



Do green bonds behave differently under geopolitical risk? Evidence from a matched-pairs portfolio study (2020-2024)

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Abstract

This thesis examines whether green bonds display different sensitivities to geopolitical risk compared to conventional corporate bonds. Despite the rapid expansion of the green bond market, little is known about its short-term behavior under geopolitical shocks, representing an important gap in the sustainable finance literature. To address this, the study constructs a bond-level matched dataset of investment-grade issuances from Europe and the Americas, covering the period from 2020 to 2024. Green bonds are matched with non-green counterparts on key structural features, and portfolio returns are analyzed using dynamic regressions with controls for U.S. Treasury yields.

The results show that geopolitical shocks generate a consistent two-day cycle: same-day losses of approximately 0.32 to 0.36 percentage points followed by near-symmetric rebounds. Treasury yields remain the dominant driver of daily variation, explaining over two-thirds of return movements. Green bonds exhibit a very small, short-lived cushion relative to conventional bonds, which reverse quickly and lack economic significance.

Keywords: green bonds, geopolitical risk, corporate bonds, COVOL (common volatility), matched-pairs portfolio, treasury yields

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Resumo

Esta dissertação procura esclarecer se as obrigações “verdes” apresentam sensibilidade e resiliência distintas, face ao risco geopolítico, quando comparadas com obrigações corporativas convencionais. Apesar da rápida expansão do mercado de obrigações verdes, pouco se sabe sobre o seu comportamento de curto prazo perante eventos geopolíticos, o que representa uma lacuna relevante na literatura de finanças sustentáveis. Para colmatar esta lacuna, o estudo constrói um conjunto de dados com emparelhamento (*matched-pairs*) ao nível da obrigação, de emissões com grau de investimento, emitidas por empresas da Europa e nas Américas, no período 2020-2024. As obrigações verdes são emparelhadas com equivalentes não “verdes” com base em características estruturais-chave, e as rendibilidades de portfólio são analisadas através de regressões dinâmicas com controlos para as rendibilidades das obrigações do tesouro dos EUA.

Os resultados evidenciam um ciclo consistente de dois dias após eventos geopolíticos: perdas no próprio dia na ordem de 0,32 a 0,36 pontos percentuais, seguidas de recuperações quase simétricas no dia seguinte. As rendibilidades das U.S. *Treasuries* mantêm-se como o principal determinante da variação diária, explicando mais de dois terços dos movimentos das rendibilidades. As obrigações verdes exibem uma almofada muito pequena e de curta duração face às obrigações convencionais, que se revertem rapidamente e não têm significado económico.

Palavras-chave: obrigações verdes, risco geopolítico, obrigações corporativas, COVOL (volatilidade comum), portfólio de pares emparelhados, obrigações do Tesouro dos EUA

Título: As obrigações verdes comportam-se de forma diferente face ao risco geopolítico? Evidência de um estudo de portfólio de pares emparelhados (2020-2024)

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Executive summary

Over the past decade, the green bond market has grown rapidly, becoming a central channel for financing climate-aligned projects and attracting strong investor demand. At the same time, global financial markets have faced recurring geopolitical shocks, including the COVID-19 pandemic, the Russian invasion of Ukraine, U.S.–China trade tensions, and conflicts in the Middle East. These events have renewed interest in how geopolitical risk affects asset pricing and whether securities labeled as “green” behave differently from conventional instruments during periods of instability. Despite the policy and market relevance, little evidence exists on the short-term dynamics of green bonds under geopolitical stress, leaving an important gap in the sustainable finance literature.

This thesis addresses that gap by examining whether green bonds exhibit distinct sensitivity to geopolitical risk relative to comparable non-green corporate bonds. A matched dataset of investment-grade issuances from Europe and the Americas was constructed for the period 2020–2024. Green bonds were paired with non-green counterparts matched on credit rating, coupon type, currency, and issue size, ensuring structural comparability. Portfolio returns were then analyzed using dynamic regressions that incorporated both lagged terms and controls for daily changes in the U.S. 10-year Treasury yield, the global benchmark for fixed-income discounting.

The results indicate that geopolitical shocks produce a consistent two-day cycle across both green and conventional corporate bonds. On the event day, a one-standard-deviation increase in systemic geopolitical risk (as measured by the Global COVOL index) reduces portfolio returns by approximately 0.32 to 0.36 percentage points. The following day, returns rebound almost symmetrically, effectively offsetting the initial loss. This shock–rebound pattern highlights the transitory nature of geopolitical risk at daily horizons, with price dislocations being corrected once uncertainty begins to ease.

Treasury yields emerge as the dominant driver of daily bond performance, explaining over two-thirds of return variation. A one percentage-point increase in the 10-year yield corresponds to immediate portfolio losses of nearly 1.9 percentage points, followed by partial correction the next day. These results confirm that discount-rate movements, rather than geopolitical shocks, remain the primary determinant of daily corporate bond pricing.

When directly comparing green and non-green portfolios, a very small and short-lived cushion is observed for green bonds on shock days (around 0.06 percentage points). However, this advantage reverses the following day, leaving no durable divergence. The effect is statistically significant but economically negligible relative to the magnitude of broader market drivers.

For investors, these findings imply that portfolio risk management should focus on interest-rate exposure, while treating geopolitical events as sources of temporary volatility rather than sustained losses. For issuers, the green label continues to deliver benefits through investor diversification, reputational gains, and potential pricing advantages. Still, it does not materially alter sensitivity to geopolitical shocks at daily horizons.

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Chapter 1. Introduction

Over the past decade, the global market for green bonds has experienced remarkable growth, establishing them as a vital financing tool for climate-related projects and advancing energy transition initiatives. Green bonds are specifically designed for environmentally sustainable projects, which include renewable energy, energy efficiency, clean transportation, and responsible waste management. Since the European Investment Bank issued the first green bond in 2007, the market has expanded significantly, reaching a cumulative issuance of \$2 trillion by 2022 (Climate Bonds Initiative, 2023). This rapid growth has been primarily driven by increased regulatory support, a rising demand from investors for sustainable investments, and heightened awareness of climate change risks (Flammer, 2021; Tang et al., 2023). Green bonds thus serve a dual purpose of mobilizing capital for critical climate investments while also generating returns for investors.

Nevertheless, this rapid institutionalization has unfolded against a backdrop of heightened global uncertainty. Frequent episodes of geopolitical stress have marked the last decade, with the COVID-19 pandemic, the Russian invasion of Ukraine, trade realignments between major economies, sanctions regimes, and the escalation of conflict in the Middle East. These recent events reignited the discussion on how geopolitical risk can play a central part in financial markets' dynamics, shaping capital flows across borders, asset pricing, and the level of risk investors are willing to bear. Such effects can unfold rapidly, triggered by sudden shifts in sentiment and spikes in market volatility (Caldara & Iacoviello, 2022; Smales, 2021, Engle and Campos-Martins 2023).

Understanding whether green bonds exhibit resilience or heightened vulnerability to such shocks is of both academic and practical relevance. For investors, the answer informs portfolio allocation, risk management, and stress testing in an era of frequent global disruptions; for issuers, it determines whether the "green" label provides reputational or market-based protection during periods of instability; and for policymakers, it clarifies whether green bonds offer a resilience benefit in addition to their positive environmental contribution. Despite this relevance, existing research has mostly been focused on static or average relationships, such as the existence and magnitude of the "greenium", a yield discount observed on green bonds relative to conventional counterparts (Zerbib, 2019; Flammer, 2021).

While both green and conventional corporate bonds share many structural features, there are reasons to suspect that their behavior under stress may not be identical. Green bonds attract ESG-oriented investors, also supported by regulation, which may sustain demand during crises (Pastor, Stambaugh & Taylor, 2022). Moreover, they trade at a “greenium,” a yield discount linked to non-financial motives (Zerbib, 2019; Flammer, 2021). These factors could plausibly alter how green bonds respond to geopolitical shocks compared with their conventional counterparts. Indeed, some evidence suggests that on certain days of heightened geopolitical stress, green and non-green portfolios have diverged markedly in their returns. Whether such divergences reflect systematic resilience of green bonds or instead represent transitory fluctuations remains an open question.

Additional contributions look at how green bonds behave under increased volatility regimes, often relying on regime-switching models (Sheehan, 2023). Nonetheless, little is known about the short-term adjustment of green bonds when exposed to geopolitical risk compared to their conventional counterparts. Do returns immediately decline? Do they rebound? Do green bonds differ from conventional ones in this adjustment path? These questions remain underexplored, representing a relevant gap in the literature.

This thesis addresses that gap by emphasizing dynamic models that capture both contemporary and lagged responses of bond returns to geopolitical shocks. By focusing on short-term dynamics, it offers new insights into whether the "green" label transforms the impact of geopolitical risk in fixed-income markets, or whether green and conventional bonds are indistinguishable once comparable structural features are controlled for.

1.1. Research and Structure

The central research question guiding this thesis is: **What is the impact of geopolitical risk on the performance of green bonds?** From this question, two sub-questions emerge:

- (i) Do geopolitical shocks measurably influence the daily returns of green bonds?
- (ii) Do green bonds exhibit greater, equal, or lower exposure to geopolitical risk relative to otherwise comparable conventional bonds?

These questions are designed to better understand not only the existence of geopolitical effects, but also their differential impact across financial instruments.

This thesis contributes to existing literature on three levels: research design, measurement, and methodology. Regarding research design, a key empirical challenge in studying green bonds is to remove the effect of the "green" label from the structural features of bond issuance (such as rating, currency, coupon type, or issue size) that may bias comparisons. To address this, the study conducts a rigorous two-stage matching process. In the first stage, exact matches are imposed on categorical variables, including currency, coupon type, and credit rating bucket. In the second stage, nearest-neighbor matching is applied to minimize differences in continuous variables, such as coupon rate and issue size. This approach reduces omitted-variable bias and ensures that any differences observed between green and conventional bonds cannot be attributed to structural mismatches.

The second contribution relates to data measurement and utilization. Existing studies of geopolitical risk often rely on text-based indices, most notably the Caldara–Iacoviello Geopolitical Risk Index, which captures the prominence of geopolitical events in newspapers. While valuable, such indices reflect narrative attention rather than the direct pricing impact of uncertainty in financial markets. In contrast, this study utilizes Global COVOL to measure geopolitical risk, thus incorporating a fully market-based metric that captures common volatility across asset classes and reflects real-time systemic shocks (Engle & Campos-Martins, 2023). Results should therefore be interpreted as the response of corporate bond returns to systemic volatility commonly associated with geopolitics, rather than to a purely narrative measure of geopolitics. To isolate the geopolitical component from broader rate dynamics, the daily change in the U.S. 10-year Treasury yield (Δy_{10}) was included as a control, given the benchmark role of the 10-year in global fixed-income pricing. The sample is restricted to investment-grade corporate bonds issued in EUR, USD and others by firms domiciled in Europe and the Americas. Findings do not generalize to high-yield, emerging-market, or sovereign bonds.

The third contribution is methodological. Most of the existing literature relies on static regressions or average absolute effects, which overlook the dynamic nature of market adjustments. In this way, this study advances the literature by employing dynamic regression models that incorporate lagged bond returns and lagged measures of geopolitical risk, allowing the analysis to capture short-lived adjustment cycles rather than only immediate responses. Furthermore, it applies a differential regression model, directly comparing green and non-green bond returns, to test divergence once structural characteristics are controlled for.

The empirical results indicate that geopolitical shocks trigger a two-day shock–rebound cycle, as both green and non-green bond portfolios experience negative returns on the day of the shock, followed by a positive rebound the next day. Additionally, Campos-Martins and Hendry (2024) demonstrate that in the oil and gas sector, investors tend to react more strongly to global shocks, such as pandemics or geopolitical tensions, than to climate-related news when these events occur simultaneously. This finding underscores the importance of isolating geopolitical risk as a driver of market dynamics and supports the relevance of this thesis, which investigates how such shocks transmit into corporate bond markets and whether green bonds display distinct sensitivities.

Taking this into consideration, this thesis contributes to several strands of asset-pricing research. It complements the safe-haven literature (Baur & Lucey, 2010) by assessing differential resilience of green IG (Investment Grade) corporates relative to matched non-green IG corporates at daily horizons during systemic volatility associated with geopolitical shocks. Sovereign bonds remain the canonical safe-haven benchmark, thus contributing to the flight-to-quality literature (Beber, Brandt, & Kavajecz, 2009), suggesting that while geopolitical shocks induce temporary repricing, they do not differentiate between ESG-labelled and conventional fixed-income instruments.

The thesis is organized into six chapters, starting with Chapter 1, where the research topic is introduced and the research rationale behind the study is presented. Chapter 2 reviews the relevant literature, synthesizing previous research on the evolution and pricing of green bonds, the measurement of geopolitical risk, and the behavior of green fixed-income assets compared to non-green ones. Chapter 3 describes the data and methodology used, explaining the construction of the dataset, the bond-matching procedure, and the portfolio design; it also introduces the key empirical measures, Global COVOL and U.S. Treasury yields, and outlines the regression models. Chapter 4 presents the results, reporting regression outcomes for both green and non-green bond portfolios, with and without treasury controls, as well as the return-differential specification. Chapter 5 discusses the findings in comparison to existing literature, the practical implications, and the study's limitations related to data frequency, risk measurement, and generalizability, suggesting directions for future research. Finally, Chapter 6 concludes the thesis by summarizing the main results, outlining the contributions to knowledge, and offering recommendations for relevant stakeholders.

Chapter 2. Literature Review

This chapter aims to set this study within the existing body of research on the intersection between sustainable finance, geopolitical risk, and fixed-income markets.

2.1. Green Bonds Market and Pricing

Green bonds are debt instruments specifically committed to financing environmentally sustainable projects. Since the European Investment Bank's inaugural issuance in 2007, the green bond market has expanded exponentially, with cumulative issuance reaching USD 2 trillion by 2022 (Climate Bonds Initiative, 2023). This results from a combination of facts, such as regulatory initiatives being put in place (e.g., EU Green Bond Standard and the EU Taxonomy on Sustainable Finance), ESG mandates being integrated into institutional investment policies, and growing awareness of climate-related financial risks by investors and the public (Flammer, 2021; Tang et al., 2023).

One of the central academic debates concerns the pricing of green bonds relative to conventional bonds with similar characteristics. A set of evidence documents the existence of a "greenium", defined as a yield discount on green bonds relative to otherwise comparable conventional bonds. Zerbib (2019) provides one of the earliest empirical analyses, employing a matching approach to compare green and conventional bonds and finding an average yield discount of around two basis points, with variation across currencies and issuers. Flammer (2021) extends this line of research to corporate bonds, showing that green bonds are issued at lower yields, consistent with excess demand from investors.

Nevertheless, the general evidence remains mixed, as Bachelet, Becchetti, and Manfredonia (2019) confirm the presence of a yield discount in secondary markets, while Karpf and Mandel (2018) report no systematic difference, implying that the greenium may be state-dependent or issuer-specific. More recent studies suggest that the greenium is non-linear, with its magnitude depending on conventional credit spreads and may narrow or even reverse under stressed market conditions (Huang, Dekker and Christopoulos, 2022). For example, when conventional spreads are narrow, ESG-driven demand is more likely to result in a yield discount; and when spreads widen sharply, the greenium may disappear as liquidity and credit risk concerns take precedence. Further research examines the drivers of the greenium, attributing it to segmented

demand curves, where institutional investors subject to ESG mandates are willing to accept lower yields (Baker, Bergstresser, Serafeim, and Wurgler, 2021). Others emphasize reputational motives, suggesting that issuers may benefit from signaling environmental commitment when issuing green bonds (Cheng, Ioannou, & Serafeim, 2014). In summary, the literature confirms that green bonds differ from conventional bonds in pricing; however, whether this translates into differential risk exposures, particularly to systemic shocks, remains to be explored.

2.2. Geopolitical Risk and Asset Markets

Financial markets are susceptible to political developments, and the literature recognizes geopolitical risk as a vital factor of asset prices, volatility, and capital allocation. Geopolitical risk is generally defined as the probability of adverse outcomes arising from international tensions, wars, terrorism, or disruptions in international relations (Caldara & Iacoviello, 2022).

Two main approaches have emerged to quantify geopolitical risk:

- Text-based indices. Caldara and Iacoviello (2022) developed the Geopolitical Risk (GPR) Index, based on newspapers' coverage of geopolitical tensions, which measures the prominence of these events in the media and correlates it with historical crises (e.g., the Gulf War, 9/11, the Ukraine conflict). Related metrics to measure geopolitical risk include the Economic Policy Uncertainty Index (Baker, Bloom, & Davis, 2016), which captures policy-driven uncertainty in geopolitics.
- Market-based indices. Recently, Engle and Campos-Martins (2023) introduced Global COVOL, a measure of systemic volatility shocks resulting from multivariate GARCH models across asset classes. Contrary to text-based indices, COVOL is based on realized market data, reflecting the extent to which volatility co-moves across global assets in response to shocks. It therefore captures actual market stress rather than narrative prominence.

Thus, while text-based indices may capture anticipatory or sentiment-driven effects, they often lag real-time market reactions. Market-based measures, by contrast, register the immediate impact on asset prices, though they offer less clarity about the narratives driving those movements. The choice of measure is therefore a determining factor, and this thesis adopts the second approach, consistent with its focus on short-term adjustment dynamics.

Empirical research confirms that geopolitical shocks have a significant impact on asset returns. Pastor and Veronesi (2013) demonstrate that political uncertainty is reflected in the pricing of equities, thereby increasing required returns. Boutchkova, Doshi, Durnev, and Molchanov (2012) document that political risk exposure varies across sectors, with higher sensitivity for defense, oil, and utilities. Smales (2021) finds that geopolitical events trigger a flight-to-safety response, leading to an increase in flows into government bonds. Yet, little work isolates the effect on corporate green bonds, leaving an unexplored intersection between two active areas of literature.

2.3. Sustainable Fixed Income under Uncertainty

Scholars have increasingly explored how sustainable finance instruments respond under scenarios of uncertainty, with several studies suggesting that ESG assets have different responses to conventional assets during periods of heightened volatility. For example, Tang, Chen, Sarker and Baroudi (2023) exhibit that ESG indices display increased sensitivity to geopolitical events yet tend to recover quickly afterward. Sheehan (2023) applies regime-switching models and documents that green bonds are more volatile in high-risk regimes than in low-risk regimes.

However, the methodologies employed in this literature are often static or regime-based. Many studies rely on cross-sectional or average regressions that do not capture the day-to-day dynamics of adjustment. Regime-switching models identify state dependence but are limited in tracing the temporal path of shocks, whether these impacts are immediate, persistent, or reversed. This creates uncertainty about whether observed differences are due to structural factors or result from model design. Moreover, most evidence comes from index-level data, which may conflate structural features (e.g., maturity, rating, liquidity) rather than isolate the effect of the green label itself. As Zerbib (2019) and Flammer (2021) show, bond characteristics matter significantly for yields and returns. Without controlling for these factors, any apparent differences in green bond behavior may be false.

This thesis addresses these limitations by combining bond-level matching with dynamic regressions, therefore releasing the green label effect from structural bond attributes and tracing the short-term adjustment path of returns to geopolitical shocks.

2.4. Conceptual channels

Several conceptual mechanisms suggest that geopolitical risk may influence green bonds differently from non-green bonds:

- Policy and regulation channel, whereby geopolitical events reshape expectations around climate policy, subsidies, and regulatory frameworks. For example, conflicts that affect energy security can either accelerate or delay commitments to renewable energy, thereby altering the cash-flow risk profile of green projects (Bolton & Kacperczyk, 2021).
- Liquidity channel, as geopolitical shocks often trigger a flight-to-quality, with investors shifting into safer and more liquid assets, such as U.S. Treasuries. While this reduces yields across fixed-income markets, the relative effect on green bonds is less clear: if seen as equally liquid, they may benefit; if seen as niche or less liquid, they could underperform (Beber, Brandt, & Kavajecz, 2009).
- Clientele and commitment channel, as ESG-oriented investors may sustain demand for green bonds during crises, thereby softening outflows and stabilizing prices (Pastor, Stambaugh, & Taylor, 2022). On the other hand, concentrated ESG demand may also create crowding, amplifying volatility in the event of large shocks.

2.5. Gaps in the Existing Literature

Bringing together these points, several gaps in the literature are identified: (i) reliance on indices, as many studies use index-level data (such as green bond indices and ESG indices), conflates bond-level heterogeneity and fails to isolate the effect of the green label; (ii) usage of static methods, since most existing work employs static regressions (Zerbib, 2019; Flammer, 2021) or regime-switching models (Sheehan, 2023), which fail to capture short-term adjustment cycles; (iii) limited usage of controls, as few studies disentangle geopolitical shocks from macro-financial drivers such as treasury rates, which dominate bond returns; (iv) absence of matched-pair designs, even though matched approaches have been used to identify greenium (Zerbib, 2019).

This thesis directly addresses these gaps by implementing a matched-pair portfolio design, applying dynamic time-series regressions, and explicitly controlling for daily changes in U.S. Treasury yields.

2.6. Hypotheses

Based on the literature and conceptual channels, three hypotheses can be formulated:

- **H1 (Dynamic Adjustment):** Geopolitical shocks impact bond returns contemporaneously (day t) but partially reverse on the following trading day ($t+1$), consistent with a short-run shock–rebound cycle (Boutchkova et al., 2012; Pastor & Veronesi, 2013).
- **H2 (Differential Exposure):** Green and non-green portfolios exhibit differential sensitivity to geopolitical shocks, as evidenced by return-difference regressions. In this specification, the coefficients on geopolitical risk (δ_0 for contemporaneous shocks, δ_1 for lagged shocks) capture whether the difference in returns is systematically related to geopolitical events. Evidence of $\delta \neq 0$ would imply that the green label alters exposure.
- **H3 (Macro Control Robustness):** The effect of geopolitical risk remains statistically significant after controlling for Treasury yields, though interest rate dynamics explain a larger share of return variation (Fama & Bliss, 1987; Adrian, Crump, & Moench, 2013).

Chapter 3 – Methodology

This study examines how geopolitical risk affects the performance of green bonds and compares the results with conventional bonds. The analysis conducted combines bond-level matching with time-series regressions, which include dynamic structures and macroeconomic controls.

3.1. Data

The bond dataset is sourced from Refinitiv Eikon (Thomson Reuters), through the bond market deals screener. This specific tool is widely recognized in academic literature for its comprehensive coverage of fixed-income markets, and is frequently used in studies of green bonds, such as those by Zerbib (2019) and Flammer (2021). To ensure comparability with prior work and to focus on the most liquid and relevant segment of the bond market, the selection criteria followed established practices in the green bond literature (Flammer, 2021; Bachelet, Becchetti, & Manfredonia, 2019). The filters applied were:

- Issuer type: Investment-grade corporate bonds only. Sovereign and municipal bonds were excluded to avoid differences in risk premiums caused by fiscal power or sovereign-specific factors.

- Geographic scope: Bonds issued by corporations domiciled in Europe and the Americas. This scope encompasses the two largest corporate bond markets, characterized by a similar economic environment, while still offering variation in regulatory conditions.
- Issue size: Just bonds with a minimum issue amount of €250 million (or its local currency equivalent) were included, to ensure market liquidity and alignment with index provider criteria (e.g., ICE BofA, Bloomberg).
- Issue period: 1 January 2014 – 31 December 2024. This period marks the modern phase of the green bond market, which accelerated after 2014 following the launch of the Green Bond Principles (ICMA, 2014).
- Sustainable finance flag: Bonds characterized as “TRUE” for the sustainable finance flag in Eikon were classified as green bonds (Sustainable Flag = Yes), while those characterized as “FALSE” served as potential control candidates as non-green bonds.¹

The raw data collection resulted in 1,540 green bonds and 12,538 non-green bonds in Europe, and 569 green bonds and 18,745 non-green bonds in the Americas. This imbalance emphasizes the prominence of conventional fixed-income markets relative to the still-developing green segment, making rigorous matching essential to avoid structural biases.

For each bond, the following attributes were retrieved:

- Identification: ISIN, issuer name.
- Issue characteristics: issue date, maturity date, issue amount, coupon rate, coupon type (fixed, floating, zero), and currency.
- Credit quality: issuer credit rating, harmonized from Moody’s to standard buckets (AAA, AA, A, BBB, BB/B, NR).

These variables are recognized as key determinants of yields and spreads (Zerbib, 2019; Karpf & Mandel, 2018), forming the basis for the matching procedure and allowing the construction of structurally comparable portfolios.

¹ Sustainable Finance Flag (Yes/No): Assigned by Refinitiv (LSEG) to each deal in its Deal Screener that signals whether the instrument qualifies as a sustainable finance issuance, such as a green bond, social bond, sustainability bond, or sustainability-linked instrument. The classification is based on publicly disclosed labeling, alignment with recognized frameworks and compliance of the deal’s use of proceeds.

Matching Design

A core methodological challenge in sustainable finance research is separating the effect of the "green" label from other structural factors of bond pricing. Without appropriate controls, any observed differences in returns may be attributed to differences in credit risk, maturity, liquidity, etc. To address this challenge, this thesis applies a two-stage matching procedure inspired by Flammer (2021) and Baker et al. (2021). The design combines:

- Exact matching on categorical variables (currency, coupon type, rating bucket), ensuring that green and non-green bonds are directly comparable on dimensions most likely to influence pricing.
- Nearest-neighbor matching on continuous variables (coupon rate, issue amount), minimizing differences in quantitative features that drive yields and liquidity.

This design is based on the framework of causal inference in observational data (Rosenbaum & Rubin, 1983), where matching reduces omitted-variable bias and improves internal validity. The goal is to construct a synthetic control portfolio of non-green bonds that mirrors the green portfolio as closely as possible, with the only systematic difference being the green label. This type of approach is significant for green bonds, as issuance is often concentrated among highly rated and large entities. Therefore, without these matching procedures, the results could easily overstate discrepancies between the sets, making it unclear whether they truly reflect sensitivity to geopolitical risk.

3.2. Stage 1 (Exact Matching)

The first stage ensures comparability on categorical attributes that are non-continuous but central to bond pricing.

3.2.1. Pre-processing Steps

- Credit ratings: For this characteristic, credit scores by Moody's were grouped into discrete buckets (AAA, AA, A, BBB, BB/B, NR), following Flammer (2021), which reduces unnecessary data granularity while preserving meaningful distinctions.
- Dates: Issue and maturity dates were standardized to consistent formats, ensuring alignment in subsequent time-series analyses.
- Coupon types: Coupon labels were normalized for case and spelling to distinguish reliably between fixed, floating, and zero-coupon bonds.

3.2.2. Exact Matching Variables

- **Region.** Bonds were exclusively matched with counterparts from the same macro-region (e.g., a green bond from Europe was only matched with non-green bonds from Europe).
- **Currency.** Matching on currency controls for currency-specific yield curves and monetary policies (Zerbib, 2019). A green bond denominated in EUR must be matched with non-green EUR bonds, preventing cross-currency misshaping.
- **Coupon type.** Fixed versus floating coupons showcase different sensitivities to interest rate movements, so matching ensures that green and non-green bonds encounter equal exposure to rate dynamics.
- **Credit rating bucket.** Ratings are a primary determinant of spreads and default premia, so its matching guarantees that differences in geopolitical sensitivity are not driven by credit quality.
- **Issue size filter.** Candidate matches were restricted to non-green issues with amounts between 50% and 200% of the green bond's issue size, following Karpf & Mandel (2018).

By enforcing equality on these bond-level characteristics, the matched sample avoids significant structural imbalances. However, exact matching alone cannot eliminate residual differences in continuous features such as coupon rate or issued amount. To further refine comparability, Stage 2 implements nearest-neighbor matching on these dimensions.

3.3. Stage 2 (Nearest-Neighbor Matching)

Although exact matching accounts for categorical factors in bond pricing, it doesn't address differences in continuous factors, such as the coupon rate or the issued amount. To overcome this, the second stage applies a nearest-neighbor (NN) matching algorithm, which minimizes these remaining differences.

The performance of fixed-income assets is significantly influenced by the coupon rate and the amount issued. A higher coupon rate directly raises the yield-to-maturity, whereas larger issue sizes typically improve liquidity and lower spreads (Karpf & Mandel, 2018). Even when matching credit rating, currency, and coupon type, disparities in these continuous metrics can bias comparisons. NN matching is broadly adopted by scholars in applied finance and econometrics when refining studies with matched-pairs designs (Zerbib, 2019; Flammer, 2021).

Applying this step enables the selection of the non-green bond that minimizes the relative distance to a specific green bond, based on specified continuous variables; thus, ensuring that the portfolios built are both qualitatively and quantitatively aligned.

Even though much of the green bond literature (e.g., Flammer, 2021; Baker et al., 2021) employs propensity score matching (PSM), this study adopts nearest-neighbor matching as the second stage for three reasons. First, exact matching in Stage 1 already aligns categorical factors (such as currency, coupon type, and credit rating), thereby reducing the scope for a propensity score to add discriminatory power.

Second, the primary residual imbalances concern continuous variables for which NN matching provides a direct optimization, whereas PSM only balances them indirectly. Third, NN matching preserves sample size more effectively than PSM, especially given the smaller pool of green bonds. Finally, NN matching uses a more transparent and direct distance criterion, facilitating the interpretation of the matching process.

3.3.1. Distance Metric

The variables selected for nearest-neighbor matching were the coupon rate difference (absolute difference in percentage points of the coupon rates) and the issued amount difference (absolute difference in issue size, expressed in logarithmic form to stabilize effects and reduce skewness). Both variables were z-scored for comparability, ensuring that neither variable dominated the distance metric due to scale. The Euclidean distance was then calculated as:

$$Distance_{g,ng} = \sqrt{z_{coupon\ rate}^2 + z_{issue\ size}^2}$$

where $z_{coupon\ rate}$ and $z_{issue\ size}$ represent the standardized values of coupon and issue size differences. Each green bond was initially matched with its three closest non-green candidates based on the Euclidean distance (W. Cao et al., 2019). From these, a final one-to-one match was selected using nearest-neighbor allocation without replacement, meaning that once a non-green bond was paired, it could not be reused. In cases where multiple green bonds shared the same closest neighbor, a random jitter was applied to break ties.

The two-stage matching process combines the strengths of exact and NN matching by ensuring that green and non-green bonds are aligned on key categorical factors (exact matching) and fine-tuning the comparison by minimizing differences in continuous attributes. This design ensures comparability not only at the aggregate level but also bond-by-bond, where each green bond is explicitly paired with a non-green counterpart. Due to this, this study represents an advancement over index-based studies, which often conflate bond heterogeneity (Bachelet et al., 2019) and is consistent with best practices in causal inference (Rosenbaum & Rubin, 1983).

3.4. Portfolio Construction and Analysis

Following the matching procedure, the analysis proceeds with the construction of green and non-green portfolios and the extraction of daily return series for time-series econometric analysis. The matching procedure produced two synthetic portfolios:

1. Green Bond Portfolio – all green bonds that satisfied the inclusion and matching criteria.
2. Non-Green Bond Portfolio – the corresponding set of matched non-green bonds, structurally equivalent to the green portfolio.

The constructed portfolios were structured as unbalanced daily panels, in line with methodologies used by major index providers (Bloomberg, ICE BofA). This means that a bond enters the panel on the first day return data becomes available and remains active until its maturity date or until data availability ceases (whichever comes first). Bonds with missing data were excluded from the portfolio. To preserve comparability, if one bond in a pair was dropped due to missing data, its counterpart was also removed from the other portfolio. This approach mirrors index methodology while maintaining the integrity of the matched design.

The descriptive features of the matched dataset include sample size, issuer details (sectoral and geographic information), coupon and maturity profiles (mean, median, and standard deviation). Table 1 also showcases specific statistics of each portfolio and variable.

Table 1 - Summary Statistics

Panel A. Bond Summary Statistics					
	obs	mean	sd	min	max
Green Bonds					
Duration (in years)	138	12.781	11.204	1.443	60.090
Coupon-Rate	328	3.744	1.366	0.183	10.125
Amount Issued	402	749.240	518.967	248.815	4778.784
<hr/>					
Non-Green Bonds	obs	mean	sd	min	max
Duration (in years)	154	11.107	8.865	1.947	40.260
Coupon-Rate	342	3.437	1.748	0.250	11.750
Amount Issued	402	698.075	391.234	260.088	2500.000
<hr/>					
	Non-Green	Green	Total	% (total)	
Rating Bucket	402	402	804	100%	
AAA	4	4	8	1%	
AA	58	57	115	14%	
A	123	124	247	31%	
BAA	169	167	336	42%	
<BAA	48	50	98	12%	
<hr/>					
Currency	402	402	804	100%	
USD	335	335	670	83%	
EUR	31	31	62	8%	
CAD	23	23	46	6%	
Other	13	13	26	3%	
<hr/>					
Coupon Type	402	402	804	100%	
Fixed	335	343	678	84%	
Float	45	39	84	10%	
Other	22	20	42	5%	

Panel B. Portfolio Summary Statistics										
	mean	sd	p50	min	max	skew	kurt	SR	CV	# Active
Green portfolio	0.001	0.158	0.006	-1.079	0.693	-0.489	7.231	0.006	160.063	233.6
Non-green portfolio	-0.002	0.160	0.002	-1.115	0.721	-0.687	8.395	-0.010	-102.131	261.5

Note: Returns are daily log returns, in percentage points. Sharpe Ratio (daily) uses $r_f=0$. CV = sd/mean. Active = number of active bonds in portfolio per day.

Panel C. Context Variables							
	mean	sd	p50	min	max	skew	kurt
Geopolitical risk (index)	0.5925	0.3217	0.5481	0.0323	2.8508	2.9841	17.6609
$\Delta 10y$ Treasury (bps)	-0.0001	0.0586	0.0000	-0.3100	0.2900	-0.2959	6.2886

Note: Geopolitical risk is the raw index. $\Delta 10y$ Treasury shown in percentage points (pps). Skewness and kurtosis computed from daily observations.

3.4.1. Return Calculation

For each bond, a daily return series was constructed using the Total Return Index (RI) from Refinitiv Datastream. This measure accounts for both price fluctuations and coupon reinvestments, providing a comprehensive view of the total return for the bondholder (Zerbib, 2019; Bachelet et al., 2019). Daily log returns were calculated as:

$$r_{g,ng} = \ln\left(\frac{RI_{i,t}}{RI_{i,t-1}}\right)$$

where $r_{i,t}$ denotes the log return of bond i at day t , g represents the green portfolio, and ng the non-green portfolio. Then, portfolio returns were computed as the equally weighted average of active bond returns on day t :

$$r_{p,t} = \frac{1}{N_t} \sum_{i=1}^{N_t} r_{i,t}$$

where N_t is the number of bonds in portfolio p on day t , equally weighted averaging avoids concentration in larger issuances (biasing results toward more liquid or benchmark bonds), which is consistent with other matched-bond studies (Zerbib, 2019; Flammer, 2021).

In traditional asset-pricing studies, returns are often expressed as excess returns over the short-term risk-free rate (e.g., Fama & French, 1993; Adrian et al., 2010). However, for this thesis, raw log returns are employed for three reasons:

- Negligibility at daily frequency, as treasury bill yields are economically negligible relative to daily bond return volatility (on the order of basis points).
- Symmetry across portfolios, as both green and non-green portfolios share the same baseline interest rate environment, means that risk-free adjustments would cancel out in a comparative analysis.
- Maturity differences arise because incorporating a single short-term T-bill series would create a mismatch relative to the mixed maturities in the sample.

This decision aligns with studies of short-horizon responses to political risk, which use raw returns (Boutchkova et al., 2012; Smales, 2021).

Timeline

Daily return series were constructed for the period from January 1, 2020, to December 31, 2024. This interval captures recent geopolitical shocks (COVID-19, Russia–Ukraine war, U.S.–China trade tensions, Middle East conflicts) and ensures a relevant dataset for dynamic time-series analysis.

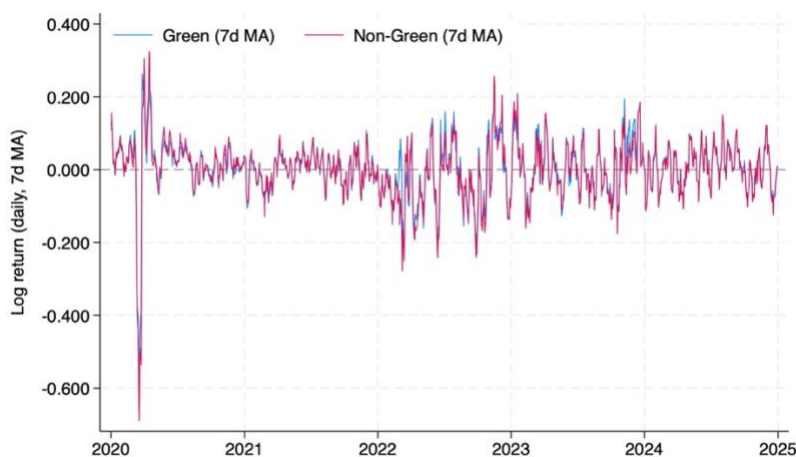
Variables for Regression Modelling

The framework design for the regression models operationalizes the primary variables, comprising (i) the dependent variable (portfolio returns), (ii) the key independent variable (geopolitical risk), (iii) the macro-financial control (U.S. Treasury yields), and (iv) the lagged returns to capture autocorrelation.

(i) Dependent Variable (Portfolio Returns)

As detailed previously, the dependent variable is the daily log returns of each portfolio (green and non-green), constructed from Refinitiv Datastream’s Total Return Index (TRI), which incorporates both price movements and coupon reinvestments. This measure is commonly used in literature for fixed-income market analysis (Zerbib, 2019; Bachelet et al., 2019).

Figure 1-Time series of portfolio returns (Green vs. Non-Green)²



² Series are daily log returns. For small magnitudes, log returns are approximately equal to simple percentage returns. A 7-day moving average is overlaid for readability. Source: Thomas Reuters

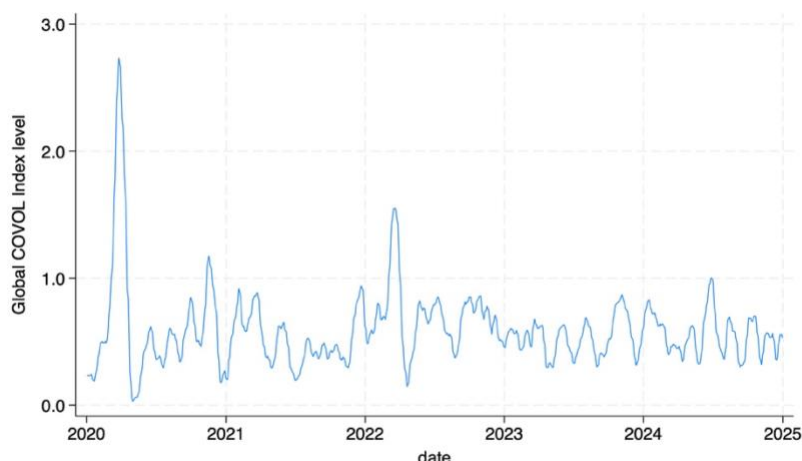
(ii) Independent Variable (Geopolitical Risk)

The primary explanatory variable is geopolitical risk, based on the Global COVOL index developed by Engle & Campos-Martins (2023). Specifically, the study employs the Country-Level ETF COVOL Common Volatility Analysis, which estimates systemic volatility shocks from a wide set of exchange-traded funds (ETFs) that represent country-level exposures. By focusing on country ETFs, this measure captures how shocks propagate globally through equity and bond markets at the national level, offering a comprehensive lens on cross-border financial stress.

Conceptually, Global COVOL measures the extent to which volatilities across different asset classes move together in response to shocks, derived from a framework where a common factor is extracted from volatility standardized idiosyncratic returns of multiple assets. The key insight is that the squared residual of asset returns still show correlated volatility after controlling for conventional risk factors, indicating that global shocks tend to move markets simultaneously. As a result, COVOL serves as a significant market-based measure of systemic stress, capturing actual price dynamics rather than just media prominence.

Compared to text-based indices such as the Caldara and Iacoviello (2022) Geopolitical Risk index, which track media references to geopolitical events, COVOL has several advantages. It avoids dependence on narratives, offers higher-frequency data, and directly reflects the realized impact of shocks on asset prices. At the same time, its focus on co-movement ensures that only systemic events are captured. For implementation, daily COVOL values were obtained from NYU's Volatility Lab. Following Engle & Campos-Martins (2023), the index is defined such that its expected value equals 1 in a stable state, representing normal levels of common volatility. To facilitate interpretation, the series was re-centered by subtracting 1, so that coefficients in regressions capture the effect of a one-unit deviation from the stable benchmark (i.e., an "excess" systemic volatility shock). This transformation ensures that the baseline corresponds to a neutral state, and positive values reflect abnormal increases in systemic volatility. This makes COVOL especially well-suited for short-term analyses, since the focus is on immediate financial reactions to geopolitical developments (Smales, 2021). Moreover, the country-level ETF specification captures various geographic exposures, enhancing the measure's ability to reflect the genuinely global nature of shocks.

Figure 2 - Time series of Global COVOL (Country-Level ETF Common Volatility Analysis)³



(iii) Macro-Financial Control (U.S. Treasury Yields)

To isolate the rate channel, we control for movements in the U.S. risk-free benchmark using the daily change in the constant-maturity 10-year Treasury yield, Δy_{10} . We include both contemporaneous ($\Delta y_{10,t}$) and one-day lagged ($\Delta y_{10,t-1}$) terms to allow for delayed price adjustment. Δy_{10} is measured in percentage points (1.00 = 100 bps) and is constructed from the U.S. Department of the Treasury's daily constant-maturity series. Using changes rather than levels is consistent with bond-pricing mechanics at daily horizons and mitigates concerns about non-stationarity. This specification follows asset-pricing evidence that interest-rate movements dominate corporate bond returns (Fama & Bliss, 1987; Adrian, Crump, & Moench, 2013) and recent sustainable finance work that separates monetary policy from ESG-related effects (e.g., Tang et al., 2023; Liu et al., 2024).

The 10-year U.S. Treasury is the global fixed-income benchmark combining (i) maturity/duration relevance (its DV01 maps closely to intermediate-term corporate bond exposures), (ii) depth and liquidity (minimizing idiosyncratic noise and microstructure effects), and (iii) pricing centrality for discount-rate movements that dominate credit instruments at daily horizons. Using Δy_{10} (changes, not levels) captures the principal rate channel while mitigating non-stationarity. Future work could consider richer rate controls (e.g., level/slope/curvature factors, term-structure PCs, Bund/Gilt/JGB yields by currency) or duration-matched risk-free series to probe robustness.

³ Global COVOL index measures forward-looking geopolitical risk. Higher values indicate greater uncertainty. Source: Volatility-Lab (NYU), Engle & Campos-martins, 2023

Figure 3 - Time series of the U.S. 10-year Treasury yield⁴

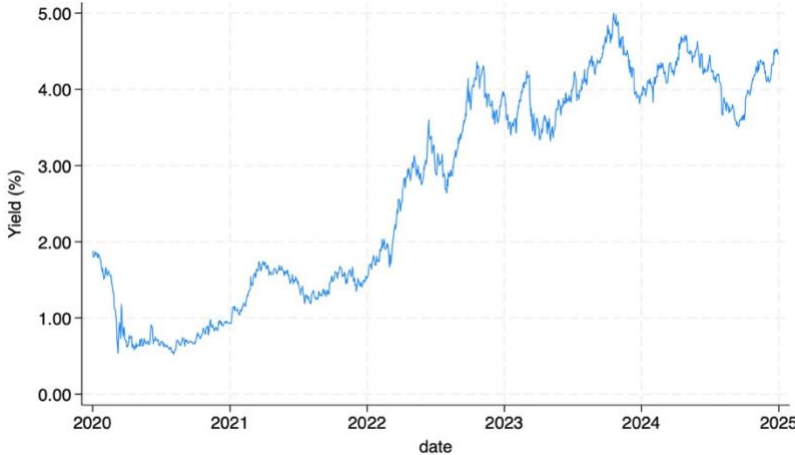
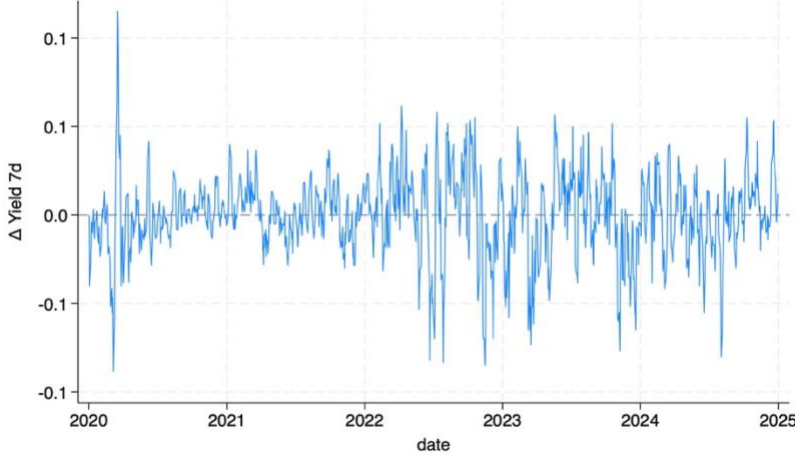


Figure 4 - Time series of daily changes in the U.S. 10-year Treasury yield



(iv) Return Autocorrelation

Corporate bond returns often exhibit short-term persistence due to market microstructure frictions, trading illiquidity, and the gradual diffusion of information, as evidenced by previous studies (Ilmanen, 2011; Gebhardt, Hvidkjaer, & Swaminathan, 2005). To address this issue, the model incorporates a measure for the lagged dependent variable ($r_{p,t-1}$), which controls for the dynamics of predictable returns and prevents residuals from absorbing autocorrelation. With the inclusion of autocorrelation, short-term adjustment dynamics are captured, which helps in understanding whether the effects of geopolitical risk persist across multiple days and reduces biases and inefficiencies in the estimates.

⁴ Figure 3 showcases daily yield on the U.S. 10-year Treasury bond (in percent), and in Figure 4 Δ yield denotes daily change in the U.S. 10-year Treasury yield. Shown as a 7-day moving average. Source: U.S. Federal Reserve

3.5. Hypothesis Testing and Regression Specifications

The empirical objective is to test the impact that geopolitical risk has on the performance of green bonds and assess whether these bonds differ from conventional bonds in their exposure to geopolitical risk. To this end, four regression specifications are estimated, and the results are reported in chapter 4, progressively incorporating dynamics and macro controls.

a) Baseline Static Model (OLS)

The starting point is a simple static regression:

$$r_{p,t} = \alpha_p + \beta_p \cdot GeoRisk_t + \varepsilon_{p,t}$$

where $r_{p,t}$: daily log return of portfolio p (green or non-green); $GeoRisk_t$: Global COVOL measure of geopolitical risk on day t ; β_p : contemporaneous sensitivity of portfolio returns to geopolitical risk. This specification aligns with earlier studies that examine the mean effects of political risk (Boutchkova et al., 2012; Pastor & Veronesi, 2013). It tests whether geopolitical risk has any measurable average effect on bond returns.

b) Dynamic Model with Lagged Returns and Risk

Next, the model is extended to capture temporal dynamics:

$$r_{p,t} = \alpha_p + \phi_p \cdot r_{p,t-1} + \beta_{0,p} \cdot GeoRisk_t + \beta_{1,p} \cdot GeoRisk_{t-1} + \varepsilon_{p,t}$$

where ϕ_p captures autocorrelation, and $\beta_{0,p}$ and $\beta_{1,p}$ measures immediate and lagged effects.

This specification directly tests H1 (Dynamic Adjustment), to assess whether geopolitical shocks produce a short-run negative effect followed by a rebound, consistent with a shock–rebound cycle (Pastor & Veronesi, 2013; Ilmanen, 2011).

c) Dynamic Model with Treasury Yield Controls

To control for macro-financial drivers, the model is augmented with daily changes to U.S. Treasury yields:

$$r_{p,t} = \alpha_p + \phi_p \cdot r_{p,t-1} + \beta_{0,p} \cdot GeoRisk_t + \beta_{1,p} \cdot GeoRisk_{t-1} + \gamma_{0,p} \cdot \Delta y10_t + \gamma_{1,p} \cdot \Delta y10_{t-1} + \varepsilon_{p,t}$$

Here, Δy_{10} is the daily change in the 10-year U.S. Treasury yield (percentage points). Coefficients γ_0 and γ_1 capture the contemporaneous and next-day sensitivity of portfolio returns to rate changes. This specification tests H3 (Macro Control Robustness) to assess whether geopolitical risk remains significant after controlling for interest rate dynamics, which are known to dominate bond returns (Fama & Bliss, 1987; Adrian, Crump & Moench, 2013).

d) Differential Model (Green vs. Non-Green Returns)

To understand whether green and non-green portfolios differ in their sensitivity, a difference-in-returns portfolio is constructed, through:

$$Diff_t = r_{g,t} - r_{ng,t}$$

where $r_{g,t}$ and $r_{ng,t}$ are the green and non-green portfolio returns, respectively. The regression is specified as:

$$Diff_t = \alpha + \phi \cdot Diff_{t-1} + \delta_0 \cdot GeoRisk_t + \beta_1 \cdot GeoRisk_{t-1} + \varepsilon_{p,t}$$

where δ test for same-day and lagged differences in sensitivity. Also, Treasury yield changes are added to ensure macro-financial comparability.

$$Diff_t = \alpha + \phi \cdot Diff_{t-1} + \beta_0 \cdot GeoRisk_t + \beta_1 \cdot GeoRisk_{t-1} + \delta_0 \cdot \Delta y_{10,t} + \delta_1 \cdot \Delta y_{10,t-1} + \varepsilon_{p,t}$$

The model aims to test whether green and non-green portfolios differ in contemporaneous or lagged sensitivity to geopolitical risk. A finding of $\delta = 0$ implies exposures are statistically equivalent. This model operationalizes H2 (Differential Exposure) by comparing returns directly, rather than indirectly, across separate regressions.

Estimation and Inference

All regression models are estimated using ordinary least squares (OLS) with heteroskedasticity- and autocorrelation-robust standard errors (Newey & West, 1987). Model fit is assessed through adjusted R^2 , F-statistics, and information criteria. The hypothesis tests focus on the signs and magnitudes of the geopolitical risk coefficients (β , δ), their statistical significance across contemporaneous and lagged terms, and the persistence of effects once daily changes in treasury yields are controlled for. Finally, the differential regressions allow for a direct assessment of whether green and non-green bonds exhibit distinct sensitivities to geopolitical risk.

Chapter 4 – Results

This chapter presents empirical results on the relationship between geopolitical risk and the performance of corporate bonds, with a particular emphasis on the comparative behavior of green versus non-green portfolios. The study follows the empirical strategy outlined in Chapter 3 and is structured around three steps. The analysis begins with static and dynamic regressions that exclude macro-financial controls, providing a baseline view of how bond returns respond in the short run to geopolitical shocks. These models capture the effects of return persistence and delayed adjustment, offering an initial test of H1 (Dynamic Adjustment). The next step introduces daily changes in Treasury yields as controls to test H3 (Macro Control Robustness), examining whether geopolitical shocks still matter once interest-rate movements are considered. Third, differential regressions (green minus non-green) directly assess H2 (Differential Exposure), testing whether green bonds respond differently from matched conventional bonds when exposed to geopolitical shocks.

Table 2 - Regression Results for Green and Non-Green Portfolios⁵

	Green Portfolio			Non-Green Portfolio		
	static	dynamic	+ treasuries	static	dynamic	+ treasuries
GeoRisk (t)	-0.033 (0.031)	-0.202 (0.138)	-0.323*** (0.090)	-0.045 (0.032)	-0.246* (0.133)	-0.357*** (0.088)
L.GeoRisk (t-1)		0.185 (0.124)	0.312*** (0.081)		0.220* (0.122)	0.337*** (0.081)
L.Return (t-1)		0.188*** (0.050)	0.130*** (0.043)		0.225*** (0.048)	0.213*** (0.043)
Δy_{10} (t) (pp)			-1.952*** (0.065)			-1.894*** (0.068)
L. Δy_{10} (t-1) (pp)			-0.014 (0.090)			0.191* (0.099)
Constant	-0.012 (0.015)	-0.000 (0.017)	0.002 (0.011)	-0.020 (0.015)	-0.006 (0.016)	-0.004 (0.012)
Adjusted R ²	0.004	0.046	0.698	0.008	0.067	0.664
Observations	1258	987	987	1258	987	987

Notes:

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Daily data from 1 January 2020 to 31 December 2024; L. denotes a one-day lag; Δy_{10} : daily change in the 10-year U.S. constant-maturity Treasury yield, measured in percentage points (1.00 = 100 bps)

⁵ Regression coefficients measure the change in daily portfolio returns associated with a one-unit change in the explanatory variable; see Appendix 2 for detailed interpretation.

4.1. Static Regression Results

a) Baseline Static Model (OLS)

The static regressions, where daily portfolio returns were regressed solely on contemporaneous geopolitical risk, yielded small and statistically insignificant coefficients for both portfolios (green: $\beta = -0.033$; non-green: $\beta = -0.045$; $R^2 < 0.01$). This outcome is not surprising, as static specifications are too restrictive at a daily frequency, as they overlook both the short-term persistence of bond returns and the potential for delayed responses to shocks across time zones.

In fixed-income markets, thin trading and gradual information diffusion further reduce the ability of purely static models to capture meaningful relationships (Ilmanen, 2011; Gebhardt, Hvidkjaer & Swaminathan, 2005). Consequently, the static results offer limited insight and mainly serve as a diagnostic baseline, motivating the use of dynamic specifications that incorporate lagged terms.

4.2. Dynamic Regression Results (Without Treasury Yield Controls)

b1) Dynamic Regression Results of Green Portfolio

The results of the dynamic regressions for the green portfolio yield three main insights. First, return autocorrelation is evident as the lagged dependent variable is positive and highly significant ($\phi = 0.188$, $p < 0.01$). This is consistent with established findings of short-term persistence in corporate bond markets, reflecting microstructure frictions, thin trading, and slow price adjustments. So, the presence of autocorrelation justifies the use of dynamic models for this analysis. Second, the coefficient of contemporaneous geopolitical risk is negative but statistically insignificant ($\beta_0 = -0.202$). While the sign is consistent with the hypothesis that geopolitical shocks depress bond returns, the lack of significance indicates that immediate sensitivity is limited in green bonds.

Third, lagged geopolitical risk is positive ($\beta_0 = +0.185$), indicating a rebound effect the day after the shock, though not reaching conventional significance levels. This sign pattern is consistent with a short-lived shock–rebound dynamic but lacks robust statistical backing. Overall, the dynamic regressions suggest that green bonds follow the hypothesized two-day cycle, with an initial negative response followed by partial recovery; however, the evidence remains weak in the baseline setting.

b2) Dynamic Regression Results of Non-Green Portfolio

Turning to the non-green portfolio, the regressions yield a qualitatively similar pattern but with somewhat stronger signals. First, return persistence is slightly higher ($\phi = 0.225$, $p < 0.01$), indicating more substantial autocorrelation compared to green bonds. One interpretation is that ESG-oriented investors in green bonds create “stickier” demand, reducing persistence relative to conventional markets (Pastor, Stambaugh & Taylor, 2022). Second, contemporaneous geopolitical risk is negative and marginally significant ($\beta_0 = -0.246$, $p < 0.10$), confirming that non-green bonds are more immediately sensitive to geopolitical shocks.

Third, the lagged term is positive and marginally significant ($\beta_1 = 0.220$, $p < 0.10$), pointing to a rebound in returns as uncertainty eases. Taken together, non-green bonds display the hypothesized shock–rebound cycle more clearly than green bonds. This provides more substantial support for H1 (Dynamic Adjustment), although the explanatory power of these baseline models remains modest ($R^2 < 0.10$).

Comparing the two portfolios, both display the expected shock–rebound pattern, with returns falling on the day of a geopolitical shock and recovering the next, consistent with a two-day adjustment cycle documented in earlier studies (Pastor & Veronesi, 2013; Boutchkova et al., 2012). Non-green bonds appear to be slightly more sensitive, but the differences are modest and not statistically robust. Overall explanatory power remains low ($R^2 < 0.10$), indicating that while geopolitical shocks matter, most of the variation in corporate bond returns is driven by other factors.

In sum, the baseline regressions (both static and dynamic) provide tentative support for H1 (Dynamic Adjustment), as corporate bonds exhibit short-lived losses followed by rebounds in response to geopolitical shocks.

4.3. Dynamic Regression Results (With Treasury Yield Controls)

The second set of regressions introduces the daily changes in the 10-year U.S. Treasury yield and its lag as additional explanatory variables. This step directly addresses H3 (Macro Control Robustness) by testing whether geopolitical shocks retain significance once the dominant driver of bond returns (interest rate dynamics) is controlled for.

c1) Dynamic Regression Results of Green Portfolio, controlling for treasury rates

For the green bond portfolio, explanatory power increases dramatically once Treasury yields are included (adjusted R^2 rises from below 0.10 to approximately 0.70), reflecting the significant role of interest-rate movements in driving daily returns. The daily change in Treasury yield coefficients follows standard bond-pricing mechanics, as contemporaneous change in the 10-year yield is strongly negative ($\gamma_0 = -1.952$, $p < 0.01$).

The contemporaneous coefficient of geopolitical risk is -0.323 ($p < 0.01$), while the lagged coefficient is $+0.312$ ($p < 0.01$), supporting the hypothesized two-day shock–rebound cycle. These results demonstrate that geopolitical risk exerts an independent effect on green bonds, over and above the dominant Treasury channel. Crucially, geopolitical risk remains significant even after Treasury dynamics are considered.

c2) Dynamic Regression Results of Non-Green Portfolio, controlling for treasury rates

For the non-green portfolio, results are qualitatively similar. The adjusted R^2 also rises to around 0.67, again underscoring the dominance of Treasury yields in explaining daily variation. The contemporaneous Treasury coefficient is negative ($\gamma_0 = -1.894$, $p < 0.01$), and the lagged coefficient is positive ($\gamma_1 = 0.191$, $p < 0.01$). Geopolitical risk likewise remains statistically significant. The contemporaneous coefficient is -0.357 ($p < 0.01$), and the lagged coefficient is $+0.337$ ($p < 0.01$). The magnitudes are slightly larger than those for the green portfolio, indicating a somewhat stronger reaction of conventional bonds to shocks. Nevertheless, the pattern is the same, showcasing a sharp initial decline followed by a rebound the next day.

Comparing across portfolios, the results confirm that Treasury yields dominate corporate bond pricing, explaining most of the daily variation. At the same time, geopolitical risk exerts a statistically robust, independent effect that produces a transitory two-day adjustment cycle. The coefficients for non-green bonds are somewhat larger in magnitude, suggesting a marginally higher sensitivity; however, the overlapping confidence intervals indicate that the difference is not statistically significant. In economic terms, a one-standard-deviation increase in global geopolitical risk reduces daily green bond returns by approximately 0.33 percentage points on the day of the shock and daily non-green bonds returns by approximately 0.36 percentage points, followed by a nearly symmetric rebound the next day. Given that average daily corporate bond returns are small, this effect is non-trivial, even though it is short-lived. To synthesize the results, the preferred regression model can be expressed as:

$$\begin{aligned} \text{green } r_{p,t} = & 0.002 + 0.130^{***} \cdot r_{p,t-1} - 0.323^{***} \cdot \text{GeoRisk}_t + 0.312^{***} \cdot \text{GeoRisk}_{t-1} \\ & - 1.952^{***} \cdot \Delta y10_t - 0.014 \cdot \Delta y10_{t-1} + \varepsilon_{p,t} \end{aligned}$$

$$\begin{aligned} \text{nongreen } r_{p,t} = & -0.004 + 0.213^{***} \cdot r_{p,t-1} - 0.357^{***} \cdot \text{GeoRisk}_t + 0.337^{***} \cdot \text{GeoRisk}_{t-1} \\ & - 1.894^{***} \cdot \Delta y10_t - 0.191^* \cdot \Delta y10_{t-1} + \varepsilon_{p,t} \end{aligned}$$

where $r_{p,t}$ denotes daily portfolio returns, GeoRisk is the standardized COVOL index of geopolitical risk, and $\Delta y10_t$ represents the daily change in the 10-year Treasury yield. This formulation captures the key elements established in the empirical analysis: return autocorrelation, independent effects of geopolitical shocks, and the dominant role of Treasury yields.

4.4. Differential Regressions (Green vs. Non-Green Returns)

To test H2 (Differential Exposure) directly, regressions were estimated on the return spread between the green and non-green portfolios ($\text{Diff}_t = r_{g,t} - r_{ng,t}$). By construction, this approach eliminates structural differences across portfolios and focuses solely on whether the “green label” itself alters sensitivity to geopolitical shocks.

Table 3 - Differential Regression Results

	baseline	+ treasuries
GeoRisk (t)	0.059* (0.031)	0.058* (0.031)
L.GeoRisk (t-1)	-0.047* (0.027)	-0.045* (0.027)
L.Diff_Ret (t-1)	0.158* (0.093)	0.159* (0.092)
$\Delta y10$ (t) (pp)		-0.043 (0.027)
L. $\Delta y10$ (t-1) (pp)		-0.037 (0.028)
Constant	0.007 (0.004)	0.008* (0.004)
Adjusted R ²	0.047	0.057
Observations	987	987

Notes:

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Daily data from 1 January 2020 to 31 December 2024; L. denotes a one-day lag; $\Delta y10$: daily change in the 10-year U.S. Treasury yield (in percentage points, 1.00 = 100 bps); Ddaily return differential: $\text{Diff}_t = r_{g,t} - r_{ng,t}$

d1) Baseline Differential Results

In the specification without Treasury controls, weak evidence of persistence emerges. The lagged dependent variable is positive and marginally significant ($\phi_0 = 0.158$, $p < 0.10$), suggesting that differences in performance between the two portfolios exhibit slight short-term continuity.

The coefficients on geopolitical risk point to a modest and temporary effect. The contemporaneous term is positive ($\beta_0 = +0.059$, $p < 0.10$), implying that green bonds may marginally outperform conventional ones on the day of a geopolitical shock. This could reflect “stickier” ESG-driven demand that cushions immediate declines (Pastor, Stambaugh & Taylor, 2022). Although statistically significant at the 10% level, the effect is economically negligible relative to the impact of geopolitical risk on the overall portfolio returns (for green and non-green). The lagged term is negative ($\beta_1 = -0.047$, $p < 0.10$), indicating that some of temporary outperformance of green bonds is reversed. Overall, the baseline regressions suggest that differential performance exists but is weak, transitory, and of little economic significance.

d2) Differential Results with Treasury Controls

When Treasury yields are included, evidence for differential exposure becomes slightly weaker. The lagged dependent variable remains weakly positive ($\delta_0 = 0.159$, $p < 0.10$), but the key coefficients on geopolitical risk lose statistical significance. The contemporaneous term is $+0.058$ ($p < 0.10$), while the lagged term is -0.045 ($p < 0.10$). Importantly, Treasury yields themselves are insignificant in the differential specification. This confirms that rate movements drive both portfolios equally and therefore cancel out when considering the return difference. In other words, once macro-financial conditions are controlled for, no systematic divergence remains between green and non-green bonds in their reaction to geopolitical risk.

To synthesize the results of the differential analysis, the preferred regression model for the green–non-green return spread can be expressed as:

$$\begin{aligned} Diff_t = & 0.008^* + 0.159^* \cdot Diff_{t-1} + 0.058^* \cdot GeoRisk_t - 0.045^* \cdot GeoRisk_{t-1} \\ & - 0.043 \cdot \Delta y10_t - 0.037 \cdot \Delta y10_{t-1} + \varepsilon_{p,t} \end{aligned}$$

where $Diff_t = r_{g,t} - r_{ng,t}$ denotes the daily return differential between the green and non-green portfolios, GeoRisk is the standardized COVOL index of geopolitical risk. Δy_{10} represents the daily change in the 10-year Treasury yield. This specification captures the same dynamic adjustment and rate-control structure applied to each portfolio individually but isolates whether the green label introduces a systematic difference in sensitivity to shocks.

4.5. Synthesis of Findings

The results across baseline, dynamic, and differential regressions yield four main conclusions:

- Dynamic adjustment matters (fail to reject H1). Static models obscure the effects of geopolitical shocks, but dynamic specifications reveal a consistent two-day cycle as returns decline on the day of the shock and rebound the following day.
- Treasury yields dominate (fail to reject H3). Interest-rate dynamics explain the vast majority of daily variation in corporate bond returns. Nonetheless, geopolitical shocks exert an independent effect, even after yields are controlled for.
- Slight overperformance of green bonds (fail to reject H2). Green bonds cushion 0.06 pps on shock days, partially lost in the following days. The effect is statistically marginal and economically negligible, therefore failing to reject that green bonds are slightly more resilient (still, no additional support for systematic resilience).
- Geopolitical shocks are transitory. They produce measurable but short-lived disturbances, consistent with safe-haven and flight-to-quality behavior (Beber, Brandt & Kavajecz, 2009; Pastor & Veronesi, 2013).

Taken together, the evidence indicates that geopolitical risk (mainly manifested through shocks) has statistical significance and relevance in the performance of green bonds (and their non-green counterparts), independently of daily changes to interest rates. This impact is usually short-lived and dissipated in a two-day adjustment cycle. As these results cover and measure daily effects, their magnitude is small but taking into consideration longer time period (with incremental effects) their economic implications and relevance gains substance. Also, the evidence was able to support that there is some resilience with green bonds (in comparison with non-green bonds), by showcasing in a statistical significant difference in returns when subject to equal geopolitical risk conditions. This difference, however, is marginal and not indicative of systematic dynamics.

Chapter 5 – Discussion and Limitations

The results reported in Chapter 4 indicate a consistent pattern in the daily response of investment-grade corporate bonds to geopolitical risk. After controlling for movements in the 10-year U.S. Treasury yield, a one-standard-deviation increase in the standardized COVOL index is associated with a contemporaneous reduction in portfolio returns of approximately 0.32 to 0.36 percentage points, followed by a near-symmetric rebound of about 0.31 to 0.34 percentage points on the next trading day. This recovery in returns is evident for both green and non-green portfolios, which supports the view that geopolitical variations trigger temporary price dislocations that are subsequently corrected as uncertainty fades, and liquidity returns.

The differential specification, defined as the green minus non-green portfolio return, shows a small same-day cushion for green bonds of about 0.06 percentage points, which reverses the following day by roughly 0.05 percentage points. The magnitude is modest in economic terms when compared with the effects of Treasury yield changes or geopolitical risk itself. Nonetheless, the effect is present at conventional significance thresholds, which warrants recognizing a very small, short-lived difference at daily horizons.

The discussion that follows interprets these findings, reconciles them with prior evidence, draws implications for market participants and policy, and sets out key limitations and avenues for future research.

(i) Short-run pricing under geopolitical stress

The two-day pattern provides evidence of transitory dislocations in fixed-income markets during geopolitical stress. On the shock day, investors reduce risk exposure, which widens credit discounts and lowers corporate bond prices. The subsequent rebound reflects partial resolution of uncertainty, portfolio adjustments, and reallocations toward income-bearing assets once the initial information shock has been digested. The positive and significant lagged return terms in the portfolio regressions (approximately 0.19 for green and 0.23 for non-green) are consistent with short-run persistence generated by market microstructure, including thin trading, order-flow autocorrelation, and settlement frictions. This structure aligns with the documented shock–rebound dynamics in the broader literature on political and macroeconomic effects on financial instruments (Pastor & Veronesi, 2013; Ilmanen, 2011).

(ii) Economic magnitude and event scaling

Interpreted as percentage points, the estimated contemporaneous geopolitical risk effects are material at a daily frequency. A one-standard-deviation increase in COVOL reduces returns by about 0.32 to 0.36 percentage points, which is large relative to typical daily means near zero and to the dispersion of investment-grade daily returns. Event scaling illustrates the potential impact on high-stress dates. Supposing the increase in COVOL on a specific episode was ten standard deviations, the model implies a same-day change of -3.2 percentage points for green and -3.6 percentage points for non-green, with a next-day rebound of similar magnitude. Such calculations should be based on observed σ -moves in the data window to maintain accuracy and transparency.

(iii) Interest rates and geopolitical risk effect

Including the daily change in the 10-year Treasury yield raises adjusted R^2 into the 0.67-0.70 range. The same-day treasury change coefficient is close to -1.9 percentage points per 1 percentage-point increase in yield. These estimates confirm that movements in the discount rate dominate daily pricing in corporate bonds. Additionally, geopolitical risk coefficients remain statistically significant after controlling for treasury rate changes, with the additional explanatory content provided by COVOL demonstrating that it exerts an independent influence rather than merely acting as a proxy for interest-rate uncertainty.

(iv) Difference between green and non-green

The differential regressions indicate a slight same-day outperformance of green bonds relative to non-green bonds under geopolitical risk exposure. A plausible explanation is that investor clientele effects and ESG-driven demand create a marginal cushion against immediate selling pressure in ESG-labeled securities. Index inclusion, investor mandates, and the reputational strength of green financial instruments may support this cushion when risk aversion spikes. The quick reversal suggests that this advantage is not durable once broader market forces and discount-rate dynamics are reasserted. Consequently, the evidence suggests a minimal and transitory difference in daily sensitivity, rather than a structural divergence in risk transmission.

5.1. Implications for practice

From an investor perspective, portfolio construction and risk management should prioritize interest-rate exposure, since Treasury movements explain most of the daily variation in

corporate bond returns. Geopolitical events can produce significant same-day effects, typically followed by partial rebounds within a single trading session. Stress testing should reflect this short-lived pattern and avoid assuming persistent losses from geopolitical shocks in the absence of concurrent macro or credit regime changes. The small same-day cushion in green bonds seems to be insufficient to justify treating green bonds as hedges against geopolitical risk at daily horizons. Issuers of green-labeled debt benefit from reputational gains, investor diversification, and potential pricing advantages associated with the greenium. The results indicate that these benefits do not extend to additional protection from geopolitical shocks. Communication around new issues and investor relations materials should therefore emphasize the integrity of use-of-proceeds and alignment with credible taxonomies and standards.

5.2. Reconciling with Prior Studies

Several empirical studies have reported differences between sustainable and conventional assets during high-volatility regimes or major geopolitical episodes (Sheehan, 2023; Tang, Chen, Sarker, and Baroudi, 2023). Three design features of the present analysis help better understand mixed findings. First, the composition of the comparative portfolios, as Index-level comparisons frequently confound differences in credit rating, maturity structure, industry mix, and currency denomination with the effect of the green label. For instance, green bond indices may tend to tilt toward supranational or highly rated issuers, whereas conventional indices encompass a broader spectrum of corporate issuers (Bachelet, Becchetti, & Manfredonia, 2019; Flammer, 2021). The matched-pairs approach employed here eliminates much of this compositional noise by pairing each labeled bond with a conventional counterpart matched on key structural characteristics, in line with Zerbib (2019).

Second, model dynamics are critical to the analysis, since static regressions ignore the two-day trajectory that underlies the results in Chapter 4. Without lagged terms, contemporaneous coefficients can underestimate the immediate impact of shocks or misinterpret the next day rebound as persistent outperformance. Dynamic specifications recover the temporal effect of adjustment, which reveals that apparent differences often reflect timing rather than sustained divergence. This interpretation is consistent with the evidence of short-run political and policy shocks in asset pricing (Boutchkova et al., 2012; Pastor & Veronesi, 2013).

Third, macro controls are crucial for a comprehensive assessment of the relationship between geopolitical risk and corporate bond performance. The changes to the 10-year Treasury yield are a dominant driver of daily bond returns and a core determinant of discounting in fixed income (Fama & Bliss, 1987; Adrian, Crump, & Moench, 2013). Designs that do not explicitly control for discount-rate movements might be attributing risk-induced variation to the green label. Once Treasury changes are controlled for, differential responses shrink to the minimal same-day effect documented here. This pattern is consistent with clientele and microstructure channels that operate at high frequencies (Pastor, Stambaugh, & Taylor, 2022) but does not alter the underlying risk transmission of labeled bonds.

5.3. Contributions to Literature

This study contributes along empirical and methodological dimensions. The empirical contribution is to document that geopolitical shocks are associated with material same-day declines and near-symmetric next-day rebounds in investment-grade corporate bond returns, and to show that this pattern holds for both green and non-green portfolios once bonds are matched on structural characteristics. The differential regressions reveal a minuscule and transitory cushion for green-labeled instruments, indicating that a minor difference exists at daily horizons. The analysis does not provide additional support for incremental hedging properties beyond this modest and short-lived effect. The methodological contribution is to combine exact matching and nearest-neighbor matching at the bond level with dynamic time-series regressions and explicit Treasury yields' controls. This design enhances comparability, captures the temporal effect of adjustment, and separates discount-rate influences from geopolitical shocks.

5.4. Limitations of the Study

The analysis is subject to several limitations that frame the scope of inference. First, data frequency and time horizon, since daily data is well-suited to identify short-run responses and the shock–rebound cycle documented here. Nonetheless, it is less informative about slower channels that unfold over weeks or months, including regulatory adjustments, trade diversion, and supply-chain realignment. Secondly, the choice of macro control variables for the regression model. Although the 10-year U.S. Treasury rate is an effective benchmark for discount-rate changes and liquidity, a single factor cannot span the entire term structure.

Alternative specifications that use level, slope, and curvature factors or duration-matched risk-free benchmarks by currency could refine the measurement and test robustness. Third, the design of the risk proxy used. Although Global COVOL is well-suited for high-frequency analysis, it does not capture narrative framing or sentiment intensity. Complementing COVOL with text-based indices, such as the GPR index, could provide a multidimensional view of geopolitical risk that combines realized market stress with the salience of events in media coverage.

Additionally, the scope of the data used, as this dataset is restricted to investment-grade corporate bonds issued by firms domiciled in Europe and the Americas, above the 250M€ issue threshold. This improves comparability and data quality but limits generalizability, as sovereign instruments, high-yield corporates, and emerging-market issuances can exhibit materially different liquidity profiles, investor bases, and policy sensitivities. Next, the matching process utilized may limit the representativeness of the final matched sample, as the criteria used reduce sample size and exclude unmatched bonds. Finally, pooling different currencies into each portfolio (computing returns in local currencies) can transmit cross-currency co-movements into the aggregate portfolios.

5.5. Future Research

Several directions can extend these findings. First, shifting to longer horizons could clarify whether the two-day shock–rebound cycle aggregates into medium-term outcomes. Estimating regressions at weekly or monthly frequency would reveal whether shocks fade quickly or lead to slower repricing. Second, richer macro controls would strengthen inference. Beyond the control variables used, incorporating term-structure factors and adding credit-spread benchmarks would test whether geopolitical shocks transmit partly through spread risk (rather than just via the risk-free curve).

Third, hybrid measures of risk could offer a more comprehensive picture; so, combining Global COVOL, a market-based proxy of systemic volatility (Engle & Campos-Martins, 2023), with narrative indices such as the Caldara–Iacoviello GPR (Caldara & Iacoviello, 2022) would capture both realized co-movements and the salience of events in media coverage. Fourth, regime-dependent models such as Markov-switching (Hamilton, 1988) could identify whether sensitivities differ across high- and low-volatility states. This would test if the small same-day

green bond cushion expands during acute stress and/or disappears in calmer conditions. Finally, further applications could explore sovereign green bonds, high-yield corporates, and emerging-market debt (Sheehan, 2023; Tang, Chen, Sarker and Baroudi, 2023) and/or or test how the greenium itself behaves under stress (Zerbib, 2019; Flammer, 2021). Event-study calibrations (for example, during the Ukraine invasion in February 2022) would provide case-specific insights for risk management.

5.6. Concluding Remarks

The evidence demonstrates that geopolitical shocks have a clear and measurable impact on daily corporate bond returns after accounting for discount-rate movements. The effect is short-lived, with losses on the event day followed by a near-symmetric rebound on the next day, with green and non-green portfolios sharing this adjustment path. The differential analysis detects a minimal same-day cushion for green-labeled bonds that reverses quickly. This pattern provides no additional support for the incremental hedging properties of the green label at daily horizons. Interest-rate risk remains the dominant driver of day-to-day credit valuations, while geopolitical risk operates as a secondary source of transitory variation. The implications for investment practice and issuance strategy are to treat green labeling as a tool for capital mobilization and transparency, rather than a mechanism for short-run resilience.

Chapter 6 - Conclusions

This thesis aimed to investigate whether geopolitical risk affects the performance of investment-grade green corporate bonds and whether these instruments behave differently from conventional bonds when structural features are controlled for. To answer these questions, a bond-level matched dataset was constructed for issuers domiciled in Europe and the Americas, denominated in EUR, USD, and others. Each green bond was paired with a non-green equivalent matched on credit rating, coupon type, currency, and issue size. From these matched pairs, daily total return portfolios were formed for the period 2020–2024. Geopolitical risk was proxied by the standardized Global COVOL index, which measures systemic volatility across global markets. Daily changes in the 10-year U.S. Treasury yield were included to capture discount-rate dynamics, ensuring that shocks were distinguished from broader macro-financial drivers. The empirical strategy combined dynamic regressions for each portfolio with a differential specification comparing green and non-green returns directly.

Key Findings and Takeaways

The analysis yielded a consistent set of results. Geopolitical shocks matter for corporate bond returns, but their effects are brief. A one-standard-deviation increase in COVOL generated same-day losses of about 0.32 to 0.36 percentage points, followed by rebounds of similar size on the next trading day. This two-day shock–rebound cycle reflects a transitory repricing rather than a sustained shift in valuation, consistent with patterns of flight-to-quality and short-run liquidity rebalancing observed in prior studies of political risk. Interest-rate movements emerged as the primary driver of daily credit performance.

Introducing the 10-year Treasury change significantly increased the explanatory power of the regressions, with adjusted R^2 values approaching 0.70. The estimated coefficients showed that a one percentage-point increase in yields corresponded to immediate portfolio losses of nearly 1.9 percentage points, followed by a partial correction the next day. These findings reaffirm the central principle of bond pricing, which states that discount factors drive the bulk of daily variation, while other shocks, including geopolitical events, play a secondary but still detectable role. Importantly, geopolitical risk retained independent explanatory power after controlling for Treasury dynamics. The persistence of significant coefficients on COVOL indicates that event-driven forces cannot be reduced to rate volatility alone even if smaller in magnitude than interest-rate effects.

When comparing green and non-green portfolios, differences proved minimal. On shock days, green bonds showed a slight cushion of around 0.06 percentage points relative to their conventional counterparts. The effect is detectable at the statistical level yet negligible in economic terms compared with the magnitude of interest-rate or geopolitical shocks. Once structural comparability and macro-financial controls were ensured, green and non-green bonds behaved essentially the same at daily horizons. Considered together, these results answer the two guiding research questions. Geopolitical shocks do affect the daily returns of green bonds, producing a clear shock–rebound pattern. However, green bonds do not display systematically greater or lower exposure than matched conventional bonds. The very small same-day cushion observed is offset almost immediately, meaning the evidence does not support claims of additional hedging benefits linked to the green label.

These conclusions have broader implications for the role of green bonds in sustainable finance. The findings suggest that green bonds should not be expected to provide distinct short-term resilience during geopolitical crises. Their contribution lies in mobilizing capital for climate-aligned projects, in enhancing transparency through use-of-proceeds commitments, and in supporting the credibility of sustainable finance frameworks. The so-called greenium, as documented in the literature, is a yield discount linked to ESG demand, which reflects investor willingness to pay for alignment with ESG objectives, not an altered resistance to shocks.

From a methodological standpoint, the study illustrates the value of combining bond-level matching with dynamic specifications. Matching eliminates structural differences that often distort index-level comparisons, ensuring that the observed effects can be more confidently attributed to the green label. The dynamic regressions capture the temporal adjustment path, uncovering the two-day cycle that static models would miss. Incorporating Treasury yields provides a necessary benchmark, separating discount-rate movements from other shocks. These design choices strengthen the robustness of the results and provide a template for future research on ESG fixed income at high frequency.

For practitioners, the results carry several messages. For investors, interest-rate risk remains the primary concern in portfolio management, while geopolitical events should be treated as sources of temporary volatility. The evidence does not support the assumption that green bonds offer additional hedging benefits beyond those of conventional credit. For issuers, the findings underscore that the advantages of green bonds lie in reputational gains, investor diversification, and compliance with evolving regulatory standards, rather than in added protection against systemic shocks.

Ultimately, this thesis contributes to the literature on sustainable finance and asset pricing by clarifying the boundaries of what the green bond label delivers. Green bonds are effective instruments for directing capital toward climate-related projects and for aligning investment practices with sustainability goals. Yet they remain embedded in the conventional dynamics of global credit markets, shaped first and foremost by discount-rate movements and subject to transitory impacts from geopolitical stress.

Final Reflections

The broader academic significance of this work lies in highlighting the need for nuance when evaluating ESG-labeled instruments. By using a matched-pair design, a market-based measure of geopolitical risk, and dynamic regressions with rate controls, this thesis provides a more precise assessment of green bonds. The results show that the green label matters for pricing and demand but does not fundamentally alter the channels through which shocks transmit into returns. In a financial system increasingly shaped by both climate urgency and geopolitical instability, clarity about these strengths and limitations is vital. Overstating the protective qualities of green bonds risks undermining their credibility, while underestimating their importance in financing the transition would overlook their central role in sustainable capital markets. The evidence presented here supports a balanced view that green bonds are powerful tools for mobilizing climate finance and shaping investor demand, yet their risk dynamics remain closely aligned with those of conventional corporate bonds.

This recognition provides a more grounded foundation for academic debate, market practice, and policy design. It situates green bonds within the mainstream of fixed income while affirming their unique contribution to the energy transition. By establishing clear boundaries between pricing effects and risk transmission, the thesis enhances the understanding of how sustainable instruments operate in practice and helps ensure that expectations surrounding them remain both ambitious and realistic.

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List of Abbreviations

- pps – Percentage points (1/100 of a percentage point)
- COVOL – Common Volatility Index (Global COVOL, Engle & Campos-Martins, 2023)
- ESG – Environmental, Social, and Governance
- EU – European Union
- EUR – Euro
- GPR Index – Geopolitical Risk Index (Caldara & Iacoviello, 2022)
- ICE BofA – Intercontinental Exchange Bank of America (bond indices provider)
- IG – Investment Grade
- OLS – Ordinary Least Squares
- PSM – Propensity Score Matching
- TRI – Total Return Index
- USD – United States Dollar
- Δy_{10} – Daily change in the 10-year U.S. Treasury yield

Glossary

- **Bond Matching:** A statistical method used to pair green and conventional bonds with equivalent structural features (credit rating, currency, coupon type, issue size) to ensure comparability.
- **COVOL (Common Volatility Index):** A market-based measure of systemic risk capturing common volatility across global asset classes, interpreted as a proxy for geopolitical shocks.
- **Credit Rating:** An assessment of the creditworthiness of a bond issuer, typically provided by agencies such as Moody's, S&P, or Fitch, expressed in rating buckets (AAA, AA, A, BBB, etc.).
- **Dynamic Regression:** An econometric specification that includes lagged variables to capture delayed or persistent effects, particularly useful for modeling short-term market adjustments.
- **Geopolitical Risk:** The probability of adverse market outcomes resulting from international conflicts, wars, terrorism, or political instability.
- **Green Bond:** A fixed-income security whose proceeds are earmarked exclusively for financing environmentally sustainable projects, such as renewable energy, clean transport, or energy efficiency.
- **Greenium:** The yield discount observed on green bonds compared with structurally equivalent conventional bonds, attributed to excess ESG demand.
- **Investment Grade (IG):** Bonds with relatively low credit risk, typically rated BBB– or higher by credit rating agencies.
- **Matched-Pair Design:** An empirical method where each green bond is paired with a non-green counterpart to isolate the effect of the “green” label from other structural factors.
- **Safe Haven:** An asset expected to retain or increase in value during times of market turbulence, often associated with government bonds or gold.
- **Shock–Rebound Cycle:** A short-term market pattern where asset prices fall on the day of a geopolitical shock but recover in the following trading session.
- **Total Return Index (TRI):** A measure that incorporates both price changes and coupon reinvestments, providing a comprehensive view of bondholder returns.
- **U.S. Treasury Yield (Δy_{10}):** The yield on the 10-year U.S. Treasury bond, widely used as a global benchmark for discounting and risk-free returns.

Appendices

Appendix 1 – Stata Code (for bond-matching process)

Stage 1) Exact matching

```
clear all
import excel "/Users/Desktop/bonds_data.xlsx", sheet("green_bonds") firstrow clear
gen green = 1
save green_bonds_raw.dta, replace
import excel "/Users/Desktop/bonds_data.xlsx", sheet("green_bonds") firstrow clear
gen green = 0
save non_green_bonds_raw.dta, replace

use green_bonds_raw.dta, clear
append using non_green_bonds_raw.dta
save all_bonds_raw.dta, replace
rename DatesIssueDate issue_date
rename IssuerBorrowerNameFull issuer
rename CouponCouponType coupon_type
rename ProceedsAmountThisMarket issued_amount
rename NewIssuesRatingsMoodyDebt credit_rating
rename PackageOfferCurrency currency
rename ISIN isin
rename MaturityMaturityDate maturity_date
rename CouponCouponRate coupon_rate
format issue_date %td

gen rating_bucket = .
replace rating_bucket = 1 if credit_rating == "AAA"
replace rating_bucket = 2 if inlist(credit_rating, "AA1", "AA2", "AA3")
replace rating_bucket = 3 if inlist(credit_rating, "A1", "A2", "A3", "A")
replace rating_bucket = 4 if inlist(credit_rating, "BAA1", "BAA2", "BAA3")
replace rating_bucket = 5 if inlist(credit_rating, "BA1", "BA2", "BA3", "B1", "B2", "B3", "NR", "P1", "P2")

egen match_group = group(currency coupon_type rating_bucket)
gen id = _n
save all_bonds_clean.dta, replace
```

```

use all_bonds_clean.dta, clear
keep if green == 1
rename coupon_type g_coupon_type
rename issued_amount g_issued_amount
rename issue_date g_issue_date
rename maturity_date g_maturity
rename coupon_rate g_coupon_rate
rename isin g_isin
gen g_id = _n
save green_bonds_clean.dta, replace

```

```

use all_bonds_clean.dta, clear
keep if green == 0
rename coupon_type ng_coupon_type
rename issued_amount ng_issued_amount
rename issue_date ng_issue_date
rename maturity_date ng_maturity
rename coupon_rate ng_coupon_rate
rename isin ng_isin
gen ng_id = _n
save non_green_bonds_clean.dta, replace

```

```

use green_bonds_clean.dta, clear
joinby match_group using non_green_bonds_clean.dta, unmatched(master)
gen ratio = ng_issued_amount / g_issued_amount
keep if ratio >= 0.5 & ratio <= 2
save matched_pairs_stage1.dta, replace
export excel using "matching_stage1.xlsx", firstrow(variables) replace

```

Stage 2) Nearest-neighbor matching

```

clear all
import excel "/Users/matching_stage1.xlsx", sheet("Sheet1") firstrow

gen g_logamt = log(g_issued_amount)
gen ng_logamt = log(ng_issued_amount)
gen coupon_diff = abs(ng_coupon_rate - g_coupon_rate)
gen amt_diff = abs(ng_logamt - g_logamt)
egen z_coupon = std(coupon_diff)
egen z_amt = std(amt_diff)

```

```

foreach v in z_coupon z_amt {
  replace `v' = 0 if missing(`v')
}

gen dist = sqrt(z_coupon^2 + z_amt^2)
set seed 12345
gen dist_j = dist + runiform()*0.000001
bysort g_id (dist_j): gen rank_g = _n
keep if rank_g <= 3
bysort ng_id (dist_j): gen rank_ng = _n
keep if rank_ng == 1
drop rank_ng
bysort g_id (dist_j): gen rank_g2 = _n
keep if rank_g2 == 1
drop rank_g rank_g2 dist_j
drop if missing(ng_isin)

save matched_pairs_stage2.dta, replace
export excel using "matching_stage2.xlsx", firstrow(variables) replace

```

Appendix 2 - Interpretation of Regression Coefficients

Each coefficient measures the change in daily portfolio returns (in percentage points) associated with a one-unit change in the corresponding variable, holding all else constant. Because the COVOL index is standardized, its coefficient indicates the return impact of a one-standard-deviation increase in systemic geopolitical risk. A negative contemporaneous coefficient (GeoRisk t) means that returns fall on the same day risk rises. A positive lagged coefficient (GeoRisk $t-1$) indicates a rebound effect, where part of the previous day's loss is reversed the following session.

The lagged return coefficient (R_{t-1}) captures short-run persistence in bond returns, reflecting market frictions and adjustment dynamics: a positive value suggests that negative shocks are partially carried over, but also that rebounds are stronger once corrections begin. Coefficients on the 10-year Treasury yield changes (Δy_{10} and its lag) are interpreted analogously: they show the immediate and next-day sensitivity of corporate bond returns to benchmark interest-rate movements.