pairwise sovereign risk spillovers. A 1-unit increase in ESG scores significantly reduces pairwise risk spillovers by 0.8%, supporting hypothesis **H1**. This finding suggests that countries with stronger ESG practices are less prone to transmitting or absorbing financial risks within the BRI network. Sovereign-level ESG practices influence how financial risks propagate across borders since BRI countries with stronger ESG practices exhibit lower levels of risk contagion.

These findings align with network theory, which suggests that stronger ESG performance improves financial resilience by reducing systemic vulnera-

[7]In estimating the impact of distance, $Z_{j,t}$ and $Z_{i,t}$ are the same so only one variable included into the regression.

Table 2.1: Impact of ESG on sovereign risk connectedness

	TWFE(1)	TWFE(2)	TWFE(3)	TWFE(4)
ESG_j	-0.008***	-0.009***		
	(0.002)	(0.002)		
ESG_i	-0.008***	-0.006***		
	(0.018)	(0.002)		
E_j			-0.010***	-0.010***
			(-0.001)	(0.001)
E_i			-0.003***	-0.003***
			(-0.001)	(0.001)
S_j			-0.002	-0.003
			(-0.002)	(0.002)
S_i			-0.003	-0.003
			(0.002)	(0.002)
G_j			0.001	-0.001
			(0.001)	(-0.001)
G_i			-0.003***	-0.002***
			(0.001)	(-0.001)
R-squared	0.005	0.002	0.008	0.004
Observation	11904	11904	11904	11904
Controls	No	Yes	No	Yes

Notes: This table demonstrates the effect of the sustainable performance of BRI participants on directional pairwise sovereign risk connectedness. It presents coefficient estimates β_1 and β_2 from equation (2.10) with the directional risk connectedness between country pairs as the outcome variable. Column (1) presents the effect of aggregate ESG performance, controlling for country pair-fixed effects and year-fixed effects; column (2) adds control variables, including GDP, Inflation, Debt-to-GDP ratio, Current account balance, Unemployment and the Index of Political Stability; column (3) presents the impact of individual pillar's effect by substituting aggregate ESG scores with three pillars' scores; column (4) adds control variables including GDP, Inflation, Debt-to-GDP ratio, Current account balance, Unemployment and the Index of Political Stability. The appendix Table B.1 shows a detailed description of the control variables. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.

bilities within the interconnected BRI network. Moreover, financial contagion theory indicates that countries with weak ESG frameworks are more vulnerable to external shocks. Specifically, BRI countries with robust ESG practices tend to have more transparent financial systems, better governance structures, and more sustainable economic policies, all contributing to minimizing cross-border risk spillovers. These factors collectively contribute to a stable economic environment and a resilient financial system. This finding highlights the importance of ESG-related policies in mitigating pairwise risk spillovers and reducing exposure to sovereign risk within interconnected financial networks.

Impact of Sovereign ESG Pillars

Environmental factors exert the most substantial influence on pairwise sovereign risk spillovers among BRI countries, supporting the hypothesis **H2**. Risk-transmitting countries with weak environmental policies and high carbon dependency are more likely to amplify financial instability, propagating through interconnected financial networks. These results imply that environmental sustainability is crucial in reducing sovereign risk spillovers. Countries with strong environmental policies exhibit lower risk transmission, likely due to improved investor confidence and reduced exposure to climate-related economic disruptions. Therefore, preventing risk generation at the source is more effective than mitigating risks at the destination within interconnected financial networks.

Governance factors significantly reduce risk spillovers in risk-receiving countries, supporting hypothesis **H4**. This finding is consistent with existing literature, suggesting that strong governance structures, including transparency, regulatory quality, and institutional effectiveness, mitigate the likelihood of sovereign risk contagion. BRI countries with weak institutions and high levels of corruption are vulnerable to risk spillovers. This finding also underscores the importance of strengthening governance structures to improve financial stability and risk management, particularly because many BRI participants are developing nations with high vulnerability to financial distress.

Social factors show negative but statistically insignificant effects on sovereign risk spillovers. While improvements in social policies are expected to reduce risk transmission, empirical results suggest that their impact is weaker than that of environmental and governance factors. One possible explanation is that social factors take longer to influence financial markets, as their effects are more structural and less immediately observable in sovereign credit markets. BRI projects focus on infrastructure and resource extraction, which are more directly influenced by environmental and geopolitical risks, making social factors less influential in the short term. Additionally, limited data availability on social indicators may contribute to the weaker statistical significance observed in this study.

Robustness Checks

To validate the main findings, Table 2.2 presents regression results of robustness checks. The consistency across specifications underscores the reliability of the relationship between country-level ESG performance and sovereign risk spillovers. First, country fixed effects were replaced by BRI-expansion-group fixed effects to control the potential unobserved heterogeneity arising from cluster effects of countries joining the BRI at the same time. For instance, countries joining the BRI simultaneously may experience similar external shocks, regulatory harmonization or geopolitical alignment, which could cluster their risk transmission patterns. The stability of coefficients in column (1) confirms the statistical robustness of sovereign-level ESG performance as a determinant of reduced risk spillovers. Second, the connectedness methodology employed in the analysis is sensitive to the selection of tuning parameters. Therefore, the order of the VAR model is set to two or four lags to assess the robustness of the results. The consistent significance of coefficients across lag specifications (3) to (6) suggest that ESG practices in BRI countries exhibit a persistent influence on bilateral risk spillovers.

Table 2.2: Robustness checks

	TWFE(1)	TWFE(2)	TWFE(3)	TWFE(4)	TWFE(5)	TWFE(6)
ESG_j	-0.009***		-0.008***		-0.008***	
	(0.002)		(0.002)		(0.002)	
ESG_i	-0.006***		-0.008***		-0.006***	
	(0.002)		(0.002)		(0.002)	
E_ j		-0.010***		-0.009***		-0.009***
		(-0.001)		(-0.001)		(-0.001)
E_ i		-0.002***		-0.002***		-0.002***
		(-0.001)		(-0.001)		(-0.001)
S-j		-0.003		-0.002		-0.002
		(0.003)		(0.003)		(0.003)
S-i		-0.003		-0.001		-0.001
		(-0.002)		(-0.002)		(-0.002)
G_ j		-0.001		-0.003		-0.003
		(-0.001)		(-0.002)		(-0.002)
G_ i		-0.002***		-0.002***		-0.002***
		(-0.001)		(-0.001)		(-0.001)
Country fixed effects			Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
BRI-expansion-group fixed effects	Yes	Yes				
Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.03	0.004	0.002	0.002	0.002	0.002
Observation	20664	20664	20664	20664	20664	20664

Notes: This table reports regression estimates from two robustness checks. It displays coefficients β_1 and β_2 derived from Equation (2.10), where the dependent variable measures directional risk connectedness between BRI country pairs. Columns (1) and (2) substitute country fixed effects in the baseline model with BRI-expansion-group fixed effects; columns (3)–(4) and (5)–(6) report results from estimating the VAR model under alternative lag specifications (2 lags and 4 lags, respectively). All models incorporate year fixed effects and the full set of control variables. Appendix Table B.1 shows a detailed description of the control variables. Standard errors in parentheses are clustered at the entity level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level. Table B.4 in the Appendix presents the Variance Inflation Factors (VIFs) for the main trade and investment variables. All statistics are below 3, with a mean VIF of 2.05, suggesting no significant multicollinearity concerns.

2.5.2 Impact of international trade and investment

Estimation results presented in Table 2.3 focus on evaluating the relative importance of trade and investment flows from source to destination countries. The effect of geographical distance on pairwise sovereign risk connectedness is also examined. The subsample regression contains 32 BRI countries from 2010 to 2021.

Stronger bilateral trade relationships between countries are associated with higher pairwise sovereign risk connectedness. Both imports and exports exhibit positive and highly significant coefficients across model specifications. This finding has profound implications for BRI countries, as many of them are the major exporters of an increasingly integrated global economy. The larger volume of trade flows between BRI countries could expose them to more significant financial vulnerabilities within the highly interconnected sovereign risk network. Given that many BRI countries rely on specific trade routes and commodities, economic shocks from one country could amplify the risk of connectedness to their trading partners.

FDI significantly increases pairwise risk connectedness among BRI countries. The positive relationship between FDI and directional sovereign risk connectedness implies that countries receiving extensive investment are more exposed to financial risk connectedness from their investor countries. Since most BRI-related projects are infrastructural investments with the nature of long-term and capital-intensive, financial distress or policy change in the investor country could incur connectedness effects to the recipient country within the interconnected sovereign risk network.

The results estimated by model (6) in Table 2.3 show that the coefficient of FDI becomes insignificant, accounting for the impact of trade factors. This finding implies that the impact of FDI on risk connectedness might already be captured by trade variables since investments in infrastructure and manufacturing are mainly driven by the goal of fostering trade among BRI countries. This finding provides insights for policymakers that strategies to mitigate risk connectedness should focus more on trade policies and regional trade agreements, as they are the primary vehicle for sovereign risk connectedness within the BRI network.

Table 2.3: Impact of country-specific fundamentals on sovereign risk connectedness

	FE(1)	FE(2)	FE(3)	FE(4)	FE(5)	FE(6)
Import	0.129***	0.116***			0.056***	0.055***
	(0.019)	(0.019)			(0.02)	(0.02)
Export	0.202***	0.177***			0.105***	0.102***
	(0.018)	(0.019)			(0.018)	(0.019)
FDI		0.029***	0.058***	0.017***		0.008
		(0.006)	(0.006)	(0.006)		(0.006)
OFDI		0.008	0.043***	0.008		-0.002
		(0.006)	(0.006)	(0.006)		(0.006)
Distance				-0.125***	-0.193***	-0.192***
				(0.007)	(0.007)	(0.007)
ESG_ source				-0.594***	-0.533***	-0.527***
				(0.064)	(0.063)	(0.064)
ESG_ target				-0.269***	-0.183***	-0.190***
				(0.063)	(0.063)	(0.064)
R-squared	0.057	0.061	0.026	0.167	0.176	0.176
Observation	11904	11904	11904	11904	11904	11904
Controls	No	No	No	Yes	Yes	Yes

Notes: This table demonstrates the effect of the trade flows, investment flows and distance of BRI participants on directional pairwise sovereign risk connectedness. It presents coefficient estimates β_1 and β_2 from equation (2.10) with the directional risk connectedness between country pairs as the outcome variable. Columns (1)-(3) presents the effect of bilateral trade flows and investment flows, controlling for country pair-fixed effects and year-fixed effects; columns (4)-(6) adds distance, ESG scores and control variables, including GDP, Inflation, Debt-to-GDP ratio, Current account balance, Unemployment and the Index of Political Stability, controlling for country pair-fixed effects. Appendix Table B shows a detailed description of the control variables. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.

2.5.3 Impact of geographical distance

Geographic distance is identified as a main driver of pairwise sovereign risk connectedness among BRI countries. The negative correlations indicate that geographically neighboring countries tend to share more sovereign risk spillover from risk-transmitting countries. Meanwhile, the indicator of distance provides better explanatory power than trade and investment variables, as shown in columns (4)-(6) in Table 2.3. This finding suggests that bilateral and regional cooperation might foster the effect of distance on sovereign risk spillovers. Though geographical distance remains the same, 'economic distance' can be shortened through the BRI because it facilitates trade access and information dissemination among BRI-participating countries. Distance could be associated with unobservable factors influencing connectedness, such as shared bank holdings and aligned risk preferences, which could account for relatively high explanatory power in our regressions.

2.6 Conclusion and implication

This paper demonstrates that sovereign ESG performance significantly mitigates sovereign risk spillovers within BRI financial networks. Empirical findings highlight the crucial role of environmental and governance factors in shaping sovereign risk transmission dynamics. The dominance of environmental factors underscores the systemic risks posed by climate vulnerabilities and resource dependencies, reinforcing the need for sustainable economic policies. Bilateral trade and FDI emerge as key determinants of pairwise sovereign risk connectedness, with the influence of international trade outweighing that of FDI. Notably, exporters exhibit a stronger transmission of risk to importers within the BRI countries.

Given the ESG diversity among BRI countries, these findings underscore the importance of integrating ESG considerations into risk management strategies to enhance financial stability. Policymakers in BRI countries should strengthen environmental policies to reduce climate-related financial risks and improve governance structures to build financial resilience. Main findings also imply that trade concentration increases countries' exposure to macroeconomic shocks, suggesting the need for diversification in trade partnerships to mitigate systemic vulnerabilities. The significant effect of geographical distance also emphasizes the structural importance of spatial relationships in shaping sovereign risk dynamics.

Recent globalization has significantly increased global integration and fostered economic cooperation. However, this integration has also introduced new vulnerabilities through the transmission of systemic risks, and the implications of growing interdependence have been largely ignored. China has made agreements with over 70% of countries worldwide to start BRI-related projects since 2013 and reshaped global economic integration. The main findings in this paper provide insights into the financial vulnerabilities that arise from highly interconnected sovereign risk networks. Countries need to monitor and mitigate risk spillover by understanding the main driving forces of cross-border sovereign risk connectedness. However, the study is constrained by the lack of standardized sovereign ESG ratings, which introduces variability in scoring methodologies and limits cross-country comparability. Future research could expand the dataset to include a larger sample of countries and refine sovereign ESG measurement frameworks.

Chapter 3

What is China's role in transmitting sovereign risk?

[1]

[1]Declaration of original contribution: This chapter is based on original research conducted by the author and has not been published elsewhere in its current form. A version of this chapter has been submitted to Journal of Development Economics under the title "Sovereign Risk Spillovers: The Impact of the Belt and Road Initiative" (co-authored with Dr. Jingong Huang, Dr. Chaoyan Wang, Prof. Matthew-Greenwood Nimmo and Prof. Shujie Yao). The author's contributions to this chapter include data analysis, literature review, methodology design, writing and interpretation. All co-authors have reviewed and consented to the inclusion of this work in the thesis.

3.1 Introduction

How sovereign risk propagates across sectors and countries constitutes an important research question. The existing literature indicates that shocks traverse sectors and regions through production, trade, and financial networks (Huang and Liu, 2023; Ballester et al., 2019; Acemoglu et al., 2012, 2016; Chang et al., 2022; Shen and Abeysinghe, 2021; Kaminsky and Reinhart, 2002). A key insight from this literature is that network structures play a pivotal role in the dissemination of shocks. In this study, we leverage China's BRI as an experimental setting to examine how this policy shock changes the network of sovereign risk and to explore the underlying mechanisms driving this change.

Inaugurated in 2013, the BRI aims to foster economic integration through trade and investment spanning Asia, Europe, and Africa. The BRI primarily focuses on infrastructure development in BRI-participating countries, heavily relying on extensive debt financing, much of which is sourced from overseas.[2] Previous research suggests that as financial markets become increasingly integrated, credit risks can potentially be transmitted across countries (Stiglitz, 2010). This paper thus addresses the following research questions: (i) Does involvement in the BRI alter the sovereign risk network between China and BRI countries, thereby increasing the spillover of sovereign risk?; and (ii) if so, what mechanisms drive the transmission of sovereign risk spillover?

Our research questions hold significant importance for both academia and policymakers. The literature underscores the recurring nature of financial crises, which, while manifested in different forms, follow a similar pattern of contagion (Ballester et al., 2019). Since the 1990s, crises that were once localized have increasingly spread across global markets, as seen in the Mexican currency crisis,

[2] According to a World Bank report in 2016, the average levels of private and public sector external debt in 35 BRI countries have risen markedly since the launch of the BRI in 2013.

the Asian financial crisis, and the 2007-2009 global financial crisis originating in the U.S. Despite varying triggers, these crises similarly affected emerging markets by halting capital inflows and causing economic downturns, highlighting the interconnectedness of global financial systems. The BRI, a large-scale project driven by substantial debt financing and involving primarily emerging market economies, raises important questions about how sovereign risk may arise and evolve within this framework, an area where knowledge remains limited.

Following the methodology of Bostanci and Yilmaz (2020), we use sovereign credit default swap (CDS) spreads to measure sovereign credit risk. A CDS acts as an insurance contract, allowing a bondholder to transfer the bond's default risk to the seller in exchange for a premium over a specified period. The CDS market is widely regarded as a leading platform for credit risk price discovery, with the five-year tenor being one of the most liquid options available (Blanco et al., 2005). Accordingly, we utilize 5-year sovereign CDS spreads as our primary measure of sovereign credit risk. Our CDS data, sourced from Markit, spans the period from January 2010 to May 2021 and is available at a daily frequency for 66 countries.

We adopt the connectedness framework of Diebold and Yilmaz (2012) to compute the directional risk spillover index, leveraging the forecast error variance decomposition in a vector autoregressive (VAR) model. This method enables us to quantify both the direction and intensity of sovereign risk spillovers among countries while mitigating the issue of omitted variables that can affect networks derived from bivariate regressions. We analyze the shifts in bilateral risk spillovers between China and both BRI and non-BRI countries following the launch of the BRI. Our findings reveal that the sovereign risk networks between China and BRI countries, in both directions, have become more interconnected post-BRI.[3] Conversely, this pattern is not observed between China and non-BRI countries; in fact, the inward risk network, which captures spillovers from non-BRI countries to China, has decreased in density since the BRI's introduction. These results suggest a structural shift in the sovereign risk network among BRI countries, potentially driven by the BRI's implementation.

Next, we apply a staggered Difference-in-Difference (DiD) method to study the causal effect of joining the BRI on the transmission of sovereign risk between a country and China. We begin with an event-study approach to test the parallel trend assumption, which is a crucial prerequisite for our DiD analysis. Our findings show no pre-existing trend in either inward or outward risk spillovers before a country joined the BRI, thereby validating the use of the DiD method in our empirical analysis. Our main analysis uses a regression model with an indicator variable representing a country's participation in the BRI as the key independent variable. We find a positive and statistically significant average treatment effect on the outward risk spillover from China to other countries, even after controlling for various country-specific factors. Our results remain robust across different model specifications. Additionally, we find moderate evidence, depending on the model specification, that joining the BRI increases a country's sovereign risk spillover to China.

Finally, we perform an empirical analysis to investigate the mechanisms through which BRI affiliation affects risk contagion between China and BRI countries. We examine four potential channels: outward foreign direct investment (FDI) from China to a BRI country, inward FDI from a BRI country to China, exports from a BRI country to China, and imports by a BRI country from China. Our findings reveal a strong and statistically significant effect of China's investment in BRI countries and their imports from China. These re-

[3] BRI countries refer to countries that participated in BRI during specific periods in our data sample.

sults suggest that joining the BRI increases a country's exposure to sovereign risk spillovers from China, as heightened imports and investment from China intensify the transmission of sovereign risk.

Our research contributes to several strands of literature. Our paper is closely related to the literature that examines the relationship between the network structure and shock transmission.[4] Among them, Battiston et al. (2012) underscores the pivotal role of centrally located nodes in determining systemic risk. Elliott et al. (2014) develops a network model to identify systemically important nodes within financial networks, demonstrating that nodes with high centrality and interconnectedness contribute significantly to shock transmission and contagion propagation. Acemoglu et al. (2015) finds that the extent of financial contagion exhibits a phase transition, varying with the density of interconnectedness among financial institutions. Our paper complements these studies by providing empirical evidence of how a policy shock can lead to structural changes in the cross-country sovereign risk network. Our findings underscore the complex interactions between policy shocks and network structures, a dynamic often overlooked in existing literature.

Another strand of literature studies the transmission of sovereign credit risk between the financial sector and the sovereign sector and across countries (Diebold and Yilmaz, 2012; Galariotis et al., 2016; Alter and Beyer, 2014; Augustin et al., 2018; Gai and Kapadia, 2010; Greenwood-Nimmo et al., 2019; Bostanci and Yilmaz, 2020; Huang and Liu, 2023; Sun et al., 2020). Most of these studies restrict their attention to either OECD or European countries during periods of increased market uncertainty and economic downturns, such as the global financial crisis in 2008 and the European sovereign debt crisis around 2015. Our paper, instead, focuses on the participants of the BRI project, most

[4]See, for example, Acemoglu et al. (2012), Acemoglu et al. (2015), Acemoglu et al. (2016), Allen and Babus (2009), Battiston et al. (2012) and Elliott et al. (2014).

of which are developing countries located in Asia. This provides a unique empirical setting to investigate the dynamics of sovereign risk networks in developing countries and the key drivers behind the evolution of these networks.

Our paper is most closely related to the literature that seeks to identify the determinants of sovereign credit risk. Eyssell et al. (2013) study the determinants of sovereign CDS in China and find China's domestic economic factors and global factors were both relevant in explaining the CDS level and change. Longstaff et al. (2011) explore the nature of sovereign credit risk using sovereign CDS data, concluding that global factors account for the majority of sovereign credit risk. Similarly, Ang and Longstaff (2013) investigate this issue for the U.S. and major Eurozone countries, finding that systemic sovereign risk is closely linked to financial market variables. Blommestein et al. (2016) study the determinants of sovereign CDS spreads for five European countries following the collapse of Lehman Brothers, reinforcing the findings of Longstaff et al. (2011). Blommestein et al. (2016) find that global and European Monetary Union (EMU)-wide factors, are the predominant drivers of changes in the sovereign CDS spreads. Hilscher and Nosbusch (2010) focus on emerging market sovereign credit spreads, showing that the volatility of terms of trade has a significant effect on spreads. A similar conclusion is drawn by Bostanci and Yilmaz (2020), who find that bilateral trade and investment substantially contribute to sovereign CDS connectedness. Our paper builds on these studies by providing one of the first assessments of the causal effect of a policy shock on sovereign risk spillovers. Our findings underscore the role of the BRI in shaping the structure of the sovereign risk network between China and BRI-participating countries.

Our paper contributes to the growing literature assessing the economic impacts of the BRI on the financial stability and economic development of

BRI-participating countries. Recent studies have highlighted the significant role of infrastructure investment in expanding BRI transport networks (Chen and Lin, 2020; Baniya et al., 2020; De Soyres et al., 2020; Wong et al., 2021). For instance, Chen and Lin (2020) confirms the positive effect of BRI on cross-border investment for BRI-participating countries through transport network spillovers. Wong et al. (2021) highlights the advantages of the China-European Railway (CER) opening in promoting China's outward foreign direct investment by improving infrastructure connectivity. Similarly, Baniya et al. (2020) and De Soyres et al. (2020) focus on the trade effects of BRI, finding a notable increase in trade flows among BRI-participating countries. However, the net trade benefits are asymmetrically distributed due to varying infrastructure costs. Given the existing high levels of debt vulnerabilities in many BRI countries, these nations are likely to face increased debt pressures due to the substantial infrastructure costs in the medium term (Bandiera and Tsiropoulos, 2020). Furthermore, Bastos (2020) examines the impact of Chinese trade shocks on the cross-industry exports of BRI countries, noting that deeper economic integration with China could heighten their exposure to supply and demand shocks. Our paper is the first to assess the impact of the BRI on BRI-participating countries' sovereign credit risk, identifying both investment and trade as key channels of risk transmission. Our findings emphasize China's role as a risk transmitter to BRI participants and highlight two major channels of risk spillovers through the sovereign CDS network.

The rest of the paper is organized as follows: Section 2 details the methodology employed to construct measures of the sovereign risk spillover. Section 3 presents the empirical strategy and the data used in our empirical analysis. Section 4 discusses the main empirical results, and Section 5 concludes with policy implications.

3.2 Sovereign risk network

This section briefly discusses the empirical approach used in our paper to estimate the sovereign credit risk network, which features a general network structure with a directed and weighted edge. The direction of an edge captures the sovereign risk flows from one country to another, while the weight of an edge reflects the strength of risk spillover.

3.2.1 Connectedness index

The essence of our empirical strategy involves estimating a connectedness index that relates forecast error variance decompositions from vector autoregressions (VAR) to edge weights in networks (Diebold and Yılmaz (2014)). The first step in implementing the method is estimating a VAR(p) model[5] as follows:

$$\mathbf{x}_t = \textstyle\sum_{l=1}^{p} \Phi_l \mathbf{x}_{t-l} + \varepsilon_t, \tag{3.1}$$

where $\mathbf{x}_t = (x_{1,t}, x_{2,t}, \cdots, x_{N,t})$ is a vector of log differences[6] of sovereign CDS spreads for N countries at time t. Φ_l is the $N \times N$ l-th autoregressive parameter matrix, in which ϕ_{ijl} represents the effect of the l-lagged value of variable j on the current value of variable i. $\varepsilon_t \sim (0, \Sigma)$ is a vector of independently and identically distributed disturbances. The coefficient matrices are derived from the corresponding moving-average representation

$$\mathbf{x}_t = \textstyle\sum_{l=0}^{\infty} A_l \varepsilon_{t-l}, \tag{3.2}$$

[5] Wooldridge test for residual autocorrelation in panel VAR model shows no first order autocorrelation (p-value=0.754).

[6] The empirical analysis uses the log differences of CDS spreads because CDS spreads themselves have a unit root, but the hypothesis of a unit root is strongly rejected for the difference of log sovereign CDS spreads. Table A.1 in the Appendix shows unit root test results.

where

$$A_l = \Phi_1 A_{l-1} + \Phi_2 A_{l-2} + \cdots + \Phi_p A_{l-p}. \tag{3.3}$$

Note that A_0 is an identity matrix and A_l is a zero matrix for $l < 0$.

The generalized FEVD of equation (4.1) forms a weighted network that summarizes the pairwise connectedness among the elements of $\mathbf{x}_t$. The (i, j)th element of the H-step-ahead FEVD matrix is defined as:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \Sigma e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \Sigma A_h' e_i\right)} \tag{3.4}$$

where e_i is the selection vector with one as the ith element and zeros otherwise, A_h is h-step moving average coefficient matrix, Σ is the covariance matrix for the error vector ε and σ_{jj} is the standard deviation of the error term for the jth equation. Since the sum of the entries of each row in the variance decomposition matrix is not equal to 100, we apply the row-sum normalization to obtain:

$$\tilde{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N} \theta_{ij}(H)} \tag{3.5}$$

Hence, by construction, $\sum_{j=1}^{N} \tilde{\theta}_{ij}(H) = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H) = N$. Note that $\tilde{\theta}_{ij}(H)$. can be interpreted as the proportion of the H-step ahead forecast error variance (FEV) of variable i that is explained by shocks to variable j.

3.2.2 Estimation method

In the estimation of the VAR model, the number of parameters to be estimated increases quadratically with the number of countries included in the regression. We use the elastic net (EN) estimation to address this issue, which nests together the Least Absolute Shrinkage and Selection Operator (LASSO) regression and Ridge regression. The LASSO regression introduces L1 penalty terms to the cost function, effectively shrinking coefficients to absolute zero if estimating them does not substantially reduce the in-sample prediction error. It is crucial to recognize that penalized VAR estimation with LASSO confronts the issue of introducing bias in estimation due to the selection of penalty parameters, a process often guided by data-driven strategies such as cross-validation. Ridge regression incorporates L2 penalty terms into the cost function, pushing coefficients closer to zero (though not reaching zero) and minimizing their impact on the training data. The Elastic Net regularization technique combines both L1 (LASSO) and L2 (Ridge) penalties in the linear regression model (Zou and Hastie (2005)). This method simultaneously encourages sparsity (some coefficients are precisely zero) through the L1 penalty and handles multicollinearity by grouping correlated predictors through the L2 penalty. The EN-regularized estimator for variable i minimizes:

$$\hat{\Phi}_i^{\mathrm{EN}} = \arg\min_{\phi_{ijl}} \left(\sum_{t=p+1}^{T} \left(x_{i,t} - \sum_{l=1}^{p} \sum_{j=1}^{N} \phi_{ijl} x_{j,t-l} \right)^2 + \lambda \sum_{l=1}^{p} \sum_{j=1}^{N} \left[\alpha |\phi_{ijl}| + (1-\alpha) \phi_{ijl}^2 \right] \right) \tag{3.6}$$

The EN estimation has two tuning parameters, the shrinkage coefficient λ and selection coefficient $\alpha \in [0, 1]$. The estimator is equivalent to LASSO when $\alpha = 1$ and Ridge when $\alpha = 0$. Following Bostanci and Yilmaz (2020), this paper opts for a VAR model order of 3, indicating the number of lags of the endogenous variable included, and sets a 10-day forecast horizon. The tuning parameters in elastic net Estimation consist of α, which is fixed at 0.5, and the value of λ is determined through a 10-fold cross-validation procedure[7].

[7]Figures A.1 and A.2 in Appendix A display the results of the sensitivity analyses conducted on the VAR lag order selection and the tuning parameter α in the Elastic Net estimation, respectively. The findings demonstrate that variations in these parameters show limited influence on the connectedness index, confirming the robustness and stability of the estimation strategy.

3.2.3 Sovereign CDS Data

The backbone for our empirical analysis is the 5-year sovereign CDS spread, obtained from Markit. CDS spreads offer a precise measure of credit risk compared to other measures, such as bond yields. CDS contracts are standardized financial products with pre-defined and well-documented credit derivatives agreements. On the contrary, the terms and conditions of the bonds exhibit heterogeneity and depend on various features, such as maturity, issue amount, and coupon structure. In addition, CDS markets often lead bond markets in the price discovery process, providing a timely market-based indicator of credit risk.

In our sample, we include all BRI countries for which the sovereign CDS spreads data are available for the period between 2010 and 2021. This choice allows us to compare the change of sovereign credit risk networks due to countries joining the BRI. Also included in our sample are major economies in the world with available sovereign CDS spread data. In total, our dataset is composed of 30 BRI countries and 36 non-BRI countries. Table 3.1 provides summary statistics of the log difference of sovereign CDS spreads for all countries in our sample.

3.2.4 Risk network: BRI v.s. non-BRI

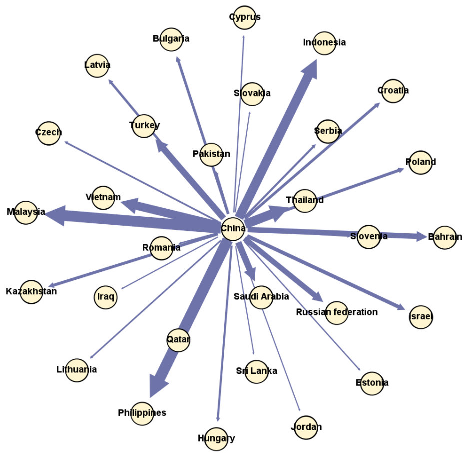
In this section, we present the results of our network analysis. The primary focus is to examine the structural change of the sovereign risk network centred around China. Specifically, we construct different sovereign risk networks that capture inward risk spillovers from other countries to China and outward risk spillovers from China to other countries using the GVD method discussed in

Table 3.1: Descriptive statistics of sovereign CDS by country

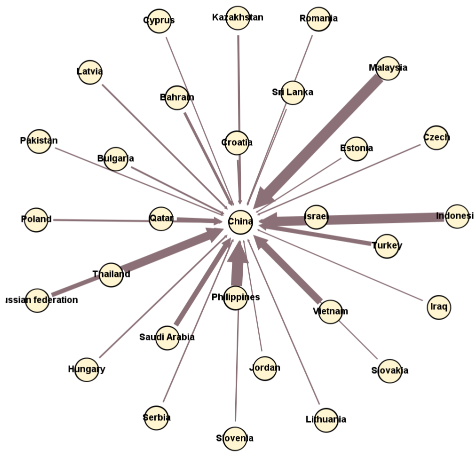
non-BRI country				BRI country			
	Mean	Median	StDev		Mean	Median	StDev
Austria	-5.161	-3.158	177.413	Bahrain	-0.791	-0.994	91.269
Belgium	-4.854	-1.397	164.273	Bulgaria	-1.371	-0.292	84.098
Brazil	-2.407	-4.070	200.695	China	-2.247	-5.798	127.120
Canada	-0.620	-0.012	125.005	Croatia	-1.292	-0.101	83.185
Chile	-0.446	-4.576	146.431	Cyprus	-2.615	-0.019	203.340
Colombia	0.288	-4.455	147.563	Czech	-0.930	-0.238	151.582
Costa Rica	1.033	-0.107	177.387	Estonia	-1.552	-0.156	71.893
Denmark	-0.915	-0.084	168.935	Hungary	-0.663	0.000	83.058
Dominican Republic	-1.917	-0.021	106.211	Indonesia	-0.627	-5.467	127.437
El Salvador	0.022	-0.039	95.240	Iraq	-1.839	0.003	72.956
Finland	-1.456	-0.226	167.762	Israel	1.630	-0.304	68.346
France	-3.346	-1.644	170.361	Jordan	-1.221	0.000	129.071
Germany	-3.415	-0.519	170.216	Kazakhstan	0.558	-0.171	97.659
Ghana	-1.377	0.000	145.875	Latvia	-2.236	-0.376	69.327
Guatemala	0.123	-0.014	119.728	Lithuania	-1.562	-0.048	69.125
Iceland	-2.558	-0.182	122.786	Malaysia	0.853	-6.281	131.460
Ireland	-5.060	-3.352	159.844	Pakistan	-1.536	0.058	99.412
Italy	-4.059	-2.977	194.054	Philippines	1.896	-6.618	124.096
Jamaica	-2.051	-0.001	113.926	Poland	-1.642	-0.551	94.943
Japan	-1.764	-3.044	137.564	Qatar	-3.532	-3.809	104.979
Korea	-1.981	-6.792	143.845	Romania	-0.548	-0.074	89.108
Mexico	-1.238	-3.733	153.132	Russian Federation	-1.654	-2.503	146.974
Morocco	-0.415	-0.027	77.490	Saudi Arabia	-0.939	-2.412	112.402
Netherlands	-1.954	-0.791	179.132	Serbia	-0.429	0.007	84.844
Norway	-3.123	-0.045	153.363	Slovakia	-1.697	-0.187	79.962
Panama	-1.709	-6.722	132.859	Slovenia	-1.693	-0.011	87.464
Peru	-0.740	-6.168	143.585	Sri Lanka	1.999	0.000	259.644
Portugal	-2.105	-5.415	185.591	Thailand	-0.979	-4.651	107.822
South Africa	-1.511	-1.621	127.173	Turkey	0.519	-1.439	122.206
Spain	-1.622	-5.929	201.877	Vietnam	-2.492	-4.041	78.486
Sweden	-4.015	-0.227	165.243				
Switzerland	-3.684	-0.246	132.938				
Trinidad and Tobago	-1.191	-0.005	182.802				
United Kingdom	-2.197	-0.515	158.211				
United States	-3.139	-0.075	463.670				
Uruguay	-0.749	-0.552	229.707				

Notes: This table summarizes the log difference of sovereign CDS spreads for all countries in two sub-samples. All statistics are reported in basis points.

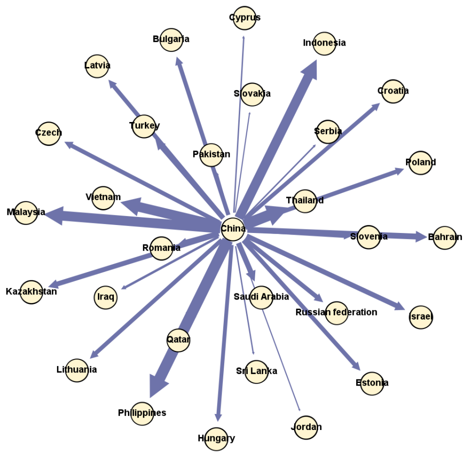
the previous section. We differentiate BRI countries from non-BRI countries in our sample and divide the period based on the announcement date of the BRI.



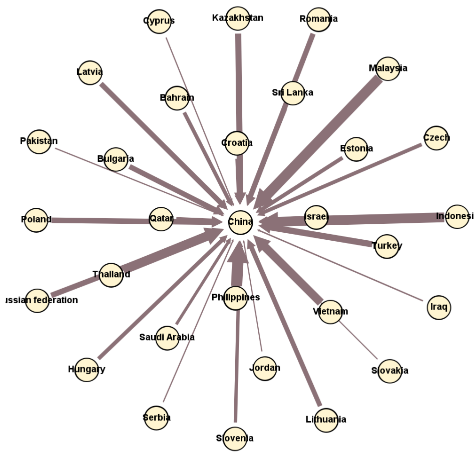
(a) Outward risk spillovers from China before BRI



(b) Inward risk spillovers to China before BRI



(c) Outward risk spillovers from China after BRI



(d) Inward risk spillovers to China after BRI

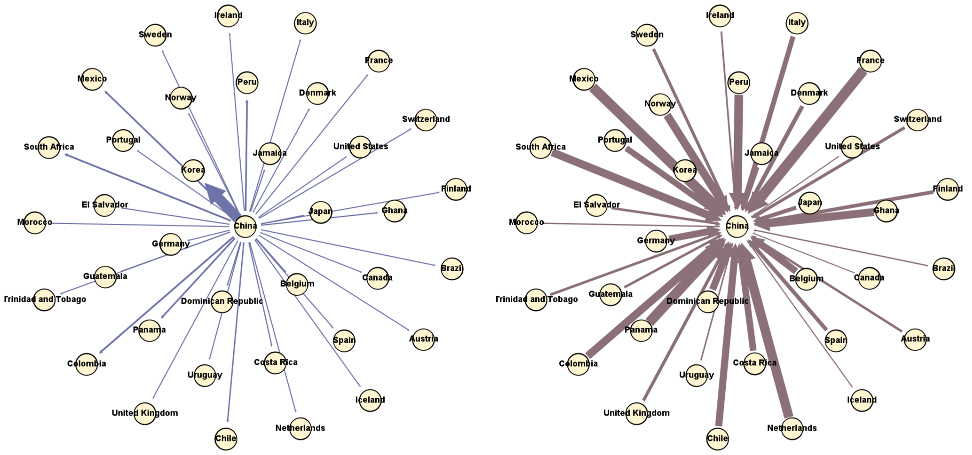
Figure 3.1: Sovereign risk spillovers between China and BRI countries, 2010-2021

Notes: Sovereign CDS Network of 30 BRI participants, 2010–2021. Table 1 presents the list of BRI countries. Panel (a) and (b) use data between 2010 and 2013, while panel (c) and (d) use data between 2014 and 2021. The edges show directional risk spillovers, and the thickness of an edge captures the strength of risk spillovers.

In Figure 3.1, we visualise the linkages for four sovereign credit risk networks. Panel (a) depicts the outward risk spillovers from China to other BRI countries before China announced the BRI project. In contrast, panel (b) shows the inward risk spillovers from BRI countries to China. An edge captures the risk spillover from one country to another. The thickness of an edge denotes the strength of the risk spillover. Prior to the announcement of BRI, China differed in risk spillovers it generated to and received from other countries. A comparison between panels (a) and (b) reveals that the network for inward risk spillovers to China is generally more sparse than its counterpart for outward risk spillovers originating from China, indicating China's role as a net risk transmitter among BRI countries.

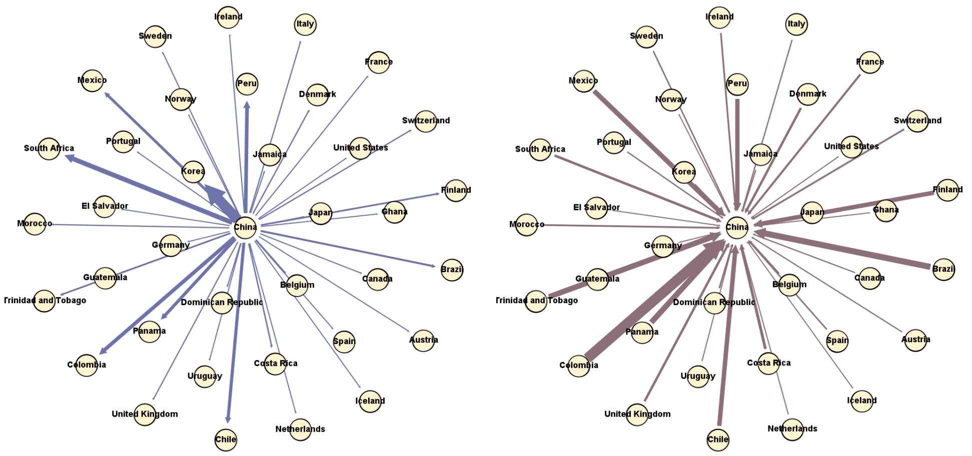
Panels (c) and (d) show the counterparts of panels (a) and (b) after the announcement of BRI. The introduction of the BRI noticeably changes the structure of the sovereign risk network. Both inward and outward risk spillover networks become denser over time due to the BRI. This is consistent with our expectation that the BRI project integrates regional economies and enhances China's role as a central player in this region.

Figure 3.2 contrasts with Figure 3.1, showing the sovereign risk networks between China and the selected sample of non-BRI countries between 2010 and 2021. An important insight derived from a comparison between the two figures highlights that the potential effects of the BRI on the structure of sovereign risk networks between China and BRI countries are unlikely to be driven by other time-correlated confounding factors. Relative to BRI countries, the outward risk spillovers from China to non-BRI countries remain limited throughout the period of examination. More interestingly, the inward risk spillovers from non-BRI countries to China decrease substantially after the announcement of BRI, indicating that no pre-existing trend common to both BRI and non-BRI countries before the announcement of the BRI drives the network dynamics of the two groups of economies.



(a) Outward risk spillovers from China before BRI

(b) Inward risk spillovers to China before BRI



(c) Outward risk spillovers from China after BRI

(d) Inward risk spillovers to China after BRI

Figure 3.2: Sovereign risk spillovers between China and non-BRI countries, 2010-2021

Notes: Notes: Sovereign CDS Network of 36 non-BRI participants, 2010-2021. Table 1 presents the list of non-BRI countries. Panel (a) and (b) use data between 2010 and 2013, while panel (c) and (d) use data between 2014 and 2021. The edges show directional risk spillovers, and the thickness of an edge captures the strength of risk spillovers.

3.3 Secondary regressions

3.3.1 Empirical strategy

This section constitutes the key part of our empirical analysis. We aim to provide causal evidence for the impact of becoming a BRI country on the structure of sovereign risk networks between China and the member countries of the BRI. For this purpose, we leverage the staggered participation of BRI countries in the years 2014 through 2019. Figure 3.2 shows a timeline mapping that highlights the timing in which different countries join the BRI[8]. Note that countries join the initiative in clusters, with the largest intake occurring in 2015. The identification strategy of our analysis relies on the quasi-experimental variation generated by the staggered participation of BRI countries using a generalized difference-in-differences approach. This strategy compares the before-after difference in risk spillover measures between countries that join the BRI and those that do not, between the two periods.

Table 3.2: Timeline of countries joining the BRI

2014	**2015**	**2016**	**2017**	**2018**	**2019**
Kazakhstan	Bulgaria	Latvia	Croatia	Bahrain	Cyprus
Sri Lanka	Czech	Saudi Arabia	Estonia	Indonesia	Qatar
	Hungary	Jordan	Lithuania	Philippines	
	Iraq		Malaysia		
	Israel		Pakistan		
	Poland		Slovenia		
	Romania		Thailand		
	Russian Federation		Viet Nam		
	Serbia				
	Slovakia				
	Turkey				

Notes: This table presents the year of the Memorandum of Understanding (MoU) related to the BRI for each partner country.

We estimate a two-way fixed effects model as our baseline specification as

[8] See details of the formal MoU framework for cooperation between China and partner countries on the State Council of the People's Republic of China and the Belt and Road Official Website.

follows:

$$Y_{i,g,t} = \beta_0 + \beta \times BRI_{g,t} + \gamma \times X_{i,t} + \alpha_g + \tau_t + \varepsilon_{i,g,t}, \tag{3.7}$$

where $Y_{i,g,t}$ is measures of risk spillovers estimated at time t for country i that belong to expansion group g. Two dependent variables are the focus of the empirical analysis here. The first is the risk spillover from China to other BRI countries, i.e. $\theta^H_{ij,t}$, where j is China and i is one of the countries that participate in the BRI; The second is the inward risk spillover from BRI countries to China, that is $\theta^H_{ji,t}$. Note that we fix j to be China; the dependent variable is thus only indexed by i.

The key independent variable for our analysis is $BRI_{g,t}$, which equals one if, in year t, country i belongs to the expansion country group g that joins the BRI and zero otherwise. We include in our regression a constant term β_0, a set of control variables $X_{i,t}$, which contain exports and imports, foreign direct investment (FDI), outward foreign direct investment (OFDI), GDP, inflation, government debt to GDP ratio, current account balance, the unemployment rate and an index of political stability. Lastly, α_g and τ_t denote expansion-group fixed effects and year fixed effects, respectively. In an alternative specification, we replace the expansion-group fixed effects with country-fixed effects to test the robustness of our results. We present summary statistics of our control variables in Table C.1.

The two-way fixed effects model specified in (3.7) allows us to rule out concerns that our results are driven by time-invariant differences across countries or global shocks that affect country-pair risk spillovers symmetrically over time. For example, countries that are geographically closer to China may find themselves subject to China's risk spillovers more easily. By including country-fixed effects, such concerns can be ruled out.

Under the assumption that, in the absence of the BRI, the sovereign risk connection between China and different expansion groups would have evolved along parallel trends, and assuming country-level average treatment effects are homogeneous across countries. Over time, the coefficient of interest β identifies the average treatment effect on the treated (ATT) of joining the BRI for a country on this country's risk connection with China. If participating in the BRI strengthens the risk spillover between a participant country and China, we expect β to be positive.

In the rest of our analysis, we present the empirical results for the outward risk spillover from China to other countries. Then, we analyze and compare the impact of joining the BRI on the inward risk spillover to China.

3.3.2 Risk spillovers from China to BRI countries

Before proceeding to the main results of our empirical analysis, we first test for parallel trends and study the dynamics of treatment effects. We estimate a dynamic version of the two-way fixed effects model specified previously with indicators for time distance to/from joining the BRI for individual countries as follows:

$$Y_{i,g,t} = \alpha_g + \tau_t + \beta_k \times \sum_{k=-4}^{2} D_{k(gt)} + \gamma \times X_{i,t} + \varepsilon_{i,g,t}, \tag{3.8}$$

where $D_{k(gt)}$ is a set of indicator variables that take the value of one if time t is k years away for expansion group g and zero otherwise. As in equation (3.7), we control for expansion group, time fixed effects, and a set of country-specific factors. To estimate the model, we treat the year before a country joined the BRI as the omitted category and compare them to other country-year observations.

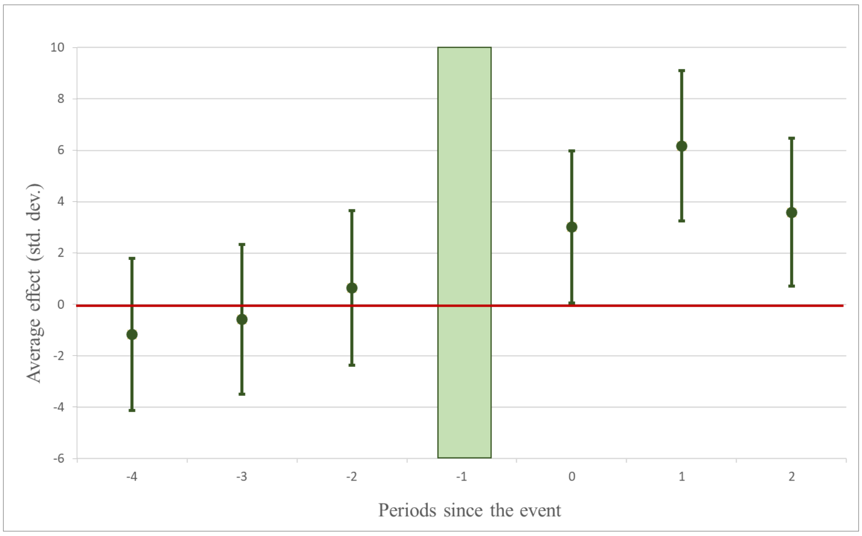


Figure 3.3: Dynamic analysis of BRI on China's outward credit risk spillover

Notes: This figure demonstrates the policy effect of participation in the BRI on China's outward risk spillover to BRI countries. It presents estimates of coefficient β_k from equation (3.8) with the risk spillover from China to other BRI countries as the outcome variable. The maximum number of pre-periods is four, and post-periods is two, displayed in this figure because the staggered participation of BRI countries started continuously from 2014 to 2019. Appendix Table A.1 shows a detailed description of the control variables. The bars represent 95% confidence intervals. Standard errors are clustered at the country level.

Figure 3.3 shows the estimates of indicator variables for the dynamic model in equation (3.8). Consistent with the assumption of parallel trends, all the coefficients on the year dummies prior to joining the BRI for a country are not statistically different from zero. In contrast, the coefficients on the year dummies post a country's participation in the BRI are all positive and statistically significant, confirming the existence of treatment effects. The dynamics of treatment effects are non-linear, peaking in the second year after a country joins the BRI before levelling off.

Table 3.3 presents the estimation results for equation (3.7) on outward sovereign credit risk spillover from China to BRI countries. The first column in Table 3.3 shows results for the baseline specification. In this specification, we include non-BRI countries (never treated units) in our control group. We also control for country-fixed effects and year-fixed effects. The coefficient of the post-BRI indicator is equal to 3.359 and is statistically significant at the

Table 3.3: Policy effect of BRI on China's outward credit risk spillover

	Outwards risk spillover of China			
	(1)	(2)	(3)	(4)
Post BRI introduction	3.359***	2.799***	3.833***	3.426**
	(0.746)	(0.734)	(1.517)	(1.485)
Country fixed effects	✓		✓	
BRI-expansion-group fixed effects		✓		✓
Year fixed effects	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Never-treated units	✓	✓		
R-squared	0.082	0.068	0.167	0.196
Observations	780	780	348	348

Notes: This table demonstrates the policy effect of participation in the BRI on China's outward risk spillover to BRI countries. It presents estimates of coefficient β_k from equation (3.7) with the risk spillover from China to other BRI countries as the outcome variable. Column (1), our baseline specification, estimates equation (3.7) including both never-treated and not-yet-treated units in our control group, controlling for country fixed effects and year fixed effects; column (2) replaces country fixed effects with BRI-expansion-group fixed effects; column (3) excludes never-treated units in our control group, controlling for country fixed effects and year fixed effects; column (4) uses not-yet-treated units in our control group, controlling for BRI-expansion-group fixed effects and year fixed effects. All estimations include control variables, including bilateral trade flows (Import and Export), bilateral investment flows (FDI and OFDI), GDP, Inflation, debt-to-GDP ratio, Current account balance, Unemployment and the Index of Political Stability. Appendix Table A.1 shows a detailed description of the control variables. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.

1% level. This result implies that participating in the BRI, on average, raises the risk of spillovers from China to the target country by 3.359 units. To better understand the magnitude of this estimate, the average risk spillover from China to all BRI countries in our sample period is merely 3.037. Thus, joining the BRI substantially increases the inward risk spillover that BRI countries receive.

We conduct several robustness tests. In column (2), we replace country fixed effects with BRI-expansion-group fixed effects to control the potential cluster effects of countries joining the BRI simultaneously. It is interesting that controlling for expansion-group fixed effects significantly reduces the magnitude of the coefficient of interest from 3.359 in the baseline to 2.799. Nonetheless, the standard error of the estimate remains roughly the same, confirming the consistency of our results.

One concern of our analysis is the use of non-BRI countries in our regression. The implicit assumption here is that there is no discrepancy between the time trends for risk spillovers from China to non-BRI and BRI countries. If this assumption is violated, our estimate could be biased. To investigate the sensitivity of our results to this assumption, we exclude non-BRI countries from our regression and rerun regressions in columns (1) and (2). The estimation results are shown in columns (3) and (4). Excluding non-BRI countries from our regressions increases the coefficient estimate of interest without changing their statistical significance. For example, compared to the baseline case in column (1), the coefficient estimate for the post-BRI indicator in column (3) is about 14% higher. The difference is even more pronounced when expansion-group fixed effects are included, as revealed by comparing columns (2) and (4).

Overall, the empirical analysis in this section demonstrates that joining the BRI strongly impacts a country's sovereign risk spillovers from China.

3.3.3 Risk spillover from BRI countries to China

This section evaluates the causal and dynamic effects of joining the BRI on inward sovereign risk spillovers to China by using the sovereign risk spillover from other countries to China from 2010 to 2021 as the dependent variable in equations (3.7) and (3.8).

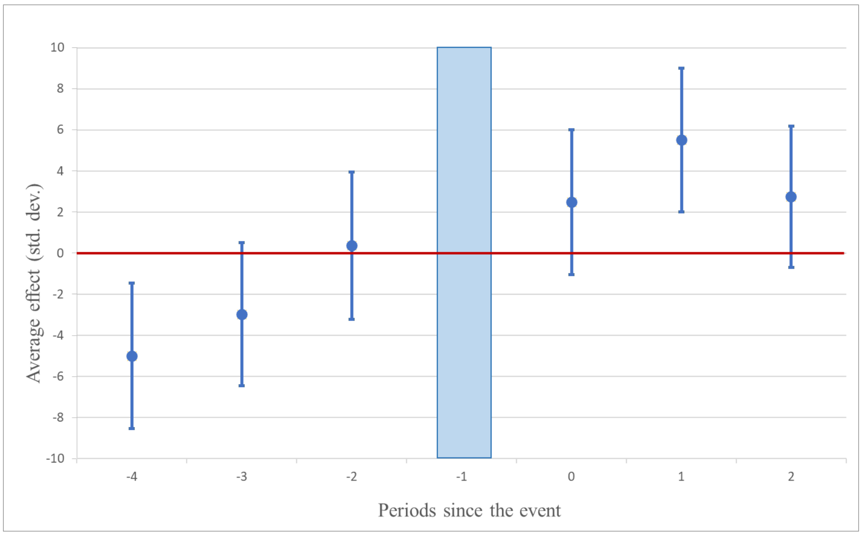


Figure 3.4: Dynamic analysis of BRI on China's inward credit risk spillover

Notes: This figure demonstrates the policy effect of participation in the BRI on the inward risk spillover to China. It presents estimates of the coefficient β_k from equation (3.8) with the risk spillover from other BRI countries to China as the outcome variable. The maximum number of pre-periods is four, and the post-periods are two, as displayed in this figure, because the staggered participation of BRI countries started continuously from 2014 to 2019. Appendix Table A.1 shows a detailed description of the control variables. The bars represent 95% confidence intervals. Standard errors are clustered at the country level.

Figure 3.4 depicts the test results for the parallel trend. Unlike the case for the outward risk spillover from China to other countries, the treatment effect of joining the BRI on the risk spillover from a BRI country to China only appears to be significant one year after joining the BRI but becomes insignificant in the second year.

Table 3.4 shows the estimation results from the regressing equation (3.7) with the inward risk spillover to China as the dependent variable. Columns (1) and (2) present the full sample results for the estimation. Regarding whether

Table 3.4: Policy effect of BRI on China's inward credit risk spillover

	Inwards risk spillover of China			
	(1)	(2)	(3)	(4)
Post BRI introduction	0.931	0.900	3.300*	3.394*
	(1.059)	(1.028)	(1.928)	(1.879)
Country fixed effects	✓		✓	
BRI-expansion-group fixed effects		✓		✓
Year fixed effects	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Never-treated units	✓	✓		
R-squared	0.02	0.068	0.058	0.106
Observations	780	780	348	348

Notes: This table demonstrates the policy effect of participation in the BRI on the inward risk spillover to China. It presents estimates of coefficient β from equation 3.7 with the risk spillover from other BRI countries to China as the outcome variable. Column (1), the baseline specification, estimates equation 3.7 including both never-treated and not-yet-treated units in our control group, controlling for country fixed effects and year fixed effects; column (2) replaces country fixed effects with BRI-expansion-group fixed effects; column (3) excludes never-treated units in our control group, controlling for country fixed effects and year fixed effects; column (4) uses not-yet-treated units in our control group, controlling for BRI-expansion-group fixed effects and year fixed effects. All estimations include control variables, including bilateral trade flows (Import and Export), bilateral investment flows (FDI and OFDI), GDP, Inflation, debt-to-GDP ratio, Current account balance, Unemployment and the Index of Political Stability. Appendix Table A.1 shows a detailed description of the control variables. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.

we control for country-fixed effects or expansion-group fixed effects, there is no significant impact of joining the BRI on a country's sovereign risk spillover to China compared to countries that do not join the BRI simultaneously. In contrast, in columns (3) and (4), when we exclude non-BRI countries (never-treated units) from our sample and only include not-yet-treated countries as the control group, the estimates for the coefficient of interest are more than 3 times larger than the baseline case. However, these estimates are only significant at the 10% level, suggesting substantial variation of changes in a country's risk spillovers to China before and after joining the BRI.

3.3.4 Placebo test

This section provides two placebo tests to examine the robustness of our findings that participation in BRI raises sovereign risk spillover from China to BRI-participating countries.

First, we examine whether the actual treatment effect is significantly different from the effects of random treatment assignment (Liu et al., 2024; Athey and Imbens, 2017). We conducted a placebo test with 1000 iterations by randomly assigning treatment at the unit level and running the regression in column (1) Table 3.3 1000 times. Figure 3.5 shows the distribution of placebo treatment effects. The red dashed line indicates the actual treatment effect estimated from our baseline model, while the green solid line marks the mean of the placebo treatment effects. The distribution of placebo effects centres around zero, suggesting that the average random treatment effect is not significant. The treatment effect marked by the red dashed line lies outside the right tail of the placebo treatment effect distribution, implying that the treatment effect in our baseline model is unlikely due to random variation. We repeat the above placebo test for the other three specifications in Table 3.3 and present the results in Appendix Figure C.1. Overall, we obtain consistent results regardless of the model specifications.

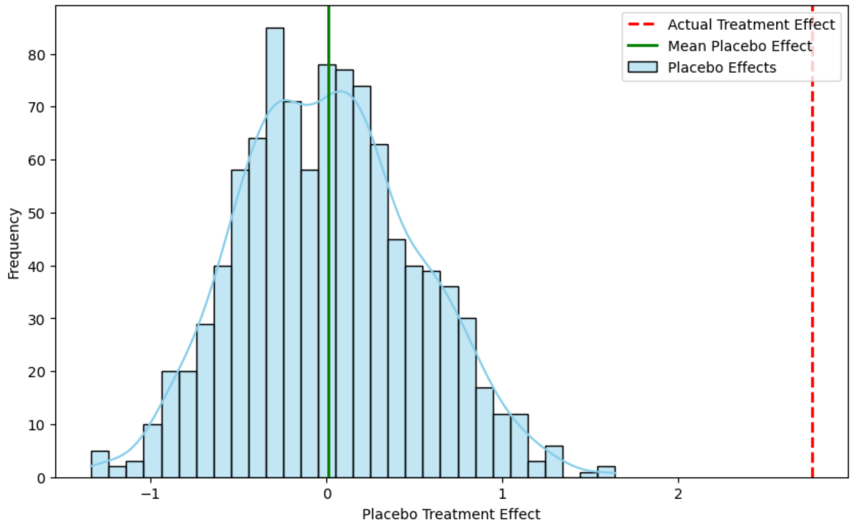


Figure 3.5: Placebo test using randomized treatment

Notes: This figure demonstrates the distribution of placebo treatment effects of participation in the BRI on China's outward risk spillover to BRI countries. It presents the distribution of estimates of the coefficient β_k from equation (3.7) using randomized treatment interaction as the independent variable. The bars represent the frequency distribution of placebo treatment effects obtained from the 1000 iterations. The red dashed line represents the actual treatment effect estimated from our baseline model's equation (3.7). The green solid line represents the mean of the placebo treatment effects. The bars represent 95% confidence intervals. Standard errors are clustered at the country level. Appendix Figure A.1 presents the outcomes of placebo tests conducted on alternative models, indicating consistency with the findings observed in the baseline model.

Our second placebo test involves assigning fictitious BRI participation dates to each country. We experiment with two different dates: one year prior and two years prior to the actual commencement date of a country's participation in the BRI. Table 3.5 shows the estimated results of the treatment effect using false policy years. All estimates are statistically insignificant at the 10% level, confirming that the increased sovereign risk spillovers from China to BRI countries are caused by BRI involvement instead of other random factors.

Table 3.5: Placebo test using spurious post-policy years

	Outwards risk spillover of China							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
One-year-ahead BRI introduction	0.548	0.448	2.693	2.773				
	(2.544)	(2.378)	(1.601)	(1.590)				
Two-year-ahead BRI introduction					2.452	2.262	2.996	3.014
					(2.631)	(2.488)	(1.627)	(1.602)
Country fixed effects	✓		✓		✓		✓	
BRI-expansion-group fixed effects		✓		✓		✓		✓
Year fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Never-treated units	✓	✓			✓	✓		
R-squared	0.011	0.011	0.064	0.111	0.012	0.012	0.066	0.112
Observations	780	780	348	348	780	780	348	348

Notes: This table demonstrates the spurious policy effect of participation in the BRI on China's outward risk spillover to BRI countries. It presents estimates of coefficient β_k from equation (3.7) with the false post-BRI introduction one year ahead and two-year ahead. Appendix Table A.1 shows a detailed description of the control variables. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.

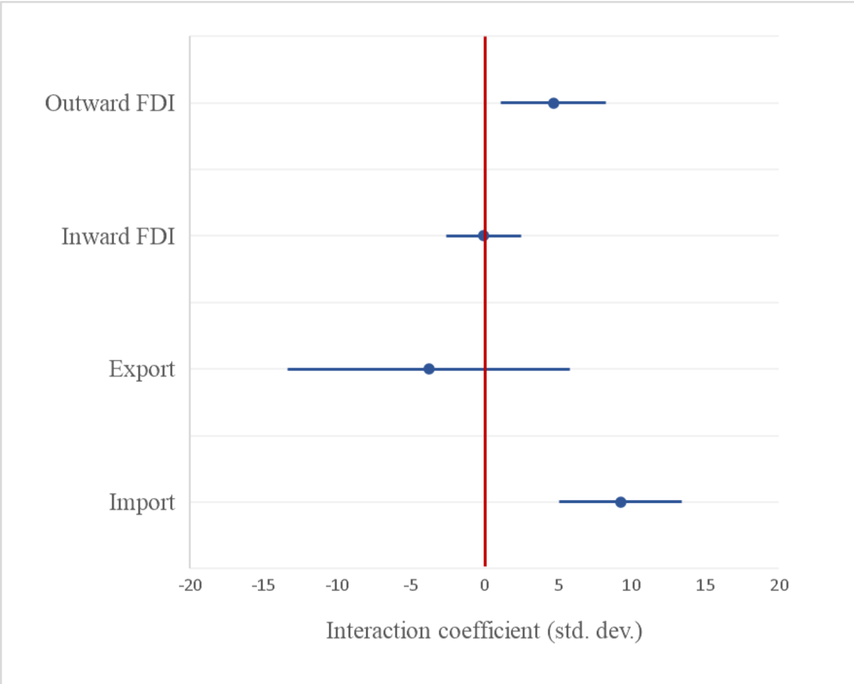


Figure 3.6: Heterogeneous effects of bilateral trade and investment, outward spillover from China

Notes: This figure demonstrates the mechanisms behind the effects of the participation in the Belt and Roald Initiative on China's outward risk spillover to BRI countries. It presents estimates from a version of equation 3.9 in which the treatment indicator interacts with a set of variables in a regression with China's outward risk spillover as the outcome variable. The estimates are obtained by controlling for the BRI-expansion-group and time fixed effects as well as a set of control variables. Appendix Table A.1 shows a detailed description of the control variables. The bars represent 95% confidence intervals. Standard errors are clustered at the country level.

3.3.5 Mechanism analysis

This section examines the potential channels through which the BRI affects the sovereign risk spillover. Given the empirical evidence presented in the preceding section, which underscores a substantial impact of BRI membership on the transmission of sovereign risk from China to the respective BRI country, our analysis henceforth concentrates on elucidating the channels facilitating this outward risk propagation from China to BRI countries.

Recent studies have identified trade concentration and investment flows as key mechanisms for propagating global and local economic shocks (Kramarz et al., 2020; Bostanci and Yilmaz, 2020; Chang et al., 2022). Considering that the principal objective of the BRI project is to stimulate investment and trade, we consequently direct our analytical attention towards these two facets. We accomplish this by estimating a model as follows:

$$Y_{i,g,t} = \beta_0+\beta_1\times\mathcal{X}_{i,t}+\beta_2\times BRI_{g,t}\times\mathcal{X}_{i,t}+\beta_3\times BRI_{g,t}+\gamma\times Z_{i,t}+\alpha_g+\tau_t+\varepsilon_{i,g,t}, \quad (3.9)$$

where $Y_{i,g,t}$ is measures of risk spillover from China to BRI country i that belong to expansion group g estimated at time t. $BRI_{g,t}$ equals one if, in year t, country i belongs to the expansion country group g that joins the BRI and zero otherwise. $\mathcal{X}_{i,t}$ is a vector of four variables, including the outward foreign direct investment (FDI) from China to a designated BRI country i, the inward FDI to China from country i, the export from country i to China and the import of country i from China. The interaction between $BRI_{g,t}$ and $\mathcal{X}_{i,t}$ allows us to capture the change in the marginal effect of $\mathcal{X}_{i,t}$ on the risk spillover from China to country i, induced by country i's participation in the BRI.

A set of control variables $Z_{i,t}$, which contain GDP, inflation, government debt to GDP ratio, current account balance, the unemployment rate and an index of political stability, are included in the regression. Lastly, α_g and τ_t denote expansion-group fixed effects and year fixed effects, respectively. We present summary statistics of our control variables in Table C.1.

Figure 3.6 plots estimates of the coefficient on the interaction between our treatment indicator and the four variables as mentioned above, respectively, in regression with China's outward risk spillover as the outcome variable. The results from Figure 3.6 show a strong and statistically significant effect on China's investment in a BRI country. Specifically, a 1% increase in investment from China to a country amplifies the sovereign risk spillover from China to that country by approximately five units more after the country joins the BRI than before. This contrasts with the coefficient on the inward FDI from a BRI country to China, which is close to zero and statistically insignificant.

Importing from China is another channel through which the BRI propagates the sovereign risk shock from China to BRI countries. The sensitivity of risk spillovers to import increases by about 10 units after a country joined the BRI. On the other hand, the coefficient on the interaction between export and the treatment indicator is negative but statistically insignificant. From a macroeconomic perspective, exposure to a dominant trade partner increases countries' vulnerability to shocks, particularly when the relationship is concentrated around key sectors. As BRI countries engage more closely with China through international trade and investment, they are essentially concentrating their economic links with China. The lack of diversification in trade and investment channels can make countries more susceptible to China's economic fluctuations such as changes in demand for exports or shifts in economic policy.

These results imply that joining the BRI makes a country more likely to be subject to the sovereign risk spillover from China, as the imports and investments from China amplify the intensity of the spillover of sovereign risk.

3.4 Conclusion

This paper investigates the dynamics of the sovereign credit risk network among the Belt and Road countries using a network approach developed by Diebold and Yilmaz (2012). By analyzing sovereign CDS spreads, the study constructs a country-pair measure of sovereign credit risk spillovers that evolves over time. It then employs a staggered Difference-in-Difference method to assess the causal impact of BRI membership on the spread of sovereign risk between China and other BRI countries. The findings indicate a significant increase in risk spillovers from China to BRI countries after they join the BRI. Further analysis identifies Foreign Direct Investment (FDI) and imports from China as key channels through which BRI membership affects these spillovers.

Our study's results have important policy implications. The estimated one trillion dollars BRI initiative is part of a broader strategy of infrastructure-led development, aimed at creating transnational networks that integrate BRI countries into global production and trade systems. This integration is expected to attract foreign investment, stimulate industrial upgrades, and promote export-driven growth (Schindler and Kanai, 2021). However, our paper also highlights that the BRI's integration process increases China's role as a central player in regional financial stability, with potential risks being transmitted to other BRI countries due to strengthened economic ties. This underscores the need for policymakers to design measures to manage and mitigate sovereign risk spillovers within the BRI network. As noted by Stiglitz (2010), diversification and contagion are different sides of the same coin: greater financial integration (especially if not done carefully) increases the risk of adverse contagion in the event of a large negative shock. BRI is restructuring international trade relationships by increasing trade concentration between China and member countries. BRI countries with concentrated import share and FDI with

China are more exposed to sovereign risk spillovers from China. Therefore, the lack of diversification in trade and investment channels plays a critical role in transmitting sovereign credit risk. Countries may need to reconsider diversification strategies to have more diversified trade relations geographically or across different industries. It helps to reduce debt vulnerability and exposure to shock stemming from highly interconnected sovereign risk networks.

Overall, our paper contributes to the growing literature on the economic and financial effects of the BRI by providing empirical evidence of sovereign credit risk dynamics within the network. This study emphasizes the importance of sovereign risk networks as a critical metric for assessing economic interconnectedness and exposure to risks among BRI countries as they deepen their cooperation with China. Future research could expand the dataset to include more BRI countries and extend the analysis over a longer period for a more comprehensive understanding.

Chapter 4

From solo star to binary star, how does bipolarity reshape the region?

[1]

[1]Declaration of original contribution: This chapter is based on original research conducted by the author and has not been published elsewhere in its current form. A version of this chapter has been submitted to The World Economy under the title "From solo star to binary star, how does bipolarity reshape the region?" (co-authored with Dr. Chaoyan and Prof. Shujie Yao). The author's contributions to this chapter include data analysis, literature review, methodology design, writing and interpretation. All co-authors have reviewed and consented to the inclusion of this work in the thesis.

4.1 Introduction

Hayek (1945) argues that price-relevant local information, be it the knowledge of communication or transportation, is vital to understanding whether production should be centralized (planning) or decentralized (competition). Huang et al. (2017) test Hayek (1945) on the Chinese experience of decentralizing SOEs and confirm this insight: when the distance to the government is farther, the SOE is more likely to be decentralized, and this distance-decentralization link is more pronounced with higher communication costs and greater firm-performance heterogeneity. The interpretation of distance in these two papers is purely physical, which is treated as a proxy to represent the accessibility of local information. Nevertheless, local information accessibility can be improved through technology development, be it through reduced costs of communication or transportation. For example, Cao and Chen (2022) find that the abandonment of China's Grand Canal—the world's largest and oldest artificial waterway—disrupted regional trade access and has contributed to social conflicts.

Inspired by these three influential papers, we argue that even though geographical distance remains the same, economic distance can be shortened through new trade routes because it facilitates trade access and information dissemination and encourages competition, therefore resulting in decentralization. We also examine whether the economic distance-decentralization link can explain the centralization or decentralization of countries when facing the rise of a local polar economy and further the escalating competition between the bipolarity economies.

We consider a special setting, BRI, which was announced in 2013 and launched in 2016. The BRI encourages greater policy coordination, infrastructure connectivity, investment and trade cooperation, financial integration, cultural exchange and regional cooperation between Asia, Europe and Africa by creating jointly built trade routes emulating the ancient Silk Road. The BRI will encompass more than 70 per cent of the world's population (4.4 billion dollars) and 62 per cent of the world's GDP (around 21 trillion dollars), illustrating the substantial scale of the initiative[2]. Because the BRI is essentially a transcontinental transport infrastructure project, which is found to have reduced the cost of transport and facilitated trade (Lu et al., 2018), such a unique setting allows us to test the following three hypotheses.

First, if, as hypothesized that BRI induced decentralization, at an aggregate level, countries within the BRI region should become more decentralized after the launch of the BRI. Second, given China is the largest economy and net exporter in the BRI region, besides China being the starting location in the BRI trade routes, which makes China naturally the centre of the BRI network, information shocks originating in China can be easily transmitted to other countries, and vice versa. If, as hypothesized, BRI induced decentralization, information shocks from China to the rest of BRI countries should be more pronounced than information shocks from other countries to China. Third, the geopolitical risk induced by the U.S.-China trade war can reshape the sovereign CDS network by magnifying feedback effects among countries in the interconnected network. When China's status as the centre was weakened due to the intensified economic competition between China and the U.S., the risk spillover among countries became more significant.

We follow Bostanci and Yilmaz (2020) to measure the connectedness of BRI countries. Specifically, we adopt the Diebold-Yilmaz connectedness index (Diebold and Yılmaz, 2014) and use the Sovereign Credit Default Swap

[2]Details about the BRI project and its impact can be found https://www.rand.org/randeurope/research/projects/china-belt-and-road-initiative.html

(sovereign CDS) spreads, which are a proxy for sovereign default probabilities. We chose this approach based on the following concern, despite various methods being employed in a large volume of literature. For example, the studies on the countries' interdependence usually employ the small-scale Vector Autoregression (VAR) model, trade - or financial-linked VAR model or factor-augmented VAR model to disentangle the contribution of internal and external sources and to identify the channels of international transmission (Abeysinghe and Forbes, 2005; Canova et al., 2007). The studies on the common dynamic properties of business cycle fluctuations across countries employ the Dynamic Factor Model to simultaneously capture the contemporaneous and dynamic spillover effects of shocks, but keep silent about the direction of these spillovers (Kose and Riezman, 2001; Kose et al., 2003). These approaches are limited in identifying the dynamic information transmission channel from one country to other countries, or vice versa. Because they either cannot handle a large number of countries and high-frequency data or simply neglect the spillover direction.

Our findings confirm the economic distance-decentralization link as of Huang et al. (2017) and Hayek (1945). First, using 30 BRI countries' daily sovereign CDS data from 2010 to 2021, we find the system-wide connectedness of the BRI network is declining; the speed of decline is faster after 2013, when the BRI was announced. However, the declining trend was disrupted in 2016, we suspect that was due to the competition between China and the U.S. began to rival[3]. Second, we calculate the total information shock spillover from the rest of BRI countries to China (we follow the terminology of Bostanci and Yilmaz (2020) and name it "China From"), and the total information shock spillover from China to the rest of the BRI countries ("China To"). Our findings show that China is more of a sender than a receiver of information shocks, which

[3]Competition between China and U.S.: https://www.chinadaily.com.cn/opinion/2016-02/23/content_23599604.htm

indicates that BRI countries tend to be more decentralized than centralized. Third, the connectedness index of both “China To” and “China From” dropped noticeably in 2018, the year when the China-U.S. trade war began to intensify; this finding confirms that countries tend to be more decentralized when the centre is challenged. We also find the U.S.-China trade war has reshaped the sovereign CDS network by altering risk spillovers and connectedness patterns. This finding reveals the influence of geopolitical risk on increased feedback loops and contagion effects within the sovereign CDS network, transforming localized trade tensions into global financial risks.

The remainder of the paper is structured as follows: Section 2 briefly describes the data set used in our empirical analysis. Section 3 describes the estimating methodology. Section 4 presents the static structure of the estimated network, followed by the time-varying structure of the networks discussed in Section 5. Section 6 presents the endogeneity verification of the network estimation results. Section 7 examines the impact of bipolarity on the BRI risk network, and Section 8 concludes the paper.

4.2 Data

The credit default Swap (CDS) spread of BRI countries is used as an indicator of each country’s sovereign credit risk. The main empirical analysis involves 32 sovereign CDS spreads from 2010 to 2021 with a maturity of five years, including 29 BRI countries[4] Appendix D.1 shows the summary of statistics. The sovereign CDS spread comprehensively mirrors factors such as interest rate variations and movements in the liquidity of sovereign debt prices. Using intra-day

[4]There are overall 65 BRI countries: 25 of them have no available CDS spread data from Markit, 11 countries cannot fully cover the period from 2010 to 2021. China, as well as the U.S. and Japan.

data sourced from Markit, even daily jumps not necessarily caused by shocks to macroeconomic fundamentals can be observed in the connectedness of the sovereign CDS spreads. In addition, compared with bond yields, which are also used in literature as a proxy for sovereign credit risk, CDS spreads provide a more accurate measure of credit risk than bond yields for three main reasons. Firstly, CDS contracts are standardized products with pre-specified and fully documented credit derivatives agreements (Augustin, 2018). In contrast, bond terms and conditions are heterogeneous and depend on various features, including maturity, issue amount and coupon structure. Secondly, CDS markets are typically less influenced by liquidity effects than bond markets. Longstaff et al. (2011), for example, finds that a large proportion of bond spreads is related to measures of bond-specific liquidity such as bid-ask differentials. Thirdly, CDS spreads provide a timelier market-based indicator of credit risk, as empirical studies show that CDS markets lead bond markets in the price discovery process (Blanco et al., 2005).

4.3 Methodology

Diebold and Yılmaz (2014) framework enables the establishment of both a static and dynamic network structure through which one can observe either the full network at any point in time or the dynamic behaviour of pairwise connectedness throughout the whole sample period. This study employs elastic net estimation to overcome the dimensionality problem that arises due to the large number of countries included in the analysis. All countries with available data are included in the study. Furthermore, sovereign CDS connectedness is displayed visually in network graphs, facilitating a better understanding of the underlying network structure. Finally, in implementing the DY model, the daily log-returns of sovereign CDS spreads rather than the sovereign CDS spreads themselves are chosen as the key variable of interest. The daily sovereign CDS spreads have unit roots, but the hypothesis of unit roots is strongly rejected for the log difference. Table A.1 in the Appendix shows unit root test results.

4.3.1 Diebold-Yilmaz connectedness index

The Diebold-Yilmaz connectedness framework is based on assessing the forecast error variance decomposition (FEVD) from a Vector Autoregression (VAR) model to obtain an estimate of the underlying network. This method provides a variance decomposition matrix that shows how the shocks to all variables in the system explain the forecast error variance of each variable. The matrix can be linked to a weighted directed network where each variable is a node, and the variance decomposition values represent the strength and direction of the edges between the nodes. One concern of using financial time series, especially at daily frequency, is the satisfaction of the orthogonality assumption. The generalized FEVD of VAR does not require a particular causal ordering among the variables. In comparison with other methods, the Cholesky VAR model relies on a recursive ordering of the variables. If the true causal relationships are not in line with the assumed ordering, the results will be problematic; the Granger Causality test does not quantify the contribution of each shock to forecast error; the Impulse Response Function (IRF) does not provide information on the relative importance of each shock, but only traces the dynamic effects after a shock.

The first step in implementing the method is estimating a VAR(p) model[5]

[5] Wooldridge test for residual autocorrelation in panel VAR model shows no first order autocorrelation (p-value=0.122).

as follows:

$$\mathbf{x}_t = \textstyle\sum_{l=1}^{p} \Phi_l \mathbf{x}_{t-l} + \varepsilon_t, \tag{4.1}$$

where $\mathbf{x}_t = (x_{1,t}, x_{2,t}, \cdots, x_{N,t})$ is a vector of log differences of SCDS spreads for N countries at time t. Φ_l is the $N \times N$ l-th autoregressive parameter matrix, in which ϕ_{ijl} represents the effect of the l-lagged value of variable j on the current value of variable i. $\varepsilon_t \sim (0, \Sigma)$ is a vector of independently and identically distributed disturbances. The coefficient matrices are derived from the corresponding moving-average representation

$$\mathbf{x}_t = \textstyle\sum_{l=0}^{\infty} A_l \varepsilon_{t-l}, \tag{4.2}$$

where

$$A_l = \Phi_1 A_{l-1} + \Phi_2 A_{l-2} + \cdots + \Phi_p A_{l-p}. \tag{4.3}$$

Note that A_0 is an identity matrix and A_l is a zero matrix for $l < 0$.

The generalized FEVD of equation (4.1) forms a weighted network that summarizes the pairwise connectedness among the elements of $\mathbf{x}_t$. The (i, j)th element of the H-step-ahead FEVD matrix is defined as:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \Sigma e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \Sigma A_h' e_i\right)} \tag{4.4}$$

where e_i is the selection vector with one as the ith element and zeros otherwise, A_h is h-step moving average coefficient matrix, Σ is the covariance matrix for the error vector ε and σ_{jj} is the standard deviation of the error term for the jth equation. Since the sum of the entries of each row in the variance decomposition matrix is not equal to 100, we apply the row-sum normalization to obtain:

$$\tilde{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N} \theta_{ij}(H)} \tag{4.5}$$

Hence, by construction, $\sum_{j=1}^{N} \tilde{\theta}_{ij}(H) = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H) = N$. Note that $\tilde{\theta}_{ij}(H)$. can be interpreted as the proportion of the H-step ahead forecast error variance (FEV) of variable i that is explained by shocks to variable j.

The system-wide connectedness measures the sum of off-diagonal entries in the generalized FEVD matrix, which is the average of total directional connectedness measures across countries:

$$S(H) = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} * 100 = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{ij}(H)}{N} * 100 \tag{4.6}$$

The net pairwise connectedness measures the difference in directional connectedness from country j to country i and directional connectedness from country i to country j :

$$S_{ij}(H) = \frac{\tilde{\theta}_{ij}(H) - \tilde{\theta}_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} * 100 = \frac{\tilde{\theta}_{ij}(H) - \tilde{\theta}_{ji}(H)}{N} * 100 \tag{4.7}$$

4.3.2 Estimation method

We apply the Elastic Net regularizations method, which effectively combines Lasso and Ridge regression to balance variable selection and shrinkage to address over-fitting problems (Zou and Hastie, 2005). The estimation is based on generalized variance decompositions with a 10-day forecast horizon derived from the VAR(3) model.

The LASSO regression introduces $L1$ penalty terms to the cost function, effectively shrinking coefficients to absolute zero if estimating them does not substantially reduce the in-sample prediction error. It is crucial to recognize that penalized VAR estimation with LASSO confronts the issue of introducing bias in estimation due to the selection of penalty parameters, a process often guided by data-driven strategies such as cross-validation. Ridge regression incorporates $L2$ penalty terms into the cost function, pushing coefficients closer to zero (though not reaching zero) and minimizing their impact on the training data. The Elastic Net regularization technique combines both $L1$ (LASSO) and $L2$ (Ridge) penalties in the linear regression model (Zou and Hastie, 2005). This method simultaneously encourages sparsity (some coefficients are precisely zero) through the $L1$ penalty and handles multicollinearity by grouping correlated predictors through the $L2$ penalty. The EN-regularized estimator for variable i minimizes:

$$\hat{\Phi}_i^{\mathrm{EN}} = \arg\min_{\phi_{ijl}} \left(\sum_{t=p+1}^{T} \left(x_{i,t} - \sum_{l=1}^{p} \sum_{j=1}^{N} \phi_{ijl} x_{j,t-l} \right)^2 + \lambda \sum_{l=1}^{p} \sum_{j=1}^{N} \left[\alpha |\phi_{ijl}| + (1-\alpha) \phi_{ijl}^2 \right] \right) \tag{4.8}$$

The EN estimation has two tuning parameters, the shrinkage coefficient λ and selection coefficient $\alpha \in [0,1]$. The estimator is equivalent to LASSO when $\alpha = 1$ and Ridge when $\alpha = 0$. Following Bostanci and Yilmaz (2020), this paper opts for a VAR model order of 3, indicating the number of lags of the endogenous variable included, and sets a 10-day forecast horizon. The tuning parameters in elastic net Estimation consist of α, which is fixed at 0.5, and the value of λ is determined through a 10-fold cross-validation procedure[6].

4.3.3 Network visualization

The network structure of sovereign CDS is visualized using Gephi. The node sizes represent the end-of-sample period credit ratings of sovereigns. Trading Economics (TE) credit rating system provides a numerical index that scores a

[6] Figures A.1 and A.2 in Appendix A display the results of the sensitivity analyses conducted on the VAR lag order selection and the tuning parameter α in the Elastic Net estimation, respectively. The findings demonstrate that variations in these parameters show limited influence on the connectedness index, confirming the robustness and stability of the estimation strategy.

country's creditworthiness on a scale from 0 (likely to default) to 100 (risk-free). Unlike traditional credit ratings from major agencies, TE ratings are based on a forward-looking macroeconomic model that integrates leading economic indicators and financial market data with minimal discretionary adjustments. This approach ensures a more transparent and insightful comparison across countries. Appendix D.2 details the TE credit rating reported by major agencies. Appendix D.3 shows the sovereign debt credit rating for a list of BRI countries. Edge thickness reflects the average pairwise directional connectedness between sovereigns. The ForceAtlas2 algorithm in Gephi determines the node placement. This algorithm models the network as a system where nodes repel each other while edges attract connected nodes. Through iterative adjustments, the algorithm identifies a stable configuration where repulsive and attractive forces between nodes are balanced. In this equilibrium, nodes with stronger pairwise connectedness are positioned closer together, allowing for the identification of potential clusters within the network.

4.4 Static structure of the sovereign CDS network

Figure 4.1 visualizes the position of 30 BRI countries and corresponding 30^2 edges in the network. It shows that the sovereign CDS of BRI participants is highly integrated. The average total connectedness equals 58.1%, calculated as of Equation 4.6. Potential geopolitical clusters exist as countries within the same region are more interconnected. Figure 4.2 presents the network structures of the sample with the U.S. and Japan. The average total connectedness with 32 sovereigns equals 57.1%, indicating the BRI network is slightly decentralized when the U.S. and Japan are included[7]. It is noticeable that China's position in the network does not change when the U.S. and Japan are included. Meanwhile, the U.S. stays far from others and is located at the periphery of the sovereign CDS connectedness network. In contrast, Japan is located relatively closer to the group of ASEAN countries but still outside the centre of the sovereign CDS network. Presenting the whole network with all the edges would hide the basic patterns in the network structure. Therefore, panels (b) and (c) in Figure 4.2 keep the 50% and 25% thickest edges in the network graphs, respectively. In the BRI network, the average return connectedness of the U.S. and Japan is negligible compared to that of China. We can find various heterogeneous effects in the sovereign CDS connectedness at the continental and country levels. Southeast Asian countries have become the largest risk connectedness with China, highlighting its central position in propagating sovereign credit risk within the BRI network. Central and Eastern European (CEE) countries exhibit closer interconnected relationships within the geopolitical region, but are also highly connected with China.

Then, we rank each country's total directional connectedness before and after the BRI (see details in Appendix D.4 and D.5), and the main findings reveal a shift in the primary drivers of risk transmission from developed to emerging markets. Prior to the BRI, European countries were the dominant senders/receivers of risk within the sovereign CDS network. However, following the announcement of the BRI, the primary risk transmitters shifted to ASEAN countries, with Indonesia emerging as the leading source of connectedness. Notably, before implementing the BRI, China's total risk spillover to others was approximately double that of Japan and twenty times larger than that of the United States. However, after 2013, the disparity significantly diminished as

[7]We also tried with/without Japan, it does not change the results as long as the U.S. is considered.

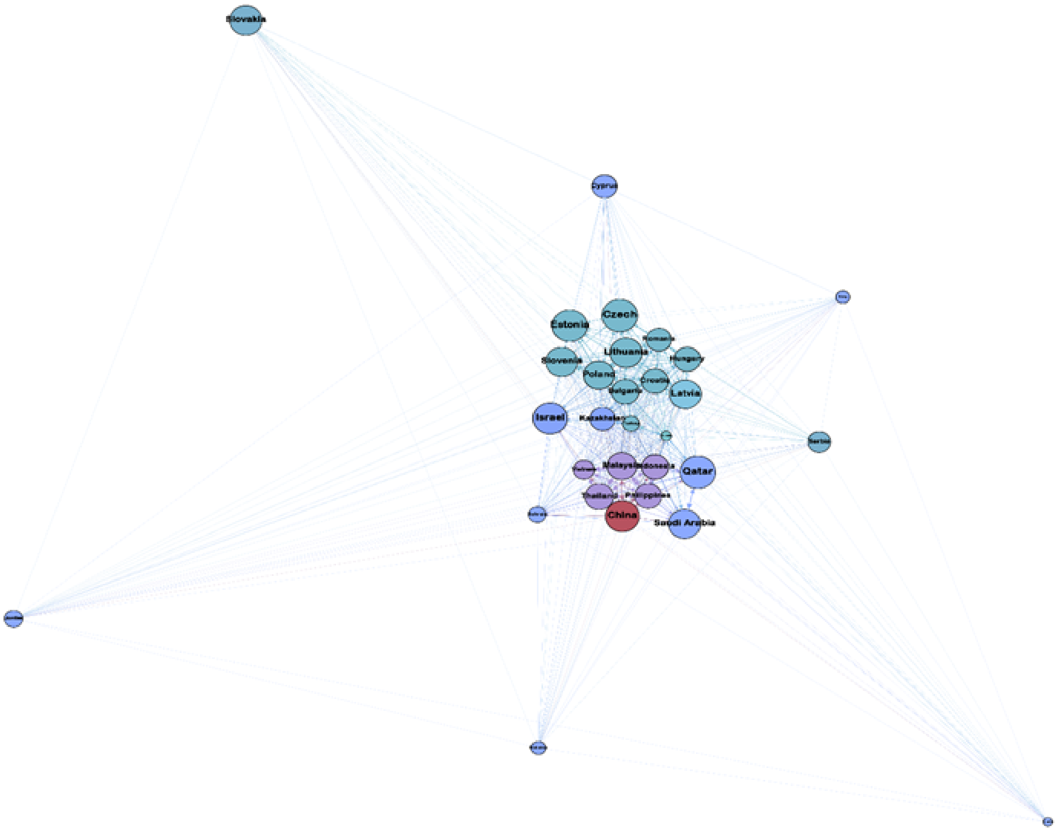
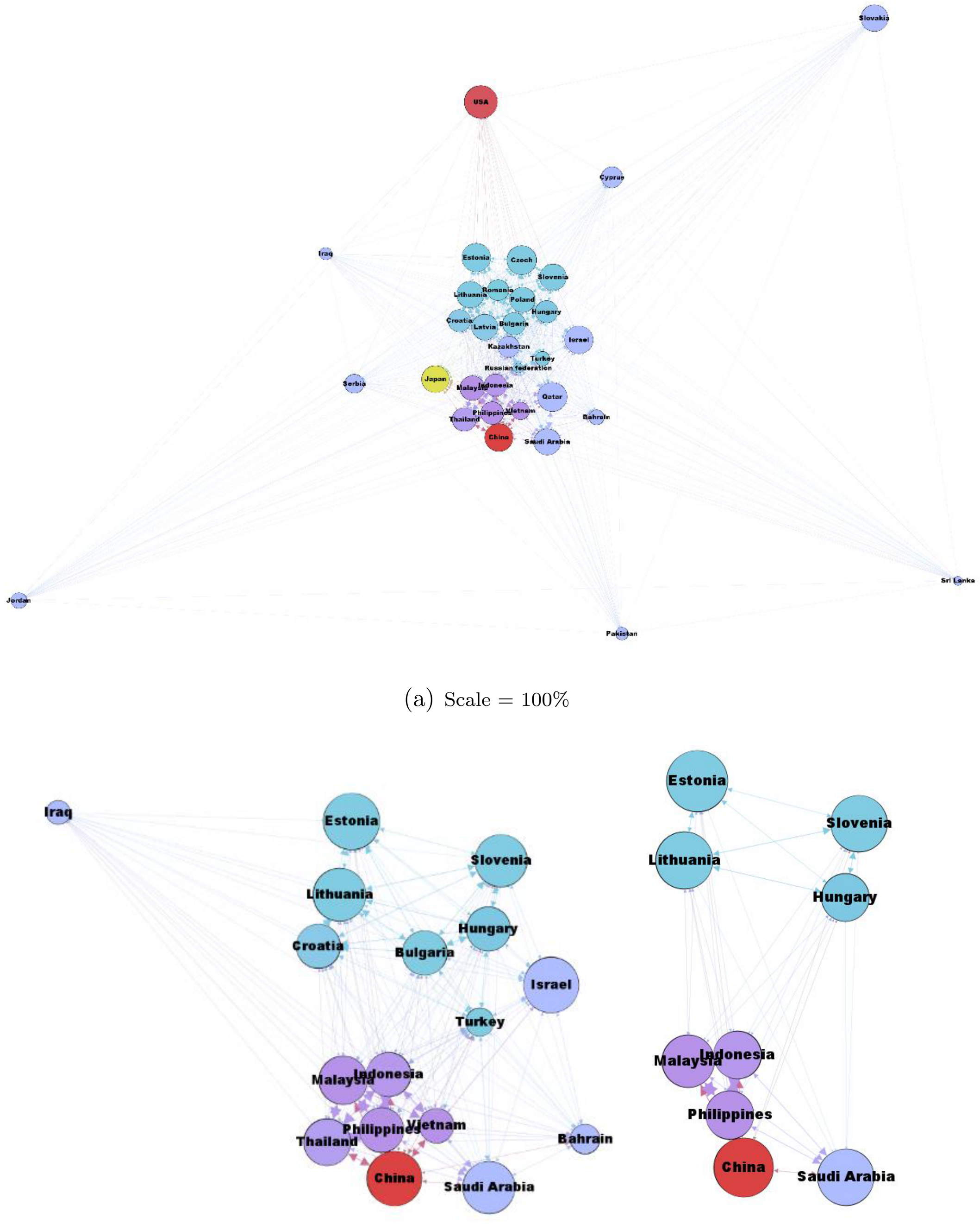


Figure 4.1: Sovereign CDS network of 30 countries, 2010-2021 (without the U.S./Japan)

Notes: The edges show directional return connectedness, and the thickness of an edge captures the strength of pairwise connectedness. The colour of nodes distinguishes the geographical clusters of BRI countries.

the United States exhibited a tenfold increase in its directional connectedness with others. This convergence suggests a shift toward a more bipolar structure in the sovereign CDS network. Overall, these findings suggest that the BRI has reshaped the structure of global sovereign risk, with emerging economies now playing a more prominent role in both transmitting and receiving credit risk.



(a) Scale = 100%

(b) Scale = 50%

(c) Scale = 25%

Figure 4.2: Sovereign CDS network of 32 countries, 2010-2021 (with the U.S./Japan)

Notes: Panel (a) shows the overall network structure of 32 sovereign CDS, while panels (b) and (c) display the network with the highest 50% and 25% directional connectedness. The edges show directional risk connectedness, and the thickness of an edge captures the strength of risk connectedness. The colour of nodes distinguishes the geographical clusters of BRI countries.

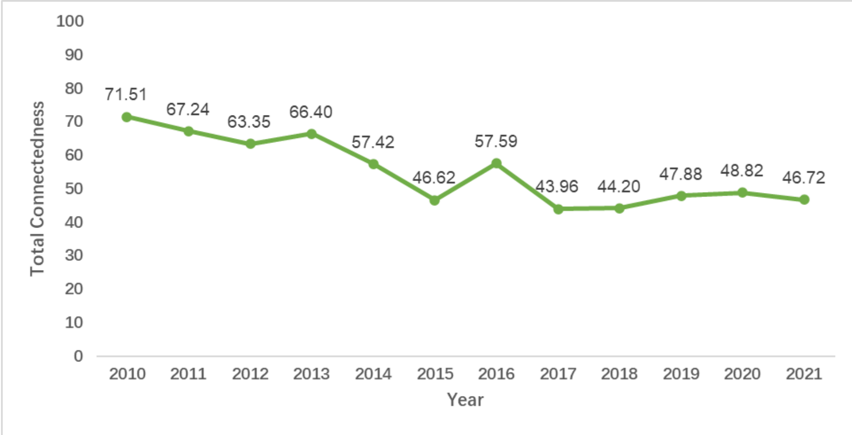


Figure 4.3: System-wide return connectedness, 2010-2021.

4.5 Time-varying pattern of sovereign credit risk network

The dynamics of the system-wide connectedness index as of Equation 4.6 display the change of total risk spillovers among BRI countries and China from 2010 to 2021. Figure 4.3 shows the time-varying pattern of this index. Overall, the dynamic variation of total connectedness indicates a decentralized trend. The speed of decline increased after 2013, which confirms our first hypothesis that BRI induced decentralization. At the aggregate level, BRI countries become more decentralized after the launch of the BRI. While 2016 marks an exceptional, indicating an endogenous shock to network structure potentially due to the rivals between China and the U.S.

Figure 4.4 presents the directional connectedness of China, breaking into "China From" and "China To". We follow the terminology of Bostanci and Yilmaz (2020) and define the total information shock spillover from the rest of BRI countries to China as "China From" and name the total information shock spillover from China to the rest of the BRI countries as "China To". It clearly shows that "China To" has been higher than "China From" for most of

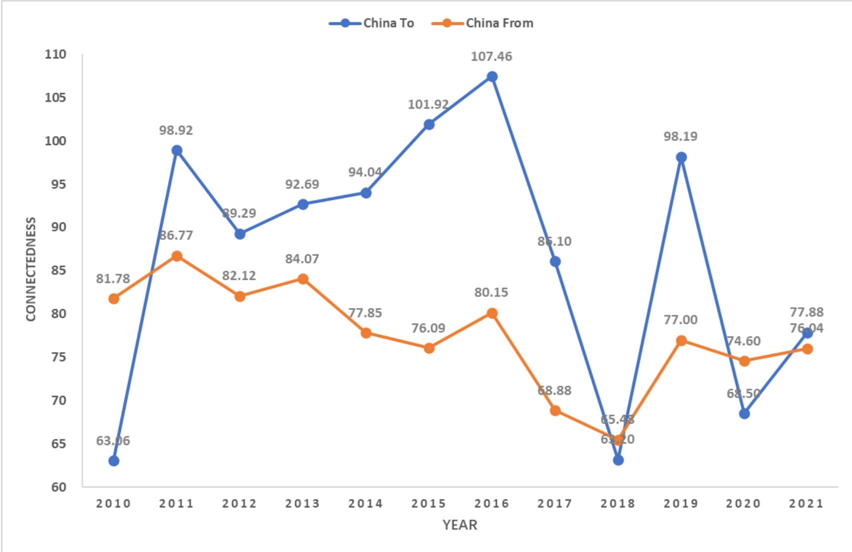


Figure 4.4: Directional connectedness of China, 2010-2021.

Notes: The "from connectedness" measure cannot be greater than 100% by construction, and there is no such constraint on the 'to connectedness' measure. Referring to Diebold and Yılmaz (2014) for details of the measure.

the time, and the divergence between the two lines noticeably widened in 2013. It confirms our second hypothesis that information shocks from China to the rest of the BRI countries should be more pronounced than information shocks from other countries to China. It is interesting to notice that the two lines crossed in 2018 when the China-U.S. trade war began to escalate. Our sample also includes the COVID period, when the "lockdown" policy implemented by China was stricter than in other countries in 2020, while it was relatively more relaxed than in other countries in 2021. Figure 4.4 also reflects this policy shift, shown by the line "China To" being lower than "China From" in 2020 and bouncing back in 2021.

Figure 4.5 compares the time-varying trend of directional connectedness originating from China and the United States to the rest of BRI countries. The risk transmitted from China to the rest of the countries is significantly higher than that of the United States, peaking at 1.07 in 2016. In contrast, the total amount of directional connectedness originating from the United States to

Figure 4.5: Directional connectedness of China and U.S. to the system, 2010-2021.

Notes: This figure compares the total directional connectedness from China and the United States to other countries in the network.

other BRI countries is negligible. However, the divergence between the two lines tightened significantly in 2018. The yearly trends move in opposite directions before 2018, but change simultaneously afterwards. Bilateral economic frictions between China and the United States increased dramatically after the U.S. announced tariffs on imports from China in early 2018. The U.S.-China trade war causes domestic economic dislocations and generates ripple effects throughout the Asian economies. Statistically, although the system-wide connectedness decreased from 64.7% to 56.5% after the announcement of BRI, the total sovereign CDS connectedness between Asian countries and China increased by 32.6%. The credit risk of China is largely decentralized to major trading partners, which is reflected by the sharp rise of "To connectedness" from 2018 to 2019, shown in Figure 4.4. Meanwhile, we can also witness the largest increase in U.S. risk spillovers to the rest of the countries during the same period, indicating the strong contagion effects of credit risk networks during an economic recession. Furthermore, the propagation of credit risk is likely to amplify the transmission of geopolitical risk among underlying sovereigns, exacerbating the decentralization of shock via international trade channels.

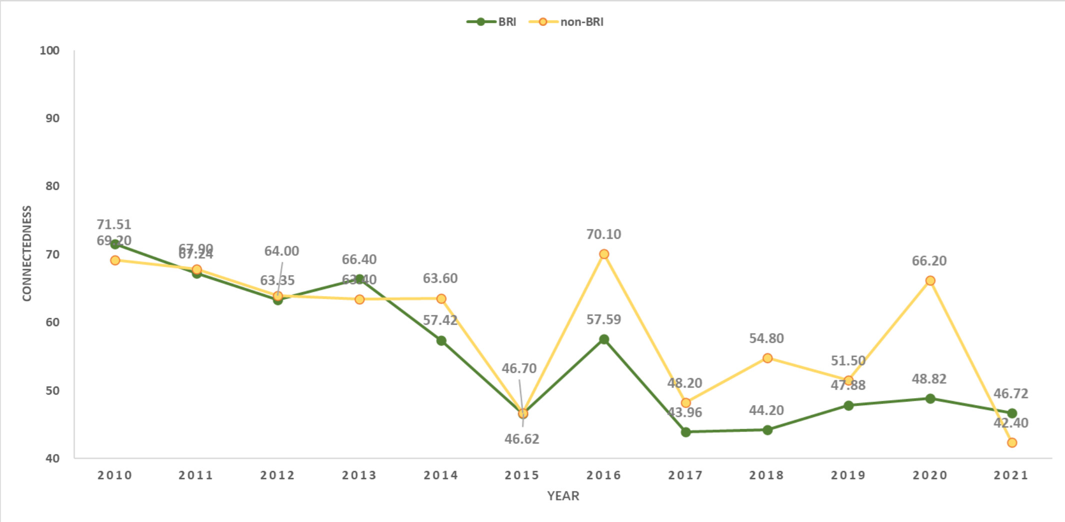


Figure 4.6: System-wide return connectedness of non-BRI versus BRI countries 2010-2021.

Notes: The non-BRI group includes countries with available CDS data from 2010 to 2021 that have not participated in the BRI-related projects until 2021. See detailed country list in Appendix D.6.

4.6 Endogeneity verification

Concerning potential endogeneity, we compare the dynamic trend of sovereign CDS connectedness of countries that have not participated in the BRI. The trends shown in Figure 4.6 suggest that BRI participation might have contributed to the decentralization of sovereign CDS connectedness. The contrasting volatility in non-BRI countries could indicate that external shocks or country-specific factors are more pronounced outside the BRI framework. During the pre-BRI period (2010-2013), the dynamics of sovereign CDS connectedness for both BRI and non-BRI countries were relatively parallel. Both groups showed a declining trend with similar trajectories. After the launch of the BRI, a noticeable divergence between the two groups occurred. The non-BRI countries showed greater volatility, with a sharp decline in 2015 and a spike in 2016. Afterwards, non-BRI countries display higher volatility, peaking in 2020 before sharply declining in 2021 by 36%. In contrast, BRI countries show a smoother decline, reaching a trough in 2015, but with less fluctuation. After 2016, BRI

Figure 4.7: Directional connectedness of China to non-BRI countries, 2010-2021.

Notes: The non-BRI group includes countries with available CDS data from 2010 to 2021 that have not participated in the BRI-related projects until 2021. See detailed country list in Appendix D.6.

countries exhibit a steady, moderate upward trend in connectedness.

In addition, the time-varying patterns of directional connectedness from China to the non-BRI countries also show distinct differences, as illustrated in Figure 4.7. The magnitudes of total directional sovereign CDS connectedness from China to non-BRI countries are notably smaller than to BRI countries. China plays a role as a net risk transmitter in the BRI network (See details in Figure 4.4), but its "To connectedness" is kept below the "From connectedness" to the non-BRI countries after 2013.

This comparative analysis strengthens endogenous verification by demonstrating that BRI countries follow distinct post-BRI dynamics compared to non-BRI counterparts. The pre-BRI similarity further validates using the BRI as an exogenous intervention. The evidence supports our hypothesis that BRI may cause decentralization as countries within the BRI region become more decentralized after the launch of the BRI.

4.7 The impact of bipolarity on the BRI network

This section uses the Difference-in-Differences (DiD) approach and includes non-BRI countries as counterparts to examine three main hypotheses. First, countries that participated in BRI became more decentralized after the launch of the BRI. Second, if as hypothesized BRI induced decentralization, information shocks from China to the rest BRI countries should be more pronounced than information shocks from other countries to China. Third, the geopolitical risk induced by U.S.-China trade would increase the contagion effects and feedback effects within the sovereign CDS network, transforming localized trade tensions into system-wide financial risks. The DiD strategy compares the before-after difference in net connectedness measures between countries that join the BRI and those that do not between the two periods. The baseline specification is:

$$S_{ij}^{H} = \beta_0 + \beta_1 \times BRI \times Post + \beta_2 \times X_{i,t} + \alpha_i + \tau_t + \varepsilon_{i,t}, \tag{4.9}$$

where S_{ij}^{H} is measures of net pairwise risk connectedness estimated at time t for country i as specified in Equation 4.7. We compare the impact of BRI on net connectedness from China and the U.S. to other countries, so there are two target dependent variables. The first is the net pairwise risk connectedness S_{ij}^{H} from China to other BRI countries, where j is China and i is one of the countries that participate in the BRI; The second is the net pairwise risk connectedness from the U.S. to other BRI countries, where j is the U.S. and i is one of the BRI countries.

The key independent variables for our analysis are BRI and $Post$. Treat-

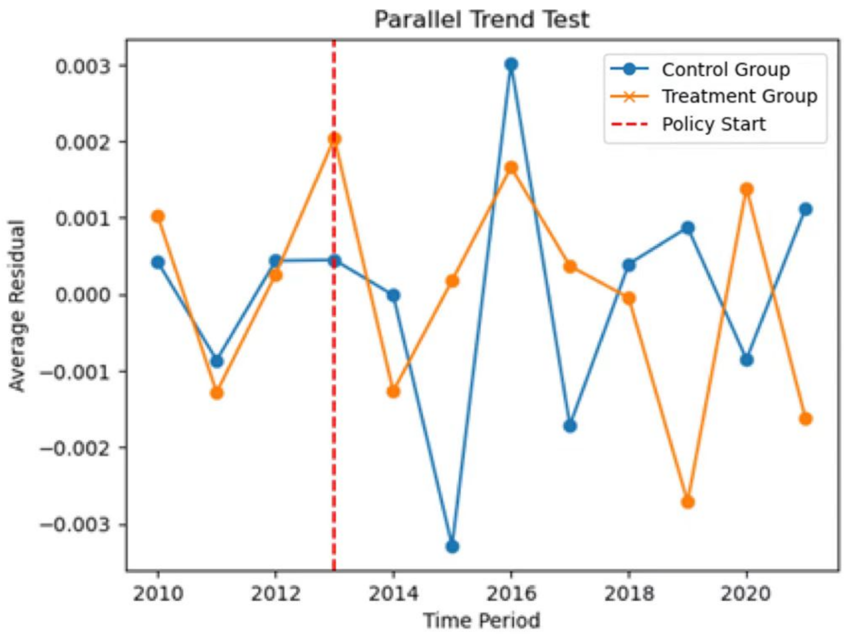


Figure 4.8: Parallel trend test

Notes: This figure shows the mean residuals calculated for the treatment and control group from 2010 to 2021. The treatment group includes BRI countries, and the control groups include non-BRI countries. See detailed country list in Appendix D.6.

ment dummy BRI equals one if country i belongs to the BRI region and zero otherwise. Time dummy $Post$ equals one for a year after the policy implementation and zero otherwise. The coefficient of interest β_1 identifies the average treatment effect on the treated (ATT) of joining the BRI for a country on this country's risk connectedness with China (U.S.). If, as hypothesized, BRI induced decentralizations, we expect β_1 to be negative. We include in our regression a constant term β_0, a set of control variables $X_{i,t}$, which contain country-level ESG performance, GDP, inflation, government debt to GDP ratio, current account balance, the unemployment rate and an index of political stability. The summary statistics of variables are presented in Appendix D.7. The robustness of the findings is supported by the inclusion of both country-fixed effects α_g and year-fixed effects τ_t, which control for unobserved heterogeneity across countries and common shocks across years.

We first conducted a parallel trend test. As Figure 4.8 showed, the treat-

Table 4.1: Impact of BRI on sovereign risk decentralizations

	DiD		**PSM-DiD**			
			Yearly Matching		**Cross-sectional Matching**	
	China	U.S.	China	U.S.	China	U.S.
Net risk connectedness	(1)	(2)	(3)	(4)	(5)	(6)
BRI*Post	-0.003***	-0.001	-0.003**	-0.001	-0.003**	-0.001
	(-0.001)	(0.003)	(-0.001)	(0.001)	(-0.001)	(0.001)
Country fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
R-squared	0.07	0.06	0.08	0.09	0.07	0.09
Observations	780	780	572	576	580	590

Notes: This table demonstrates the impact of China's BRI on the decentralized financial risk connectedness of BRI-participating countries. We use the net sovereign CDS connectedness from China and the U.S. to the rest of the countries as outcome variables, respectively. Columns (1) and (2) present estimates of the coefficient β_1 from the baseline specification 4.9. Columns (3)-(6) present the results of the robustness check using propensity score matching (PSM). All estimations include control variables and two-way fixed effects. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.

ment and control groups had similar trends but did not exhibit parallel trends perfectly before the BRI. After 2013, the policy introduction, the patterns between the two groups appear to diverge or fluctuate independently. Table 4.1 presents the full-sample regression results. We confirm the hypothesis that countries participating in the BRI become more decentralized after the launch of the initiative. The estimates in Column (1) indicate that countries participating in the BRI experienced a decrease of 0.003 percentage points in their net connectedness with China, which is statistically significant at the 1% level. The BRI participants could shift toward more diversified trade partners and financial cooperation within the BRI network, contributing to system-wide risk financial diversification and decentralization. In contrast, there are no significant results were found on the impact of BRI on the United States' net risk connectedness to other countries.

One concern is that countries that participated in the BRI might differ systematically from those that did not. The differences in economic fundamentals, geographic adjacency or trade relationships could bias the estimation of the BRI's effects. Therefore, the propensity score matching (PSM) method is applied to check the robustness of the estimated treatment effect due to potential selection bias and ensure that the comparison between treatment and control groups is more valid. The PSM attempts to approximate the conditions of a randomized controlled trial (Rosenbaum and Rubin, 1983) by matching BRI and non-BRI countries based on similar propensity scores. This matching ensures that both groups are balanced with respect to observable characteristics so that both groups satisfy the assumption of parallel trends.

The matching procedure could be implemented through cross-sectional matching or period-by-period matching (Rosenbaum and Rubin, 1983). Cross-sectional matching involves converting panel data into cross-sectional data, which may introduce potential issues such as self-matching. Period-by-period matching, on the other hand, can lead to inconsistencies in the matched samples across different periods. Both matching methods are applied to address these limitations, and the resulting matched data are compared with the benchmark regression results obtained without matching. In specific, Columns (3)-(4) in Table 4.1 present results using yearly matching to control for temporal trends, and Columns (5)-(6) employ cross-sectional matching. The results across all models remain consistent, with the treatment effect of BRI participation on China's net risk connectedness with others being statistically significant at the 5% level. This comparison serves to verify the robustness and reliability of the conclusions that BRI induce risk structure decentralization in the underlying sovereign CDS network.

To further verify the robustness of the findings, placebo tests were conducted by randomly assigning treatment through 1,000 iterations of randomized treatment assignments. The null hypothesis is that participation in BRI

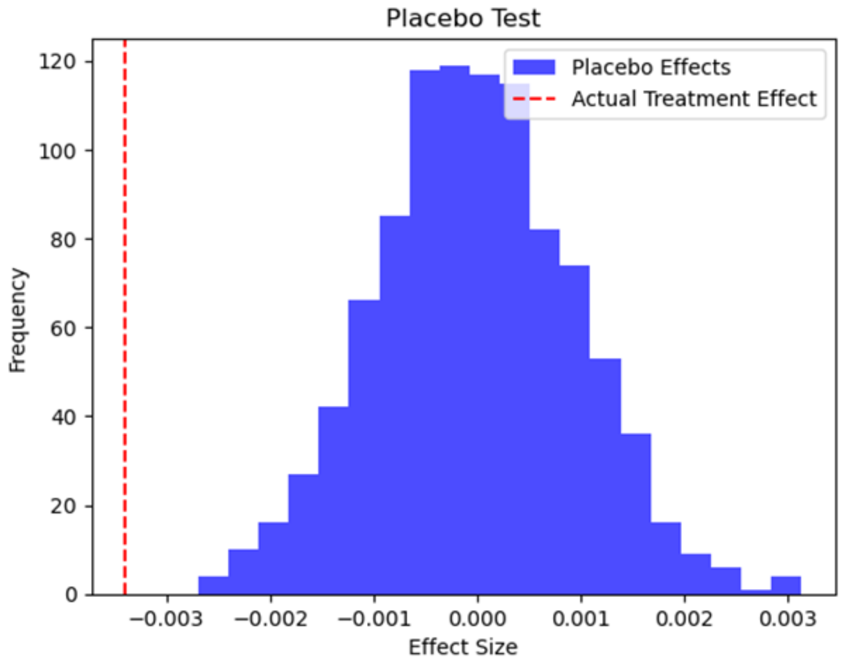


Figure 4.9: Placebo test

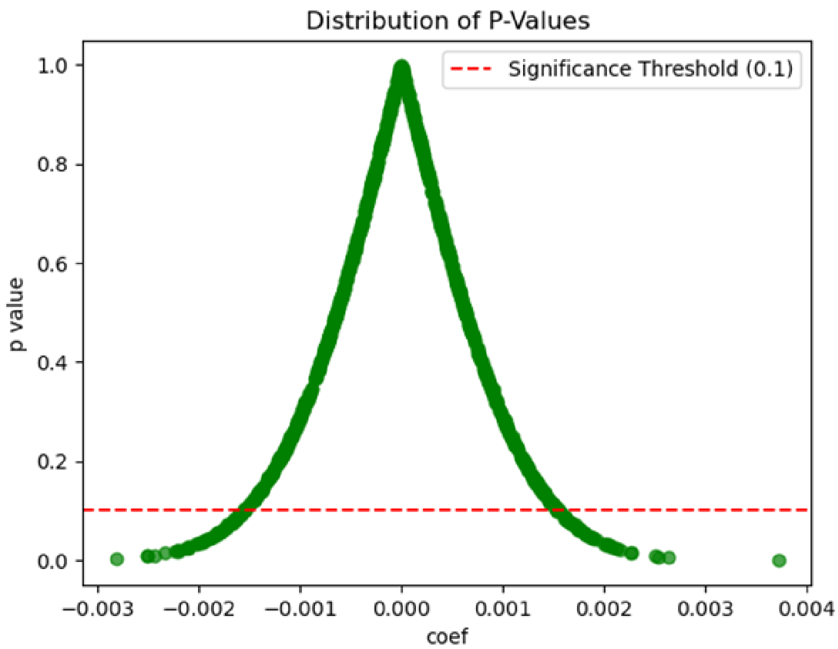


Figure 4.10: Placebo test, distribution of P-values

has no actual treatment effect on risk decentralization. The result in Figure 4.9 demonstrates a clear distinction between the actual treatment effect and the distribution of placebo effects. The treatment effect lies far from the centre of the placebo distribution. This supports the statistical significance and causal validity of the hypothesis that the BRI promotes the decentralization of sovereign credit risk among BRI-participating countries. Additionally, Figure 4.10 illustrates the distribution of p-values from the placebo tests. The scarcity of p-values below the 0.1 significance threshold further corroborates the robustness of the identified treatment effect. These results provide consistent evidence for the causal impact of the BRI on the decentralization of sovereign credit risk among its participants. It suggests the BRI contributes to a more diversified and resilient risk-sharing network within the global sovereign credit system.

$$S_{ij}^H = \beta_0 + \beta_1 \times BRI \times Post_{BRI} + + \beta_2 \times BRI \times Post_{TradeWar} + \beta_3 \times X_{i,t} + \alpha_i + \tau_t + \varepsilon_{i,t}, \tag{4.10}$$

Considering the impact of the U.S.-China Trade War on China's risk connectedness with BRI participants, we add an additional time dummy in the regression model to account for variation in the treatment effect of both the BRI and the U.S.-China trade war. The dynamic DiD model, as specified in equation 4.10, captures treatment effects over a pre-treatment period before 2013, during the treatment period, and the post-treatment period after 2018. The parallel trend assumption is satisfied using the dynamic DiD model as illustrated in Figure 4.11. Table 4.2 summarize the estimates of β_1 and β_2 respectively. Column (1) estimates are statistically significant and further confirm the BRI's impact on risk decentralization. In addition, we find the estimates of the interaction term $BRI * Post_{TradeWar}$ are statistically larger than

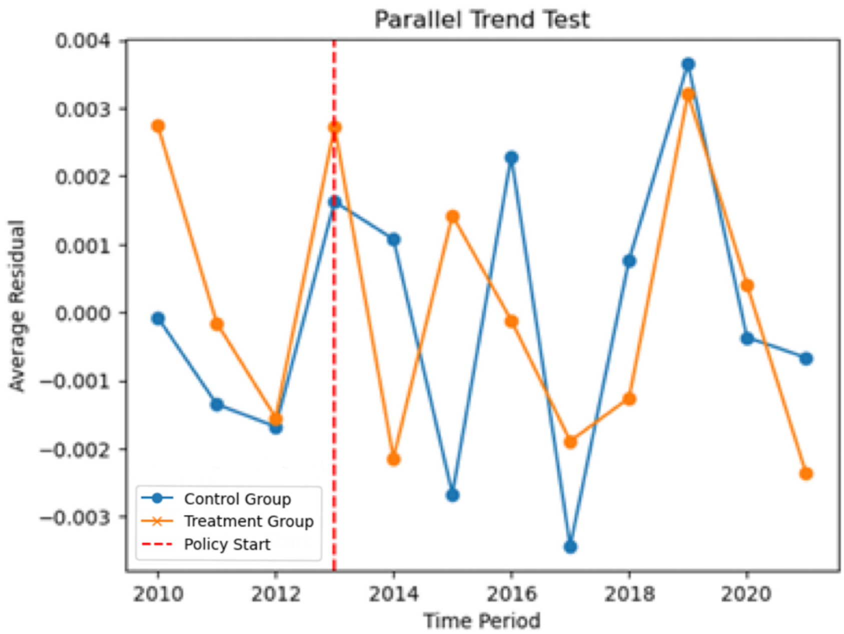


Figure 4.11: Parallel trend test, Dynamic DiD analysis

Notes: This figure shows the mean residuals calculated for the treatment and control group from 2010 to 2021. The treatment group includes all BRI countries, and the control groups include all non-BRI countries. See detailed country list in Appendix D.6.

$BRI * Post_{BRI}$ across all specifications. This suggests that the U.S.-China trade war further reduced China's net risk connectedness with other countries. The escalation of economic tensions between the U.S. and China appears to have increased its vulnerability to U.S. economic fluctuations and intensified China's net risk spillover to BRI participants, contributing to a more decentralized risk structure.

$$\tilde{\theta}_{ij}^{H} = \beta_0 + \beta_1 \times BRI \times Post_{BRI} + + \beta_2 \times BRI \times Post_{TradeWar} + \beta_3 \times X_{i,t} + \alpha_i + \tau_t + \varepsilon_{i,t}, \tag{4.11}$$

Then, we substitute the net connectedness of China/U.S. with directional connectedness shown by Equation 4.11 to analyze China's role in the sovereign CDS network. We find the coefficients for the *To* direction (China's risk connectedness to other countries) are consistently more significant than those for

Table 4.2: Summary statistics of dynamic DiD analysis

	Net connectedness		**Directional connectedness**			
	China (1)	U.S. (2)	China To (3)	China From (4)	U.S. To (5)	U.S. From (6)
$BRI * Post_{BRI}$	-0.003***	0.000	-0.002**	-0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$BRI * Post_{TradeWar}$	-0.004***	0.002	0.005***	0.002**	0.002	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Country fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
R-squared	0.09	0.08	0.11	0.04	0.08	0.06
Observations	780	780	780	780	780	780

Notes: This table demonstrates the impact of both the BRI and the U.S.-China trade war on the sovereign CDS connectedness of China and the United States. We use both the net connectedness and the directional connectedness of China and the U.S. as outcome variables, respectively. Columns (1)-(2) present the estimates of coefficient β_1 and β_2 from the dynamic model specification 4.10; and columns (3)-(6) compares the effects on both directions of risk connectedness of China and U.S. as specified in model 4.11. All estimations include control variables and two-way fixed effects. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.

the $From$ direction (directional risk connectedness from other countries to China) in Table 4.2. This result verifies our second hypothesis that information shocks from China to the rest of the BRI countries are more pronounced than information shocks from other countries to China. Given that China is the largest economy and net exporter in the BRI region, information shocks originating in China can be easily transmitted to other countries. In contrast, the coefficients for the To and $From$ directions of risk spillover involving the United States are not statistically significant, which aligns with the findings from the analysis of net connectedness. The U.S. maintained a relatively stable risk profile. This reflects its resilience to external sovereign risk transmission during heightened trade tensions, in contrast to China's more prominent position in transmitting sovereign risk to other countries in the network.

Moreover, the spillover effects of the U.S.-China trade war are particularly notable as coefficients for the interaction term $BRI * Post_{TradeWar}$ are statistically significant for $ChinaTo$, $ChinaFrom$ and $U.S.From$. Since trade tensions led to economic decoupling between the U.S. and China, the risk transmission among countries may generate a feedback loop through the economic distance—decentralization link. While the BRI promoted financial decentralization by reducing China's interconnectedness with other countries, the trade war is likely to intensify the trade concentration between China and BRI participants. This highlights the role of geopolitical risk in reshaping a country's position in the global risk network, where economic shocks originating from political tensions can affect countries with close economic ties to China. In the long term, a highly integrated risk network would strengthen China's role in influencing global risk dynamics. Meanwhile, managing geopolitical risks is becoming increasingly important to ensure financial resilience in a world of rising geopolitical competition. Finally, we also use the PSM-DiD method as a robustness check to address the self-selection bias inherent in policy evaluations. Appendix D.8 specifies the regression results and provides consistent evidence of our conclusions.

4.8 Conclusion

In this study, we propose the economic distance-decentralization link argument because economic distance can be shortened through new trade routes, which enhance the accessibility of local information and encourage competition. This hypothesis is tested and confirmed in the context of China's BRI.

Key findings reveal that system-wide sovereign risk among BRI countries exhibits a clear trend of decentralization. This finding demonstrates the potential of infrastructure-driven initiatives to reshape global risk dynamics by improving economic connectivity and trade accessibility. It highlights the role of economic integration and infrastructure development in promoting financial resilience through reduced economic distance. In addition, our findings reveal that China, as the central hub of the BRI network, mainly functions as an information shock transmitter rather than a receiver. This indicates that local information shocks originating in other BRI countries tend to be absorbed within the regional economies, aligning with the system-wide trend of risk decentralization. However, China's central role diminishes when economic competition with the U.S. intensifies. The geopolitical conflicts can reshape global supply chains and shift the dynamics of sovereign risk transmission, increasing China's spillovers to BRI countries. Meanwhile, the directional risk connectedness transmitted from BRI participants to China and the U.S. increased as well. This suggests that trade conflicts and geopolitical disputes may generate a feedback loop where both large and small economies influence each other's sovereign risk profiles.

These findings emphasize the complex interdependence between trade policies, geopolitical tensions, and sovereign risk dynamics. For policymakers, these results indicate the need to consider economic fundamentals and account for the geopolitical risks when assessing the risk exposure of sovereign debt in the highly interconnected financial network. Geopolitical risk management thus becomes a critical component of financial stability strategies, particularly for countries dependent on external trade and investment flows. By closely monitoring geopolitical developments, diversifying trade and investment partnerships, and fostering regional cooperation, nations can mitigate feedback loops and reduce the risk of cascading financial instability.

Chapter 5

Conclusions

This thesis provides a comprehensive examination of the sovereign credit risk dynamics among Belt and Road Initiative countries, focusing on the role of non-financial factors, economic integration, and geopolitical risks in shaping sovereign risk transmission. The research critically assesses how these factors influence sovereign risk spillovers within the global sovereign credit default swap network, intending to offer both theoretical insights and practical policy recommendations. Through three distinct but interconnected empirical studies, this thesis contributes to understanding sovereign credit risk transmission in an increasingly interconnected global economy. The research highlights the critical role of sustainability in reducing vulnerability to financial shocks and underscores the complex relationship between economic integration and sovereign risk exposure. Moreover, it emphasizes the importance of integrating geopolitical risk management into sovereign risk assessments as global political tensions increasingly shape financial stability. This research contributes to the literature by providing a comprehensive framework for understanding sovereign risk dynamics in an interconnected world, emphasizing the need for strategic risk management in developing countries facing heightened vulnerabilities due to increased economic integration and geopolitical tensions.

The first study emphasizes the significant role of environmental, social, and governance factors in mitigating sovereign risk connectedness within the BRI network. It is demonstrated that BRI countries exhibiting stronger environmental performance are less vulnerable to sovereign risk spillovers, suggesting that sustainable development can improve financial resilience by lowering exposure to external shocks. The study, aligned with the growing body of literature, confirms the impact of macroeconomic fundamentals on sovereign risk connectedness, such as bilateral trade and bilateral investment. It further supports the idea that geographical distance remains a key determinant of sovereign risk connectedness. These results suggest that sustainability is a critical component of long-term economic development and essential for enhancing financial market stability.

The second study explores the causal impact of BRI membership on the transmission of sovereign risk between China and BRI countries. The study confirms that the BRI has increased risk transmission from China to its partner countries by developing a time-varying measure of pairwise risk spillovers. Through the mechanism analysis, this study identifies FDI and Chinese exports as primary channels for China's outward risk spillover to BRI countries. The findings reveal the dual nature of economic integration. Although economic integration within the BRI provides opportunities for growth, greater economic connectivity also generates new vulnerabilities by exposing BRI countries to risks originating from China. Identifying key risk transmission channels demonstrates that reliance on a dominant trade partner increases a country's vulnerability to economic shocks, particularly when the relationship is concentrated in major sectors. These findings underscore that insufficient diversification in trade and investment relationships can render countries more vulnerable to fluctuations in China's economy and policy shifts.

The third study examines the geopolitical risks arising from the intensifying economic competition between China and the U.S. and their impact on sovereign risk dynamics. The analysis reveals that the economic decoupling between the U.S. and China reshaped the network structure of sovereign risk. The study proposes the economic distance-decentralization link as we identified a trend of decentralization in system-wide sovereign risk connectedness among BRI countries. However, the U.S.-China trade war disrupts this decentralization by increasing risk spillovers both from China to BRI countries and from BRI countries back to China. The findings suggest that geopolitical tensions lead to a feedback loop in which both large and small economies influence each other's sovereign risk connectedness. These results highlight the growing importance of geopolitical risk management in sovereign risk assessments. The trade war and related geopolitical conflicts not only disrupt global supply chains but exacerbate financial vulnerabilities through increased contagion effects on broader financial and economic networks.

These findings have important policy implications. First, countries participating in the BRI should actively diversify their trade and investment relationships beyond China to reduce concentration on a single dominant partner. Investment in regional infrastructure projects, such as cross-border transport and communication networks, can further reduce the economic distance between BRI countries. This will promote a more decentralized network structure of sovereign risks, which allows countries to share risks more evenly and mitigate the cascade effect of shocks (Acemoglu et al., 2012). Second, this paper contributes to understanding how economic shocks can escalate from a localized event into a systemic crisis that affects the entire network. As geopolitical risks arising from U.S.-China tensions can exacerbate the concentration of sovereign risk within the BRI, BRI countries should focus on enhancing political risk diversification. This strategy reduces their exposure to both Chinese and U.S. economic policies and fosters greater resilience in the face of geopolitical uncertainties. Third, as sustainable development, particularly in environment and governance, has been confirmed to reduce financial vulnerability to global financial shocks, policymakers are suggested to incorporate ESG factors into national economic and financial policies to improve sovereign risk resilience. By improving governance and transparency, countries can manage their debt and economic risks more effectively, enhancing their ability to withstand external shocks and promoting decentralization in the sovereign risk network. Overall, investors and policymakers in BRI countries are encouraged to develop risk management frameworks that balance the opportunities of economic integration with China against the high debt vulnerabilities related to BRI projects. The main findings in this paper contribute to developing an early-warning system for monitoring the evolving interconnectedness within the BRI network.

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Appendices

Appendix A

Diagnostic Tests and Sensitivity Analysis

Table A.1: Unit Root Tests

Variables	ADF Statstics	P-value
Sovereign CDS spreads (log differences)		
Pairwise Sovereign CDS connectedness	-61.747	0.000
Directional CDS Connectedness from China	-10.682	0.000
Directional CDS Connectedness to China	-10.682	0.000
Net CDS Connectedness of China	-8.824	0.000
Net CDS Connectedness of U.S.	-3.234	0.003
Country-level Control Variables (log)		
ESG	-5.491	0.000
GDP	-4.394	0.000
Inflation	-5.527	0.000
Debt-to-GDP Ratio	-1.892	0.029
Current Account Balance	-11.066	0.000
Unemployment	-8.356	0.000
Import	-11.254	0.000
Export	-3.950	0.000
FDI	-9.139	0.000
OFDI	-8.410	0.000
Political Stability	-5.453	0.000

Notes: This table presents the statistics of Augmented Dickey-Fuller (ADF) tests on log differences of sovereign CDS used in three studies and log of control variables. All variables reject the unit root hypothesis, validating the use of these variables in the empirical analysis.

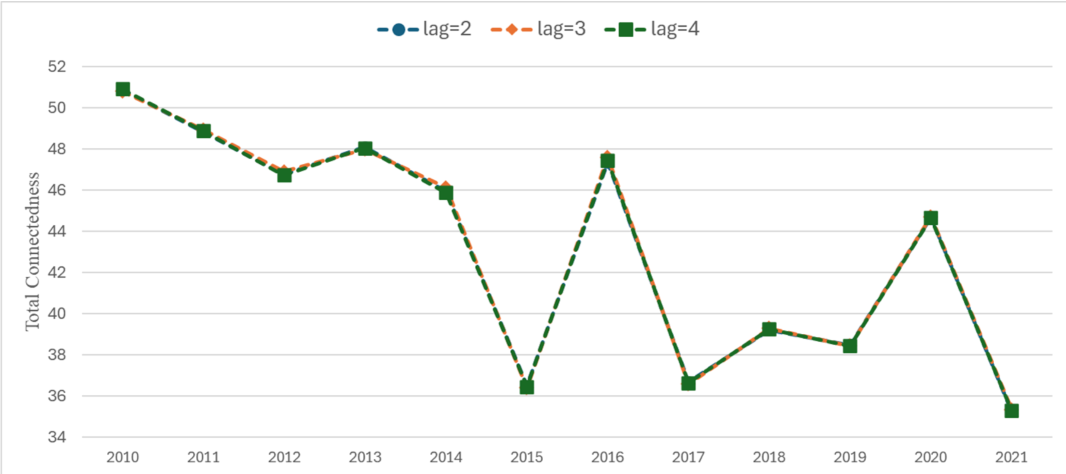


Figure A.1: Sensitivity of Connectedness Index to VAR model lag order

Notes: This figure presents the sensitivity of the system-wide connectedness measure to the lag order of the VAR model. Estimation results using 2 lags and 4 lags are consistent with the baseline model using 3 lags.

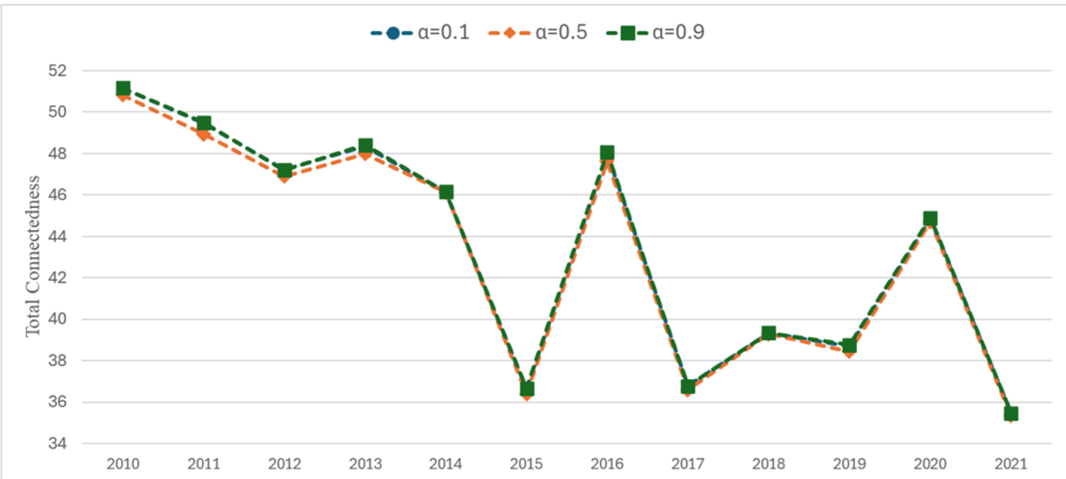


Figure A.2: Sensitivity of Connectedness Index to Elastic Net Regularization Parameter

Notes: This figure presents the sensitivity of the system-wide connectedness measure to the tuning parameter α in the Elastic Net. Estimation results remain consistent as long as positive coefficients exist for both the ridge and lasso penalties.

Appendix B

Supplementary Materials-Chapter 1

Table B.1: Data summary of two-way fixed effects estimation

Statistics	Average	Max	Min	Median	Sd
Pairwise Sovereign CDS (bps)	0.013	0.365	0.000	0.004	0.022
E_standardized	0.000	0.930	-0.455	-0.082	0.270
S_standardized	0.000	0.975	-0.525	0.001	0.256
G_standardized	0.000	1.163	-1.904	-0.010	0.561
ESG_standardized	0.000	0.516	-0.750	-0.010	0.228
Current account balance (% GDP)	-0.040	18.830	-18.422	0.117	3.812
Debt-to-GDP ratio (%)	52.087	154.900	1.562	45.655	29.246
Inflation (% annual)	3.430	19.596	-2.540	2.771	3.366
GDP (bn)	551.732	17700.000	13.221	145.500	1822.719
Unemployment (% of total labor force)	7.135	28.770	0.100	6.160	4.840
Political stability (%)	48.823	92.417	0.474	51.544	22.977

Table B.2: Descriptive statistics of sovereign CDS by country

BRI country	Mean	Median	StDev
Bahrain	-0.791	-0.994	91.269
Bulgaria	-1.371	-0.292	84.098
Chile	-0.446	-4.576	146.431
China	-2.247	-5.798	127.120
Costa Rica	1.033	-0.107	177.387
Croatia	-1.292	-0.101	83.185
Cyprus	-2.615	-0.019	203.340
Czech	-0.930	-0.238	151.582
Dominican Republic	-1.917	-0.021	106.211
El Salvador	0.022	-0.039	95.240
Estonia	-1.552	-0.156	71.893
Ghana	-1.377	0.000	145.875
Hungary	-0.663	0.000	83.058
Indonesia	-0.627	-5.467	127.437
Iraq	-1.839	0.003	72.956
Italy	-4.059	-2.977	194.054
Jamaica	-2.051	-0.001	113.926
Kazakhstan	0.558	-0.171	97.659
Latvia	-2.236	-0.376	69.327
Lithuania	-1.562	-0.048	69.125
Malysia	0.853	-6.281	131.460
Morocco	-0.415	-0.027	77.490
Pakistan	-1.536	0.058	99.412
Panama	-1.709	-6.722	132.859
Peru	-0.740	-6.168	143.585
Pillippines	1.896	-6.618	124.096
Poland	-1.642	-0.551	94.943
Portugal	-2.105	-5.415	185.591
Qatar	-3.532	-3.809	104.979
Romania	-0.548	-0.074	89.108
Russian Federation	-1.654	-2.503	146.974
Saudi Arabia	-0.939	-2.412	112.402
Serbia	-0.429	0.007	84.844
Slovakia	-1.697	-0.187	79.962
Slovenia	-1.693	-0.011	87.464
South Africa	-1.511	-1.621	127.173
Sri Lanka	1.999	0.000	259.644
Thailand	-0.979	-4.651	107.822
Trinidad and Tobago	-1.191	-0.005	182.802
Turkey	0.519	-1.439	122.206
Uruguay	-0.749	-0.552	229.707
Veitnam	-2.492	-4.041	78.486

Notes: This table summarizes the log difference of sovereign CDS spreads for BRI countries. All statistics are reported in basis points.

Table B.3: Sovereign ESG indicators

Pillar	Indicator
Enviroment	Access to electricity (% of population) Adjusted savings: natural resources depletion (% of GNI) Adjusted savings: net forest depletion (% of GNI) Agricultural land (% of land area) Agriculture, forestry, and fishing, value added (% of GDP) CO2 emissions (metric tons per capita) Cooling Degree Days Energy intensity level of primary energy (MJ/$2017 PPP GDP) Food production index (2014-2016 = 100) Forest area (% of land area) Heat Index 35 Heating Degree Days Land Surface Temperature Methane emissions (metric tons of CO2 equivalent per capita) Nitrous oxide emissions (metric tons of CO2 equivalent per capita) PM2.5 air pollution, mean annual exposure (micrograms per cubic meter) Renewable energy consumption (% of total final energy consumption) Standardised Precipitation-Evapotranspiration Index Tree Cover Loss (hectares)
Social	Fertility rate, total (births per woman) Labor force participation rate, total (% of total population ages 15-64) (modeled ILO estimate) Life expectancy at birth, total (years) Mortality rate, under-5 (per 1,000 live births) Population ages 65 and above (% of total population) Population density (people per sq. km of land area) Unemployment, total (% of total labor force) (modeled ILO estimate)
Governance	Control of Corruption: Estimate GDP growth (annual %) Government Effectiveness: Estimate Net migration Political Stability and Absence of Violence/Terrorism: Estimate Proportion of seats held by women in national parliaments (%) Ratio of female to male labor force participation rate (%) (modeled ILO estimate) Regulatory Quality: Estimate Rule of Law: Estimate Scientific and technical journal articles Voice and Accountability: Estimate

Notes: The Environment pillar measures emissions, energy use, food security and natural resource endowment, management, and its risk or resilience to climate change. The social pillar quantifies the sustainability of a country's economic performance in terms of its efficacy in meeting the basic needs of its population, demographic criteria, and investment in human capital and productivity. The Governance pillar measures sovereigns' institutional capacity to support long-term stability, growth, human rights, and the strength of a country's political systems.

Table B.4: Variance Inflation Factors for Trade and FDI factors

Variables	VIF
Import	2.66
Export	2.59
FDI	1.45
OFDI	1.49
Mean VIF	2.05

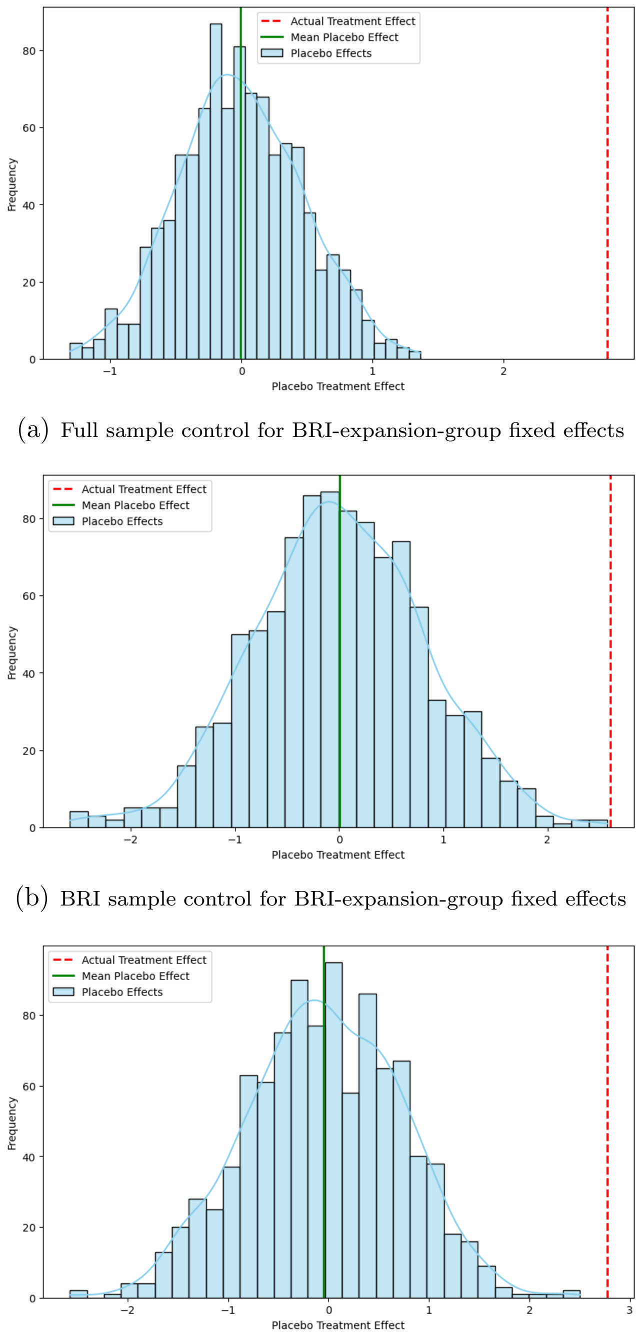
Notes: This table presents the Variance Inflation Factors (VIFs) for the main trade and investment variables. All statistics are below 3, with a mean VIF of 2.05 suggesting no significant multicollinearity concerns.

Appendix C

Supplementary Materials-Chapter 2

Table C.1: Descriptive statistics

Statistic	Mean	Median	Min	Max	Sd
Risk spillover from China (‰)	5.50	1.03	0.00	65.11	6.05
Risk spillover to China (‰)	3.04	2.43	0.00	58.62	7.90
GDP (tn)	1.05	0.25	0.01	23.3	2.77
Inflation (% annual)	4.52	2.31	-2.54	112.40	12.88
Debt-to-GDP ratio (%)	60.67	53.58	1.56	263.14	36.30
Current account balance (% GDP)	0.07	0.09	-18.42	20.76	3.49
Export(bn)	24.21	6.55	0.07	577.64	55.91
Import (bn)	1.94	0.43	0.00	21.36	3.74
OFDI(bn)	2.00	0.05	-6.61	755.08	28.13
FDI(bn)	2.18	0.02	0.00	96.88	9.42
Unemployment (% of total labor force)	7.12	6.10	0.10	28.77	4.61
Political stability (%)	54.11	57.58	0.47	99.53	25.34



(a) Full sample control for BRI-expansion-group fixed effects

(b) BRI sample control for BRI-expansion-group fixed effects

(c) BRI sample control for country fixed effects

Figure C.1: Placebo test results

Appendix D

Supplementary Materials-Chapter 3

Table D.1: Descriptive statistics of sovereign CDS by country

Country	Mean	Median	StDev
Bahrain	-0.791	-0.994	91.269
Bulgaria	-1.371	-0.292	84.098
China	-2.247	-5.798	127.120
Croatia	-1.292	-0.101	83.185
Cyprus	-2.615	-0.019	203.340
Czech	-0.930	-0.238	151.582
Estonia	-1.552	-0.156	71.893
Hungary	-0.663	0.000	83.058
Indonesia	-0.627	-5.467	127.437
Iraq	-1.839	0.003	72.956
Israel	1.630	-0.304	68.346
Jordan	-1.221	0.000	129.071
Kazakhstan	0.558	-0.171	97.659
Latvia	-2.236	-0.376	69.327
Lithuania	-1.562	-0.048	69.125
Malaysia	0.853	-6.281	131.460
Pakistan	-1.536	0.058	99.412
Philippines	1.896	-6.618	124.096
Poland	-1.642	-0.551	94.943
Qatar	-3.532	-3.809	104.979
Romania	-0.548	-0.074	89.108
Russian Federation	-1.654	-2.503	146.974
Saudi Arabia	-0.939	-2.412	112.402
Serbia	-0.429	0.007	84.844
Slovakia	-1.697	-0.187	79.962
Slovenia	-1.693	-0.011	87.464
Sri Lanka	1.999	0.000	259.644
Thailand	-0.979	-4.651	107.822
Turkey	0.519	-1.439	122.206
Veitnam	-2.492	-4.041	78.486
United States	-3.139	-0.075	463.670
Japan	-1.764	-3.044	137.564

Notes: This table summarizes the log difference of sovereign CDS spreads for all countries in regressions. All statistics are reported in basis points.

Table D.2: Trading Economics (TE) credit rating specification

TE	S&P	Moody's	DBRS	Description
100	AAA	Aaa	AAA	Prime
95	AA+	Aa1	AA (high)	High grade
90	AA	Aa2	AA	
85	AA-	Aa3	AA (low)	
80	A+	A1	A (high)	Upper medium grade
75	A	A2	A	
70	A-	A3	A (low)	
65	BBB+	Baa1	BBB (high)	Lower medium grade
60	BBB	Baa2	BBB	
55	BBB-	Baa3	BBB (low)	
50	BB+	Ba1	BB (high)	Non-investment grade
45	BB	Ba2	BB	
40	BB-	Ba3	BB (low)	
35	B+	B1	B (high)	Highly speculative
30	B	B2	B	
25	B-	B3	B (low)	
20	CCC+	Caa1	CCC (high)	Substantial risks
15	CCC	Caa2		
10	CCC-	Caa3		In default
	CC	Ca		
5	C	C		Junk
	DD	DDD		
	D	D		

Table D.3: Sovereign debt credit rating for a list of BRI countries

Order	Country	TE credit rating
1	Czech	85
2	Qatar	85
3	Estonia	83
4	Israel	81
5	China	80
6	Lithuania	76
7	Slovakia	76
8	Saudi Arabia	75
9	Slovenia	75
10	Latvia	73
11	Poland	71
12	Malaysia	68
13	Thailand	65
14	Bulgaria	61
15	Philippines	61
16	Croatia	60
17	Hungary	60
18	Indonesia	60
19	Kazakhstan	56
20	Cyprus	55
21	Romania	55
22	Serbia	48
23	Vietnam	43
24	Jordan	36
25	Bahrain	33
26	Turkey	31
27	Pakistan	25
28	Iraq	23
29	Russia	14
30	Sri Lanka	11

Table D.4: Rank of directional "To connectedness" before and after BRI

Rank	Country	"Connectedness To" (2010-2013)	Rank	Country	"Connectedness To" (2013-2021)
1	Romania	1.257	1	Indonesia	1.436
2	Latvia	1.195	2	Malaysia	1.358
3	Poland	1.185	3	Thailand	1.267
4	Russia	1.164	4	Vietnam	1.179
5	Bulgaria	1.157	5	Philippines	1.085
6	Kazakhstan	1.138	6	Poland	1.01
7	Turkey	1.106	7	Turkey	0.847
8	Philippines	1.093	8	Qatar	0.744
9	Lithuania	1.077	9	Hungary	0.733
10	Malaysia	1.026	10	Saudi Arabia	0.727
11	Croatia	1.005	11	Russian federation	0.721
12	China	0.979	12	China	0.693
13	Indonesia	0.941	13	Croatia	0.687
14	Hungary	0.875	14	Japan	0.67
15	Thailand	0.858	15	Estonia	0.615
16	Vietnam	0.815	16	United States	0.504
17	Israel	0.765	17	Slovenia	0.496
18	Slovenia	0.753	18	Romania	0.495
19	Czech	0.739	19	Iraq	0.458
20	Qatar	0.726	20	Lithuania	0.453
21	Estonia	0.703	21	Israel	0.435
22	Bahrain	0.553	22	Kazakhstan	0.425
23	Japan	0.501	23	Czech	0.403
24	Saudi Arabia	0.31	24	Latvia	0.378
25	Serbia	0.091	25	Bulgaria	0.348
26	Iraq	0.087	26	Pakistan	0.19
27	Pakistan	0.059	27	Bahrain	0.185
28	United States	0.047	28	Serbia	0.183
29	Cyprus	0.043	29	Jordan	0.174
30	Slovakia	0.028	30	Cyprus	0.163
31	Sri Lanka	0.026	31	Slovakia	0.158
32	Jordan	0.009	32	Sri Lanka	0.133

Table D.5: Rank of directional "From connectedness" before and after BRI

Rank	Country	"Connectedness From" (2010-2013)	Rank	Country	"Connectedness From" (2013-2021)
1	Slovenia	0.97	1	Indonesia	0.839
2	Romania	0.887	2	Malaysia	0.836
3	Latvia	0.881	3	Thailand	0.825
4	Russia	0.881	4	Vietnam	0.814
5	Poland	0.88	5	Philippines	0.794
6	Bulgaria	0.879	6	Poland	0.78
7	Kazakhstan	0.879	7	Turkey	0.751
8	Turkey	0.876	8	Hungary	0.713
9	Lithuania	0.871	9	Croatia	0.712
10	Philippines	0.87	10	Russia	0.709
11	Croatia	0.866	11	China	0.705
12	Malaysia	0.865	12	Qatar	0.705
13	China	0.858	13	Estonia	0.688
14	Indonesia	0.852	14	Saudi Arabia	0.683
15	Hungary	0.848	15	Japan	0.679
16	Thailand	0.842	16	Romania	0.613
17	Vietnam	0.831	17	Slovenia	0.603
18	Czech	0.818	18	Israel	0.589
19	Israel	0.817	19	Lithuania	0.586
20	Estonia	0.811	20	Kazakhstan	0.578
21	Qatar	0.807	21	Iraq	0.571
22	Bahrain	0.76	22	USA	0.544
23	Japan	0.754	23	Bulgaria	0.532
24	Saudi Arabia	0.633	24	Latvia	0.528
25	Serbia	0.342	25	Czech	0.507
26	Iraq	0.281	26	Serbia	0.357
27	Cyprus	0.203	27	Bahrain	0.337
28	Pakistan	0.183	28	Jordan	0.325
29	United States	0.15	29	Pakistan	0.297
30	Sri Lanka	0.085	30	Slovakia	0.258
31	Slovakia	0.071	31	Cyprus	0.222
32	Jordan	0.026	32	Sri Lanka	0.195

Table D.6: Descriptive statistics of sovereign CDS by country

non-BRI country				BRI country			
	Mean	Median	StDev		Mean	Median	StDev
Austria	-5.161	-3.158	177.413	Bahrain	-0.791	-0.994	91.269
Belgium	-4.854	-1.397	164.273	Bulgaria	-1.371	-0.292	84.098
Brazil	-2.407	-4.070	200.695	China	-2.247	-5.798	127.120
Canada	-0.620	-0.012	125.005	Croatia	-1.292	-0.101	83.185
Chile	-0.446	-4.576	146.431	Cyprus	-2.615	-0.019	203.340
Colombia	0.288	-4.455	147.563	Czech	-0.930	-0.238	151.582
Costa Rica	1.033	-0.107	177.387	Estonia	-1.552	-0.156	71.893
Denmark	-0.915	-0.084	168.935	Hungary	-0.663	0.000	83.058
Dominican Republic	-1.917	-0.021	106.211	Indonesia	-0.627	-5.467	127.437
El Salvador	0.022	-0.039	95.240	Iraq	-1.839	0.003	72.956
Finland	-1.456	-0.226	167.762	Israel	1.630	-0.304	68.346
France	-3.346	-1.644	170.361	Jordan	-1.221	0.000	129.071
Germany	-3.415	-0.519	170.216	kazakhstan	0.558	-0.171	97.659
Ghana	-1.377	0.000	145.875	Latvia	-2.236	-0.376	69.327
Guatemala	0.123	-0.014	119.728	Lithuania	-1.562	-0.048	69.125
Iceland	-2.558	-0.182	122.786	Malaysia	0.853	-6.281	131.460
Ireland	-5.060	-3.352	159.844	Pakistan	-1.536	0.058	99.412
Italy	-4.059	-2.977	194.054	Pillippines	1.896	-6.618	124.096
Jamaica	-2.051	-0.001	113.926	Poland	-1.642	-0.551	94.943
Japan	-1.764	-3.044	137.564	Qatar	-3.532	-3.809	104.979
Korea	-1.981	-6.792	143.845	Romania	-0.548	-0.074	89.108
Mexico	-1.238	-3.733	153.132	Russian Federation	-1.654	-2.503	146.974
Morocco	-0.415	-0.027	77.490	Saudi Arabia	-0.939	-2.412	112.402
Netherlands	-1.954	-0.791	179.132	Serbia	-0.429	0.007	84.844
Norway	-3.123	-0.045	153.363	Slovakia	-1.697	-0.187	79.962
Panama	-1.709	-6.722	132.859	Slovenia	-1.693	-0.011	87.464
Peru	-0.740	-6.168	143.585	Sri Lanka	1.999	0.000	259.644
Portugal	-2.105	-5.415	185.591	Thailand	-0.979	-4.651	107.822
South Africa	-1.511	-1.621	127.173	Turkey	0.519	-1.439	122.206
Spain	-1.622	-5.929	201.877	Veitnam	-2.492	-4.041	78.486
Sweden	-4.015	-0.227	165.243				
Switzerland	-3.684	-0.246	132.938				
Trinidad and Tobago	-1.191	-0.005	182.802				
United Kingdom	-2.197	-0.515	158.211				
United States	-3.139	-0.075	463.670				
Uruguay	-0.749	-0.552	229.707				

Notes: This table summarizes the log difference of sovereign CDS spreads for all countries in two sub-samples. All statistics are reported in basis points.

Table D.7: Descriptive statistics of variables in DiD regression

Statistic	Mean	Median	Min	Max	St.dev.
Net connectedness of China (‰)	2.46	0.69	-37.56	31.66	6.21
Net connectedness of U.S. (‰)	3.00	0.85	-44.37	38.98	5.52
ESG	0.00	0.52	-0.75	-0.01	0.23
GDP (tn)	1.05	0.25	0.01	23.3	2.77
Inflation (% annual)	4.52	2.31	-2.54	112.40	12.88
Debt-to-GDP ratio (%)	60.67	53.58	1.56	263.14	36.30
Current account balance (% GDP)	0.07	0.09	-18.42	20.76	3.49
Unemployment (% of total labor force)	7.12	6.10	0.10	28.77	4.61
Political stability (%)	54.11	57.58	0.47	99.53	25.34

Table D.8: Robustness check of BRI's impact on directional connectedness, PSM-DiD

	Yearly Matching				**Cross-sectional Matching**			
	China To (1)	China From (2)	U.S. To (3)	U.S. From (4)	China To (5)	China From (6)	U.S. To (7)	U.S. From (8)
$BRI * Post_{BRI}$	-0.002**	-0.001	0.000	0.000	-0.002**	-0.001**	0.000	0.000
	(-0.001)	(0.001)	(-0.001)	(0.001)	(-0.001)	(-0.001)	(-0.001)	(-0.001)
$BRI * Post_{TradeWar}$	0.005***	0.003**	0.001	0.002	0.006***	0.003**	0.001	0.001
	(-0.001)	(0.001)	(-0.001)	(0.001)	(-0.001)	(-0.001)	(-0.001)	(-0.001)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
R-squared	0.14	0.07	0.10	0.07	0.14	0.07	0.10	0.07
Observations	572	572	576	576	580	580	590	590

Notes: This table presents the robustness check using the propensity score matching method. We use the directional sovereign CDS connectedness of China and the U.S. as outcome variables, respectively. Columns (1)-(4) present the results of the robustness check using yearly propensity score matching; and columns (5)-(8) present the cross-sectional propensity score matching outcome. All estimations include control variables and two-way fixed effects. Standard errors in parentheses are clustered at the country level. *** indicates the estimate is statistically significant at the 1% level; ** indicates the estimate is statistically significant at the 5% level; * indicates the estimate is statistically significant at the 10% level.