MODELING THE EFFECTS OF SUSTAINABLE DEVELOPMENT ON THE EQUITY RISK PREMIUM

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Abstract:

This paper is a secondary data analysis regarding the relationship between sustainable development and the cost of equity (Equity Risk Premium — ERP) in the European context, with the main objective of providing a panel econometric model with country and time-specific effects for ERP estimation. The study adopts a quantitative methodology, combining panel regression and secondary data analysis of a sample from 28 European countries over the period 2000–2023. The findings reveal a generally negative correlation between the Sustainable Development Index (SDG Index) and ERP. Moreover, it was observed that most individual SDG indicators did not show statistical or economic significance; out of the 17 components of the aggregate SDG Index, only 6 proved to be significant. The study emphasizes that the panel econometric model employed can estimate ERP values with high accuracy, average estimation errors being small. Thus, the choice of long-term bond yields and the aggregate Sustainable Development Index (SDG Index) as independent variables generated significant results, indicating that these variables can be used in models for estimating the cost of equity.

Keywords: *econometric panel model, cost of capital, equity risk premium, sustainable development*

JEL classification: *C23, G32*

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Introduction

The concept of sustainable development occupies a central place in today's economy, aiming to achieve economic growth that meets present needs without compromising the ability of future generations to meet their own. In this context, the relationship between sustainable development and the cost of capital has become a topic of interest for both the academic community and economic professionals. The equity risk premium (ERP) reflects investors perception of the risks associated with investing in a particular economy and serves as a key reference indicator in investment decision-making. Exploring this relationship can provide valuable insights into how progress in sustainable development influences risk perception in financial markets.

The main objective of this research is to establish a panel econometric model to estimate the cost of equity (ERP) for commercial companies. To construct this econometric model, the analysis focused on 28 European countries over the period 2000–2023, examining the evolution of the relationship between the equity risk premium (ERP) and the Sustainable Development Goals Index (SDG Index). In the model all of the European countries during the mentioned period will be included and using a panel econometric model 672 observations are obtained for the final sample.

The specific objectives of the research include: (1) selecting the most appropriate economic variable alongside the Sustainable Development Index and analyzing their relationship, (2) determining and statistically interpreting the coefficients and statistical tests specific to panel econometric models, (3) identifying the best estimation method, whether fixed or random effects, and (4) selecting the most suitable panel econometric model for future ERP estimates by comparing the estimation errors across multiple models.

The paper is organized into three sections: (1) the first section introduces the study context, outlines the addressed issues, and reviews existing literature, highlighting relevant conclusions and identified gaps; (2) the second section presents the research methodology and describes the sample used; (3) the final section includes the statistical analysis of the variables considered in the study and details the panel econometric models employed, as well as the statistical tests conducted to select the most appropriate econometric model.

Literature Review

In the specialized literature, research on the influence of sustainable development indicators on the equity risk premium at the macroeconomic level remains rather limited. Most studies focus on analyzing these indicators at the firm level, without exploring in detail the relationship between a country's sustainable development and the equity risk premium of the national economy. Sustainable development indicators reflect the economic, social, and environmental dynamics of a country and serve as an important tool for assessing long-term economic sustainability and competitiveness.

The study titled "On the Correlation between Market Risk Premiums and SDGs" investigates the relationship between sustainable development indicators (SDGs: Sustainable Development Goals) and market risk premiums (MRPs) at the global level, as well as their effects on firm value. The main objective of the research is to analyze the extent to which initiatives and actions associated with the Sustainable Development Goals can influence the market risk premium and, consequently, the value of firms. The applied methodology is based on a panel regression model used to assess the relationship between the SDG Index score and market risk premiums over the period 2016–2020.

The analysis was conducted on a sample of 790 observations from 158 countries, using three types of market risk premiums: MRP (F), estimated by Fernandez et al. for the period 2016–2021; MRP (CR), calculated by Damodaran based on credit ratings; and MRP (CS), determined by the same author using CDS spreads. To test the formulated hypotheses, the authors applied the Hausman test to determine the appropriate specification between the fixed-effects and random-effects models. In order to correct potential issues of autocorrelation and heteroskedasticity, robust Driscoll-Kraay estimators were employed. Additionally, the model included control variables such as GDP per capita, the Democracy Index, and the ratio of public debt to GDP.

The conclusions of the study highlight the existence of a significant negative correlation between the overall SDG Index score and market risk premiums. The estimated coefficients for the SDG Index Score ranged from -0.036 to -0.121, indicating that a one-point increase in this score leads, on average, to a reduction of approximately 5.5 basis points in the market risk premium. For instance, to achieve a 1% decrease in the MRP, an increase of about 18 points in the SDG score would be required.

The analysis of individual goals revealed significant relationships between certain SDGs and market risk premiums, such as SDG 3 (Good Health and Well-being) and SDG 13 (Climate Action), both were showing a relevant negative correlation. This suggests that improvements in public health and the reduction of climate-related risks contribute to lowering investors' perceived risk.

Conversely, SDG 9 (Industry, Innovation, and Infrastructure) exhibited a positive correlation with MRPs, implying that infrastructure and innovation projects may amplify perceived market risk. For SDG 15 (Life on Land) and SDG 16 (Peace, Justice, and Strong Institutions), no significant relationships were found, indicating the need for further research in these areas.

The results of the study show that sustainable development initiatives can contribute to reducing market risk premiums and increasing firm value, particularly through measures aimed at improving public health and protecting the environment.

The authors suggest that integrating the Sustainable Development Goals (SDGs) into national economic strategies could lower the cost of capital and support sustainable economic growth. However, the research has certain limitations, including the relatively short analysis period of five years (2016–2020), which reduces the ability to capture long-term trends. Additionally, the study was conducted at a global level without examining regional or continental differences, even though risk factors may vary considerably across different areas. Moreover, for some SDGs—such as SDG 1, 2, 4–8, 10–12, 14, and 17—no clear relationship with market risk premiums was identified, indicating the need for further research.In conclusion, the study provides relevant evidence of the link between sustainable development and the reduction of market risk premiums, while emphasizing the importance of extending the analysis period and conducting region-specific investigations in future research (Ito, 2022).

In this context, the present study aims to investigate how macroeconomic indicators of sustainable development influence the equity risk premium at the national level. The research will use statistical data from official international sources such as the World Bank, the IMF, and Eurostat, and will apply advanced econometric techniques to analyze the causal relationships between sustainable development and the equity risk premium. The results obtained will provide insights into how sustainable progress can affect a country financial stability and its attractiveness to investors.

Methodology and Data

Data source and key variables used for the econometric panel model

The research aims, through panel econometric models, to examine how the equity risk premium is influenced by the evolution of sustainable development.

The study analyzes the impact of sustainable development indicators on the equity risk premium (ERP) across Europe during the period 2000–2023, considering the 28 countries included in the analysis.

The SDG Index (Sustainable Development Index) is composed of 17 components, each representing specific aspects of a country and its economy, with each component assigned a specific weight to determine the aggregate index.

The 17 components are described in the table below, and in the analysis, each was individually examined to assess the extent to which it influences the ERP.

Table 1: Description of the variable used and data sources

Name of the variable	Abvreviation	Source	Description
Equity Risk Premium	ERP	Online Damodaran Database https://pages.stern.nyu.edu/~adamodar/	To estimate the equity risk premium (ERP) for a specific country, a methodology is used that starts with the risk premium of a developed market (the U.S.) and adds a country-specific risk supplement. First, the risk premium of the U.S. market is determined, where the ERP is calculated based on the implied risk premium of the S&P 500 index. This reflects the difference between the markets expected return and the risk-free rate, such as long-term government bonds.
Country Risk Premium	CRP	Online Damodaran Database https://pages.stern.nyu.edu/~adamodar/	The Country Risk Premium (CRP) reflects the additional risk of investing in a specific country. It is estimated based on the Credit Default Swap (CDS) spread, which is calculated using a country's Moody's credit ratings.
GDP Growth	GDP%	World Bank- indicator (NY.GDP.MKTP.KD.ZG)	The annual growth rate of GDP at market prices, based on constant local currency. Aggregates are calculated using constant 2015 prices, expressed in U.S. dollars.
Inflation Rate	CPI	World Bank- indicator (FP.CPI.TOTL.ZG)	The annual percentage change in the cost borne by the average consumer for an increase in the price of a basket of goods and services
Risk free rate	Rf	Online Damodaran Database Online- https://pages.stern.nyu.edu/~adamodar/	US 10-year government bond yield
Credit Default Spread	CDS	Online Damodaran Database https://pages.stern.nyu.edu/~adamodar/	The interest rate differential between the yield on U.S. government bonds and the yield on government bonds of the country under analysis.
Long term treasury bond rate	LT_T-Bond Rate	Damodaran database	Own calculations based on CDS and Rf data taken from the Damodaran database
Global Economic Policy Uncertainty Index	GEPU	Davis, Steven J., 2016. "An Index of Global Economic Policy Uncertainty," Macroeconomic Review, October. https://www.policyuncertainty.com/global_monthly.html	The Global Economic Policy Uncertainty Index (GEPU) is an aggregate index that measures economic policy uncertainty at the global level. It is used to assess the impact of uncertainty on economic decisions such as investment, consumption, and financial markets.

			The index provides a quantitative measure of the degree of uncertainty associated with government economic policies worldwide.
Sustainable Development Index	SDG INDEX	Sachs, J.D., Lafortune, G., Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Paris: SDSN, Dublin: Dublin University Press. doi:10.25546/108572	The SDG Index score is presented on a scale from 0 to 100 and can be interpreted as the percentage of progress toward optimal performance in achieving the Sustainable Development Goals (SDGs). Therefore, the difference between 100 and the specific country score in the SDG Index represents the gap, expressed in percentage points, that must be overcome to reach optimal SDG performance. To minimize bias caused by missing data, a general SDG Index score is not calculated, and rankings are not produced for countries that lack data for more than 20% of the indicators. The same set of indicators and similar performance thresholds are used for all countries to generate comparable scores and rankings.
Index SDG 1- No Poverty		SDG 1	
Index SDG 2- Zero Hunger		SDG 2	
Index SDG 3- Good Health and Well-being		SDG 3	
Index SDG 4- Quality Education		SDG 4	
Index SDG 5- Gender Equality		SDG 5	
Index SDG 6- Clean Water and Sanitation		SDG 6	
Index SDG 7- Affordable and Clean Energy		SDG 7	

Source: as indicated in the table

Description of the Research Method

This research adopted a quantitative method, with the main objective of examining the relationship between sustainable development and the cost of capital. The methodology employed involved both statistical and econometric analyses, aiming to identify and interpret the relationships between economic variables and the indicators associated with sustainable development.

Type of research: The study conducted is quantitative in nature, based on the processing and interpretation of numerical data relevant to the analyzed period.

Method used: Panel Econometric Analysis, a panel econometric analysis was applied, with the purpose of capturing the specific characteristics of each country through fixed effects, as well as the dynamics of the relationship between variables during the analyzed period through the period-specific effects.

Data source: The data used in this research were collected from internationally recognized official databases, ensuring the accuracy, reliability, and comparability of the economic information utilized.

Time interval analyzed: The analysis was carried out for the period 2000–2023. This interval was selected because it encompasses several important phases in Europe's recent evolution, while also ensuring that complete data were available for all the countries included in the analysis.

Countries included in the analysis: 28 European countries, as follows: Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Slovakia, Slovenia.

Database volume: The analysis sample includes 28 countries (cross-sections) over a period of 24 years, with the database totaling 672 observations. This extended sample ensures adequate representativeness and increased relevance of the research results.

This methodological approach, based on econometric analysis using a panel model, allows for an in-depth understanding of the relationship between sustainable development and the cost of capital, specific to each country and time period through the fixed effects inherent to panel models. Thus, each country (cross-section) and period has its own specific term, providing additional and specific empirical support for the interpretation and validation of the obtained results.

The research was carried out in two stages. The first stage consisted in selecting the control variable through a simple regression model between ERP and the control variable, while the second stage involved sequentially introducing into the regression model each of the 17 components of the SDG index, as well as the aggregated SDG index, in order to determine the best panel regression model.

For the panel regression models, tests were conducted to assess whether fixed or random effects were more appropriate, using the Hausman test and the Redundant Fixed Effects test. Additionally, for each regression model, it was verified whether the residuals were correlated across cross-sections using the Pesaran CD test. Each test employed, along with its hypotheses, is explained in the analysis section, together with the interpretation of the corresponding results obtained in EViews.

Research Step 1: Selection of control variables from the list below:

The control variables in econometric analyses are the following: GDP Changes% (annual growth rate of GDP), CPI, (consumer price index), LT_T-Bond Rate (long term bond rate), GEPU (Global economic policy uncertainty index). A panel regression model with fixed effects for country cross-sections and both fixed and random effects for time periods was used, and the control variable was selected based on statistical significance (p-value < 5%) and the highest R^2 of the model.

Research Step 2: Selection of the variable related to the Sustainable Development Index:

After the control variable was chosen and it was determined whether fixed or random effects were more appropriate, each of the 17 components of the SDG index was included one by one in the regression model, along with a separate regression model containing the control variable and the aggregated SDG index. The aim was to determine which specification is more suitable for the final regression model used to estimate the ERP.

For the selection process, the p-values associated with the coefficients and the adjusted R^2 were considered, with preference given to the model that had the highest adjusted R^2 and statistically significant coefficients. In addition, it was verified whether the economic relationship holds true, namely that as the SDG index increases, the ERP decreases.

The final regression model equation will include two independent variables: the control variable capturing the quantitative characteristics of the economy and the variable representing the Sustainable Development Index:

ERP= C + Control Variable + SDG Index Variable + Country Fixed Effects + Period Fixed or Random Effects (depending on validation tests and estimates, in the next section)

Panel Econometric Models for Estimating the Cost of Capital (ERP)

This section aims to investigate the relationship between sustainable development and the cost of equity capital through panel econometric models and by employing the most suitable econometric model as a tool for estimating the risk premium. Econometric analysis represents a crucial stage of the research, with the objective of identifying and quantifying the relationships between sustainable development indicators and the equity risk premium (ERP).

The panel regression model includes two independent variables: a control variable reflecting the quantitative characteristics of the economy and a variable representing the Sustainable Development Index, examining both the aggregated index (SDG Index) and each of its 17 individual components. Throughout this analysis, emphasis will be placed on interpreting the estimated coefficients, testing the statistical significance of the variables, and validating the core regression assumptions through specific econometric tests.

The objective of this section is to address the central research question: to what extent does sustainable development, as measured by the SDG Index, influence the equity risk premium in Europe? The results will be analyzed from the perspective of their economic relevance (the type of relationship, whether positive or negative) and statistical significance, thereby providing a detailed understanding of the mechanisms through which progress in achieving the sustainable development goals is reflected in the cost of equity capital of a national economy.

In the final stage of the analysis, regressions were estimated based on the selected variables, and specific econometric tests were applied to assess the consistency and robustness of the models obtained. This methodological strategy provides a solid foundation for interpreting the results and for drawing conclusions regarding the relationship between sustainable development and the cost of equity capital within European economies.

Analysis of the Explanatory Components: Selection of Relevant Variables for Estimating ER

Panel linear regression econometric models were employed, using both fixed effects and random effects, followed by comparative analysis and validation tests, such as the Redundant Fixed Effects test for validating fixed effects and the Hausman test for validating random effects. The analysis was conducted across European countries, including both Western Europe and Central and Eastern Europe. In total, 28 countries were included in the analysis, with data covering the period 2000–2023, resulting in a total sample of 672 observations (28 countries × 24 years).

In the first stage of the econometric analysis, the statistical significance of the control variables was tested, and the R^2 values were compared to select the best econometric model. Variables that were not statistically significant were excluded. The significance of the control variables was tested by applying a simple regression between the dependent variable ERP and each of the four control variables.

The fixed effects for countries highlight the specific characteristics of each nation, such as consumer culture, infrastructure, level of technological advancement, and other factors that are reflected in investors expected returns. Fixed effects were chosen for the time dimension as well, given that the analyzed period (2000–2023) spans two major crises—the financial crisis of 2009–2010 and the COVID-19 crisis of 2020—both of which directly and simultaneously affected the countries in the sample. The ECB's (European Central Bank) policies of maintaining low and even negative interest rates after the 2009 crisis also influenced most of the countries in the sample in a similar way. At the same time, estimation was also performed using the random effects method for the period, with results compared accordingly, including the Pesaran CD test for cross-sectional dependence among residuals and the Hausman test for validating random effects.

Subsequently, a regression model with a single explanatory variable from among the control variables was analyzed, to select one variable to be used alongside the SDG Index variable. The panel model was then applied with fixed effects for both countries (cross-section) and period. R^2 and coefficients were analyzed for all four control variables analyzed: GDP Variation, CPI, Long-Term T-Bond Rate (denoted as LT_T_Bond_R), and the GEPU Index. Across the entire sample, the variables showing notable statistical significance are GDP Variation (p-value: 0.0%) and the Long-Term T-Bond Rate. The adjusted R^2 is significantly higher for the LT_T_Bond_R variable (88.8% compared to 73%), which leads us to consider it more suitable for the panel regression model—an observation further confirmed by the Pesaran CD test statistic.

The Pesaran CD test examines whether the residuals are correlated across countries (cross-sections). If residual correlation exists, the estimators are considered inefficient, and the results of other statistical tests may be unreliable. H_0 (Pesaran CD): There is no dependence between residuals across cross-sections, H_1 (Pesaran CD): There is dependence between residuals across cross-sections. The results indicate a p-value of 61.83% > 5%, so the null hypothesis is accepted, and there is no dependence of residuals across cross-sections, confirming the appropriateness of using fixed effects. In conclusion, the control variable to be used in the panel econometric model is the long-term government bond yield, denoted in the model as LT_T_Bond_Rate.

In the next stage, the statistical significance of the aggregated Sustainable Development Index (SDG Index) was tested, along with each of its 17 components individually. The index represents a weighted average of these 17 components, and its relationship with the equity risk premium (ERP) must be negative to be economically meaningful: as the SDG Index increases, the expected returns for investors decrease.

From the total of the 17 variables analyzed, 12 exhibit a negative relationship with ERP, which is consistent from an economic perspective, while 5 show a positive relationship with ERP. Although the p-values for these 5 variables were below 5%, they were not considered because the economic rationale is invalidated. Thus, out of the 17 variables, 6 demonstrate a relationship that is both statistically and economically valid, and the results of the regression models for these variables are presented below.

In both regression models one with SDG1 and the other with SDG4 the adjusted R^2 is high, close to 90%, indicating that the econometric models are well explained by these variables. In both cases, fixed effects were used for cross-sections (countries) and for the time period, and the Pesaran CD statistic was above 5%, indicating that the residuals are not correlated across countries. The “Redundant Fixed Effects” test in EViews has p-value of 0% in both cases, confirming that the fixed effects were correctly applied and are statistically significant.

SDG1 refers to No Poverty. As a country becomes wealthier and more economically developed, the expected ERP values are lower, resulting in a negative relationship. SDG4 refers to Quality Education. As a country achieves a higher level of education, the workforce’s professional skills and innovation improve, enabling the economy to attract better-paid jobs.

In both regression models, for SDG6 and for SDG7 the adjusted R^2 is high, close to 90%, indicating that the econometric models are well explained by these variables. In both cases, fixed effects were applied for cross-sections (countries) and for the period, and the Pesaran CD statistic was above 5%, indicating that the residuals are not correlated across countries. The “Redundant Fixed Effects” test in EViews has p-value of 0% in both cases, confirming that the fixed effects were correctly applied and are statistically significant.

SDG6 refers to Clean Water and Sanitation. As a country provides access to clean water and sanitation, it indicates that the population has modern facilities and infrastructure. This index is highly correlated with SDG1 – No Poverty, sharing methodological overlaps in its calculation. SDG7 refers to Affordable and Clean Energy. This is one of the most important components because energy is a key pillar for industry. The index reflects not only the natural energy resources available in a country but also how efficiently they are managed. For example, some European countries, including our own, have abundant energy resources, yet energy prices in some cases are higher than in countries with fewer natural resources.

SDG8 refers to Decent Work and Economic Growth, SDG10 refers to Reduced Inequalities, in an economy as inequalities are reduced and consumption is more sustained, because there are more people who can buy durable goods and not just subsistence goods.

In both regression models, the one with SDG8 and the one with SDG10, the adjusted R^2 is high, close to 90%, indicating that the econometric models are well explained by these variables. In both cases, fixed effects were used for cross-sections (countries) and for periods, and the “Pesaran CD” statistic was above 5%, showing that the residuals are not correlated across countries. The EViews “Redundant Fixed Effects” test values were 0% in both cases, indicating that the fixed effects were correctly used and are significant.

Validation of the Panel Econometric Model and Selection of the Optimal Effects Structure

In this section was developed a multiple panel regression model, where the dependent variable Y is ERP and the independent variables are LT_T_Bond_R (control variable) and SDG_Index (the aggregated Sustainable Development Index). Two regression models were examined: one with fixed effects for cross-sections (countries) and random effects for time periods, and another with fixed effects for both cross-sections and time periods.

Fixed effects for cross-sections (countries) are validated by the specific economic and social characteristics of each country. These effects of the panel model add a term similar to the intercept C, but customized for each country. Fixed effects for time periods are justified by the shared events experienced by all European countries and the decisions taken by the ECB (European Central Bank), which directly and similarly affected most countries.

We will use two econometric models: one with random effects for time periods and one with fixed effects for time periods and compare their statistical tests and estimation errors to select the most suitable model. The results indicate that both independent variables are statistically significant, with p-values < 5%, and the intercept (c) is also statistically significant. The regression model has an F-statistic of 149 and an associated p-value of 5%, indicating statistical significance. The regression equation for model with random effects for period is as follows:

ERP= 0.13777 + 1.00322*LT_T_BOND_R - 0.141204*SDG_INDEX + [CX=F, PER=R]

CX = specific fixed effect for country (the cross-section), PER = random effect of the period

The relationship between ERP and LT_T_BOND_R is positive; that is, for a one-unit increase in LT_T_BOND_R, ERP is expected to increase by 1.00322, which is economically consistent. The relationship between ERP and SDG_INDEX is negative; that is, for a one-unit increase in SDG_INDEX, ERP is expected to decrease by 0.141204787151, which is also economically consistent. This makes sense because in developed countries with a high SDG_Index, the cost of equity is lower due to high competitiveness and a mature market.

Subsequently, regression validation tests were performed, including the Hausman test for validating random effects, the Redundant Fixed Effects test, and the Residual Cross-Section Dependence Test to check for residual dependence across sections.

The adequacy of fixed effects was tested in EViews using the “Redundant Fixed Effects” test, and the associated p-value is < 5%, null hypothesis was rejected, which assumes that the fixed effects are redundant, the fixed effects are significant in our case and should be used for the cross-sections (the countries in the model). The Hausman test for the adequacy of random effects was performed, and the p-value for the Hausman test is < 5%, null hypothesis was rejected, meaning that random effects are not suitable for this econometric model. The test for cross-sectional dependence in the residuals was also conducted, and the p-value for the Pesaran CD test is < 5%, null hypothesis was rejected, indicating that there is cross-sectional dependence in the residuals. Therefore, the econometric model with random effects for the period is not appropriate and must be re-estimated by introducing fixed effects.

Thus, although an adjusted R^2 of 86.5% was obtained and the coefficients are statistically significant, the tests for random effects indicate that they are not suitable for the model and may distort the results. Consequently, we will present the results of the model with fixed effects for the time period. The results suggest that both independent variables are statistically significant, with p-values < 5%, and the intercept (c) is also statistically significant. The regression model has an F-statistic of 101 and an associated p-value of 5%, indicating statistical significance. The regression equation for model with fixed effects for period is as follows:

ERP = 0.23585 + 1.05203*LT_T_BOND_R -0.27145*SDG_INDEX + [CX=F, PER=F]

CX = specific fixed effect for country (the cross-section), PER = specific fixed effect for period

The relationship between ERP and LT_T_BOND_R is positive; that is, a one-unit increase in LT_T_BOND_R is expected to result in an increase in ERP of 1.05203, which is economically consistent. The relationship between ERP and SDG_INDEX is negative; that is, a one-unit increase in SDG_INDEX is expected to result in a decrease in ERP of 0.27145, which is also economically consistent. This aligns with the fact that in developed countries with a high SDG_Index, the cost of equity is lower due to high competitiveness and a mature market.

The test for the adequacy of fixed effects was performed, and the p-value for the Redundant Fixed Effects test is < 5%, null hypothesis was rejected, which assumes that the fixed effects are redundant. In our case, the fixed effects are significant and should be used for the cross-sections (the countries in the model). The Pesaran CD test for correlation between the residuals corresponding to the countries (cross-sections) was also performed, and the p-value for the Pesaran CD test is > 5%, null hypothesis was accepted, meaning there is no correlation between the residuals of the countries (cross-sections), the fixed effects are appropriate in our case.

Thus, based on the analyses, the model with fixed effects for both cross-sections and time periods is superior to the one with random effects. This is evident from the adjusted R^2 (88.7% compared to 86.5%) and, more importantly, from the Pesaran CD test value, which indicates that there is no dependence between residuals across countries.

It was observed that the fixed effects vary from country to country, being both negative and positive. Countries with more developed economies, such as Austria, Germany, France, and Spain, exhibit positive country fixed effects, whereas less developed countries predominantly show negative effects. Regarding the analysis period, the panel model effect is negative up to 2009 and becomes positive thereafter. This is because bond yields in Europe were high before the global financial crisis of 2009 and then decreased significantly to stimulate economic growth. Thus, in future research, additional variables may be needed to capture periods of economic shocks, such as the European sovereign debt crisis, the financial crisis, and other economic disruptions, by marking those specific periods in order to provide even more accurate results.

Conclusions

The research results demonstrate the existence of a relationship between sustainable development and the equity risk premium (ERP) in Europe, although this relationship is not uniform or consistent across all the indicators analyzed. Statistical analysis using the panel model revealed a negative correlation between the Sustainable Development Index (SDG Index) and ERP across the entire sample. Thus, as economies develop, the SDG Index increases and investors expected returns are lower, reflecting higher competitiveness and, consequently, lower expected ERP values. At the same time, it was found that most individual SDG indicators were not statistically significant, suggesting that the impact of sustainable development on the cost of capital cannot be directly and independently attributed to each individual goal.

The research aimed to provide users with a tool for estimating the cost of equity capital (ERP) through a panel econometric model, and the results were satisfactory, with small estimation errors. The relationship between ERP and long-term bond yields is positive and strong, representing the most important variable in the model, while the inclusion of the SDG Index improved the overall results.

The average estimation error was small, panel model provided robust results. Developed countries were estimated most accurately, as they exhibited a more stable ERP evolution. The inclusion of fixed effects in the panel model proved effective and helped achieve better estimates, with each country reflecting particularities of economic characteristics and investors expected returns. As such, based on the 28 European countries from 2000-2023, the ERP can be estimated through a panel econometric model using SDG index and long term bond rates as independent variables.

An important limitation of the research is the inclusion of periods encompassing the financial crisis and the sovereign debt crisis, which had significant impacts on long-term interest rates and ERP. Although the results clearly show an influence of the SDG Index on ERP, the econometric methods employed are difficult for practitioners to apply in practice. There is a need for the development of a simpler model that directly reflects the way in which sustainable development affects the cost of capital of a country. Future research could use quarterly or semiannual data and incorporate additional variables to isolate the effects of these crises on the model coefficients. Additionally, applying separate econometric models for developing countries and developed economies could represent an important direction for future research.

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