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Analyzing the link between Environmental, Social and Governance (ESG) and sovereign bond spreads: an empirical analysis of CEE countries

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Abstract

This study investigates the effects of a country's environmental, social and governance (ESG) performance on sovereign bond spreads in CEE countries. We used both the sovereign bond spreads vis-à-vis the U.S. and bond spreads vis-à-vis Germany. We employed a dynamic panel generalized method of moments model, based on a sample of 10 CEE countries from 2009 to 2018. The analysis reveals that overall, better ESG performance is associated with lower sovereign bond spreads. When looking at bond spreads vis-à-vis the U.S., all three sub-dimensions of ESG are found to have significant negative impacts on sovereign bond spreads. When using bond spreads vis-à-vis Germany, only environmental and governance sides show significant effects. In addition, the results suggest that environmental side has more pronounced economic impacts on sovereign bond spreads than the other two sides.

Keywords

ESG, soverign credit risk, sovereign bond spreads, CEE countries, sustainbility

Range of thesis: 20450 words, 55 pages

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague 31.07.2022 **Yanqi Guan** Yanqi Guan

Institute of Economic Studies
Master thesis propsal

Provisional Title:
Environmental, Social and Governance (ESG) and financial performance of sovereign bond: an empirical analysis of CEE countries.

Key research question:
To what extent countries' Environmental, social and governance (ESG) performance can affect sovereign bond spreads?

Reasoned description
Sovereign bond yields are connected with ESG factors. On the one hand, investors care about the ESG performance of their portfolio. On the other hand, sovereigns with lower ESG scores seem to have higher risk of default. However, ESG is still a relatively new and fast expanding area, and the majority of the relevant studies in the recent century focus on identifying the influence of ESG indicators on the cost of corporate bonds and few pay attentions to the link between ESG and sovereign bond risks. Therefore, this paper is interested in exploring the possible relationships between overall ESG performance and sovereign bond spreads in CEE countries. For example, is the relationship positive or negative? Or is the impact of ESG on short-term government bond differs from long-term bond? In addition, this paper may also look at the financial impacts of environmental, social, and governance factors respectively.

Proposed methodology and sources of data:
This paper may use a dynamic panel generalized method of moments model to investigate relationships between ESG and sovereign bond spreads. Data are mainly collected from World Development Indicators (WDI) database and Datastream.

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- Data and Methodology
- Results and Discussion
- Conclusion

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1. Introduction

Environmental, Social and Governance (ESG), a concept that covers environmental considerations, socially responsible behavior as well as strong corporate governance, is becoming an increasingly prominent theme for institutional investors. ESG criteria are now considered when making investment decisions, whether investors rely on rating agencies for their capital markets investments or PE fund managers that have endorsed the UN Principles for Responsible Investment. One crucial reason for the growing emphasis on ESG is that investors have come to believe that non-financial factors, such as ESG, can have a significant economic impact. Focusing on that, a group of studies (Eliwa et al., 2021; Weber et al., 2014; Ge & Liu, 2015) tries to figure out whether ESG performance is associated with the cost of debt. These studies believe that ESG practices play a significant role in how lending institutions assess a borrowing institution's (e.g. a firm or a country) creditworthiness. They also contend that lending institutions consider ESG information when making lending decisions in order to assess the default risk and reputational risk posed by these borrowing institutions (Weber et al., 2014).

Existing literature on the link between the ESG and the cost of debt mainly focuses on two sperate research fields. One is interested in the impact of ESG on the cost of debt at the firm level (micro-level). These studies investigate whether companies that have better ESG performance can borrow at a lower cost of debt. However, findings in this strand are ambiguous. Some literature (Ye and Zhang, 2011; Ge & Liu, 2015; Goss and Roberts, 2011; Hasan et al., 2017; Gracia and Siregar, 2021) show that lenders do take a company's ESG performance into consideration when making lending decisions, although such information sometimes is regarded as supplementary information. Other studies (Erragragui, 2017; Stellner et al., 2015; Hoepner et al., 2016), however, argue that there is only a weak linkage between superior corporate social performance (CSP) and systematically lower credit risk. Different from those studies, some scholars investigate the relationship between ESG performance and the cost of debt at the country-level (macro-level). In other words, they study whether and how a country's ESG performance relates to its sovereign borrowing costs in international capital markets. Among existing literature, Capelle-Blancard (2019) and Margaretic and Pouget (2018) both find that a country's overall ESG performance has

a significant impact on the cost of sovereign debt, and countries with better ESG performance tend to have lower sovereign bond spreads.

The determinants of sovereign bond have been studied in literature for more than forty years, and most studies has focused on the impact of macroeconomic fundamentals on sovereign bond yield spreads. Specifically speaking, studies have found that sovereign bond spreads are mainly influenced by three groups of variables, namely country-specific risk factors such as public debt level and current account level (Ardagna et al., 2007; Baldacci and Kumar, 2010; Beirne and Fratzscher, 2013; Attinasi et al., 2009; Heppke-Falk and Hüfner, 2004; Costantini et al., 2014), which play a particularly crucial role in European sovereign bond market; factors related to liquidity risks (Codogno et al., 2003; Gomez-Puig, 2006; Beber et al., 2009), which are found to have more significant impacts during the period of financial distress; and risk factors at the international level such as risk aversion of investors (Gomez-Puig, 2006; Barrios et al., 2009; Manganelli and Wolswijk, 2009). It was not until the recent decades that "soft information" or "extra-financial factors" were paid attention to by researchers to explain the evolution in sovereign bond spreads, because more and more studies argue that the explanation power of conventional macroeconomic fundamentals on sovereign bond spreads has become limited, especially after the global financial crisis and European sovereign debt crisis (Gomez-Bengoechea and Arahuetes, 2018; Geyer et al., 2004; Beirne and Fratzscher, 2013). Thus, these findings suggest the need to investigate whether sovereign bond spreads are affected by extra-financial factors or what kinds of extra-financial factors have pronounced impacts on sovereign credit risks. As stated by Hoepner et al. (2016), understanding these issues can better help investors identify financial market risks, as well as help policymakers make decisions that benefit their own bond markets.

From a theoretical perspective, sustainability or ESG influences the sovereign bond spreads through at least three channels. Firstly, investors may regard ESG as a signal of low default risk. They believe that sound sustainability performance is associated with a long-term economic benefit to a country, thus signaling a country's credible commitment to repay long-term debt (Capelle-Blancard, 2019). Secondly, countries with better ESG performance may take bigger losses if they default, which in turn motivates them to repay debt. In other words, during the process of improving ESG

performance, the communication and cooperation on ESG issues between countries and the other parties (e.g. companies and international organizations) help to build trust and reduce information asymmetries. In this way, default in debt will damage countries' reputations and lead to a loss in future chances to borrow (Margaretic and Pouget, 2018). In addition, better ESG performance is also perceived by investors as a buffer against adverse shocks, as investors believe that a country's natural and social resources can become an extra-guard against losses (ibid).

The objective of this paper is threefold. It first investigates whether the cost of public debt can be determined by extra-financial performance. We especially examine whether smaller sovereign bond spreads in CEE nations are associated with better ESG performance. Secondly, we investigate the three sub-dimensions (environmental, social and governance) in ESG framework individually in order to see which sub-dimension has more pronounced impact on sovereign bond spreads. Additionally, because access to ESG databases is restricted and the authenticity of ESG data is hotly contested (Scholtens, 2017), we solve the data problem by building the ESG index from 21 indicators utilizing information from non-commercial providers for 10 CEE nations. Overall, the aim of this study is to shed light on the economic effect of ESG factors at the country level. In two aspects, this study primarily adds to the body of empirical research already in existence. As for the strand of determinations of sovereign bond spreads, this paper provide evidence that extra-financial factors can have an impact on sovereign credit risks of CEE countries. In terms of the ESG strand, this study concentrates on the macroeconomic level examination of ESG in CEE countries, whereas the majority of the work to date is focused on the microeconomic level.

To test how ESG performance impact a country's sovereign bond spreads, we use an estimation based on the Generalized Method of Moments (GMM), which allows the model to contain lagged dependent variable. Our sample consists of 10 CEE countries and covers the period from 2009 to 2018. To measure sovereign bond spreads, we use the 10-year sovereign bond yield differential compared to that of the US as well as Germany for robustness purpose, all data come from Refinitiv Datastream. To proxy a country's ESG performance, we follow the instruction of OECD and JRC (Nardo et al., 2008; Luzzati and Gucciardi, 2015) and construct four composite indicators for

overall ESG performance and its sub-dimensions performance, namely *environmental sustainability index (ENSI), social sustainability index (SOSI),* and *governance sustainability index (GOSI)*, and then use the linear weighted rule to aggregate them into the *ESG country index (ESGCI)*.

We are interested in CEE countries for three reasons. First, existing studies that include European countries in their samples always focus on either developed European countries or eurozone countries, few studies single out CEE as a single subject of study. However, as stated by Karkowska and Urjasz (2021), CEE countries are more interconnected with each other than with global markets, and therefore it is more reasonable to assess developed and developing bond markets separately in European nations. Secondly, after the global financial crisis, the sovereign bond yields of CEE countries have experienced a unified and gradual decline against the sovereign bond yields of the US. Beirne and Fratzscher (2013) argue that small spreads and extremely high co-movements of sovereign rates within the European area indicate that, in contrast to other advanced economies, variables other than macroeconomic fundamentals may have been the important determinants of public debt in Europe. In addition, since the time period of this study includes European sovereign debt crisis, focusing on CEE countries can limit the changes in sovereign bond yield caused by this crisis, because CEE countries maintain more solid public finances during this period than other European countries such as Greece, Ireland and Italy (Karkowska and Urjasz, 2021).

The first finding of the paper is that Environmental, Social and Governance (ESG) performance measured at the composite level is priced by sovereign bond market. Good ESG performance is associated with lower sovereign bond spreads, and such association happens contemporaneously. Second, the evidence we present suggests that environmental, social and governance factors on their own have heterogeneous impacts on CEE economies' cost of debt. In addition, such impacts are also influenced by whether the US bond or German bond are used as benchmarks for sovereign bond spreads. As for environmental factors, this paper suggests that environmental factors seem to exert a more pronounced negative impact on sovereign bond spreads, with the environmental indicator being negative and significant for both US-based sovereign bond spreads and Germany-based sovereign bond spreads. This

is remarkable since previous studies such as Capelle-Blancard (2019) and Margaretic and Pouget (2018) all find that environmental factor has little influence on sovereign bond spreads than social and governance factors. One explanation for this finding is that, during the time period under study, environmental issues in CEE countries were perceived as a high level of materiality by investors. Another explanation could be that we use different measuring criteria to assess countries' environmental performance, thus making the results different from previous studies.

In addition, social indicator exhibits a negative and highly significant coefficient when estimating with US-based sovereign bond spreads, but no significant relationship was found between social factors and German-based sovereign bond spreads. One possible explanation for the lack of significance in Germany-based sovereign bond spreads model is that social factors are not priced by investors for the risk premium of CEE countries' long-term sovereign bond over long-term German sovereign bond on government bond market. Moreover, our analysis shows that the governance factors also has a negative and significant impact on sovereign bond spreads, and these factors have more pronounced explanation power for the changes in Germany-based sovereign bond spreads than in US-based sovereign bond spreads. However, different from previous studies (Capelle-Blancard, 2019; Margaretic and Pouget, 2018), we do not find that governance factors have the most pronounced economic impact among the three ESG sub-dimension factors. Overall, our studies confirm that sovereign bond spreads are determined by extra-financial factors and such effects can be economically large.

The remainder of this study is organized as follows. Section 2 summarizes the results of literature reviews literature. Section 3 describes the data used in our empirical analysis. Section 4 presents the models specified and the methodology used to estimate models. Section 5 shows the results of empirical analysis, and the results are further discussed and explained in that section. Section 6 includes the robustness analysis. Finally, Section 7 provides a summary of the research and draws some concluding remarks on the results achieved, as well as limitations and recommendations for further research.

2. Literature Review and Hypothesis Development

2.1 Introduction

This paper is related to two strands of literature. In the first part, this review will critically evaluate previous studies on the determinants of sovereign bond spreads. In the second part, this review will first introduce the theory of environmental, social and governance (ESG) and existing studies in this research field. Then it will further examine the empirical evidence on the correlation between ESG performance and the cost of debt, at both company-level and county-level.

2.2 Determinants of sovereign bond spreads

There is abundant empirical literature on the economic determinants of sovereign bond spreads. Most literature has identified fundamental conditions of economics as the factor influencing risk premia paid by governments relative to the benchmark government bond. Some of the prior research has found that fiscal fundamentals, in particular those associated with default risk and liquidity risk, are potential determinants of sovereign bond spreads (Ardagna et al., 2007; Heppke-Falk and Hüfner, 2004; Geyer et al., 2004). Others have identified that international risk aversion influences sovereign bond spreads (Barrios et al., 2009; Haugh et al., 2009).

Most prominently, the level of public debts and fiscal deficits, as well as the debt/GDP ratio and the deficit/GDP ratio, have been identified as the default risk-related variables that most significantly affect spreads. For example, Ardagna et al. (2007) estimate the effects of government debts and deficits on long-term interest rates of 16 OECD countries from 1960 to 2002. They find a non-linear relationship between the level of government debts and long-term interest rates, as significant relationships only occur for countries with above-average-levels debt. Further evidence in this direction was provided by Baldacci and Kumar (2010), who reexamined the impact of fiscal deficits and government debt on long-term interest rates during 1980-2008 for 31 advanced and emerging economies. A significant but non-linear relationship is detected, and they indicate that higher deficits and public debt contribute to a significant increase in long-term interest condition. In addition, Baldacci and Kumar (2010) also show that the magnitude of such influence depends on several country-specific factors such as initial fiscal, institutional and structural

conditions, as well as spillovers from global financial markets. Focusing on the period of European sovereign debt crisis, Beirne and Fratzscher (2013) analyzed the drivers of sovereign risk for 31 advanced and emerging economies and find that debt and fiscal deficit as well as real GDP growth and current account are significant determinants of emerging market economies' sovereign bond yield spreads, and a deterioration in these fundamentals are the main explanations for the rise in sovereign yield spreads during the crisis. Poghosyan (2013) distinguish the determinants of borrowing costs between long-run and short-run by using the panel cointegration methodology, and find that in the long run, government bond rates rise by around 2 basis points for every percentage point increase in the government debt/GDP ratio, and by about 45 basis points for every percentage point increase in the potential growth rate.

For European and, in particular, EMU countries, a significant impact of fiscal variables on sovereign bond spreads is also detected in empirical studies. Attinasi et al. (2009) find that during the period end-July 2007 to end-March 2009, higher expected budget deficits and/or higher government debt to GDP ratios vis-à-vis Germany contributed to higher government bond yield spreads in the euro area. Such results become more robust during the period from end-August 2008 to end-March 2009 when financial crisis has worsened. Similarly, assuming that expected budget deficits matter for borrowing costs, Heppke-Falk and Hüfner (2004) use a Seemingly Unrelated Regressions (SUR) framework to examine the impact of expected budget deficit-to-GDP ratios on interest rate swap spreads in France, Germany and Italy. However, the results show no significant relation between expected deficits and swap spreads over the whole sample period (1994-2004). Costantini et al. (2014) take a panel cointegration approach and find that expected government debt/GDP differentials are the main long-term drivers of sovereign spreads within EMU countries. But when including only countries belonging to optimal currency areas (OCA) in the sample, expected government debt-to-GDP differentials turns out to be the less important and expected budget balance differentials become more statistically important. Also employing a SUR framework but focusing on past outcomes rather than expected fiscal fundamentals, Codogno et al. (2003) arrive at the conclusion that debt-to-GDP ratios turns out to be significant for yield differentials only in the cases of Italy and Spain, and for other countries in the sample (e.g. Belgium, France and

Portugal), the yield differentials are better explained by international risk-related factors. Bernoth et al. (2004) discover that fiscal fundamentals, as measured by the budget balance or government debt, have a considerable influence on sovereign bond spreads for a sample of 13 EU nations. Hallerberg and Wolff (2006) got comparable findings using fixed effects panel estimates.

In addition to fiscal variables such as public debts and fiscal deficits, extension research has analyzed the impact of liquidity risk factors on sovereign bond spreads, but the evidence is less clear-cut. Using bid/ask spread, trading volume and turnover ratio as proxies for liquidity risk, Codogno et al. (2003) find that liquidity factors play only a small role in explaining yield differences in EMU countries, and France is the only country in the sample where liquidity matters more than international risk. Geyer et al. (2004), who apply a state-space approach, arrive at a similar conclusion with Codogno et al. (2003) on that no evidence is found for a significant impact of liquidity related variables on EMU government bond spreads. In contrast, several studies (e.g. Gomez-Puig, 2006; Beber et al., 2009; and Manganelli and Wolswijk, 2009) present conflicting findings on the importance of liquidity in determining sovereign bond spread with previously described studies. Gomez-Puig (2006) use bid-ask spreads and relative market size as proxies for liquidity and regress yield spreads against it. The results show that liquidity factor plays an important role in explaining sovereign bond spreads after the introduction of the euro in EMU countries. Beber et al. (2009) study liquidity through intraday European bond quotes and transaction data from the MTS securities platform. They find that variations in credit quality explain the majority of Euro-area sovereign yield spreads, albeit liquidity plays a significant impact, particularly for low credit risk nations and during periods of market uncertainty. Manganelli and Wolswijk (2009) reach at a similar conclusion that liquidity premia accounts for a considerable portion of the time variation in eurozone government bond spreads, however their study's underlying assumption that the liquidity premium is the same for all bonds is debatable.

International risk aversion, which is explained as investor sentiment towards this asset class for each country, is found to be another common determinant of sovereign bond spread in a considerable amount of literature (Attinasi et al., 2009). Codogno et al. (2003) use banking and corporate risk premiums in the United States to measure it

and conclude that international risk-related factors appear to be the main source of variation in yield differentials, especially in countries with higher debt-to-GDP ratio. In line with the existing empirical literature, Gomez-Puig (2006) uses spreads between 10-year fixed interest rates on US swaps and the yield on 10-year Moody's Seasoned AAA US corporate bonds as a proxy for international risk aversion. They regress it both linearly and reciprocally with the domestic risk variables in their models, and find that compared to domestic factors (both liquidity and default risk), the role of international risk factors in explaining adjusted spread changes is more statistically important in non-euro markets than in euro-area markets. In addition, Barrios et al., (2009) and Haugh et al. (2009), focusing on euro-area and OECD countries respectively, both find that international variables, particularly risk perception, have a significant role in explaining government bond spreads, and such international risk perception can magnify the effects of fiscal performance (e.g. current account deficits and debt service to tax receipts ratio) on government bond yield spreads. However, as argued by Manganelli and Wolswijk (2009), despite statically significant relations between international risk aversion and sovereign boon spreads found in existing studies, such explanation seems to be unsatisfactory for at least two reasons. Firstly, the reason why measuring international risk aversion by US risk premium rather than other variables (e.g. euro area government bond spreads) lacks clear interpretation. Secondly, relying on external changes in investors' risk appetite to explain spreads in the eurozone government bond market does not help us understand how these spreads behave.

However, although the importance of fiscal fundamentals and international factors on sovereign bond spreads has been confirmed widely in literature, the research is still ambiguous on the key factors that influence sovereign spread. Evidence has shown that after the European economic and monetary union (EMU) was formed, the explanation provided by fiscal position on interest rate spreads of 10-year government bonds against the German benchmark has become more limited. For instance, while spreads increased over the years 2003–2005, deficits and debt levels decreased during the same period. Also, despite the fact that many governments made progress in reducing fiscal imbalances in 2006 and 2007, the spreads have since rebounded to levels that are higher than those seen in the early years of EMU, as a result of the financial market turmoil that began in the summer of 2007 and intensified in 2008.

Furthermore, it is argued that the markets underestimated the sovereign debt risk prior to and during the 2008 global financial crisis (Dufrénot, Gente and Monsia, 2016; Beirne and Fratzscher, 2013), and the link between sovereign bond spreads and macroeconomic fundamentals appears to have broken down after the financial crisis (Capelle-Blancard et al., 2017). For instance, Gomez-Bengoechea and Arahuetes (2018) built an unbalanced panel with quarterly data from 2000 Q1 to 2012 Q2 and evaluated the macroeconomic factors of Eurozone sovereign bond spreads. They discover that macroeconomic fundamentals, from all the categories considered to be significant in the previous research, only partially explain sovereign bond yield behaviour. Furthermore, the nation-sentiment or non-fundamental country effect is significant in explaining the evolution of sovereign risks. Beirne and Fratzscher (2013) observe that in the pre-crisis era for European economies, economic fundamentals often perform a poor job of explaining sovereign risk, indicating that the market price of sovereign risk may not have been completely reflecting fundamentals prior to the crisis. Geyer et al. (2004) focus on measuring systematic risk in EMU government bond spreads, and in their model that is implemented using a state-space approach, macroeconomic variables (e.g. current account balance, industrial production growth and economic sentiment) are not found to be important determinants of the spread factors. Furthermore, by using panel cointegration techniques, Poghosyan (2013) discover that in some members of the euro area, bond yield spreads (relative to Germany) deviate from the equilibrium value associated with long-run and short-run macroeconomic fundamentals.

These findings have brought renewed interest in whether other factors could explain changes in government sovereign bond spreads. As a result, a growing number of articles have sought to investigate the possible role of "qualitative variables" in influencing sovereign bond spreads. According to Capelle-Blancard et al., (2017), qualitative factors are meant to measure a country's ability to meet its obligations in a "soft" way. These factors try to measure a country's willingness rather than its ability to pay interest. They also look into the adaptability of an economy and its capacity for development, as well as countries' data openness, fiscal credibility, and commitment to prudent borrowing. The importance of some qualitative factors has been discussed in literature. For example, Attinasi et al. (2009) measure the effects of the announcements of bank rescue packages on government bond yield spreads.

Interestingly, they find that the size of rescue packages does not have, on average, a statistically significant effect on sovereign bond yield spreads, but the government commitment to support banks in financial distress does influence investors' perceptions on sovereign bond risks. Furthermore, Nelson (2013) notes that when considering the sustainability of government's bond market, qualitative factors, in particular political factors (e.g. government reputation or changes in political leadership) should be taken into account. Similarly, Papanikos (2014), who focuses on the public debt problem in Greece, also points out that when willingness to pay rather than ability to pay matters, political and political economy factors (rather than purely economic factors) are significant in testing the sustainability of public debt.

To conclude, extensive previous research has shown that sovereign bond spread is determined by macroeconomic fundamentals such as fiscal deficits, public debt level, liquidity risk of government bonds and international risk reverse. However, recent research has found that these factors in some cases failed to explain the whole picture of borrowing costs in international capital market, and the limitation of using only macroeconomic fundamentals as explanation factors has become more apparent. Therefore, the impact of qualitative factors or soft factors on sovereign bond spreads has received more and more attention. So far, however, the role of qualitative factors in sovereign bond market is still understudied, and among existing literature that have studied qualitative factors, most of them only focus on the political side of qualitative factors. Hereby, our study aims to contribute to existing literature by exploring the importance of a wider range of qualitative factors (i.e. environmental, social and governance factors) in determining sovereign bond spreads.

2.3 Environmental, Social and Governance (ESG) and the cost of debt

2.3.1 Environmental, Social and Governance (ESG): theory and empirical studies

The application of the environmental, social, and governance (ESG) principle is required as the global economy and society continue to develop in a sustainable manner. Since its initial official proposal in 2004, the ESG principle has evolved throughout the course of the past 17 years (Li et al., 2021). The ESG principle is a

framework system that consists of environmental (E), social (S), and governance (G) factors. European Banking Authority (2021) defines these factors as "environmental, social or governance matters that may have a positive or negative impact on the financial performance or solvency of an entity, sovereign or individual". In practice, as a byproduct of responsible investing, ESG is commonly used by investors to assess the behavior and future financial performance of companies. The three basic ESG factors are the key points to consider in the process of investment analysis and decision making, as they are regarded as an important investment concept for evaluating the sustainability of business activities and sustainable development of enterprises (Li et al., 2021).

Since the concept of ESG has gradually become the mainstream in business and finance, it has been widely examined, practiced, and popularized in the practical field, stimulated the interest of scholars worldwide. However, since ESG is still an emerging topic, there are currently few literature reviews on ESG research, most of which focus on its association with company's financial and business activities. For instance, the relationship between ESG and corporate financial performance is one of the earliest topics studied by scholars. Early studies believe that ESG practice has a negative impact on company's financial performance, because they assume that maximizing shareholder's profits is the company's only social responsibility and payoffs of ESG activities do not exceed their costs (Vance, 1975; Friedman, 1970). Recent studies, however, argue that ESG practices enhance financial performance and firm value (Malik, 2015; Fatemi et al., 2018; Yoon et al. 2018), as socially responsible behavior better meets the interests of nonowner stakeholders and brings more opportunities for future risk reduction and company development (Fatemi and Fooladi, 2013). ESG investment is another popular topic studied by recent research, and the majority of the published research focuses on whether the performance of ESG investing is different from that of conventional investing (Daugaard, 2020). While recent empirical studies are consistent in the conclusion the risk-adjusted performance between ESG and conventional investing is statistically indifferent (Humphrey and Lee, 2011; Friede et al., 2015; Revelli and Viviani, 2015), there is still a small part of literature persisting that extra returns can be achieved by actively managed ESG portfolios (Guerard, 1997; Sparkes, 2002; Kempf and Osthoff, 2007). In addition, other studies also focus on the motivation and behavior of ESG reporting

(Lokuwaduge and Heenetigala, 2016), the influence of firm size on the ESG score (Drempetic et al., 2020), the relationship between ESG performance and the cost of debt (Eliwa et al., 2021), and the importance and role of ESG factors in the financial decision-making process (Ziolo et al., 2019). Moreover, another smaller strand of literature studies ESG at the country or macroeconomic level. For example, Diaye et al. (2021) investigate the relationship between ESG performance and GDP per capital; and Capelle-Blancard et al. (2019) and Crifo et al. (2017) study how a country's ESG performance relates to its sovereign borrowing costs. Since the analysis in this paper mainly focus on the impact of ESG on bond spreads, we will further discuss the literature that addresses the impact of environmental, social and governance factors on the cost of corporate bonds and the cost of sovereign bonds. Because both ESG and Corporate Social Responsibility (CSR) are used as measures of sustainability in the literature, we use ESG and CSR interactively in the following literature reviews.

2.3.2 The relationship between Environmental, Social and Governance (ESG) and the cost of debt at company level

In the last decade, there is a growing body of literature that investigates the impact of ESG practice on the cost of corporate loans. This literature usually looks into micro-data such as the yield spreads of new corporate bond issues, ESG/CSR performance scores of individual firms, and other firm-level control variables. However, over the past decade, the research on this question presents conflicting findings. On the one hand, some literature shows that ESG practice is inversely related to the cost of debt, and better ESG performance lowers the cost of debt. On the other hand, other studies find that the relationship between ESG practice and the cost of debt is statically insignificant or even positive.

Among the literature that support the negative relationship between ESG/CSR and the cost of debt, a number of studies are interested in the developed market, especially the U.S. market. By employing corporate social responsibility (CSR) rating scores from the KLD STATS database, Ge & Liu (2015) examine the association between a firm's CSR performance and the cost of debt for U.S. firms. In their study, the association is found to be significant and negative. Specifically speaking, firms with better CSR performance have better credit ratings, and when credit rating is controlled, better CSR performance is associated with lower yield spreads. In addition, they also

conclude that the magnitude of such association is influenced by governance factors (e.g. the performance of corporate governance) and environmental factors (e.g. whether issuers operate in environmentally sensitive industries). Also focusing on the U.S. bond market, Goss and Roberts (2011) offer a new perspective on the linkage between CSR and the cost of debt by examining this issue from the view of the lender (i.e. banks). They find that firms with better CSR pay between 7 and 18 basis points less than firms with social responsibility concerns. In addition, banks view CSR as a second-order determinant of spreads. For high-quality borrowers, banks are indifferent to their CSR investments; but for low-quality borrowers, banks are more sensitive to CSR concerns and respond with higher loan spreads and shorter maturities to those who have more CSR concerns. Other studies tried to investigate the impact of one of dimensions in ESG on the cost of debt. For example, Hasan et al. (2017) estimate the relationship between social capital (social factor) and bank loan spreads in U.S. counties. Defending social capital as "the confluence of effects arising from social networks and shared common beliefs that help cooperation", they indicate that firms headquartered in U.S. counties with higher levels of social capital incur lower bank loan spreads and prefer public bonds over private bonds. They further explain that this phenomenon can be attributed to the perception of social capital by loan holders as an environmental pressure that limits opportunistic business behaviour in debt contracting.

Moreover, the negative relationship has yet to be supported in the emerging markets, specifically the ASEAN region. For instance, Gracia and Siregar (2021) decide to research how sustainability practices, as indicated by sustainability performance and disclosure, affect ASEAN companies' cost of debt. The results of generalized least square random effects regression reveal that the sustainability initiatives used by ASEAN firms reduce their cost of loan. Moreover, the negative relationship between sustainability practices and the cost of debt is found to be much stronger when sustainability disclosure is used as a measurement of sustainability practices. Therefore, the authors further conclude that when considering the cost of debt for ASEAN enterprises, debtholders do not place a high value on information exist within a firm's sustainability performance. In addition, Ye and Zhang (2011) choose to focus only on Chinese bond markets. They choose about 1700 Chinese firms listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange from 2007 to 2008, and

employ both the ordinary least square (OLS) and the two-stage instrumental variable regression methods. The results show that the association between CSR and debt financing costs is mixed. When firms' investments in CSR fall short of an ideal level, improved CSR lowers the debt financing costs; however, this relationship changes inversely if the investment in CSR exceeds the ideal level. Moreover, in contrast to most of existing literature (e.g. Fonseka et al. (2019), Ge and Liu (2015), Hasan et al. (2017)) that find a linear relationship between sustainability practices and the cost of debt, the study by Ye and Zhang (2011) concludes a non-linear relationship instead. The study by Fonseka et al. (2019) also focus on Chinese firms, but they try to assess the impact of only environmental factor - the effect of environmental information disclosure (EID) and energy product type - on the cost of debt of energy firms. They use a sample of Chinese energy firms over 2008–2014 and find that environmental information disclosure is negatively associated with the cost of debt. Similar association is also found between some type of energy products and energy firm's the cost of debt. As for samples from European countries, Eliwa et al. (2021) assess the impact of ESG practices on the cost of debt in 15 EU countries. Similar to Gracia and Siregar (2021), they use both ESG performance and ESG disclosure as indicators for ESG practices and find that firms with stronger ESG performance and better ESG disclosure can borrow at lower costs. However, the magnitude of impact of ESG performance and ESG disclosure is found indifferent on the cost of debt in this study.

In contrast, numerous studies (Erragragui, 2017; Stellner et al., 2015; Hoepner et al., 2016) do not support the negative relationship between ESG practice and the cost of debt for company and show more mixed results on this relationship. Firstly, Erragragui (2017) investigates the relationship between the constituents of Corporate Social Performance (CSP) and the cost of debt for a sample of 214 U.S firms. The prime result shows the absence of relationship between a firm's cost of debt and its CSP when measured at a composite level, but firms' cost of debt is found to be affected by some sub-constituents of CSP. Specifically speaking, Erragragui (2017) find that while governance concerns have no bearing on the cost of debt for businesses, environmental concerns do. Additionally, the findings support earlier research that shows environmental and governance strengths lower enterprises' cost of debt. Secondly, Stellner et al. (2015) are interested in how CSP (measured by Thomson Reuters ASSET4 ESG ratings universe) impacts company's credit risk

(measured by S&P credit ratings and corporate bond z-spreads). Based on the sample of 872 corporate bonds issued by non-financial companies located in the twelve EMU, they find only a weak linkage between superior corporate social performance (CSP) and systematically lower credit risk. Moreover, Stellner et al. (2015) further investigate the role that countries' ESG related performance plays in moderating this linkage. The results strongly support that a country's ESG performance moderates the CSP–credit risk relationship. Also considering country sustainability, Hoepner et al. (2016) try to finger out whether the cost of bank loans is determined by corporate and country sustainability. Focusing on 470 loan agreements signed between 2005 and 2012 and 28 different countries across the world, they find that while country sustainability has a significant impact on the cost of bank loans, no conclusive evidence shows that firm-level sustainability affect the interest rate banks would like to charge to borrowing firms. In addition, they also examine the impact of social and environmental performance dimensions on the cost of corporate loans separately and find that environmental dimension of a country's institutional framework has roughly twice the impact as the social dimension.

2.3.3 The relationship between Environmental, Social and Governance (ESG) and the cost of bond at country level

The aforementioned justifications for the connections between sustainability and the cost of debt have primarily been examined at the corporate level. However, significant scholarly work has been done that raises the analytical framework to the level of the nation where the sovereign bonds are issued. Interestingly, there is some literature examining the impacts of environmental, social and governance factors on sovereign bond spreads, and overall, these studies conclude that, taken separately or together, these three factors matter to explain sovereign bond spreads.

The vast majority of research examines governance indicators as proxies for soft components in ESG, and the vast majority of these studies also incorporate global and macroeconomic country-specific variables as extra covariates. Among them, Hansen and Zegarra (2016), Sonenshine and Kumari (2022), and Baldacci et al. (2011) focus on political risk. Hansen and Zegarra (2016) study a sample of 12 countries in Latin America for the period 2000-2013 and investigate whether the political risks of these countries influence their sovereign bond spreads. Using six different dimensions of

political risk in a country (i.e. voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption), Hansen and Zegarra (2016) find a statistically significant relationship between sovereign spreads and political risk. Specifically speaking, the countries with increased political risks have higher sovereign bond spreads. However, when examining the six dimensions individually, only regulatory quality and rule of law shows significant relationships with sovereign bond spreads. Similar conclusions are reached by Sonenshine and Kumari (2022), who find a significantly positive relationship between political risks and sovereign bond spreads in emerging market (EM) countries, and the impact of political risks on sovereign bond spreads varies across different sub-components of political risks. Also focusing on emerging market (EM) countries, Baldacci et al. (2011) study the linkage between sovereign bond spreads and political risks, along with fiscal risks. The findings suggest that political and fiscal risks affect credit risk in emerging nations, and tighter spreads are correlated with lower levels of political risk, especially during times of financial instability. In addition to these studies, Ciocchini et al. (2003) and Depken et al. (2011) concentrate on corruption. Ciocchini et al. (2003) define corruption broadly as the misuse of public office for private gain and use Transparency International's annual corruption perception index as a measurement for corruption. The findings of their study suggest that when issuing bonds, countries believed to be more corrupt earn a huge risk premium. The global bond market attributes a substantial cost to corruption: an improvement in the corruption score from that of Lithuania to that of the Czech Republic reduces the bond spread by approximately one-fifth. Besides, Cosset and Jeanneret (2015) are interested in the impact of government effectiveness on sovereign bond spreads. Using a sample of 75 developed and emerging countries over the period 1996-2011, they find that better-governed nations will be less likely to default and thus enjoy a narrower sovereign credit spread, and such relationship is non-linear. Benzoni et al. (2015), on the other hand, examine the relationship between political stability and sovereign bond spreads. Based on the theory of "fragile beliefs" (Hansen and Sargent, 2010) and using panel data on sovereign CDS spreads from January 2003 to December 2011 for eleven euro-zone countries, Benzoni et al. (2015) show that agents require a time-varying risk premium, i.e. higher CDS spreads, for bearing political uncertainty of a state.

To date, the relationship between social factors and sovereign bond spreads has also received some attentions. However, as stated by Hoepner et al. (2016), the social dimensions of ESG are significantly more varied, less integrated into national legal and regulatory frameworks, and harder to define. Therefore, it is not supervised to find that there is much less information about the effects of social factors on sovereign bond risks. Among existing literature, Bundala (2013) investigates whether human development and gender inequality may have an impact on sovereign bond risks. By applying cross country survey strategy on twenty countries from both developed and developing, Bundala (2013) find that countries with high equality-adjusted human development index have less probability to default their debt obligation and thus lower cost of debt. But no significant relationship is found between cumulative probability of default and gender inequality index. Hoepner and Neher (2013) argue that national sustainability culture is priced by sovereign bond market, and it influences sovereign bond spreads by influencing the power of government to transform the entirety of the sustainability framework in their countries.

In addition, there are also some studies that suggest a link between environmental factors and sovereign bonds spreads. For example, de Boyrie and Pavlova (2020) employ Environmental Performance Index (EPI) and conduct an empirical analysis on the link between environmental performance and sovereign credit risk. Using a dynamic panel generalized method of moments model, they find that environmental performance is negatively related to CDS spreads in the full sample, but this relationship disappears in a sub-group of European countries during times of crises. In addition, de Boyrie and Pavlova (2020) separate environmental performance objectives into environmental health (EH) and ecosystem vitality (EV) and further explore the differential effects of these two dimensions on sovereign credit risks. The results show that environmental health (EH) has a stronger impact on CDS spreads than ecosystem vitality (EV). Besides, Gervich (2011) makes a speculative claim that environmental indicators, such as national petroleum consumption and CO2 emissions per capita, can be used to predict a country's future financial performance. In other words, it can be used as an "early warning" system to speculate on the likelihood that a country will encounter financial difficulties and thereby generate higher sovereign credit risk.

So far, however, there are only three literature discussing about how a broad measure of environmental, social and governance factors affect sovereign bond markets. In addition, although these three studies differ a lot in the data and methodology used, they all find evidences supporting that better ESG performance of a country is associated with lower sovereign credit risks. Firstly, Drut (2010) is the first to relate ESG factors to sovereign bond market. He explores how the consideration of ESG metrics affects the mean–variance efficiency frontier formed by the sovereign bonds of twenty developed nations. The period of his study covers from 1994 to 2008. He employs ESG data from Vigeo Sustainability Country Ratings, which includes nearly 40 criteria from a number of international codes and norms. The empirical results of his study indicate that integrating ESG factors in sovereign bond portfolio will not lead to a significant loss of mean-variance efficiency. Secondly, relying on a sample of 33 emerging countries from 2001-2010, Margaretic and Pouget (2018) study the effect of a country's ESG performance on sovereign bond spreads. They use the Environmental Performance Index (constructed by Yale University), the Human Development Index and the World Governance Index (both from the World Bank) as the proxy for environmental, social and governance factors respectively, and add them up to measure countries' overall ESG performance. Using an estimation based on the Generalized Method of Moments (GMM), the results show that better ESG performance of a country lowers default risk by signaling good commitment ability. Among these three factors, social factor and governance factor are found to be priced by sovereign bond markets, while environmental factor does not. In addition, the governance indicator has a more immediate negative effect on sovereign bond spreads, but the social aspect has a longer-term negative effect. Thirdly, Capelle-Blancard et al. (2019) focus the association between ESG performance and sovereign bond spreads on 20 OECD countries over the period 1996–2012, and their findings are quite similar to that of Margaretic and Pouget (2018). However, unlike Margaretic and Pouget (2018) who use exiting index to measure ESG performance, Capelle-Blancard et al. (2019) use principal component analysis (PCA) to construct new ESG index for their study. Using the Kiviet corrected LSDV (LSDVC), the results first indicate that countries with better ESG performance experience lower default risks, and governance factor have the most pronounced impact on sovereign bond spreads. The environmental factor, however, also appear to be insignificant in the regression models. In addition, the relationship between ESG performance and sovereign bond

spreads are stronger in euro area countries than in other developed countries, and stronger in the post-Global Financial Crisis (GFC) than in the pre-crisis period.

As can be seen, previous studies on the effects of ESG on the bond market are restricted in terms of either private bond markets (with Ge & Liu, 2015 and Hasan et al., 2017 focus on the cost of corporate bond and bank bond spreads), or on the aspects of ESG they assess (e.g. Hansen and Zegarra, 2016 and Sonenshine and Kumari, 2022, on political risk; Bundala, 2013 on human development). They are also restricted on the time frame of their dataset (with the latest literature --- Capelle-Blancard et al., 2019--- only cover the period before 2012 and thus cannot reflect the impact of the ESG boom on sovereign bond market in recent years), or on the geographic coverage (with both Margaretic and Pouget, 2018 and Capelle-Blancard et al.,2019 focusing on international analysis). Therefore, our study aims to fill these gaps and this paper contributes to the existing empirical literature on four grounds. To begin with, our study is the first to concentrate the impact of ESG performance on bond markets on CEE countries. Secondly, we contribute to the macroeconomic-level (country-level) analysis of ESG. We complement the limited studies in analyzing the relationship between ESG performance and sovereign bond spreads by systematically including environmental, social and governance factors in our analysis and by comparing their individual influence on sovereign bond spreads. Thirdly, we cover a more recent time period (i.e. 2009-2018) in order to see whether the relationship between ESG performance and sovereign bond spreads still exist in recent years. Lastly, we address the data gap by constructing ESG index and providing ESG ratings for CEE countries based on practical ESG framework.

2.4 Hypothesis Development

The considerable attention given to ESG performance may be explained by the fact that ESG factors help to explain why nations repay their debt and why some nations are less likely to default. Economics has long debated the factors that determine whether or not nations repay their debt. The desire of sovereign entities to uphold a positive reputation in order to ensure access to borrowing in the future is one justification for repayment, as noted, for instance, by Eaton and Gersovitz (1981). However, such argument has been suspected by Bulow and Rogoff (1989), who

believe that after borrowing, a country has an incentive to use money from positive fiscal shocks to invest and smooth future negative shocks, thus avoiding future borrowing. But Cole and Kehoe (1997) add that the threat of terminating non-lending relationships, such as collaborations to exploit common resources, may induce countries to repay to preserve these agreements. Based on these models, Margaretic and Pouget (2018) then conclude that country repay their debt because they want to maintain long-term reputation.

Therefore, theoretically speaking, there are mainly three channels through which ESG performance and sovereign credit risks are connected, namely, risk signaling, investor perception and buffer (Margaretic and Pouget, 2018; Capelle-Blancard et al.,2019; de Boyrie and Pavlova, 2020). The first explanation is that ESG performance plays a role of risk signaling. In other words, since sound extra-financial (ESG) performance typically reflects long-term economic benefits, strong performance may serve as a sign of a nation's long-term orientation and commitment to repaying its debt. As a result, creditors will demand higher interest rates to hold riskier debt instruments that have lower sovereign ESG scores and therefore higher default risk. According to the second channels, a country's ESG performance influence investors' perception on the risk of investment in several ways. One the one hand, it is argued that cooperation and communication on ESG issues can reduce the asymmetries of information and build trust between investors and the country, in particular when outside parties (such as foreign countries or large private organizations) are involved in the exploitation of natural resources and social development (Margaretic and Pouget, 2018). As a result, nations with strong ESG performance might be more reluctant to default because they would not only lose their reputation and potential non-lending relationships, but also potential future borrowing opportunities. One the other hand, when considering investing money to a country, investors may consider its natural and social resources as an additional safeguard against losses (ibid). Moreover, according to Capelle-Blancard et al. (2019), natural and social resources may serve as a buffer against adverse shocks or may positively affect future growth and, consequently, the nation's ability to repay in the future. Therefore, these theories imply that countries with better ESG performance are less likely to default, thus having lower sovereign bond spreads. This leads to the first hypotheses in our study:

Hypothesis 1. There is a negative relationship between country's ESG performance and sovereign bond spreads.

Godfrey et al. (2009) state that combining different aspects of sustainability into "a single monolithic construct" makes it harder to see the financial effects of single-dimensional aspects, and Clarvis et al. (2014) also argue that in sovereign credit risk assessment, environmental risk should be assessed separately and not aggregated with social and governance elements. Therefore, we further consider the differential effects of sub-dimensions of ESG. According to previous studies (Hansen and Zegarra, 2016; Baldacci et al., 2011; Ciocchini et al., 2003; Benzoni et al., 2015), governance factors are found to be significantly associated with sovereign bond spreads, as it directly or indirectly influence the policy issues with credit implication and long-term economic development. Compared with governance factors, social and environmental factors are much less studied. While social factors are always considered to be interacted with political issues, the relationship between environmental factors and sovereign bond spreads is still not clear (Hoepner et al., 2016; Capelle-Blancard et al., 2019). We therefore hypothesize that:

Hypothesis 2. The financial impacts of environmental, social and governance side on sovereign bond spreads are different, and governance side has more pronounced impact compared to the social and environmental one.

3. Data and Descriptive statistics

In this section, we discuss the samples and data used in our study. In particular, we introduce how the ESG country index (ESGCI) as well as the sub-component index, namely environmental sustainability index (ENSI), social sustainability index (SOSI), and governance sustainability index (GOSI) are constructed. We will also present descriptive statistics and give brief analysis on that.

3.1 Samples

To analyze whether a country’s ESG performance can influence its sovereign bond spreads, we use a panel dataset consisting of 10 central eastern European (CEE) countries from 2009 to 2018, considering only the post- GFC period. In particular, the

analyzed countries are Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovak Republic, and Slovenia. We do not include Albania and Estonia because of the unavailability of ESG related data and sovereign bond data.

3.2 Variables

3.2.1 ESG Index

Our methodology for creating the composite ESG index closely follows the OECD and JRC's recommendations for constructing composite indicators. (OECD, 2008; Nardo et al., 2008; Luzzati and Gucciardi, 2015). The four main steps suggested are choice of a theoretical framework, selection of the indicators, standardisation/normalization, and weighting and aggregation.

The theoretical index framework chosen in this study is the Environmental, Social and Governance (ESG), which is a widely agreed theoretical framework measuring the performance of sustainability. One merit of this framework is that it gives a broad definition of sustainability. Except the environmental criteria that are most frequently used to represent sustainability, ESG framework also includes social and governance criteria. More importantly, ESG framework automatically divide sustainability criteria into three different sub-dimensions, allowing each dimension to become an independent indicator. Such independent indicator thus allows us not only to compare countries' overall sustainability performance, but also to compare how well the country meets the environmental, social and governance criteria respectively. Separating sustainability criteria into these three sub-dimensions has important meanings, as countries having similar overall ESG scores may have very different performance in sub-dimensions, and each sub-dimension may also have different financial impacts on countries' financial market. Therefore, given that ESG index can be a composition of three sub-indicators, we will first construct the three sub-dimension indicators respectively, namely *environmental sustainability index (ENSI), social sustainability index (SOSI),* and *governance sustainability index (GOSI)*, and then use the linear weighted rule to aggregate them into the *ESG country index (ESGCI)* .

The selection of the indicators and the weighting system applied to aggregate the index are two of the most important steps in index construction, as indicators selection is directly related to the input data, and the weightings determine to what extent the input data may influence the index (Nardo et al., 2008). Therefore, we take into account suggestions made in ESG research reports provided by rating agencies and asset managers, as well as some academic literatures while selecting the ESG criteria and indicators to construct composite ESG index. Recently published ESG analysis reports include: VIGEO (2020), MSCI ESG Ratings (2022), Thomson Reuters ESG Scores (2017), RobecoSAM Country Sustainability Ranking (2022), and Allianz Global Investors (2019). And two main academic literatures are Capelle-Blancard et al. (2019) and Diaye et al. (2021). In addition, the selection is also influenced by three major factors: how well an indicator captures a certain dimension; the breadth of nation coverage and the source's reliability; and the degree to which the government has control over the policies that have a direct impact on the outcome (Allianz Global Investors, 2019).

Consequently, we followed the Country Sustainability Ranking framework provided by RobecoSAM (2022), as the criteria and weightings used in this framework best meet our considerations. We selected 21 indicators in total, summarized in 15 criteria. The indicators selected as well as their weights are reported in Table 1, and indicators in each sub-dimension are briefly discussed below.

Table 1. Items used to construct ESG Index

ESG Criteria	Measuring Indicators	Code	Source
Environmental Indicators (ENSI) (20%)			
Environmental Performance (5%)	Air pollution	Air	WDI
	Renewable electricity output(% of total)	Electricity	WDI
	Renewable energy consumption(% of total)	Energy	WDI
Environmental Risk (7.5%)	Loss per capital caused by weather and climate-related extreme events	Loss	European Environment Agency
Environmental Status (7.5%)	Forest area (% of land area)	Forest	WDI
	Terrestrial protected areas (% of total land area)	Terrest	WDI
	Water stress	Water	WDI
Social Indicators (SOSI) (30%)			
Aging (7.5%)	Population ages 15-64 (% of total)	Population	WDI
	Life expectancy	Life	WDI
Human Capital (5%)	Human Development Index	HDI	UNDP
Inequality (5%)	Female to male labour force participation rate	Femaletomale	WDI
Social Conditions (5%)	Internet user (% of population)	Internet	WDI

	Domestic general government health expenditure per capita (current US$)	Health	WDI
Social Unrest (7.5%)	Prison Population Rate (per 100'000)	Prison	UN office on Drugs and Crime
Governance Indicators (GOSI) (50%)			
Corruption (10%)	Control of Corruption	Corruption	WGI
Globalization & Innovation (5%)	Research and development expenditure (% of GDP)	R&D	WDI
Regulation & Fin. Development (5%)	Regulatory Quality	Regulatory	WGI
Institutions (10.0%)	Rule of Law	Rule	WGI
Personal Freedom (5%)	Voice and Accountability	Voice	WGI
Political Risk (10%)	Government Effectiveness	Effectiveness	WGI
Political Stability (5%)	Political Stability	Stability	WGI

The *environmental sustainability index (ENSI)* measures a country's ability in achieving environmental sustainability. We assess such ability through three criteria: environmental performance, environmental risk, and environmental status. Environmental performance assesses a country's performance in environmental pollution and protection. Environmental pollution, such as air pollution, has an adverse impact on human health, contributing to an increase in respiratory and cardiovascular diseases. Furthermore, it has an impact on crop yields and the environment, affecting biodiversity and ecosystems. These effects will have significant economic consequences, affecting both economic growth and welfare (OECD, 2016). We include direct measures of air quality, the proportion of renewable electricity output in total electricity output, and the proportion of renewable energy consumption in total energy consumption under this criterion. Climate change, weather-related loss events, and natural disasters such as cyclones, earthquakes, floods, forest fires and others affect all countries, albeit to varied degrees. Environmental risk assesses the impact of such incidents in terms of financial damages. These occurrences can cause significant disruptions in the supply and production of products and services, resulting in negative macroeconomic consequences such as inflation, slowing GDP, and debt servicing issues (RobecoSAM, 2022). Loss per capital caused by weather and climate-related extreme events is used as indicator for environmental risk. Environmental status measures the quantity and quality of natural resources a country possesses. A diverse and high-quality natural environment improves human well-being and health. Rich natural resources can be used to help economic development, generate fiscal and export revenue, and thus help economic growth. Over-exploitation, on the other hand, can cause environmental

damage, shrinking biodiversity, and loss of natural habitats, threatening the development of long-term economic (ibid). We focus on forest area, terrestrial protected areas and water stress in this criterion.

The *social sustainability index (SOSI)* captures the degree of social welfare of a given country and its human development efforts. RobecoSAM Country Sustainability Ranking lists 5 criteria that are material and financially relevant for state development, which are aging, human capital, inequality, social conditions, and social unrest. Ageing populations present serious economic difficulties. It will lead to a decrease in the workforce, a labour shortage, a decrease in capital investments, and a consequent decrease in a nation's potential for economic growth. In addition, there is a possibility that it would lead to higher government spending on pensions and health care, which will add to the budgetary burden. Gender inequality is an important and widely discussed topic in human development. Research shows that gender inequality has an adverse impact on the production side of economy. On the one hand, gender inequality results in reducing fertility and thus less labour force; on the other hand, women have a comparative advantage in the mental labour input, which together with physical strength are modelled to be two inputs of the production side of economy (Galor and Weil, 1996). Social conditions are the elements of life shaped by society and we chose two topics of social conditions that have a large potential impact for achieving long-term development. One is the access to technology, which is measured by the percentage of Internet user in total population, and the other is healthcare, which is measured by domestic general government health expenditure per capital. Social unrest refers to the risk of violent protests and riots. It can impose significant economic and social costs, weaken state institutions, increase uncertainty, cause political instability, and thus impede economic growth (Braggion, F. et al., 2020). To measure the social unrest, we choose the prison population rate as a proxy.

The *governance sustainability index (GOSI)* measures regulatory effectiveness of the chosen countries. Criteria used in this sub-dimension include corruption, globalization and Innovation, regulation and financial development, institutions, personal freedom, political risk, political stability. Indicators in GOSI mainly come from Worldwide Governance Indicators (WGI). Corruption takes numerous forms and can have a variety of repercussions on the economy, the political climate, and society in general,

as it undermines trust in the government and the rule of law (Depken et al., 2011). It can be measured by capturing perceptions of the extent to which public power is exercised for private gain, and here we directly use the control of corruption from WGI as indicator. According to La Porta, R. et al. (2008), institutions play a significant role in defining a country's economic development and progress. Property rights protection, effective law enforcement, efficient public administration, civil liberties, and a variety of other similar norms appear to be substantially connected with improved economic performance. Rule of law is used as the indicator for institutions, assessing agents' trust in and adherence to societal standards, including the quality of contract enforcement, property rights, the police, and the courts, as well as the possibility of crime and violence. Research has shown that personal freedom to some extent has a positive relationship with growth of GDP, since countries with higher personal freedom tend to have higher economic freedom (Dolan, 2022; Carlsson and Lundström, 2002). To measure personal freedom, we use the indicator voice and accountability, which assesses residents' impressions of their ability to participate in choosing their government, as well as freedom of expression, freedom of association, and a free media. Political risk and stability encompass elements such as government politics, the electoral system, and the presence of checks and balances. Businesses, financial markets, and the economy as a whole are all touched by a number of political actions, such as taxation, government spending, regulations, fiscal and monetary policy, exchange rate and investment restrictions, or labor laws. To measure political risk and stability, we use government effectiveness and political stability from WGI respectively.

To construct environmental sustainability index (ENSI), social sustainability index (SOSI), governance sustainability index (GOSI), and ESG country index (ESGCI), normalisation is firstly conducted to put the indicators into the same unit so that they can be aggregated into a composite indicator. The ‘direction’ of each indicator is adjusted to be consistent, and higher number represent better performance of countries for each criterion. The z-scores are then calculated for each one of 21 indicators and are arithmetically averaged for each of the 15 criteria, providing criteria-level scores. Next, the scores of ENSI, SOSI, and GOSI are computed as a weighted average of each criteria-level score in corresponding sub-dimensions, and the overall ESG score (ESGCI) is computed as a weighted average of each sub-dimension. The

environmental dimension is given a weight of 20%, the social dimension 30% and governance 50%, as defined in RobecoSAM Country Sustainability Ranking (2022) framework. These weights are consistent with the weights allocated by Allianz Global Investors (2019) and Capelle-Blancard et al. (2019) in their ESG framework, as researchers and investors believe that governance factors have the greatest potential influence on a country's capacity to adopt effective environmental standards and achieve positive socioeconomic results. Lastly, the score of ENSI, SOSI, GOSI, and ESGCI are normalized on a scale from 0 to 10 (weak – advanced).

3.3.2 Sovereign bond yield spreads

We use long-term (10 year) sovereign bond spreads as the dependent variable. Our sovereign bond spreads data are from Refinitiv Datastream. The reason why we choose long-term sovereign bond spreads instead of short-term data are based on following considerations. First, Poghosyan (2012) argue that short-run factors (such as monetary policy) can cause sovereign bond yields to temporarily deviate from their long-run equilibrium level. In addition, evidences have shown that ESG can be considered as a long-term concept, and there is a time lag between the impetus of ESG factors and its direct effects on economic growth (Diaye et al., 2021). In other words, it can be challenging to determine how important a nation's ESG performance is in the short term, especially in relation to problems that arise over longer time horizons, like climate change or resource scarcity. Moreover, Diaye et al. (2021) point out the possibility that the relationship between some ESG factors and economic growth may root in the actions of other ESG factors, which take longer time to generate substantial impacts. For instance, a change in political regime will only have a short-term effect on growth, but it may have a lasting impact on development if it is linked to corruption, which in turn affects growth. What's more, Capelle-Blancard et al. (2016) distinguish between short-run and long-run impacts of ESG performance on sovereign bond spreads, and find that the economic impact is stronger in the long-run.

The sovereign bond spreads are calculated as the difference between the yields on sovereign bonds of a particular country and the yields on benchmark sovereign bonds. All yields are end-of-year value. Since half of our sample countries belong to euro-area, except using US 10-year sovereign bonds yields as benchmark, we also use German 10-year sovereign bonds as another benchmark for the purpose of robustness.

These two benchmarks are chosen because they have a low credit risk and high liquidity and are seen as the "risk-free" rate (Aristei and martelli, 2014; Capelle-Blancard et al. 2016).

3.3.3 Macroeconomic control variables

The empirical literature postulates that several financial and economic factors can determine sovereign bond spreads. Following Capelle-Blancard et al. (2019), we include six macroeconomic variables as control variables in our model, among which are related with GDP growth, inflation, fiscal condition, current account balance, international liquidity, and trade openness.

(1) *GDP growth rate* measures the development speed of a country's economy, and higher GDP growth rate indicates that countries will have less economic burden in the future and therefore less possibility to default their debt. Barrios et al. (2009) and Ghosh et al. (2013) find that countries with higher GDP growth rate have higher ability to repay debts, leading to lower sovereign bond spreads.

(2) *Inflation* reveals a country's monetary and exchange rate policies. Studies (Sokolova, 2014; Nickel et al., 2009) have shown that there are two conflicting effects between inflation and sovereign bond risks. Higher inflation rates, on the one hand, increase the country's tax base while decreasing the real value of outstanding debt denominated in domestic currency. This should relieve the country's overall financing constraints and result in lower bond spreads on foreign currency borrowing. However, higher expected inflation rates are also related with increased macroeconomic instability and would thus be detrimental to a country's creditworthiness if they exceed certain thresholds. As a result, the overall expected impact of inflation on yield spread is mixed.

(3) The effect of *fiscal condition* on sovereign bond risks has been analyzed in numerous studies (Ardagna et al., 2007; Baldacci and Kumar, 2010; Attinasi et al., 2009; Costantini et al., 2014), and in our study we choose total public debt/GDP ratio as a measurement for countries' fiscal condition. Overall, countries with higher total public debt/GDP ratio bear more default risks and have higher sovereign bond spreads.

(4) *Current account balance* reflects the situation of a country's financial inflow and outflow from key activity, such as capital markets and services. According to

Barrios et al. (2009), high current account deficits in countries heighten markets' perception of default because these countries were viewed as particularly vulnerable to changes in international funding flows. Countries with larger current account deficits are found to experience higher bond yield increases in several empirical studies (Codogno et al., 2003; Barrios et al., 2009; Beirne and Fratzscher, 2013). In line with Edwards (1983) and Beirne and Fratzscher (2013), we use current account balance/GDP ratio in our model.

(5) *International liquidity* is another external determination of sovereign bond yield. Here we use the ratio of countries' international reserves over imports, which measure a country's vulnerability to changes in the external environment. In particular, the reserve ratio shows the number of months of imports of goods and services they could pay for reserves. The relationship between the ratio and sovereign bond spreads is expected to be negative (Capelle-Blancard et al., 2019; Nickel et al., 2009).

(6) *Trade openness* is an indicator of the extent to which a country is engaged in the global trading system. We use the sum of exports and imports over GDP to measure this variable. According to Maltriz (2012), the explanation for the influence of openness on yield spreads are competing, which may lead to opposite directions of effect. One the one hand, the theory of "willingness-to-pay" indicates that countries that fail to meet their payment obligations are "punished" by trade disruptions, and therefore, more open countries bear more brunt of these punishments and are thus more willing to pay. In addition, countries that are more open are more capable of dealing with crises. Based on these theories, more openness leads to lower default risk and spreads. On the other hand, more openness also means higher exposure to international market, thus being more easily to be influenced by variations and shocks in the world economy.

Table 2: Variable Description

Variable	Code	Description	Source
Dependent variable			
10-year sovereign bond spreads (US bond as benchmark)	Spreads_US	The difference between 10-year sovereign bond yield of particular countries and 10-year sovereign bond yield of the US	Refinitiv Datastream
10-year sovereign bond spreads (German bond as benchmark)	Spreads_GE	The difference between 10-year sovereign bond yield of particular countries and 10-year sovereign bond yield of Germany	Refinitiv Datastream
ESG Index (variable of interest)			
ESGCI	ESGCI	ESG country index	Self-constructed
ENSI	ENSI	Environmental Sustainability Index	Self-constructed

SOSI	SOSI	Social Sustainability Index	Self-constructed
GOSI	GOSI	Governance Sustainability Index	Self-constructed
Control Variables			
GDP Growth Rate	$\Delta GDP/GDP$	Percentage change of Gross domestic product, constant prices	IMF
Inflation	Inf	Changes of end of period consumer prices	IMF
Fiscal condition	Debt/GDP	General government gross debt (equals all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future) to GDP ratio	IMF
Current account balance	CA/GDP	Current account (equals all transactions other than those in financial and capital items) to GDP ratio	IMF
International liquidity	Reserves/ Import	Total reserves (comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities) as a share of import	WB
Trade openness	(X+M)/Import	The sum of exports and imports of goods and services to GDP ratio	IMF

3.3 Descriptive statistics

Table 3 reports the average ESG country index (ESGCI) as well as the three sub-dimension index (ENSI, SOSI and GOSI) for the 10 CEE countries from 2009 to 2018. The ranks of countries under each index is also provided alongside in the table. As we have mentioned before, a higher score indicates a better performance of the country in that dimension, and countries are ranked from the best performance (1) to the worst (10). The table shows that these countries have relatively high scores for ENSI and GOSI, while the score for SOSI is relatively low. The results show a different pattern with the sample in Capelle-Blancard et al. (2019), where the 20 OECD countries have relatively poor rating in environmental dimension. The variation in the ratings score is much larger in governance dimension than in environmental and social dimension for the 10 countries. In addition, it can be seen from the table that one country could have a relatively good performance in one dimension while receiving a relatively poor rating score in another dimension. For example, Slovenia ranks the first under both SOSI and GOSI, but only ranks the 9th in ENSI. These phenomena further confirm the need to study the impact of environmental, social and governance factor on sovereign bond spreads separately due to the differences in the performance of each country in different ESG dimensions. Overall, Slovenia and Czech Republic have the best ESG performance among the 10 countries, and Bulgaria and Romania are in the bottom positions.

To further analyze the heterogeneity of countries' ESG performance, we plot the ESG country index (ESGCI) across and among the countries as well across and over time (see Figure 1 and Figure 2). As shown in Figure 2, the trend illustrates that overall ESG performance has been improving over time, and the score increased the fastest from 2012 to 2014, after which the rate of increase flattened. Additionally, focusing on the ESG performance of individual countries, Lithuania and Latvia has higher improvement in ESGCI scores during these 10 years, while the score of Slovak Republic and Slovenia changed little. Moreover, the Spearman's rank correlation is also conducted in order to assess the relationships among ESG country index and its sub-component index (see Table 4). It is surprised to find that environmental index is negatively related with social and governance index. This means that those countries who have a good performance in environmental demission has relatively poor performance in social and governance performance. In addition, the relation between ENSI and SOSI, and between ENSI and GOSI are far from perfect, and the correlation coefficients are 0.22 and 0.34 respectively. The correlation between SOSI and GOSI is positive, statistically significant and economically stronger, which equals to 0.58. Therefore, the results of Spearman's rank correlation suggest that the correlations between these variables are not strong.

Table 3. Average ESG index scores and ranks for 11 countries

	ENSI		**SOSI**		**GOSI**		**ESGCI**	
	Score	**Rank**	**Score**	**Ranks**	**Score**	**Ranks**	**Score**	**Ranks**
Slovenia	3.15	9	9.40	1	9.20	1	8.05	1
Czech Republic	0.72	10	4.71	2	8.71	2	5.91	2
Lithuania	7.09	4	2.25	7	7.45	3	5.82	3
Slovak Republic	7.44	2	4.39	3	5.90	6	5.75	4
Latvia	9.62	1	1.68	9	6.32	5	5.59	5
Poland	5.71	8	3.28	5	6.84	4	5.55	6
Hungary	6.47	6	2.67	6	5.40	7	4.80	7
Croatia	7.44	3	4.17	4	3.54	8	4.51	8
Bulgaria	6.49	5	2.08	8	0.91	10	2.38	9
Romania	5.92	7	0.69	10	0.94	9	1.86	10
Mean	6.00		3.53		5.52		5.02	
St.dev	2.35		2.30		2.76		1.70	

This table shows the average ESG index scores and ranks for 11 countries. *ENSI* is environmental sustainability index; *SOSI* is social sustainability index; *GOSI* is governance sustainability index; these three index measure country's performance in environmental, social and governance side respectively. *ESGCI* is the ESG country index, which measures countries' overall ESG performance. Higher score indicates better performance in that dimension. *Mean* is the arithmetic average score of the 10 countries under each dimension; *St.dev* is the standard deviation of the score of the 10 countries under each dimension.

Table 4. Spearman's rank correlation of ESGCI, ENSI, SOSI, and GOSI

	ENSI	SOSI	GOSI	ESGCI
ENSI	1.000			
SOSI	-0.224**	1.000		
GOSI	-0.345***	0.586***	1.000	
ESGCI	-0.093	0.715***	0.914***	1.000

This table shows the spearman's rank correlation of *ESGCI, ENSI, SOSI,* and *GOSI; ENSI* is environmental sustainability index; *SOSI* is social sustainability index; *GOSI* is governance sustainability index; these three index measure country's performance in environmental, social and governance side respectively. *ESGCI* is the ESG country index, which measures countries' overall ESG performance. * Significant at 10%, * * Significant at 5%. * * * Significant at 1%.

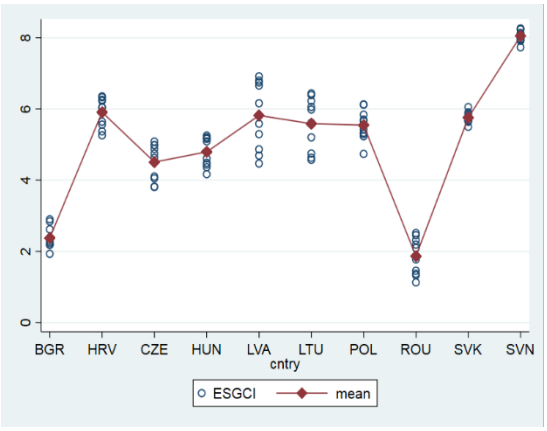

Figure 1. Heterogeneity analysis across countries

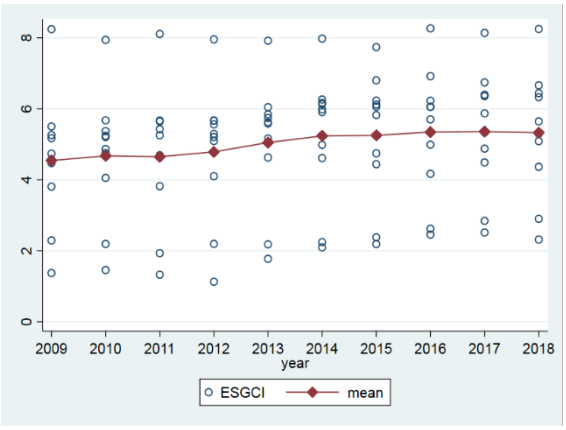

Figure 2. Heterogeneity analysis across years

Table 5 shows the descriptive statistics on all variables under study for the full sample. Although the interest rate differential against German bonds has higher mean than that against the US, the standard deviations are smaller for sovereign bond spreads calculated on German bonds. In addition, sovereign bond spreads based on US benchmark has wider range (from -2.02 to 10.49) than that based on German benchmark (from -0.62 to 7.14). Of all explanatory variables, the sum of import-to-GDP ratio and export-to-GDP ratio are the most volatile, with demonstrated standard deviations of 33.09. Most of variables have skewness that less than one, except that GDP growth has a negative skewness of -2.17 and inflation has a positive skewness of 2.27. All variables have positive kurtosis, which indicates that to some extent they all departure from normality.

Table 5. Descriptive statistics

	Mean	Median	Max	Min	SD	Skewness	Kurtosis	Obs
Spreads_US	1.34	1.26	10.49	-2.02	2.25	0.88	4.57	100
Spreads_GE	2.29	2.27	7.14	-0.62	1.53	0.54	3.07	100
ENSI	6.00	6.43	10.00	0.00	2.41	-0.84	3.31	100
SOSI	3.53	2.99	10.00	0.00	2.42	1.15	4.07	100
GOSI	5.52	6.03	10.00	0.00	2.84	-0.47	2.08	100
ESGCI	5.02	5.28	8.26	1.13	1.78	-0.37	2.64	100
GDP Growth	1.57	2.73	6.95	-14.81	3.74	-2.17	8.79	100

CA/GDP	-0.19	-0.42	7.78	-8.33	3.09	0.21	2.97	100
Debt/GDP	48.27	41.68	85.71	14.09	18.75	0.45	2.29	100
Inflation	107.83	100.48	173.01	90.52	19.78	2.27	6.99	100
(X+M)/GDP	125.95	128.13	190.70	58.47	33.09	-0.05	1.94	100
Reserves/Import	4.06	4.26	9.88	0.25	2.63	0.03	1.94	100

This table shows descriptive statistics for environmental sustainability index (ENSI), social sustainability index (SOSI), governance sustainability index (GOSI), ESG country index (ESGCI), 10-year sovereign bond spreads against US bond, 10-year sovereign bond spreads against German bond, GDP growth rate, the ratio of current account to GDP, the gross country debt to GDP ratio, primary balance to GDP ratio, inflation, the sum of import to GDP ratio and export to GDP ratio, international reserves to import ratio.

Table 6. Correlation matrix of independent variables

	ENSI	SOSI	GOSI	ESGCI	Spreads_US	Spreads_GE	GDP Growth	CA/GDP	DE/GDP	Inflation	(X+M)/GDP	Reserves/Import
ENSI		-0.224**	-0.345***	-0.093	-0.148	-0.076	0.165	0.095	0.029	-0.059	0.043	-0.013
SOSI	-0.471***		0.587***	0.716***	-0.495***	-0.491***	0.021	0.359***	0.490***	-0.060	0.393***	-0.437***
GOSI	-0.384***	0.610***		0.914***	-0.361***	-0.519***	0.048	0.124	0.208**	-0.108	0.415***	-0.601***
ESGCI	-0.227**	0.766***	0.941***		-0.529***	-0.639***	0.125	0.201**	0.268***	-0.058	0.476***	-0.691***
Spreads_US	0.078	-0.399***	-0.316***	-0.393***		0.866***	-0.490***	-0.234**	0.070	-0.138	-0.442***	0.343***
spreads_GE	0.129	-0.438***	-0.481***	-0.526***	0.834***		-0.305***	-0.196*	0.103	0.093	-0.504***	0.487***
GDP Growth	0.075	0.071	0.031	0.074	-0.582***	-0.349***		0.004	0.028	0.468***	0.227**	-0.138
CA/GDP	-0.013	0.453***	0.190*	0.332***	-0.166*	-0.239**	-0.017		0.379***	0.079	0.346***	-0.082
DE/GDP	0.018	0.432***	0.258***	0.386***	0.054	0.142	0.096	0.477***		0.230**	0.226**	-0.272***
Inflation	0.002	-0.082	0.053	0.009	-0.012	0.141	0.307***	-0.162	0.126		-0.035	0.104
(X+M)/GDP	-0.092	0.364***	0.460***	0.490***	-0.435***	-0.486***	0.266***	0.332***	0.186*	-0.292***		-0.630***
Reserves/Import	0.025	-0.515***	-0.621***	-0.698***	0.346***	0.452***	-0.140	-0.109	-0.204**	0.098	-0.631***	

This table shows correlation matrix of independent variables. Lower-triangular cells report Pearson's coefficients, and upper-triangular cells are Spearman's rank correlation. Stars *,**,***indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

4. Methodology

In this section, we first introduce the models specified to analyze the relationship between ESG performance and sovereign bond spreads, and then briefly discuss the motivations for choosing the estimating methodology.

To test our hypotheses, we model the relationship between ESG performance and sovereign bond spreads using a dynamic panel data regression. More specifically, we follow a GMM estimation that rely on Arellano and Bond (1991). We choose this model because the dependent variable *Spread* owns the property of persistence. In other words, the persistent nature of *Spread* tells that the lagged dependent variable should be included in the model to avoid the problem of omitted variable bias. Therefore, we include the lagged *Spread* in the right-side of the model and our main model is expressed as:

$$Y_{i,t} = \alpha + \beta_1 Y_{i,t-1} + \beta_2 ESGCI_{i,t} + \beta_3(\Delta GDP/GDP)_{i,t} + \beta_4 Inf_{i,t} + \beta_5(Debt/GDP)_{i,t} + \beta_6(CA/GDP)_{i,t} + \beta_7(Reserves/Import)_{i,t} + \beta_8(X+M/GDP)_{i,t} + u_i + \varepsilon_{i,t} \quad (1)$$

where *i* and *t* denote country *i* and year *t,* respectively*; Y* is the sovereign bond spreads and can be either sovereign bond spreads vis-à-vis the US bond or the German bond; u is an observed country-specific effect, and ε is the error term.

ESGCI is the independent variable of interest, which represent the score of overall ESG performance for the 10 CEE countries from 2009 to 2018. $\Delta GDP/GDP$ is the GDP growth rate. Inf denotes the inflation rate. $Debt/GDP$ denotes the gross country debt to GDP ratio. CA/GDP is current account balance as a percent of GDP. $Reserves/Import$ denotes the international reserves to import ratio. X+M/GDP is the sum of import to GDP ratio and export to GDP ratio.

After estimating the main regression model given by equation (1), we replace the *ESG country index (ESGCI)* by *environmental quality index (ENSI), social development index (SOSI),* and *governance quality index (GOSI)* respectively, in order to capture the individual impacts of environmental, social, and governance factors on sovereign bond spreads. The regressions then could be expressed as:

$$Y_{i,t} = \alpha + \beta_1 Y_{i,t-1} + \beta_2 ENSI_{i,t} + \beta_3(\Delta GDP/GDP)_{i,t} + \beta_4 Inf_{i,t} + \beta_5(Debt/GDP)_{i,t} + \beta_6(CA/GDP)_{i,t} + \beta_7(Reserves/Import)_{i,t} + \beta_8(\text{X+M/GDP})_{i,t} + u_i + \varepsilon_{i,t} \quad (2)$$

$$Y_{i,t} = \alpha + \beta_1 Y_{i,t-1} + \beta_2 SOSI_{i,t} + \beta_3(\Delta GDP/GDP)_{i,t} + \beta_4 Inf_{i,t} + \beta_5(Debt/GDP)_{i,t} + \beta_6(CA/GDP)_{i,t} + \beta_7(Reserves/Import)_{i,t} + \beta_8(\text{X+M/GDP})_{i,t} + u_i + \varepsilon_{i,t} \quad (3)$$

$$Y_{i,t} = \alpha + \beta_1 Y_{i,t-1} + \beta_2 GOSI_{i,t} + \beta_3(\Delta GDP/GDP)_{i,t} + \beta_4 Inf_{i,t} + \beta_5(Debt/GDP)_{i,t} + \beta_6(CA/GDP)_{i,t} + \beta_7(Reserves/Import)_{i,t} + \beta_8(\text{X+M/GDP})_{i,t} + u_i + \varepsilon_{i,t} \quad (4)$$

In addition, we also take into account the considerations mentioned by Capelle-Blancard et al. (2019) and Margaretic and Pouget (2018), and further test the model using lagged ESG index (*ESGCI, ENSI, SOSI, GOSI*) instead of the present ESG index value in our models. According to them, there are at least three reasons why using lagged ESG index can be reasonable. First, there is a causality relationship between ESG performance and sovereign bond spreads, and we treat sovereign bond spreads changes as a result of ESG performance changes. Secondly, the model

specification needs to take into account the possibility of sluggish adjustment of ESG elements between nations. In addition, employing lagged ESG factors prevents an endogeneity bias between those factors and spread, and simultaneity bias from ESG components to macroeconomic variables. Lastly, rating agencies and international organizations (that offer the data) often collect environmental, social, and governance data at the end of each year. So lagging ESG indicators ensures that the ESG index for each country is fully perceived by investors at time t and has been considered by financial market participants in pricing decision.

For estimation, the dynamic GMM model is selected over pooled ordinary least squares (OLS) and fixed-effect estimation procedures for the following reasons. To begin with, any form of endogeneity is likely to result in biased and inefficient estimations in Pooled OLS, making it difficult to judge whether some significant results are due to spurious correlations between the lagged dependent variable and fixed effects or not. Such estimation, therefore, can lead to an upward-based coefficient estimate for the lagged dependent variable, especially when heterogeneity is presented (Schultz et al., 2010; Flannery et al., 2013; Bond, 2002). In addition, compared with the dynamic GMM model, fixed-effect estimation does not take the correlation between the lagged dependent variable and the residual error into account, and the consistent parameter estimates is also violated due to simultaneity and dynamic endogeneity (Flannery et al., 2013). As a result, the fixed-effect estimate suffers from a downward bias (Nickel Bias) (Nickel, 1981). Therefore, since the dynamic GMM includes fixed effect and at the same time, account for simultaneity as well as the influence of past performance to the current value of the dependent variable, it is a superior over pooled OLS and fixed-effect estimation procedures (Capelle-Blancard et al., 2019; Schultz et al., 2010).

5. Empirical results and discussion

In this section, the model estimates of equation (1) is first present and discussed, which investigates the relationship between sovereign bond spreads (vis-à-vis the U.S.) and the countries' overall ESG performance. Secondly, it assesses the differential impacts of environmental, social and governance factors on sovereign bond spreads

(equations (2), (3) and (4)). For these four equations, we present the estimating results of dynamic GMM, pooled OLS, and fixed effects (FE) for comparation purpose.

5.1 Examining overall ESG performance

We start our econometric investigation by estimating the impact of a country's overall ESG performance on sovereign bond spreads (first using US bond as benchmark) for the full sample period. The results from our estimations are reported in Table 7 and Table 8.

In both Table 7 and Table 8, the first column presents the result from Pooled OLS. In the second column, based on pooled OLS, we add fixed effect in order to control omitted bias caused by unobserved variables that vary over time but constant across countries. In the third column, the model is also estimated using fixed effect, but the lagged dependent variable is included. Since the lagged dependent variable is included, this column changes to dynamic panel model and therefore, the "Nickel bias" may exist in the result. In the fourth column, the lagged dependent variable is also included, and dynamic GMM is applied to estimate the model.

Starting from Table 7 which shows the regression results of equation (1), the results indicate that ESG country index (ESGCI) has a negative and significant relationship with 10-year sovereign bond spreads (based on the US benchmark) for all the different methods used, which supports our first hypothesis. The negative sign of ESGCI suggests that countries with better overall ESG performance experience lower sovereign bond spreads. In other words, the public bond market may price the future costs of substantiality issues such as air pollution, social unrest, and political instability. In addition, the value of ENSCI coefficient is economically large, showing that one unit increase in the ESG score will lead to 1.215 basis points decrease in sovereign bond spreads. Among other determinants of the credit spread coefficients, the GDP growth rate is negatively and significantly associated with sovereign bond spreads. In other words, sovereign bond spreads tend to narrow when economy expands and country experiences higher economic growth. This result is as expected and is consistent with previous studies (de Boyrie and Pavlova, 2020; Capelle-Blancard, 2019). In addition, the results also suggest that fiscal deficit is an important

determinant of sovereign bond spreads. The negative sign of coefficient tells that countries with worsen current account has higher sovereign bond spreads, which compensate for higher default risk. This finding is supported by several previous studies, such as Beirne and Fratzscher (2013) and Barrios et al., (2009), who all suggest that current account is a key determinant of sovereign bond spreads. However, although the coefficients of trade openness and reserves are statistically significant, both of which come out with unexpected signs. Nevertheless, Nickel et al. (2009) find the positive relationship between reserve-to-import ratio and sovereign bond spreads in some central and eastern European countries, such as Hungary and Russia.

Table 8 shows the regression results of the model where the ESG country index (ESGCI) is replaced by its lag of one period. The coefficient on lagged ESG country index is negative and statistically significant using the pooled OLS and FE estimates, but it appears to be insignificant in the dynamic GMM estimates. Therefore, the results cannot conclude that a country's past ESG performance have a significant impact on its 10-year sovereign bond spreads (based on the US benchmark). This finding, however, is in contract to those of de Boyrie and Pavlova (2020) and Capelle-Blancard (2019) where such relationship is found to be significant. The lagged dependent variable is positive and significant in both FE estimates and GMM estimates. While the value of the FE coefficient is 0.451, the magnitude of the GMM coefficient is higher and equals to 0.474. This is consistent with the FE downward biases. The results also show that there are four fundamental variables help to explain sovereign bond spreads, namely, the current account to GDP ratio, the inflation index, the sum of import and export as a share of GDP, and the reserves to import ratio. As expected, the current account to GDP ratio is negatively related with long-term sovereign bond spreads. In addition, the inflation result suggests that inflation is priced by public bond marker, and lower inflation rate is associated with higher sovereign bond spreads. As stated by Nickel et al. (2009), this can be explained by the impact of inflation on real debt value. Higher projected inflation may raise the government's tax base and diminish its debt's real worth, resulting in reduced bond spreads on foreign currency borrowing and relieving the government's financial constraints. This finding is also partially supported by Capelle-Blancard et al. (2019). Similar to the results in table 6, both the trade openness ratio and the reserves ratio have statistically significant and positive coefficient. Other macroeconomic variables

such as GDP growth rate and public debt are not proved to be important factors in determining sovereign bond spread in this model.

Combining these two regression results, it shows that the first hypothesis can be proved. In other words, investors price country's ESG performance in the long-term government bond market. Countries with higher ESG rating score have lower sovereign bond spreads compared to countries that get lower ESG rating score. However, while the coefficient of ESGCI is significant in all estimating methods, the coefficient of ESGCI with lag of one period is only significant when using pooled OLS and fixed effect. This means that last year's ESG information does not help explain this year's sovereign bond spreads, and the bond market in central and eastern European counties is more sensitive to the ESG information at current time. One possible explanation of this finding is that financial market may price the effect of some elements of the ESG immediately but take longer time (more than one year) to reflect the changes in the rest of elements. We will further analyze these elements (e.g. environmental, social and governance factors) in the following part.

Table 7. Effect of overall ESG performance on sovereign bond spreads (US based)

	(1) Pooled OLS	(2) Fixed Effect	(3) Fixed Effect	(4) GMM
	Spreads_US	Spreads_US	Spreads_US	Spreads_US
$ESGCI_t$	-0.515***	-0.465***	-0.217***	-1.215***
	(-5.59)	(-5.26)	(-2.73)	(-4.04)
$\Delta GDP/GDP_t$	-0.358***	-0.187***	-0.035	-0.137**
	(-4.77)	(-2.83)	(-0.60)	(-2.10)
CA/GDP_t	-0.124	0.114	-0.021	-0.231***
	(-1.40)	(1.38)	(-0.58)	(-4.70)
DE/GDP_t	0.042***	0.031***	0.023***	0.003
	(3.45)	(3.33)	(3.58)	(0.11)
inf_t	0.010	0.019***	0.008*	-0.070
	(1.27)	(3.04)	(1.86)	(-1.48)
$(X+M)/GDP_t$	-0.005	-0.006	-0.002	0.040*
	(-0.73)	(-1.13)	(-0.47)	(1.74)
$Reserves/Import_t$	-0.022	0.009	0.001	0.240**
	(-0.31)	(0.13)	(0.01)	(2.19)
$Spreads\_US_{t-1}$			0.434***	0.341***
			(5.23)	(3.74)
cons	2.159	1.178	-0.239	8.460**
	(1.41)	(0.86)	(-0.19)	(2.41)
N	100	100	90	80
adj. R^2	0.546	0.765	0.851	

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8. Effect of overall ESG performance on sovereign bond spreads (US based), using lagged ESGCI

	(1) Pooled OLS	(2) Fixed Effect	(3) Fixed Effect	(4) GMM
	Spreads_US	Spreads_US	Spreads_US	Spreads_US
$ESGCI_{t-1}$	-0.479***	-0.416***	-0.186**	-0.022
	(-5.06)	(-4.77)	(-2.23)	(-0.05)
$\Delta GDP/GDP_t$	-0.402***	-0.088	-0.036	-0.113
	(-4.15)	(-1.21)	(-0.61)	(-1.31)
CA/GDP_t	-0.239***	0.037	-0.023	-0.268***
	(-3.29)	(0.80)	(-0.63)	(-3.95)
DE/GDP_t	0.048***	0.038***	0.022***	-0.004
	(4.06)	(5.18)	(3.25)	(-0.18)
inf_t	0.006	0.015***	0.008*	-0.082**
	(0.80)	(2.71)	(1.78)	(-2.01)
$(X+M)/GDP_t$	-0.002	-0.005	-0.002	0.047**
	(-0.32)	(-0.87)	(-0.38)	(2.09)
$Reserves/Import_t$	-0.037	-0.000	0.011	0.259**
	(-0.50)	(-0.01)	(0.18)	(2.25)
$Spreads\_US_{t-1}$			0.451***	0.474***
			(5.09)	(4.45)
cons	1.891	0.398	-0.498	2.784
	(1.16)	(0.29)	(-0.42)	(0.48)
N	90	90	90	80
adj. R^2	0.486	0.773	0.846	

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.2 Examining environmental, social and governance factors respectively

To further understand the impact of ESG performance on sovereign bond spreads, each sub-dimension of ESG is analyzed separately in this section. Table 9, Table 10 and Table 11 present the regression results of equation (2), (3), and (4) respectively, also with the corresponding models that use lagged ESG sub-dimension index.

Table 9 shows the results of the relationship between environmental factors (ENSI) and sovereign bond spreads tested using pooled OLS, fixed effect and GMM. With regard to the variable of interest (ENSI), we found that changes in terms of a country's environmental performance present a negative sign, and this variable is significant when tested using the dynamic GMM. As for lagged ENSI, the sign of coefficient is also negative and significant across all estimations and using different methods. The negative sign of the coefficient of both ENSI and lagged ENSI indicates that countries with better performance in environmental dimension tend to have lower sovereign bond spreads. This result is different from the finding of de Boyrie and Pavlova (2020) that reports an insignificant and negative association between lagged

environmental performance and credit risk in the European countries subsamples. Capelle-Blancard (2019) and Margaretic and Pouget (2018) also find that last year's environmental performance does not have significant impacts on this year's sovereign bond spreads in a sample of 20 OECD countries and 33 emerging economies, respectively. One possible explanation for the economically large and statistically significant relationship between environmental factor and sovereign bond spreads in our study can be attributed to different measuring indicators used in the index. We included the measuring indicator "Loss per capital caused by weather and climate-related extreme events" in the construction of environmental sustainability index, and this measuring indicator was given a high weight. Unlike other environmental factors, such as environmental degradation and carbon emissions, which will take long time to be perceived by the financial market, the economic losses caused by extreme weather usually have a direct negative impact on a country's economic development in that year and are therefore quickly captured by and reflected in the bond market. As for macroeconomic fundamentals variables, current account to GDP ratio, trade openness ratio and reserves ratio has significant coefficient regardless of whether ENSI or lagged ENSI is included as independent variable. When ENSI is used in the model, GDP growth rate are shown to influence sovereign bond spreads negatively. But when ENSI is replaced by lagged ENSI, the influence of GDP growth rate become insignificant, while the coefficient of inflation is negative and significant. Across all estimates and using different methods, the lagged dependent variable is highly statistically significant.

Table 9. Effect of environmental factors on sovereign bond spreads (US based)

	(1) Pooled OLS		(2) Fixed Effect		(3) Fixed Effect		(4) GMM	
	Spreads_US		Spreads_US		Spreads_US		Spreads_US	
ENSI	0.093		0.192***		-0.009		-1.701***	
	(1.28)		(3.61)		(-0.20)		(-3.85)	
$ENSI_{t-1}$		-0.479***		-0.416***		-0.186**		-1.416***
		(-5.06)		(-4.77)		(-2.23)		(-2.81)
$\Delta GDP/GDP_t$	-0.348***	-0.402***	-0.151***	-0.088	-0.008	-0.036	-0.129*	-0.126*
	(-4.75)	(-4.15)	(-2.68)	(-1.21)	(-0.12)	(-0.61)	(-1.84)	(-1.87)
CA/GDP_t	-0.184**	-0.239***	0.095	0.037	-0.051	-0.023	-0.205***	-0.175**
	(-2.14)	(-3.29)	(1.28)	(0.80)	(-1.30)	(-0.63)	(-3.42)	(-2.44)
DE/GDP_t	0.034***	0.048***	0.022**	0.038***	0.017**	0.022***	0.030	0.018
	(2.68)	(4.06)	(2.56)	(5.18)	(2.55)	(3.25)	(1.01)	(0.98)
inf_t	0.005	0.006	0.017**	0.015***	0.005	0.008*	-0.023	-0.083**
	(0.64)	(0.80)	(2.31)	(2.71)	(0.90)	(1.78)	(-0.63)	(-1.97)
$(X+M)/GDP_t$	-0.005	-0.002	-0.004	-0.005	-0.002	-0.002	0.049**	0.051**
	(-0.65)	(-0.32)	(-0.60)	(-0.87)	(-0.49)	(-0.38)	(2.40)	(2.22)
$Reserves/Import_t$	0.206**	-0.037	0.228***	-0.000	0.071	0.011	0.345***	0.317**
	(2.44)	(-0.50)	(3.88)	(-0.01)	(1.29)	(0.18)	(3.26)	(2.34)
$Spreads\_US_{t-1}$					0.537***	0.451***	0.320***	0.264***
					(5.42)	(5.09)	(3.48)	(2.99)
cons	-1.089	1.891	-2.904*	0.398	-1.102	-0.498	4.518	9.735*

	(-0.58)	(1.16)	(-1.72)	(0.29)	(-0.78)	(-0.42)	(1.14)	(1.85)
N	100	90	100	90	90	90	80	80
adj. R^2	0.482	0.486	0.746	0.773	0.836	0.846		

t statistics in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

In Table 10, the regression results of equation (3) is reported, which test the association between social factors and sovereign bond spreads. As can be observed, social factors which is measured by social sustainability index (SOSI) has a negative estimated coefficient (-0.817) and it is statistically significant at the 5 per cent based on the dynamic GMM method. The coefficient is also significant in the models excluding lagged dependent variable across all estimation method. In terms of the SOSI with lag of one period, the coefficient of the variable is also negative and statistically significant across all estimates and methods, except the one including lagged dependent variable and tested by fixed effect procedure. The results thus support that social elements, whether at current time or at past time are priced in the long-term government bond market by investors. In other words, investors perceive the country with better social performance as the one with lower credit risks, thus reducing the sovereign bond spreads in that country. Our finding is consistent with that in Capelle-Blancard (2019) and Margaretic and Pouget (2018), where social factors are found to have negative and significant association with sovereign bond spreads. Moreover, the magnitude of coefficient of SOSI is higher than that of the lagged SOSI, meaning that current social information has larger economical influence than the past social information. As for the control variables, the results are quite similar to that found in table 9. In the model with SOSI, both GDP growth rate and current account ratio show a negative and statistically significant relationship with sovereign bond spreads, which is as expected. Both trade openness ratio and reserves ratio are also significant, but the sign of coefficient is positive. Although the coefficients of debt to GDP ratio and inflation are significant in some estimation, they do not appear to be significant in the GMM estimation. However, in the model including lagged SOSI, current account balance, trade openness and reserves are found to be the determinants of sovereign bond spreads, while GDP growth rate, public debt, and inflation do not show a significant impact on credit risks of public bonds.

Table 10. Effect of social factors on sovereign bond spreads (US based)

	(1) Pooled OLS		(2) Fixed Effect		(3) Fixed Effect		(4) GMM	
	Spreads_US		Spreads_US		Spreads_US		Spreads_US	
$SOSI_t$	-0.364***		-0.325***		-0.035		-0.817**	
	(-3.58)		(-4.53)		(-0.56)		(-2.48)	
$SOSI_{t-1}$		-0.270***		-0.249***		-0.029		-0.792***
		(-3.07)		(-4.05)		(-0.45)		(-2.78)
$\Delta GDP/GDP_t$	-0.330***	-0.399***	-0.161***	-0.084	-0.018	-0.016	-0.136**	-0.105
	(-5.23)	(-4.43)	(-2.68)	(-1.22)	(-0.28)	(-0.25)	(-1.97)	(-1.28)
CA/GDP_t	-0.084	-0.196***	0.148**	0.088*	-0.034	-0.036	-0.215***	-0.223***
	(-1.07)	(-2.82)	(2.09)	(1.97)	(-0.83)	(-0.89)	(-3.22)	(-3.53)
DE/GDP_t	0.044***	0.046***	0.033***	0.036***	0.019**	0.019**	0.003	-0.008
	(3.94)	(3.78)	(4.55)	(5.18)	(2.40)	(2.37)	(0.12)	(-0.40)
inf_t	0.001	-0.000	0.011*	0.010*	0.005	0.005	-0.046	-0.057
	(0.22)	(-0.02)	(1.77)	(1.68)	(1.07)	(1.07)	(-1.10)	(-1.25)
$(X+M)/GDP_t$	-0.010	-0.007	-0.011**	-0.008	-0.003	-0.003	0.041**	0.053***
	(-1.56)	(-0.91)	(-2.02)	(-1.62)	(-0.66)	(-0.61)	(2.22)	(2.78)
$Reserves/Import_t$	0.028	0.043	0.054	0.063	0.062	0.065	0.222*	0.194*
	(0.36)	(0.52)	(0.93)	(1.17)	(1.45)	(1.53)	(1.74)	(1.90)
$Spreads\_US_{t-1}$					0.501***	0.507***	0.329***	0.376***
					(4.58)	(4.81)	(4.30)	(5.51)
cons	2.041	1.400	1.144	0.079	-0.989	-1.052	2.557	2.419
	(1.22)	(0.79)	(0.86)	(0.06)	(-0.98)	(-1.04)	(0.56)	(0.53)
N	100	90	100	90	90	90	80	80
adj. R^2	0.561	0.461	0.776	0.757	0.836	0.836		

t statistics in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Lastly, we explore the relationship between governance factors and sovereign bond spreads, and the estimation results is reported in Table 11. As can be observed, higher government sustainability scores appear to be associated with lower sovereign bond spreads. However, the coefficient of GOSI is significant when pooled OLS and fixed effect estimation are applied, but there is a lack of significance when using GMM method. Nevertheless, if we replace the GOSI with its lag of one period, the lagged GOSI is significant across all estimates and using different estimation method. The relationship between the lagged GOSI and sovereign bond spreads is in line with previous work of Hansen and Zegarra (2016), Baldacci et al. (2011), Capelle-Blancard (2019) and Margaretic and Pouget (2018), who find that higher political risk (low GOSI score) is associated with higher sovereign credit risks and thus higher sovereign bond spreads. The insignificant coefficient of GOSI and the significant coefficient of lagged GOSI indicate that financial markets are slow to reflect the impact of changes to political policies on the solvency of a country. With regard to macroeconomic fundamentals variables, when governance performance is included in the model, GDP growth rate shows no significant impact on sovereign bond spreads whether GOSI or lagged GOSI are used. The current account to GDP ratio is negatively associated with sovereign bond spreads, and such association is statistically significant in the GMM estimation. Inflation is found to be another important determinant of sovereign bond spread, and higher inflation tend to lower

sovereign bond spread. Similar to previous findings, both trade openness ratio and reserve ratio is highly significant but with unexpected positive sign. In addition, the lagged dependent variable also has significant coefficient, and the magnitude of the GMM coefficient is higher than that of the fixed effect.

Table 11. Effect of governance factors on sovereign bond spreads (US based)

	(1) Pooled OLS		(2) Fixed Effect		(3) Fixed Effect		(4) GMM	
	Spreads_US		Spreads_US		Spreads_US		Spreads_US	
GOSI	-0.198***		-0.234***		-0.109***		-0.406	
	(-3.64)		(-4.77)		(-2.70)		(-1.52)	
$GOSI_{t-1}$		-0.191***		-0.209***		-0.092**		-0.571*
		(-3.34)		(-4.58)		(-2.23)		(-1.86)
$\Delta GDP/GDP_t$	-0.365***	-0.405***	-0.182***	-0.070	-0.026	-0.027	-0.112	-0.089
	(-4.81)	(-4.22)	(-2.80)	(-0.94)	(-0.44)	(-0.45)	(-1.49)	(-1.02)
CA/GDP_t	-0.171*	-0.290***	0.093	0.008	-0.036	-0.037	-0.264***	-0.272***
	(-1.87)	(-3.84)	(1.10)	(0.16)	(-0.95)	(-0.98)	(-5.30)	(-3.38)
DE/GDP_t	0.037***	0.044***	0.026***	0.034***	0.021***	0.020***	-0.006	-0.001
	(2.89)	(3.59)	(2.69)	(4.61)	(3.30)	(3.11)	(-0.23)	(-0.05)
inf_t	0.010	0.006	0.022***	0.017***	0.009*	0.009*	-0.097***	-0.082**
	(1.25)	(0.72)	(3.38)	(2.83)	(1.98)	(1.81)	(-2.63)	(-2.13)
$(X+M)/GDP_t$	-0.003	-0.001	-0.002	-0.002	-0.001	-0.001	0.048**	0.053**
	(-0.40)	(-0.12)	(-0.48)	(-0.41)	(-0.14)	(-0.14)	(2.10)	(2.15)
$Reserves/Import_t$	0.091	0.060	0.084	0.064	0.032	0.038	0.241**	0.273***
	(1.18)	(0.76)	(1.32)	(0.97)	(0.55)	(0.69)	(2.21)	(2.62)
$Spreads\_US_{t-1}$					0.451***	0.464***	0.460***	0.539***
					(5.52)	(5.29)	(6.11)	(4.03)
cons	0.133	0.224	-0.666	-1.122	-1.094	-1.180	6.498*	-1.626
	(0.08)	(0.12)	(-0.51)	(-0.81)	(-0.95)	(-1.03)	(1.75)	(-0.25)
N	100	90	100	90	90	90	80	80
adj. R^2	0.509	0.446	0.755	0.763	0.850	0.845		

t statistics in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

The overall analysis of the results in three tables above indicates that environmental factors, social factors, and governance factors on their own, are all significantly associated with sovereign bond spreads. Better performance in environmental dimension, social dimension or governance dimension tend to lower a country's sovereign bond spreads. However, if we focus on the impact of current value of the ESG sub-dimension index on the current value of sovereign bond spreads, only environmental dimension (ENSI) and social dimension (SOSI) show a significant impact, and insignificant relationship is detected between governance dimension (GOSI) and sovereign bond spreads. But when we use lagged ESG sub-dimension index, the coefficient of the index of environmental dimension (ENSI), governance dimension (GOSI) and social dimension (SOSI) all show a significant relationship with sovereign bond spreads. The results of regression model with lagged ESG sub-dimension index is partially in line with the findings in Capelle-Blancard (2019) and Margaretic and Pouget (2018), who find that the lagged social and governance factor has significant impacts on the cost of debt. In addition, when looking at the economic magnitude of each ESG sub-dimension index, focusing on the contemporaneous

influence, the economic magnitude of a change in the country environmental score on sovereign spreads is larger than the impact of an equal change in the social score. Specifically speaking, one unit increase in ENSI score decrease the 10-year sovereign bond spreads by approximately 1.7 basis points compared to 0.81 basis points for one unit increase in SOSI score. Focusing on the lagged influence, environmental factors also have larger economic impact (with coefficient of 1.41) on sovereign bond spreads than that of social factor (with coefficient of 0.79) and governance factor (with coefficient of 0.57). These findings thus partially support our second hypothesis (H2) that the three ESG sub-dimensions have heterogeneous effect on sovereign bond spreads, but does not suggest that the financial impact of the governance side of country ESG performance is more pronounced compared to the social and environmental ones. In our studies, we find that in CEE countries, environmental and social dimension has more significant impact than governance impact on sovereign bond spreads. However, this finding is inconsistent with that found in Capelle-Blancard (2019), where governance factors have more pronounced impact on the cost of debt over the other two factors. One possible explanation is that greater emphasis is placed on a country's environmental and social performance by investors in CEE countries. Another explanation for the difference between this study and previous studies, as mentioned before, can be attributed to the different measuring indicators chosen to construct the ESG index, especially the environmental sustainability index.

6. Robustness analysis

The above analysis suggests that investors price a country’s environmental, social and governance factors in sovereign bond market. However, since the countries in our sample are all European countries, we want to check whether such relationship still exits when we further control the influence of regional factors. In addition, since the time period of our study (2009-2018) covers the period of European Sovereign Debt Crisis, it is reasonable to take account the effect of this crisis on European countries’ sovereign bond risks. Therefore, in this section, we use the German 10-year sovereign bond yield instead of the US 10-year sovereign bond yield as the benchmark for sovereign bond spread, and test the relationship between ESG performance and sovereign bond spreads.

6.1 Examining overall ESG performance

We first analyze whether a country's overall ESG performance effect the cost of public debt significantly. The results are reported in Table 12. As discussed before, the result in the first column is estimated using pooled OLS, while the second column is estimated using fixed-effect (FE). In column 3 and column 4, we include the first lag of dependent variable and estimate the model using fixed-effect (FE) and dynamic GMM.

Table 12 shows that the coefficient of ESGSI is negative and significant in all four estimations. This indicates that when we use German government bond as the benchmark to calculate sovereign bond spreads, the relationship between ESG performance and sovereign bond spreads still exists, and better ESG performance is associated with lower sovereign bond spreads. However, the coefficient of the first lag of ESGCI is positive and insignificant.

Table 12. Effect of overall ESG performance on sovereign bond spreads (GE based)

	(1) Pooled OLS		(2) Fixed Effect		(3) Fixed Effect		(4) GMM	
	Spreads_GE		Spreads_GE		Spreads_GE		Spreads_GE	
$ESGCI_t$	-0.479***		-0.474***		-0.179**		-0.758***	
	(-6.31)		(-5.98)		(-2.34)		(-4.08)	
$ESGCI_{t-1}$		-0.458***		-0.458***		-0.147*		0.205
		(-5.47)		(-5.41)		(-1.86)		(0.77)
$\Delta GDP/GDP_t$	-0.156***	-0.133***	-0.097**	-0.023	0.008	0.006	0.001	-0.012
	(-5.63)	(-2.69)	(-2.13)	(-0.42)	(0.18)	(0.14)	(0.04)	(-0.60)
CA/GDP_t	-0.130***	-0.155***	-0.034	-0.021	-0.045	-0.046	-0.122**	-0.157**
	(-3.68)	(-3.31)	(-0.96)	(-0.49)	(-1.40)	(-1.41)	(-2.21)	(-2.25)
DE/GDP_t	0.042***	0.045***	0.039***	0.041***	0.020***	0.019***	0.014	0.011
	(5.59)	(4.88)	(6.37)	(5.85)	(3.66)	(3.29)	(1.13)	(0.80)
inf_t	0.010**	0.010*	0.014***	0.016***	0.007	0.007	-0.028	-0.044
	(2.31)	(1.91)	(3.04)	(2.90)	(1.57)	(1.46)	(-0.63)	(-1.17)
$(X+M)/GDP_t$	-0.003	-0.001	-0.003	-0.001	0.001	0.001	0.015	0.019
	(-0.48)	(-0.11)	(-0.53)	(-0.20)	(0.19)	(0.28)	(0.85)	(0.95)
$Reserves/Import_t$	0.021	0.042	0.027	0.045	0.041	0.049	0.206*	0.223*
	(0.35)	(0.72)	(0.44)	(0.73)	(0.82)	(1.04)	(1.74)	(1.74)
$Spreads\_GE_{t-1}$					0.566***	0.592***	0.332**	0.459***
					(5.85)	(6.15)	(2.10)	(2.92)
cons	2.007	1.359	1.577	0.707	-0.298	-0.540	4.847	1.043
	(1.60)	(1.01)	(1.24)	(0.54)	(-0.27)	(-0.51)	(1.38)	(0.21)
N	100	90	100	90	90	90	80	80
adj. R^2	0.599	0.555	0.658	0.654	0.792	0.786		

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6.2 Examining environmental, social and governance factors respectively

Table 13 reports the effect of environmental factors on sovereign bond spreads, using German bond as benchmark. The coefficient of ENSI is highly significant while the

first lag of this variable appears to be insignificant. The results thus again support that environmental factor can be a determinant of sovereign bond spreads, and higher score of environmental sustainability index (ENSI) is associated with lower sovereign bond spreads. However, the insignificance of the lagged ENSI may indicate that while some elements in environmental dimension is perceived by public bond market timely, others (e.g. environmental degradation and carbon emissions) need more time (more than one year) to have some impacts on the sovereign bond spreads (de Boyrie and Pavlova, 2020). Nevertheless, this finding is in line with the findings in Capelle-Blancard (2019) and Margaretic and Pouget (2018), who shows that the relationship between past environmental performance (i.e. with one period of lag) and sovereign bond spreads is insignificant.

Table 13. Effect of environmental factors on sovereign bond spreads (GE based)

	(1) Pooled OLS		(2) Fixed Effect		(3) Fixed Effect		(4) GMM	
	Spreads_GE		Spreads_GE		Spreads_GE		Spreads_GE	
ENSI	0.081*		0.125***		0.009		-0.959***	
	(1.69)		(2.79)		(0.28)		(-3.03)	
$ENSI_{t-1}$		0.075		0.129***		0.013		-0.567
		(1.49)		(2.92)		(0.41)		(-1.51)
$\Delta GDP/GDP_t$	-0.146***	-0.127**	-0.064	0.025	0.022	0.022	0.003	-0.013
	(-4.59)	(-2.32)	(-1.14)	(0.36)	(0.49)	(0.49)	(0.17)	(-0.56)
CA/GDP_t	-0.185***	-0.207***	-0.063	-0.040	-0.057*	-0.057*	-0.115*	-0.115*
	(-4.57)	(-3.97)	(-1.47)	(-0.81)	(-1.71)	(-1.69)	(-1.79)	(-1.67)
DE/GDP_t	0.035***	0.038***	0.031***	0.032***	0.014**	0.014**	0.026**	0.010
	(4.35)	(4.00)	(4.99)	(4.86)	(2.62)	(2.63)	(2.13)	(1.46)
inf_t	0.006	0.005	0.011*	0.012*	0.004	0.004	-0.003	-0.043
	(1.13)	(0.91)	(1.76)	(1.76)	(0.85)	(0.88)	(-0.08)	(-1.09)
$(X+M)/GDP_t$	-0.003	-0.002	-0.002	-0.002	0.001	0.001	0.023	0.025
	(-0.45)	(-0.29)	(-0.32)	(-0.25)	(0.23)	(0.24)	(1.29)	(1.26)
$Reserves/Import_t$	0.233***	0.237***	0.244***	0.251***	0.093**	0.094**	0.274***	0.251**
	(3.82)	(3.53)	(4.68)	(4.69)	(2.39)	(2.43)	(2.63)	(2.03)
$Spreads\_GE_{t-1}$					0.680***	0.676***	0.302**	0.237
					(7.56)	(7.53)	(2.19)	(1.53)
cons	-0.961	-1.090	-1.860	-2.397	-1.202	-1.242	2.272	5.043
	(-0.61)	(-0.64)	(-1.17)	(-1.42)	(-1.07)	(-1.11)	(0.64)	(1.20)
N	100	90	100	90	90	90	80	80
adj. R^2	0.477	0.428	0.552	0.550	0.776	0.776		

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 14, we show the impact of social factors on the cost of public debt. The results indicate that while the coefficient of SOSI is negative and significant in pooled OLS estimation and fixed-effect adjusted estimation, the coefficient of SOSI is negative and insignificant when we include lagged dependent variable in the model. The same result is shown when using the first lag of SOSI instead. Therefore, we cannot conclude here that social factor has a significant impact on sovereign bond spreads, so social performance does not help explain the differential sovereign bond yields between that of CEE countries and Germany. One possible explanation of the lack of significance of SOSI and lagged SOSI in the regression results is that

European countries are more inter-connected and similar in social development, so when using German bond as benchmarked for sovereign bond spreads, social factor was not a system region-specific factor driving sovereign bonds spreads during the period that includes the European sovereign debt crisis.

Table 14. Effect of social factors on sovereign bond spreads (GE based)

	(1) Pooled OLS		(2) Fixed Effect		(3) Fixed Effect		(4) GMM	
	Spreads_GE		Spreads_GE		Spreads_GE		Spreads_GE	
$SOSI_t$	-0.230***		-0.228***		-0.059		-0.300	
	(-3.32)		(-3.61)		(-1.28)		(-1.13)	
$SOSI_{t-1}$		-0.241***		-0.258***		-0.063		-0.281
		(-3.18)		(-3.91)		(-1.40)		(-1.17)
$\Delta GDP/GDP_t$	-0.133***	-0.129**	-0.071	-0.016	0.012	0.012	-0.010	-0.003
	(-4.22)	(-2.44)	(-1.39)	(-0.22)	(0.27)	(0.26)	(-0.56)	(-0.16)
CA/GDP_t	-0.122***	-0.120**	-0.025	0.030	-0.039	-0.036	-0.132*	-0.136**
	(-3.21)	(-2.44)	(-0.58)	(0.66)	(-1.07)	(-1.00)	(-1.90)	(-2.01)
DE/GDP_t	0.041***	0.042***	0.038***	0.038***	0.016***	0.016***	0.008	0.004
	(5.07)	(4.52)	(5.84)	(5.61)	(2.82)	(2.86)	(0.92)	(0.44)
inf_t	0.004	0.004	0.007	0.010*	0.004	0.004	-0.026	-0.033
	(0.72)	(0.85)	(1.25)	(1.71)	(0.95)	(0.99)	(-0.65)	(-0.82)
$(X+M)/GDP_t$	-0.006	-0.005	-0.006	-0.005	0.000	0.000	0.018	0.023
	(-1.22)	(-0.80)	(-1.31)	(-1.06)	(0.00)	(0.04)	(1.05)	(1.46)
$Reserves/Import_t$	0.119**	0.126**	0.123**	0.121**	0.074*	0.074*	0.201	0.203*
	(2.30)	(2.21)	(2.50)	(2.51)	(1.94)	(1.96)	(1.61)	(1.81)
$Spreads\_GE_{t-1}$					0.636***	0.636***	0.337***	0.351**
					(6.95)	(7.19)	(2.94)	(2.47)
cons	1.220	0.808	0.882	0.281	-0.747	-0.781	1.733	1.826
	(0.97)	(0.59)	(0.69)	(0.22)	(-0.78)	(-0.82)	(0.41)	(0.44)
N	100	90	100	90	90	90	80	80
adj. R^2	0.537	0.500	0.591	0.607	0.780	0.781		

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The last table reports the effect of governance factors in sovereign bond spreads. As we can observe, the coefficient of governance sustainability index is negative and significant, whether the present GOSI or the lagged GOSI is regressed, in all four model estimates of the table. Therefore, the results thus again confirm that governance factors are priced by financial markets, and better performance in governance is associated with lower sovereign bond spreads. In addition, compared with previous results shown in section 5, it can be observed that the governance factor become more significant when we use German long-term sovereign bond as benchmark, and the variable GOSI also turns to be significant under this situation. Therefore, the result suggests that when the European specific-region factors and the effect of European sovereign bond crisis are controlled, governance factors have more explanation power for sovereign bond spreads within European area.

Table 15. Effect of governance factors on sovereign bond spreads (GE based)

	(1) Pooled OLS	(2) Fixed Effect	(3) Fixed Effect	(4) GMM
	Spreads_GE	Spreads_GE	Spreads_GE	Spreads_GE
GOSI	-0.228***	-0.247***	-0.084**	-0.380**

	(-5.64)		(-5.81)		(-2.20)		(-2.32)	
$GOSI_{t-1}$		-0.215***		-0.231***		-0.064*		-0.396**
		(-4.93)		(-5.49)		(-1.67)		(-2.57)
$\Delta GDP/GDP_t$	-0.168***	-0.141***	-0.092*	-0.003	0.015	0.014	0.003	-0.013
	(-5.65)	(-2.81)	(-1.86)	(-0.05)	(0.34)	(0.32)	(0.11)	(-0.63)
CA/GDP_t	-0.171***	-0.203***	-0.055	-0.053	-0.056*	-0.056*	-0.141**	-0.158**
	(-4.30)	(-3.95)	(-1.41)	(-1.14)	(-1.74)	(-1.75)	(-2.54)	(-2.21)
DE/GDP_t	0.038***	0.041***	0.035***	0.037***	0.018***	0.017***	0.013	0.012
	(4.87)	(4.43)	(5.53)	(5.35)	(3.40)	(3.14)	(1.01)	(0.82)
inf_t	0.012**	0.011**	0.018***	0.018***	0.007	0.007	-0.050	-0.042
	(2.52)	(1.99)	(3.55)	(3.06)	(1.61)	(1.41)	(-1.33)	(-1.17)
$(X+M)/GDP_t$	0.000	0.001	0.001	0.001	0.002	0.002	0.018	0.020
	(0.01)	(0.22)	(0.17)	(0.27)	(0.48)	(0.46)	(0.98)	(0.92)
$Reserves/Import_t$	0.102*	0.118*	0.099*	0.116*	0.068	0.073*	0.210*	0.237*
	(1.73)	(1.95)	(1.67)	(1.98)	(1.57)	(1.75)	(1.70)	(1.89)
$Spreads\_GE_{t-1}$					0.588***	0.614***	0.427***	0.446***
					(6.24)	(6.42)	(3.11)	(2.90)
cons	0.198	-0.212	-0.292	-0.967	-1.010	-1.080	4.897	-0.685
	(0.15)	(-0.14)	(-0.23)	(-0.72)	(-1.01)	(-1.10)	(1.47)	(-0.13)
N	100	90	100	90	90	90	80	80
adj. R^2	0.566	0.517	0.645	0.633	0.789	0.783		

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

To sum up, when using 10-year German sovereign bond as benchmark to calculate sovereign bond spreads, we can still confirm that ESG performance has a significant impact on sovereign bond spreads, although the impact of the three ESG sub-dimensions on sovereign bond spreads shows a slightly different pattern. Environmental factors are still significantly associated with sovereign bond spreads, but such significance does not show in the lagged ENSI. However, we do not find a significant relationship between social factors and sovereign in this robustness test. In addition, the association between governance factors and sovereign bond spreads become more significant, and both current GOSI and GOSI with one period of lag has negative and significant coefficient. Moreover, environmental factors still have the largest economic impact compared with governance and social factors. Thus, the findings again support the first hypothesis and only partially support the second hypothesis.

7. Conclusion

7.1 Discussion and conclusions

Many politicians and investors have aimed to gain a better understanding of sovereign credit risk and its economic and financial consequences, particularly since the European sovereign debt crisis. Some studies contend that sustainability should be taken into account in analysis and policy for broader risk analysis. They contend that sustainability, along with conventional sovereign risk factors such as public debt, fiscal deficit, inflation, and GDP growth rate, has a substantial impact on a country's

creditworthiness and is, therefore, a possible risk factor. The grounds for this particular link are that strong sustainability indicates a nation's long-term orientation and commitment to repaying its debt and may reduce the asymmetries of information and build trust between investors and the country. Better sustainability performance may also serve as a shock absorber, thus indicating a more stable long-term economic development. Therefore, nations with higher sustainability levels have less default risky and have lower borrowing costs.

This paper studies the link between environmental, social and governance (ESG) performance of countries and their sovereign bond spreads. The research mainly focuses on Central Eastern Europe (CEE) countries and cover the period from 2009 to 2018. More specifically, this paper first assesses how overall ESG performance influence countries' sovereign bond spreads. Next, this paper further investigates the relationship between each of the sub-dimension (environmental, social and governance dimension) of ESG and countries' cost of sovereign debt. For robustness and comparation purpose, this paper use two different sovereign bond spreads to analyze the impact of ESG performance on them. One is calculated as the difference between CEE countries' 10-year sovereign bond yield and the US' 10-year sovereign bond yield, and the other bond spread of CEE countries is calculated vis-à-vis Germany. We focus on CEE countries for three reasons: on the one hand, CEE countries are more interlinked with each other, and have dissimilar culture and political background with developed European countries, thus being worthwhile to be studied separately. On the other hand, small spreads and extremely high co-movements of sovereign rates within CEE countries indicate that there may be extra-financial risk factors that determine sovereign bond spreads in CEE countries. Besides, we want to control the impact of European sovereign bond crisis on the sovereign bond yields.

To measure country's ESG performance, we constructed ESG index based on Country Sustainability Ranking framework provided by RobecoSAM (2022). Specifically speaking, we first build up three sub-dimension index based on 21 measuring indicators from public resources such as Word Bank (WB), United Nations Development Program (UNDP) and the Worldwide Governance Indicators (WGI). The three sub-dimension indices are *environmental sustainability index (ENSI), social*

sustainability index (SOSI), and *governance sustainability index (GOSI)*. The three sub-dimensions are then given the weights of 20%, 30% and 50% respectively, and intergraded into the index measuring countries' composite ESG performance, namely the *ESG country index (ESGCI)*. Overall, our paper finds that Slovenia and Czech Republic receive the highest score for ESGCI, and thus is regarded as having the best ESG performance among the 10 countries, while Bulgaria and Romania receive much lower scores and have relatively poor performance in ESG.

To assess whether countries' sovereign bond spreads are determined by their ESG performance, we adopt the dynamic GMM method. The main finding in this paper is that CEE countries' ESG performance is significantly associated with sovereign bond spreads. Countries with better ESG performance (higher ESG index score) tend to have lower sovereign bond spreads. Therefore, we conclude that except financial factors such as GDP growth rate, public debt, inflation and trade openness, investors also price sustainability in long-term sovereign bond market. In addition, when focusing on the impact of environmental, social and governance side individually, the finding is more mixed in terms of whether the sovereign bond spreads are calculated vis-à-vis the U.S. or Germany. When looking at the risk premium over U.S. risk-free rate, the results indicate that environmental, social and governance side all have a negative and significant impact on sovereign bond spreads, and environmental factors have a more pronounced economic effect on the spreads compared to the other two factors. However, when assessing CEE sovereign bond yields versus that of Germany, only environmental and governance factors are found to have significant impacts on them. The social sustainability index (SOSI), however, whether regressing it on its present value or lagged value, all leads to negative but insignificant coefficient. In addition, the relationship between governance elements and sovereign bond spreads is more significant when assessing bond spreads within Europe. Therefore, this paper suggests that environmental, social and governance factors have heterogeneous impacts on CEE economies' cost of debt. In international sovereign bond markets, all three elements are priced by investors for risk of default, and investors are more sensitive to the environmental performance of countries. But in European sovereign bond market, investors consider only the environmental and governance elements, or the impact of social elements takes longer time (more than one year) to be reflected by the evolution of sovereign bond spreads.

However, the findings in this paper are only partially supported by Capelle-Blancard (2019) and Margaretic and Pouget (2018), who both suggest that while social and governance factors have significant impacts on sovereign bonds spreads, environmental factors does not. One possible explanation for the difference between our study and previous study can be attributed to the difference in the measurement method of ESG performance. Another reason could be the different samples studied, especially the time period, since the climate crisis has been paid increasing attention by the public and political agenda in recent years (Kirby, 2022).

7.2 Limitations and recommendations for further research

The first limitation of this study relates to the construction of ESG index. First of all, there is currently no unified framework for ESG index construction. In addition, as "soft information", ESG performance in itself is difficult to be quantified. Therefore, the validity of this study is influenced by the accuracy of ESG index to capture countries' performance in sustainability. Moreover, as can be observed, different organizations (e.g. VIGEO, MSCI ESG Ratings and Thomson Reuters ESG Scores) differ in the criteria and data source chosen to measure ESG performance, thus leading to different results regarding the ratings of each country's ESG performance. We concern that the indicators selected, and the weightings allocated to each indicator to some extent influence the study results, because different indicators vary in the intensity and timing of the impact on sovereign bond spreads. Based on this concern, further research should use more accurate measures of ESG performance, or use different ESG index frameworks for robustness check. Secondly, the accuracy of ESG index in this study is also restricted by data unavailability. In other words, the validity and reliability of variables that proxy for ESG factors are still a potential problem because the data in ESG related field is limited. Moreover, the lack of ESG data is also reflected in the extent of its coverage, thus limiting the number of countries we can select in research. However, as stated in Capelle-Blancard (2019), we anticipate that over the coming ten years, with the UN's Sustainable Development Goals becoming more widely known and used by businesses, governments, and society at large, the data issue will be better solved.

In addition, another limitation of this study is that we did not take the trend of countries' ESG performance into consideration. According to Allianz Global Investors (2019), it is necessary to augment the research with an analysis of whether a country is on an improving or deteriorating ESG trend due to the constraints of ESG data, which are frequently laggard and slow moving. For instance, Poland's still relatively high score in GOSI may have not yet completely taken into account the country's recent decline in the rule of law. Allianz Global Investors (2019) suggests that more recent policy changes that could possibly have an impact on ESG quality can be reflected by combining the data with a forward-looking assessment. Therefore, further studies can integrate the analysis of countries' ESG developing trend when assessing the relationship between ESG performance and sovereign bond spreads.

Moreover, in this study, we assess countries' ESG performance by constructing composite ESG index and corresponding score for each dimension (i.e., environment, social, and governance). However, several studies argue that regrading to sustainability issue (or ESG), it is necessary to distinguish positive sustainability performance (strengths) and negative sustainability performance (concerns), since these two variables are conceptually and practically different, so they are not meant to measure the same issues and could lead to very different financial impacts (Chatterji et al.,2009; Alikaj, 2017). Thus, we recommend that future studies should investigate the impact of ESG strengths and concerns on sovereign bond spreads separately.

As for endogeneity concerns, because it takes time for a nation to enhance its ESG performance, we don't think simultaneity issues are significant in this study. Furthermore, due to the fact that the indicators that we employ take into account a diverse range of criteria, we can presume that they reflect country's attitude toward ESG policies rather than a nation's capacity to finance particular projects. Overall, it appears implausible that a nation would begin formulating strategies or developing policies in order to enhance its sustainability performance because it anticipates that spreads will decline in the next year. As a consequence of this, we are of the opinion that it is the ESG performance that influence the cost of debt of a country, and the causality is not the reverse. However, we did not further check our opinion on potential endogeneity in a statistical way, and that could be another limitation of this study. The endogeneity problem in this study is open to debate. Lastly, as can be

observed, the difference between FE and GMM is quite large. This result can be attributed to the small number of time periods covered in the study. Therefore, in future research, it would be worthwhile to expand the time period, and use alternative methodologies (such as LSDVC) to test the hypotheses.

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List of appendices

Appendices

Appendix 1: Descriptive statistics: Input data for ESG index construction

Variable	Mean	Median	Max	Min	SD	Obs
Air	18.06	17.60	27.18	11.82	3.31	100
Electricity	27.86	22.68	73.96	4.67	18.71	100
Energy	20.68	18.81	42.60	8.84	9.05	100
Loss	17.69	13.11	46.75	7.03	11.97	100
Forest	37.73	34.57	61.96	22.47	11.27	100
Terrest	30.73	29.58	53.64	16.94	11.25	100
Water	16.94	8.84	84.18	1.07	22.34	100
Population	67.86	67.76	72.22	63.96	1.92	100
Life	76.18	75.79	81.38	73.08	2.11	100
HDI	0.85	0.84	0.91	0.78	0.03	100
Femaletomale	77.79	77.14	85.18	69.83	4.08	100
Internet	67.78	69.92	83.58	36.60	10.40	100
Health	752.65	655.45	1570.97	247.13	351.19	100
Prison	171.35	179.20	328.90	62.10	68.61	100
Voice	0.77	0.84	1.11	0.31	0.24	100
Stability	0.67	0.72	1.12	0.02	0.30	100
Effectiveness	0.65	0.70	1.18	-0.36	0.37	100
Regulatory	0.84	0.90	1.31	0.36	0.25	100
Rule	0.60	0.63	1.14	-0.13	0.37	100
Corruption	0.28	0.30	1.06	-0.33	0.34	100
R&D	1.04	0.86	2.56	0.38	0.54	100

This table shows descriptive statistics for input data used to construct ESG index.

DISSERTATION PROJECT
Name: Yanqi Guan
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Academic year: 2021/2022
Dissertation title: Analyzing the link between Environmental, Social and Governance (ESG) and sovereign bond spreads: an empirical analysis of CEE countries
Expected date of submitting: **August, 2022**
Head of the Seminar: doc. PhDr. Jiří Vykoukal, CSc.
Supervisor: PhDr. Jaromír Baxa, Ph.D.
Title: /
Short description of the topic: Sovereign bond yields are connected with ESG factors. On the one hand, investors care about the ESG performance of their portfolio. On the other hand, sovereigns with lower ESG scores seem to have higher risk of default. However, ESG is still a relatively new and fast expanding area, and the majority of the relevant studies in the recent century focus on identifying the influence of ESG indicators on the cost of corporate bonds and few pay attentions to the link between ESG and sovereign bond risks. Therefore, this paper is interested in exploring the possible relationships between overall ESG performance and sovereign bond spreads in CEE countries. For example, is the relationship positive or negative? Or is the impact of ESG on short-term government bond differs from long-term bond? In addition, this paper may also look at the financial impacts of environmental, social, and governance factors respectively.
Proposed structure: Introduction Literature review and Hypotheses Data and Methodology Results and Discussion Conclusion
Sources (basic selection): World Development Indicators (WDI) database and Datastream