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Prof. Dr. Mustafa METE

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CHAPTER 1

STRUCTURAL DETERMINANTS OF SOCIAL SUSTAINABILITY IN COAL- INTENSIVE ECONOMIES: A HETEROGENEOUS PANEL ANALYSIS

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Introduction

Social sustainability, the capacity of a society to safeguard equity, ensure access to essential services, and preserve collective well-being across generations, has emerged as one of the most persistently underdeveloped pillars of sustainable development (Barron et al., 2023). While the Brundtland Commission's landmark definition established a three-pillar framework balancing economic growth, environmental stewardship, and social equity (Mensah, 2019), policy and empirical research have disproportionately concentrated on economic output and ecological footprints, leaving the social dimension comparatively underexplored (Gupta & Vegelin, 2016).

The economic and environmental transformation drivers, the structural dynamics that influence economic development, are environmental accountability (Staniškis, 2022). These encompass technical innovation, regulatory frameworks, environmentally sustainable investments, trade dynamics, and institutional integrity (Ashford & Hall, 2011). They are essential in dissociating economic expansion from environmental deterioration.

Transformation drivers critically shape a nation's trajectory toward social sustainability by mediating economic expansion, resource use, and the distribution of social benefits, thereby enabling equitable and sustainable policies to broaden access to education, healthcare, employment, and justice. Whereas unguided implementation risks exacerbating inequality, environmental harm, and the marginalization of vulnerable populations (Chakrabarti et al., 2025; Gupta et al., 2020). A comprehensive understanding of these intersecting dynamics is therefore essential for strategically fostering long-term human development, strengthening social resilience, and ensuring equitable prosperity.

This gap is particularly acute in major coal-consuming economies. Despite global commitments to decarbonization, many of the world's largest producers and users of coal continue to rely on fossil fuels as structural pillars of energy security and industrial output. Coal combustion generates substantial air and water pollution, strains public health systems, and imposes disproportionate burdens on low-income communities (Hendryx et al, 2020; Hariram et al., 2023). The aggregate social consequences of coal dependence, measured using composite human development indicators, remain insufficiently documented at the cross-national level.

Beyond coal, structural transformation in these economies is shaped by additional drivers: the depth and inclusiveness of financial systems, the degree of global economic and social integration, the pace and quality of urbanization, and the rate of economic expansion. Each

carries distinct implications for social sustainability (Svirydzenka, 2016; Gygli et al, 2019). Financial development can widen access to credit, insurance, and savings channels through which households invest in health and education (Kling et al, 2022). Globalization facilitates technology transfer and market access, while Urbanization, when managed equitably, improves the efficiency of service delivery and labor market access (Goel & Vishnoi, 2022; Tang, 2025). Economic growth expands fiscal space for social programs when its gains are broadly distributed (Dagdeviren, H., Van Der Hoeven & Weeks, 2002; Fay, 2012).

Despite the policy relevance of these interconnections, no prior study has jointly evaluated how these five drivers (financial development, globalization, coal consumption, urbanization and economic growth) simultaneously affect social sustainability, measured through the Human Development Index (HDI) (Paliova, McNown, & Nülle, 2019), across the world's major coal-consuming economies using cross-sectionally robust estimators. Given the global imperative for integrated economic, environmental, and social development, this study investigates the frequently overlooked social ramifications of sustainability initiatives, which risk exacerbating the marginalization of vulnerable populations if poorly calibrated. By analyzing how economic and environmental transformations influence well-being, fairness and service accessibility, the research delivers evidence-based policy insights to advance inclusive, sustainable development while safeguarding human dignity and social stability.

Literature reviews

This study is underpinned by sustainable development theory and adopts a tripartite framework that posits long-term, inclusive progress as contingent upon the synergistic integration of economic growth, environmental conservation, and social equity (Ghimire, 2023). Drawing on the Brundtland Commission's foundational articulation, the analysis operationalizes sustainability as the pursuit of present developmental needs without undermining the capacity of future generations to fulfill their own (Mensah, 2019).

Studies have documented how coal combustion damages public health through respiratory and cardiovascular disease pathways, with mortality and morbidity concentrated near extraction and generation infrastructure. At the macro level, coal-intensive industrial structures have been linked to slower improvements in social sustainability, environmental degradation, and spatial inequality (Hendryx et al, 2020; Hariram et al., 2023). Fossil fuel lock-in delays economic diversification, constrains employment opportunities for lower-skilled workers, and perpetuates social exclusion (Fay, 2012; Wang & Zhang, 2023). Shanta and Adedokun (2025) hold the view that coal consumption adversely and significantly impacts social sustainability. Conversely,

financial development, globalization, urbanization, and economic growth exhibit positive and substantial consequences.

Cross-country evidence consistently shows that financial inclusion-access to credit, savings, and insurance-is positively correlated with social sustainability (Nanda & Kaur, 2016). By reducing poverty and enabling households to invest in health and education, well-regulated financial systems operationalize social equity (Mlachila et al., 2016). Theoretical work formalizes this mechanism: financial inclusion reduces income inequality by expanding access to credit for lower-income households (Kling et al, 2022). Most prior studies, however, rely on fixed effects or GMM estimators that do not correct for cross-sectional dependence.

Using the KOF Globalization Index (Gygli et al., 2019), prior panel studies have documented positive associations between composite globalization and life expectancy, particularly in middle-income countries (Guzel et al., 2021). Studies have shown that social globalization's knowledge and diffusion channels appear especially beneficial, and urbanization similarly presents dual pressures: concentrated urban populations improve the cost-efficiency of service delivery (Goel & Vishnoi, 2022; Tang, 2025), but rapid growth without adequate institutional capacity intensifies informality and service access inequality (Barron et al, 2023).

To achieve the objectives of the study, the following hypotheses were developed:

- H1:** The coal consumption has a negative and significant effect on social sustainability.
- H2:** Financial development has a positive and significant influence on social sustainability.
- H3:** Globalization has a positive and significant effect on social sustainability.
- H4:** Urbanization has a positive and significant impact on social sustainability.
- H5:** Economic growth has a positive and significant impact on social sustainability.

The conceptual framework linking the five drivers to social sustainability is illustrated in Figure 1.

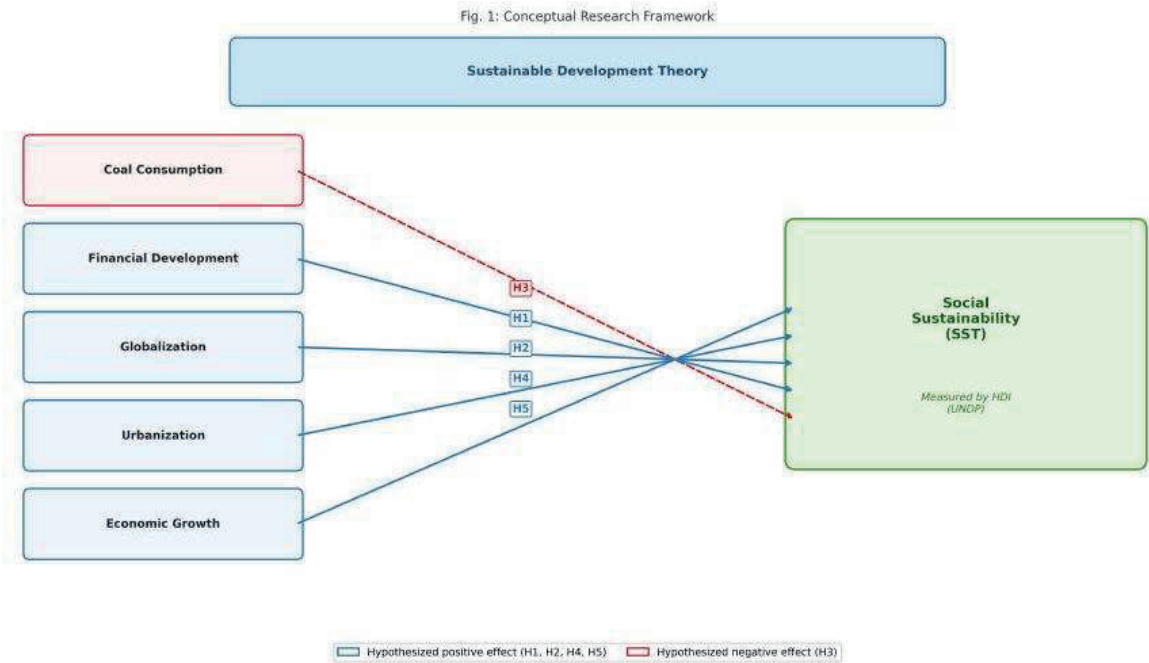


Fig. 1. Conceptual research framework. Dashed red arrow (H3) denotes the hypothesized negative effect of coal consumption; solid blue arrows (H1, H2, H4, H5) denote hypothesized positive effects.

Data and Methodology

Data Sources and Variables

The research analyzed a balanced panel of ten major coal-consuming nations (China, India, the United States, Russia, Japan, South Africa, Germany, South Korea, Indonesia, and Poland) covering the period from 1991 to 2022. These ten economies are selected because they collectively account for the dominant share of global coal consumption, span diverse income levels, represent distinct institutional and welfare-state contexts, and thus constitute an analytically coherent yet internally diverse sample for studying the coal-social nexus. Table I presents the variable definitions and sources. Social sustainability (SST) is proxied by the HDI (Paliova et al, 2019), a composite measure encompassing life expectancy, educational attainment, and per capita income. The IMF Financial Development Index captures financial sector depth, access, and efficiency. Globalization is measured by the KOF Globalization Index. Coal consumption (in million tonnes of oil equivalent) is sourced from the BP Statistical Review. Urbanization (percent urban population) and annual GDP growth are sourced from the World Bank WDI.

Table I: Variable Definitions and Data Sources

Symbol	Variable	Measure	Source
SST	Social sustainability	HDI (0-1)	UNDP
FCD	Financial development	FD Index	IMF
GLO	Globalization	KOF Index	KOF
COL	Coal consumption	in million tonnes of oil equivalent	BP
URB	Urbanization	% urban pop.	WB WDI
EMG	Economic growth	GDP growth (%)	WB WDI

Model specification and estimation techniques

We specify the baseline long-run panel model as:

$$SST_{i,t} = \beta_0 + \beta_1 FCD_{i,t} + \beta_2 GLO_{i,t} + \beta_3 COL_{i,t} + \beta_4 URB_{i,t} + \beta_5 EMG_{i,t} + u_i \quad (1)$$

where i indexes country and t indexes year. Estimation proceeds through a four-step diagnostic sequence.

First, to achieve the study objectives, a cross-sectional dependence test was conducted using the Pesaran CD test, the Friedman test, and the Frees test; null rejections necessitate CD-robust estimators (Bailey et al, 2016). Second, the Pesaran-Yamagata test is used to conduct slope homogeneity; a rejection indicates slope heterogeneity in the panel. Third, the CADF and CIPS unit root tests (Pesaran, 2007) to assess variable stationarity under cross-sectional dependence. Fourth, the Westerlund bootstrap cointegration test [20] confirms whether a stable long-run equilibrium exists.

Given confirmed cross-sectional dependence, slope heterogeneity, and cointegration, the Augmented Mean Group (AMG) estimator was adopted as the primary technique (Eberhardt, 2012; Moundigbaye et al., 2018). The AMG augments country-level regressions with a common dynamic process estimated from pooled first-difference regressions, allowing unobserved global shocks to affect each country distinctly. Country-specific estimates are subsequently averaged. Feasible Generalized Least Squares (FGLS) serves as a robustness check, correcting for panel heteroskedasticity and autocorrelation under a homogeneous slope assumption (Moundigbaye et al., 2018)

Heterogeneous Panel Methods

Cross-sectional dependence, caused by shared global shocks, biases standard errors when ignored (Bailey et al, 2016). The Pesaran CADF and CIPS tests (Pesaran, 2007) and the Westerlund bootstrap cointegration test (Westerlund, 2007) have become standard diagnostics

in energy-sustainability panels. The AMG estimator (Eberhardt, 2012) and FGLS provide complementary frameworks suited to data structures confirmed by these diagnostics, yet their application to social sustainability as a dependent variable remains sparse (Moundigbaye et al, 2018).

Results and Discussion

Pre-Estimation Diagnostics

Table 2 reports the diagnostic test results. All three cross-sectional dependence tests reject the null of independence at the 1% level (Pesaran CD = 40.39; Friedman = 146.41; Frees = 9.07), confirming that the ten economies share common global shocks-consistent with co-movement in global coal prices, capital flows, and environmental policy spillovers. The Pesaran-Yamagata delta-tilde statistic (4.33; $p < 0.01$) and its adjusted counterpart (10.73; $p < 0.01$) reject slope homogeneity, validating the country-heterogeneous structure of AMG. CADF and CIPS tests reveal that all six series are stationary at the level or after first differencing ($I(0)$ or $I(1)$), ruling out spurious regression. The Westerlund bootstrap test statistic of $-20.29(p < 0.01)$ confirms long-run cointegration, justifying level-form estimation.

TABLE 2: Pre-Estimation Diagnostic Tests

Test	Statistic	Sig.
Cross-Sectional Dependence		
Pesaran CD	40.390	***
Friedman	146.414	***
Frees	9.066	***
Slope Heterogeneity		
$\tilde{\Delta}$ statistic	4.329	***
$\tilde{\Delta}_{adj}$ statistic	10.732	***
Cointegration (Westerlund)		
Bootstrap statistic	-20.291	***

Note: *** $p < 0.01$. All CADF and CIPS unit root tests confirm stationarity at level or first difference.

Main Estimation Results

Table 3 presents the AMG and FGLS results. Both estimators deliver consistent findings: coal consumption exerts a significant negative effect on social sustainability ($p < 0.01$, confirming H3), while financial development (H1 confirmed: AMG $\hat{\beta} = 0.263$), globalization (H2

confirmed: $\hat{\beta} = 0.003$), urbanization (H4 confirmed: $\hat{\beta} = 0.012$), and economic growth (H5 confirmed: $\hat{\beta} = 0.433$) are all positively and significantly associated with social sustainability. Significance levels are consistent between AMG and FGLS for all five predictors, providing robust cross-specification support for each hypothesis. Figure 2 illustrates the coefficient profiles, reinforcing the sign consistency and the dominant magnitude of coal consumption's negative effect.

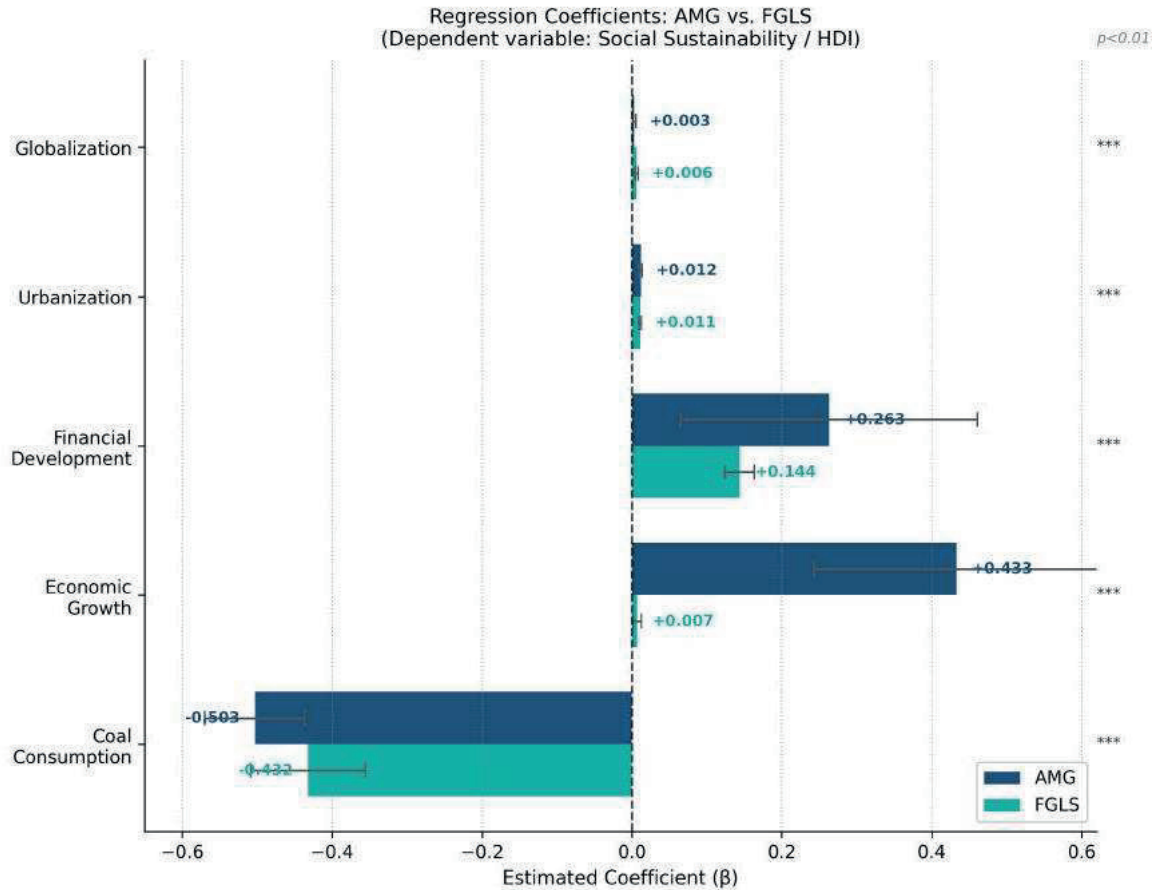


Fig. 2. Standardized regression coefficients with 95-percent confidence intervals. Navy: AMG; Teal: FGLS. The dashed line at zero separates the negative (coal) from the positive drivers.

Discussions

Coal consumption carries the largest negative coefficient in absolute value ($\hat{\beta}_{AMG} = -0.503$), confirming that each additional unit of coal consumption is associated with a 0.503 – point HDI decline. This result aligns with documented pathways through air-pollution-induced respiratory and cardiovascular disease (Hendryx et al., 2020), welfare crowding-out, as governments subsidize energy costs at the expense of social programs (Wang & Zhang, 2023), and spatial inequality, as low-income communities bear disproportionate exposure (Hariram et al, 2023).

Economic growth (H5 confirmed) shows the largest positive AMG coefficient (0.433), substantially exceeding the FGLS estimate (0.007). This divergence stems from a

methodological difference between the two estimators: AMG allows for slope heterogeneity across the ten countries, recovering individual-level growth-development linkages that are strongly positive in rapid-growth contexts (China, India) and near zero in mature welfare states (Germany, Japan). When FGLS imposes a single pooled slope, these heterogeneous effects are averaged out to near zero, suppressing the true cross-country effect. The large Pesaran-Yamagata $\tilde{A}$ statistic (4.33; $p < 0.01$) corroborates this: the slope-heterogeneity rejection is sufficiently strong to explain a 62-fold divergence in the growth coefficient across estimators. Readers should interpret the AMG estimate as the weighted average of country-specific growth effects, not a universal constant.

Financial development (H1 confirmed; AMG: 0.263; $t = 2.60$) confirms that inclusive financial systems amplify household investment capacity in health and education [8] (Nanda & Kaur, 2016; Mlachila et al., 2016). A 0.1 -unit improvement in the FD Index corresponds to a 0.026 -point social sustainability gain. The lower but still highly significant FGLS estimate (0.144; $z = 14.40$) demonstrates robustness: even under slope homogeneity, financial deepening is a reliable social sustainability lever. The convergence of both estimators around a positive sign is notable given that prior studies in Sub-Saharan Africa found ambiguous effects when financial exclusion was high (Mlachila et al., 2016).

Globalization (H2 confirmed; AMG: 0.003; FGLS: 0.006) exerts a statistically significant but economically modest effect. The small magnitude is consistent with cross-country evidence showing that globalization's social benefits are mediated by institutional quality (Tang, 2025; Guzel et al, 2021). In coal-intensive economies where governance capacity is variable, the social dividends of integration are real but limited.

Table 3: Regression Results: AMG (Primary) and FGLS (Robustness Check)

Variable	AMG			FGLS		
	$\hat{\beta}$	Std.Err.	t	$\hat{\beta}$	Std.Err.	z
Financial Dev. (FCD)	0.263***	0.101	2.604	0.144***	0.010	14.400
Globalization (GLO)	0.003***	0.001	3.000	0.006***	0.001	6.000
Coal Consump. (COL)	-0.503***	0.034	-14.794	-0.432***	0.039	-11.077
Urbanization (URB)	0.012***	0.001	12.000	0.011***	0.001	11.000
Economic Growth (EMG)	0.433***	0.097	4.464	0.007***	0.003	2.333
Constant	0.313***	0.025	12.520	0.906***	0.064	14.156
Observations		320			320	
Wald / χ^2		735.01***			330.22***	
RMSE / AIC		0.0344			-160.820	

Note: *** $p < 0.01$.

Urbanization (H4 confirmed) delivers the most coefficient-stable result across estimators (AMG: 0.012; FGLS: 0.011), suggesting that urban agglomeration reliably improves HDI regardless of slope heterogeneity. This consistency indicates that urbanization's social benefits-concentrated access to schools, hospitals, and labor markets-operate through mechanisms that are structurally similar across the ten diverse sample economies (Goel & Vishnoi, 2022; Barron et al, 2023).

Conclusion

This study provides the first joint assessment, using cross-sectional dependence robust heterogeneous panel estimators (Eberhardt, 2012), Moundigbaye et al (2018) preceded by a four-step diagnostic sequence (Bailey et al, 2016; Westerlund, 2007) of how coal consumption, financial development, globalization, urbanization, and economic growth simultaneously shape social sustainability (HDI) across the world's ten major coal-consuming economies over 1991-2022. Coal consumption exerts the largest negative effect ($\hat{\beta} = -0.503; p < 0.01$), while economic growth delivers the largest positive effect ($\hat{\beta} = 0.433$), followed by financial development, urbanization, and globalization, all positively and significantly signed in both AMG and FGLS specifications.

Three policy priorities follow directly from these findings. First, coal phase-down must be socially compensated: for coal-dependent economies such as South Africa, Indonesia, and

Poland, each unit reduction in coal consumption should be paired with ring-fenced social spending-community health clinics, reskilling programs, and clean energy subsidies-to neutralize HDI losses during the energy transition. Second, financial inclusion can act as a compensatory lever: China, India, and South Africa, which still exhibit significant financial exclusion in rural areas, can partially offset coal-driven social harm by deepening access to credit, insurance, and digital payments for lower-income households. Third, urban governance quality determines whether urbanization helps or harms: the consistent positive urbanization coefficient across the entire sample suggests that urbanization is already broadly beneficial in these ten economies, but sustaining this requires inclusive planning frameworks that extend basic services to informal urban settlements, an imperative especially for Indonesia and India.

Future research should extend the framework to include renewable energy penetration, institutional quality indices, and digital financial access, which may mediate or moderate the coal-social and finance-social pathways identified here.

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CHAPTER 2

ALGORITHMIC SKEPTICISM AND CONSUMER TRUST

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1. INTRODUCTION

In the contemporary digital marketplace, the traditional dyadic relationship between brands and consumers has been fundamentally reshaped by a third, often invisible actor: algorithms. From personalized product recommendations on Amazon to curated social media feeds on Instagram and TikTok, algorithms act as the primary gatekeepers of information, taste, and consumption choices of the users. While these "digital architects" provide undeniable convenience by reducing information overload, their increasing agency in decision-making processes has sparked a new wave of consumer skepticism.

Artificial intelligence (AI) recommenders now mediate everyday choices, from what we watch and buy to how we save and stay healthy, making their user experience a central marketing concern (Klaus & Zaichkowsky, 2021). However, a persistent paradox remains: even when algorithms are demonstrably accurate and efficient, consumers often feel uneasy or resistant to their guidance ((Gursoy et al., 2019; Shin et al., 2020). The "black-box" nature of these systems—characterized by a lack of transparency in how data is processed and why certain choices are prioritized—(Köchling & Wehner, 2020) has led to the emergence of what is now termed Algorithmic Skepticism. Unlike traditional advertising skepticism, this new form of doubt is directed toward the perceived neutrality, accuracy, and ethical alignment of these systems. As consumers become more aware that algorithms are not merely neutral tools but profit-oriented engines capable of subtle manipulation, their psychological defense mechanisms are triggered.

The Persuasion Knowledge Model (PKM) is central to understanding this tension. Originally developed to explain how consumers deconstruct traditional marketing tactics, PKM provides a robust theoretical lens for analyzing how modern consumers recognize and respond to algorithmic persuasion (Ham et al., 2015). Some researchers have found that higher levels of persuasion knowledge led to increased privacy concerns and heightened risk perceptions regarding online behavioral advertising (OBA). For instance, Aiolfi et al., (2021) observed that as people become more aware of OBA practices, they often adjust their online behaviors to mitigate perceived privacy threats. Similarly, Ham (2016) found that heightened persuasion knowledge raises privacy concerns, which in turn influences ad avoidance behaviors related to OBA. This activation often leads to a critical evaluation of the algorithm's motives, potentially resulting in resistance, avoidance, or a decline in brand trust.

Furthermore, the prevalence of Algorithmic Skepticism—the systematic and unfair discrimination inherent in automated decision-making—exacerbates this skepticism. Whether through dynamic pricing strategies that penalize certain demographics or filter bubbles that

restrict consumer autonomy, bias serves as tangible proof for consumers that algorithms may not always act in their best interest.

This study aims to explore the intricate intersection of algorithmic bias, consumer trust, and the Persuasion Knowledge Model. By examining the cognitive and emotional drivers of distrust in automated systems, this study aims to provide a comprehensive framework for understanding how consumers navigate the algorithmic landscape. Ultimately, the discussion offers strategic insights for marketers and policymakers on fostering "algorithmic transparency" and rebuilding trust in an era where data-driven persuasion is the new norm.

2. ALGORITHMIC SKEPTICISM

Algorithmic skepticism refers to a careful, inquisitive, and critical approach to artificial intelligence and algorithmic systems (Fu et al., 2020). This approach aims to evaluate algorithms in decision-making processes according to the principles of transparency, accountability, fairness, and ethics. Algorithmic skepticism is necessary to understand the impact of algorithms on human life and society and to prevent potential biases, errors, or injustices.

This concept particularly focuses on the ethical and social issues arising from AI-supported, algorithmic decision-making systems. The operation of algorithms is often complex, and this complexity can render decision-making processes invisible or incomprehensible. This situation requires people to question and approach these decisions with skepticism and caution. For example, algorithmic biases may arise from misrepresentation or deficiencies in historical data; as a result, algorithms may make unfair decisions regarding certain groups. Algorithmic skepticism emphasizes the importance of methods such as independent audits, the application of XAI techniques, and increasing data diversity to detect and eliminate such biases (Atmaja, 2025).

Additionally, algorithmic skepticism highlights the necessity of ensuring responsibility and accountability in the development and use of such systems. This involves developers, users, and policymakers working together to increase transparency and establish societal trust in such technologies (Meduri et al., 2024). It also includes the continuous review of whether algorithmic decision-making processes comply with ethical principles and the education of stakeholders to raise awareness of these issues (Bogina et al., 2021).

The historical development of algorithmic skepticism has emerged in parallel with the evolution of artificial intelligence (AI) and algorithms. In the early days of AI, algorithms were simpler, narrowly scoped automated tools; however, over time, they have transformed into advanced systems capable of learning, adapting, and making complex decisions.

According to Hayawi and Shahriar (2024), this transformation has significantly increased the role and impact of algorithms in human life, bringing ethical, social, and legal issues to the forefront.

Initially, algorithms were evaluated mainly from technical and functional perspectives; however, over time, especially in critical fields such as healthcare, law, and finance, their effects on decision-making processes have highlighted ethical dimensions. Biases inconsistent with human values, opaque decision mechanisms, and lack of accountability have become the main concerns of algorithmic skepticism (Atmaja, 2025). Therefore, algorithmic skepticism has emerged as an approach that demands the development and monitoring of algorithms according to the principles of fairness, accountability, and transparency.

The importance of algorithmic skepticism has increased as technology permeates every aspect of our lives. Because algorithms learn based on past data, they can reinforce existing social biases, leading to the further marginalization of disadvantaged groups. Accordingly, as algorithmic models influence critical decisions, it is necessary to enhance the transparency of these systems and develop independent audits and explainable AI techniques to mitigate biases (Atmaja, 2025; Samala & Rawas, 2025).

Moreover, algorithmic skepticism encompasses not only technical issues but also the preservation of responsibility and ethical value. Establishing a culture of transparency and accountability among developers, policymakers, and users plays a central role in securing public trust in AI-based systems (Meduri et al., 2024). This is necessary for the broader acceptance of algorithmic systems, their ethical use, and the continuous monitoring of their societal impacts. The complexities and ethical challenges brought about by technical advances throughout history have increased the importance of algorithmic skepticism, making it an indispensable perspective in today's digital societies. This approach enables individuals and societies to better understand and control the effects of algorithmic decisions (Atmaja, 2025; Hayawi & Shahriar, 2024; Meduri et al., 2024).

3. THE PERSUASION KNOWLEDGE MODEL

The Persuasion Knowledge Model (PKM) is a framework that explains the process by which individuals recognize persuasive attempts directed at them, become knowledgeable about these attempts, and respond accordingly. The model particularly focuses on the personal knowledge and strategies that consumers develop when faced with persuasive communications such as marketing and advertising (Friestad & Wright, 1994).

The model also reveals that access to persuasion knowledge can sometimes lead to trust and positive attitudes rather than skepticism. In particular, in persuasive attempts made by trustworthy sources and honest tactics, individuals may form favorable evaluations of the persuading agent (Isaac & Grayson, 2016). Moreover, source knowledge (e.g., expert opinion) has a strong impact on the success of persuasion. Sources with high expertise and credibility are more effective in the persuasion process; consumers pay more attention to information coming from such sources (Artz & Tybout, 1999; Wilson & Sherrell, 1993). This information is important for understanding consumer behavior and developing effective marketing and communication strategies.

The Persuasion Knowledge Model (PKM) comprises several fundamental components that explain how individuals interpret and navigate persuasive communications. At its core, persuasion knowledge refers to the personal insights and awareness an individual possesses regarding persuasive attempts and instruments. This cognitive resource enables individuals to decipher the goals, tactics, and strategies of marketers, thereby allowing them to identify manipulative or commercial efforts and cultivate appropriate attitudinal and behavioral responses (Boerman et al., 2018; Friestad & Wright, 1994).

Complementing this is agent knowledge, which encompasses the consumer's perception of the persuading party, including evaluations of the source's credibility, intent, and expertise (Wilson & Sherrell, 1993). Furthermore, tactic knowledge involves being informed about the specific techniques and methods employed during the persuasion process. Through personal experience and social learning, individuals develop an awareness of these methods, which often triggers a sense of suspicion (Evans & Park, 2015).

In terms of the persuasion process and responses, persuasion knowledge allows individuals to become cognizant of the underlying intent and tactics in communications directed toward them, leading to conscious reactions. These responses may manifest as skepticism, resistance, or openness to the persuasive message (Isaac & Grayson, 2016). Regarding model operation, the process is initiated when an individual perceives and evaluates a persuasive encounter. For instance, when a consumer identifies that an advertisement contains sponsorship or covert advertising, they effectively recognize both the persuasive goal and the underlying method (Beckert et al., 2020). Ultimately, this awareness shapes the individual's attitude toward the product or service and dictates their subsequent behavioral response.

4. THE TRIGERRING ROLE OF ALGORITHMIC BIASES ON SUSPICION

The triggering role of algorithmic biases on doubt is based on the bias inherent in artificial intelligence and algorithmic systems' decision-making processes and the resulting foundation of distrust they create among users or society. Algorithmic biases, arising from imbalances or representational deficiencies in historical datasets, can lead to unfair decisions against certain groups, and this situation generates profound doubt about whether the systems are fair, transparent, and accountable (Atmaja, 2025).

This skepticism is further heightened by the lack of transparency in algorithms and the difficulty in understanding their complex structures externally. Individuals and society have begun to question the accuracy and impartiality of algorithmic decision-making processes because the consequences of algorithmic biases can lead to serious social problems, such as the further marginalization of disadvantaged groups and the undermining of social justice. (Atmaja, 2025).

In addition, algorithmic skepticism serves as an important warning mechanism for developing fair and responsible artificial intelligence systems. Recognizing the presence of biases increases the importance of independent audits, explainable AI methods, progressive regulations and public education. Thus, by rebuilding societal trust, a broader acceptance of algorithmic systems can be achieved. (Atmaja, 2025; Meduri et al., 2024).

The fact that algorithms present users only with similar views or products, known as the echo chamber effect, creates a sense of restriction for consumers. This situation can lead to a psychological response—reactance—when a person realizes that the diversity of information and options is artificially limited. Reactance is the tendency to resist when an individual feels that their freedom is somehow being restricted.

Echo chambers are formed when algorithms present users with similar content based on their interests and previous preferences, leading to decreased information diversity. In this process, users observe that the information or products they encounter are very close to their own views or preferences and that they do not come across different perspectives or alternative options (Jeon et al., 2021; Sun et al., 2022). This awareness triggers a sense of constraint and entrapment in the individual. The feeling of restriction creates cognitive and emotional discomfort and leads individuals to perceive that their right to make free choices is being obstructed. In such cases, individuals react to the limitations they are exposed to; they may start seeking alternative information, reject the existing system, or deliberately ignore the algorithm's recommendations (Jeon et al., 2021). Such reactive behaviors may manifest as

resistance to the algorithmic recommendation system, an active search for new information, or efforts to escape the filter bubble by turning to other platforms.

The emergence of reactance is particularly accelerated when users realize that the algorithm is narrowing their information fields and confining them in a kind of "filter bubble" (Gao et al., 2023). This situation can also be observed on social media and short video platforms, where users may feel trapped in monotonous and one-sided content groups, deepening social polarization. This psychological discomfort may lead users to act more actively, inquisitively, and resist information exchange (Gao et al., 2023; Sun et al., 2022).

4.1. EFFECTS AND RESPONSES ON CONSUMER BEHAVIOR

Ad blocker usage, cookie rejection, and the use of incognito mode—behaviors aimed at limiting consumer privacy breaches and data tracking—are increasingly common. These tendencies can be interpreted as a reaction developed by consumers against personalized advertising and content in digital environments and are directly linked to the desire to control their digital footprints.

Research on Gen Z shows that consumers experience dilemmas such as "privacy-benefit" and "avoidance-irritation" in response to personalized digital marketing approaches. In other words, while consumers derive value from ads and content tailored to them, the feeling of being excessively tracked and monitored makes them uncomfortable and prompts them to take preventative measures. Ad blockers and incognito modes, in this context, are among the strategies consumers develop to protect their privacy (Mckee et al., 2023).

Cookie rejection means that consumers consciously set boundaries against data collection processes. By reducing the scope of data collected about themselves, users strive to control the amount and the ways in which personalized ads are targeted at them. This also reflects consumers' sensitivity regarding the use of their personal data and their privacy concerns (Legros et al., 2024). Additionally, consumers may deliberately use different or fake search terms to trick algorithmic recommendation systems. This behavior was developed to prevent the algorithm from confining them to specific preference patterns. Such efforts arise from the desire to escape the filter bubble or echo chamber offered by the algorithm and access a wider range of information or products. Thus, consumers actively resist excessive targeting and restricted content delivery in digital environments (Mckee et al., 2023; Singh, 2024).

These consumer strategic behaviors directly impact the consumer–brand relationship in digital marketing and advertising. For instance, while the widespread use of ad blockers reduces the reach and effectiveness of ads, methods such as using incognito mode and

rejecting cookies can weaken consumer trust in the personalization process (Farrukh et al., 2024). Therefore, marketers aim to develop strategies that consider consumers' privacy preferences and balance personalized experiences.

5. STRATEGIC SOLUTIONS FOR BRANDS

For brands developing strategic solutions to alleviate consumer doubts arising from algorithms is of critical importance in building trust and fostering customer loyalty in today's digital marketing landscape. According to the context provided, these strategies are primarily shaped by transparency, fairness, privacy protection, and customer engagement.

Ensuring Transparency: Consumers struggle to understand how algorithmic processes work and how their data are used. Brands can reduce consumer doubts by communicating openly about how algorithms function and about their decision-making mechanisms. In this context, it is recommended to use “explainable AI” techniques—developing designs that present algorithmic results and recommendations in an understandable way. Additionally, it is important to provide consumers with clear and easily accessible information about data collection, processing, and usage (Adanyin, 2024; Gupta, 2025).

Fairness and Algorithmic Neutrality: Recognizing and addressing potential biases in algorithmic decision-making processes strengthens consumers' perceptions of fairness. Brands should regularly audit their algorithms, enhance the representativeness of their datasets, and identify and rectify possible biases. In this way, they can guarantee that different consumer groups receive equal and fair services (Adanyin, 2024; Agu et al., 2024).

Prioritizing Data Privacy: Consumers are increasingly concerned about the collection and use of their personal data. Brands can instill trust by clarifying their data-protection policies and implementing strict privacy measures. Data management should be conducted with privacy-friendly designs and a “privacy-by-design” approach, ensuring that technologies and processes are shaped by this principle. Simultaneously, users must have control over their data, and clear consent procedures should be implemented (Adanyin, 2024; Kumar et al., 2025).

Increasing Consumer Feedback and Engagement: By involving consumers in the process of developing AI applications, brands demonstrate that their concerns and needs are directly considered. Feedback mechanisms should be established, and improvements should be made based on consumer opinions regarding their algorithmic experiences. Thus, a relationship based on mutual trust and respect is established between consumers and brands (Adanyin, 2024; Nadeem, 2025).

Ethical AI Design and Implementation: Brands should develop AI systems aligned with ethical principles and implement accountability and responsibility. In this regard, external audits, independent algorithm testing, and cooperation with ethics boards are important. Additionally, systematic measures should be implemented to ensure that algorithms make impartial and fair decisions (Agu et al., 2024; Patel et al., 2024).

Education and Awareness Activities: Educating consumers about how algorithms work and how their personal data are used increases their awareness and reduces suspicion. Brands can support this process with user-friendly guides, frequently asked questions, and interactive educational content. Simultaneously, internal stakeholders must be trained in ethical and responsible AI practices to ensure sustainable trust (Bogina et al., 2021; Wieczorek & Postrzednik-Lotko, 2025).

Regulatory Compliance and Standardization: Compliance with data protection and AI regulations, such as the GDPR and CCPA, helps reduce suspicion. Moreover, adherence to industry standards and certifications reinforces consumer trust in the brand (Kumar et al., 2025; Mbah & Evelyn, 2024).

5.2. AI LITERACY AND CONSUMER TRUST IN AI-DRIVEN BRAND INTERACTIONS

Increasing AI literacy affects consumer-brand relationships in nuanced and multifaceted ways, impacting trust, engagement, receptivity to AI tools, and overall attitudes towards brands leveraging AI technologies. Trust is a key mediator in consumer-brand relationships influenced by AI literacy. Studies show that consumer trust in AI-powered brand communication, such as AI chatbots or AI influencers, hinges on perceptions of expertise, anthropomorphism (human-like qualities), responsiveness, ease of use, and established brand trustworthiness. For instance, brand trust positively affects consumer trust in AI chatbots, fostering better communication and engagement, whereas perceived risks can undermine trust (Li et al., 2023).

AI literacy plays a critical role in calibrating trust. Higher AI literacy enables consumers to critically evaluate AI outputs rather than blindly trusting or distrusting them. This calibration reduces the cognitive risks of overreliance on AI and helps preserve consumers' critical engagement with branded AI interfaces, thus maintaining a balanced consumer-brand relationship (Kulal, 2025). When literacy is low, consumers may harbor unrealistic expectations or excessive skepticism, both of which can negatively affect trust.

AI literacy also affects how consumers weigh AI tools versus human influencers in their decision-making. Consumers with a greater understanding of AI may appreciate its objectivity

and precision, especially in product categories requiring technical information (e.g., electronics), thus strengthening the brand's position when deploying AI tools. Conversely, emotionally charged categories may still rely on human influencers, indicating that AI literacy helps consumers differentiate where AI adds value to brand interactions (Gerlich, 2025).

6. CONCLUSION

The integration of automated decision-making into the consumer journey has catalyzed a fundamental paradigm shift in marketing. As this study has explored, the rise of algorithmic persuasion has redefined the marketplace, transitioning it from a realm of human interaction to one governed by opaque, data-driven digital architectures. While these systems provide unparalleled efficiency, their inherent "black-box nature" has significantly strained the traditional foundations of consumer trust.

The central theme of this discussion is that as consumers encounter the pervasive influence of automated systems, they increasingly activate their Persuasion Knowledge. Applying the Persuasion Knowledge Model (PKM) to the digital landscape reveals that consumers are no longer passive recipients of personalized content; instead, they have evolved into sophisticated evaluators of algorithmic motives. This cognitive shift has fostered a multifaceted defense mechanism known as algorithmic skepticism, characterized by a growing doubt toward the perceived neutrality and ethical integrity of a brand's underlying technology.

Algorithmic bias serves as a critical catalyst for this skepticism. Whether manifesting as discriminatory pricing or the restrictive boundaries of "filter bubbles," bias acts as a tangible signal that algorithms may prioritize corporate interests over individual well-being. Such realizations often trigger psychological defense mechanisms, leading consumers to actively resist, bypass, or "game" the system in an effort to reclaim their autonomy.

To address these challenges, the marketing discipline must pivot toward a model of radical transparency and Explainable AI (XAI). Restoring trust in an era of information overload requires more than mere predictive accuracy; it demands ethical accountability. The brands that successfully navigate this landscape will be those that empower consumers by demystifying their algorithms, ensuring that personalization serves the user rather than facilitating manipulation.

In conclusion, the future of marketing resides at the intersection of technological sophistication and human-centric ethics. Navigating the interplay between algorithmic bias, consumer skepticism, and the Persuasion Knowledge Model is far more than an academic

exercise. It is a strategic imperative for any organization seeking to sustain long-term loyalty in an increasingly automated world.

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CHAPTER 3

FINANCIAL INCLUSION AND ECONOMIC GROWTH IN SUB- SAHARAN AFRICAN COUNTRIES: A DYNAMIC PANEL OF SYSTEM GMM APPROACH

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Introduction

Over recent decades, financial inclusion has attracted substantial attention from academics, policymakers, and financial experts, largely due to consistent global evidence linking financial exclusion to challenges in economic growth and poverty reduction. In this context, financial inclusion refers to the broad accessibility and availability of formal financial services, including savings accounts, credit, and insurance, to every participant in an economy. When inclusion is high, individuals and businesses can effectively leverage these institutional systems to secure long-term financial stability and build capital. Conversely, in regions like African countries where inclusion remains low, limited access to services leaves many unable to navigate financial challenges. Research indicates that approximately 2.5 billion individuals worldwide remain financially excluded, representing nearly 30% of the global population and highlighting a persistent barrier to widespread economic security (GPFI, 2011; FIDWG, 2013).

Sub-Saharan Africa (SSA) presents one of the most striking paradoxes in development economics: rapid growth alongside severe financial exclusion, with an estimated 57 per cent of adults lacking access to formal financial services (Demirgüç Kunt et al., 2018, 2022). Across 54 SSA economies, only 22 per cent of adults hold formal bank accounts; credit, savings, and insurance remain inaccessible to rural populations and the informal sector (World Bank, 2014). This exclusion constitutes a binding constraint on capital accumulation, entrepreneurship, and consumption smoothing - channels through which formal financial intermediation feeds directly into per-capita income growth (Honohan, 2004; Cull et al., 2014).

The theoretical case for a finance-growth nexus is well established. McKinnon (1973) and Shaw (1973) showed that financial repression suppresses saving mobilization and the efficiency of capital allocation. King and Levine (1993) provided cross-country evidence that financial depth predicts growth, while Levine (2005) consolidated the mechanisms through which the financial systems promote economic activity. More recently, attention has shifted to financial inclusion: household and firm access to affordable financial products (Sahay et al., 2015).

Three methodological limitations beset the SSA empirical literature. First, most studies proxy inclusion with a single indicator - bank branch per 100,000 adults, credit to GDP, or account ownership - ignoring the multidimensionality of access, availability, and usage (Ndebbio, 2004; Honohan, 2004). Second, static estimators (pooled OLS, fixed effects) ignore dynamic GDP persistence, introduce Nickell bias, and treat financial inclusion as exogenous despite strong

grounds for bidirectional causality (Anarfo et al., 2020; Ibrahim & Alagidede, 2017). Third, income-group heterogeneity across SSA is rarely modeled explicitly, thereby masking differences in growth magnitudes across development stages (Mlachila et al., 2013; Kpodar & Andrianaivo, 2011).

This paper addresses all three limitations. The study constructs a multidimensional time-varying FII for 41 SSA countries (2008-2023) using two-stage PCA across eight indicators in three sub-dimensions: penetration (bank branches, ATMs, and depositors per 100,000 adults), availability (branches and ATMs per 1,000 km²; outstanding deposits as a share of GDP, and usage (outstanding loans as a share of GDP; mobile money accounts per 1,000 adults). The FII is embedded in an augmented neo-classical production function (Odedokun, 1996) and estimated with Arellano-Bover/Blundell-Bond System GMM (Arellano-Bover, 1995; Blundell-Bond, 1998) and Windmeijer-corrected standard errors (Windmeijer, 2005). Causality is examined using Dumitrescu and Hurlin's (2012) heterogeneous panel non causality tests to investigate the variables' directional relationships.

Related Work

Financial inclusiveness is a crucial element of efforts paramount to achieving inclusive growth. Inclusive finance is vital for maintaining social-economic development, hence enhancing economic advancement and financial system stability. It is a fundamental element in creating an inclusive financial system that fosters wealth creation and facilitates economic progress. The correlation between economic growth and several macroeconomic issues related to financial inclusion has received considerable attention in the research literature. The data mostly suggest that a resilient financial system and universal financial access improve the efficiency of resource allocation and foster inclusive growth. The foundational contributions to this landmark, including King and Levine (1993), Levine (1993), Schumpeter (1911), Shaw (1973) and Goldsmith (1969), all illustrated that the financial institutions system acts as a catalyst for growth of the economy by enabling capital accumulation and improving productivity. Van et al (2021) indicated that financial inclusion favorably influences Vietnam's growth. The findings of Nizam et al. (2020) align with those of Van et al. (2021). Hajilee and Niroomand (2019) show that financial inclusion and the shadow economy asymmetrically affect trade openness and growth in emerging economies, using ARDL/NARDL, revealing country-specific effects.

Single-indicator and static models. Early SSA studies used single financial proxies in OLS regressions: Ndebbio (2004) used broad money and credit; Honohan (2004) used aggregate

depth measures. More recent single-proxy studies, including Anarfo et al. (2020) and Ibrahim and Alagidede (2017), use ATMs or account ownership in fixed-effects or ARDL frameworks, establishing a positive financial inclusion-growth association, but failing to address multidimensionality and endogeneity simultaneously.

Composite FII studies. Sarma (2008) proposed the first HDI-style composite FII; Sarma (2012) refined it with min-max normalization. Gupte et al. (2012) introduced PCA weighting; Nagar and Basu (2014) formalized the two-stage PCA used here. Chinoda and Kwenda (2019) constructed a PCA-based FII for 40 African countries. Existing composite SSA studies are predominantly cross-sectional, and none integrates a time-varying PCA-weighted FII into a dynamic GMM model with DH causality tests (Jolliffe, 2002). Dynamic GMM studies. Kpodar and Andrianaivo (2011) first applied Arellano-Bond GMM to financial inclusion and African growth. Adedokun and Aga (2021) are the most comparable GMM estimation with 36 SSA countries; Kim et al. (2018) applied System GMM to OIC countries; Sethi and Acharya (2018) examined 31 countries; Nkoa and Song (2020) covered 48 African countries. None of these studies simultaneously constructs a PCA-based FII from eight indicators and complements GMM with DH causality tests. This combination is our principal contribution.

Data, Variables, and Methodology

Data and Financial Inclusion Index

This study examined all fifty-four (54) nations in Sub-Saharan Africa as per the World Bank development indicators (World Bank, 2025). This study includes only 41 economies due to the availability of data on the necessary indicators to derive actual policy implications and achieve the research objective. The variables employed for the study are financial Inclusion, good governance, economic growth, trade capital stock, and human capital (See Table 1 for data sources and definitions). The financial inclusion and good governance index were constructed employing principal component analysis (PCA).

Table 1: The data sources and definitions.

Variables	Definitions	Symbol	Sources
Financial Inclusion	Financial Inclusions Index (Availability, penetration, and usage).	FII	IMF (2025)
Trade	Trade (% GDP)	TRA	World Bank (2025a)
Good governance	Country level governanc	GGI	World Bank (2025b)
Capital Stock	Capital Stock	CAP	Feanstra et al (2015)
Human capital development	Human capital index	HCI	Feanstra et al (2015)
Economic Growth	GDP per capital	GDP	World Bank (2025a)
Labour Force	Population ages from 15-64, total	LAB	World Bank (2025)

Source: Author's work

Financial inclusion and good governance index

Stage 1 of the two-stage PCA procedure min-max normalizes eight raw indicators to [0,1] (Sarma, 2012) and extracts the first principal component within each subdimension: (i) Penetration - bank branches and ATMs per 100,000 adults, depositors per 1,000 adults; (ii) Availability - branches and ATMs per 1,000 km², outstanding of deposits as a share of GDP; (iii) Usage - outstanding of loans as a share of GDP, mobile money of accounts per 1,000 adults. Stage 2 pools the three-dimensional scores into the composite FII using a second PCA, yielding $FII \in [0,1]$ (Nagar & Basu, 2014; Jolliffe, 2002). Figure 1 illustrates this two-stage procedure. The GGI is constructed analogously from six WGI indicators.

System GMM and Dumitrescu-Hurlin Test Estimations

The dynamic model

$$LNGDP_{it} = \alpha + \rho LNGDP_{i,t-1} + \beta_1 FII_{it} + \gamma \mathbf{X}_{it} + \mu_i + \varepsilon_{it}$$

The Arellano-Bover/Blundell-Bond System GMM (Arellano-Bover, 1995; Blundell-Bond, 1998) with Windmeijer-corrected standard errors (Windmeijer, 2005) separately for each income group.

The Dumitrescu and Hurlin (2012) test allows individual causal coefficients $\beta_i^{(k)}$ to differ across units i in the linear model $y_{i,t} = \alpha_i + \sum_k \gamma_i^{(k)} y_{i,t-k} + \sum_k \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t}$, testing the null of homogeneous non-causality. The Dumitrescu and Hurlin (2012) heterogeneous non-

causality test is applied to all variable pairs, allowing individual causal coefficients $\beta_i^{(k)}$ to differ across units.

Table 2: Descriptive Statistics ($N = 656$)

Variable	Mean	SD	Min	Max
FII	0.358	0.151	0.013	1.110
GDP	7.126	1.080	5.338	9.920
TRA (%)	76.67	34.27	19.10	246.0
CAP	11.285	1.414	8.631	14.95
LAB	15.37	1.537	7.778	18.49
HCI	49.38	306.2	1.011	2,391
GGI	0.405	0.228	0.078	0.957

Source: Authors' Computations.

Table 1 summarises the descriptive statistics for all variables. The FII mean of 0.358 confirms SSA operates well below the financial inclusion midpoint.

Table 3: Pairwise Correlation Test Results

Indicators	GDP	FII	TRA	CAPT	LAB	HCI	GGI
GDP	1.000						
FII	0.4866	1.000					
TRA	0.5381	0.3523	1.000				
CAPT	0.1264	0.0545	-0.2001	1.000			
LAB	-0.1480	-0.1116	-0.3843	0.7698	1.000		
HCI	-0.0693	-0.0676	-0.0582	-0.0666	-0.1055	1.000	
GGI	0.3370	0.7020	0.2695	-0.0091	-0.1724	-0.0886	1.000

Source: Authors' Computations.

The pairwise FII-GDP correlation is 0.486; the high FII-GGI correlation (0.7029) motivates the composite GGI to limit multicollinearity

The unit root diagnostics results indicate that the Pesaran (Pesaran, 2007) CADF test confirms that all seven variables are $I(1)$: e.g., FII $Z_{\text{level}} = 1.466(p = 0.929)$, $Z_{\text{diff}} = -7.441(p <$

0.001); $\text{LNGDP } Z_{\text{level}} = 3.280(p = 0.999)$, $Z_{\text{diff}} = -4.152(p < 0.001)$. Post-estimation validity is confirmed by applying the Sargan and Hansen over-identification tests, AR(2), and Wald χ^2 .

Empirical Results

System GMM Estimates

The lagged LNGDP is strongly positive throughout ($\hat{\rho} = 0.79\text{--}1.41$), validating the dynamic specification. Across the full SSA sample, $\text{FII} = 0.35^{**}(\text{SE} = 0.18)$.

Table 4: System GMM Results: Dependent Variable = LNGDP

Variable	Coefficient and Standard Errors
LNGDP	0.79*** (0.050)
FII	0.35** (0.18)
TRA	0.0019* (0.0010)
CAP	0.15*** (0.034)
LAB	-0.20*** (0.040)
HCI	-0.00082*** (0.00027)
GGI	-0.90*** (0.31)
Constant	3.01*** (0.64)
Obs.	615
Countries	41
Instruments	23
Sargan p	[0.37]
Hansen p	[0.284]
AR(2) p	[0.252]
Wald p	[0.000]

* $p < 0.10$. ** $p < 0.05$, *** $p < 0.01$, Standard errors in parentheses. Two-step System GMM, Windmeijer-corrected SEs. FII rows in bold. Sargan/Hansen H_0 : instruments valid. AR(2) H_0 : no second-order autocorrelation. Both desired not to be rejected.

Source: Author's work

Discussions

The findings in Table 4 show that current economic growth is positively and significantly impacted by the GDP per capita lag. The results show that the region's current economic growth is positively affected. To promote economic growth in Sub-Saharan African nations, policymakers must continuously enact measures to guarantee the availability of inclusive financial products at suitable times and locations and at reduced costs. It also shows that financial inclusion and economic growth in the SSA region are positively and significantly correlated. Through better accessibility and increased financial resources, greater financial inclusion in the area will improve economic prospects.

The study found a strong and favorable correlation between Sub-Saharan trade and commerce with economic growth. As shown in Table 4, this finding suggests that increased commerce and trade are linked to regional economic expansion. According to the data, capital stock and economic growth in Sub-Saharan Africa are significantly correlated. According to subsequent research, the stock market helps the region's economy grow, suggesting that strengthening capital market institutions and attracting foreign direct investment could help the area even more.

The results show a negative correlation between labor and economic growth in Sub-Saharan Africa, implying that a larger labor force is associated with slower economic growth. Reduced labor productivity and inefficiency could be the cause of this. The Sub-Saharan region's economic growth and human capital development are significantly correlated negatively, according to this study's findings. This suggests that human capital development is of inadequate quality. The results show that there is a statistically significant negative correlation between economic development and effective governance. This suggests a negative relationship between the two variables. The research by Chinoda and Kwenda (2019), which showed that institutional quality and governance significantly affect financial inclusion across African regions, differed from our study.

Causality analysis results

The Dumitrescu-Hurlin tests reveal bidirectional causality between FII and GDP for the SSA, confirming simultaneous supply-leading (FII drives growth) and demand-following (growth expands financial access) dynamics (Patrick, 1966). Financial inclusion also exhibits

bidirectional causality with capital stock accumulation, labor, and human capital, thereby positioning financial inclusion as a deeply embedded node in the SSA growth system. Two notable unidirectional outflows from FII are: FII to TRA (financial deepening enables cross-border trade capacity), and FII to GGI (financial access generates institutional accountability pressures). GDP also Granger-causes TRA and GGI unidirectionally, indicating growth subsequently creates demand for both trade integration and governance reform, as shown in Figure 4.

Causal Architecture: Full SSA Sample (Dumitrescu-Hurlin Test)

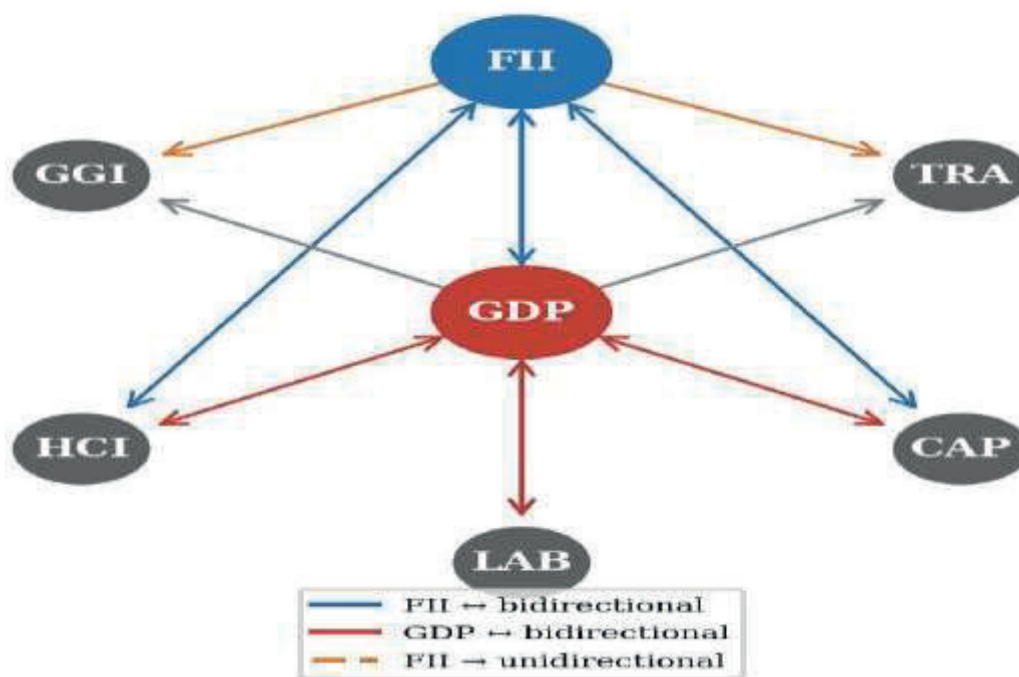


Figure 4: Dumitrescu-Hurlin causal network for the full SSA sample. Double-headed arrows denote bidirectional causality; single-headed arrows denote unidirectional causality. Central finding: FII ↔ GDP.

Conclusion

This paper provides the most comprehensive dynamic panel evidence on the financial inclusion-growth connection in SSA, combining a two-stage PCA-based FII for 41 countries over 2008-2023. The research indicates that the financial inclusion index significantly enhances economic growth in Sub-Saharan African nations. Supplementary data indicate a bi-directional causality correlation between economic development and financial inclusion. This suggests that economic progress fosters financial inclusivity; hence, governments ought to prioritize economic growth initiatives

to improve access to affordable resources and high-quality financial services and products, thereby advancing inclusive growth across the continent. The threshold amplification mechanism identified - whereby growth returns to marginal financial inclusion escalates from 0.51 to 4.46. This provides policymakers with a theoretically grounded and empirically calibrated justification for investment in income-group-targeted financial inclusion.

Future research should examine whether the adoption of fintech and mobile money introduces structural breaks in the relationship between financial inclusion and economic growth. This will amplify the coefficient and make it sensitive to financial system depth measures beyond the composite financial inclusion index.

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CHAPTER 4

BEYOND DIGITAL COOPERATIVES: A THEORETICAL FRAMEWORK FOR DAO-COOPERATIVE HYBRID GOVERNANCE IN COMMUNITY ENERGY SYSTEMS A Financial Governance Perspective

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1. Introduction

The most striking manifestation of blockchain technology's claim to transform organizational life has been decentralized autonomous organizations (DAOs). Operating through rules encoded in smart contracts, lacking a central management layer, and making decisions by member vote, these structures quickly became the bearer of a normative promise (Santana and Albareda, 2022; Wang et al., 2019): DAOs bypass intermediaries to distribute economic power to the base, functioning as 'cooperatives of the digital age.' Yet this parallelism between the DAO and the cooperative has remained at the rhetorical level; it has not been systematically tested at the level of organizational design principles. This study addresses precisely this gap and asks how cooperative principles and DAO governance can be coherently integrated into a hybrid framework, with a particular focus on energy communities.

The gap between DAOs' democratic claims and empirical reality has, in recent years, become an increasingly prominent research finding. Token-weighted voting (1-token-1-vote) mechanisms offer ostensibly open participation, but in practice, they lead to the concentration of voting power in a small minority. Empirical studies on MakerDAO have clearly documented this phenomenon, termed 'the illusion of decentralization', revealing that governance is in fact centralized and that investors face a trade-off between decentralization and performance (Sun et al., 2024). Broader analyses suggest that tradable voting rights risk producing not 'democracy' but minority rule—a form of timocracy (Barbureau et al., 2023). A quantitative analysis covering more than thirty thousand DAO communities revealed that as communities grow, they reproduce Michels's 'iron law of oligarchy', with a positive relationship between voting-power concentration and community size (Peña-Calvin et al., 2024).

These problems clearly demonstrate why cooperative movement is relevant. The International Cooperative Alliance's (ICA) principles of democratic member control, open and voluntary membership, and member economic participation are precisely the institutional responses developed against the power-concentration and participation problems that DAOs face today (ICA, 1995). The cooperative governance literature has long examined the risk of managers becoming an entrenched power center in member-based democratic organizations (Spear, 2004). Ostrom's (1990) design principles have been extensively validated empirically (Cox et al., 2010), discussed in terms of their potential to reinforce cooperative principles (Guttmann, 2021), and recently evaluated against DAO governance mechanisms (Esposito et al., 2025). However, these three literatures (cooperative theory, institutional economics, and

DAO governance) continue to advance largely in isolation from one another; a theoretical synthesis that integrates all three within a coherent design framework is lacking.

The most productive testing ground for this synthesis is energy systems. The modularity of renewable resources has paved the way for bottom-up democratic initiatives; energy cooperatives and energy communities have become concrete carriers of the ‘energy democracy’ perspective, which holds the energy transition to be not merely a technological but a socioeconomic transformation (Bauwens et al., 2016; van Veelen, 2018; Wahlund and Palm, 2022). Simultaneously, blockchain-based P2P energy trading is rapidly spreading, with smart contracts enabling intermediary-free energy exchange (Mengelkamp et al., 2018; Siano et al., 2019; Wu et al., 2022). However, this technical literature focuses predominantly on pricing, optimization, and security problems, leaving unaddressed the question of by whom and according to which principles the system will be governed. In the community energy field, the phenomenon of ‘convenience cooperatives’, in which institutional actors instrumentalize the cooperative form to capture policy tools intended for the community, demonstrates that the existence of formal democratic structures is insufficient to guarantee mission alignment (Tarhan, 2025). The goal is therefore not merely to build a technical infrastructure that decentralizes energy but also to identify the institutional design principles that make the governance of that infrastructure resistant to both oligarchic concentration and mission drift.

Within this framework, the research question that the article answers is as follows: how can cooperative principles (ICA, 1995) be integrated into DAO-based energy governance structures, and what design principles should this integration be grounded in? To answer this question, the article develops a three-layered theoretical framework: cooperative theory (first layer), Ostrom’s collective action and common-pool resources theory (second layer), and the DAO governance literature (third layer). The original contribution of this article lies in concretizing these three layers in four interrelated dimensions: the redefinition of the token not as a property share but as a nontransferable membership right; hybrid voting mechanisms that preserve the 1-member-1-vote logic instead of the 1-token-1-vote logic; the adaptation of patronage refund logic to smart contracts; and lock mechanisms that protect the social mission against financialization pressure.

Section 2 reviews the literature and identifies the hybrid structure gap; Section 3 develops the three-layered framework; Section 4 evaluates the framework against existing applications and presents policy recommendations; Section 5 concludes.

2. Literature review

This section reviews four bodies of literature; cooperative theory, DAO governance, energy democracy and community energy, and the hybrid structure gap, exposing the theoretical tensions and complementarities that ground the article's contribution.

2.1. Cooperative theory: Ownership, control, and democratic governance

The cooperative differentiates itself from other organizational forms by the manner in which ownership rights are assigned. Chaddad and Cook's (2004) ownership rights perspective addresses residual claim rights and control rights jointly, providing a typology that directly grounds the article's question of 'is the token a property share or a membership right': the debate is fundamentally about whether residual claim rights can be separated from control rights. Hansmann's transaction cost-based logic of ownership is extended by Sacchetti and Borzaga (2021) toward a multistakeholder social purpose which is the theoretical justification for the mission alignment dimension.

The central problem of cooperative governance is how democratic member control is to be maintained over time. Spear (2004) emphasized the risk of managers gradually becoming an entrenched power center, the 'degeneration thesis', and the importance of counterbalancing mechanisms. To address the problem of diluted participation in large cooperatives, Pek (2023) proposes deliberative mini-publics a concern remarkably similar to 'governance fatigue' in the DAO literature. Nevertheless, the resilience of the cooperative model draws on member-centeredness and mission-centeredness; it has been demonstrated that cooperatives can behave more resiliently than traditional firms during the COVID-19 crisis (Billiet et al., 2021). In sum, the cooperative literature offers a rich normative and institutional legacy regarding democratic governance; however, this legacy is afflicted by persistent problems such as participation erosion, capital constraints, and degeneration and has been almost entirely unrelated to algorithmic/digital governance layers.

2.2. DAO governance research: Promise, mechanisms, and the plutocracy problem

DAOs are a new organizational form operating through smart-contract-encoded governance rules (Santana and Albareda, 2022). Santana and Albareda's integrative review identifies four theoretical perspectives including 'institutions for collective action', which serves as a conceptual bridge to the Ostromian tradition. Wang et al. (2019) presented a five-layer reference architecture, whereas Faqir-Rhazoui et al. (2021) mapped the empirical landscape of the DAO ecosystem by comparing platforms such as Aragon, DAOstack, and DAOhaus. The fundamental tension in governance architecture is the trade-off between on-

chain (transparent and immutable but costly) and off-chain (flexible and low-cost but prone to centralization) models (Viario Bridi et al., 2025).

The gap between DAOs' democratic promise and empirical reality constitutes the most critical strand of this literature. Analysis of MakerDAO has documented the 'illusion of decentralization' (Sun et al., 2024); tradable voting rights produce timocracy rather than democracy (Barbereau et al., 2023); and communities grow oligarchic, reproducing Michels's iron law (Peña-Calvin et al., 2024). Concentration is persistent not only within a single protocol but also across protocols (Eisermann et al., 2025), and agent-based simulations show concentration occurs even with a 'fair' initial distribution, pointing to token tradability as a key driver (Fernandez et al., 2024) — the empirical justification for redefining the token as a nontransferable membership right. Large token holders ('whales') create a governance vulnerability as their interests can diverge from those of small holders (Han et al., 2025), and weighted decision-making structures can weaken long-term viability (Rikken et al., 2023). At the theoretical level, it has been formally proven that in a system where the token is the sole voting instrument, Sybil resistance and plutocracy resistance cannot be achieved simultaneously (Mohan et al., 2024).

Mechanism design proposals developed against these problems carry traces of a search that converges with cooperative principles. Quadratic voting aims to limit the dominance of large holders by allowing preference intensity to be expressed (Dimitri, 2022); however, it has been shown that it does not guarantee the optimal outcome under incomplete information (Benhaim et al., 2025) and is vulnerable to coalition (Tamai and Kasahara, 2024). The most meaningful convergence is reputation-based governance developed for nonprofit organizations: it has been shown that nonprofit entities need a mechanism beyond token-based equity-like voting and that reputation-based, peer-evaluation systems can fill this gap (Saito and Rose, 2023) — quite close to an algorithmic translation of the 1-member-1-vote logic. The absence of a design framework that systematically bridges these two bodies of work constitutes the first gap argument of the article.

2.3. Energy democracy, community energy, and blockchain applications

The energy democracy literature focuses on the energy transition beyond a technological matter to address it as a socioeconomic transformation, centering community control over the means of production and distribution. Van Veelen (2018) showed how democratic practice in community energy is shaped by local context. Wahlund and Palm (2022) distinguish energy democracy (participatory governance, collective actors) from energy citizenship (individual

behavioral change). Bauwens et al. (2016) analysed community energy drivers through Ostrom's social-ecological system framework, revealing the collective action strategies that allow wind cooperatives to survive in hostile regulatory environments.

The most striking warning is the phenomenon of 'convenience cooperatives,' in which institutional actors capture policy tools designated for the community under the guise of a cooperative form: the existence of formal democratic structures is insufficient to guarantee genuine community rootedness and participation, limiting the energy democracy potential (Tarhan, 2025). This finding directly explains why the mission alignment lock is a necessary design dimension.

In contrast to this normative richness, the blockchain-based energy literature is predominantly technical in character. The establishment of local energy markets on private blockchain (Mengelkamp et al., 2018), the application of distributed ledger technology to peer-to-peer energy exchange (Siano et al., 2019), and P2P trading with dynamic pricing via smart contracts (Song et al., 2021) constitute the main axes of this literature. While these studies analyse pricing, optimization, and security problems, they largely leave governance unaddressed. Exceptions exist. Todorean et al. (2023), Umar et al. (2024), and Montakhabi et al. (2023) approach governance yet none use cooperative principles or Ostrom design principles as a systematic source of institutional design. The energy democracy literature demands governance but leaves its design vague; the blockchain energy literature builds infrastructure but does not theorize governance a gap that directly motivates this article's choice of application domain.

2.4. The hybrid structure gap: Converging but not meeting

The three bodies of literature converge in fragments. Platform cooperativism combines the cooperative with the digital economy. Schneider (2018) and Nicoli and Paltrinieri (2019) develop democratic ownership models. Though a systematic review revealed that the platform cooperativism literature has not been sufficiently related to the governance theory of cooperative firms (Ghirlanda and Kirov, 2024). The critical analysis of the risk of platform cooperativism losing its original mission under financialization and co-optation pressure (Sandoval, 2020) feeds the mission alignment dimension of the article. This literature rarely addresses blockchain-based algorithmic governance as a design object.

The second convergence is between the commons and DAO literatures. Guttmann (2021) showed how Ostrom's design principles reinforce ICA cooperative principles. Esposito et al. (2025) evaluated DAOs through an Ostromian lens, and Linåker and Runeson (2022)

noted that digital commons require adaptation of the framework. While this strand brings Ostrom into dialogue with DAOs, it does not systematically mobilize cooperative theory. In particular, the ICA principles and concrete cooperative mechanisms such as patronage refunds, as a design source. The legal recognition literature documents the risk of unlimited liability arising from the classification of DAOs as partnerships and the fragmented responses of frameworks such as Wyoming and MiCA (Borgogno and Martino, 2024; Cheng, 2025; Grant et al., 2024; Guillaume, 2024), making visible the legal ground necessary for the institutionalization of the hybrid model.

When these three concepts are assessed together, a clear gap emerges: to the best of our knowledge, few studies have integrated cooperative theory, Ostrom's collective action theory, and DAO governance research within a single coherent design framework along the dimensions of membership, vote weighting, income distribution, and mission alignment and this integration has not yet been realized in a form specific to the community energy field. The three-layered framework and four-dimensional hybrid model developed in this article aim to fill this intersectional gap.

2.5. Tokenization and financial governance

Underlying all three streams is a common financial object read only obliquely so far: the governance token. In the decentralized finance (DeFi) literature the token is theorized first as a financial instrument, a tradable asset whose value derives from network adoption and from claims on platform cash flows, rather than as a neutral coordination device (Cong et al., 2021; Schär, 2021). This reframes the plutocracy problem as a problem of financial governance: when one instrument is simultaneously an investment asset and a vote, control rights become priced and tradable, so capital concentration converts directly into governance concentration. Evidence on token sales reinforces the point, showing that liquidity and exchange listing shape who holds and exercises token-based claims (Howell et al., 2020). Two design implications follow. First, the utility-versus-security distinction from financial regulation maps onto the cooperative question of whether the token conveys a residual claim, a control right, or both, separating them is itself a financial-governance choice. Second, patronage-based surplus distribution and asset locks can be read as a financial-governance architecture that severs the cash-flow right from the control right and constrains the financialization of membership. The hybrid framework developed below is, in this sense, a financial-governance corrective: it preserves the token's technical and financial functions while denying capital the power to purchase constitutional control.

3. Theoretical framework

This section develops the article's original contribution in three steps. First, it sets out the operational logic of the three-layered framework (the 'translation' principle between layers); then, it presents the typology of design principles derived from these layers; and finally, it concretizes this typology in a four-dimensional hybrid governance model, summarizing the model in a diagram (Figure 1).

3.1. The logic of the three-layered framework: Discipline from purpose to code

The central claim of the proposed framework is as follows: arguably, the three layers must operate within a hierarchical disciplinary relationship. The first layer, cooperative theory, provides the normative purposes that determine what the organization serves and who controls it: the ICA's principles of democratic member control, open and voluntary membership, and member economic participation; Birchall's (2012) ownership–control–benefit triad; and the logic of ownership developed by Hansmann, extended by Sacchetti and Borzaga (2021) toward a multistakeholder social purpose. This layer defines the organization's telos and membership logic but does not specify how this telos is to be transformed into governable rules. The second layer, Ostrom's collective action and common-pool resources theory, precisely provides the institutional grammar that performs this translation. Ostrom's (1990) design principles translate abstract cooperative purposes into operational institutional arrangements (Cox et al., 2010). Within this framework, two principles are particularly prominent: the principle of rules adapted to local conditions requires that governance rules be adapted to the community's actual production–consumption patterns, and the principle of the collective choice arena makes compulsory the institutionalized venues in which members themselves can modify the rules. Both principles are directly mappable onto the DAO's technical design.

The third layer, DAO governance, provides the technical possibilities and constraints that transform theory into code: smart contracts, the on-chain/off-chain governance mix, and token mechanisms. When designed naively, this layer also harbors pathologies that systematically undermine the purposes of the upper layers: plutocracy (Sun et al., 2024; Barbereau et al., 2023), the whale agency problem (Han et al., 2025), concentration inherent in tradability (Fernandez et al., 2024), and governance fatigue are among the foremost of these. The dominant failure mode of existing DAOs is that design is driven upwards from this layer: tradable tokens and token-weighted voting, as technical possibilities, become the dominant force determining purposes, and the result inevitably arrives at plutocracy. The proposed framework reverses this flow: cooperative purposes (first layer) and Ostrom grammar (second

layer) are the design sources that discipline technical choices (third layer); DAO mechanisms are the instruments chosen to serve these purposes, not their own purposes. The logic of ‘discipline from purpose to code’ constitutes the methodological backbone of the framework and operates again in each of the four design dimensions.

3.2. Design principles typology

The operationalization of the framework requires a mapping typology that specifies, for each Ostrom design principle, its resonance with a cooperative principle and the DAO mechanism that will put it into practice. Table 1 summarizes this mapping. The meta-principle underlying the typology is hybridity itself: which rules are to be kept on-chain (immutable, automatically enforced) and which off-chain (deliberative, flexible) is a design choice (Viaro Bridi et al., 2025). The framework recommends that constitutional and mission-related rules be fixed on-chain (thus protecting them against capture), whereas operational and technical decisions are left to off-chain deliberation; this distinction both alleviates governance fatigue and follows Ostrom’s intuition of graduated, nested governance.

Table 1. Typology of three-layered design principles

Ostrom design principle (Layer 2)	Relevant cooperative principle (Layer 1)	DAO mechanism (Layer 3)
Clearly defined boundaries	Open and voluntary membership	Nontransferable membership identity (membership token/NFT)
Rules adapted to local conditions	Member economic participation	Patronage-based smart contract distribution
Collective choice arena	Democratic member control	Two-tier voting (1-member-1-vote + weighted)
Monitoring	Member control	On-chain transparent transaction record, meter data
Graduated sanctions	Autonomy and independence	Automated rule enforcement, reputation downgrade
Conflict resolution	Education and cooperation	Off-chain deliberation + blockchain arbitration
Recognition of the right to organize	Concern for community	Legal wrapper, cooperative legal personality
Nested structures	Cooperation among cooperatives	Federated/multi-DAO architecture

This typology provides the institutional grammar of the four-dimensional model developed in the subsequent sections of the article; each design dimension concretizes one or several of the principle-mechanism mappings in the table.

3.3. The four-dimensional hybrid model

The original contribution of the framework is to concretize the above typology in four interrelated design dimensions. These dimensions have been selected to correspond exactly to the failure points of existing DAOs.

The first dimension is the membership structure: the token is redefined not as a property share but as a nontransferable membership right. This proposal derives directly from the empirical finding that concentration is inherent in the tradability of the token (Fernandez et al., 2024): if the problem originates from transferability, it can be argued that the solution must be sought in nontransferability. Here, Chaddad and Cook's (2004) distinction between residual claim rights and control rights takes on a decisive function; the membership token carries control rights but does not trade on the open market. Voting power therefore cannot be purchased through capital accumulation. Reputation-based membership architectures developed for nonprofit organizations (Saito and Rose, 2023) serve to demonstrate the technical feasibility of this dimension.

The second dimension is vote weighting, which is a two-tier hybrid mechanism that preserves the 1-member-1-vote logic instead of the 1-token-1-vote logic. Since it has been proven that token-weighted voting leads to plutocracy and that Sybil resistance and plutocracy resistance cannot be achieved simultaneously when the token is the sole instrument (Mohan et al., 2024; Sun et al., 2024), voting design must be differentiated by decision type. Constitutional and strategic decisions (missions, profit distribution rules, and membership criteria) are subjected strictly to the 1-member-1-vote principle; this is the essence of the ICA's democratic member control. Operational and technical decisions may be opened to limited contribution- or reputation-based weighting, since in these decisions, expertise and continuity enhance efficiency. This distinction also aligns with findings on MakerDAO: voting on strategic decisions may positively affect operational performance, whereas voting on operational decisions may affect it negatively (Zhao et al., 2022). Quadratic and reputation-based mechanisms can be instrumentally used at the operational layer; however, given their vulnerability to coalition (Tamai and Kasahara, 2024), they should be positioned alongside rather than in place of the constitutional layer.

The third dimension is income distribution: the adaptation of cooperative patronage refund logic to smart contracts as a tokenized surplus-distribution (dividend) mechanism. In the traditional cooperative, the surplus is distributed not according to capital share but rather according to the volume of transactions a member conducts with the organization (patronage); financially, this severs the cash-flow right from capital ownership. In the community energy

context, this means that the smart contract automatically distributes revenue surplus in proportion not to token holdings but to the amount of energy the member has contributed to or consumed from the grid. This mechanism is technically feasible: on-chain meter data and dynamic pricing infrastructure already exist (Song et al., 2021; Umar et al., 2024). Patronage-based distribution combines the ICA's member economic participation principle with Ostrom's principle of rules adapted to local conditions and erects a structural barrier against financialization pressure: revenue rewards actual use rather than speculative capital accumulation.

The fourth dimension is mission alignment: lock mechanisms that protect the social mission against financialization pressure. This dimension is a direct response to both the phenomenon of 'convenience cooperatives' (Tarhan, 2025) and the co-optation risk of platform cooperatives (Sandoval, 2020) and is also justified by the finding that weighted voting and equity-like incentives weaken viability (Rikken et al., 2023). The proposed lock mechanisms are three-layered: an asset lock, functioning as a corporate-finance safeguard against hostile financialization, prevents the transfer of revenue surplus outside the membership or the sale of the organization at the smart contract level; a purpose clause requires a qualified majority and multistakeholder approval to change the mission (Sacchetti and Borzaga, 2021); and a recognition clause guarantees the representation of energy-poor and vulnerable members, embedding the recognition dimension of energy justice (Hanke et al., 2021) into governance. Together with Ostrom's principles of recognition of the right to organize and nested structures, these mechanisms protect the mission against both external capture and internal drift.

3.4. The model's schema and integrated logic

Figure 1 summarizes how the three layers discipline the four design dimensions from top to bottom. The integrated logic of the model is as follows: cooperative purposes and Ostrom grammar constrain and direct the DAO's technical possibilities (without rejecting them) so that they serve specific purposes. In this way, the DAO's technical advantages (transparency, disintermediation, automatic execution) are preserved, whereas the cooperative movement's democratic legacy provides the institutional brakes that prevent these advantages from turning into plutocracy. The next section tests this model in light of existing application examples.

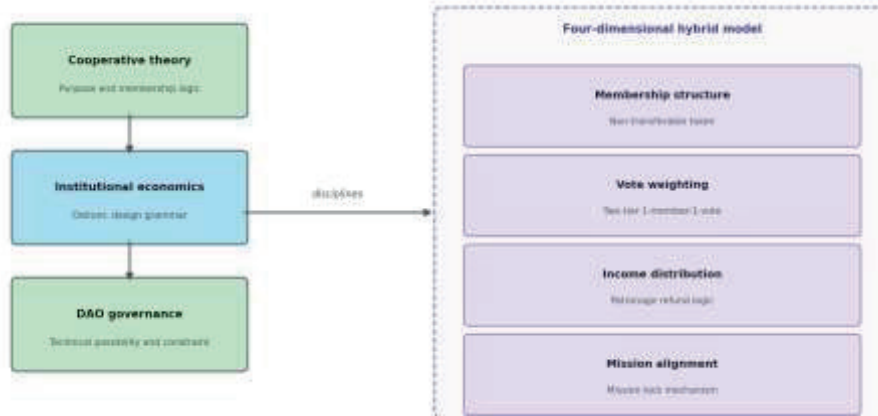


Figure 1. Three-layered framework and four-dimensional hybrid model.

Source: own elaboration.

4. Discussion

This section evaluates the developed four-dimensional hybrid model in three steps: first, it tests the model in light of existing blockchain-based energy applications; second, it discusses the limitations of the framework; and finally, it develops policy recommendations for regulators and practitioners.

4.1. Evaluation of the model in light of the application examples

A systematic map of blockchain-based energy initiatives shows that the field is expanding rapidly but has remained predominantly at a technical level of maturity. Andoni et al.'s (2019) comprehensive review, covering 140 research projects and initiatives, reveals that the large majority of blockchain applications in the energy sector focus on peer-to-peer trading, decentralized marketplaces, and microgrid transactions and that democratization of governance is rarely at the center of the design. This pattern reveals why the four-dimensional model is necessary as a corrective design agenda. The three cases examined below were selected as illustrative of the two dominant patterns identified in this review: private-blockchain local energy marketplaces (Brooklyn Microgrid) and platforms financed and operated by their own tradable tokens (Power Ledger, SunContract).

The Brooklyn Microgrid is the pioneering example of this technical maturity: it establishes an intermediary-free, transparent local energy market that enables neighbor-to-neighbor renewable energy exchange at the local level via a private blockchain (Mengelkamp et al., 2018; Zia et al., 2020). However, in this initiative, ‘governance’ has essentially been reduced to a market-clearing logic; it does not function as a collective decision arena in which members democratically determine the organization’s constitutional rules. Accordingly, the Brooklyn Microgrid powerfully realizes the technical P2P layer from the perspective of the

model while systematically incorporating none of the four governance dimensions. Power Ledger and SunContract represent a second pattern: marketplaces financed and operated by their own tradable tokens (Andoni et al., 2019). In this model, the token is designed as an asset carrying platform access and value rather than a membership right, which constitutes a critical problem in view of the empirical findings that concentration is inherent in token tradability (Fernandez et al., 2024) and the financialization pressure argument (Sandoval, 2020). These platforms operate with institutional or platform-centric governance; democratic member control and patronage-based income distribution are not part of the design.

Table 2 maps the two patterns against the model's technical layer and its four governance dimensions, making explicit where each application realizes and where it fails the proposed design.

Table 2. The four-dimensional model evaluated against existing blockchain-based energy applications

Model layer / dimension	Brooklyn Microgrid (private-blockchain marketplace)	Power Ledger & SunContract (tradable-token platforms)
Technical P2P layer (Layer 3)	Realized: intermediary-free, transparent local energy market for neighbor-to-neighbor exchange.	Realized: token-financed P2P marketplaces with platform-wide trading.
D1 – Membership (nontransferable membership right)	Absent: participation organized as market access, not as a defined membership right.	Absent: token designed as a tradable asset carrying access and value, exposing the structure to concentration.
D2 – Vote weighting (1-member-1-vote)	Absent: governance reduced to market-clearing logic; no collective decision arena over constitutional rules.	Absent: institutional/platform-centric governance; democratic member control not part of the design.
D3 – Income distribution (patronage-based)	Absent: surplus follows market transactions, not patronage proportional to energy contributed/consumed.	Absent: returns accrue to token value/holding, rewarding speculative capital rather than actual use.
D4 – Mission alignment (lock mechanisms)	Absent: no asset lock, purpose clause or recognition clause embedded in the design.	Absent: exposed to financialization pressure; no safeguard against mission drift or capture.
Overall governance character	Technically strong, governance-thin: a market without a cooperative constitution.	Technically strong, prone to plutocracy: tradable tokens reproduce financialization patterns.

Source: own elaboration based on Mengelkamp et al. (2018), Andoni et al. (2019), Zia et al. (2020), and the model developed in Section 3.

This comparison yields two conclusions. First, existing applications have largely fulfilled the technical promise of decentralized energy; the third layer of the proposed model is therefore technically feasible. Second, and more critically, these applications have almost

entirely failed to fulfil the governance promise in a cooperative sense; in contrast, through tradable tokens and market-centered structures, they have tended to reproduce the plutocratic and financialization patterns that the model aims to prevent. This is consistent with the article's central argument: the problem is not the absence of a technical infrastructure but the absence of an institutional design that disciplines infrastructure with cooperative purposes and Ostrom grammar. The four-dimensional model proposes a concrete design template that fills this gap; for example, the nontransferable membership token (first dimension) structurally prevents Power Ledger-type financialization, whereas patronage-based distribution (third dimension) and the mission lock (fourth dimension) can add a democratic and equitable institutional framework to Brooklyn Microgrid's market logic.

4.2. Limitations

The limitations of the study must be explicitly stated. First and most fundamentally, this is a conceptual-theoretical article; the proposed model has not yet been empirically tested. The viability of the model can be validated only through pilot applications and longitudinal field studies; the DAO governance literature emphasizes that the effects of organizational purposes, distribution infrastructure, and user type on viability need to be examined in future research (Rikken et al., 2023). Second, technical constraints cannot be ignored: the transaction costs and scalability limits of on-chain governance and the dependence of patronage-based distribution on reliable meter data and oracle reliability condition the applicability of the model (Umar et al., 2024). Third, regulatory uncertainty continues to be a critical obstacle: the legal status of DAOs has not been clarified in most jurisdictions, and 'unwrapped' DAOs risk being classified as partnerships and bearing unlimited liability for their members (Borgogno and Martino, 2024; Cheng, 2025). The proposed hybrid structure's need for a legal wrapper, preferably a cooperative legal personality, is therefore indispensable.

The fourth and theoretically most significant limitation is that the model harbors an internal tension. The nontransferable membership token reduces the plutocracy risk by preventing the purchase of voting power; however, it simultaneously reproduces in digital form the classical capital acquisition constraint of cooperatives (Birchall, 2012). The model cannot fully eliminate this tension; it can render it manageable only by separating the residual claim right (patronage refund) from the control right (membership vote). Fifth, a structure requiring blockchain and crypto literacy may, in practice, exclude the vulnerable and energy-poor members it aims to include (Hanke et al., 2021); recognition clauses aim to mitigate this risk, but the digital divide is a real obstacle. Finally, as both the Ostrom tradition and the energy

democracy literature warn, the model is not a universal prescription but a design grammar that must be adapted to local conditions (van Veelen, 2018).

4.3. Policy recommendations

These limitations point to four policy recommendations. First, in the area of legal recognition, regulators should develop legal wrappers embedded in cooperative law for energy DAOs. The Wyoming model recognizes the DAO as a special form of limited liability company (Cheng, 2025; Grant et al., 2024) and offers a starting point, but the more appropriate form for the proposed structure is digital cooperative statutes that recognize the 1-member-1-vote principle and nontransferable membership; the EU's renewable energy community (REC) framework can be extended to include such recognition. Second, as a direct response to the 'convenience cooperatives' problem (Tarhan, 2025), energy regulators should incorporate community rootedness and mission lock criteria into the qualification conditions for access to incentives and support designated for the community. Third, in the area of standard setting, interoperable and auditable smart contract templates encoding patronage-based distributions and asset locks should be encouraged. Fourth, each application should be designed together with digital literacy programs and energy poverty provisions; recognition justice should be embedded in governance (McCauley and Heffron, 2018; McCauley et al., 2019).

These recommendations also point to the future research agenda. The priority is to establish a pilot community energy initiative with hybrid governance and to test its viability compared with that of its token-weighted counterparts. The framework further opens a research agenda at the intersection of cooperative finance and decentralized financial governance, particularly in the design of tokenized surplus-distribution mechanisms and in the empirical pricing of the separation between cash-flow and control rights. Such an empirical program would both test the validity of the proposed model and mature the theoretical synthesis between cooperative theory, institutional economics, and DAO governance in field reality.

5. Conclusion

This article sets out from the gap between blockchain's most ambitious organizational promise, 'DAOs are digital cooperatives', and the empirical reality of that promise. It was demonstrated that token-based governance, despite its claim to democratize, concentrates voting power in a small minority and that this structural tendency, documented through phenomena such as the 'illusion of decentralization,' timocracy, and the iron law of oligarchy, is inherent in the tradable token itself. Against this background, the cooperative movement has developed more than one hundred and seventy years of institutional legacy precisely against

these problems of power concentration and participation, yet this legacy has almost entirely failed to encounter algorithmic governance. The article brings these two traditions into dialogue on the terrain of energy systems, answering the following questions: how can cooperative principles be integrated into DAO-based energy governance structures, and what design principles should this integration be grounded in?

The answer given is a three-layered theoretical framework and a four-dimensional hybrid model derived from it. The original logic of the framework is that the layers operate within a hierarchical disciplinary relationship (from purpose to code): the first layer, cooperative theory, determines the organization's telos; the second layer, Ostrom's collective action theory, translates this telos into operational design principles; and the third layer, DAO governance, provides the technical possibilities that cast these principles into code. The dominant failure of existing DAOs is that design is driven upwards from technical possibilities, inevitably arriving at plutocracy; the proposed framework reverses this flow, making cooperative purposes and Ostrom grammar the dominant design source. This logic is concretized in four interrelated dimensions: the redefinition of the token as a nontransferable membership right; two-tier voting that preserves the 1-member-1-vote principle in constitutional decisions and is open to limited weighting in operational decisions; the adaptation of patronage refund logic to smart contracts; and the mission lock mechanisms consisting of asset lock, purpose clause, and recognition clause.

The theoretical contribution of this framework is multifaceted. The DAO literature offers an integrated response to the plutocracy problem grounded in the cooperative institutional legacy, going beyond point-solution patches of mechanism design; the vulnerability of point solutions such as quadratic voting indicates that the problem lies not only in the voting formula but also in the ownership structure itself. Cooperative theory gains a digital-algorithmic application horizon and codes institutional brakes against participation erosion. Institutional economics is offered the opportunity to extend Ostrom's design principles to a hybrid commons that combines physical and digital dimensions. Platform cooperativism is, through this study, carried beyond Web2 ownership debates into the domain of blockchain governance and energy applications. The core contribution of this study is not to advance these four literatures separately but rather to cross them in a coherent single design framework specific to community energy.

At the practical level, the model offers both a concrete design template for practitioners and a policy agenda for regulators. The evaluation of existing blockchain-based energy applications has shown that they largely fulfil the technical promise of decentralized energy but

do not fulfil the governance promise in a cooperative sense; in contrast, they reproduce financialization patterns. The proposed policy measures (legal wrappers embedded in cooperative law for energy DAOs, qualification criteria preventing ‘convenience cooperatives,’ auditable smart contract standards encoding patronage and asset lock, and digital inclusion provisions) are indispensable complements for the model to operate in the real world.

The limitations of the study also define future research agendas. This is a conceptual article; the viability of the model can be validated only through pilot applications and comparative field studies with token-weighted counterparts. The model also harbors an internal tension: nontransferable membership reduces the plutocracy risk while digitally reproducing the classical capital acquisition constraint of cooperatives; the solution is not to eliminate this tension but to render it manageable by separating the residual claim right from the control right. The risk that a structure requiring crypto-literacy excludes the vulnerable members it aims to include is real, and recognition clauses can mitigate this risk only. As both the Ostrom tradition and the energy democracy literature warn, the model is not a universal prescription but a design grammar that must be adapted to local conditions.

Ultimately, whether blockchain-based energy systems become a democratizing force or a new financialized intermediary will be determined not by the technology itself but by the design of the governance architecture. For this choice, the most tested institutional grammar is provided by the cooperative tradition, which learned to operate democratic collective ownership long before the digital age. The hybrid framework developed in this article is a first step toward bringing that tradition into dialogue with the possibilities of the algorithmic age.

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CHAPTER 5

ARTIFICIAL INTELLIGENCE AND IFRS SUSTAINABILITY DISCLOSURE STANDARDS: A TEXT ANALYSIS OF OPEN ACCESS RESEARCH FROM WEB OF SCIENCE

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INTRODUCTION

The IFRS Foundation is a non-profit organization operating in the public interest, dedicated to the development of high-quality, clear, enforceable, and globally recognized accounting and sustainability disclosure standards. Under its governance framework, the International Accounting Standards Board (IASB) is responsible for issuing accounting standards, whereas the International Sustainability Standards Board (ISSB) is charged with establishing standards for sustainability-related disclosures.

On 3 November 2021, at the COP26 Conference held in Glasgow, the IFRS Foundation formally announced the establishment of the ISSB. This development reflects the growing integration of sustainability factors into mainstream investment decision-making processes. Feedback obtained from extensive consultations with market participants indicates an increasing demand for high-quality, consistent, and globally comparable information on companies' sustainability-related risks and opportunities.

In response to these needs, the ISSB aims to create a global baseline for sustainability disclosures and has articulated four core objectives:

- to establish a global baseline for sustainability disclosure standards;
- to address the information requirements of investors and other capital providers;
- to allow companies to disclose sustainability-related information that is comprehensive and comparable across global capital markets; and
- to support interoperability with jurisdiction-specific disclosure requirements and/or frameworks designed for a wider range of stakeholders.

To date, the ISSB has released two IFRS Sustainability Disclosure Standards: IFRS S1 – General Requirements for Disclosure of Sustainability-related Financial Information and IFRS S2 – Climate-related Disclosures. These standards constitute an important advancement in sustainability reporting by integrating decision-useful financial information with broader sustainability priorities, including the United Nations Sustainable Development Goals (SDGs).

IFRS S1 aims to ensure that entities disclose sustainability-related risks and opportunities that are relevant to the primary users of general-purpose financial reports when making resource allocation decisions. Building upon this overarching framework, IFRS S2 concentrates specifically on climate-related risks and opportunities, setting out disclosure requirements

concerning the financial implications of climate change. The linkage between the IFRS Sustainability Disclosure Standards and the United Nations Sustainable Development Goals is presented in Figure 1.

Figure 1. Sustainability Development Goals



Source: United Nation Department of Economic and Social Affairs Sustainable Development
The 17 Goals

For investors, the figures reported in a company's primary financial statements are no longer sufficient on their own. Beyond traditional financial information, investors increasingly consider firms' corporate governance structures, their commitment to environmental protection, and the social impact generated through their contributions to society. The reporting framework that consolidates these dimensions is sustainability reporting.

In parallel with these developments, sustainability indices have been established in stock exchanges worldwide, reflecting the growing relevance of non-financial performance in capital markets. Sustainability reporting encompasses Environmental, Social, and Governance (ESG) dimensions. The risks and opportunities disclosed by companies in accordance with the IFRS Sustainability Disclosure Standards contribute positively to the assessment of a firm's long-term viability, which, under accounting principles, is based on the going concern assumption. Consequently, sustainability-related disclosures provide decision-useful information that complements traditional financial reporting and supports long-term value creation.

The historical development of artificial intelligence (AI) dates back to the 1950s, beginning with the pioneering work of Alan Turing, and has since evolved through successive stages marked by increasing technological sophistication and expanding application domains.

Over time, advances in computational power, data availability, and algorithmic design have significantly broadened the scope and impact of AI technologies. The key milestones in the historical evolution of artificial intelligence can be summarized as follows:

- 1940–1956: The foundational concepts of the field began to take shape, particularly with Alan Turing’s influential 1950 paper “Computing Machinery and Intelligence,” which laid the theoretical groundwork for machine intelligence and proposed what later became known as the Turing Test.
- 1956–1970: The term artificial intelligence was formally introduced by John McCarthy at the Dartmouth Conference in 1956, marking the official birth of AI as a scientific discipline.
- 1970–1980: Progress slowed due to limited computational power, insufficient data, and underdeveloped algorithms, leading to a period commonly referred to as the “AI Winter.”
- 1980–1990: A revival occurred with the development of expert systems, which applied rule-based reasoning to domain-specific problems and renewed interest in AI research.
- 1990–2010: The emergence of machine learning marked a significant shift, with notable advances in natural language processing, computer vision, and recommender systems.
- 2010–2015: Artificial neural networks, particularly deep learning architectures, gained prominence due to improved training techniques and increased computing capabilities.
- 2016–2020: AI applications expanded rapidly, including image and speech recognition, natural language processing, chatbots, autonomous systems, self-driving vehicles, and healthcare-related applications.
- 2021–2025: AI systems, especially those based on advanced natural language processing models, have progressed beyond understanding data to generating coherent and meaningful text, images, and audio content, reflecting a new phase of generative artificial intelligence.

As indicated in the 2021–2025 period of the historical development of artificial intelligence, natural language processing (NLP) has reached an advanced level of maturity through AI-driven technologies. In particular, web-based intelligent agents process large volumes of data and provide users with insights, recommendations, and decision-support outputs. To

ensure that artificial intelligence contributes positively to humanity, its integration with sustainability principles is of critical importance.

Sustainability is not only relevant for institutions and organizations but also for individuals, societies, and other living beings. Accordingly, this study analyzes academic articles that jointly address sustainability standards and artificial intelligence, with the aim of identifying emerging trends, research directions, and intersections between these two domains.

MATERIALS AND METHODS

The purpose of this study is to examine academic research that integrates the International Financial Reporting Standards Sustainability Disclosure Standards (IFRS Sustainability Standards) and artificial intelligence using a text analysis approach. For the purpose of text analysis, Voyant Tools, a web-based application, was selected. According to its official website, Voyant Tools is designed “to perform analyses such as word frequency and word relationships in academic studies, research projects, or large textual datasets. It examines texts using a ‘distant reading’ technique and provides visualizations in the form of graphs, lists, and word clouds.”

Text analysis represents one of the many applications of Natural Language Processing (NLP) (Chen et al., 2025). Within the scope of the study, a search was conducted in the Web of Science database using the keywords “IFRS Sustainability Disclosure Standards artificial intelligence.” The search yielded a total of 101 documents, which constitute the research population. When the search was refined to include only open-access articles, 49 articles were identified (Appendix 1), forming the research sample.

All 49 articles included in the sample were subjected to text analysis, and the findings derived from this analysis are presented in the results section. One article could not be accessed in full, which constitutes a limitation of the study.

RESULTS

In this study, the primary findings include the research field, year of publication, number of authors, the most prolific institutions, the study with the highest number of references, publication language, and the countries of researchers contributing to this field. Of the articles included in the research sample, 48 were published in English and one was written in Portuguese. Table 1 presents information on the publication years of the analyzed articles.

Table 1. Publication Years of Article

Publication Years	Article
2014	1
2018	1
2021	6
2022	11
2023	7
2024	7
2025	16

It is noteworthy that studies jointly examining the IFRS Sustainability Disclosure Standards and artificial intelligence were published most frequently in 2025. The table also indicates that no publications were recorded in certain years. Overall, the trend in publication years does not exhibit a consistent increase or decrease; rather, it displays irregular fluctuations over time.

Table 2. Web of Science Categories of Article

Area	Article
Business Finance	12
Business	8
Environmental Studies	8
Environmental Sciences	11
Green Sustainable Science	7
Technology	
Management	7
Law	16
The others*	1

Table 2 presents the distribution of studies examining the IFRS Sustainability Disclosure Standards and artificial intelligence according to Web of Science categories. As shown in the table, the highest number of publications falls within the fields of Law, Business Finance, and Environmental Sciences, respectively. The category labeled “Others” is not further disaggregated, as it represents areas with only a single article; therefore, it is reported collectively as one for representational purposes.

Table 3. Country/Region of Researchers

Country	Researchers
USA	13
Peoples Republic of China	7
Spain	5
Australia	4
England	4
Malaysia	4
Saudi Arabia	3
South Korea	3
Taiwan	3
Finland	2
Netherlands	2
Germany	2
Norway	2
Poland	2
Singapore	2
The Others*	1

Table 3 presents the country-based distribution of scholars contributing to the field. The results show that the majority of contributions originate from the United States, followed by the People's Republic of China. The category "Others" is used to collectively represent countries with only one contributing scholar.

Table 4. Journals

Journal	Article	Journal	Article
International Journal Of Accounting Information Systems	1	Accounting Horizons	1
International Journal Of Computational Intelligence And Applications	1	A1 & Society	1
International Journal Of Computational Intelligence And Applications	2	Amazonia Investiga	1
International Journal Of Technology	1	Asian Journal Of Law And Economics	1
International Review Of Financial Analysis	1	Big Data & Society	1
Journal Of Accounting Research	1	Business Ethics The Environment & Responsibility	1
Journal Of Corporate Accounting And Finance	1	Business Strategy And The Environment	1
Journal Of Innovation & Knowledge	1	Business Systems Research Journal	1
Journal Of International Financial Management & Accounting	1	Cambridge Law Journal	1
Journal Of Strategic Information Systems	1	Corporate Social Responsibility And Environmental Management	1
Journal Of Sustainable Finance & Investment	1	Data & Policy	1
Management Systems In Production Engineering	1	Data In Brief	1
Navus-Revista De Gestao E Tecnologia	1	Electronics	1
Revista De Contabilidad-Spanish Accounting Review	1	Energies	1
Scientific Data	1	European Business Organization Law Review	2
Society	1	Finance Research Letters	1
Studia Prawnicze Kul	1	Frontiers In Artificial Intelligence	1
Sustainability	5	Gaia-Ecological Perspectives For Science And Society	1
Sustainable Development	1	Human Resource Development Review	1

Sustainable Futures	1	Humanities & Social	1
		Sciences Communications	
Systems	1	Information	1
		Intelligent Systems In	1
		Accounting Finance &	
		Management	

Articles in the relevant field have been published across 43 different journals. Among these, Sustainability is the journal with the highest number of publications on this topic.

Table 5. Publishers

Publishers	Article
MDPI	11
Wiley	8
Elsevier	7
Springer Nature	5
Cambridge Univ. Press	2
Sage	2
Sciendo	2
The Others*	11

Table 5 presents the list of publishers that have published in the relevant field. An examination of the table reveals that MDPI is the publisher with the highest number of publications in this area. The category labeled “Others” includes publishers with a single publication each, with a total of 11 publications represented in this group.

Table 6. Authors Information

Number of Authors	
1 Author	11
2 Author	10
3 Author	14
4 Author	6
5 Author	5
6 Author	1
7 Author	1
8 Author	1

As shown in Table 5, publications in the relevant field are predominantly authored by three authors. It can be stated that co-authored studies exceed single-authored publications by 55%. The presence of a study with as many as eight authors is also a noteworthy feature highlighted in the table.

The number of studies associated with the United Nations Sustainable Development Goals is as follows: 25 articles address Industry, Innovation and Infrastructure; 2 articles focus on Decent Work and Economic Growth; and 1 article each relates to No Poverty, Good Health

and Well-Being, Peace, Justice and Strong Institutions, and Partnerships for the Goals. It can be stated that studies aligned with the Industry, Innovation and Infra-structure goal are predominant.

Within the scope of the research, the keywords and abstracts of 49 articles were analyzed using Voyant Tools, a web-based text analysis software. The keyword cloud generated by the software is presented in the study as Figure 2.

Figure 2: Keywords Clouds



The results of the keyword analysis produced the following output values: a vocabulary density of 0.443, a readability index of 28.713, and an average of 72.9 words per sentence. The most frequently used terms, as illustrated in the figure and confirmed by the software output, are intelligence, artificial, corporate, AI, and ESG.

In addition, the word cloud derived from the abstracts was analyzed using the same software. The abstract-based word cloud generated by the program is presented in the study as Figure 2.

The Voyant Trends analysis reveals a structured thematic progression throughout the texts. While concepts related to ESG and intelligence are emphasized in the introductory sections, AI-related terms peak in the core analytical sections. This is followed by an increased focus on corporate-level implications in the concluding sections.

Figure 3. Abstract Text Clouds



Figure 3. shown result of the analysis of words appearing in the abstracts, the soft-ware output yielded the following values: a vocabulary density of 0.253, a readability in-dex of 19.803, and an average of 25.6 words per sentence. The most frequently used terms, as illustrated in the figure and identified by the program output, include AI, sustainability, ESG, disclosure, and corporate.

CONCLUSIONS

Based on the findings obtained in line with the aim of the study, it is observed that researchers examining the IFRS Sustainability Disclosure Standards in conjunction with artificial intelligence predominantly prefer English as the language of publication. The publisher and journal with the highest number of publications in this field are MDPI and Sustainability, respectively. However, it was also identified that studies on this topic have been published across 43 different journals beyond Sustainability, indicating that the subject possesses sufficient breadth and relevance to be addressed in a wide range of academic outlets.

With respect to geographical distribution, it can be stated that a substantial proportion of the contributing researchers are affiliated with institutions in the United States. An examination of publication years reveals that the highest number of publications occurred in 2025 and 2022. In contrast, no publications were identified for certain years, and no clear increasing or decreasing trend can be observed over time. Overall, the temporal distribution of publications reflects an irregular pattern.

The findings further indicate that studies in this field are predominantly co-authored, with publications involving two or three authors being particularly common. When categorized by research area, the publications are mainly classified under Law, Business Finance, and Environmental Sciences.

In terms of alignment with the United Nations Sustainable Development Goals (SDGs), the analyzed publications contribute to six distinct goals. Among these, Industry, Innovation and Infrastructure emerges as the most strongly associated goal. This strong association is largely attributed to the focus of the analyzed studies on artificial intelligence, which has become an integral component of contemporary industrial systems and infrastructural development across sectors. This alignment further enhances the scientific value and practical relevance of the publications.

An examination of the keyword and abstract-based word clouds reveals that the most frequently used terms include intelligence, artificial, corporate, AI, ESG, sustainability, and disclosure. The textual analysis of the abstracts demonstrates a consistent and structured linguistic profile aligned with sustainability-oriented academic research. The vocabulary density value of 0.253 indicates a moderate level of lexical diversity, suggesting that core concepts are systematically reiterated to strengthen conceptual clarity without excessive redundancy. The readability index of 19.803 reflects an advanced academic writing level, which is appropriate for an interdisciplinary field that integrates complex theoretical and technical frameworks. Additionally, the average sentence length of 25.6 words points to information-dense sentence constructions commonly observed in analytical and review-based studies. Frequency analysis further highlights that the most recurrent terms—AI, sustainability, ESG, disclosure, and corporate—underscore the dominant thematic focus of the literature on artificial intelligence in sustainability practices, ESG reporting, and corporate disclosure.

The keyword-based textual analysis similarly reveals a highly concentrated and concept-driven linguistic structure. A vocabulary density value of 0.443 reflects relatively high lexical diversity, indicating that the keywords encompass a broad range of conceptually distinct terms rather than repetitive expressions. The readability index of 28.713 points to a markedly advanced level of textual complexity, which is expected in keyword datasets composed primarily of compound terms and multi-word technical expressions. Consistent with this observation, the average of 72.9 words per sentence highlights the presence of extended keyword strings and combined conceptual phrases rather than conventional sentence structures. The most frequently occurring terms—intelligence, artificial, corporate, AI, and

ESG—further confirm the central thematic orientation of the literature toward artificial intelligence applications within corporate sustainability and ESG-related contexts.

Overall, the findings demonstrate strong thematic coherence and methodological consistency across the analyzed publications. In this regard, the present study serves as a valuable reference source for future research integrating artificial intelligence, sustainability reporting, and ESG frameworks. This study contributes to the literature by systematically examining the emerging intersection of artificial intelligence and the IFRS Sustainability Disclosure Standards through bibliometric and text-mining analyses, thereby enhancing the theoretical understanding of AI-driven sustainability reporting within an IFRS-based framework. From a policy and standard-setting perspective, the findings provide empirical insights that may support regulators and standard developers, particularly the IFRS Foundation and the ISSB, in considering the role of artificial intelligence in the future development and implementation of sustainability disclosure standards. Furthermore, the study offers a structured foundation for future research by identifying key thematic trends and research gaps, encouraging further empirical and interdisciplinary investigations at the intersection of artificial intelligence, sustainability reporting, and ESG practices.

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APPENDIX A

No	Author(s)	Article Title	Years	No	Author(s)	Article Title	Years
1	Alshareef, MN	Artificial Intelligence-Enhanced Environmental, Social, and Governance Disclosure Quality and Financial Performance Nexus in Saudi Listed Companies Under Vision 2030	2025	26	Shiyyab, FS; Alzoubi, AB; Obidat, QM; Alshurafat, H	The Impact of Artificial Intelligence Disclosure on Financial Performance	2023
2	Bogdan, V; Hategan, CD; Török, RM; Blidisel, RG; Popa, DN; Pitorac, RI	Driving Sustainable Value. The Dynamic Interplay Between Artificial Intelligence Disclosure, Financial Reporting Quality, and ESG Scores	2025	27	Kunkel, S; Schmelzle, F; Niehoff, S; Beier, G	More sustainable artificial intelligence systems through stakeholder involvement?	2023
3	Mustafa, F; Smolarski, J; Elamer, AA	The Convergence of Artificial Intelligence and Sustainability Reporting: A Systematic Review of Applications, Challenges and Future Directions	2025	28	Tian, JF; Cheng, Q; Xue, R; Han, YL; Shan, YL	A dataset on corporate sustainability disclosure	2023
4	Gandía, JAG; Ancillo, AD; Núñez, MTD	The Role of Artificial Intelligence and Knowledge in Enhancing Corporate Sustainability	2025	29	Raghupathi, W; Wu, SJ; Raghupathi, V	Understanding Corporate Sustainability Disclosures from the Securities Exchange Commission Filings	2023
5	Neiroukh, N; Caglar, D	Information Systems Quality and Corporate Sustainability: Unpacking the Interplay of Financial Reporting, Artificial Intelligence, and Green Corporate Governance	2025	30	Bonsón, E; Bednárová, M; Perea, D	Disclosures about algorithmic decision making in the corporate reports of Western European companies	2023
6	Bastos, MFL; Perlin, AP; Dos Santos, JA; Soares, AKD	Contributions of Artificial Intelligence to the Objectives of Sustainable Development in the organizational context	2025	31	Dimmelmeier, A	Dataset on environmental, social and governance information firms and their merger and acquisitions activities	2023
7	Yang, T	Opportunities and challenges to improve accounting and accountability of Corporate Social Responsibility with artificial intelligence: insights from scientific mapping	2025	32	Thompson, EK; Buerter, S	Which firms opt for corporate social responsibility assurance? A machine learning prediction	2023
8	Shen, LH; Li, ZR; Liang, YQ; Feng, YQ; Zhang, ZY	Artificial intelligence adoption and corporate ESG performance: evidence from a refined large language model	2025	33	Zhao, JC; Fariñas, BG	Artificial Intelligence and Sustainable Decisions	2023
9	Iwasaki, M	Proxy Advisors Under Artificial Intelligence: Unverified Reasoning in Shareholder Voting Recommendations	2025	34	Sætra, HS	The AI ESG protocol: Evaluating and disclosing the environment, social, and governance implications of artificial intelligence capabilities, assets, and activities	2023

10	Saini, J; Burke-Kolehmainen, C; Kumar, G	Sustainability Performance, National Culture, and Corporate Financial Performance	2025	35	Brusseau, J	AI human impact: toward a model for ethical investing in AI-intensive companies	2023
11	Siddique, MA; Karim, S	Can ESG disclosure predict carbon risk? Evidence from machine and deep learning models	2025	36	Chi, DJ; Shen, ZD	Using Hybrid Artificial Intelligence and Machine Learning Technologies for Sustainability in Going-Concern Prediction	2022
12	Kirk, M; Molk, P; Pondel, E	AI in Corporate Disclosure: IR Survey Evidence, Legal Risks, and Research Opportunities	2025	37	Qing, YJ; Lim, E	A LEGAL FRAMEWORK FOR ARTIFICIAL INTELLIGENCE FAIRNESS REPORTING	2022
13	Habek, P	Evaluating ESG Software Solutions for Sustainability Reporting in the Manufacturing Sector	2025	38	Rodriguez, CP	Ethical principles in the use of artificial intelligence in the financial sector from a European perspective	2022
14	Agapova, A; King, T; Ranta, M	Navigating transparency: The interplay of ESG disclosure and voluntary earnings guidance	2025	39	Eroglu, M; Kaya, MK	Impact of Artificial Intelligence on Corporate Board Diversity Policies and Regulations	2022
15	Hamdouni, A	AI, Sustainability and Value Creation: Empirical Insights from Saudi Banks (2015-2024)	2025	40	Grishunin, S; Naumova, E; Burova, E; Suloeva, S; Nekrasova, T	The Impact of Sustainability Disclosures on Value of Companies Following Digital Transformation Strategies	2022
16	Lang, TN	Identifying Financially Material Content in Corporate Social Responsibility Reports	2025	41	Svanberg, J; Ardeshiri, T; Samsten, I; Öhman, P; Neidermeyer, PE; Rana, T; Semenova, N; Danielson, M	Corporate governance performance ratings with machine learning	2022
17	Pu, TQ	Bridging digitalization and environmental, social, and governance performance: the moderating effect of CEO duality and government linked corporations	2025	42	van der Merwe, J; Al Achkar, Z	Data responsibility, corporate social responsibility, and corporate digital responsibility	2022
18	Papagiannidis, E; Mikalef, P; Conboy, K	Responsible artificial intelligence governance: A review and research framework	2025	43	Chi, DJ; Chu, CC	Artificial Intelligence in Corporate Sustainability: Using LSTM and GRU for Going Concern Prediction	2021

19	Chang, YL; Ke, J	Socially Responsible Artificial Intelligence Empowered People Analytics: A Novel Framework Towards Sustainability	2024	44	Elliott, K; Price, R; Shaw, P; Spiliotopoulos, T; Ng, M; Coopamootoo, K; van Moorsel, A	Towards an Equitable Digital Society: Artificial Intelligence (AI) and Corporate Digital Responsibility (CDR)	2021
20	Schiff, DS; Kelley, S; Ibáñez, JC	The emergence of artificial intelligence ethics auditing	2024	45	Cihon, P; Schuett, J; Baum, SD	Corporate Governance of Artificial Intelligence in the Public Interest	2021
21	Krueger, P; Sautner, Z; Tang, DY; Zhong, R	The Effects of Mandatory ESG Disclosure Around the World	2024	46	Krasodomska, J; Simnett, R; Street, DL	Extended external reporting assurance: Current practices and challenges	2021
22	Ievsieieva, O; Tsikalo, Y; Mulyk, T; Udodova, Y; Nazarenko, O	Adapting accounting to the digital age: The urgent need for new regulatory standards	2024	47	Liu, AC; Wang, JY; Zhan, YT; Li, CJ; Li, Y	Meta-Frontier Analysis of Disclosing Sustainable Development Information: Evidence from China's AI Industry	2021
23	Subramaniam, RK; Samuel, SD; Seera, M; Alam, N	Utilising machine learning for corporate social responsibility (CSR) and environmental, social, and governance (ESG) evaluation: Transitioning from committees to climate	2024	48	Alvarez-González, LI; García-Rodríguez, N; Sanzo-Pérez, MJ	Online Voluntary Transparency in Spanish Retail Firms. Measurement Index and CSR-Related Factors as Determinants	2018
24	Minkinen, M; Niukkanen, A; Mäntymäki, M	What about investors? ESG analyses as tools for ethics-based AI auditing	2024	49	Shahi, AM; Issac, B; Modapothala, JR	Automatic Analysis of Corporate Sustainability Reports and Intelligent Scoring	2014
25	Hua, XZ; Hasan, NAM; De Costa, F; Qiao, WH	Opportunities or Challenges? The Interplay between Artificial Intelligence and Corporate Social Responsibility Communication	2024				

CHAPTER 6

A PARADIGM SHIFT IN CORPORATE TAXATION

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1. INTRODUCTION

The effects of globalization on tax policies also constitute an integral part of this transformation. The fact that international economic activities transcend national borders has, on the one hand, paved the way for intense tax competition among countries, while on the other hand, it has led to the emergence of loopholes—such as transfer pricing, hidden capital, tax havens, and the taxation of the digital economy—that result in significant fiscal losses. These loopholes, which Vito Tanzi has termed “fiscal termites,” are eroding governments’ tax revenues and placing a disproportionate burden on low-income countries in particular.

The most striking development in the context of tax competition has been the sharp decline in corporate tax rates. The average corporate tax rate, which stood at approximately 40.18% worldwide in 1980, had fallen to 23.45% by 2023. In this competitive environment, multinational enterprises have resorted to various mechanisms to minimize their tax liabilities; this situation has necessitated coordinated measures at the international level.

In this context, the BEPS Action Plan, implemented in 2013, aimed to reduce tax losses resulting from base erosion and profit shifting practices. However, the plan failed to fundamentally transform the existing international tax regime due to the inability to establish new principles and rules; these shortcomings have led to the search for a more comprehensive solution. As a concrete outcome of this search, the Global Minimum Corporate Tax proposal—adopted in October 2021 under the leadership of the OECD with the participation of 136 countries—signals a paradigm shift in the international tax system.

This study examines the effects of globalization on tax policies and the transformations occurring in the corporate tax sector during this process. In this context, the economic dimensions of globalization were first examined, followed by a discussion of tax practices and policies during the globalization era, as well as the phenomenon of tax competition. In the subsequent sections of the study, the effects of globalization on corporate tax were evaluated; finally, the OECD’s Global Minimum Corporate Tax proposal and its key components were analyzed in detail.

2. ECONOMIC DIMENSIONS OF GLOBALIZATION

The phenomenon of globalization, which has an important place in today's social sciences research, has the power to deeply affect many areas of life, although there is no consensus on its origin, development process and scope. According to some, the globalization

process includes the entire history of humanity and will continue to exist in the future as it has existed in the past. Others emphasize the cyclical or periodicity of globalization and argue that certain events or developments shape the process. However, despite these differences of opinion, the absolute reality is that globalization is partially or fully determinative in practices and policies in many areas such as economy, politics, culture, art, education, science, sports, health, etc. in today's world (Ritzer, 2011: 57-65).

The economic and financial dimensions of globalization are quite extensive. In fact, it is possible to say that the research and discussions on the economic aspects of globalization have overtaken other dimensions (political, sociological, cultural, ecological, etc.). The paradigm shift in economic thought (the replacement of the Keynesian economic view by the neoliberal view) as well as the tendency of international capital to move production and consumption processes to a global dimension, especially since the 1980s, have been decisive in this (Aktel, 2001: 196-199). Today, one of the most important pillars of economic globalization is the increase in international trade. Global export and import figures, which are one of the important indicators of economic integration among countries, increased by approximately 300 times from 60 billion USD to 17 trillion USD between 1948 and 2020 with the effect of liberalization steps taken (WTO, 2021: 56-57).

The concentration in international capital flows is another hallmark of the globalization process. Foreign capital flows, which can be closely associated with economic and financial liberalization processes, reached the highest level in history with the globalization process, and especially since the late 1970s, capital flows from developed central economies to less developed or developing peripheral economies have increased (Goldin and Reinert, 2005: 458-461). However, capital flows are currently concentrated mainly among advanced economies, with less developed or developing countries, excluding China, receiving a relatively smaller share (OECD, 2022a: 10).

The process of financialization is another important indicator of economic-financial globalization. Although financialization, which corresponds to a process in which economic activities shift from the real sector to finance, is perceived as the financial sector's exclusion of the real sector from the economy, in essence, it refers to an economic structure in which non-financial enterprises are gradually integrated with the financial sector. In this new structure, both the share of the financial sector in national economies and the weight of profits based on financial activities in corporate profits have increased significantly, and the basic dynamics of capital accumulation have been replaced by activities based on finance and

banking system instead of activities based on industry and trade (Şahin and Önder, 2020: 1547).

In the process of globalization, it is observed that the sphere of dominance of the nation-state is shrinking and supranational structures such as international organizations and Multinational Enterprises (MNEs) are gaining power in the economic and financial sphere. There are three main global organizations that determine economic relations across the world. While the International Monetary Fund (IMF) and the World Bank (WB) act more as creditor institutions, the World Trade Organization (WTO) aims to minimize trade barriers between countries and liberalize global trade (Steger, 2013: 78-82). Transnational corporations (TNCs) -as a result of their financial power- can influence economic and (or) non-economic areas such as investment processes, industrial relations, employment policies, international relations, etc., especially in underdeveloped or developing countries in need of funds (Oran, 2020: 7-9).

3. TAX PRACTICES AND POLICIES IN THE GLOBALIZATION ERA

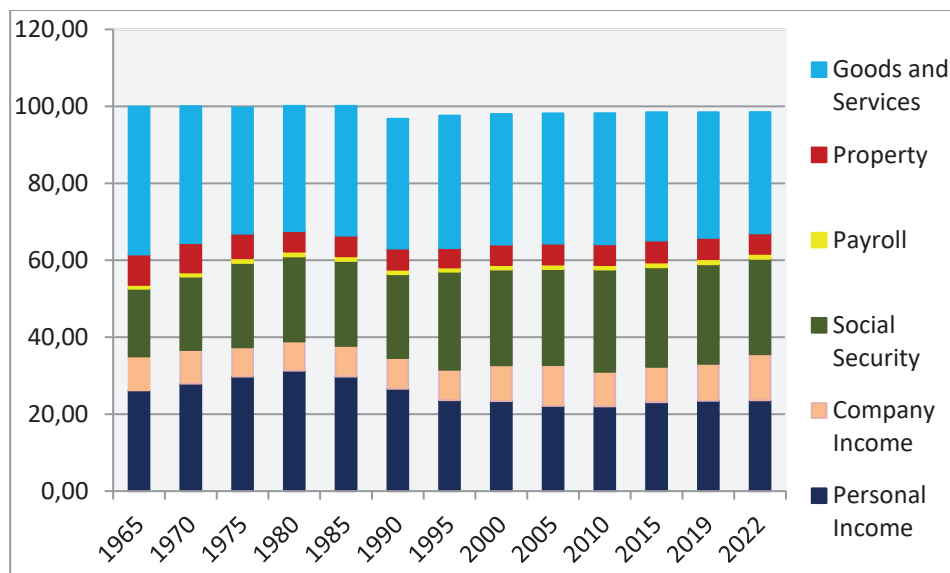
Before the liberalization and deregulation processes that followed the Twin Oil Crises (1973 and 1979), national economies were largely under the influence of protectionist policies and international economic relations were relatively limited. However, the globalization process has changed this situation to a great extent. Likewise, as a result of globalization and the integration between countries that developed in parallel with it, international economic activities have started to intensify since the 1980s, and as a result, tax issues have gradually gained a global dimension by transcending national borders (Tanzi, 1996: 4-5).

In this new paradigm, it is possible to say that supply-side economics is the main determinant in shaping tax practices and policies (especially in taxes on income). Laffer (1981), who is considered as the founder and the most important name of the school, paved the way for policies involving large tax cuts by stating that tax cuts would increase the level of employment, the amount of production, economic growth and tax revenues, while decreasing the tax collection costs of the state on the contrary. As a matter of fact, Income Tax rates and Corporate Tax rates decreased significantly in the period following 1980 (Şahin, 2014: 3089-3090).

A similar situation applies to customs duties. The efforts to eliminate barriers to global trade, which started with the Agreement on Tariffs and Trade (GATT) signed in 1947, right after World War II, gained a new dimension with the Uruguay Round (1986-1994) and the

Marrakesh Agreement (1995), which led to the establishment of the World Trade Organization (WTO), and in this process, reducing Customs Duties (tariffs) became an important policy instrument as well as reducing quantity restrictions and regulating intellectual property rights in international trade. In addition to these global developments, regional economic cooperation such as the European Union (EU) and the North American Free Trade Agreement (NAFTA) and bilateral or multilateral Free Trade Agreements (FTAs) have also had a significant impact on the reduction of Customs Duty rates. However, it should be noted that with the *trade wars*, an upward trend in customs duties has been observed again (Şahin, 2019a).

Figure 1: Share of Each Tax Type in Total Tax Revenues in OECD Member Countries (%)



Source: OECD, 2022b; OECD, 2024a: 63-68.

In the process of globalization, changes are observed in the overall composition of tax revenues as well as tax rates. Figure 1 shows the share of major tax types in total tax revenues in OECD countries. Accordingly, it can be said that the most significant change has occurred in income taxes on personal earnings. Likewise, the share of this tax type in total tax revenues increased from 26.20% to 31.30% between 1965 and 1980, and then started to decline after 1985, reaching 23.60% by 2022. There has been a steady increase in the share of social security-based payments or taxes in total taxes, which rose from 17.60% to 24.80% between 1965 and 2022.

The globalization of tax practices beyond national borders has led to the emergence of fiscal loopholes that Vito Tanzi calls 'Fiscal Termites' (Tanzi, 2001). The main ones are; 'E-Commerce and international transactions, electronic money, intra-firm trade and transfer

pricing, offshore financial centers, derivatives and hedge funds, difficulties in taxing financial capital, increase in overseas activities, overseas purchases, international double taxation, global tax competition, tax havens and tax shelters, taxation of digital services, taxation of crypto assets' (Tanzi, 2001; Saraç, 2006; Zucman, 2013; Şahin, 2019b; Şahin, 2020; Şahin and Yılmaz, 2018). Fiscal loopholes, also due to advances in technology and innovations in financial engineering, can lead to significant tax losses for governments. These losses and evasions can affect low-income countries more profoundly. High-income countries have higher tax losses and evasion but a smaller share in their budgets, while low-income countries have low tax losses and evasion but a high share in their budgets (Tax Justice Network, 2021: 7-8).

4. TAX COMPETITION

Tax competition can be defined as “the efforts of administrative structures, which are decisive in tax policies at both regional (local governments or states) and national (central governments) levels, to attract production factors such as capital and skilled labor to their own regions by providing various tax reductions, incentives, etc. and thus to gain a kind of competitive advantage over rival administrations” (Aktan and Vural, 2004: 2). It is possible to categorize the types of tax competition into three main categories (horizontal and vertical tax competition according to the position of the competitors, national, regional and global tax competition according to the scale, and beneficial and harmful tax competition according to their effects). Competition between two different states or two different local governments within a state is horizontal; competition between the central government and state governments in federal states is vertical (also national); competition within an economic integration (e.g. the European Union) is regional; competition across the world is global; Competition that increases the productivity of the private sector and (or) reduces the wastefulness of the public sector (imposes fiscal discipline) is considered beneficial and competition that leads to erosion of tax revenues, the emergence of free riders in public services and distancing from tax justice is considered harmful tax competition (Saraç, 2006: 133-140).

The causes of tax competition may vary. For example; “fiscal discipline, increasing welfare and standard of living, realization of efficient resource allocation in the economy based on the principle of neutrality of taxes, price stability, the use of taxes as a kind of incentive tool in cases where the economic conjuncture deteriorates, the idea that tax competition will also be beneficial depending on the approach that competition is generally

positive, the fact that Multinational Corporations (MNCs) may see the countries where they invest as a kind of distribution base (hub) from time to time in order to reach consumers in neighboring countries, improvement of administrative and legal regulations regarding taxes” etc. (Giray, 2005: 97-99).

In tax competition, public authorities mainly utilize general purpose incentives and special purpose incentives. General incentives include reductions in taxes on income (income tax and corporate income tax), wealth taxes and consumption (expenditure) taxes, as well as the elimination of withholding taxes on individuals and (or) companies. Special purpose incentives, on the other hand, mostly include incentives for certain types of income or sectors (such as the manufacturing sector or the financial sector) (Armağan and İçmen, 2012: 150-152). In addition, incentives to encourage tax competition include various public instruments such as free zones, tax holidays and dual income tax schemes (Peker and Kılıçer, 2014: 169-172).

The concept of *harmful tax competition* has a particularly important place in tax competition. Especially in international organizations such as the OECD and the European Union (EU) and in countries such as the United States of America (USA) where capital exports are intensively experienced, there is an increase in studies on harmful tax competition (Kargı and Karayılmazlar, 2009: 24). Likewise, according to Vito Tanzi, although the approach of minimizing the economic and fiscal activities of the state has gained weight among economists in the post-1980 period, there is also a global questioning that tax competition may not always be a good thing. According to him, harmful tax competition can make itself felt mainly in three areas. First, public revenues would erode, leading to a significant reduction in taxes. Second, the ability of the public authority to regulate taxes may decline. Finally, tax justice may disappear due to the shift away from the progressive structure of taxes (Tanzi, 1996: 20-21).

Since the 1980s, when the globalization process gained momentum -as a result of the removal of barriers to international capital flows- a sharp tax competition has started to be experienced among countries. This situation has made itself felt mainly through significant decreases in the rates of two types of taxes on income (Income Tax and Corporate Tax) (Özer, 2009: 38-48). As an indicator of tax competition, Figure 2 shows the course of average Income Tax and Corporate Tax rates in OECD member countries over the last forty years. According to the figure, from the early 1980s until today, the average Income Tax rate

decreased by -25% from 67% to 42% and the average Corporate Tax rate decreased by -19.1% from 41.9% to 22.8%.

Figure 2: Average Income Tax and Corporate Tax Rates in OECD Member Countries (%)¹



Source: Armağan and İçmen, 2012: 157-158; KPMG, 2022

It is possible to utilize index values to see the position of countries in tax competition rankings. The tax competitiveness rankings of 37 OECD member countries with their tax competitiveness index scores (Highest = 100 and Lowest = 0) are shown in Table 1. According to the overall ranking, the countries with the highest tax competitiveness scores are Estonia, Latvia and New Zealand, while the countries with the lowest scores are Italy, Poland and France. However, the rankings can change significantly when different tax types are considered. For example, Chile, which ranked 27th in the overall ranking, ranked 1st in the Corporate Tax (CIT) competition ranking, while New Zealand, which ranked 3rd in the overall ranking, ranked 28th in the Corporate Tax ranking. The same is true for the rankings of cross-border tax rules, which largely include income tax, consumption taxes and wealth taxes, as well as rules for the domestic taxation of foreign earnings.

¹ Includes 1981 instead of 1980 for the Corporate Tax rate and 2009 instead of 2010 for the Income Tax rate.

Table 1: Tax Competitiveness Scores and Rankings in OECD Member Countries

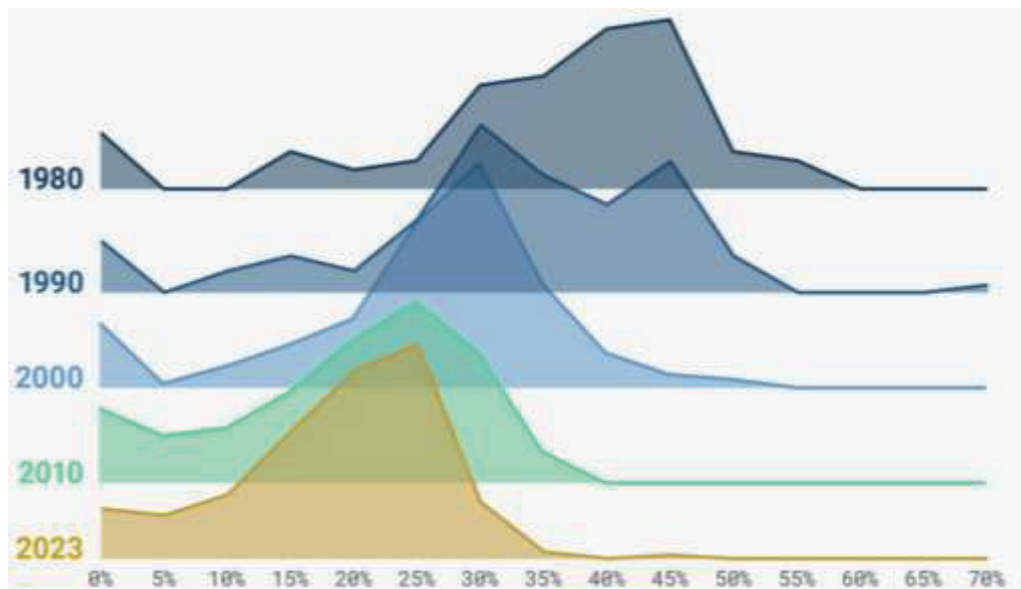
Ülke	Rank	Score	CIT Rank	PIT Rank	Consumption Tax Rank	Wealth Tax Rank	Cross-Border Tax Rules Rank
<i>Estonia</i>	1	100,0	3	1	9	1	15
<i>Latvia</i>	2	85,1	2	5	27	5	9
<i>New Zealand</i>	3	81,3	28	6	6	2	22
<i>Switzerland</i>	4	78,4	10	15	1	35	2
<i>Luxembourg</i>	5	76,5	25	20	4	13	5
<i>Lithuania</i>	6	76,5	4	7	24	7	23
<i>Czechia</i>	7	75,5	8	4	35	6	12
<i>Sweden</i>	8	72,9	9	18	16	8	14
<i>Australia</i>	9	71,3	29	17	7	4	24
<i>Norway</i>	10	70,6	11	13	18	15	11
<i>Slovakia</i>	11	69,3	19	3	34	3	34
<i>Netherlands</i>	12	69,2	24	22	14	21	3
<i>Hungary</i>	13	69,0	6	9	36	17	4
<i>Israel</i>	14	67,6	17	29	12	10	10
<i>Finland</i>	15	67,4	7	28	15	19	21
<i>Germany</i>	16	67,2	27	25	11	11	6
<i>Türkiye</i>	17	66,7	26	8	23	22	8
<i>Austria</i>	18	65,7	21	32	13	14	7
<i>Ireland</i>	19	64,7	5	30	25	18	19
<i>Canada</i>	20	64,6	23	27	8	24	16
<i>USA</i>	21	62,4	20	26	5	28	32
<i>UK</i>	22	61,8	18	23	22	33	1
<i>Belgium</i>	23	61,6	15	11	30	30	18
<i>Japan</i>	24	61,5	36	21	3	26	27
<i>Slovenia</i>	25	61,3	12	14	31	25	20
<i>Korea Rep.</i>	26	60,6	33	24	2	32	33
<i>Chile</i>	27	58,2	1	35	29	12	37
<i>Denmark</i>	28	57,9	16	34	17	16	30
<i>Greece</i>	29	57,5	22	10	32	29	25
<i>Spain</i>	30	57,1	32	19	10	36	17
<i>Colombia</i>	31	55,0	37	2	20	23	35
<i>Iceland</i>	32	53,7	13	36	19	27	31
<i>Mexico</i>	33	52,5	31	16	26	9	36
<i>Portugal</i>	34	49,0	35	31	33	20	28
<i>France</i>	35	48,7	34	37	21	34	13
<i>Poland</i>	36	45,7	14	12	37	31	29
<i>Italy</i>	37	44,6	30	33	28	37	26

Source: Bunn ve Asen, 2021: 3.

5. THE IMPACT OF GLOBALISATION ON CORPORATE TAX

The globalisation process has significantly affected corporate tax practices and policies. However, it should be noted that national and local factors are as decisive as globalisation in new tax policies. Increasing unemployment rates and economic stagnation have led governments towards efficiency-based, low tax rate policies. This has been particularly evident in corporate profits and capital gains. Before the Twin Oil Crises (1973 and 1979), economic thought was dominated by the Keynesian school of thought, which aimed to achieve equality and economic growth through a policy set consisting of a combination of tax rates, investment incentives and other tax expenditures. However, since the 1980s, when neoliberal economic thought became dominant, this approach has been abandoned and the issue of reducing the tax burden on capital has gained priority. Of course, this change has not been realised simultaneously in all countries. For example, while tax rates in Anglo Saxon countries such as the USA and the UK as well as in France and the Netherlands fell relatively faster, tax rates in Germany remained at a relatively high level even in the late 1990s. Italy, on the other hand, was still unable to implement a comprehensive tax reform during these years (Swank, 2008: 65-69; 94-96).

Figure 3: Average Historical Corporate Tax Rates (%)



Source: Enache, 2023.

In fact, the impact of globalisation on corporate tax is not limited to developed economies. The whole globe, including developing and less developed countries, has been affected by this change. As can be seen in Figure 3, Corporate Tax rates have been continuously decreasing worldwide over the last forty years. In 1980, the average tax rate was

approximately 40.18 per cent. By 2023, this rate has decreased to 23.45 per cent. Thus, the decrease in the tax rate between 1980 and 2023 was 16.73%. As of 2023, 91 per cent of countries will have a corporate tax rate below 30 per cent. In terms of regions, the most significant decrease (from 44.6 per cent to 19.92 per cent) was experienced in Europe. In South America, the decline was more limited (from 36.66 per cent to 28.38 per cent) (Enache, 2023).

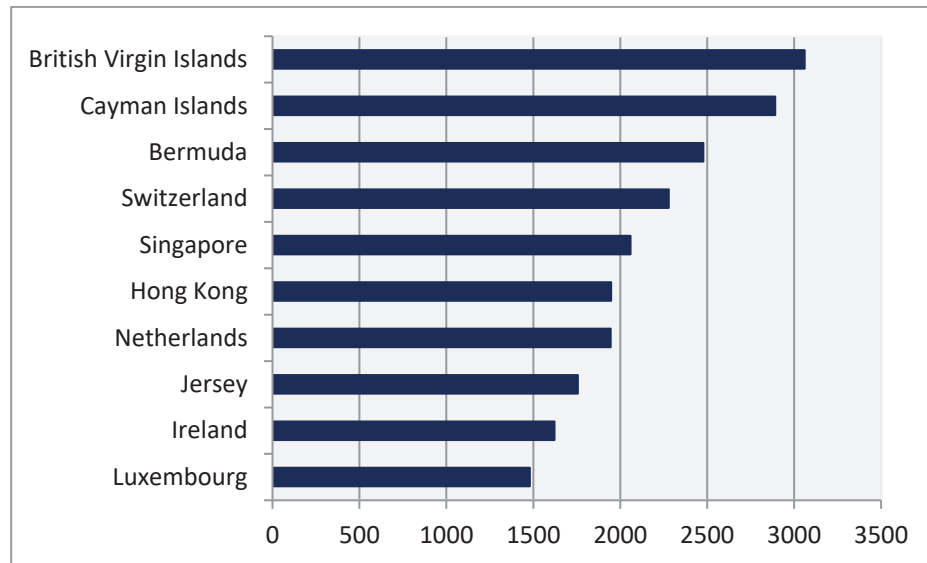
One of the most important indicators of economic globalisation -in tandem with changes in technological structure and new institutional structures- is the increase in international capital movements. Increasing capital competition has led to radical changes in Corporate Tax as a result of tax competition between governments. On the one hand, governments wanted to realise tax reductions that would ensure productivity increases, but on the other hand, they faced difficulties in financing the budget and social protection services (Swank, 1998: 690-691). There are two different approaches on how to overcome this contradiction. In the first generation tax competition approach, it is claimed that the tax burden is directed from high-mobility factors of production to low-mobility factors of production. Accordingly, since the mobility of the labour factor is relatively more limited than that of the capital factor, the tax burden is gradually shifted from capital to labour. In the second generation approach, it is stated that the tax loss caused by the reductions in corporate tax rates is compensated by reducing the incentives (investment credits, accelerated depreciation, etc.) in corporate tax. The starting point of the second generation theory is the 1986 US tax reform. This reform set an example for other developed countries and found a wide application area over time (Swank, 2016: 571-576).

Tax competition based on capital competition initiated a kind of *race to the bottom* among countries. One of the first examples of this was the introduction of the portfolio interest exemption by the US in the second half of the 1980s, followed by similar exemptions by major economies concerned about capital flows to the US. As a matter of fact, a report prepared by the European Economic Community (EEC) in 1992 emphasised the relationship between capital competition and tax competition by stating that ‘the imposition of a withholding tax on cross-border interest flows could lead to the flight of financial capital outside the Community’. On the other hand, the process is not only limited to the difficulties encountered in the taxation of portfolio income or savings, but also includes problems regarding the taxation of Multinational Corporations (MNCs). During the globalisation process, a significant portion of multinational corporations have tried to minimise their tax

liabilities by taking advantage of the loopholes in the fiscal system and in this direction, they have tended to shift their profits to countries with low tax rates through methods such as *transfer pricing* or *thin capitalisation* (Avi-Yonah, 2000: 1579-1597).

Depending on the economic and financial changes caused by the globalisation process, companies make significant use of tax havens in order to avoid their tax liabilities. Today, *tax havens* (*tax shelters*) cause significant tax losses within the framework of the harmful tax competition phenomenon, causing a distorting effect on income distribution (Yıldız and Demir, 2019: 340-348). The annual tax loss caused by these structures is estimated to be approximately 500 billion dollars. Tax havens generally consist of relatively small-scale countries in terms of population or area. Although these countries have a small share of the global economy, they have significant financial influence (Tax Justice Network, 2024). Figure 4 shows the index values of corporate tax havens and provides an important clue as to which countries are preferred by multinational corporations to avoid tax liabilities.

Figure 4: The Corporate Tax Havens Index



Source: Tax Justice Network, 2024: 18.

6. MINIMUM CORPORATE TAX PROPOSAL OF OECD

6. 1. The Road to the Minimum Corporate Tax Proposal

Factors such as transfer pricing, thin capitalisation, tax havens and the digital economy, which have intensified especially with globalisation, have led to a significant erosion in the tax revenues of states and necessitated various measures to be taken both at national and international level. One of the most fundamental arrangements in this direction is

the BEPS (Base Erosion and Profit Shifting) action plan implemented in 2013. The action plan aims to reduce tax losses arising from tax avoidance and evasion by Multinational Enterprises (MNEs). The annual tax loss due to BEPS is estimated to be between 100 and 240 billion USD. This corresponds to between 4 per cent and 10 per cent of global corporate tax revenues (OECD, 2015: 4). BEPS Action Plan (Figure 5) includes 15 actions.

Figure 5: BEPS Action Plan



Source: Teles, 2023: 2.

The content of the Plan consists of four main components. The first component aims at combating harmful tax practices and aims to identify preferential tax regimes that facilitate base erosion and profit shifting by giving special tax treatment to certain sectors. The second component relates to preventing taxpayers from exploiting the complex network of tax treaties to obtain tax advantages. The third component includes country-by-country reporting. According to this component, large-scale multinational enterprises with an annual turnover of more than EUR 750 million are required to submit detailed financial information to the competent authorities in the countries in which they operate. And finally, in the component that can be handled under the title of mutual treaty procedure, member states are expected to implement effective dispute resolution mechanisms for tax-related disputes that may arise between their own tax authorities, an MNE group and a partner tax authority abroad (Teles, 2023: 3-4). The action plan is based on three basic principles. It is possible to list them as follows; ‘a) adopting a cooperative approach to international taxation rather than competition; b) recognising interdependence in tax regulations between countries and adopting a

systematic and holistic approach instead of an ad hoc approach; c) introducing new solutions to existing problems, contrary to the traditional structure of the international tax regime' (Brauner, 2014: 58-59).

The emergence of the BEPS action plan was determined by the relative ineffectiveness of previous regulations on tax losses and evasion. In fact, it is possible to say that the insufficient parts of national regulations and bilateral (and sometimes multilateral) double taxation avoidance treaties come to the fore at the basis of the concerns regarding the prevention of losses and evasion in corporate tax. Changing technological conditions, new business models and intensified international capital movements have necessitated new tax regulations based on international co-operation in the spirit of the age (OECD, 2013: 13-14). Even before the OECD's BEPS action plan, the problems caused by tax losses and evasion were known. Discussions on the subject date back to the 1960s. However, since the 1980s, when globalisation gained momentum, tax losses and evasions started to go beyond a relatively acceptable level and attracted more public attention. Thus, international reform discussions, which first started within the G-20, turned into a concrete text with the OECD BEPS action plan (Brauner, 2014: 58-59).

However, it would be more realistic to consider the BEPS action plan not as a final text, but as a first step towards eliminating the deficiencies in the international tax system. Although the plan basically aims to eliminate the gaps in the global tax regime, it did not go beyond the patching of old rules and principles due to the failure to establish new principles and rules. This is because many old principles of international tax law have been preserved in the BEPS action plan and the mixture of new principles and old principles has to some extent jeopardised the value of the new principles. As a result, a complete overhaul of the existing international tax regime has not been realised and new rules guided by new principles have largely not been formulated. This is extremely important for global tax practice, as without the support of new principles and rules, the goal of harmonising the taxation of MNE profits with economic activity is difficult to achieve (Avi-Yonah and Hu, 2017: 6-7). Due to these shortcomings, it was not possible to fully eliminate global problems in corporate taxation with the BEPS action plan and the Global Minimum Corporate Tax proposal was put forward by the OECD.

6. 2. Global Minimum Corporate Tax: Pillar 1 and Pillar 2

The failure of the BEPS Action Plan to prevent global corporate tax losses and evasion caused by multinational enterprises led the OECD to propose a Global Minimum Corporate

Tax. In this context, 136 countries gathered in October 2021 and proposed a two-pillar (Pillar 1 and Pillar 2) solution aimed at ensuring that multinational enterprises pay a fair share of taxes in the countries where they operate. The Global Minimum Corporate Tax proposal constitutes the second pillar (Pillar 2) of this framework. Accordingly, under the Subject To Tax Rule (STTR), this framework grants the right to impose additional taxation on countries where the effective corporate tax rate is below 9%, and permits raising the tax rate to 15% in accordance with the Global Anti-Base Erosion (GloBE) Model Rules. The additional tax may be collected either by the country where the multinational enterprise operates under a tax known as the Qualified Domestic Minimum Top-Up Tax (QDMTT), or, in cases where QDMTT is not applied, by the country where the company's headquarters is located (OECD, 2023: 5–8).

The Global Minimum Corporate Tax proposal consists of three core components: the Income Inclusion Rule (IIR), the Subject To Tax Rule (STTR), and the Undertaxed Payments Rule (UTPR). The IIR will apply within the jurisdiction of the head office and will be valid for each jurisdiction where any subsidiary or branch of the multinational enterprise group is located, but will not apply to the head office's own jurisdiction. The UTPR will be applied after the IIR and will serve as a supporting mechanism for the IIR. The UTPR will apply when a multinational enterprise group's headquarters is located in a jurisdiction with an effective tax rate below the minimum tax rate. This is because the IIR does not apply to the head office's jurisdiction. The IIR and UTPR will operate in a complementary manner and will reference a similar calculation methodology and set of rules. The framework created by the IIR and UTPR together is referred to as GloBE. The STTR is a treaty-based rule and differs from the IIR and UTPR. STTR will be applied prioritarily to both IIR and UTPR. However, the scope of STTR is narrower than that of IIR and UTPR. STTR is an agreement-based measure and is expected to enter into force bilaterally upon the request of one of the parties to the agreement (Culver, 2021).

The implementation of the GloBE Model Rules corresponds to a six-step process. The first step is determining whether the multinational enterprise group falls within the scope. The requirement to be a member of a Group means that the GloBE rules cannot be applied to independent entities that are not consolidated with any other entity. However, more importantly, the GloBE rules also apply to an entity that operates internationally and has a permanent establishment in another jurisdiction as its parent entity. The second step involves allocating the revenue of the constituent entities by jurisdiction. Once it is determined that the

MNE group falls under the scope of the GloBE rules, each constituent entity must determine its location and revenue. Each constituent company is defined as having a location according to local tax regulations. Step 3 focuses on calculating GloBE revenue. The constituent company's profit or loss is determined through specific adjustments to the Financial Accounting Net Income or Loss (FANIL) figure. The adjustments made to convert FANIL into GloBE Revenue are performed to align the tax base established for the global minimum tax with local practices. Step 4 involves the process of determining the adjusted comprehensive taxes. After calculating the global profit or loss for each parent entity, the taxes related to this revenue must also be calculated. In calculating these taxes, the current tax expense shown in financial statements—which includes deferred tax adjustments and any tax benefits from losses—is used as the basis. Finally, the fifth step involves calculating the effective tax rate and the additional tax, while the sixth step involves collecting the additional tax (OECD, 2023: 12–21).

The Global Minimum Corporate Tax applies to companies with at least two of their last four years' revenues exceeding 750 million euros. This threshold takes into account the consolidated financial statements of multinational enterprises. Certain entities, such as government agencies, international organizations, non-profit organizations, pension funds, and investment funds, are excluded from the GloBE Model Rules. Additionally, an exemption applies to income derived from international maritime transport. Therefore, if a multinational enterprise group has such income, the share of this income received by each constituent company may be excluded from the calculation of GloBE income or loss. When determining the minimum tax rate, the effective tax rate will serve as the basis. Consequently, while countries with a corporate tax rate below 15% are more likely to be subject to Pillar 2 regulations, countries with a corporate tax rate above 15% but an effective tax rate below the threshold may also fall under this scope. In conclusion, the GloBE Model Rules include provisions aimed at ensuring that the profits of large multinational corporations are taxed at a minimum level, and as a result, they are expected to significantly impact tax competition (Liotti et al., 2022).

7. CONCLUSION

When the topics addressed in this study are considered as a whole, it is evident that the globalization process has led to profound transformations in corporate tax practices and policies. The globalization process, which gained momentum starting in the 1980s, has intensified international capital flows; this situation has paved the way for fierce tax

competition among countries. This competition has caused a significant erosion in tax rates on capital income, particularly corporate income tax. Indeed, the global average corporate tax rate, which stood at approximately 40.18% in 1980, had dropped to 23.45% by 2023; thus, a decline of approximately 16.73 percentage points occurred over a period of more than forty years. In parallel with these developments, the tendency of multinational corporations to minimize their tax liabilities through mechanisms such as transfer pricing, hidden capital, and tax havens has intensified. It is estimated that the annual tax loss caused by tax havens amounts to approximately \$500 billion; this situation has a distorting effect on income distribution and negatively impacts the budget balances of low-income countries in particular.

One of the most significant steps taken at the international level to address these issues was the BEPS (Base Erosion and Profit Shifting) Action Plan, implemented in 2013. However, the plan failed to fundamentally transform the existing international tax regime due to the inability to establish new principles and rules; it remained largely limited to patching up old rules and principles. These shortcomings paved the way for the proposal of a global minimum corporate tax. The two-pillar framework, adopted in October 2021 under the leadership of the OECD and with the participation of 136 countries, aims to ensure that multinational enterprises are taxed fairly in the countries where they operate. The Global Minimum Corporate Tax, which constitutes the second pillar, grants the right to impose additional taxation in cases where the effective corporate tax rate falls below 9%, and enables this rate to be raised to 15% under the GloBE Model Rules. This framework, comprising the Income Inclusion Rule (IIR), the Subject to Taxation Rule (STTR), and the Under-Taxed Payments Rule (UTPR), applies to multinational enterprises with consolidated revenues exceeding 750 million euros in at least two of the past four years.

Consequently, the GloBE Model Rules contain provisions aimed at ensuring that the profits of large multinational corporations are taxed at a minimum level, and as such, are expected to have a significant impact on tax competition. This regulation represents the most concrete manifestation of the paradigm shift occurring globally in the corporate tax arena and constitutes a critical step toward the restructuring of the international tax system.

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