

THE ROLE OF ECONOMIC FREEDOM AND FINANCIAL DEVELOPMENT IN DRIVING SUSTAINABLE DEVELOPMENT

O PAPEL DA LIBERDADE ECONÔMICA E DO DESENVOLVIMENTO FINANCEIRO NA PROMOÇÃO DO DESENVOLVIMENTO SUSTENTÁVEL

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Abstract

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findings demonstrate that economic freedom does not automatically promote sustainable development and that financial development plays a critical conditioning role. The study highlights the importance of context-specific policies that align market liberalization with financial structures conducive to long-term sustainable development.

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1 INTRODUCTION

Over the past several decades, the global economy has been repeatedly exposed to severe economic, financial, and geopolitical shocks. Episodes such as the Asian financial crisis, the collapse of the dotcom bubble, the global financial crisis, the Covid-19 pandemic, and recent geopolitical conflicts have not only disrupted economic activity but also revealed deeper structural weaknesses in the global development model. Beyond short-term macroeconomic instability, these shocks have intensified long-standing challenges related to environmental degradation, climate change, energy insecurity, and resource depletion. A development trajectory that has traditionally prioritized output expansion and income growth has often underestimated ecological constraints, leading to mounting pressure on natural systems and raising concerns about the long-term sustainability of economic progress (Lee *et al.*, 2022). As a result, sustainable development has emerged as a central policy objective, emphasizing the need to simultaneously advance economic performance, social welfare, and environmental protection (ESCAP & Scientific, 2015; Dinh, 2025a, Dinh, 2025b; Dinh, 2025c, Dinh, 2025d; Kim & Quoc, 2024).

Despite broad international consensus on the importance of sustainability, achieving sustainable development remains particularly challenging in economies where industrial expansion is closely tied to continuous production and rising resource use. Industrialization has historically served as a key engine of growth, yet it has also contributed significantly to environmental pollution and carbon emissions, complicating the pursuit of sustainability goals (Bekabil, 2020). These tensions are especially pronounced in developing countries, where improving living standards, reducing poverty, and accelerating economic growth are often closely associated with higher levels of

economic freedom. From a theoretical perspective, economic freedom reflects the extent to which individuals and firms can engage in voluntary exchange, investment, and production without excessive regulatory constraints (Krueger, 1974). By reducing barriers to market entry and encouraging competition, economic freedom is widely regarded as a catalyst for economic dynamism and growth.

A substantial body of empirical literature supports the positive relationship between economic freedom and economic growth (Doucouliagos & Ulubasoglu, 2006; Akin *et al.*, 2014; Hussain & Haque, 2016). However, much of this literature focuses narrowly on income expansion and productivity, paying limited attention to environmental and social dimensions of development. In practice, greater economic freedom may encourage investment in pollution-intensive sectors, particularly in economies where financial systems channel capital toward short-term, high-return activities rather than sustainable projects. This pattern helps explain why many developing economies continue to experience rapid environmental deterioration despite market liberalization. At the same time, developed economies—although equipped with advanced technologies and cleaner production methods—remain among the world’s major polluters, suggesting that market freedom alone does not guarantee sustainable outcomes (Alvarado *et al.*, 2021). These mixed experiences point to the need for complementary mechanisms that guide economic freedom toward sustainable development objectives.

In this context, financial development plays a critical but often underexplored role. Well-functioning financial systems influence how economic freedom translates into real economic activities by determining the allocation of capital, access to credit, and incentives for investment. Financial development can facilitate sustainable development by mobilizing savings, improving access to finance, supporting innovation, and enabling investment in cleaner technologies and renewable energy. Conversely, when financial systems are underdeveloped or skewed toward speculative or carbon-intensive activities, economic freedom may amplify environmental pressures rather than alleviate them. Thus, the sustainability implications of economic freedom are likely to depend not only on market openness but also on the depth, efficiency, and orientation of the financial sector.

Despite its importance, existing empirical research examining the relationship between economic freedom and sustainable development remains limited. Early studies primarily investigated social or economic dimensions of development (Madan, 2002;

Mushtaq & Khan, 2018), while more recent contributions have incorporated specific channels such as circular economy mechanisms (Lima *et al.*, 2021) or renewable energy deployment (Shahnazi & Shabani, 2021). However, systematic evidence on how financial development shapes the sustainability outcomes of economic freedom, particularly across countries at different stages of development, remains scarce. Moreover, most prior studies rely on traditional frequentist econometric approaches, which impose restrictive assumptions and treat model parameters as fixed, potentially limiting their ability to capture uncertainty and heterogeneity in cross-country data.

To address these gaps, this study adopts a Bayesian regression framework to examine the impact of economic freedom on sustainable development while explicitly accounting for the role of financial development. Using data from both developed and developing countries, the Bayesian approach allows for probabilistic inference and greater flexibility in dealing with small samples, parameter uncertainty, and complex relationships. By doing so, this study provides new insights into whether and under what conditions economic freedom and financial development jointly contribute to sustainable development, and derives policy implications tailored to different country groups (Van *et al.*, 2025a; Van *et al.*, 2025b, Tuyet & Dinh, 2025; Van & Le Quoc, 2024).

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data and methodology. Section 4 presents and discusses the empirical results. Section 5 concludes and outlines policy implications.

2 LITERATURE REVIEW

Economic freedom is commonly understood as the extent to which individuals and firms are allowed to own property, engage in voluntary exchange, and make economic decisions with minimal interference, provided that such activities respect the rights of others. This concept emphasizes open markets, freedom of choice, and competitive behavior as fundamental drivers of economic activity. Classical economic thought, beginning with Adam Smith's notion of the invisible hand, argues that decentralized decision-making and market competition enhance efficiency and foster economic prosperity. Subsequent contributions by economists such as Ricardo and Friedman further reinforced the view that market freedom and individual initiative are central to long-term economic growth (North & Thomas, 1973).

While economic freedom is widely associated with higher productivity and income growth, its implications for sustainable development are far more ambiguous. In competitive markets, firms face strong incentives to minimize costs and maximize profits. In the absence of appropriate financial incentives or constraints, this behavior may encourage environmentally harmful practices, such as excessive resource extraction, reduced investment in waste treatment, and reliance on pollution-intensive production processes. As highlighted by Copeland and Taylor (2017), trade liberalization and market openness can generate environmental externalities when production shifts toward regions where environmental costs are lower. Under these conditions, economic freedom may contribute to the relocation of pollution-intensive activities to countries with weaker environmental capacity, reinforcing the so-called “pollution haven” effect.

The mixed sustainability outcomes of economic freedom suggest that market openness alone is insufficient to guarantee environmentally and socially responsible development. In this regard, financial development emerges as a crucial mechanism through which economic freedom influences sustainable development. Financial development reflects the depth, efficiency, and accessibility of financial institutions and markets, which shape how savings are mobilized, how credit is allocated, and which types of economic activities receive funding. A well-developed financial system can direct capital toward productive and sustainable investments, support technological innovation, and facilitate the adoption of cleaner production methods. Through improved access to finance, firms are better positioned to invest in energy-efficient technologies, renewable energy projects, and environmentally friendly processes, thereby aligning economic freedom with sustainability objectives.

Conversely, when financial systems are shallow, inefficient, or biased toward short-term returns, economic freedom may exacerbate sustainability challenges. In such environments, capital tends to flow toward sectors with quick profits rather than long-term social or environmental benefits. As a result, economic freedom may intensify industrial expansion based on fossil fuels and resource-intensive activities, particularly in developing economies where financial markets remain underdeveloped. This dynamic helps explain why many countries experience rapid economic growth under liberalized markets while simultaneously facing environmental degradation and rising social costs.

From a theoretical perspective, financial development reduces transaction costs, improves risk sharing, and enhances information flows within the economy. These

functions strengthen the capacity of markets to support sustainable development by promoting efficient capital allocation and encouraging innovation. Moreover, developed financial systems can internalize environmental risks through mechanisms such as green finance, sustainable lending practices, and climate-related financial instruments. In this way, financial development does not merely complement economic freedom but actively conditions its impact on sustainable development outcomes.

These arguments imply that the relationship between economic freedom and sustainable development is inherently conditional on the level of financial development. Economic freedom may serve as a catalyst for sustainable development when supported by a mature and inclusive financial system, but it can also magnify environmental and social pressures when financial markets fail to guide economic activity toward sustainable pathways. Therefore, examining the sustainability effects of economic freedom without accounting for financial development provides an incomplete picture of the underlying mechanisms at work.

2.2 Research gaps

Existing empirical research on the relationship between economic freedom and sustainable development remains limited and fragmented, with most studies concentrating on specific dimensions of development rather than sustainability as an integrated concept. Early contributions primarily examined the growth effects of economic freedom. For example, Easton and Walker (1997), using cross-sectional data from 57 countries, found that greater market liberalization enhances private ownership and income generation, thereby promoting economic growth. Similar conclusions were reached by Ayal and Karras (1998) and Carlsson and Lundström (2002), who showed that various components of economic freedom jointly contribute to higher economic performance. However, not all evidence is consistent. Ali and Crain (2002) reported a negative association, suggesting that economic freedom alone does not necessarily guarantee faster growth, particularly when political and civil conditions are not aligned.

Subsequent studies expanded this line of inquiry by exploring the channels through which economic freedom affects economic outcomes. Doucouliagos and Ulubasoglu (2006), using both cross-sectional and panel data for 82 countries, demonstrated that economic freedom influences growth directly and indirectly by

stimulating physical capital accumulation. Justesen (2008) provided further evidence of a causal link between economic freedom—especially trade and monetary freedom—and economic growth, while finding weaker feedback effects in the opposite direction. Williamson and Mathers (2011), adopting a broader perspective across 141 countries, showed that economic freedom generally supports growth, although its interaction with cultural factors may constrain economic performance in certain contexts.

Beyond growth, a growing strand of literature has examined how economic freedom relates to individual dimensions of sustainable development. On the economic pillar, studies such as Doucouliagos and Ulubasoglu (2006), Akin *et al.* (2014), and Hussain and Haque (2016) confirmed that economic freedom fosters income expansion and productivity improvements. On the environmental side, research by Carlsson and Lundström (2001), Adesina and Mwamba (2019), Riti *et al.* (2021), Shahnazi and Shabani (2021), Sart *et al.* (2022), Huy & Loan (2022); Huy *et al.* (2024); Huy *et al.* (2023a, 2023b), Huy & Tam (2025), and Wu *et al.* (2022) investigated the environmental consequences of economic freedom, often focusing on CO₂ emissions. These studies provide mixed evidence, suggesting that market openness may either mitigate or exacerbate environmental degradation depending on country-specific conditions. With respect to the social dimension, earlier works by Esposto (1999), Madan (2002), and Gehring (2013) explored the relationship between economic freedom and human development or subjective well-being, again yielding heterogeneous results.

Despite these valuable contributions, most existing studies adopt a partial approach by focusing on isolated pillars of sustainability rather than evaluating sustainable development as a multidimensional outcome. More recent research has attempted to broaden this perspective by incorporating specific channels, such as the circular economy (Lima *et al.*, 2021) or renewable energy deployment (Shahnazi & Shabani, 2021). However, a critical gap remains in understanding how financial development shapes the sustainability effects of economic freedom. While financial systems play a central role in allocating capital, supporting innovation, and financing environmentally responsible investments, their interaction with economic freedom in the context of sustainable development has received limited systematic attention. This constitutes the first major gap addressed by the present study.

A second gap relates to cross-country heterogeneity. Prior research has been conducted at both global and regional levels (e.g., Easton & Walker, 1997; Williamson

& Mathers, 2011; Mushtaq & Khan, 2018; Riti *et al.*, 2021), yet relatively little attention has been paid to differences between developed and developing economies. In developing countries, economic liberalization often coincides with rapid industrial expansion and rising demand for energy and natural resources, which may intensify environmental pressures when financial systems are underdeveloped. In contrast, developed economies typically possess deeper financial markets and greater access to sustainable finance instruments, yet they remain among the largest contributors to global emissions. This divergence suggests that the sustainability outcomes of economic freedom may depend critically on the level of financial development, an issue that has not been adequately explored in the existing literature.

From a methodological perspective, most empirical studies rely on traditional frequentist econometric techniques. For instance, Mushtaq and Khan (2010) employed GMM estimators, Riti *et al.* (2021) applied the PMG approach, and Wu *et al.* (2022) used spatial econometric models. While informative, these methods impose strong assumptions and treat model parameters as fixed, which may limit their ability to capture uncertainty and heterogeneity in cross-country data. In contrast, Bayesian methods treat parameters as probabilistic and allow for more flexible inference, particularly in the presence of small samples, endogeneity, heteroscedasticity, and autocorrelation (Gelman & Hill, 2006; Kruschke, 2014). Therefore, the present study adopts a Bayesian regression framework to investigate the impact of economic freedom on sustainable development, explicitly incorporating the role of financial development across developed and developing countries. This methodological contribution represents the third and final gap addressed in this research.

3 RESEARCH MODELS AND METHODOLOGY

3.1 Research models and data

To evaluate the relationship between economic freedom and sustainable development, this study adopts a quantitative research approach. Following the methodology proposed by Oanh (2024), the Sustainable Development Goal Index (SDGI) is computed by aggregating 17 indicators (see Appendix 1), each corresponding to one of the three core pillars of sustainability: economic, social, and environmental, as defined in

the Sustainable Development Goals (SDGs). This composite index is widely regarded as a comprehensive measure of a nation's sustainable development performance (Schmidt-Traub *et al.*, 2017), with data sourced from the official sdgindex.org portal.

The Economic Freedom Index (EFI) is formulated by integrating several economic and institutional variables that reflect ethical business conduct and the regulatory environment. Key components include property rights, judicial independence, government transparency, fiscal burden, public expenditure, macroeconomic stability, and freedoms related to business, labor, money, trade, investment, and finance. The EFI score is derived as the arithmetic mean of these indicators, where values range from 0 (no economic freedom) to 100 (maximum freedom). This metric has been extensively used in earlier empirical works, such as Mushtaq & Ali Khan (2018) and Santiago *et al.* (2020), with data obtained from the Heritage Foundation.

Moreover, the selected control variables included in the model encompass economic growth, environmental quality, foreign direct investment, trade openness, urbanization rate, population growth rate, and inflation rate. The source and data of the research are presented in Appendix 1. The research model is as follows:

$$SDGI_{i,t} = \beta_0 + \beta_1 EFI_{i,t} + \beta_2 FD_{i,t} + \beta_3 EFI * FD_{i,t} + \beta_x Z_{i,t} + \varepsilon_{i,t} \quad (1)$$

For $i = 1, 2, \dots, n$; $t = 1, 2, \dots, t$ (where i represents countries and t represents observation time points in the model from 2008 to 2022), the variable Z represents the control variables including: (1) CO2 emissions (CO2); (2) Urbanization rate (UR); (3) Foreign direct investment (FDI); (4) Population growth rate (POP); (5) GDP growth (GDP), (6) Inflation rate (INF), (7) Financial development index (FD), and (8) Trade openness (OPEN).

3.2 Methodology

Bayesian statistics integrates empirical data with prior beliefs to generate a posterior distribution, which is interpreted as the probability distribution of parameter values. Unlike traditional methods, Bayesian inference does not heavily depend on large sample sizes, making it particularly suitable for small-sample studies (Zondervan-Zwijnenburg *et al.*, 2017). Fundamentally, Bayesian and frequentist approaches are

grounded in distinct philosophical frameworks. In Bayesian thinking, the observed data is treated as fixed, while the model parameters are viewed as random variables. In contrast, frequentist methods consider the data as arising from repeated sampling, with the parameters regarded as unknown but constant. Bayesian inference estimates the posterior distribution of parameters by combining the likelihood function derived from observed data with a prior distribution. This is expressed formally as:

$$y \sim N(\beta^T X, \sigma^2 I) \quad (2)$$

where:

y is generated from a normal distribution characterized by the mean and variance. The mean value of the linear regression is the transpose of the weight matrix multiplied by the predictor matrix. The variance is the square of the standard deviation (σ) multiplied by the identity matrix.

Not only the output (y) is generated from a probability distribution, but also the model parameters are assumed to come from a distribution. The posterior probability of the model parameters conditioned on the inputs and outputs takes the following form:

$$P(\beta|y, X) = \frac{P(y|\beta, X)(P(\beta|X))}{P(y|X)} \quad (3)$$

where:

$P(\beta|y, X)$ is the posterior probability distribution of the model parameters for the inputs and outputs;

$P(y|\beta, X)$ is the likelihood of the data;

$P(\beta|X)$ is the prior probability distribution,

and $P(y|X)$ is the normalization constant and can be dropped. Therefore, equation (***) is often simplified to:

$$P(\beta|y, X) = P(y|\beta, X)(P(\beta|X)) \quad (4)$$

To assess the influence of economic freedom on sustainable development, this study applies Bayesian linear regression through three steps. First, it adopts a prior

distribution for each coefficient—specifically, a normal distribution centered at zero. This reflects a conservative assumption that coefficients are more likely to be close to zero, minimizing prior-driven bias. Second, the model assumes that the likelihood function for each coefficient follows a normal distribution, in accordance with equation (*). Third, the estimation relies on the Markov Chain Monte Carlo (MCMC) method, particularly the Gibbs Sampler, to simulate posterior distributions. A total of 12,500 iterations are run, discarding the initial 2,500 as burn-in. MCMC is widely recognized for its effectiveness in estimating complex Bayesian models across disciplines (Levy, 2020). This study investigates data spanning the years 2008–2023, comprising 22 developing and 28 developed countries. Given the modest sample size and potential issues such as autocorrelation, heteroscedasticity, and endogeneity, the Bayesian approach is well-suited for the analysis.

4 EMPIRICAL RESULTS

4.1 Descriptive Statistics

Table 1

Descriptive statistics of the variables for the period 2008-2023

Variable	Developing countries				Developed countries			
	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum
SDGI	71.8423	6.2185	51.4892	83.9041	75.9784	4.0126	66.8724	88.9347
EFI	7.5489	0.6354	5.1247	8.4632	7.3898	0.5016	5.9621	8.9142
FD	0.4628	0.2139	0.1526	0.9824	0.5584	0.2519	0.0895	1.0187
GDP	3.1026	4.9734	-27.6845	14.4528	1.7389	3.3882	-10.5824	25.6113
CO2	5.6214	3.0546	0.6425	14.9821	7.2146	4.4957	1.4219	23.4986
UR	57.9328	21.1047	17.3846	97.4632	77.4861	12.6154	42.7586	96.0284
POP	0.4487	0.8395	-2.1483	2.4716	0.7194	0.9128	-5.9846	3.4129
OPEN	97.3284	53.4017	31.9864	333.2189	101.4762	65.1043	22.7164	402.1875
FDI	9.6842	30.9127	-4.1968	268.9146	4.8923	13.5864	-39.8742	143.9621
INF	5.2143	5.2876	-1.9864	47.9842	2.1426	2.7024	-4.2169	16.1285

Source: Authors

The descriptive statistics highlight notable contrasts between developing and developed countries in terms of sustainable development, economic freedom, and financial development (Table 1). Developed countries achieve a higher average Sustainable Development Goal Index (SDGI) of 75.98, compared to 71.84 in developing countries. Moreover, the dispersion of SDGI is substantially lower in developed

economies, as indicated by a standard deviation of 4.01 relative to 6.22 in developing countries. This pattern suggests that developed countries not only perform better on average in achieving sustainable development goals but also exhibit more stable and homogeneous sustainability outcomes, whereas developing countries display greater cross-country variation, reflecting uneven progress across economic, social, and environmental dimensions.

With respect to economic freedom, developing countries record a slightly higher mean Economic Freedom Index (EFI) of 7.55, compared to 7.39 in developed countries. This finding implies that many developing economies have increasingly relied on market liberalization, deregulation, and openness as key strategies to accelerate growth and attract investment. However, the higher variability of EFI in developing countries indicates considerable heterogeneity in market conditions, suggesting that economic freedom is unevenly distributed and implemented across these economies. In contrast, developed countries exhibit a narrower dispersion of EFI, reflecting more consistent and mature market frameworks.

Developed countries display a higher average Financial Development (FD) index of 0.56, compared to 0.46 in developing countries, along with a wider range of values. This indicates that financial systems in developed economies are generally deeper, more diversified, and more sophisticated, offering broader access to financial services and instruments. In developing countries, lower average FD and a more constrained range suggest that financial markets remain less developed and may face structural limitations in mobilizing savings and efficiently allocating capital.

4.1.1 Bayesian regression results and discussion

The Bayesian regression results reveal pronounced heterogeneity in the relationship between economic freedom, financial development, and sustainable development across developing and developed countries. The estimates indicate that both the direct effects and the interaction effects differ not only in magnitude but also in direction, underscoring the conditional nature of market-based development strategies.

For developing countries, the coefficient of economic freedom (EFI) is negative and relatively large in magnitude (Mean = -6.3184 , Std. Dev. = 0.4219), indicating that higher levels of market liberalization are associated with lower sustainable development

outcomes, holding other factors constant. This result suggests that, in economies where production structures are heavily reliant on resource-intensive and pollution-prone activities, economic freedom may intensify competitive pressures that prioritize cost minimization and short-term profitability over environmental protection and social inclusion. In such contexts, liberalization can encourage rapid industrial expansion without sufficient internalization of environmental and social costs, thereby weakening progress toward sustainable development.

In contrast, financial development (FD) exhibits a positive coefficient in developing countries (Mean = 0.5842, Std. Dev. = 1.2387), albeit with greater uncertainty. This finding implies that improvements in financial depth and access can contribute to sustainable development by enhancing capital allocation efficiency, easing credit constraints, and supporting productivity-enhancing investments. A more developed financial system may facilitate technological upgrading and enable firms to adopt cleaner production processes, thereby partially offsetting the adverse sustainability effects associated with market liberalization.

However, the interaction term between economic freedom and financial development (EFI_FD) is negative in developing countries (Mean = -0.7426, Std. Dev. = 0.3918), indicating that the joint expansion of market freedom and financial development tends to reduce sustainable development outcomes. This result suggests that, when financial development advances in tandem with strong liberalization, financial resources may be disproportionately directed toward short-term, high-return sectors such as extractive industries, construction, or energy-intensive manufacturing. In the absence of sufficiently developed green finance mechanisms or sustainability-oriented credit allocation, financial development may amplify the scale of environmentally harmful activities rather than promote sustainable investment. Consequently, while financial development alone may support sustainability, its interaction with high economic freedom can weaken sustainable development in developing economies.

A markedly different pattern emerges for developed countries. Economic freedom is positively associated with sustainable development (Mean = 1.5237, Std. Dev. = 0.6841), suggesting that, in mature market economies, liberalized markets can enhance innovation, efficiency, and social welfare, thereby supporting sustainable development objectives. These economies typically possess advanced production technologies,

stronger market discipline, and greater demand for environmentally responsible goods and services, allowing economic freedom to translate into higher-quality growth.

Financial development plays an even more prominent role in developed countries, with a large and positive coefficient (Mean = 4.3928, Std. Dev. = 0.6214). This result highlights the critical contribution of sophisticated financial systems in promoting sustainable development through diversified financial instruments, deep capital markets, and the expansion of green finance. In developed economies, financial development supports investment in renewable energy, low-carbon technologies, and sustainability-oriented innovation, thereby strengthening all three pillars of sustainable development.

Importantly, the interaction between economic freedom and financial development is positive in developed countries (Mean = 1.4312, Std. Dev. = 0.4417), indicating that financial development enhances the positive sustainability effects of economic freedom. This finding suggests that, when financial markets are sufficiently mature, market competition and liberalization incentivize firms not only to improve efficiency but also to innovate and adopt environmentally sustainable practices. In this context, financial development acts as a reinforcing mechanism that channels the forces of economic freedom toward long-term, sustainability-oriented outcomes, rather than toward purely profit-maximizing activities.

Overall, these findings demonstrate that economic freedom does not inherently lead to sustainable development, and that financial development plays a crucial conditioning role. In developing countries, financial development can mitigate some adverse effects of market liberalization but may also amplify sustainability challenges when combined with high economic freedom. In contrast, in developed countries, financial development strengthens the capacity of economic freedom to support sustainable development. This asymmetric pattern underscores the importance of considering financial development and country-specific contexts when evaluating the sustainability implications of economic freedom.

Table 2

Bayesian Regression Results for 2 Country Groups

SDGI	Developing countries			Developed countries		
	Mean	Std. Dev.	MCSE	Mean	Std. Dev.	MCSE
EFI	-6.3184	0.4219	0.0026	1.5237	0.6841	0.0040
FD	0.5842	1.2387	0.0071	4.3928	0.6214	0.0036
EFI_FD	-0.7426	0.3918	0.0023	1.4312	0.4417	0.0026

GDP	-0.2251	0.0558	0.0003	-0.0217	0.0412	0.0002
CO2	-0.3214	0.0819	0.0005	-0.4176	0.0348	0.0002
UR	0.0846	0.0157	0.0001	0.0107	0.0131	0.0001
POP	-0.9481	0.3319	0.0019	-0.6834	0.1552	0.0009
OPEN	0.0239	0.0056	0.0000	-0.0001	0.0025	0.0000
FDI	-0.0271	0.0093	0.0001	-0.0129	0.0096	0.0001
INF	0.2358	0.0473	0.0003	0.0712	0.0544	0.0003
CONS	16.6824	2.8819	0.0179	64.9312	4.5241	0.0275
Acceptance rate	0.9433			0.9466		
Efficiency: min	0.7344			0.79311		
Max Gelman-Rubin Rc	1.0000			1.0000		

Source: Authors

The convergence diagnostics indicate that the Bayesian estimation procedure performs satisfactorily for both developing and developed country samples. The acceptance rates are 0.9433 for developing countries and 0.9466 for developed countries, which are substantially above the commonly accepted threshold of 0.10. These high acceptance rates suggest good mixing properties of the Markov chains and imply that the Metropolis–Hastings algorithm efficiently explores the posterior distributions. In addition, the minimum efficiency values are 0.7344 for developing countries and 0.7931 for developed countries, both well above the conventional benchmark of 0.01. This indicates that the effective sample sizes are sufficiently large and that the posterior estimates are statistically reliable. Furthermore, the maximum Gelman–Rubin convergence diagnostic (R_c) equals 1.0000 in both country groups, providing strong evidence that the Markov chains have converged to their stationary posterior distributions. Taken together, these diagnostic results confirm the robustness and stability of the Bayesian regression estimates and support the reliability of the empirical findings reported in this study.

5 CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusion

This study investigates the role of economic freedom and financial development in shaping sustainable development outcomes using cross-country data spanning the period 2004–2021 for both developing and developed economies. By employing a Bayesian regression framework, the analysis accounts for parameter uncertainty and cross-country heterogeneity, offering a more flexible and robust alternative to traditional

frequentist approaches. This methodological choice allows the study to provide probabilistic insights into the sustainability implications of market liberalization and financial system development over a period characterized by major global economic and environmental challenges. The empirical findings reveal substantial differences between developing and developed countries. In developing economies, economic freedom is found to exert a negative effect on sustainable development during the 2004–2021 period, suggesting that market liberalization in these contexts may have intensified resource-intensive growth patterns and environmental pressures. Although financial development shows a positive direct association with sustainable development, the interaction between economic freedom and financial development is negative. This indicates that, over the study period, financial expansion combined with strong liberalization tended to channel capital toward short-term, high-return activities rather than sustainability-oriented investments, thereby constraining progress toward sustainable development. In contrast, the results for developed economies over the same period present a fundamentally different dynamic. Both economic freedom and financial development contribute positively to sustainable development, and their interaction further strengthens this relationship. These findings imply that, between 2004 and 2021, advanced financial systems in developed countries enhanced the ability of market-based mechanisms to support sustainable development by facilitating innovation, green investment, and efficient resource allocation.

5.2 Policy implications

The findings of this study provide important policy implications for countries seeking to advance sustainable development in the context of economic liberalization and financial sector expansion during the period 2004–2021. The results clearly indicate that economic freedom and financial development do not exert uniform effects across countries at different stages of development. Consequently, policy strategies must be tailored to country-specific financial structures and development conditions rather than adopting a one-size-fits-all approach.

For developing countries, the negative impact of economic freedom on sustainable development suggests that rapid market liberalization, when pursued in isolation, may intensify environmental degradation and social pressures. Policymakers should therefore

adopt a more gradual and sequenced approach to liberalization, ensuring that market openness is aligned with sustainability objectives. Given the positive direct role of financial development, strengthening financial systems should be prioritized, particularly by expanding access to long-term finance and improving the allocation of credit toward productive and sustainability-enhancing activities. Policies that encourage the growth of green finance instruments, such as sustainable lending frameworks, climate-related risk assessment, and incentives for low-carbon investment, can help redirect financial resources away from pollution-intensive sectors. Importantly, the negative interaction between economic freedom and financial development implies that financial expansion without sustainability-oriented guidance may amplify unsustainable investment patterns. To mitigate this risk, financial development policies should explicitly integrate environmental and social considerations into credit evaluation and investment decision-making.

In developed countries, the positive and reinforcing effects of economic freedom and financial development highlight the effectiveness of market-based mechanisms in promoting sustainable development when supported by mature financial systems. Policymakers in these economies should continue to enhance financial market depth and innovation, particularly in areas related to green bonds, sustainable asset management, and climate finance. Maintaining a high degree of economic freedom can further stimulate competition and innovation, encouraging firms to adopt cleaner technologies and improve resource efficiency. At the same time, financial authorities should ensure that sustainability risks are adequately priced in financial markets, thereby strengthening the role of finance as a catalyst for long-term sustainable growth rather than short-term profit maximization.

Across both country groups, the results underscore the importance of aligning financial development with sustainable development goals. Policies that promote transparency, improve financial literacy, and strengthen risk management practices can enhance the capacity of financial systems to support sustainable outcomes. Additionally, international cooperation can play a valuable role in facilitating knowledge transfer, technical assistance, and access to sustainable finance, particularly for developing countries seeking to improve financial depth and resilience. By tailoring economic freedom and financial development policies to national circumstances, governments can better harness market forces to support sustainable development over the long term.

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APPENDIX

Appendix 1

17 indicators for calculating the sustainable development index

Sustainable Development Index (SDGI)		SDGIndex.org
Indicator 1	No Poverty	
Indicator 2	No Hunger	
Indicator 3	Good Health and Well-Being	
Indicator 4	Quality Education	
Indicator 5	Gender Equality	
Indicator 6	Clean Water and Sanitation	
Indicator 7	Affordable and Clean Energy	
Indicator 8	Decent Work and Economic Growth	
Indicator 9	Industry, Innovation and Infrastructure	
Indicator 10	Reduced Inequalities	
Indicator 11	Sustainable Cities and Communities	
Indicator 12	Responsible Consumption and Production	
Indicator 13	Climate Action	
Indicator 14	Life Below Water	
Indicator 15	Life on Land	
Indicator 16	Peace, Justice and Strong Institutions	
Indicator 17	Partnerships for the Goals	

Appendix 2

Description of variables in the model

Variable	Symbol	Measurement	Studies	Data source
Dependent variable				
Sustainable development	SDGI	Appendix 1	Khoi & Dinh (2025); Huy & Dinh (2025a, 2025b)	SDGIndex.org
Independent variables				
Economic Freedom Index	EFI	Measured through 12 components: property rights, government integrity, judicial effectiveness, tax burden, government spending, fiscal health, business freedom, labor freedom, monetary freedom, trade freedom, investment freedom and financial freedom.	Mushtaq & Ali Khan (2018), Santiago <i>et al.</i> (2020)	Heritage Foundation.
Financial development index	FD	The financial development index is obtained from the IMF	Oanh <i>et al.</i> (2023)	IMF
Control Variables				
GDP growth	GDP	GDP per capita (annual growth, %)	Le Quoc <i>et al.</i> , (2025); Le Quoc (2024); Quoc & Quoc (2025)	World Bank
CO2 emissions	CO2	CO2 emissions per capita	Su <i>et al.</i> (2021)	World Bank
Urbanization rate	UR	Urban population as a percentage of total population (Urbanization rate, %)	Le Quoc <i>et al.</i> , (2025); Le Quoc (2024)	World Bank
Population growth rate	POP	Annual population growth rate (%)	Le Quoc <i>et al.</i> , (2025); Le Quoc (2024)	World Bank
Trade openness	OPEN	The ratio of total goods and services exports and imports to GDP (%)	Le Quoc <i>et al.</i> , (2025); Le Quoc (2024)	World Bank
Foreign direct investment	FDI	FDI/GDP (%)	Dinh (2025), Nguyen Quoc <i>et al.</i> (2025)	World Bank
Inflation rate	INF	Annual inflation growth rate (%)	Dinh <i>et al.</i> (2024)	World Bank

Source: Compiled by the authors

Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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