

ANALYZING THE ROLE OF TOKENIZATION
IN ENHANCING SUSTAINABLE INVESTING IN BRAZIL:
A MIXED-METHOD STUDY OF INTERNATIONAL INVESTOR PERSPECTIVES

By

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THESIS

Presented to the Swiss School of Business and Management Geneva

In Partial Fulfillment

Of the Requirements

For the Degree

DOCTOR OF BUSINESS ADMINISTRATION

SWISS SCHOOL OF BUSINESS AND MANAGEMENT GENEVA

MAY, 2026

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ACKNOWLEDGMENTS

This work is dedicated to my wife, my son, and my parents, who have been the inspiration of everything I have achieved.

To my wife, for her amazing support, patience, and love. Through every challenge and moment of doubt, you stood by me with strength and belief, giving me the courage to continue.

To my son, whose joy, energy, and happiness brought light to even the most demanding days. You reminded me, in the simplest and most profound way, why every effort is worthwhile.

To my parents, for their unconditional love, guidance, and the values they instilled in me. This achievement is a reflection of your sacrifices, your teachings, and the path you helped me build.

Completing this stage of intense study fills me with deep gratitude and happiness, because I know I did not walk this journey alone. This accomplishment belongs to all of you.

ABSTRACT
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2026

Sustainable investment has gained increasing global relevance, with Environmental, Social, and Governance (ESG) criteria playing a central role in shaping investment decisions. Brazil, given its abundant natural resources and expanding carbon credit market, presents significant potential for attracting international capital toward sustainable projects. However, persistent challenges—such as regulatory uncertainty, greenwashing risks, and limited investor confidence—continue to constrain this potential. In this context, Tokenization, enabled by blockchain technology, has emerged as a promising mechanism to enhance transparency, liquidity, and accessibility in ESG investments.

This research investigates the role of Tokenization in fostering foreign investment in Brazil's sustainable finance sector, with a particular focus on investor perceptions, regulatory dynamics, and the attractiveness of tokenized ESG assets. The study adopts a mixed-methods approach, integrating quantitative and qualitative data to provide a comprehensive and multidimensional understanding of the phenomenon. The quantitative component, based on a survey of international investors, employs Structural Equation Modeling (SEM) and ordinal regression analysis to test nine hypotheses and examine the relationships between key constructs influencing investment decisions. The qualitative component, based on semi-structured interviews with key stakeholders, uses thematic analysis to explore the research questions in depth, enabling the identification of underlying patterns, contextual factors, and the emergence of new insights beyond the predefined hypotheses.

A convergent design is employed, whereby both data strands are analyzed independently and integrated during interpretation through triangulation and convergent analysis, allowing the identification of areas of convergence, divergence, and complementarity. This approach not only strengthens the robustness and credibility of the findings but also enables a more nuanced understanding of the mechanisms shaping investor behavior.

The findings show that the attractiveness of tokenized sustainable investments in emerging markets is not primarily driven by technological advantages, but by the interaction between investor trust, regulatory perception, and institutional legitimacy. While the results offer indicative and analytically generalizable insights based on the studied sample, they are interpreted with appropriate caution given the study's scope and sampling approach. The research provides theoretical contributions by integrating behavioral and institutional perspectives, and practical implications by offering insights for policymakers and market participants seeking to enhance regulatory clarity and the global competitiveness of Brazil's sustainable finance ecosystem.

Overall, this study advances the academic and policy debate on Tokenization as a financial innovation with the potential to unlock international capital flows into sustainable investments in emerging economies.

KEYWORDS

Tokenization; Sustainable Finance; ESG Investments; Emerging Markets; Behavioral Finance; Institutional Theory; Regulatory Framework; Investor Trust; Mixed-Methods; Structural Equation Modeling (SEM); Ordinal Regression; Digital Assets; Brazil

ABREVIATIONS

AML – Anti-Money Laundering

BCB – Banco Central do Brasil (Central Bank of Brazil)

CFA – Confirmatory Factor Analysis

CVM – Comissão de Valores Mobiliários (Brazilian Securities and Exchange Commission)

DeFi – Decentralized Finance

ESG – Environmental, Social, and Governance

GDPR – General Data Protection Regulation

GRI – Global Reporting Initiative

IFRS – International Financial Reporting Standards

ISSB – International Sustainability Standards Board

MAXQDA – Qualitative Data Analysis Software

OECD – Organisation for Economic Co-operation and Development

PLS-SEM – Partial Least Squares Structural Equation Modeling

PoS – Proof of Stake

PoW – Proof of Work

RQ – Research Question

SEM – Structural Equation Modeling

SFDR – Sustainable Finance Disclosure Regulation

TCFD – Task Force on Climate-related Financial Disclosures

TRU – Investor Trust

THR – Perceived Threats

TOK – Tokenization

WIL – Willingness to Invest

TABLE OF CONTENTS

LIST OF TABLES	10
LIST OF FIGURES.....	14
CHAPTER I: OVERVIEW	16
1.1 Introduction	16
1.2 Research Problem.....	17
1.3 Purpose of Research	18
1.4 Research Questions	19
1.5 Research Hypotheses.....	20
1.6 Significance of the Study	22
1.7 Scope and Delimitations.....	22
CHAPTER II: LITERATURE REVIEW.....	24
2.1 Conceptual Foundations and Theoretical Perspectives	24
2.2 Applicability of Tokenization to Sustainable Investments	25
2.3 Scalability, Energy Consumption and Interoperability Challenges	26
2.4 Fraud, Security Vulnerabilities and Governance Challenge	28
2.5 Impact on National and International Regulation	29
2.6 Investor Perceptions and Decision-Making	30
2.7 Research Gaps	31
2.8 Conceptual Framework Model.....	35
CHAPTER III: RESEARCH DESIGN AND METHODOLOGICAL APPROACH (MIXED METHODS)	38
3.1 Research Paradigm and Mixed Methods Design	38
3.2 Methodological Flow	39
3.3 Integration Strategy	42
3.4 Convergent Analysis	42
3.5 Validity and Rigor.....	43
3.6 Ethical Considerations.....	44
CHAPTER IV: QUANTITATIVE METHOD	45
4.1 Research Design.....	45
4.2 Population and Sample.....	45
4.3 Variables.....	46

4.4 Data Collection.....	51
4.5 Statistical Analysis	52
4.6 Method Limitations	56
CHAPTER V: QUANTITATIVE RESULTS.....	58
5.1 Exploratory Analysis.....	58
5.2 Structural Equation Modeling	65
5.3 Hypotheses Testing	76
CHAPTER VI: QUALITATIVE METHOD	95
6.1 Qualitative Approach	95
6.2 Interviews	95
6.3 Data Collection.....	95
6.4 Coding and Analysis	96
6.5 Limitations	97
CHAPTER VII: QUALITATIVE RESULTS.....	99
7.1 Participants Overview	99
7.2 Thematic Analysis.....	100
7.3 Interpretative Analysis	102
7.4 Findings and Empirical evidences.....	114
CHAPTER VIII: INTEGRATION OF FINDINGS (MIXED-METHODS)	119
8.1 Integration Approach and Triangulation Strategy.....	119
8.2 Integrated Analysis of Findings (Convergent analysis)	122
8.3 Joint Display.....	126
8.4 Integrated Discussion	131
CHAPTER IX: DISCUSSION.....	135
9.1 Theoretical Discussion	135
9.2 Comparison with Literature	149
9.3 Implications	154
9.4 Integrated Regulatory Framework for Tokenized ESG assets	159
CHAPTER X: CONCLUSIONS.....	163
10.1 Summary of Findings.....	163
10.2 Contributions.....	167
10.3 Limitations	172
10.4 Future Research.....	174

APPENDIX A: SEMI STRUCURED INTERVIEW COVER LETTER	176
APPENDIX B: CONSENT FORM.....	177
APPENDIX C: SEMI-STRUCTURED INTERVIEW GUIDE.....	178
APPENDIX D: SURVEY COVER LETTER AND CONSENT FORM	179
APPENDIX E: SURVEY QUESTIONS	180
APPENDIX F: CFA MEASUREMENT MODEL	183
APPENDIX G: QUANTITATIVE SUPPLEMENTARY MATERIAL	189
APPENDIX H: QUALITATIVE CODE LIST	223
BIBLIOGRAPHY	226

LIST OF TABLES

Table 1: <i>Research questions and hypothesis</i>	21
Table 2: <i>Comparative overview of mixed-methods approach</i>	39
Table 3: <i>Comparison of instruments</i>	41
Table 4: <i>Sampling criteria for statistical validity</i>	46
Table 5: <i>List of observed variables defined for survey</i>	50
Table 6: <i>Prolific Research Platform recruiting criteria</i>	52
Table 7: <i>Descriptive analysis of the variables of the international investor profile, Brazil, 2025</i>	59
Table 8: <i>Global Fit Indices of the Structural SEM Model</i>	71
Table 9: <i>Box 10. Summary of hypothesis testing results from ordinal regression analyses ...</i>	92
Table 10: <i>Summary of Hypotheses, Methods and Key Findings</i>	94
Table 11: <i>Triangulation methodology</i>	120
Table 12: <i>Joint Display Research Question 1</i>	127
Table 13: <i>Joint Display Research Question 2</i>	128
Table 14: <i>Joint Display Research Question 3</i>	129
Table 15: <i>Joint Display Research Question 4</i>	130
Table 16: <i>General Joint Display by Research Questions</i>	134
Table 17: <i>Risks and opportunities of tokenized ESG Assets</i>	151
Table 18: <i>Drivers and Barriers of Tokenized Adoption</i>	152
Table 19: <i>Comparative Framework</i>	154
Table 20: <i>Descriptive analysis of likelihood to invest in tokenized ESG assets in Brazil in the next 12 months, Brazil, 2025.</i>	189
Table 21: <i>Descriptive analysis of aspects of willingness to adopt Tokenized ESG assets, Brazil, 2025.</i>	190
Table 22: <i>Descriptive analysis of perceived risks against the willingness to adopt ESG Tokenized assets, Brazil, 2025.</i>	191

Table 23: <i>Descriptive analysis of features of ESG Alignment and Financial Accessibility, Brazil, 2025.</i>	192
Table 24: <i>Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and variables of the international investor profile, Brazil, 2025.</i>	192
Table 25: <i>Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and aspects of willingness to adopt Tokenized ESG assets, Brazil, 2025.</i>	193
Table 26: <i>Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and perceived risks against the willingness to adopt ESG Tokenized assets, Brazil, 2025.</i>	194
Table 27: <i>Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and ESG Alignment and Financial Accessibility, Brazil, 2025.</i>	195
Table 28: <i>A - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and the variables of the international investor profile, Brazil, 2025.</i>	196
Table 29: <i>B - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and aspects of willingness to adopt Tokenized ESG assets, Brazil, 2025.</i>	197
Table 30: <i>C - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and perceived risks against the willingness to adopt ESG Tokenized assets, Brazil, 2025.</i>	199
Table 31: <i>D - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and ESG Alignment and Financial Accessibility, Brazil, 2025.</i>	201
Table 32: <i>Global fit indices from the final models for Confirmatory Factor Analysis of the latent scales</i>	202

Table 33: <i>Matrix of correlations between latent factors estimated in the structural equation model</i>	203
Table 34: <i>Standardized path coefficients of the Structural SEM Model</i>	203
Table 35: <i>Mediation effects in the relationships between predictors and likelihood to invest in the structural SEM model</i>	203
Table 36: <i>Global Fit Indices of the Structural SEM Model by Economic Instability (Moderator)</i>	204
Table 37: <i>Standardized path coefficients of the Structural SEM Model Stratified by Economic Instability (Moderator)</i>	205
Table 38: <i>Box 1. Hypothesis 1 – Construct and Operational Variables</i>	206
Table 39: <i>Hypothesis 1 - Direct, indirect, and total effects of Tokenization on likelihood to invest mediated by investor trust</i>	207
Table 40: <i>Box 2. Hypothesis 2 – Construct and Operational Variables</i>	208
Table 41: <i>Hypothesis 2 - Direct, indirect, and total effects of perceived threats on likelihood to invest mediated by investor trust</i>	209
Table 42: <i>Box 3 - Hypothesis 3 – Construct and Operational Variables</i>	210
Table 43: <i>Hypothesis 3 - Direct effects of regulatory barriers on Familiarity with Tokenization</i>	210
Table 44: <i>Box 4. Hypothesis 4 – Construct and Operational Variables</i>	211
Table 45: <i>Hypothesis 4 - Direct effects of Technological challenges on Tokenization</i>	212
Table 46: <i>Box 5. Hypothesis 5 – Construct and Operational Variables</i>	212
Table 47: <i>Hypothesis 5 - Direct effects of Alignment of ESG metrics on Likelihood to Invest</i>	213
Table 48: <i>Box 6. Hypothesis 6 – Construct and Operational Variables</i>	213
Table 49: <i>Hypothesis 6 - Direct effects of Advantages of Tokenization on Likelihood to Invest</i>	214
Table 50: <i>Box 7. Hypothesis 7 – Construct and Operational Variables s</i>	214
Table 51: <i>Hypothesis 7 - Direct effects of Financial accessibility and ESG adoption on Likelihood to Invest</i>	215

Table 52: <i>Box 8. Hypothesis 8 – Construct and Operational Variables</i>	215
Table 53: <i>Hypothesis 8 – Direct effects of Tokenization on likelihood to invest and tests of moderation by macroeconomic instability and regulatory uncertainty</i>	216
Table 54: <i>Box 9. Hypothesis 9 – Construct and Operational Variables</i>	217
Table 55: <i>Hypothesis 9 - Direct, indirect, and total effects of regulatory uncertainty on likelihood to invest mediated by investor trust</i>	218
Table 56: <i>E - Confirmatory factor Analysis – global fit indices. With all items originally planned for each latent variable.</i>	219
Table 57: <i>Qualitative code list (MaxQDA)</i>	223

LIST OF FIGURES

<i>Figure 1: Conceptual Framework.....</i>	<i>36</i>
<i>Figure 2: Theoretical Framework.....</i>	<i>38</i>
<i>Figure 3: Detailed conceptual framework</i>	<i>53</i>
<i>Figure 4: Matrix of associations* among the variables that showed a statistically significant association with with the likelihood to invest in tokenized ESG projects in Brazil in the next 12 months, Brazil, 2025.....</i>	<i>64</i>
<i>Figure 5: Confirmatory Factor Analysis of the latent scale Tokenization: global fit indices of the final model</i>	<i>65</i>
<i>Figure 6: Confirmatory Factor Analysis of the latent scale Perceived threats: global fit indices of the final model</i>	<i>67</i>
<i>Figure 7: Confirmatory Factor Analysis of the latent scale Investor trust: global fit indices of the final model</i>	<i>68</i>
<i>Figure 8: Full structural SEM Model</i>	<i>72</i>
<i>Figure 9: Code System</i>	<i>101</i>
<i>Figure 10: Word Cloud</i>	<i>102</i>
<i>Figure 11: Integrated Regulatory Framework for Tokenized ESG assets.....</i>	<i>162</i>
<i>Figure 12: Integrated Behavioral–Institutional Model of Tokenized ESG Assets.....</i>	<i>168</i>
<i>Figure 13: Likelihood (%) to invest in tokenized ESG Assets in Brazil in the next 12 months, 2025.....</i>	<i>189</i>
<i>Figure 14: Distribution (%) of factors that would positively influence the decision to adopt tokenized ESG Assets, Brazil (2025)</i>	<i>190</i>
<i>Figure 15: Distribution (%) of perceived risks against the willingness to adopt ESG Tokenized assets, Brazil, 2025.....</i>	<i>191</i>
<i>Figure 16: Point estimates and 95% confidence intervals (error bars) for standardized regression coefficients, across strata of Economic instability in Brazil</i>	<i>205</i>
<i>Figure 17: Confirmatory Factor Analysis of the latent scale Tokenization: global fit indices of the final model - including all originally planned items</i>	<i>220</i>

<i>Figure 18: Confirmatory Factor Analysis of the latent scale Perceived threats: global fit indices of the final model - including all originally planned items.....</i>	<i>221</i>
<i>Figure 19: Confirmatory Factor Analysis of the latent scale Investor trust: global fit indices of the final model - including all originally planned items</i>	<i>222</i>

CHAPTER I: OVERVIEW

1.1 Introduction

Sustainable development is increasingly important in global investment strategies, with ESG (Environmental, Social, and Governance) criteria guiding decisions on responsible capital allocation. However, one of the key challenges in sustainable finance is ensuring sufficient liquidity, accessibility, and transparency in ESG-aligned investments.

Tokenization—the process of converting ownership rights or claims to an asset into digital tokens on a blockchain—has emerged as a transformative solution to address these barriers. By enabling fractional ownership, reducing reliance on intermediaries, and facilitating cross-border transactions, Tokenization can unlock new opportunities for sustainable investment. This is particularly relevant for Brazil, a country with vast renewable energy resources and biodiversity, which faces persistent challenges in attracting international capital for its sustainable projects.

The terminology in sustainable development is constantly evolving, with key terms such as “ESG Finance,” “Sustainable Investment” and “Green Finance” often used interchangeably. “ESG financing” refers to investment and funding activities that integrate Environmental, Social, and Governance (ESG) factors to assess risks and opportunities (Friede, Busch and Bassen, 2015). Sustainable investment, in a broader sense, incorporates these factors into decision-making to generate long-term financial returns while promoting positive environmental and social outcomes (Talan and Sharma, 2019). Green finance, a subset of sustainable investment, specifically focuses on financial instruments and investments that support environmentally beneficial projects, such as renewable energy and climate change mitigation (OECD, 2017).

By increasing liquidity, improving transparency, and reducing financial barriers, Tokenization can align with global ESG financing trends and create new pathways for foreign investment in sustainable initiatives. Tokenized assets allow investors to participate in ESG-driven projects with lower capital thresholds while ensuring regulatory oversight through blockchain’s immutable record-keeping (Maleki, 2023). In the Brazilian context,

Tokenization presents a viable mechanism to attract international investors, expand funding for sustainable projects, and position the country as a key player in the evolving landscape of sustainable finance.

The research aims to analyze the potential of Tokenization to attract foreign capital to sustainable investments in Brazil. It explores the feasibility and effectiveness of Tokenization as a financing tool, focusing on key factors such as regulatory frameworks, ESG criteria alignment, and blockchain technology's scalability and interoperability. The research addresses questions regarding the impact of Tokenization on international investors' decision-making, the challenges of implementing Tokenization, and the factors that increase the attractiveness of tokenized ESG assets. The literature review also examines Brazil's regulatory framework and its influence on the adoption of Tokenization in the sustainability sector.

1.2 Research Problem

Few studies have focused specifically on the intersection of Tokenization and sustainable projects in emerging economies like Brazil. A significant gap exists in understanding how these technologies improve to meet the demands and needs of sustainability-focused investments, particularly in the context of attracting foreign capital. This research was built upon existing studies, filling the gap by exploring and proposing a possible framework to enhance the attractiveness of tokenized Brazilian sustainable investments to international investors.

A relevant part of this research aims to analyze main challenges arising from the Brazil's sustainable finance landscape, especially those related to the adoption of clear ESG criteria and mechanisms that can mitigate risks and allow an adequate level of confidence among foreign investors. In order to achieve its potential as proposed in this study, the regulatory framework for tokenized assets needs further clarity and harmonization. Although the Brazilian Securities and Exchange Commission (CVM) has begun adopting global standards, including guidelines for tokenized instruments, the lack of uniformity and comprehensive legislation poses risks for investors..

1.3 Purpose of Research

The main objective of this study is to analyze the potential of Tokenization to attract foreign capital to sustainable investments in Brazil and identify the key factors influencing the success of this strategy in the international market, exploring the feasibility and effectiveness of Tokenization as a financing tool.

Considering current limited academic research covering the intersection between sustainable investments in Brazil and Tokenization, this research aims to contribute to the policy and practice in transforming Brazil's sustainable finance sector:

- 1) Providing a deep understanding of how Tokenization can improve the accessibility and attractiveness of Brazilian sustainable investments for foreign investors, identifying key factors that influence the appeal of tokenized investments to international investors.
- 2) Providing a framework for the integration of Tokenization in Brazil's sustainable finance landscape, that can be relevant for academic discussions as well the continuous debate among stakeholders such developers and project managers interested in leverage tokenized ESG assets in Brazil.
- 3) Offering policy recommendations for Brazilian regulators, overcoming the legal and technological barriers to Tokenization, providing insights in which measure Tokenization may represent a path to enhance capital inflow, democratize investments, reduce costs, and improve transparency. These findings might support policymakers by establishing regulatory framework to protect and attract foreign investors, and encourage developers to scale up sustainable initiatives in Brazil.
- 4) Discussing future research opportunities arising from this study, by exploring similarities and differences between Brazil and other emerging economies, paving the way for further cross-border collaborations and transferable best practices. This case study might add knowledge to the set of research questions in a consolidated way.

Being more specific, the research aims to delve into the following sub-objectives:

- i. Explore Tokenization mechanisms and describe its applicability to sustainable investments;
- ii. Assess the competitive advantages over traditional financial methods;

- iii. Investigate the impact of national and international regulations on ESG and asset Tokenization;
- iv. Analyze foreign investor perceptions and its preferences and barriers in relation to sustainable tokens issued by Brazilian projects.

1.4 Research Questions

To operationalize its objectives, this research is guided by a set of questions and hypotheses designed to structure the analysis. These research questions address the mechanisms, challenges, and potential of Tokenization in the Brazilian sustainable finance context.

Research Main Question 1: How does Tokenization influence investor trust and decision-making in sustainable Brazilian projects?

This question examines whether Tokenization improves investor confidence by providing transparency, immutability, and traceability through blockchain. It also explores potential negative perceptions linked to risks of fraud, technological limitations, and regulatory uncertainty. The analysis aims to identify whether these factors encourage or discourage international investors when considering tokenized ESG assets.

Research Main Question 2: What are the primary legal, economic, and technological challenges for implementing Tokenization in Brazilian sustainable finance?

This question aims to map the barriers to Tokenization in Brazil, particularly focusing on gaps in regulation, compliance costs, blockchain scalability, and interoperability issues.

Understanding these challenges is essential to determine how Brazil can adapt international best practices and design a framework that balances investor protection with market innovation.

Research Main Question 3: What key factors enhance the attractiveness of tokenized ESG assets to international investors?

This question investigates the drivers that make Brazil's tokenized projects attractive, including ESG adoption, financial accessibility, and alignment with global sustainability standards. It analyzes whether features such as fractional ownership, transparency of

environmental impacts, and reduced entry barriers foster greater participation of institutional and retail investors.

Research Main Question 4: To what extent does Brazil's regulatory framework facilitate or inhibit the adoption of Tokenization in the sustainability sector?

This question evaluates the degree to which Brazil's existing regulatory environment provides clarity, stability, and international alignment. It also considers the moderating effect of macroeconomic stability and political predictability on foreign investment decisions. The objective of this study is to provide information on the need for regulatory reforms to position Brazil as a global leader in sustainable Tokenization initiatives.

1.5 Research Hypotheses

This research provides empirical validation for relationships among variables, addressing a gap in the intersection of blockchain technology, sustainable finance, and investor behavior, aiming to investigate how Tokenization can increase the attractiveness of Brazilian sustainable projects to foreign investors, focusing on key regulatory, financial, and technological factors. The study addresses the following research questions:

- i. How does Tokenization influence investor trust and decision-making in sustainable Brazilian projects?
- ii. What are the primary legal, economic, and technological challenges for implementing Tokenization in Brazilian sustainable finance?
- iii. What key factors enhance the attractiveness of tokenized ESG assets to international investors?
- iv. To what extent does Brazil's regulatory framework facilitate or inhibit the adoption of Tokenization in the sustainability sector?

The research questions were categorized into 9 hypotheses (H1 to H9), which guide the Mixed-methods analysis.

Table 1: *Research questions and hypothesis*

Research questions	Hypothesis
1) How does Tokenization influence investor trust and decision-making in sustainable Brazilian projects?	H1: Tokenization positively affects Investor Trust, enhancing the decision-making process of international investors in sustainable Brazilian projects. H2: Perceived threats (e.g., regulatory, economic and technological) adversely affect investors' willingness to participate in tokenized assets.
2) What are the primary legal, economic, and technological challenges for implementing Tokenization in Brazilian sustainable finance?	H3: Regulatory barriers, such as legal uncertainties and compliance costs, hinder the widespread adoption of Tokenization in Brazil's sustainable finance sector. H4: The scalability and integration of blockchain technology within Brazil's financial and legal infrastructure affect the feasibility and adoption of tokenized sustainability projects.
3) What key factors enhance the attractiveness of tokenized ESG assets to international investors?	H5: Brazil's alignment with global ESG standards significantly enhance international investors' interest in tokenized ESG assets. H6: The advantages provided by Tokenization, such as the traceability of environmental and financial impacts of projects from blockchain technology, improves the international investors' willingness to engage in tokenized ESG assets. H7: Financial accessibility and ESG adoption positively influence investor trust, which in turn facilitates international investment in tokenized ESG assets.
4) To what extent does Brazil's regulatory framework facilitate or inhibit the adoption of Tokenization in the sustainability sector?	H8: Brazil's macroeconomic stability and regulatory clarity moderate the relationship between Tokenization and international investment, influencing investor sentiment and participation. H9: Regulatory stability and enforcement predictability significantly influence investor trust, shaping their willingness to engage with tokenized ESG assets.

Source: elaborated by Author

1.6 Significance of the Study

This study is relevant for academic, policy, and market domains, as it provides empirically grounded evidence on how Tokenization interacts with investor behavior and institutional conditions in an emerging market context.

From a theoretical perspective, it clarifies how behavioral and institutional factors jointly shape investment decisions in digital financial environments. From a policy perspective, it identifies how regulatory uncertainty influences investment primarily through trust mechanisms. From a market perspective, it highlights the conditions under which tokenized ESG assets become attractive to international investors.. It contributes to the limited body of knowledge on Tokenization in emerging markets, particularly within the context of sustainable finance in Brazil. It also provides insights into how Tokenization can help Brazil overcome barriers such as investor distrust, regulatory uncertainty, and limited market access.

For policymakers, the research offers recommendations for strengthening the regulatory environment and aligning Brazil's financial sector with global ESG standards. For investors, it clarifies the risks and opportunities of tokenized assets, fostering greater confidence in sustainable initiatives.

This research also contributes to positioning Brazil as a competitive player in the global market for sustainable investments, leveraging Tokenization to attract international capital while ensuring environmental and social impact.

1.7 Scope and Delimitations

This study examines the adoption and implications of Tokenization within Brazil's sustainable finance sector, focusing on the intersection between blockchain-enabled digital assets, ESG investment frameworks, investor behavior, and regulatory environments. The research is situated within the context of Brazil as an emerging market characterized by significant natural capital, evolving digital infrastructure, and a complex and developing legal framework.

The scope of the study encompasses both quantitative and qualitative evidence, consistent with a mixed-methods research design. The quantitative component draws on

survey data collected from international investors to identify patterns, test theoretically grounded relationships, and provide analytical insights into investor behavior and perceptions. The qualitative component, based on semi-structured interviews with key stakeholders, offers in-depth, contextualized understanding of regulatory, institutional, and technological dimensions that shape the adoption of tokenized ESG assets.

Rather than prioritizing one method over the other, the study adopts a convergent mixed-methods approach, in which quantitative and qualitative data are analyzed independently and integrated during the interpretation phase. This design enables triangulation, complementarity, and deeper explanation of findings, strengthening the overall robustness and credibility of the research.

In terms of scope, the analysis remains primarily focused on the Brazilian ecosystem, although international perspectives are incorporated through the inclusion of foreign investors and comparative references where relevant. The study emphasizes investor perceptions, institutional conditions, and strategic-level factors, rather than technical evaluation of specific tokenized projects or detailed financial performance metrics.

Regarding generalization, the quantitative findings provide indicative and analytically generalizable insights into investor attitudes and behavioral patterns, based on the sample studied. However, given the non-probabilistic elements of sampling and the exploratory nature of the research context, the results should be interpreted with appropriate caution, without claiming universal statistical generalizability across all investor populations.

The study is further delimited by its focus on professional and semi-professional investors engaged with sustainable finance, blockchain, or digital assets. It does not examine retail consumer behavior at scale, nor does it aim to represent the broader cryptocurrency market. Additionally, the rapidly evolving nature of Tokenization technologies and regulatory frameworks implies that findings reflect the conditions observed during the period of data collection.

These delimitations were necessary to ensure analytical depth, methodological coherence, and feasibility, while addressing a complex and interdisciplinary research problem. Future research may extend this work by employing probabilistic sampling strategies,

longitudinal designs, or cross-country comparative analyses to enhance the external validity and generalizability of findings.

CHAPTER II: LITERATURE REVIEW

2.1 Conceptual Foundations and Theoretical Perspectives

This research draws on two primary theoretical perspectives to analyze the dynamics of Tokenization in sustainable finance within the Brazilian context: Behavioral Finance and Institutional Investment Theory. These frameworks offer complementary lenses for understanding both individual and organizational decision-making processes in uncertain, evolving financial environments.

From the perspective of Behavioral Finance, the study incorporates key concepts such as Prospect Theory (Kahneman and Tversky, 1979), Regret Aversion (Loomes and Sugden, 1982) and Herding Behavior (Banerjee, 1992). Prospect Theory posits that individuals do not always act rationally when making decisions under risk; instead, they tend to evaluate outcomes relative to a reference point and exhibit loss aversion—placing greater weight on potential losses than equivalent gains. This is particularly relevant in ESG investing, where investors may be hesitant to adopt innovative structures like tokenized assets due to perceived volatility or unfamiliarity. Similarly, Regret Theory suggests that anticipated regret can influence investor behavior, leading to conservative decision-making or avoidance of pioneering financial instruments if the outcomes are uncertain. Herding Behavior further explains how investors—especially in emerging markets—may mimic the investment choices of others rather than act independently, driven by informational cascades and reputational concerns.

In parallel, Institutional Investment Theory offers an organizational-level understanding of how firms and financial institutions respond to external pressures. DiMaggio and Powell (1983) framework of institutional isomorphism—which includes coercive, mimetic, and normative mechanisms—helps explain why organizations may adopt similar

structures or investment strategies, not solely for efficiency but to maintain legitimacy within their institutional environment. For instance, Tokenization may gain traction not only due to its operational benefits but also as a response to normative pressures from international ESG standards or mimetic behavior among financial institutions seeking legitimacy in the global market.

Furthermore, the concept of legitimacy management (Suchman, 1995) reinforces how firms strategically adopt innovations like blockchain and Tokenization to align with evolving expectations from regulators, investors, and society at large. The analysis also integrates insights from Pecking Order Theory (Myers and Majluf, 1984), which suggests that firms prefer internal financing to external equity issuance due to information asymmetries and the risk of adverse selection. This theoretical lens is particularly applicable when assessing why institutional investors may be cautious about engaging in tokenized ESG markets, especially in jurisdictions like Brazil, where regulatory uncertainty can exacerbate perceptions of risk.

Together, these theoretical perspectives provide a multidimensional understanding of the interplay between investor psychology, institutional behavior, and structural legitimacy, offering a robust foundation for the interpretative analysis that follows.

2.2 Applicability of Tokenization to Sustainable Investments

Tokenization has emerged as a transformative mechanism in sustainable finance, enhancing liquidity, transparency, accessibility, and efficiency in green investments. Through blockchain technology, tokenized assets facilitate digital ownership, automation via smart contracts, and cost reductions in transactions. Maleki (2023) highlights that tokenized green bonds mitigate greenwashing, a misleading marketing practice where firms exaggerate their environmental impact (Spaniol *et al.*, 2024). Studies by Juan *et al.*, (2023), Tapscott and Tapscott (2018) and Mhaskey (2024) demonstrate how blockchain reduces transaction costs, optimizes resource allocation, and supports circular economy principles. Tian *et al.*, (2022) and Montovanelli (2023) further argue that Tokenization can broaden financing infrastructure and carbon credit opportunities in emerging markets by attracting retail and foreign investors.

Best practices such as tokenized sustainable water infrastructure projects in South Africa, allowing investors to directly finance water conservation and distribution initiatives in underserved communities (Arafat, 2022), and tokenized renewable energy assets from emerging markets, such as wind and solar farms, implemented by SolarCoin, WePower Token, and ZiyenCoin, facilitate direct investment to investors worldwide (Tian *et al.*, 2022). In Brazil is emerging few initiatives in tokenized carbon credit, including the leading company Ambipar (Forbes, 2021), signaling a promising market, although regulation is still under development.

While literature acknowledges Tokenization's potential, many studies overemphasize technology while neglecting institutional and human adoption factors (Juan *et al.*, 2023; Maleki, 2023). Moreover, discussions often highlight benefits while underestimating regulatory complexities and interoperability challenges. Future research must take an interdisciplinary approach to fully assess Tokenization's long-term viability in sustainable finance. Despite its advantages, Tokenization faces challenges for wide adoption, such as Scalability, Energy Consumption, Interoperability, Fraud, Security Vulnerabilities, and Governance challenges.

2.3 Scalability, Energy Consumption and Interoperability Challenges

Scalability is a critical factor influencing the adoption and efficiency of blockchain-based financial instruments. The ability of blockchain networks to process a high volume of transactions without significant delays or excessive costs determines the feasibility of tokenized green bonds, carbon credits, and sustainability-linked financial products (Zhang, Gong and Zhou, 2024).

While the immutability offered by Blockchain is one of its main strengths, it also offers a large area of debate due to the environmental impact arising from energy consumption. According to Maadallah *et al.* (2025), Proof-of-Work (PoW) is a consensus mechanism widely used in blockchain technology to validate transactions and secure decentralized networks. It operates by requiring participants, known as miners, to solve

complex mathematical puzzles using computational power, with the first miner to find a valid solution earning the right to add a new block to the blockchain.

This process ensures network security and prevents malicious attacks by making it computationally expensive to manipulate transaction history. PoW has been criticized for its high-energy consumption and scalability limitations, driving the adoption of alternatives like Proof-of-Stake (PoS). Lener and Furnari (2024) and Maadallah et al.(2025) argue that PoW conflicts with sustainability goals and advocate for PoS, which offers greater energy efficiency, lower transaction costs, and improved scalability while maintaining network security and decentralization.

Scalability remains one of the most significant limitations of public blockchains, particularly those relying on Proof-of-Work (PoW) consensus mechanisms. Ethereum, prior to its transition to Proof-of-Stake (PoS), experienced severe network congestion and high transaction fees, as evidenced by the CryptoKitties bottleneck in 2017, which disrupted transaction flow and raised concerns over blockchain's capacity for mainstream financial adoption (Werbach, 2018). The literature suggests that scalability challenges could hinder the expansion of tokenized ESG markets, as institutional investors require fast, cost-efficient, and regulatory-compliant blockchain infrastructure (Lener and Furnari, 2024).

Interoperability is also a critical barrier. In the context of this research, refers to the ability of different blockchain networks, financial platforms, and regulatory systems to seamlessly communicate, exchange data, and integrate with one another. It ensures that tokenized assets, such as carbon credits, green bonds, and other sustainable financial instruments, can be transacted across different blockchain ecosystems, financial markets, and regulatory jurisdictions without friction.

Tian et al. (2022) argue that isolated blockchain networks hinder widespread adoption, while Lima et al. (2024) stress the importance of standardized protocols to enable seamless integration. Scalability and cybersecurity risks further complicate Tokenization's adoption, as blockchain networks require significant computational resources to maintain security without sacrificing efficiency (Mulligan, Morsfield and Cheikosman, 2024).

Current research often assumes Tokenization universally resolves financial inefficiencies without considering market-specific constraints (Goel *et al.*, 2022; Montovanelli, 2023). Additionally, there is limited empirical research on Tokenization's long-term effects on financial inclusivity and sustainability. Future studies should focus on overcoming these structural limitations to enhance Tokenization's scalability and resilience.

2.4 Fraud, Security Vulnerabilities and Governance Challenge

While Tokenization offers significant advantages in sustainable finance, it is not without risks. One of the primary concerns is fraud and security vulnerabilities, particularly in decentralized blockchain ecosystems where smart contract exploits, hacking incidents, and phishing attacks have led to substantial financial losses. For example, the DAO hack in 2016, which resulted in the theft of \$60 million worth of Ether, exposed fundamental security flaws in self-executing smart contracts and led to the controversial Ethereum blockchain split (Werbach, 2018).

Similarly, the collapse of Terra-Luna in 2022 demonstrated the dangers of algorithmic instability in tokenized financial ecosystems, shaking investor confidence and triggering widespread sell-offs in ESG-linked crypto assets (Santiago, Charifzadeh and Herberger, 2024). These cases highlight the importance of strong governance frameworks, external audits of smart contracts, and regulatory oversight to mitigate security risks in tokenized sustainable investments. Without such measures, the inherent transparency of blockchain could paradoxically become an avenue for illicit financial activity and investor exploitation.

A major area of debate is the regulatory environment and the role of centralized governance in tokenized systems. Authors like Zhang *et al.* (2024) and Lima *et al.* (2024) argue for centralized oversight mechanisms to ensure trust, interoperability and mitigate risks such as fraud, cybersecurity breaches, and market volatility. In contrast, Mhaskey (2024) and Domingo and Mathew (2021) advocate for decentralized models, where smart contracts autonomously manage compliance and enhance system efficiency.

2.5 Impact on National and International Regulation

Tokenized ESG finance presents an opportunity to improve transparency and sustainability goals globally. In Brazil, regulatory developments such as Law No. 14,430/22 have laid the groundwork for securitizing tokenized assets, including green bonds and carbon credits (Nogueira, 2023). However, inconsistencies in domestic and international ESG standards limit scalability and hinder the attraction of global investors (Goel *et al.*, 2022; Montovanelli, 2023). While Nogueira (2023) advocates for strong regulations to enhance fiduciary security, Montovanelli (2023) and Mhaskey (2024) favor flexible regulatory approaches that foster market innovation.

The debate extends to regulatory models. The European Union enforces strict ESG criteria through the SFDR (Sustainable Finance Disclosure Regulation), whereas emerging markets, such as Brazil, often favor adaptable regulations (Gama, 2024). Brazil faces significant challenges in ESG compliance and greenwashing prevention, defined as a practice of misleading consumers or investors by falsely portraying products, services, or investments as environmentally friendly or sustainable. Although existing laws provide foundations for Tokenization, they lack specificity in ESG integration (Nogueira, 2023). Additionally, the absence of standardized ESG metrics complicates impact assessments and investor confidence (Netto and Alvares, 2023).

Many scholars assume that technology and regulations will naturally align to resolve governance challenges, which Cavalcante (2023) considers an oversimplification. There is limited empirical research on the long-term effectiveness of tokenized ESG investments. Future studies should assess Brazil's regulatory harmonization with global standards and propose frameworks that balance regulatory compliance with innovation.

According to Gama (2024), Brazil's regulatory environment faces unique challenges to ensure compliance, align with global ESG standards and address greenwashing. According to Nogueira (2023), while existing laws provide a foundation for Tokenization, they lack the specificity needed to integrate ESG principles across various sectors. At the same time, Brazil's renewable energy market and carbon credit initiatives present significant opportunities for tokenized finance. However, the lack of standardized ESG criteria and

metrics complicates efforts to measure impact and attract international investors (Goel *et al.*, 2022; Netto and Alvares, 2023).

2.6 Investor Perceptions and Decision-Making

The emerging and limited literature on foreign investor engagement with sustainable tokens in Brazil highlights the increasing interest in ESG-linked digital assets due to their potential for transparency, liquidity, and alignment with global sustainability goals (Goel *et al.*, 2022; Montovanelli, 2023). According to Nogueira (2023), Brazil's rich natural resources and leadership in renewable energy present significant opportunities for tokenized ESG investments, making it an attractive destination for international investors seeking impactful and innovative financial products.

While there is consensus on the potential of sustainable tokens, authors differ on the key factors influencing foreign investor perceptions. Some, like Gama (2024), highlights the importance of strong regulatory frameworks and standardized ESG metrics to address concerns about greenwashing and fraud. In contrast, Netto and Alvares (2023) argues that foreign investors prioritize scalability and interoperability over strict regulatory requirements, emphasizing the need for flexible frameworks to encourage adoption. Additionally, challenges such as limited international recognition of Brazilian tokenized assets and inconsistent ESG compliance across projects hinder foreign investment (Goel *et al.*, 2022; Montovanelli, 2023).

A critical evaluation reveals gaps in understanding the nuanced preferences of foreign investors and the long-term effectiveness of sustainable tokens in achieving measurable ESG outcomes. Much of the literature assumes a universal investor profile, overlooking variations in risk tolerance, regional priorities, and technological familiarity among foreign stakeholders (Nogueira, 2023; Gama, 2024). Furthermore, there is limited empirical evidence on the performance of Brazilian tokenized ESG assets in global markets, creating a disconnect between theoretical potential and practical outcomes. The lack of focus on cultural and market-specific dynamics further limits insights into how Brazil can effectively attract and retain foreign investment in sustainable tokens.

The literature broadly assumes that foreign investors evaluate tokenized ESG assets solely on their financial performance and regulatory compliance. However, limited empirical research examines the specific investor preferences related to governance structures, market accessibility, and risk exposure (Montovanelli, 2023; Gama, 2024). Additionally, while studies discuss the role of blockchain in sustainable finance, there is a lack of structured analysis on how Brazil can implement an effective framework to bridge the gap between local Tokenization initiatives and global capital markets. More research is needed on the comparative success of tokenized ESG assets in other emerging-market jurisdictions and their applicability to Brazil.

2.7 Research Gaps

Despite the growing body of literature on blockchain technology, sustainable finance, and digital assets, several important research gaps remain in understanding how Tokenization can influence investment decisions in sustainable projects, particularly within emerging markets. While previous studies have examined these topics individually, the intersection between Tokenization, investor behavior, and sustainable finance ecosystems remains underexplored. This section identifies the key gaps in the existing literature that this research seeks to address.

2.7.1 Limited Integration between Tokenization and Sustainable Finance Literature

Although blockchain technology and Tokenization have attracted increasing academic attention, much of the existing research focuses primarily on cryptocurrencies, decentralized finance (DeFi), or tokenized securities, with relatively limited attention given to their potential application in sustainable investment markets. At the same time, the literature on sustainable finance and ESG investing has largely concentrated on traditional financial instruments such as green bonds, sustainability-linked loans, and impact investment funds. Few studies have explored how digital technologies such as blockchain can transform ESG investment structures by improving transparency, traceability, and investor access.

This separation between the blockchain literature and the sustainable finance literature creates a significant knowledge gap regarding how Tokenization could function as a financial innovation capable of supporting sustainable investment ecosystems. As a result, there is limited empirical evidence on the role that tokenized assets may play in enhancing the credibility, accessibility, and efficiency of sustainable investment markets.

2.7.2 Limited Understanding of Investor Behavior toward Tokenized ESG assets

Another important gap in the literature concerns the behavioral dimensions of investor decision-making in tokenized sustainable investments. While financial technology research often emphasizes the technological advantages of blockchain-based systems, fewer studies have examined how investors perceive and evaluate tokenized assets in practice. Existing studies in behavioral finance suggest that investors frequently rely on heuristics, risk perceptions, and trust mechanisms when evaluating new financial instruments. However, the interaction between behavioral biases, trust formation, and emerging digital financial technologies remains insufficiently explored.

In particular, little empirical research has examined how factors such as perceived transparency, technological risk, regulatory uncertainty, and ESG alignment influence investor willingness to adopt tokenized sustainable investment instruments. Understanding these behavioral dynamics is essential for explaining why certain financial innovations gain widespread adoption while others face resistance in financial markets.

2.7.3 Insufficient Research on Institutional and Regulatory Drivers of Tokenization Adoption

The adoption of tokenized financial instruments is also influenced by the institutional and regulatory environments in which they operate. While several studies have discussed the importance of regulatory frameworks in shaping financial innovation, there remains limited empirical evidence regarding how regulatory conditions influence the development of tokenized sustainable finance markets. In particular, there is a lack of research examining how institutional legitimacy, regulatory clarity, and policy frameworks influence investor

perceptions of tokenized assets. This gap is especially relevant in emerging markets, where regulatory frameworks for digital assets are still evolving and institutional environments may differ significantly from those in developed economies.

There is a lack of empirical assessments of regulatory approaches to tokenized governance, particularly through comparative studies of jurisdictions implementing centralized oversight versus decentralized compliance models. Studies should explore the effectiveness of advanced security frameworks, such as AI-driven fraud detection and zero-knowledge proof-based privacy solutions, in mitigating tokenized asset risks (Goel *et al.*, 2022). Another key research gap is understanding investor sentiment toward different governance structures—whether institutional investors and retail participants prefer regulated tokenized markets over purely decentralized finance models (Cavalcante, 2023). Real-world case studies of successful governance frameworks in ESG-linked tokenized investments could provide valuable insights into best practices for ensuring security, reducing fraud risks, and fostering responsible innovation in sustainable finance. Addressing these gaps is critical for designing governance frameworks that ensure both security and scalability in tokenized financial markets.

There is a lack of study that explores how Brazil can overcome these barriers by tailoring tokenized ESG offerings to the specific needs and concerns of foreign investors. This includes examining the role of transparency, regulatory harmonization, and innovative financing models in boosting investor confidence. Comparative studies of successful tokenized ESG assets in other jurisdictions could provide actionable insights for enhancing Brazil's market appeal. Addressing these gaps support the development of a comprehensive framework that aligns foreign investor preferences with Brazil's sustainability goals, advancing both academic understanding and practical application in this emerging field.

Other important outcome of future research should focus on developing a structured framework to enhance the attractiveness of tokenized Brazilian sustainable projects abroad. This includes identifying key regulatory reforms, exploring best practices from other countries, and establishing standardized ESG disclosure mechanisms to align with international investment criteria. A multidimensional approach that incorporates regulatory

clarity, technological interoperability, and institutional trust could significantly improve Brazil's positioning in the global tokenized sustainability market. Addressing these gaps also provides a roadmap for policy recommendations and practical strategies to foster greater international investment in Brazilian tokenized ESG assets.

Understanding the role of institutional factors is therefore essential for explaining the conditions under which tokenized sustainable investment markets can develop successfully.

2.7.4 Limited Empirical Evidence from Emerging Markets

Another significant gap in the literature concerns the geographical concentration of existing research. Most empirical studies on blockchain adoption and Tokenization have focused on developed economies, particularly in North America, Europe, and parts of Asia.

However, emerging markets such as Brazil present unique opportunities and challenges for sustainable finance. Brazil possesses vast natural resources, biodiversity assets, and renewable energy potential, making it a strategically important destination for ESG investments. At the same time, regulatory frameworks, institutional stability, and financial market structures differ significantly from those of developed economies.

There is a lack of understanding identifying possible directions to harmonize Brazilian regulations with international standards while accommodating the unique characteristics of the local market. This includes assessing the effectiveness of existing legislation, such as Law No. 14,430/22, and exploring international best practices that could be adapted to Brazil's context. Addressing gaps in the literature by developing standardized ESG metrics and evaluating the real-world impacts of Tokenization support a comprehensive framework for fostering sustainable finance in Brazil. Such research not only would support policymaking but also could enhance investor confidence and drive innovation in ESG finance.

Despite Brazil's importance in global sustainability discussions, there remains limited empirical research examining how Tokenization may influence sustainable investment flows within the Brazilian context. This gap highlights the need for context-specific studies that consider the institutional and economic characteristics of emerging markets.

2.7.5 Lack of Integrated Theoretical Frameworks

A final gap in the literature relates to the lack of integrated theoretical frameworks capable of explaining the adoption of tokenized sustainable investments.

Existing studies often analyze blockchain adoption from a technological perspective, focusing on system architecture, efficiency improvements, or transaction cost reductions. Other studies examine sustainable investment behavior through the lens of behavioral finance or institutional theory. However, few studies integrate these theoretical perspectives to explain how technological innovation interacts with investor psychology and institutional environments in shaping financial market outcomes.

This research addresses this gap by developing an Integrated Behavioral–Institutional Model of Tokenized Sustainable Investment, which combines insights from Behavioral Finance and Institutional Theory to explain how Tokenization influences investor trust, investment decisions, and sustainable capital allocation.

2.8 Conceptual Framework Model

A revised conceptual framework - a tool for designing research projects proposed by Maxwell (2013) - structures the analysis to determine whether Tokenization serves as a mechanism to attract foreign investment in sustainable investments. The framework suggests that Investor Trust mediates the relationship between Tokenization (TOK) and Willingness to Invest (WIL), highlighting how perceived transparency, security, and regulatory clarity shape investor confidence. The attractiveness of tokenized ESG assets depends on both the inherent advantages of Tokenization (such as financial accessibility and blockchain transparency) and the alignment of sustainability efforts with international ESG standards.

Risk perceptions that inhibit adoption and investment — regulatory, economic, and technological serve as Perceived Threats (THR), influencing Investor Trust (TRU), which in turn affects Willingness to Invest (WIL). The extent to which Tokenization facilitates foreign capital flows depends not only on these direct factors but also on the "moderating role of Brazil's Economic Instability". Specifically, macroeconomic stability and political predictability shape the relationship between Tokenization (TOK) and Willingness to Invest

(WIL), determining whether foreign investors perceive Brazil as a financially and politically secure market.

To isolate the impact of Tokenization within this framework, the analysis assumes a neutral baseline for Brazil's macroeconomic conditions, political stability, and geopolitical context, ensuring that variations in international investment can be more directly attributed to Tokenization's role rather than external fluctuations.

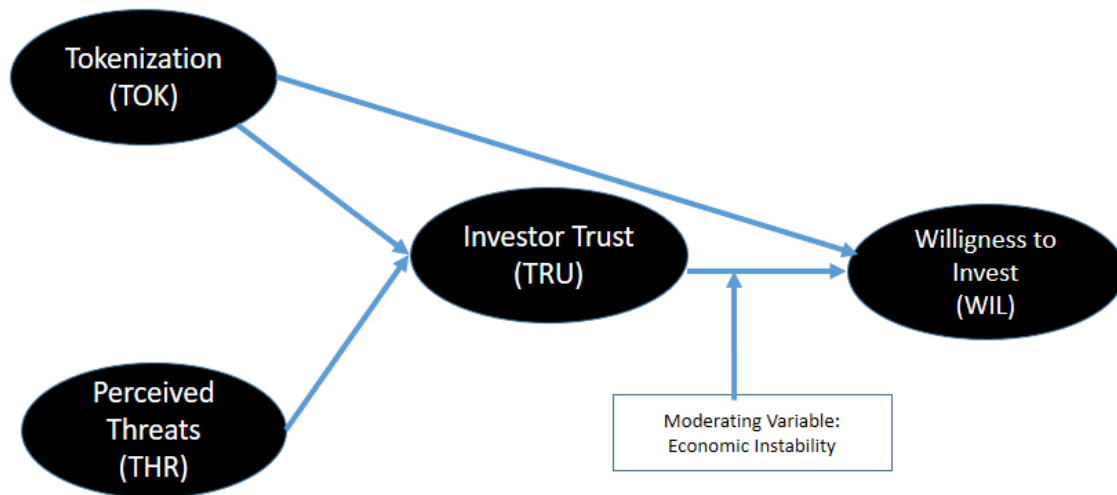


Figure 1: Conceptual Framework

Source: Author's elaboration

The conceptual framework for Tokenization in Brazilian sustainable investments is theoretically grounded by integrating behavioral finance and institutional investment theories, which explain investor decision-making in emerging markets. Prospect Theory, developed by Kahneman and Tversky (1979), is a foundational concept in behavioral finance that explains how individuals make decisions under uncertainty. Unlike traditional expected utility theory, which assumes that investors are rational and aim to maximize gains, Prospect Theory argues that people perceive gains and losses asymmetrically, placing greater psychological weight on losses than on equivalent gains.

This phenomenon is known as Loss Aversion. Prospect Theory is particularly relevant in explaining how international investors behave in emerging markets like Brazil, especially when considering sustainable tokenized assets. It highlights why investors do not always make decisions based purely on financial returns but are instead influenced by perceived regulatory risks, technological uncertainty, and loss aversion.

Additionally, Regret Aversion Theory (Loomes and Sugden, 1982) indicates that investors may avoid tokenized assets due to fear of making irreversible mistakes in a volatile legal environment. Herding Behavior Theory (Banerjee, 1992) further explains how international investment decisions may follow institutional leaders, meaning that widespread Tokenization adoption depends on early participation by large ESG funds and financial institutions. These behavioral perspectives clarify how trust in blockchain, regulatory stability, and financial accessibility interact in shaping investment preferences, aligning with the framework's focus on the interplay between Tokenization and investor sentiment.

From an institutional perspective, according to DiMaggio and Powell (1983) institutional theory suggests that international investors are influenced by normative pressures, regulatory compliance, and industry best practices, reinforcing the idea that Brazil's alignment with global ESG standards enhances tokenized asset adoption. Legitimacy theory (Suchman, 1995) further supports this argument, asserting that investments require institutional legitimacy, which in this context would be provided by government support, regulatory clarity, and reputable financial intermediaries. Meanwhile, pecking order theory (Myers and Majluf, 1984) explains why investors may favor tokenized assets if blockchain technology enhances transparency and reduces information asymmetry.

Theoretical Framework

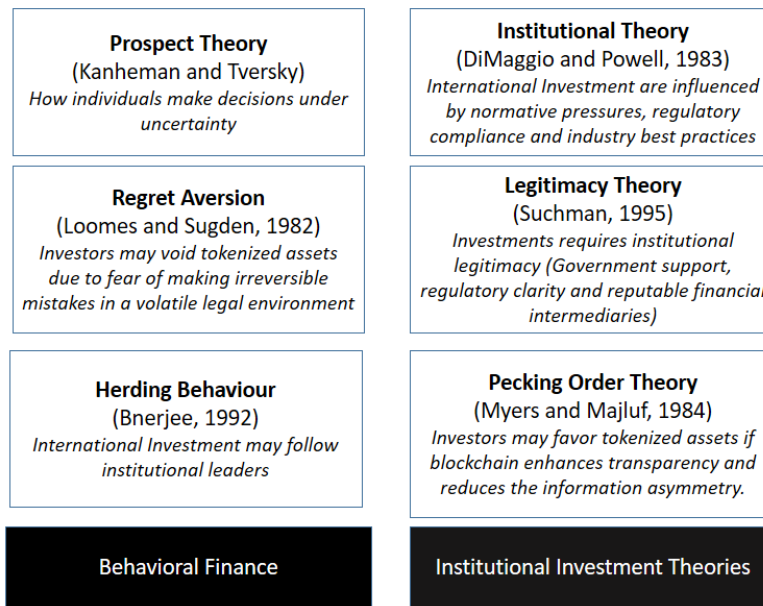


Figure 2: Theoretical Framework

Source: Author's elaboration

These institutional perspectives provide deeper justification for the conceptual model, demonstrating that Tokenization's success hinges on its ability to mitigate investor concerns through regulatory stability, financial transparency, and institutional legitimacy. By integrating these theoretical foundations, the study strengthens its analytical depth and offers a more comprehensive understanding of the drivers and barriers to international investment in Brazilian sustainable projects.

CHAPTER III: RESEARCH DESIGN AND METHODOLOGICAL APPROACH (MIXED METHODS)

3.1 Research Paradigm and Mixed Methods Design

This study employs a mixed-methods approach, combining qualitative and quantitative research to provide a comprehensive and multidimensional analysis of Tokenization in sustainable investments from an international investor perspective. The rationale for this methodological choice is that qualitative data can capture the nuanced perceptions, motivations, and concerns of investors, while quantitative data can provide measurable insights into investor sentiment, willingness, and market potential. By integrating

these approaches, the study aims for a more robust, triangulated understanding of how Tokenization influences foreign investment decisions in sustainable assets.

Table 2: *Comparative overview of mixed-methods approach*

Aspect	Qualitative Study	Quantitative Study
Objective	Explore perceptions and barriers.	Measure trends and test hypotheses.
Method	Semi-structured interviews.	Structured survey.
Sample	9 key stakeholders.	220 international investors.
Data Collection	Interviews, observation, documents.	Online surveys via networks/platforms.
Data Analysis	Thematic coding, pattern identification.	Descriptive stats, regression, SEM.
Outcome	Rich narratives and insights.	Measurable, generalizable results.

Source: elaborated by Author

The qualitative component follows an exploratory case-study design, enabling an in-depth examination of tokenized sustainable investments and their appeal to international investors. This approach ensures strong theoretical alignment with behavioral finance and institutional investment theories. The quantitative component employs an exploratory and explanatory survey design to measure investor sentiment, perceived risks, and interest in tokenized ESG assets in Brazil.

3.2 Methodological Flow

The study employs two main research instruments—semi-structured interview protocols for the qualitative method and a structured survey questionnaire for the quantitative method—complemented by secondary data analysis from regulatory documents and policy reports. Together, these instruments ensure both exploratory depth and statistical generalizability.

The outcomes of semi-structured interviews and structured surveys are complemented by Document Analysis (e.g. Laws, regulations, policy papers, contextualizing the findings of the interviews and surveys) and Observation Notes, including insights from conferences,

webinars, and ESG-finance panels. The use of multiple instruments allows triangulation. Survey findings are compared with interview narratives and document analysis to ensure consistency. This enhances validity, mitigates biases, and provides a holistic understanding of Tokenization's role in sustainable investments.

Table 3: *Comparison of instruments*

	Semi-Structured Interview Protocols	Structured Survey Questionnaire
Purpose	Capture nuanced insights on perceptions, trust, risks, and regulatory clarity.	Generate measurable data on investor sentiment and test hypotheses.
Structure	Flexible guide with open-ended questions, allowing follow-up.	Fixed questionnaire with Likert scales, rankings, and closed-ended items.
Themes	Investor trust in blockchain, regulatory barriers, perceptions of ESG alignment, and attractiveness of tokenized assets.	(1) Willingness to adopt tokenized ESG assets, (2) Perceptions of regulatory, economic, and technological risks, (3) Impact of ESG alignment and financial accessibility on investment decisions.
Strengths	Provides depth, captures emerging themes, and allows contextual understanding.	Ensures generalizability, allows statistical analysis and hypothesis testing.
Format	A guide with 21 core questions but flexible sequencing, allowing follow-up based on participants' responses.	Online survey with 18 questions, including Likert-scale items, ranking scales, and closed-ended multiple-choice questions.
Validation	Questions are derived from established frameworks in sustainable finance and blockchain adoption studies.	Survey items adapted from validated instruments in ESG investment and blockchain adoption research.

Source: elaborated by Author

3.3 Integration Strategy

By integrating quantitative and qualitative methods, this approach provides a holistic and reliable understanding of investor perceptions, regulatory concerns, and market adoption. Triangulation minimizes methodological bias, enhances data consistency, and ensures that research findings are comprehensive and cross-validated (Saunders, Philip and Adrian, 2023).

Convergent Analysis phase involves cross-referencing survey results with qualitative insights, allowing the study to identify patterns and consistencies between investor sentiment and regulatory perceptions. This step ensures that statistical trends observed in quantitative data align with the narratives and concerns expressed in qualitative interviews. Such an approach strengthens the credibility of the findings by validating trends through multiple sources of data and ensuring that no single data collection method dominates the interpretation of results.

Sequential Integration leverages initial survey findings to refine interview questions, allowing for a more targeted exploration of emerging themes. This dynamic approach ensures that qualitative data not only complements but also explains key trends observed in the statistical results.

Mixed-Methods Validation enhances the coherence of findings by systematically comparing quantitative trends with qualitative narratives, ensuring that conclusions drawn from the study are grounded in both empirical data and experiential insights. This triangulation process strengthens the research's validity, reliability, offering a more nuanced, and actionable understanding of how Tokenization influences sustainable investment decisions.

3.4 Convergent Analysis

The selection of quantitative and qualitative data analysis techniques follows the Convergent Analysis methodological principles outlined by Saunders et al. (2023) and Creswell (2011) ensuring a structured and rigorous approach to understanding investor sentiment and regulatory concerns in tokenized sustainable investments. The survey responses was analyzed using descriptive statistics to summarize key trends and identify patterns in investor perceptions. Regression analysis aims to examine the relationships between

independent variables (e.g., trust, risk perception, regulatory confidence) and dependent variables (investment willingness in tokenized ESG assets). This approach aligns with (Saunders, Philip and Adrian, 2023) recommendation for inferential statistical methods in business research, allowing the study to determine the significance and strength of relationships between key variables. Furthermore, structural equation modeling (SEM) provides a holistic analytical framework, capturing latent constructs such as investor confidence, decision-making processes, and risk mitigation strategies, ensuring a deeper understanding of the complex interactions shaping investment behavior.

In addition to quantitative methods, Thematic Analysis of qualitative data is crucial to complement numerical findings with contextual insights. Interview transcriptions were analyzed using coding techniques to identify recurring themes, ensuring that investor concerns, regulatory expectations, and trust factors are systematically categorized. This method enhances the reliability and validity of qualitative insights by structuring the analysis into key emergent themes rather than isolated individual responses. Moreover, secondary data analysis through document and regulatory reviews support in contextualizing the study within real-world market conditions, ensuring that findings align with existing legal and financial frameworks. This triangulated approach strengthens the credibility of conclusions, integrating multiple data sources to enhance research validity and reliability.

3.5 Validity and Rigor

To ensure validity and rigor across both qualitative and quantitative components, this study adopted multiple strategies aligned with best practices in Mixed-methods research. For the qualitative strand, credibility was enhanced through methodological triangulation, member checking, and systematic coding using software MAXQDA, which allowed for transparent and replicable thematic analysis.

Dependability was reinforced through an audit trail documenting the decision-making process, coding iterations, and researcher reflexivity. Confirmability was achieved by maintaining neutral interpretation practices and linking findings directly to the participants' narratives. For the quantitative components, internal validity was supported by the use of

validated instruments and consistent data collection protocols. Data integration followed a convergent design logic, wherein findings from both strands were analyzed independently and then compared to identify convergence, complementarity, or divergence. This multi-dimensional approach strengthens the study's overall trustworthiness and ensures that conclusions are grounded in a robust and transparent analytical process.

3.6 Ethical Considerations

Ethical integrity is a cornerstone of this research, which involves collecting and analyzing expert insights on the adoption of Tokenization in Brazil's sustainability sector. Given the involvement of human participants, the study adhered strictly to established ethical guidelines to ensure voluntary participation, informed consent, confidentiality, and responsible data handling.

Regarding Informed Consent, all participants were briefed in advance about the purpose, scope, and intended outcomes of the research. Each interviewee received an informed consent form, which clearly outlined their rights, including the voluntary nature of participation, the ability to withdraw at any time, and assurances regarding the confidentiality and anonymity of their responses. Recorded or written consent was obtained prior to the interviews, depending on the participant's preference.

To protect participant identity, all personal information and affiliations were anonymized using unique identifiers (e.g., INT_01, INT_02). Data was stored securely on encrypted and access-restricted devices, and transcripts were stripped of any directly identifying information. No individual or institutional names are disclosed in the published findings without explicit permission. The anonymized quotations used in the analysis serve only to illustrate thematic patterns and not to attribute opinions to specific persons.

All data generated throughout the study—including audio recordings, interview transcripts, and coded datasets—were handled in strict compliance with institutional ethical standards and international data protection regulations, including the GDPR. Files were stored on secure, access-restricted platforms and backed up using encrypted formats to safeguard confidentiality. Identifiable information was accessible exclusively to the principal researcher

and will be retained for a maximum of five years, after which it will be permanently and securely deleted.

Particular attention was paid to ethical integrity in relation to the avoidance of harm and sensitivity to context. Given the nature of the topics discussed—such as regulation, finance, and blockchain technology—the study was designed to minimize any potential reputational or professional risk to participants. Interview protocols were structured to elicit high-level, professional insights, avoiding any requests for personal, confidential, or proprietary information. The political and regulatory complexities of the Brazilian context were acknowledged throughout the research process, and care was taken to ensure that participants were never placed in a position that could be perceived as controversial or compromising.

CHAPTER IV: QUANTITATIVE METHOD

4.1 Research Design

The quantitative component employs an exploratory and explanatory survey design to systematically measure investor sentiment, perceived risks, and interest in tokenized ESG assets in Brazil.

The survey includes structured questions derived from prior studies on investor behavior, blockchain adoption, and ESG investment, ensuring consistency with existing research. Key themes include:

- i. Investor willingness to adopt tokenized ESG assets.
- ii. Perceived regulatory, economic, and technological risks affecting investment decisions.
- iii. The impact of ESG alignment and financial accessibility on investor confidence and participation.

4.2 Population and Sample

The target population consists of international investors and stakeholders directly or indirectly involved in sustainable finance. The study focuses on institutional investors (pension funds, ESG-aligned funds), venture capital firms investing in blockchain solutions, impact investors prioritizing sustainability, and blockchain professionals contributing to financial innovations. The quantitative survey has reached 220 respondents to achieve

statistical significance. The sample size is justified based on power analysis, with an estimated effect size (Cohen's $f^2 = 0.15$) and a 95% confidence level, ensuring sufficient statistical power (0.80) for detecting meaningful relationships.

Table 4: *Sampling criteria for statistical validity*

Parameter	Justification
Effect Size Cohen's $f^2 = 0.15$	Effect size measures the magnitude of relationships between variables. In financial research, a moderate effect size (0.15) is commonly used in multiple regression analyses where several factors (e.g., investor trust, regulatory stability, ESG adoption) influence investment decisions (Cohen, 2013).
Statistical Power 0.80 or 80%	Statistical power refers to the probability of detecting a true effect if one exists. A power level of 0.80 means that the study has an 80% chance of detecting statistically significant relationships, reducing the risk of Type II errors (failing to identify real effects) (Faul <i>et al.</i> , 2009). This power level is widely accepted in behavioral finance and market research for investor sentiment studies.
Confidence level 95%	A 95% confidence level ensures that the findings are statistically robust and not due to random chance. This means that if the study were repeated multiple times, 95% of the time, the results would fall within the expected range (Field, 2024)

Source: elaborated by Author

Prior studies on investor sentiment in emerging blockchain-based financial markets (e.g., Friede *et al.*, 2015; Maleki, 2023) demonstrate that a sample of 200 respondents provides sufficient variability to analyze investor sentiment while maintaining practical feasibility.

4.3 Variables

The variables used in the quantitative component of the study (Structured Survey Questionnaire – Appendix E) and explains how the theoretical constructs identified in the

conceptual framework were operationalized for empirical analysis. The variables were derived from the literature on sustainable finance, behavioral finance, and blockchain-based financial innovation, and were incorporated into the research model to examine how Tokenization influences the attractiveness of sustainable investments in Brazil.

The study includes independent variables, a mediating variable, moderating variables, and a dependent variable, reflecting the multidimensional nature of investor decision-making in emerging financial markets.

4.3.1 Dependent Variable

4.3.1.1 Willingness to invest in Tokenized ESG assets (WIL): The dependent variable in this study is the willingness of international investors to invest in tokenized ESG assets in Brazil. This variable captures the extent to which investors are interested in allocating capital to sustainable investment opportunities that are structured using blockchain-based Tokenization mechanisms.

Willingness to invest represents the final outcome of the decision-making process analyzed in this research and reflects the attractiveness of tokenized ESG assets from the perspective of international investors. The construct is grounded in behavioral finance literature, which emphasizes the importance of investor perceptions, trust, and risk evaluation in shaping investment decisions. In the empirical analysis, investment willingness was measured using Likert-scale survey items assessing the respondents' likelihood of investing in tokenized ESG assets under different institutional and technological conditions.

4.3.2 Independent Variables

4.3.2.1 Tokenization Advantages (TOK): One of the main independent variables in this study is the perceived advantages of Tokenization in sustainable investment markets. Tokenization refers to the digital representation of real-world assets on blockchain networks, enabling fractional ownership, improved liquidity, and enhanced transparency. The literature suggests that Tokenization can reduce transaction costs, expand investor access to previously illiquid assets, and improve traceability of ESG performance indicators. These characteristics may increase the attractiveness of sustainable investments by improving market efficiency

and transparency. The construct is measured as a Index that combines investor perceptions regarding familiarity, perceived functional value of Tokenization (e.g. transparency, liquidity, accessibility) and Traceability, essential function associated with ESG tokenized assets.

4.3.2.2 Perceived Threats (THR): variable that represents investor concerns regarding the potential challenges associated with tokenized financial instruments. These risks include technological vulnerabilities, regulatory uncertainty, cybersecurity threats, and the perceived immaturity of blockchain-based financial infrastructure.

Behavioral finance literature emphasizes that perceived risks play a critical role in shaping investor decisions, particularly when evaluating new financial technologies. Investors often display risk-averse behavior when faced with uncertainty or unfamiliar financial instruments. The concept is measured as an index that combines perceptions of technological, regulatory, and market risks associated with tokenized sustainable investments.

4.3.3 Mediating Variable

4.3.3.1 Investor Trust (TRU): represents a key mediating variable in the research model. Trust is defined as the degree to which investors believe that tokenized sustainable investment systems are reliable, transparent, and capable of delivering accurate information regarding project performance and ESG impact. The literature on financial innovation suggests that trust plays a crucial role in facilitating the adoption of new technologies in financial markets. Blockchain technology may strengthen trust by enabling immutable record-keeping and transparent verification of transactions. In this study, investor trust is hypothesized to mediate the relationship between Tokenization advantages and investment willingness. The construct is measured as an Index that combines investor perceptions of transparency, credibility of ESG data, and reliability of blockchain-based financial systems.

4.3.4 Moderating Variable

4.3.4.1 Macroeconomic Instability: Macroeconomic instability refers to the broader economic conditions of the host country, including political stability, economic growth prospects, and financial market reliability. Investors often consider macroeconomic conditions when evaluating investment opportunities in emerging markets. The literature on international investment suggests that macroeconomic stability can moderate investor

willingness to allocate capital, particularly in emerging economies where political and economic volatility may increase perceived risk. In this study, macroeconomic stability is measured through survey items assessing investor perceptions of Brazil's economic environment and its impact on investment decisions.

Table 5: List of observed variables defined for survey

Construct	Definition	Observed variables (in database)	Justification
Tokenization (TOK)	Degree to which the investor perceives and understands the advantages of Tokenization for sustainable investments (e.g., liquidity, traceability, disintermediation).	1.1 Familiarity_Tokenization	Cognitive measure of exposure to technology
		2.2 Adoption_Increased_liquidity	They reflect the perceived functional value of Tokenization.
		2.3 Adoption_Enhanced_transparency	
		2.4 Adoption_Lower_transaction	
		2.5 Adoption_fractional_ownership	
		2.6 Adoption_Portfolio_Diversification	
		2.7 Financial_Accessibility	It indicates an essential function of Tokenization in ESG.
Perceived Threats (THR)	Risk perceptions that inhibit adoption and investment — regulatory, economic, and technological.	3.1 Blockchain_Traceability	
		4.1 Regulatory_Uncertainty	A direct measure of the perception of legal barriers.
		4.2 Risk_Regulatory_uncertainty	
		5.1 Tech_Challenges	Technological infrastructure risks (scalability and interoperability)
		5.2 Risk_Technological_immaturity	
		6.1 Risk_Blockchain_security_concerns	High impact on decentralized markets
Investor Trust (TRU)	Investor confidence in the institutional security and regulatory stability of the Tokenization market in Brazil.	7.1 Risk_Illiquidity_of_tokenized_assets	Lack of asset liquidity may limit adoption.
		8.1 ESG_Alignment_Confidence	Trust built through ESG alignment and regulation.
		9.1 ESG_Disclosure_Importance	
		9.2 Adoption_Alignment_ESG	High importance in the decision-making process suggests confidence based on evidence.
		9.3 Risk_Lack_ESG_standardization (inverse)	
		10.1 Risk_Lack_of_institutional_trust (inverse)	Fear of the unstable origin of assets reduces confidence.
		10.2 Adoption_institutional_backing_or_regulation	
Macroeconomic Instability (Moderating Factor)		10.3 Risk_Absence_of_credible_third_party_verification (inverse)	
		11.1 Econ_Instability	Aversion to unstable countries affects the decision.
		11.2 Risk_Macroeconomic_volatility	
Willingness to invest (WIL)	Behavioral disposition (intention) to invest in sustainable tokenized assets in Brazil	12.1 Likelihood_Invest_Brazil	Direct behavioral intention (main dependent variable)
		12.2 Portfolio_Allocation	In practice, it reflects the expected level of engagement.

Source: elaborated by Author

4.4 Data Collection

Participants for the quantitative component of this study were selected using a purposive and stratified sampling strategy, with the objective of ensuring representation across key investor segments relevant to the research scope. This approach was deemed appropriate given the exploratory nature of the study and the need to capture informed perspectives from stakeholders with direct experience in sustainable finance, blockchain technologies, and tokenized investment instruments. The sampling strategy focused on three primary groups: institutional investors, including pension funds and ESG-aligned investment funds; venture capital firms with demonstrated interest in blockchain-based financial innovations; and impact investors prioritizing sustainability-driven financial models.

Participant recruitment was conducted through multiple complementary channels in order to enhance sample diversity and mitigate access limitations commonly associated with senior financial professionals. First, respondents were identified through professional investment networks and specialized forums, including CFA Society events, sustainable investment associations, and blockchain-finance communities. Second, industry conferences, seminars, and webinars focusing on ESG investment, blockchain Tokenization, and sustainable finance were leveraged as recruitment platforms, enabling direct engagement with practitioners actively involved in the field.

In addition, targeted outreach was undertaken via LinkedIn, where professionals and organizations engaged in sustainable finance, fintech, and digital asset markets were contacted directly. This method facilitated access to geographically diverse participants and allowed for selective engagement with individuals whose professional profiles aligned with the study's inclusion criteria. To further supplement the sample and broaden participation, the Prolific research platform was utilized, particularly to include retail investors and individuals with prior experience in blockchain-based or digital asset investments and are concern about Environment Issues. This strategy supported access to a larger and more heterogeneous group of respondents, thereby enriching the qualitative dataset.

Table 6: *Prolific Research Platform recruiting criteria*

Criteria	Definition
Participants residency	World (except Brazil)
Employment Status	Full Time or Part Time or Other
Types of investment	Venture Capital Fund
Cryptocurrency	Yes
Climate Change	Yes
Concern about Environment Issues	Concern/Very Concern

Source: elaborated by Author

Note: The above criteria resulted in 415 eligible participants from 192,715 potential users in Prolific Research Platform.

Recruitment efforts extended to online investment platforms and fintech communities, including educational and discussion forums such as Binance Academy, CoinDesk, and decentralized finance (DeFi) investment groups. These channels were particularly relevant for reaching participants familiar with Tokenization mechanisms, blockchain infrastructure, and emerging digital investment models.

All participants who met the eligibility criteria were invited to respond to an initial research survey administered via Google Forms, which served both as a data collection instrument and as a screening mechanism for subsequent qualitative engagement. The use of Google Forms enabled standardized data collection, secure handling of responses, and efficient management of participant information across multiple recruitment channels. Responses obtained through the survey informed the selection and categorization of participants for the qualitative analysis and supported the integration of survey data within the broader mixed-methods research design.

4.5 Statistical Analysis

4.5.1 Exploratory Analysis

Considering that the study variables are categorical, dichotomous, or ordinal (scales ranging from 1 to 3 points and from 1 to 5 points), a descriptive analysis of the data was conducted using absolute and relative frequencies. The Kolmogorov–Smirnov test was performed to assess the adherence of the outcome variable to the normal distribution curve (Bonamante, 2012).

Subsequently, comparative analyses using contingency tables and chi-square tests were conducted to identify potential associations between the independent variables and the outcome variable (likelihood to invest in tokenized ESG assets in Brazil in the next 12 months).

A matrix of associations based on the chi-square test was also created, allowing for a preliminary assessment of associations among all variables and helping to identify potential issues of co-associations that may hinder estimations in subsequent analyses. A p-value on its own does not convey direction or strength, only the presence of an association. As this analysis was purely exploratory, its purpose was to guide later decisions on data reclassification and model specification, rather than to serve as a basis for inferential conclusions. Subsequent analyses can incorporate more in-depth assessments, including correlation matrices, to refine the understanding of the relationships among variables.

4.5.2. Structural Equation Modeling

Aiming to conduct an overall assessment of the proposed theoretical model (Figure 1), a full structural equation modeling analysis, including both the measurement model and the structural model, was performed.

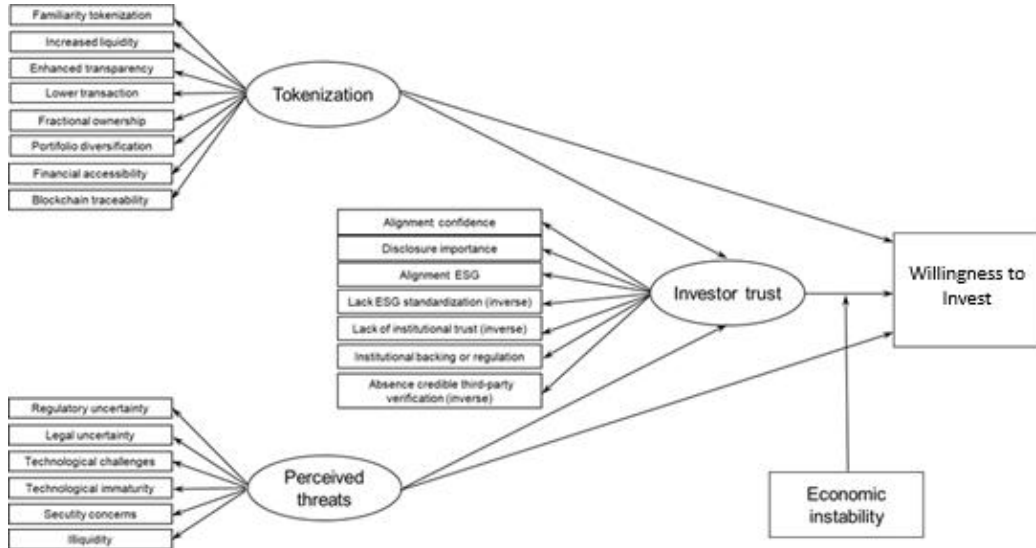


Figure 3: Detailed conceptual framework

Source: Author's elaboration based on qualitative data

Structural Equation Modeling – SEM comprises two interdependent components: the measurement model, which specifies the relationships between latent constructs and their observed indicators through confirmatory factor analysis – CFA, and the structural

model, which defines the directional regression paths among latent and observed variables, enabling the estimation of causal effects within the theoretical framework (Hoyle, 2012; Neves B., 2018; Kline, 2023). As such, SEM is a comprehensive statistical modeling technique that integrates principles from both factor analysis and regression, allowing researchers to test complex relationships between observed and latent variables and to estimate direct and indirect effects of explanatory variables on outcomes (Hoyle, 2012; Neves B., 2018; Kline, 2023).

In SEM, variables receive specific classifications. Regarding the nature of the construct, a variable may be observed (directly measured) or latent (a theoretical construct not directly measured but derived from observed variables through CFA). In terms of its role, a variable may be exogenous (a causal variable that is not explained by any other variable in the model) or endogenous (at some point in the analyses, it is explained by at least one other variable in the model). Importantly, a variable's role may change throughout the analyses (Hoyle 2012; Alexandre & Neves 2018; Kline 2023).

SEM and CFA are based on estimation methods (Appendix F), which are procedures are mathematical procedures used to obtain the model's parameter values—such as factor loadings, variances, covariances, and structural coefficients—that best reproduce the covariance matrix observed in the data (Brown, 2015).

A SEM was grounded in a solid theoretical model of the construct(s) of interest (Hoyle 2012; Alexandre & Neves 2018; Kline 2023). The theoretical model is represented through a path diagram, which graphically depicts how the observed and latent variables relate within the structural equation model. It serves as the graphical representation of the hypotheses under investigation (Hoyle, 2012; Neves B., 2018; Kline, 2023).

4.5.5 Regression Ordinal Analysis

To test the study hypotheses, which examine direct, indirect (mediated), or moderated effects, an ordinal regression approach was employed. Ordinal regression models estimate the relationship between predictor variables and the cumulative probabilities of an ordinal outcome, typically under the proportional odds assumption. When this assumption is violated, partial proportional odds models may be used, allowing selected predictors to exhibit varying effects across different thresholds of the ordinal outcome (Williams, 2006; Harrell, 2015).

The proportional odds assumption was initially assessed using the Brant test. When no evidence of violation was detected ($p > 0.05$), ordinal logistic regression

models assuming proportional odds were estimated. When the assumption was violated ($p < 0.05$), partial proportional odds models were fitted, allowing predictors to have non-proportional effects across outcome thresholds (Williams, 2006).

Path coefficients were estimated on the log-odds scale and exponentiated to obtain odds ratios (ORs) for interpretative purposes. For ordinal outcomes, ORs should be interpreted as reflecting the odds of being in a higher versus a lower category rather than changes in absolute probabilities. Robust variance–covariance estimators (VCE) were applied to account for potential heteroskedasticity and potential model misspecification (Williams, 2006; Harrell, 2015; StataCorp, 2015b).

Although ordinal predictors were initially specified as categorical variables using indicator (dummy) coding, models including full sets of category indicators exhibited sparse data patterns and unstable parameter estimates, particularly for predictors measured on Likert-type scales with multiple response categories. Therefore, ordinal predictors were modeled as continuous variables to preserve statistical power and ensure model identifiability. For dichotomous predictors, equivalent results are obtained with or without indicator coding. The same specification was adopted across the main effects, mediation, and interaction analyses.

Mediation effects were calculated following the same approach used in SEM, with the proportion of the total effect mediated estimated on the log-odds scale as the ratio of the indirect effect to the total effect (Buis, 2010).

The moderation models were estimated in two steps. First, baseline models including only the main effects of the predictor and the respective moderator were estimated to assess their direct associations with the outcome. Second, interaction models were specified by including a product term between the predictor and the moderator (Williams, 2006; Harrell, 2015).

Given data sparsity, predictors were modeled as linear terms, reflecting theoretical assumptions of a monotonic relationship with the outcome and ensuring parsimony given the data structure. Predictors were mean-centered prior to the construction of interaction terms. Mean-centering was applied to facilitate the interpretation of main effects (Williams 2006; Harrell 2015).

4.5.6 Level of significance

In all analyses, a 5% significance level was adopted.

4.5.7 Software

For data collection, Prolific Platform (<https://www.prolific.com/>) and Google Forms was used. Subsequently, the data were exported to Microsoft Excel / version 365 (Microsoft Corporation 2025) for recoding and preliminary consistency checks.

Descriptive analyses, association tests, and ordinal regression analyses were conducted using Stata/IC version 14.2. For hypotheses involving direct associations with an ordinal outcome, ordinal logistic regression models were estimated using the `ologit` command or the `gologit2` module. For hypotheses involving mediation or simultaneous pathways, the Generalized Structural Equation Modeling (GSEM) framework implemented in Stata was adopted (Williams, 2006; StataCorp, 2015b).

Structural Equation Modeling (SEM) analyses, including Confirmatory Factor Analysis (CFA), were additionally conducted using JASP version 0.95.3.0, which relies on the *lavaan* package for SEM and CFA estimation (Rosseel, 2012; JASP Team, 2023).

4.5.8 Analytical Strategy Clarification

This study adopts a structured analytical hierarchy to ensure clarity and methodological rigor. Structural Equation Modeling (SEM) was initially employed as an exploratory and diagnostic tool to assess the overall theoretical model and examine relationships between latent constructs. However, due to limitations identified in the measurement model—particularly related to reliability and model fit—the SEM results were interpreted with caution and not used as the primary basis for hypothesis confirmation. Consequently, ordinal regression analysis was adopted as the principal confirmatory method, as it demonstrated greater robustness and stability given the nature of the data and measurement constraints. Therefore, while SEM contributes to the conceptual and exploratory validation of the model, the main empirical evidence supporting the study's hypotheses is derived from the ordinal regression results, which provide more reliable estimates of the relationships under investigation.

4.6 Method Limitations

Limitations related to data measurement and the construction of variables and indicators contributed to the methodological issues highlighted in this section. Although the use of ordinal regression analysis proved to be more robust and stable than the previous SEM-based analyses, several methodological considerations emerged across the ordinal regression analyses conducted in this study, encompassing both mediation and moderation models.

Initially, some constructs were measured using single indicators or scales with limited dispersion, which constrained variability in key predictors and moderators. By contrast, other indicators exhibited substantial dispersion. Although these measurement characteristics had been addressed in earlier stages of the study design, they nonetheless influenced the performance and interpretability of the ordinal models estimated at this stage.

Sparse distributions across certain combinations of predictor levels and outcome categories posed challenges for model flexibility. In particular, limited cell frequencies restricted the estimation of less constrained model specifications and reduced the statistical power to detect conditional effects, such as interaction terms. As a result, the analyses prioritized more parsimonious model formulations, balancing statistical feasibility with theoretical coherence.

Such measurement characteristics are known to affect model performance and parameter stability, particularly in ordinal regression settings, where limited variability and sparse distributions may constrain estimation and reduce power (Williams, 2006; Harrell, 2015).

Several predictors were modeled as linear terms rather than fully unrestricted categorical specifications (dummies). This choice reflects both theoretical assumptions about monotonic relationships and practical considerations arising from the data structure. While unrestricted models allow for greater flexibility, they require sufficient information across all outcome thresholds to yield stable and interpretable estimates. In the present context, the use of linear specifications was therefore deemed appropriate to ensure model convergence and robustness, while still capturing the substantive relationships of interest (Williams, 2006; Harrell, 2015).

An important limitation of this study concerns the measurement of variables originally derived from qualitative constructs. Converting qualitative information into quantitative indicators requires rigorous procedures for instrument development, pre-testing, and validation (Guillemin, Bombardier and Beaton, 1993; Beaton *et al.*, 2000; American Educational Research Association, American Psychological Association and National Council on Measurement in Education, 2014; Streiner, Norman and Cairney, 2015; Mokkink *et al.*, 2019). Ensuring validity and reliability is essential to minimize systematic and random measurement errors and to guarantee that instruments validly and consistently capture the intended constructs (American Educational Research Association, American Psychological Association and National Council on

Measurement in Education, 2014; Streiner, Norman and Cairney, 2015). The absence of such rigor may have affected both the precision and interpretability of some measures.

These measurement considerations are particularly relevant for interpreting non-significant direct, indirect, and moderating effects. Limited variability and sparse distributions, particularly in ordinal outcomes, may reduce statistical power, suggesting that null findings should be interpreted with caution. Nevertheless, the consistency of the main effects across models supports the overall robustness of the observed associations (Williams, 2006; Harrell, 2015).

Overall, taken together, these considerations indicate that the observed limitations are primarily associated with measurement complexity and certain constraints related to the design of the measurement instrument, along with sample size considerations, rather than model misspecification. Accordingly, the findings should be interpreted as exploratory, emphasizing patterns of association rather than definitive parameter estimates. Future studies using improved measurement instruments and larger samples are warranted to further evaluate the proposed theoretical model.

CHAPTER V: QUANTITATIVE RESULTS

5.1 Exploratory Analysis

5.1.1 Descriptive Analysis

Table 7 presents the variables related to the investor profile of the study population. With respect to the investor type, the highest proportions were in categories institutional investor (31.4%), venture capital professional (19.1%), impact investor (14.5%) and ESG-aligned asset manager (12.7%). Regarding the primary region of investment, the most frequent were North America (43.6%) and Europe (36.4%).

Among the 220 investors analyzed, the predominant size of investment fund was less than USD 50 million (57.7%). In a smaller proportion were those with USD 50–250 million (17.7%). And 10.0% preferred not to disclose the fund amount.

The levels of experience in ESG-aligned projects most frequent were medium (34.1%) and experience (25.0%). And previous investments blockchain-based were reported by 81.4% of participants.

Table 7: Descriptive analysis of the variables of the international investor profile, Brazil, 2025

Variable	n°	%
Investor type		
Venture capital professional	42	19.1
Blockchain professional	15	6.8
Regulatory experts	15	6.8
Institutional investor	69	31.4
ESG-aligned asset manager	28	12.7
Impact investor	32	14.5
Individual Investor	19	8.6
Primary region of investment		
North America	96	43.6
Europe	80	36.4
Latin America	8	3.6
Asia-Pacific	9	4.1
Middle East and Africa	2	0.9
Global	25	11.4
Size of investment fund		
Over USD 1 billion	10	4.5
USD 250–1 billion	22	10.0
USD 50–250 million	39	17.7
Less than USD 50 million	127	57.7
Prefer not to say	22	10.0
Experience in ESG-aligned projects		
No Experience	24	10.9
Low experience	42	19.1
Medium	75	34.1
Experience	55	25.0
Highly Experience	24	10.9
Previous investments blockchain-based		
Yes	179	81.4
Not sure	10	4.5
No	31	14.1
Total	220	100.0

Source: elaborated by Author

NOTE: Following statistical outputs, including extended descriptive tables are provided in Appendix D.

Figure 13 presents the distribution of response frequencies for the dependent variable, “likelihood to invest in tokenized ESG assets in Brazil in the next 12 months”. Most investors (37.7% reported high levels (likely or very likely) of likelihood of

making this type of investment. The category with the highest frequency of isolated responses was the neutral (30.5). The low likelihood (unlikely and very unlikely) of investing was 31.8%. Additionally, the Kolmogorov-Smirnov test was performed, which confirmed that the outcome variable does not have a parametric distribution ($p < 0.001$).

Table 21 shows aspects of willingness to adopt Tokenized ESG assets. Regarding the familiarity with tokenized investment products. Most investors (62.3%) indicated some relevant degree of familiarity, and the categories with the highest frequencies were familiar (26.4%) and medium familiar (25.0%).

Regarding the proportion of the ESG investment portfolio that investors would be willing to allocate to tokenized assets, assuming regulatory compliance and market stability, most respondents (76.8%) expressed some degree of willingness, up to 25.0%. In addition, 10.9% mentioned the availability of none at this stage.

Figure 14 shows the factors that would positively influence the decision to adopt tokenized ESG investment products. The most frequent were increased liquidity (57.7%), enhanced transparency and traceability (55.5%), lower transaction and operational costs (51.8%), and alignment with global sustainability standards (47.3%). Other factors appear to have less importance: improved portfolio diversification, institutional backing or regulation, and smaller-scale projects via fractional ownership.

Table 22 shows aspects of perceived risks against the willingness to adopt ESG Tokenized assets. Regarding regulatory uncertainty in Brazil, most of participants (82.3%) consider this aspect a relevant negative factor: high negative (37.7%), medium (30.5%) or strong negative (14.1%). In relation to the Blockchain scalability and interoperability limitations, these are perceived as risks, but at a low level, with most participants falling into the categories neutral (39.5%) or low challenge (37.3%). Economic instability in Brazil was identified as a risk by 69.5% of the participants

Table 22 shows the factors that would negatively influence the decision to adopt tokenized ESG investment products. The most frequent were regulatory uncertainty (61.4%), blockchain security concerns (41.8%), lack of institutional trust (40.9%), and lack of ESG standardization (39.5%). Other factors are observed at lower frequencies: illiquidity of tokenized assets, macroeconomic volatility, absence of credible third-party verification, and technological immaturity.

Table 23 presents the features of ESG alignment and financial accessibility. With respect to the importance of transparent ESG, most participants (71.4%) attach great

importance to this characteristic: extremely important (35.9%) and high important (35.5%). Alignment with international disclosure standards is considered important by 66.4% of the investors: agree (40.9%) and strongly agree (25.5%). Blockchain's ability to provide immutable traceability is considered somewhat important by 53.2% of the investors, and 40.9% consider it significantly important. Financial accessibility is considered important by 67.7% of the investors.

5.1.2 Comparative Analysis

The contingency tables, with the outcome variable Likelihood to Invest in Tokenized ESG assets in Brazil in the next 12 months, indicated a highly sparse data structure, characterized by a considerable number of cells with low or null frequencies. This pattern reflects substantial dispersion across categories and imposes constraints on statistical modeling, particularly with respect to estimation precision and the reliability of inference.

Due to this dispersion and the presence of sparse or empty cells in the contingency tables, the variables were regrouped and recategorized to ensure greater stability and reliability in the chi-square tests. For ordinal variables with highly dispersed categories and very low cell frequencies, it is recommended to collapse adjacent levels to preserve the ordinal structure and ensure stable model estimates (Hosmer et al. 2013). The dependent variable was grouped into 3 categories: unlikely (very unlikely and unlikely), neutral, and likely (likely and very likely).

Table 24 presents the comparative analysis between the profile of international investor and the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months. With respect to investor type, the association was statistically significant ($p = 0.017$), with the highest frequency of individuals reporting an intention to invest observed among venture capital professionals (54.8%). The size of the investment fund was associated with the likelihood to invest ($p < 0.001$), with larger funds showing higher frequencies of individuals intending to invest, reaching 62.5% among those with funds over 250 million. Similarly, experience in ESG-aligned projects showed a statistically significant association ($p < 0.001$), with more experienced investors exhibiting a higher frequency (65.8%) in the likelihood to invest. Individuals with previous investments in blockchain-based projects showed a higher frequency of likelihood to invest (43.6%) compared to the other study participants (12.2%) ($p <$

0.001). Only the primary region of investment did not show a statistically significant association ($p=0.181$).

Table 25 presents the comparative analysis between the aspects of willingness to adopt Tokenized ESG assets and the likelihood to invest. Familiarity with tokenized investment products showed a statistically significant association ($p < 0.001$), with more familiar investors exhibiting a higher frequency (63.4%) in the likelihood to invest. The proportion of the ESG portfolio to be allocated was associated with the likelihood to invest ($p < 0.001$), with individuals allocating larger proportions showing higher frequencies of investment intention, reaching 73.2% among those allocating more than 25% of the ESG portfolio. Participants who identified increased liquidity as a favorable factor showed a higher frequency of likelihood to invest (47.2%) compared to the other study participants (24.7%) ($p = 0.001$). Investors who reported alignment with global sustainability standards as a favorable factor showed a higher frequency of likelihood to invest (46.2%) compared to the other study participants (30.2%) ($p = 0.008$). The remaining variables did not show a statistically significant association.

Table 27 presents the comparative analysis between the ESG Alignment and Financial Accessibility and the likelihood to invest. All variables showed a statistically significant association with the outcome. The importance attributed to transparent ESG disclosure in the decision-making process was associated with the likelihood to invest ($p = 0.040$), with higher perceived importance corresponding to higher frequencies of likelihood to invest, reaching 42.0% among investors who reported high importance. The alignment with international disclosure standards was also associated with the outcome ($p = 0.010$), with participants who agreed that such alignment would increase their confidence reporting a higher frequency of likelihood to invest (43.8%) compared to those with neutral confidence (30.0%) or those who disagreed (16.7%). Blockchain's ability to provide immutable traceability showed a statistically significant association ($p < 0.001$), with individuals who considered that this feature could influence their decision exhibiting a higher frequency (54.4%) in the likelihood to invest than the other participants (26.2%). Finally, individuals who considered financial accessibility a meaningful incentive reported a higher frequency (45.6%) in the likelihood to invest than the other investors assessed (21.1%), and this difference was statistically significant ($p = 0.001$).

5.1.3 Chi-square Association Matrix

To explore preliminary relationships among categorical variables, an association matrix based on chi-square tests was constructed. Several variables exhibited statistically significant associations, indicating potential conceptual overlap and informing subsequent variable selection for multivariable modelling. Additionally, some variable combinations presented sparse cells or zero counts, suggesting the presence of rare categories.

Although the full chi-square association matrix is presented in Figure 4, several patterns warrant particular attention. First, in the upper-left section, there is a noticeable concentration of darker colours, indicating statistically significant associations ($p < 0.001$ and $p < 0.050$) between investor profile variables and variables related to alignment with global sustainability standards and willingness to adopt tokenized ESG investment assets. These include investor type, size of investment fund, experience in ESG-aligned projects, previous investments in blockchain-based assets, familiarity with tokenized investment products, proportion of ESG portfolio allocation, and perceptions of enhanced transparency and traceability. Most of these variables are also associated with the likelihood to invest.

Another important pattern appears in the lower portion of the matrix, showing associations between variables related to ESG alignment and financial accessibility, and several variables representing investor profile, willingness to adopt tokenized ESG assets, and perceived risks.

These results informed decisions to collapse or recategorize certain variables in order to ensure more stable estimates in subsequent analyses. They also supported the identification of potential mediation and moderation effects, as well as risks of overfitting.

	Likelihood to invest	Investor type	Primary region of investment	Size of investment fund	Experience in ESG-aligned projects	Previous investments blockchain-based	Familiarity with tokenized investment products	Proportion of ESG portfolio to allocate	Increased liquidity	Enhanced transparency and traceability	Alignment with global sustainability standards	Lower transaction and operational costs	Smaller-scale projects via fractional ownership	Institutional backing or regulation	Improved portfolio diversification	Regulatory uncertainty in Brazil	Blockchain scalability and interoperability limitations	Economic instability in Brazil	Regulatory uncertainty	Lack of ESG standardization	Blockchain security concerns	Illiquidity of tokenized assets	Lack of institutional trust	Macroeconomic volatility	Technological immaturity	Absence of credible third party verification	Importance of transparent ESG disclosure	Alignment of with international disclosure standards	Blockchain's ability to provide immutable traceability	Financial accessibility
Likelihood to invest	--																													
Investor type	0.017	--																												
Primary region of investment	0.181	0.054	--																											
Size of investment fund	<0.001	0.815	0.407	--																										
Experience in ESG-aligned projects	<0.001	0.568	0.582	<0.001	--																									
Previous investments blockchain-based	<0.001	0.010	0.457	0.248	<0.001	--																								
Familiarity with tokenized investment products	<0.001	0.421	0.008	<0.001	<0.001	<0.001	--																							
Proportion of ESG portfolio to allocate	<0.001	0.106	0.518	<0.001	<0.001	0.002	<0.001	--																						
Increased liquidity	0.001	0.759	0.005	0.274	0.042	0.047	0.101	0.135	--																					
Enhanced transparency and traceability	0.331	0.267	0.065	0.310	0.019	0.113	0.012	0.073	0.158	--																				
Alignment with global sustainability standards	0.008	0.784	0.432	0.157	<0.001	0.241	0.037	0.003	0.407	0.065	--																			
Lower transaction and operational costs	0.420	0.276	0.432	0.800	0.376	0.261	0.451	0.098	0.252	0.151	0.401	--																		
Smaller-scale projects via fractional ownership	0.078	0.110	0.543	0.838	0.082	0.146	0.005	0.034	0.436	0.520	0.062	0.081	--																	
Institutional backing or regulation	0.051	0.038	0.763	0.214	<0.001	0.101	0.084	0.266	0.023	0.001	0.001	0.196	0.675	--																
Improved portfolio diversification	0.205	0.205	0.013	0.667	0.598	0.396	0.927	0.821	0.956	0.347	0.225	0.137	0.246	0.167	--															
Regulatory uncertainty in Brazil	0.043	0.298	0.372	0.969	0.577	0.069	0.089	0.968	0.621	0.151	0.028	0.061	0.969	0.063	0.078	--														
Blockchain scalability and interoperability limitations	0.395	0.339	0.272	0.449	0.001	0.368	0.017	0.038	0.573	0.003	0.173	0.021	0.154	0.003	0.288	<0.001	--													
Economic instability in Brazil	0.052	0.836	0.729	0.277	0.288	0.005	0.145	0.244	0.695	0.085	0.050	0.707	0.795	0.399	0.590	<0.001	<0.001	--												
Regulatory uncertainty	0.766	0.889	0.924	0.250	0.684	0.443	0.517	0.511	0.024	0.015	0.743	0.990	0.240	0.008	0.258	0.012	0.009	0.006	--											
Lack of ESG standardization	0.071	0.944	0.749	0.156	0.151	0.667	0.739	0.160	0.950	0.383	0.105	0.014	0.439	0.535	0.143	0.395	0.958	0.880	0.008	--										
Blockchain security concerns	0.037	0.927	0.624	0.766	0.248	0.764	0.081	0.290	0.424	0.138	0.131	0.363	0.104	0.693	0.956	0.854	0.007	0.771	0.898	0.074	--									
Illiquidity of tokenized assets	0.787	0.141	0.923	0.074	0.566	0.596	0.519	0.816	0.047	0.799	0.417	0.063	0.636	0.434	0.074	0.070	0.881	0.320	0.010	0.268	0.030	--								
Lack of institutional trust	0.386	0.691	0.663	0.167	0.026	0.184	0.104	0.248	0.587	0.491	0.881	0.861	0.337	0.376	0.576	0.141	0.898	0.675	0.234	0.065	0.464	0.002	--							
Macroeconomic volatility	0.507	0.998	0.447	0.789	0.341	0.201	0.867	0.629	0.088	0.552	0.377	0.689	0.636	0.115	0.730	0.655	0.721	0.591	0.159	0.048	0.860	0.096	0.011	--						
Technological immaturity	0.636	0.866	0.009	0.950	0.743	0.931	0.824	0.115	0.246	0.078	0.685	0.200	0.033	0.360	0.242	0.345	0.946	0.558	0.015	0.011	0.133	0.833	0.304	0.002	--					
Absence of credible third party verification	0.004	0.844	0.013	0.070	0.457	0.134	0.769	0.194	0.386	0.814	0.349	0.436	0.805	0.143	0.340	0.087	0.639	0.108	0.936	0.232	<0.001	0.871	0.154	0.015	0.436	--				
Importance of transparent ESG disclosure	0.040	0.819	0.559	0.102	<0.001	0.001	<0.001	0.185	0.202	<0.001	0.027	0.518	0.495	0.002	0.442	<0.001	0.008	0.006	0.005	0.633	0.404	0.567	0.465	0.465	0.873	0.879	--			
Alignment of with international disclosure standards	0.010	0.610	0.074	0.148	<0.001	<0.001	0.001	0.007	0.082	<0.001	<0.001	0.412	0.284	0.031	0.270	0.007	<0.001	0.001	0.030	0.183	0.695	0.323	0.240	0.410	0.908	0.513	<0.001	--		
Blockchain's ability to provide immutable traceability	<0.001	0.972	0.195	0.037	<0.001	0.004	0.020	<0.001	0.084	0.001	0.013	0.336	0.793	0.031	0.712	0.197	0.614	0.062	0.047	0.041	0.266	0.470	0.520	0.173	0.185	0.571	<0.001	0.006	--	
Financial accessibility	<0.001	0.401	0.306	0.043	0.004	0.001	0.039	0.119	0.025	<0.001	0.002	0.438	0.019	0.019	0.283	0.283	0.208	0.013	0.271	0.192	0.390	0.715	0.658	0.452	0.624	0.462	<0.001	<0.001	<0.001	--
p-value:		<0.001		0.001 a 0.050		0.051 a 0.200		>0.200		* Chi-square association test																				

Figure 4: Matrix of associations* among the variables that showed a statistically significant association with the likelihood to invest in tokenized ESG projects in Brazil in the next 12 months, Brazil, 2025.

Source: Author's elaboration based on quantitative data

5.2 Structural Equation Modeling

5.2.1 Measurement Model

Two constructs were assessed using observed variables. The behavioural Willingness to invest in tokenized ESG assets in Brazil (WIL) was measured with a three-category ordinal variable (Likelihood to invest), while the perception of economic instability in Brazil affecting the willingness to invest in tokenized sustainable investments (Macroeconomic instability) was measured using a dichotomous variable (yes/no).

For the other three constructs (TOK - Tokenization, TRU - Investor Trust, and THR - Perceived Threats), measurement models were evaluated using CFA. Results of the global fit are presented in Table 32.

5.2.1.1 Tokenization (TOK). An initial measurement model was conducted, which showed satisfactory global fit indices, except for reliability, which yielded McDonald's $\omega = 0.493$ (0.394; 0.593). However, local fit measures did not perform well: the factor loadings for the variables Increased Illiquidity, Lower Transaction, Fractional Ownership, and Portfolio Diversification were low (<0.300), the residual variances were high (>0.900), and the factor loading for Portfolio Diversification was not statistically significant ($p = 0.459$). Modification indices were not considered because the global fit was satisfactory. These results are presented in Table 32.

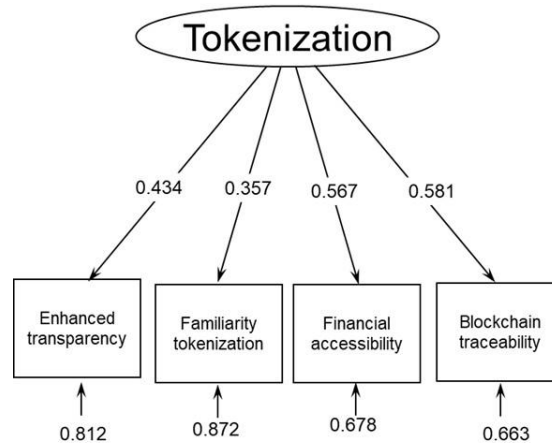


Figure 5: Confirmatory Factor Analysis of the latent scale Tokenization: global fit indices of the final model

Source: Author's elaboration based on quantitative data

Subsequently, a revised measurement model was evaluated, with results presented in Table 32 and Figure 5. In this model, variables that exhibited low factor loadings in the initial model were excluded. The retained model included Familiarity with Tokenization, Adoption of Enhanced Transparency, Financial Accessibility, and Blockchain Traceability, and demonstrated satisfactory global fit indices. Reliability remained an exception, with McDonald's $\omega = 0.497$ (0.390; 0.605); removing Familiarity with Tokenization would slightly increase reliability to 0.535. Hoelter's Critical N was 3341.094 ($\alpha = 0.05$) and 5135.538 ($\alpha = 0.01$), indicating an adequate sample size. At the local level, the factor loadings for Familiarity with Tokenization and Adoption of Enhanced Transparency were below the preferred threshold (< 0.500), although statistically significant ($p < 0.001$), and residual variances remained elevated (> 0.600). Considering the theoretical relevance of these variables for the proposed model and the hypotheses under investigation, they were retained in the latent construct. Modification indices were not considered, as the global fit was satisfactory.

5.2.1.2 Perceived Threats (THR). An initial measurement model showed poor global fit. Reliability was also low (McDonald's $\omega = 0.346$; 95% CI: 0.115–0.223). The omega estimate was computed only for the items retained in the analysis, as two of the six original items were not entered into the reliability computation. The low reliability may reflect limited item variability and attenuated correlations due to ordinal/dichotomous measurement (Flora and Curran, 2004; Gadermann, Guhn and Zumbo, 2012), as well as potential item-quality issues that weaken internal consistency (Kline, 2023).

Except for Regulatory uncertainty and Technological challenges, the local fit measures also performed poorly: factor loadings were very low. Three variables (technological immaturity, security concerns, and illiquidity) did not reach statistical significance. Residual variances were high. These results are presented in Table 56.

Subsequently, a revised measurement model was evaluated, with results presented in Table 32 and Figure 6. This version excluded the three variables with non-significant factor loadings from the initial model, leaving Regulatory uncertainty, Legal uncertainty, and Technological challenges. With only three indicators, the model became just-identified ($df = 0$), which precludes the computation of global fit indices. CFA models with three indicators leave no degrees of freedom for testing model fit (Kline 2016; Brown 2015). Consequently, the chi-square statistic cannot be estimated, and the RMSEA is reported as zero because it depends on chi-square and df (Steiger

1990). Indices such as SRMR may show numerical instability under these conditions, especially with ordinal estimators (Bentler 2007; Maydeu-Olivares 2017), because residual covariances and their standardizations approach zero in saturated models. Reliability improved but remained modest, with McDonald's $\omega = 0.551$ (95% CI: 0.423–0.679). Thus, global fit indices are not interpretable, and the solution should be viewed only as descriptive.

At the local level, Legal Uncertainty showed a low factor loading (0.277) and a high residual variance (0.923). The other two variables presented acceptable loadings (> 0.600), although their residual variances remained elevated (> 0.550). Considering the theoretical relevance of these items for the proposed model and the hypotheses under investigation, as well as the necessity of retaining at least three variables for model identification, all were kept in the latent construct. Modification indices were not examined because the global fit was satisfactory.

Despite the observed limitations, including identification challenges in the reduced model, this specification was adopted as the most parsimonious and theoretically coherent solution among the alternatives tested for this latent variable.

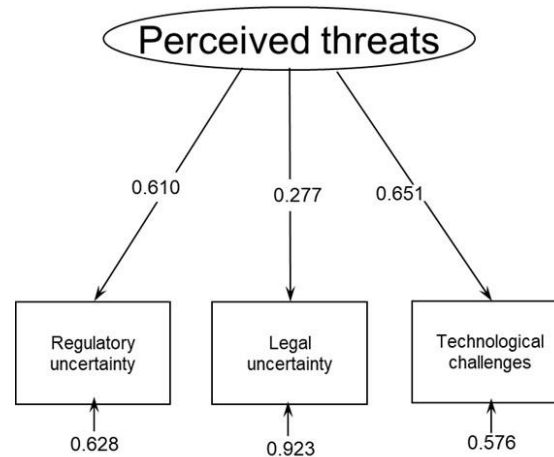


Figure 6: Confirmatory Factor Analysis of the latent scale Perceived threats: global fit indices of the final model

Source: Author's elaboration based on quantitative data

5.2.1.3 Investor Trust (TRU). An initial measurement model was estimated. Three items related to perceived risks had their scores reverse-coded to align them with the positively oriented items: Lack of ESG standardization, Lack of institutional trust, and Absence of credible third-party verification. Global fit indices indicated satisfactory

results, except for the TLI (slightly low) and reliability, with McDonald's $\omega = 0.412$ (95% CI: 0.303–0.521).

However, the local fit indices did not perform well. Only Alignment confidence and Disclosure importance showed factor loadings above 0.500 and were statistically significant ($p < 0.001$). Alignment ESG and Institutional backing or regulation had factor loadings below 0.400, although still statistically significant ($p < 0.001$). The three perceived-risk items that were reverse-coded showed low and negative factor loadings and were not statistically significant ($p > 0.200$). Modification indices were not examined because the global fit was satisfactory. These results are presented in Table 56.

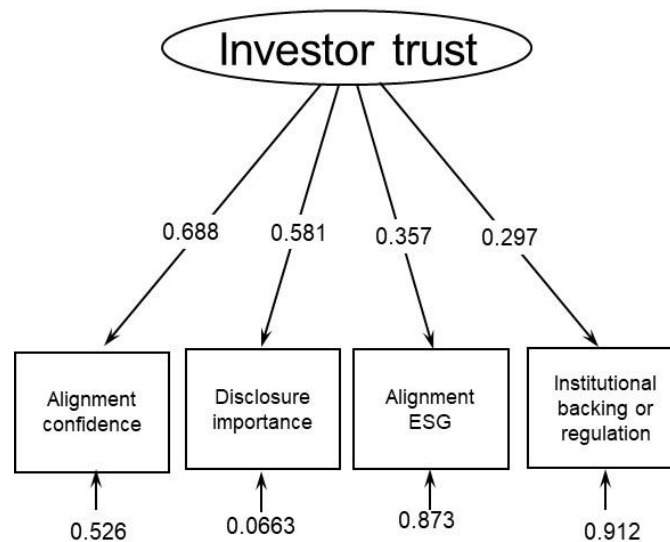


Figure 7: Confirmatory Factor Analysis of the latent scale Investor trust: global fit indices of the final model

Source: Author's elaboration based on quantitative data

Subsequently, a revised measurement model was evaluated, with results presented in Table 32 and Figure 7. In this model, variables that were not statistically significant in the initial model were excluded. The retained model included Alignment confidence, Disclosure importance, Alignment ESG and Institutional backing or regulation. Among the global fit indices, there was a slight decrease in TLI (to 0.866) and an increase in RMSEA which went to 0.082(0.000–0.176). Hoelter's Critical N was 266.036 ($\alpha = 0.05$) and 408.425 ($\alpha = 0.01$), indicating an adequate sample size. Reliability increased to 0.601 (0.514; 0.688).

At the local level, all four variables showed statistical significance ($p < 0.001$); however, Alignment ESG and Institutional backing or regulation had factor loadings below 0.400, and residual variances remained high (> 0.500). Considering the theoretical relevance of these variables for the proposed model and the hypotheses under investigation, all items were retained in the latent construct. Modification indices were not considered, as the global fit was satisfactory.

5.2.1.4 Additional comments. Overall, the three latent variables displayed similar patterns: global fit indices were generally satisfactory, whereas local fit indicators revealed important limitations. In the initial models, several items did not share sufficient common variance with the target construct and, therefore, did not integrate adequately into the proposed latent structure. This lack of convergence justified their exclusion and the subsequent evaluation of more parsimonious measurement models.

Even after re-specification, some items retained low factor loadings, indicating that they captured only a limited portion of the latent factor's variance. Such weak item–factor associations reduce convergent validity and compromise the internal coherence of the construct. In general, factor loadings below 0.40 are considered weak or potentially problematic unless strong theoretical justification supports their retention (Brown, 2015; Hair *et al.*, 2021; Kline, 2023). Additionally, elevated residual variances indicated that a substantial proportion of item variance was attributable to measurement error or unmodeled influences, undermining model precision and constraining the factor's ability to consistently summarize the information captured by its items fit (Hoyle, 2012; Brown, 2015; Kline, 2023).

Several explanations may account for these findings:

- (a) *Model misspecification*, in which items do not adequately reflect the same theoretical construct (Brown, 2015; Kline, 2023).
- (b) *Content- or interpretation-related issues*, including semantic ambiguity, unclear wording, or multidimensional item meaning (Guillemin, Bombardier and Beaton, 1993; Beaton *et al.*, 2000).
- (c) *Limited response variability*, asymmetric distributions, or sparsely populated categories (common in ordinal scales), which weaken inter-item correlations and may even yield anomalous or negative loadings (Wheaton *et al.*, 1977; Flora and Curran, 2004; Gadermann, Guhn and Zumbo, 2012).
- (d) *Weak factorial structure*, when the construct is diffuse, multidimensional, or only partially represented by the available items (Brown, 2015; Kline, 2023).

- (e) *Method effects*, particularly those associated with reverse-coded items, which frequently introduce systematic variance unrelated to the substantive latent construct and may produce weak or even negative factor loadings (Brown, 2015; Kline, 2023).

Taken together, these weak associations between indicators and latent factors raise concerns about measurement quality and threaten the validity of the factorial structure. These findings underscore the need for careful evaluation of the subsequent structural model and the use of complementary analytical strategies — such as ordinal regression in the present study — to support the investigation of the proposed hypotheses and mitigate potential limitations arising from the measurement stage.

5.2.2 Structural Model

5.2.2.1 Correlations between Latent Factors: Table 33 presents the correlations between latent factors, obtained from the standardized factor covariances estimated in the SEM model. The latent correlation between Perceived threats and Tokenization, estimated from the standardized factor covariances in the SEM, was 0.413 ($p < 0.001$), indicating that higher perceived threats are associated with a greater degree to which investors recognize and understand the advantages of Tokenization for sustainable investments.

The latent correlation between Investor trust and Tokenization as 1.141 ($p < 0.001$), indicating that higher investor trust is associated with a greater degree to which investors recognize and understand the advantages of Tokenization for sustainable investments. The estimation of the association between these factors resulted in a standardized factor covariance exceeding 1, indicating a statistically inadmissible solution. This result suggests that the correlation structure among the indicators did not provide sufficient information to empirically distinguish the proposed latent factors. In the CFAs, factor loadings were predominantly low and accompanied by high residuals, reflecting limited shared variance among the items and insufficient empirical support for the definition of well-defined latent constructs. Consequently, the common variance was inadequate to sustain stable estimates of latent covariances and correlations, compromising the evaluation of associations between constructs (Kline, 2023).

The latent correlation between Perceived threats and Investor trust was 0.755 ($p < 0.001$), indicating that higher perceived threats are associated with a greater degree of

investor trust. Moreover, the correlation was close to 0.800, which is considered indicative of potential collinearity (Papageorgiou, 2022).

High correlations between latent factors (e.g., $r = 0.755$) suggest multicollinearity, which hampers the distinction of each construct's effects, increases standard errors, and renders path estimates unstable. Moreover, standardized covariances exceeding 1 indicate statistically inadmissible solutions, signalling that the factors may be nearly indistinguishable or that the items are redundant, thereby compromising the reliability of the estimates, the interpretation of associations between constructs, and the overall validity of the SEM model (Hoyle, 2012; Papageorgiou, 2022; Kline, 2023).

5.2.2.2 Structural Model: The limitations identified in the CFA and the correlation matrix indicate the need for adjustments to the theoretical model and its factors. However, given the original theoretical framework and the available data, it was not possible to modify the composition of the factors or remove problematic indicators. Therefore, the following estimates should be interpreted with caution, considering these methodological limitations.

Table 18 shows the fit results of the final model. The global fit indices were satisfactory: $\chi^2/df = 1.643$; CFI = 0.923; SRMR = 0.054; RMSEA = 0.054 (90% CI: 0.032–0.075). The only exception was the TLI = 0.897, slightly below the recommended threshold. Hoelter's Critical N was 245.932 ($\alpha = 0.05$) and 277.614 ($\alpha = 0.01$), suggesting that the chi-square test would not reject the model at the current sample size. Modification indices were not considered, as the global fit was satisfactory.

Table 8: *Global Fit Indices of the Structural SEM Model*

Fit indices *	Expected values **	Results
χ^2	--	80.53
χ^2 (p)	> 0.050	0.003
χ^2 / df	≤ 3.000	1.643
CFI	³ 0.950	0.923
TLI	³ 0.950	0.897
SRMR	≤ 0.080	0.054
RMSEA (upper bound CI _{90%})	< 0.060 (<0.100)	< 0.054 (0.032;0.075)
Hoelter's critical N ($\alpha = .05$)	> 200.000	245.932
Hoelter's critical N ($\alpha = .01$)	> 200.000	277.614

* Fit indices:

χ^2 = qui-square test

χ^2 (p) = p-value

χ^2 / df = ratio of the chi-square value to the degrees of freedom

CFI = comparative fit index

TLI = Tucker-Lewis Index

SRMR = standardized root mean residual

RMSEA (CI_{90%}) = root mean square error of approximation (interval confidence 90%)

Hoelter's critical N ($\alpha = 0.05$ or $\alpha = 0.01$)

** References: Wheaton et al. 1977; Hayes & Coutts 2020; Kline, 2023; Rogers 2024

The final structural model is illustrated in Figure 8. Item-level results for the latent variables are not shown to maintain parsimony, as they have already been presented earlier. Table 34 shows the standardized path coefficients of the structural SEM model.

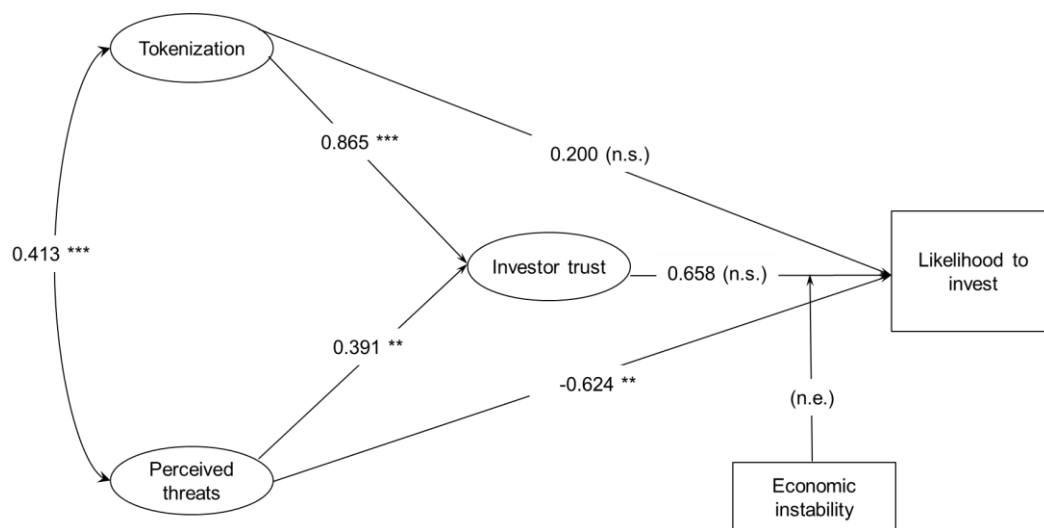


Figure 8: Full structural SEM Model

Source: Author's elaboration based on quantitative data

Notes: Global fit: χ^2 / df (ratio of the chi-square value to the degrees of freedom) = 1.643; p-value (χ^2)=0.003; CFI (Comparative Fit Index) =0.923; TLI (Tucker-Lewis Index) = 0.897; SRMR (Standardized Root Mean Residual) = 0.054; RMSEA (Root mean Square Error of Approximation) - CI90% (Confidence Interval 90%) = 0.54 (0.032; 0.075); Hoelter's critical N ($\alpha =0.05$ and $\alpha =0.01$ >200.000).

Item-level results for the latent variables are not shown for parsimony (reported elsewhere). Values on directional arrows represent standardized regression coefficients with significance levels; values on bidirectional arrows represent correlations. All estimates obtained using WLSMV (Weighted Least Squares Mean

and Variance Adjusted).

*** $p < 0.001$; ** $p < 0.05$; (ns) not statistically significant; (n.e.) not estimable.

The results indicate a weak positive association between Tokenization and the latent propensity underlying higher categories of the ordinal outcome (Likelihood to invest); however, this association did not reach statistical significance (standardized estimate = 0.200; $p = 0.677$). This is not consistent with the proposed general theoretical model, which hypothesized an association between the two variables.

Perceived threats were negatively associated underlying lower categories of Likelihood to invest (standardized coefficient = -0.624 ; $p = 0.008$), indicating a strong inverse relationship. This finding is consistent with the proposed general theoretical model. Investor trust was not associated with the likelihood to invest (standardized estimate = 0.658; $p = 0.261$). This finding is not consistent with the proposed general theoretical model.

The results also indicate a strong, positive, and statistically significant association between Tokenization and the latent propensity underlying higher categories of the investor trust (standardized estimate = 0.865; $p < 0.001$). This finding is consistent with the proposed general theoretical model.

Perceived threats were positively associated with the latent propensity underlying higher categories of investor trust (standardized coefficient = 0.391; $p = 0.002$). This result runs counter to the proposed general theoretical model, which hypothesized a negative association between the two constructs.

The correlation between the latent predictor factors *Tokenization* and *Perceived Threats* was freely estimated; however, its inclusion did not alter the structural coefficients, indicating that this association ($r = 0.413$; $p < 0.001$) is adequately explained by the directional paths specified in the model.

5.2.2.3 Mediation analysis – indirect and total effects: Table 19 shows the standardized path coefficients of the direct effects in the structural SEM, and Table 20 shows the indirect and total effects from the mediation analysis. In the regression path between Tokenization and Likelihood to invest, with Investor trust specified as a mediator, the standardized direct effect was 0.200 ($p = 0.677$). The total effect was 0.769 ($p < 0.001$), while the standardized indirect effect was 0.569 ($p = 0.260$), accounting for 74.0% of the total effect.

Although representing a substantial proportion of the total effect, the indirect effect did not reach statistical significance, indicating that the effect of Investor Trust as a mediator is not supported by the data. The lack of statistical significance may be related to limited statistical power, which is common in mediation analyses, particularly in SEM models. Additionally, earlier results of this study indicated potential issues related to model identification and item measurement. Therefore, the mediation hypothesis involving Investor Trust should be interpreted with caution and considered exploratory rather than confirmatory.

In the regression path between Perceived threats and Likelihood to invest, with Investor trust specified as a mediator, the standardized direct effect was -0.624 ($p = 0.008$). The total effect was -0.367 ($p = 0.002$), while standardized indirect effect was 0.258 ($p = 0.195$), accounting for -70.3% of the total effect. Although representing a large negative proportion of the total effect, the indirect effect did not reach statistical significance, indicating that the mediation pathway through Investor trust does not significantly explain the relationship between Perceived threats and Likelihood to invest.

The association occurs primarily through a direct effect. Furthermore, the negative percentage suggests that the indirect and total effects operate in opposite directions. The discrepancy between the total and direct effects implies that factors other than Investor Trust may be partially influencing the relationship between Perceived Threats and Likelihood to Invest. Given these limitations, the mediation analyses should be interpreted as exploratory and descriptive, rather than as confirmation of a theoretical hypothesis.

5.2.2.4 Moderation Analysis: In this study, moderation was initially assessed within a SEM framework using multiple-group path analysis, with Investor trust specified as a latent predictor, Economic instability as an observed moderating variable, and Likelihood to invest as an observed outcome. However, the multigroup models failed to converge, likely due to insufficient sample size in some moderator categories and/or limitations related to data quality and model complexity.

Given these constraints, moderation was further explored through stratified analyses, in which the same parameter specifications and model constraints as in the original SEM were maintained. Differences in the estimated path coefficients across strata of Economic instability were then examined to assess potential variations in the relationships of interest.

Table 36 presents the fit indices of the final models stratified by Economic instability, with 67 participants in the No / not sure stratum and 153 participants in the Yes stratum.

Regarding global model fit, the No / not sure stratum showed satisfactory results for nearly all fit indices: $\chi^2/df = 1.121$; CFI = 0.968; TLI = 0.956; SRMR = 0.074; RMSEA = 0.043 (90% CI: 0.000; 0.094). The only exception was Hoelter's critical N, which suggested that the chi-square test would reject the model at the current sample size, with values of 119.593 ($\alpha = 0.05$) and 134.933 ($\alpha = 0.01$).

In contrast, the model for the Yes stratum showed satisfactory fit only for $\chi^2/df = 1.140$; SRMR = 0.065; e RMSEA = 0.054 (90% CI: 0.021; 0.080). The remaining indices indicated inadequate model fit, including CFI = 0.883, TLI = 0.843, and Hoelter's critical N, also suggested that the chi-square test would reject the model at the current sample size, with values of 175.168 ($\alpha = 0.05$) and 197.696 ($\alpha = 0.01$).

Although fit indices differed across strata of Economic instability, both models were affected by sample size limitations, as indicated by Hoelter's critical N. Despite lower incremental fit indices in the Yes stratum, the overall pattern of model fit was slightly similar to that of the non-stratified model, indicating no clear evidence of stratum-specific structural misspecification. Therefore, stratified results should be interpreted as exploratory in nature.

The regression coefficient results for the stratified models are presented in Table 37. Although the estimated coefficients differed meaningfully in magnitude across strata, neither association reached statistical significance.

In the No / not sure stratum, Investor trust was negatively associated with underlying lower categories of Likelihood to invest; however, this association was not statistically significant (standardized coefficient = -0.179 ; $p = 0.949$). As such, this result does not provide empirical support for the proposed general theoretical model.

In the Yes stratum, Investor trust was positively associated with underlying lower categories of Likelihood to invest, but this association was also not statistically significant (standardized coefficient = 0.577 ; $p = 0.382$). Consequently, this finding likewise does not support the proposed general theoretical model due to the lack of statistical significance. Consistent with the model fit indices, results from the Yes stratum were more similar to those obtained in the non-stratified model.

These results are confirmed by the point estimate plot, which shows that the standardized regression coefficients of Investor trust differed in direction and magnitude

across strata of Economic instability. In the No/Not sure stratum, the estimated coefficient was negative and close to zero, with a wide confidence interval that largely overlapped zero, indicating substantial uncertainty around the estimate. In contrast, the Yes stratum exhibited a positive coefficient of moderate magnitude; although its confidence interval also included zero, it was comparatively narrower, indicating greater precision but no statistically significant association.

Overall, the stratified analyses suggested heterogeneity in both the direction and magnitude of the estimated associations across strata, although none reached statistical significance. These findings may reflect limited statistical power due to insufficient sample sizes within strata, as well as previously discussed limitations related to model specification and the measurement of items and variables. Importantly, these stratified analyses do not constitute a formal test of interaction but rather provide an exploratory assessment of potential heterogeneity across levels of Economic instability.

5.2.2.5 Methodological Limitations: Although structural equation modeling (SEM) is a robust technique for assessing associations among latent constructs, the results of this study reveal relevant methodological limitations. As previously cited, the main weakness of the model lies in the fragility of the measurement model, characterized by latent variables with low factor loadings, high residual variance, and low reliability. These limitations compromise the quality of the latent factors and result in unstable latent correlations and structural associations.

Nevertheless, given the originally proposed theoretical structure and the constraints imposed by the available data, it was not possible to modify the composition of the factors or their subsequent parameter estimates. Accordingly, the results suggest that the constructs were not adequately measured, which limits the interpretation of the structural coefficients and indicates that the model, as specified, does not demonstrate sufficient empirical adequacy.

5.3 Hypotheses Testing

The empirical testing of the study's hypotheses follow a structured analytical hierarchy designed to ensure methodological clarity and robustness. As outlined in the analytical strategy, Structural Equation Modeling (SEM) was initially employed to assess the overall theoretical framework and explore the relationships among latent constructs. While SEM provided valuable insights into the structure of the proposed model,

limitations related to measurement reliability and model fit constrained its suitability as a confirmatory approach.

In light of these limitations, and considering the ordinal nature of the study variables, ordinal regression analysis was adopted as the principal method for hypothesis testing. This approach offers more stable and reliable estimates under the data conditions observed and allows for a more robust assessment of direct, mediated, and moderated relationships among variables.

Accordingly, while SEM results are referenced as part of the exploratory and diagnostic evaluation of the model, the primary empirical evidence supporting the acceptance or rejection of the study's hypotheses is derived from the ordinal regression analyses presented in this section.

Considering the limitations observed in the SEM analyses and the ordinal nature of the study variables, ordinal regression models were estimated to assess the presence of mediation and moderation effects, aiming to investigate the nine study hypotheses. Given that the latent variables obtained from the confirmatory factor analysis (CFA) generally did not demonstrate stable measurement properties and led to the exclusion of some observed variables, the CFA framework was not retained. Consequently, all variables originally specified in the theoretical model were directly incorporated into the regression analyses.

For each hypothesis tested, based on a predefined theoretical framework, representative variables were selected for each construct. Some constructs were operationalized using single observed variables, whereas others were represented by derived variables (indicators) constructed by summing the corresponding observed variables.

5.3.1 Definitions

5.3.1.1 Tokenization: defined as the degree to which the investor perceives and understands the advantages of Tokenization for sustainable investments, such as liquidity, traceability, and disintermediation. Based on the study's theoretical framework, Tokenization comprises three main components: (1) familiarity with Tokenization, which reflects the perceived functional value of Tokenization; (2) the functional value of Tokenization; and (3) the ability of blockchain to provide immutable traceability of environmental and social outcomes.

This indicator was constructed by summing the scores of eight questions representative of this construct, resulting in an index with a possible score ranging from

1 to 10 points. The higher the score, the greater the perceived advantages of Tokenization.

5.3.1.2 Investor Trust: defined as the investor's confidence in the institutional security and regulatory stability of the Tokenization market in Brazil. Based on the study's theoretical framework, Investor Trust comprises three main components: (1) regulatory trust (proxy); (2) ESG governance; and (3) trust in the institutional origin.

This indicator was constructed by summing the scores of seven questions representative of this construct, resulting in an index with a possible score ranging from 2 to 11 points. Three original questions that represented risk situations had their scores reversed to reflect the absence of risk. The higher the score, the greater the perceived level of investor trust.

5.3.1.3 Likelihood to Invest: defined as the probability that an investor will invest in tokenized ESG assets in Brazil over the next 12 months. This indicator was constructed from a single variable, with a score ranging from 1 to 3. The higher the score, the greater the likelihood of investing.

5.3.1.4 Perceived Threats: defined as the perception of risks that inhibit adoption and investment, such as regulatory, economic, and technological risks. Based on the study's theoretical framework, Perceived Threats comprise four components: (1) regulatory uncertainty; (2) technological challenges; (3) the presence of security risks; and (4) liquidity risks. This indicator was constructed by summing the scores of six questions representative of this construct, resulting in an index with a possible score ranging from 1 to 8 points. The higher the score, the greater the perception of threats associated with investment in tokenized assets.

5.3.1.5 Regulatory Barriers: defined as regulatory uncertainty. Based on the study's theoretical framework, this construct was operationalized through two variables: (1) Regulatory Uncertainty and (2) Risk of Regulatory Uncertainty. Due to the small number of variables, no composite indicator was constructed; instead, the effect of each variable was assessed separately. Both variables were dichotomous, with scores of 0 and 1. Familiarity with Tokenization was categorized as the investor's familiarity with tokenized investment products (e.g., blockchain-based ESG assets). Based on the study's theoretical framework, this construct was operationalized through a single variable, namely Familiarity with Tokenization, with a score ranging from 1 to 3 points.

5.3.1.6 Technological Challenges: defined as the investor's perception of the extent to which blockchain scalability and interoperability limitations represent a challenge to the adoption of tokenized ESG assets. Based on the study's theoretical framework, this construct was operationalized through a single variable, namely Technological Challenges, with a score ranging from 1 to 3 points.

5.3.1.7 Alignment of ESG Metrics: defined as the alignment of Brazil's ESG metrics with international disclosure standards (e.g., SFDR, TCFD, ISSB), thereby increasing confidence in tokenized sustainable investments. This indicator was operationalized through a regulatory trust proxy variable, with a score ranging from 1 to 3 points. The higher the score, the greater the perceived alignment with ESG metrics.

5.3.1.8 Advantages of Tokenization: defined as advantages such as traceability and transparency (arising from Tokenization) that increase investment intention. Based on the study's theoretical framework, Advantages of Tokenization comprise two main components: (1) the functional value of Tokenization; and (2) the ability of blockchain to provide immutable traceability of environmental and social outcomes.

This indicator was constructed by summing the scores of seven questions representative of this construct, resulting in an index with a possible score ranging from 0 to 7 points. The higher the score, the greater the perceived advantages of Tokenization.

5.3.1.9 Financial Accessibility and ESG Adoption: defined as financial accessibility as a significant incentive to consider tokenized ESG investments, combined with the functional value of Tokenization (financial accessibility) and ESG governance, thereby increasing investment intention. Based on the study's theoretical framework, Financial Accessibility was defined as aspects such as fractional ownership and lower barriers to entry. ESG governance encompassed three main aspects: (1) transparent ESG disclosure; (2) alignment with global sustainability standards in ESG compliance; and (3) absence of risk arising from a lack of ESG standardization. This indicator was constructed by summing the scores of four questions representative of this construct, resulting in an index with a possible score ranging from 1 to 6 points. The higher the score, the stronger the perception of Financial Accessibility and ESG Adoption.

5.3.1.10 Macroeconomic Stability and Regulatory Clarity: defined from a risk perspective, as Macroeconomic Instability and Regulatory Uncertainty. Macroeconomic Instability included two indicators:

- i. economic instability in Brazil affecting the willingness to invest in tokenized ESG assets, assessed through a dichotomous variable in which 0 represents a favorable willingness to invest (no or not sure about instability), and 1 represents an unfavorable willingness to invest (yes regarding instability);
- ii. the perception of the presence of a risk of macroeconomic volatility as a contributor to reduced interest in investing, assessed through a dichotomous variable in which 0 represents the absence of this risk and 1 represents its presence.

Regulatory Uncertainty included two additional indicators:

- iii. the impact of regulatory uncertainty, understood as the extent to which regulatory uncertainty in Brazil reduces the investor's willingness to adopt tokenized ESG investments, assessed through a dichotomous variable in which 0 represents a favorable assessment of no, low, or medium negative impact, and 1 represents an unfavorable situation characterized by a high negative impact; and
- iv. the perception of the presence of a risk of regulatory uncertainty as a contributor to reduced interest in investing, assessed through a dichotomous variable in which 0 represents the absence of this risk and 1 represents its presence.

All moderators were coded such that 0 indicated better conditions and 1 indicated worse conditions, facilitating the interpretation of interaction effects.

5.3.1.11 Regulatory Stability: defined as the extent to which regulatory uncertainty in Brazil reduces the investor's willingness to adopt tokenized ESG investments. This indicator adopted a dichotomous variable in which 0 represents an understanding of high negative impact, and 1 represents a favorable situation characterized by no, low, or medium negative impact. The scoring was inverted in relation to the original variable.

NOTE: Detailed statistical outputs, including supplementary regression models are provided in Appendix D.

5.3.2 (H1): Tokenization positively affects Investor Trust, enhancing the decision-making process of international investors in sustainable Brazilian projects:

This hypothesis posits a mediating role of investor trust in the association between Tokenization and likelihood to invest:

Tokenization → Investor trust → Likelihood to invest

The theoretical justification for operationalizing this hypothesis is that the Tokenization Index functions as a proxy for Investor Trust. The literature shows that familiarity with digital assets and clarity about the technology directly influence trust and the intention to invest. This theoretical framework is illustrated in Table 38 while Table 39 presents the results of the mediation analysis testing Hypothesis 1. The analysis examined the effects of Tokenization on Likelihood to Invest through Trust. Tokenization was significantly associated with Trust (OR = 1.577, 95% CI: 1.369 - 1.785, $p < 0.001$), indicating that higher Tokenization increased the odds of being in a higher Trust category; specifically, for each one-unit increase in Tokenization, the odds of Trust being in a higher category increased by 57.7%. However, the path from Trust to Likelihood to Invest was not statistically significant (OR = 1.134, 95% CI: 0.922 - 1.346, $p = 0.187$).

The direct effect of Tokenization on Likelihood to Invest was significant (OR = 1.588, 95% CI: 1.352 - 1.825, $p < 0.001$), meaning that each one-unit increase in Tokenization increased the odds of being in a higher Likelihood to Invest category by 58.8%. The indirect effect via Trust was not significant (OR = 1.059, 95% CI: 0.967 - 1.151, $p = 0.196$), representing approximately 11% of the total effect, although not statistically significant. The total effect, combining direct and indirect pathways, was significant (OR = 1.682, 95% CI: 1.445 - 1.919, $p < 0.001$), indicating that the combined effects increased the odds of being in a higher Likelihood to Invest category by 68.2%.

In summary, Tokenization significantly increased Likelihood to Invest (OR = 1.588, $p < 0.001$), with a small, non-significant indirect effect via Trust (OR = 1.059, $p = 0.196$, 11% mediated), indicating that the relationship is primarily direct (total effect

OR = 1.682, $p < 0.001$).

Tokenization increased the Likelihood to Invest, but the proposed mediation through Investor Trust was not supported. This indicates that the effect of Tokenization on investment decisions occurs primarily through a direct pathway rather than via Investor Trust. **The results provide partial support for Hypothesis 1.**

5.3.3 (H2): Perceived threats (e.g., regulatory, economic and technological) adversely affect investors' willingness to participate in tokenized assets

This hypothesis posits a mediating role of investor trust in the inverse association between perceived threats and likelihood to invest:

Perceived threats → Investor trust → Likelihood to invest

The theoretical justification for operationalizing this hypothesis is that, according to Prospect Theory, investors place greater weight on losses (perceived threats). A high perception of threats reduces trust and the intention to invest in tokenized assets. This theoretical framework is illustrated in Table 40.

Table 41 presents the results of the mediation analysis testing Hypothesis 2. The analysis examined the effects of Perceived threats on Likelihood to Invest through Trust. Perceived Threats was significantly associated with Investor Trust (OR = 1.835, 95% CI: 1.446 - 2.224, $p < 0.001$), indicating that each one-unit increase in Perceived Threats increased the odds of being in a higher Trust category by 83.5%. Investor Trust was also significantly associated with Likelihood to Invest (OR = 1.520, 95% CI: 1.244 - 1.795, $p < 0.001$).

The direct effect of Perceived Threats on Likelihood to Invest was negative and not statistically significant (OR = 0.847, 95% CI: 0.670 - 1.024, $p = 0.119$), suggesting that, when controlling for Investor Trust, higher levels of perceived threats tended to reduce the odds of being in a higher Likelihood to Invest category by 15.3%. This direct effect operated in the opposite direction of the indirect pathway. The indirect effect via Investor Trust was positive and statistically significant (OR = 1.289, 95% CI: 1.119 - 1.459, $p < 0.001$), indicating that Perceived Threats increased Investor Trust, which in turn was associated with a higher Likelihood to Invest. The total effect, combining both direct and indirect paths, was small and not statistically significant (OR = 1.092, 95% CI: 0.860 - 1.323, $p = 0.417$).

Notably, the percentage of the total effect accounted for by the indirect pathway through Investor Trust was 289.5%, exceeding 100%. This occurs because the indirect and direct effects have opposite signs: the positive indirect effect via Investor Trust offsets the small negative direct effect. As a result, the total effect is smaller than the indirect effect alone, reflecting an inconsistent (or suppressor) mediation pattern. In substantive terms, higher perceived threats tend to be directly associated with a lower Likelihood to Invest, while simultaneously increasing investment likelihood indirectly through enhanced.

5.3.4 (H3): *Regulatory barriers, such as legal uncertainties and compliance costs, hinder the widespread adoption of Tokenization in Brazil's sustainable finance sector*

This hypothesis posits a direct negative effect of Regulatory barriers on familiarity with Tokenization

Regulatory barriers → Familiarity with Tokenization

The theoretical justification for operationalizing this hypothesis is that, according to Institutional Theory, international investors are influenced by normative pressures, regulatory compliance, and industry best practices. This theoretical framework is illustrated in Table 42 while Table 43 presents the results of the ordinal regression analysis testing Hypothesis 3. The analysis examined the direct effects of variables of Regulatory barriers on Familiarity with Tokenization. The proportional odds assumption was violated for the variable Regulatory uncertainty (Brant test $p < 0.050$). Therefore, generalized ordered logistic regression models with partial proportional odds were estimated with robust standard errors. For this variable, at the first cutpoint of the ordinal outcome, the estimated association with familiarity with Tokenization was positive (OR = 1.595, 95% CI: 0.920 - 2.766, $p = 0.096$). At the second cutpoint, the estimated association was negative (OR = 0.963, 95% CI: 0.556 - 1.665, $p = 0.891$). Despite differences in coefficient magnitude across cutpoints, neither effect reached statistical significance.

For the variable risk regulatory uncertainty, the proportional odds assumption was not violated (Brant test $p > 0.050$). Thus, proportional odds ordinal logistic regression models were estimated with robust standard errors. This variable was not significantly associated with familiarity with Tokenization (OR = 1.205, 95% CI: 0.735 - 1.977, $p = 0.460$).

In summary, Regulatory uncertainty showed a weak and inconsistent association with Familiarity with Tokenization, with effects varying across levels of the ordinal outcome and failing to reach statistical significance. Risk regulatory uncertainty was not significantly associated with Familiarity with Tokenization. This suggest that Regulatory barriers may not play a decisive role in shaping Familiarity with Tokenization in the analyzed sample. The results provide **limited support for Hypothesis 3.**

5.3.5 (H4): The scalability and integration of blockchain technology within Brazil's financial and legal infrastructure affect the feasibility and adoption of tokenized sustainability projects

This hypothesis posits a direct negative effect of Technological challenges on Tokenization

Technological challenges → Tokenization

The theoretical justification for operationalizing this hypothesis is that the success of Tokenization depends on the technology's ability to scale and to integrate with the traditional financial system. This theoretical framework is illustrated in Table 44.

Table 45 presents the results of the ordinal regression analysis testing Hypothesis 4. The analysis examined the direct effects of Technological challenges on Tokenization. The proportional odds assumption was not violated (Brant test $p > 0.050$), therefore, proportional odds ordinal logistic regression models were estimated with robust standard errors.

Technological challenges were significantly associated with Tokenization (OR = 1.836, 95% CI: 1.278 - 2.638, $p = 0.001$), indicating that each one-unit increase in Technological challenges was associated with an 83.6% increase in the odds of being in a higher category of Tokenization.

Given that higher scores on the Technological challenges variable represent greater perceived challenges, this result suggests that investors who report higher Technological challenges also tend to report higher levels of Tokenization. This finding runs counter to the study's initial hypothesis, which assumed that technological challenges would act as a barrier to Tokenization.

In summary, Technological challenges were positively associated with Tokenization, such that investors who perceive greater technological challenges tend to

exhibit higher levels of Tokenization, contrary to **Hypothesis 4, which was not supported.**

5.3.6 (H5): Brazil's alignment with global ESG standards significantly enhance international investors' interest in tokenized ESG assets.

This hypothesis posits a direct effect of alignment of Brazil's ESG metrics with global ESG standards on Likelihood to Invest

Alignment of ESG metrics → Likelihood to Invest

The theoretical justification for operationalizing this hypothesis is that ESG alignment is an important predictor for institutional investors, as demonstrated in the literature on Legitimacy Theory and global regulatory standards. Based on this premise, it is understood that Brazil's adherence to global ESG standards increases the interest of international investors in tokenized projects. This theoretical framework is illustrated in Table 46.

Table 47 presents the results of the ordinal regression analysis testing Hypothesis 5. The analysis examined the direct effects of Alignment of ESG metrics on Likelihood to invest. The proportional odds assumption was not violated (Brant test $p > 0.050$), therefore, proportional odds ordinal logistic regression models were estimated with robust standard errors.

Alignment of ESG metrics were significantly associated with Likelihood to invest (OR = 1.953, 95% CI: 1.343 -2.841, $p < 0.001$), indicating that each one-unit increase in Alignment of ESG metrics was associated with an 95.3% increase in the odds of being in a higher category of Likelihood to invest.

In summary, Alignment of ESG metrics were positively associated with Likelihood to invest, such that investors who perceive greater alignment of ESG metrics tend to exhibit higher levels likelihood to invest. **Hypothesis 5 was supported.**

5.3.7 (H6): The advantages provided by Tokenization, such as the traceability of environmental and financial impacts of projects from blockchain technology, improves the international investors' willingness to engage in tokenized ESG assets.

This hypothesis posits a direct effect of Advantages of Tokenization on Likelihood to Invest

Advantages of Tokenization → Likelihood to Invest

The theoretical justification for operationalizing this hypothesis is that the literature indicates that blockchain-based traceability (transparency) strengthens trust, especially in the ESG context, by mitigating the risks of greenwashing. This theoretical framework is illustrated in Table 48.

Table 49 presents the results of the ordinal regression analysis testing Hypothesis 6. The analysis examined the direct effects of Advantages of Tokenization on Likelihood to invest. The proportional odds assumption was not violated (Brant test $p > 0.050$), therefore, proportional odds ordinal logistic regression models were estimated with robust standard errors.

Advantages of Tokenization were significantly associated with Likelihood to invest (OR = 1.549, 95% CI: 1.322 – 1.815, $p < 0.001$), indicating that each one-unit increase in Advantages of Tokenization was associated with an 54.9% increase in the odds of being in a higher category of Likelihood to invest.

In summary, Advantages of Tokenization were positively associated with Likelihood to invest, such that investors who perceive greater advantages tend to exhibit higher levels likelihood to invest. **Hypothesis 6 was supported.**

5.3.8 (H7): Financial accessibility and ESG adoption positively influence investor trust, which in turn facilitates international investment in tokenized ESG assets.

This hypothesis posits a direct effect of Financial accessibility and ESG adoption on Likelihood to Invest

Financial accessibility and ESG adoption → Likelihood to Invest

The theoretical justification for operationalizing this hypothesis is that the literature indicates that ESG access and alignment function as antecedent variables of trust. Institutional Theory argues that normative practices (such as ESG) strengthen legitimacy. This theoretical framework is illustrated in Table 50.

Table 51 presents the results of the ordinal regression analysis testing Hypothesis 7. The analysis examined the direct effects of Financial accessibility and ESG adoption on Likelihood to invest.

The proportional odds assumption was not violated (Brant test $p > 0.050$), therefore, proportional odds ordinal logistic regression models were estimated with robust standard errors.

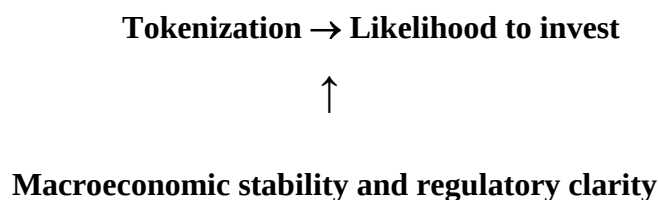
Advantages of Tokenization were significantly associated with Likelihood to invest (OR = 1.432, 95% CI: 1.171 – 1.752, $p < 0.001$), indicating that each one-unit increase in

Financial accessibility and ESG adoption was associated with an 43.2% increase in the odds of being in a higher category of Likelihood to invest.

In summary, Financial accessibility and ESG adoption were positively associated with Likelihood to invest, such that investors who perceive greater positive situation tend to exhibit higher levels likelihood to invest. **Hypothesis 7 was supported.**

5.3.9 (H8): Brazil's macroeconomic stability and regulatory clarity moderate the relationship between Tokenization and international investment, influencing investor sentiment and participation.

This hypothesis posits a moderating role of macroeconomic stability and regulatory clarity in the association between Tokenization and likelihood to invest:



The theoretical justification for operationalizing this hypothesis is that loss aversion theory and pecking order theory suggest that stable environments reduce perceived risks and encourage investment. This theoretical framework is illustrated in Table 52 while Table 53 presents the results of the moderation analysis testing Hypothesis 8. The analysis examined the moderating role of four indicators in the relationship between Tokenization and likelihood to invest.

5.3.9.1 Indicator 1 - Economic instability: In the model **without interaction**, Tokenization showed a positive and statistically significant association with likelihood to invest (OR = 1.687; 95% CI: 1.464 – 1.945; $p < 0.001$), indicating that higher levels of Tokenization are associated with greater odds of investment. Economic instability exhibited a negative effect; however, this association did not reach statistical significance (OR = 0.578; 95% CI: 0.303–1.101; $p = 0.095$).

After including the interaction term, the main effect of Tokenization remained positive and statistically significant (OR = 1.718; 95% CI: 1.309 – 2.253] $p < 0.001$), indicating that each one-unit increase in Tokenization was associated with a 71.8% increase in the odds of being in a higher category of likelihood to invest, holding the other variables constant. Economic instability remained non-significant (OR = 0.571;

95% CI: 0.288 – 1.132; $p = 0.109$). Compared to the condition of greater economic stability (0), higher economic instability (1) was associated with a 42.9% reduction in the odds of being in a higher likelihood-to-invest category, at the mean level of Tokenization.

The interaction term between Tokenization and economic instability was not statistically significant (OR = 0.974; 95% CI: 0.713 – 1.330; $p = 0.868$). Taken together, these results indicate that the positive association between Tokenization and likelihood to invest does not differ significantly between contexts of lower and higher economic instability, suggesting the absence of a moderating effect.

5.3.9.2 Indicator 2 - Risk of macroeconomic volatility: In the model without interaction, Tokenization was positively and statistically significantly associated with likelihood to invest (OR = 1.651; 95% CI: 1.441 – 1.892; $p < 0.001$), indicating that higher levels of Tokenization are associated with greater odds of investment. The perceived risk of macroeconomic volatility was not significantly associated with likelihood to invest (OR = 1.221; 95% CI: 0.710 – 2.099; $p = 0.471$).

After including the interaction term, the main effect of Tokenization remained positive and statistically significant (OR = 1.676; 95% CI: 1.422 – 1.975; $p < 0.001$), indicating that each one-unit increase in Tokenization was associated with a 67.6% increase in the odds of being in a higher likelihood-to-invest category, holding other variables constant. The effect of macroeconomic volatility risk remained non-significant (OR = 1.217; 95% CI: 0.709 – 2.090; $p = 0.477$).

The interaction term between Tokenization and macroeconomic volatility risk was not statistically significant (OR = 0.955; 95% CI: 0.717 – 1.274; $p = 0.756$). These findings indicate that the positive association between Tokenization and likelihood to invest does not vary significantly across different levels of perceived macroeconomic volatility risk, providing no evidence of a moderating effect.

5.3.9.3 Indicator 3 - Impact of regulatory uncertainty: In the model without interaction, Tokenization showed a positive and statistically significant association with likelihood to invest (OR = 1.732; 95% CI: 1.505 – 1.993; $p < 0.001$). In contrast, the perceived impact of regulatory uncertainty was negatively and significantly associated with likelihood to invest (OR = 0.381; 95% CI: 0.220 – 0.658; $p = 0.001$), indicating lower odds of investment under greater regulatory uncertainty.

With the inclusion of the interaction term, the main effect of Tokenization remained positive and statistically significant (OR = 1.974; 95% CI: 1.592 – 2.449; $p < 0.001$). The

negative effect of regulatory uncertainty also remained statistically significant (OR = 0.363; 95% CI: 0.207 – 0.639; $p < 0.001$).

However, the interaction between Tokenization and regulatory uncertainty was not statistically significant (OR = 0.802; 95% CI: 0.609 – 1.057; $p = 0.117$).

Although regulatory uncertainty directly reduced the likelihood to invest, the results indicate that it did not significantly alter the strength of the association between Tokenization and investment likelihood, suggesting that the positive effect of Tokenization is relatively stable even under more adverse regulatory conditions.

5.3.9.4 Indicator 4 - Risk of regulatory uncertainty: In the model without interaction, Tokenization was positively and significantly associated with likelihood to invest (OR = 1.688; 95% CI: 1.466 – 1.944; $p < 0.001$). The perceived risk of regulatory uncertainty was not significantly associated with likelihood to invest (OR = 0.639; 95% CI: 0.367 – 1.112; $p = 0.113$).

After including the interaction term, the main effect of Tokenization remained positive and statistically significant (OR = 1.555; 95% CI: 1.219–1.983; $p < 0.001$). The effect of regulatory uncertainty risk remained non-significant (OR = 0.663; 95% CI: 0.378 – 1.162; $p = 0.151$).

The interaction term between Tokenization and regulatory uncertainty risk was also not statistically significant (OR = 1.132; 95% CI: 0.843–1.521; $p = 0.410$).

These results suggest that the positive association between Tokenization and likelihood to invest does not differ significantly between lower and higher levels of perceived regulatory uncertainty risk, indicating no evidence of a moderating effect.

5.3.9.5 Overall synthesis of the moderation analyses: Tokenization exhibited a positive and statistically significant association with likelihood to invest across all estimated models. None of the four variables tested provided evidence of a moderating effect on this relationship, as no interaction terms reached statistical significance. Although certain macroeconomic and regulatory conditions exerted direct effects on investment decisions, the results suggest that the positive impact of Tokenization remains robust even under more adverse economic and regulatory conditions. The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated. Robust standard errors were used.

5.3.10 (H9): Regulatory stability and enforcement predictability significantly influence investor trust, shaping their willingness to engage with tokenized ESG assets.

This hypothesis posits a mediating role of investor trust in the association between regulatory stability and likelihood to invest:

Regulatory stability → Perceived threats → Likelihood to invest

The theoretical justification for operationalizing this hypothesis is that regulatory stability and predictability influence investor confidence, shaping the willingness to engage with tokenized assets. This theoretical framework is illustrated in Box 9.

Table 25 presents the results of the mediation analysis testing Hypothesis 9. The analysis examined the effects of Regulatory uncertainty on Likelihood to Invest through Trust. Regulatory uncertainty (classified as no, low, or moderate negative impact) was negatively and significantly associated with Investor Trust (OR = 0.466, 95% CI: 0.247–0.685, $p = 0.001$), indicating that a one-unit increase in this measure decreased the odds of being in a higher Trust category by 53.4%. In turn, Investor Trust was positively and significantly associated with Likelihood to Invest (OR = 1.552, 95% CI: 1.296–1.808, $p < 0.001$).

The direct effect of regulatory uncertainty (no, low, or moderate) on Likelihood to Invest was positive and statistically significant (OR = 2.638, 95% CI: 1.275–4.000, $p < 0.001$), suggesting that higher values on this measure were associated with a 163.8% increase in the odds of being in a higher Likelihood to Invest category.

The indirect effect of Regulatory uncertainty on Likelihood to Invest via Investor Trust was negative and statistically significant (OR = 0.715, 95% CI: 0.553–0.876, $p = 0.004$), indicating that lower regulatory uncertainty was associated with lower investor trust, which in turn reduced the likelihood of investing.

When considering both pathways simultaneously, the total effect of Regulatory uncertainty (no, low, or moderate negative impact) on Likelihood to Invest was positive and statistically significant (OR = 1.885, 95% CI: 0.836–2.934, $p = 0.026$). However, the indirect effect via Investor Trust operated in the opposite direction to the direct effect, accounting for –53.0% of the total effect. This pattern indicates an inconsistent mediation, in which the mediating pathway partially suppresses the direct association rather than transmitting it. Given the limitations in the measurement of regulatory uncertainty, the total effect should be interpreted with caution and viewed primarily as

exploratory.

In summary, although the overall association between regulatory uncertainty (no, low, or moderate negative impact) and Likelihood to Invest was statistically significant, the evidence does not support the presence of an indirect pathway operating through Investor Trust. The indirect effect of regulatory uncertainty via Investor Trust operated in the opposite direction to the direct effect, indicating an inconsistent mediation pattern rather than a conventional mediating mechanism. Limitations in the measurement of regulatory uncertainty may have influenced these results. **Hypothesis 9 received partial support.** Table 9 presents a synthesis of the results obtained from the ordinal regression analyses.

Table 9: Box 10. Summary of hypothesis testing results from ordinal regression analyses

Hypothesis	Analysis	Results	Conclusion
H1: Tokenization positively affects Investor Trust, enhancing the decision-making process of international investors in sustainable Brazilian projects.	Mediation	Tokenization increased the Likelihood to Invest, but the proposed mediation through Investor Trust was not supported. This indicates that the effect of Tokenization on investment decisions occurs primarily through a direct pathway rather than via Investor Trust.	H1 was partially supported
H2: Perceived threats (e.g., regulatory, economic and technological) adversely affect investors' willingness to participate in tokenized assets.	Mediation	Perceived Threats were inversely associated with Likelihood to Invest, as hypothesized, but both the direct and total effects were not statistically significant; however, a significant indirect pathway through Investor Trust was observed.	H2 was partially supported
H3: Regulatory barriers, such as legal uncertainties and compliance costs, hinder the widespread adoption of Tokenization in Brazil's sustainable finance sector.	Direct effects	Regulatory barriers were not significantly associated with familiarity with Tokenization: regulatory uncertainty showed weak and inconsistent effects across outcome levels, while perceived regulatory risk showed no statistically significant association.	H3 was not supported
H4: The scalability and integration of blockchain technology within Brazil's financial and legal infrastructure affect the feasibility and adoption of tokenized sustainability projects.	Direct effects	Technological challenges were positively associated with Tokenization, such that investors who perceive greater technological challenges tend to exhibit higher levels of Tokenization, contrary to the specified hypothesis.	H4 was not supported
H5: Brazil's alignment with global ESG standards significantly enhance international investors' interest in tokenized ESG assets.	Direct effects	In summary, Alignment of ESG metrics were positively associated with Likelihood to invest, such that investors who perceive greater alignment of ESG metrics tend to exhibit higher levels likelihood to invest.	H5 was supported

H6: The advantages provided by Tokenization, such as the traceability of environmental and financial impacts of projects from blockchain technology, improves the international investors' willingness to engage in tokenized ESG assets.	Direct effects	Advantages of Tokenization were positively associated with Likelihood to invest, such that investors who perceive greater advantages tend to exhibit higher levels likelihood to invest.	H6 was supported
H7: Financial accessibility and ESG adoption positively influence investor trust, which in turn facilitates international investment in tokenized ESG assets.	Direct effects	Financial accessibility and ESG adoption were positively associated with Likelihood to invest, such that investors who perceive greater positive situation tend to exhibit higher levels likelihood to invest. Hypothesis 7 was supported.	H7 was supported
H8: Brazil's macroeconomic stability and regulatory clarity moderate the relationship between Tokenization and international investment, influencing investor sentiment and participation.	Moderation	None of the macroeconomic or regulatory variables tested moderated the relationship between Tokenization and Likelihood to invest, as no interaction terms were statistically significant. The positive effect of Tokenization remained robust even under more adverse economic and regulatory conditions.	H8 was not supported
H9: Regulatory stability and enforcement predictability significantly influence investor trust, shaping their willingness to engage with tokenized ESG assets.	Mediation	Although the overall association between regulatory uncertainty (no, low, or moderate negative impact) and Likelihood to Invest was statistically significant, the evidence does not support the presence of an indirect pathway operating through Investor Trust. The indirect effect of regulatory uncertainty via Investor Trust operated in the opposite direction to the direct effect, indicating an inconsistent mediation pattern rather than a conventional mediating mechanism. Limitations in the measurement of regulatory uncertainty may have influenced these results. Hypothesis 9 received partial support.	H9 was partially supported

Source: elaborated by Author

To improve clarity and facilitate interpretation, Table 10 summarizes the main empirical results for each hypothesis, including the method used, level of support, key findings, and their interpretation.

Table 10: *Summary of Hypotheses, Methods and Key Findings*

Hypothesis	Method Used (Primary)	Supported	Key Empirical Finding	One-line Interpretation
H1	Ordinal Regression	Partially Supported	Tokenization positively influences investor trust, but effects vary and are not consistently strong across models	Tokenization contributes to trust formation, but not as a uniformly strong driver
H2	Ordinal Regression	Partially Supported	Perceived threats reduce willingness to invest indirectly through investor trust	Risk perceptions affect investment mainly by eroding trust rather than directly
H3	Ordinal Regression	Not Supported	Regulatory barriers show weak or non-significant effects on familiarity with Tokenization	Regulatory constraints are not a primary determinant of Tokenization awareness
H4	Ordinal Regression	Not Supported	Technological challenges are positively associated with Tokenization, contrary to expectations	Perceived challenges may reflect engagement rather than barriers
H5	Ordinal Regression	Supported	ESG alignment is positively associated with willingness to invest	Alignment with ESG standards is a key driver of investor interest
H6	Ordinal Regression	Supported	Tokenization advantages (e.g., transparency, traceability) increase willingness to invest	Functional benefits of Tokenization enhance investment attractiveness
H7	Ordinal Regression	Supported	Financial accessibility and ESG adoption positively influence investment willingness	Accessibility and ESG integration strengthen investor engagement
H8	Ordinal Regression	Not Supported	Macroeconomic and regulatory variables do not significantly moderate relationships	External instability does not significantly alter investment behavior in this model
H9	Ordinal Regression	Partially Supported	Regulatory uncertainty affects investment directly, but not consistently through trust (inconsistent mediation)	Regulatory factors matter, but their effect on trust is complex and non-linear

Source: elaborated by Author

Note: While Structural Equation Modeling (SEM) was initially employed to assess the theoretical model, the results presented above are based on ordinal regression analyses, which provided more robust and reliable estimates given the data characteristics.

CHAPTER VI: QUALITATIVE METHOD

6.1 Qualitative Approach

The qualitative component follows an exploratory case-study design, enabling an in-depth examination of tokenized sustainable investments and their appeal to international investors. This approach ensures strong theoretical alignment with behavioral finance and institutional investment theories.

6.2 Interviews

All interviews were conducted via video conferencing platforms or in-person meetings and were audio-recorded with the informed consent of participants. The recordings were transcribed verbatim to ensure accuracy and to preserve the richness of respondents' narratives. Particular attention was given to maintaining semantic integrity, including emphasis and contextual expressions relevant to investor sentiment and regulatory perceptions. To ensure confidentiality and compliance with ethical research standards, all personal identifiers were removed, and participants were anonymized using unique case identifiers.

6.3 Data Collection

To explore investor trust, risk perception, and regulatory concerns—factors that quantitative surveys alone may not fully capture—the study gathered rich qualitative insights through multiple sources:

- i. Document analysis of regulatory guidelines, policy reports, and market analyses to assess the legal and economic landscape of Tokenization.
- ii. Observational insights from industry conferences, webinars, and expert panels on blockchain and sustainable finance, providing additional context for emerging trends.
- iii. Semi-structured interviews with key stakeholders (N=9), including Institutional investors (pension funds, ESG-aligned funds), Venture capital firms investing in blockchain-based financial innovations, Impact investors prioritizing sustainability-focused financial models, Blockchain professionals and regulatory experts.

6.4 Coding and Analysis

After transcription, all interview documents were reviewed for consistency and completeness before being imported into the MaxQDA qualitative data analysis software. Each transcript was treated as an individual case, enabling systematic comparison across stakeholder groups.

In parallel, data collected through the quantitative survey were cleaned, standardized, and prepared for integration into MaxQDA. Survey responses were assigned unique case identifiers aligned with the qualitative interview cases. Closed-ended questions were recoded into numerical variables, such as Likert-scale and binary indicators, while open-ended survey responses were converted into text-based documents. This preparation enabled the integration of quantitative variables and qualitative material within the same analytical environment.

The coding process followed a hybrid deductive–inductive approach. An initial codebook was developed deductively based on the interview guide, research objectives, and the theoretical framework underpinning the study, including institutional investment theory, behavioral finance, and blockchain adoption literature. Core analytical categories included perceptions of Tokenization, regulatory and governance challenges, investor sentiment and decision-making, and technological considerations related to blockchain-based finance.

Each main category was subdivided into analytical subcategories reflecting specific dimensions explored during the interviews, such as perceived risks and opportunities, cross-border regulatory compliance, trust in ESG data, and the credibility of Brazil’s sustainable finance market. Clear definitions and inclusion criteria were established for each code to ensure consistency throughout the analytical process. During the coding process, inductive or emergent codes were incorporated whenever recurring themes arose that were not fully captured by the initial framework. These emergent themes included issues such as credibility gaps in tokenized ESG assets, skepticism regarding blockchain interoperability, and Brazil-specific regulatory and

market barriers. This iterative refinement of the codebook enhanced the depth and responsiveness of the qualitative analysis.

All interview transcripts and open-ended survey responses were coded using MaxQDA at the segment level. Multiple codes could be applied to the same textual segment when relevant, reflecting the multidimensional nature of investor perceptions in which regulatory, technological, and behavioral aspects frequently overlap. Analytical memos were systematically used to document coding decisions, emerging interpretations, and reflections, contributing to the transparency and auditability of the research process.

Following the completion of the coding stage, MaxQDA's analytical tools were employed to identify patterns, relationships, and contrasts across stakeholder groups. Code frequency tables and code matrix browsers were used to compare thematic prevalence among different investor profiles, while code relations browsers enabled the examination of co-occurring themes, such as the interaction between regulatory barriers and cross-border investment constraints.

6.5 Limitations

Several methodological limitations related to the qualitative component of this study should be acknowledged. First, the number of interviews conducted was relatively limited when compared to broader qualitative investigations, which may restrict the diversity of viewpoints captured across the ecosystem of tokenized sustainable finance. Although efforts were made to include participants from different stakeholder groups—such as institutional investors, venture capital firms, impact investors, and regulatory or blockchain experts—the sample size inevitably constrains the extent to which the findings can be generalized beyond the study context.

In light of these constraints, a convenience sampling strategy was adopted. This approach was primarily driven by practical considerations, including access to senior-level professionals, time availability of respondents, and the emerging nature of tokenized ESG investments. While convenience sampling enabled the inclusion of participants with substantial expertise and direct market experience, it may introduce

selection bias, as the sample may overrepresent individuals who are more engaged with or favorable toward blockchain-based financial innovations. Consequently, certain dissenting or more conservative perspectives may be underrepresented.

Additional limitations stem from the semi-structured interview format itself. Although this design allowed for flexibility and in-depth exploration of complex topics, it also resulted in variations in how specific themes were addressed across interviews. Differences in interview flow, emphasis, and respondent interpretation may have influenced the depth of discussion on particular issues, such as regulatory barriers or technological risks. Furthermore, the qualitative data rely on self-reported perceptions and experiences, which are inherently subject to cognitive bias, strategic framing, and differences in individual understanding of ESG standards and Tokenization mechanisms.

The qualitative findings should be interpreted in light of the rapidly evolving technological and regulatory environment surrounding tokenized assets and sustainable finance. Regulatory frameworks, market infrastructure, and investor familiarity with Tokenization are continuously developing, which means that some insights captured during the interviews may reflect temporal conditions rather than long-term structural patterns. Despite these limitations, the qualitative approach remains valuable for providing contextualized and interpretive insights, particularly when triangulated with quantitative survey results within the mixed-methods framework adopted in this study.

CHAPTER VII: QUALITATIVE RESULTS

7.1 Participants Overview

The qualitative component of this study included semi-structured interviews with international participants (N=9) from diverse professional and geographic backgrounds, all of whom have experience or interest in blockchain technologies and sustainable finance. The interviewees represented a variety of roles, including impact investors, fund managers, blockchain consultants, former regulators, and innovation leads at financial institutions. Countries represented include Poland, Canada, Australia, Japan, Singapore, and the United States, providing a global lens through which tokenized ESG investments in Brazil were analyzed.

Participants exhibited varying levels of expertise in ESG investment and Tokenization. Some had direct involvement in deploying tokenized financial products or designing blockchain infrastructure, while others participated as retail investors in ESG-focused ETFs or had theoretical exposure through academic or consulting work. This diversity allowed the research to capture a broad spectrum of perceptions — from highly technical and regulatory insights to user-level challenges related to understanding, accessibility, and risk perception. In some cases, participants had over a decade of experience in blockchain regulation or development, while others were in the early stages of exploring its applicability to sustainable investing.

Despite their differences, all participants engaged with the Brazilian context from the standpoint of foreign investors evaluating tokenized ESG opportunities. Their inputs revealed important cross-border concerns related to legal clarity, regulatory harmonization, market accessibility, and the transparency of ESG data. Cultural and institutional factors from their home countries—such as regulatory conservatism in Japan, blockchain openness in Australia, and the DeFi culture in Canada—shaped their perspectives on Brazil’s readiness for tokenized sustainability finance. Collectively, their insights contributed to identifying enabling factors and structural barriers to international adoption of tokenized ESG instruments in emerging markets.

7.2 Thematic Analysis

Thematic analysis was conducted to identify recurring patterns, meanings, and contrasts in participants' responses regarding tokenized sustainable investment in Brazil. Drawing from the QTT framework (Questions, Themes, Theories) using MaxQDA Software, seven major themes emerged across the dataset, reflecting both the opportunities and challenges perceived by international investors. These themes were coded and refined using an inductive-deductive approach, supported by theoretical concepts such as legitimacy theory, prospect theory, and technological acceptance models.

7.2.1 Coding Process and Thematic Coverage in MaxQDA

The qualitative data was coded using MaxQDA based on a predefined and iteratively refined thematic code system aligned with the study's conceptual framework. Codes were applied deductively from the research questions and literature (e.g., ESG, Tokenization, trust), and inductively based on emerging insights from the interviews. The coding matrix, illustrated in Figure 13, reveals significant thematic density and variation across the three participant groups: Institutional Investors, Impact Investors, and Blockchain Experts.

The most frequently referenced themes across all groups were Regulation (Institutional: 55; Impact: 36; Blockchain: 72), Drivers/Enablers (Institutional: 37; Impact: 48; Blockchain: 73), and Barriers/Risks (Institutional: 14; Impact: 13; Blockchain: 48), confirming the centrality of legal, strategic, and technical considerations in shaping perceptions of tokenized ESG assets. Notably, Blockchain Experts showed high engagement with technology-related codes such as Technology (30) and Smart Contracts & DeFi Trust (11), reflecting their technical depth. In contrast, Institutional Investors placed stronger emphasis on Regulation, Investor Perceptions (32), and Trust-related themes, while Impact Investors coded more frequently for ESG Factors (13), Opportunities of Tokenized ESG Assets (11), and Credibility & Maturity of Brazil's Market (9).

This distribution highlights how stakeholder perspectives vary not only in content but also in intensity, providing a multi-angled view of the challenges and drivers related to sustainable Tokenization in Brazil. The coding matrix thus informed both the cross-case analysis and thematic co-occurrence modeling developed in later stages of the research.

Code System	Institutional Investor	Impact Investors	Blockchain Experts
> Drivers/Enablers	37	48	73
> Barriers/Risks	14	13	48
> ESG Factors	14	3	18
> Investor Perceptions	32	20	27
> Regulation	55	36	72
> Technology	20	15	30
Role of tokenization in ESG strategies	5	5	8
Blockchain impact on sustainable finance	2	4	7
> Sentiment regarding Brazilian sustainable assets	8	12	9
Market maturity perception		2	2
Investor education & awareness	1	2	1
Smart contracts & DeFi trust	10	16	11
Opportunities of tokenized ESG assets	1	11	1
Credibility & maturity of Brazil's market	5	2	4
Factors influencing investment in Brazil	3	7	3
Comparison with traditional ESG instruments	1	7	1

Figure 9: Code System

Source: Author's elaboration based on qualitative data

7.2.2 Code Cloud Visualization

To complement the frequency analysis and provide a visual representation of thematic prominence, a Code Cloud was generated in MaxQDA Software. This visualization displays all applied codes across the dataset, with font size corresponding to their frequency of occurrence. The result (Figure 9) highlights “Regulation” and “Drivers/Enablers” as the most dominant themes, reflecting their centrality in discussions about the viability of tokenized ESG investments in Brazil. Other highly prominent codes include “Investor Perceptions”, “Technology”, “Valuable Blockchain Features”, and “Barriers/Risks”, indicating the multi-dimensional nature of concerns among international stakeholders.

Several medium-frequency codes such as “Trust in ESG Data Providers”, “Cross-border Compliance”, “Transparency”, and “Smart Contracts & DeFi Trust” underscore the relevance of credibility, interoperability, and data security in shaping adoption. Meanwhile, less frequent yet conceptually important codes like “Greenwashing”, “Risk Aversion”, and “Technical Shortcomings” add granularity to the perceived challenges. The Code Cloud thus offers a visual summary that reinforces the quantitative coding matrix and highlights the thematic saturation around legal clarity, technical infrastructure, and investor confidence — core pillars in evaluating Brazil’s readiness for ESG Tokenization.



Figure 10: Word Cloud

Source: Author’s elaboration based on qualitative data

7.3 Interpretative Analysis

This chapter applies the QTT (Questions – Themes – Theories) framework to interpret the qualitative findings in alignment with the study’s four research questions. Each section discusses one research question, linking empirical evidence (themes) to relevant theoretical lenses. This approach enables both pattern recognition and contextual theorization, ensuring analytical rigor while remaining grounded in participant narratives.

7.3.1 Research Question 1: How does Tokenization influence investor trust and decision-making in sustainable Brazilian projects?

Interviewees emphasized that Tokenization plays a multifaceted role in shaping investor trust and decision-making regarding sustainable Brazilian projects, while it significantly improves transparency, accessibility, and liquidity, it also introduces challenges such as regulatory ambiguity and perceived technological risks that influence investor behavior and institutional engagement.

A major driver of trust is the enhanced transparency and traceability afforded by blockchain. INT_06 perceive that Tokenization 'provides transparency and traceability, which supports ESG confidence and investment strategy.' INT_01 noted that blockchain 'increases transparency' and helps reduce concerns like greenwashing. Similarly, INT_04 stated that 'transparency of the transactions builds trust in the market,' particularly when tracking ESG metrics in real time. This immutability ensures ESG data cannot be tampered with, giving investors confidence that projects are genuinely meeting their sustainability objectives.

Accessibility and liquidity were repeatedly highlighted. INT_03 perceive Tokenization as 'a lot better, a lot more efficient,' enabling 'easier access and less barrier to entry.' INT_09 emphasized that Tokenization brings 'accessibility' to projects once limited to institutional investors. According to INT_07, the international nature of digital assets and their ability to increase 'market liquidity' makes Tokenization particularly appealing for ESG finance. INT_08 added that it allows 'smaller portions' to be purchased, broadening participation.

Smart contracts were also recognized for their automation and assurance capabilities. As INT_06 highlighted, these contracts reduce the need for intermediaries and help ensure that ESG-linked obligations are met automatically, supporting credibility in compliance reporting. This programmable layer enables real-time ESG validation—a significant enhancement over traditional green bonds that often lack enforceable performance mechanisms.

Nonetheless, regulatory uncertainty was the most frequently cited barrier. INT_01 referred to the 'main barrier' as regulation and noted that 'regulatory approval' is required to increase exposure. INT_02 called for 'strong laws' to improve market reliability, while INT_09 stressed the need for 'regulatory clarity' and 'investor protections.' INT_07 emphasized 'regulatory convergence' as a key enabler, particularly for cross-border adoption. Without clear and harmonized frameworks, interviewees also worry that future legal shifts could negatively affect previously compliant investments.

Concerns also persist around technological risk. INT_02 mentioned that quantum computing could pose a 'big technological risk' to blockchain security in the future. INT_08 cited 'smart contract vulnerabilities' and scalability issues as limiting factors. INT_05, having been a victim of fraud, emphasized cybersecurity risks, and INT_06 added that long-term technological viability and platform interoperability are vital for market adoption.

While Brazil's ESG potential is widely acknowledged, trust in its sustainable finance maturity remains mixed. INT_04 and INT_05 spoke to Brazil's ecological strength and role in climate policy, but interviewees also raised concerns about political uncertainty and market inconsistency. INT_07 noted that Brazil's innovation ecosystem—including projects like Pix and COP30—may signal growing credibility, but this optimism depends on regulatory follow-through.

Interviewees agreed that government support and incentives could significantly influence investor decisions. INT_01 and INT_05 called for tax breaks and government guarantees to reduce risk exposure. INT_04 suggested more proactive, pro-investor policies could help standardize the market. International standards and interoperability frameworks were also viewed as essential for creating unified ESG models; as INT_06 put it, standardization helps 'build trust' and enables token models to scale safely. In conclusion, Tokenization holds transformative potential for sustainable investment in Brazil by increasing trust, transparency, and access. However, interview insights make clear that to fully realize these benefits, Brazil must address regulatory fragmentation, technological risks, and investor confidence gaps. With clear legal frameworks,

international alignment, and improved blockchain literacy, tokenized ESG assets could become a trusted and scalable mechanism for advancing sustainable development goals.

7.3.2 Research Question 2: What are the primary legal, economic, and technological challenges for implementing Tokenization in Brazilian sustainable finance?

According to interviewees, the implementation of Tokenization in Brazilian sustainable assets faces a multifaceted array of challenges spanning legal, economic, and technological domains. These challenges are primarily rooted in regulatory uncertainty, market immaturity, and the inherent complexities of emerging blockchain technologies.

7.3.2.1 Legal Challenges: The most significant legal challenge identified is the lack of clear and universal regulation. Interviewees consistently highlight that regulatory ambiguity creates a major barrier to adoption, particularly for international investors. As INT_01 states, "the main barrier is regulation... having a universal regulation that encompasses that allows... safety across the board." This is further complicated by differing regulatory landscapes across countries, where Brazilian compliance might not align with the stricter requirements of regions like the UK or Europe. The absence of a harmonized regulatory framework makes cross-border compliance difficult and costly, as assets need to meet multiple jurisdictional requirements.

Another legal hurdle is the slow pace of regulatory development in Brazil concerning blockchain and Tokenization. While Brazil is seen as preparing its regulatory framework to attract investments, the current lack of specific protocols and rules creates uncertainty for investors. This is contrasted with countries like the United States, which are perceived to have faster adoption and business development in this field. The need for "strong laws, strong trust" in the regulatory environment is emphasized to encourage investment. Furthermore, the legal system's complexity, including various taxes on transactions, and the difficulty of seeking recourse through the Brazilian judicial system, are significant concerns for foreign investors.

The concept of legal claim to underlying assets is also a critical legal challenge. As INT_09 points out, for Tokenization to truly take off, policies and governance need to fully embrace blockchain, allowing blockchain-based settlements and ensuring that tokenized investments represent a legal claim, not just economic rights, to the underlying asset.

7.3.2.2 Economic Challenges: Several economic challenges impede the implementation of Tokenization in Brazilian sustainable assets:

- i. *Market Immaturity and Lack of Liquidity:* The market for tokenized ESG assets in Brazil is still nascent, with limited liquidity. Investors, such as INT_07, prioritize market liquidity, stating, "When I want to buy, I can buy. When I want to sell, I can sell." The absence of a broad investor base and sufficient liquidity makes these assets less attractive.
- ii. *Investor Familiarity and Trust:* There is a general lack of understanding and trust in Tokenization among investors, with some perceiving it as a "fad" or even a "scam." This skepticism, coupled with the novelty of the technology, makes investors hesitant to engage. INT_03 notes the "risk is high up there" due to uncertainty and volatility.
- iii. *Commercial Incentives and Returns:* For Tokenization to be widely adopted, there needs to be a clear commercial incentive and attractive returns for investors. INT_01 suggests that "returns would have to be at a premium" to attract investors. The ability to recoup investment costs is crucial for organizations to participate.
- iv. *Cross-Border Financial Disclosure Rules:* Selling financial products in countries like Japan requires adherence to specific financial disclosure rules. If Brazilian disclosure rules are not deemed equivalent or interoperable with those of other major markets, it creates a significant burden for issuers and limits market access.
- v. *Taxation and Foreign Investment Friendliness:* The complexity of Brazil's tax system, with various hidden taxes, and the overall foreign investor friendliness

are significant economic concerns. Clearer and simpler policies regarding foreign investment and taxation would increase willingness to invest.

7.3.2.3 Technological Challenges: Despite the inherent advantages of blockchain, several technological challenges need to be addressed:

- i. *Smart Contract Vulnerabilities and Cybersecurity Risks:* While smart contracts offer automation and transparency, concerns exist regarding their vulnerabilities and potential for errors. INT_08 highlights that "their assets can be lost because of the smart contract errors." Cybersecurity is also a major concern, with interviewees acknowledging the risk of hacks and fraud in the blockchain space. The need for robust safeguards and contingency plans is paramount.
- ii. *Interoperability and Scalability:* While some interviewees are optimistic about the progress in interoperability and scalability, others still view them as limitations. The ability for different blockchain platforms to seamlessly connect and for the technology to handle a large volume of transactions is crucial for widespread adoption. As INT_06 notes, "interoperability across blockchain platforms will be... an important solution so that you're not locked into one particular platform."
- iii. *Technology Maturity and Longevity:* Blockchain is still considered a relatively new technology, and its broad acceptance and adoption in enterprise and industry are not yet universal. Investors are wary of "novel innovations that may not necessarily be guaranteed to be around in the longer term." The longevity and critical mass for ongoing operation of foundational platforms are also concerns.
- iv. *Privacy Concerns:* The transparency inherent in blockchain, while beneficial for ESG data, raises questions about individual privacy. As INT_09 points out, "privacy is still something that hasn't been solved entirely yet. How do we create that transparency and auditability without compromising our individual level privacy?"

- v. *Technical Skills and Infrastructure*: A lack of skilled individuals and the necessary infrastructure to implement and manage blockchain solutions can also be a barrier.

In conclusion, while Tokenization holds immense promise for enhancing sustainable investments in Brazil by offering increased transparency, accessibility, and liquidity, its successful implementation hinges on addressing these significant legal, economic, and technological challenges through concerted efforts in regulatory harmonization, market development, and technological maturation.

7.3.3 Research Question 3: What key factors enhance the attractiveness of tokenized ESG assets to international investors?

International investors are increasingly drawn to tokenized ESG assets due to a combination of technological advantages, market opportunities, and evolving regulatory landscapes. Key factors include enhanced transparency and traceability, increased accessibility and liquidity, the potential for new market creation, and the development of supportive regulatory frameworks.

7.3.3.1 Transparency and traceability through blockchain technology:

According to the interviewees, blockchain technology plays a central role in enhancing the attractiveness of tokenized ESG assets by offering unprecedented levels of transparency, traceability, and data integrity—all of which are essential in fostering trust among international ESG investors. In a sector often scrutinized for greenwashing, the immutable nature of blockchain records ensures that critical information—such as CO₂ emissions, project milestones, or impact metrics—remains tamper-proof and verifiable in real time. This assurance allows investors to validate that sustainability targets are being met.

Several participants reinforced this view. INT_01 stated that blockchain “increases transparency” and helps “reduce things like greenwashing,” while INT_02 emphasized that when standards and regulations are in place, they make investments “more reliable” and enable companies to “prove that you are doing good.” INT_04

further explained that “transparency of the transactions builds trust in the market,” allowing real-time tracking of impact, which is especially valuable for ESG reporting. INT_06 described Tokenization as a “critical enabler for ESG maturation,” noting that it “provides transparency and traceability” that directly support investor confidence and strategy alignment.

From a technical standpoint, INT_07 highlighted blockchain’s ability to resolve core structural issues such as the “double spending issue” in carbon markets, adding that its tamper-proof design ensures accurate data provenance. Similarly, INT_09 underscored that blockchain “creates a transparency” and “helps to increase the level of scrutiny” on sustainability claims, acting as an “immutable, transparent, public” source of truth. Collectively, these perspectives affirm that trust—driven by transparency and real-time validation—is a primary factor in attracting international capital to tokenized ESG assets.

7.3.3.2 Enhanced Accessibility and Liquidity: Interviewees consistently highlighted that Tokenization significantly increases accessibility and liquidity, two elements considered essential by international investors evaluating ESG opportunities in emerging markets. By lowering financial entry barriers and allowing fractional ownership, Tokenization democratizes access to traditionally exclusive sustainable projects. As INT_01 noted, Tokenization “allows multiple, multiple people to invest,” thereby enabling risk diversification across smaller portfolios.

INT_04 emphasized that Tokenization “lowers entry barriers” and allows “broader access to the high-value ESG projects,” giving investors the ability to “buy fractions of the assets.” This granular access not only opens the market to retail investors but also facilitates global participation, as INT_07 remarked: tokenized assets are “international by nature,” offering seamless exposure across jurisdictions. Liquidity was also a key aspect for INT_07, who highlighted the importance of “market liquidity” in enhancing investment attractiveness. INT_08 echoed these points by stating that blockchain “makes the investment more open and transparent,” especially for “smaller investors” able to invest through “smaller portions.” Finally, INT_09 underscored that

Tokenization brings “accessibility,” enabling investments previously restricted to “institutions or high-net-worth investors” to reach a “large audience.”

7.3.3.3 Regulatory Clarity and Supportive Policy Environments: A second major theme relates to the importance of a clear, predictable, and supportive regulatory landscape, which participants viewed as a foundational requirement for institutional adoption of tokenized ESG products. INT_01 explicitly identified regulation as the “main barrier” but also recognized that “regulatory approval” and “more tax breaks” could significantly increase investor exposure. Echoing this view, INT_02 emphasized that “strong regularisation” and “strong laws” are crucial, as investing in unregulated assets carries considerable risk.

Other participants provided deeper insights into the specific policies needed to unlock the market. INT_03 suggested the establishment of “some type of insurance” or enhanced “customer protection” to attract institutional capital. INT_04 pointed out that “pro-investor government policies” and alignment with global standards “support investment models” by making the industry “more transparent” and “globally equal.” Similarly, INT_05 argued that eliminating capital gains tax and “lowering the taxes” would create a more conducive environment for adoption. INT_06 highlighted the role of a “regulatory certainty” and “accommodative regulatory setting,” describing them as crucial drivers of trust and participation.

INT_07 added that “regulatory convergence” across jurisdictions is key for unlocking cross-border flows and market growth. Meanwhile, INT_08 reflected on regional challenges, noting that “Japanese law hinders the development” of tokenized assets and advocating for knowledgeable “policymakers” and government-backed insurance mechanisms as a “first priority” for investors. INT_09 concluded that “the biggest barriers are more regulatory related,” stressing the need for “clearer rules,” “investor protections,” and overall “regulatory clarity” to support adoption and scale.

7.3.3.4 Creation of New Markets and Value: Beyond accessibility and regulation, several interviewees underscored Tokenization’s role in creating new markets and unlocking previously untapped value. Through the programmability of

assets via smart contracts, Tokenization enables the design of integrated, impact-driven financial products. INT_06 described Tokenization as a mechanism that “creates the opportunity to make markets,” while noting that programmable assets can “add value by linking them to new products and services.”

INT_04 further emphasized the dual potential for financial and societal gain, observing that “the probabilities and the opportunities” in this market can yield not only returns but also “positive impact on the socially environmental impact.” INT_09 extended this view by suggesting that Tokenization fosters “more awareness” and “more accessibility so that people can participate” in ESG-aligned instruments, essentially enabling broader market-building in the sustainability space.

7.3.3.5 Addressing Technical Risks and Shortcomings: While many participants praised the benefits of blockchain, they also recognized the need to address technical vulnerabilities and systemic risks to ensure sustainable adoption. INT_01 raised the concern of cybersecurity, citing the threat of exchange hacks and the importance of mechanisms to “safeguard the technology and the tokens.” Similarly, INT_02 flagged future-facing risks, such as the possibility of “quantum computing” breaking current blockchain encryption, calling it a “big technological risk.”

INT_05 also noted cybersecurity risks and expressed personal experience with digital fraud, warning that AI and emerging technologies may further complicate blockchain deployment. INT_06 added that “technology risk” includes uncertainties around platform resilience and lifecycle, in addition to “operational or cyber vulnerabilities.” He also emphasized the challenges posed by “interoperability across blockchain platforms” and the “longevity of a particular technology platform.”

Echoing these concerns, INT_07 acknowledged that “technical troubles” are inherent to innovation, advocating for contingency plans in case blockchain systems “stop” or data is “falsified.” He stressed that “blockchain, cybersecurity risk and conventional technologies... are basically the same” in terms of requiring robust safeguards. Lastly, INT_08 focused on “smart contract vulnerabilities” as a critical

concern, where coding errors could lead to asset loss. He also cited “limitation of scalability, or the transaction speed” as potential bottlenecks for widespread adoption.

In summary, the attractiveness of tokenized ESG assets to international investors is multifaceted, driven primarily by the transparency and traceability offered by blockchain, the increased accessibility and liquidity of these assets, and the potential for new market creation. While regulatory clarity and supportive government policies are crucial for mitigating risks and fostering institutional adoption, addressing technical challenges such as smart contract vulnerabilities and cybersecurity remains important. Overall, the sentiment among investors is positive, recognizing the transformative potential of Tokenization in sustainable finance, particularly in resource-rich regions like Brazil.

7.3.4 Research Question 4: To what extent does Brazil’s regulatory framework facilitate or inhibit Tokenization in the sustainability sector?

According to interviewees, Brazil’s regulatory framework presents a complex and evolving landscape for the adoption of Tokenization in the sustainability sector, marked by both promising advances and considerable uncertainty. While the country possesses inherent advantages for ESG-related investments, the current state of blockchain and Tokenization regulation introduces perceived risks for international investors, particularly around legal clarity and enforcement.

A primary barrier is the lack of a clear, comprehensive, and harmonized regulatory framework. As noted by INT_01, regulation remains “the main barrier,” and only “regulatory approval” and fiscal incentives such as “tax breaks” would shift investor sentiment. INT_02 echoed this concern, warning that operating without “strong regularisation and strong laws” significantly increases the risk profile of ESG investments. INT_06 added that without “regulatory certainty” and an “accommodative regulatory setting,” institutional participation remains limited.

Several interviewees highlighted the sluggish nature of regulatory adaptation. INT_07 noted that Brazil lacks “regulatory convergence” with global markets, which

deters cross-border investments and slows interoperability. The possibility of sudden legal changes and the risk of investments being affected retroactively were also noted as real concerns. In the words of INT_04, global alignment is crucial for investor confidence and market transparency. Participants also referenced other jurisdictions, such as Japan, where slow regulatory approvals significantly delayed the operationalization of tokenized instruments—an issue mirrored in Brazil’s still-developing policy landscape.

Despite these inhibiting factors, interviewees acknowledged Brazil’s strong sustainability profile and emerging political commitment as facilitators. INT_05 pointed to the country’s rich ecological base and climate leadership as major drivers of ESG investment attractiveness. INT_07 added that Brazil is seen as a “leader in innovation” among emerging markets, citing developments like Pix and Brazil’s role as host of COP30. INT_04 and INT_06 agreed that accommodative government policies—including tax leniency and marketing permissions—could further support tokenized ESG adoption.

Moreover, blockchain’s intrinsic transparency, traceability, and real-time tracking are seen as highly valuable for ESG verification—particularly in addressing greenwashing. However, as INT_03 and INT_09 emphasized, this potential is undermined if regulatory frameworks do not provide institutional trust and legal safeguards. Several participants highlighted the need for Brazil to not only clarify domestic laws but also align with global standards to facilitate interoperability and scale.

In conclusion, Brazil’s new regulatory framework offers some promising signs of support for Tokenization, particularly within the sustainability sector. However, interviews reveal that it currently acts more as an inhibitor due to its fragmented structure, lack of international alignment, and institutional inertia. To fully realize the potential of blockchain in ESG finance, Brazil must prioritize regulatory clarity, investor protection, and cross-border harmonization. Doing so would convert its natural advantages into a globally competitive, tech-enabled ESG investment ecosystem.

7.4 Findings and Empirical evidences

This chapter presents the core findings and empirical evidences that emerged from the qualitative analysis of expert interviews and thematic interpretation of data. Each subchapter addresses a major topic central to the adoption and evolution of tokenized sustainable investments in Brazil, structured according to recurring themes from the interview transcripts and summary documents.

7.4.1 Perception of Tokenization in ESG Investment

The perception of Tokenization in ESG investment is predominantly positive, viewed as a beneficial tool with the potential to revolutionize sustainable finance, though significant skepticism and barriers to adoption persist.

7.4.1.1 Perceived Benefits and Opportunities: A strong consensus across documents highlights Tokenization's capacity to enhance accessibility and lower entry barriers for ESG investments ((INT_01), (INT_03), (INT_04), (INT_08), (INT_09)). This includes enabling fractional ownership, allowing a broader range of investors, including retail and smaller participants, to engage in sustainable projects ((INT_04), (INT_06), (INT_08)). Increased liquidity is another frequently cited advantage ((INT_03), (INT_04), (INT_09)), along with greater efficiency and speed compared to traditional methods ((INT_03), (INT_05)). Tokenization is also seen as a mechanism for diversifying investment portfolios and managing risk ((INT_01), (INT_05)).

A core benefit emphasized by multiple interviewees is the enhanced transparency and traceability offered by blockchain technology ((INT_01), (INT_04), (INT_06), (INT_07)). This is crucial for building investor trust, combating greenwashing, and ensuring the veracity and integrity of ESG claims ((INT_01), (INT_04), (INT_06), (INT_07)). The global reach of tokenized assets is also seen as a significant opportunity, opening new markets and allowing international investors to participate without substantial barriers ((INT_04), (INT_07), (INT_08)). Furthermore, Tokenization is perceived to create new markets and value, particularly for assets that

were not previously viable, through digitization, fractionalization, and programmability ((INT_06), (INT_07)).

7.4.1.2 Challenges, Risks, and Barriers to Adoption: Despite the optimism, several significant challenges and barriers to adoption are consistently identified. A pervasive issue is the lack of understanding and widespread misunderstanding of Tokenization and blockchain technology ((INT_02), (INT_03), (INT_05), (INT_08)). This often leads to negative perceptions, with some viewing it as a "fad or a trend" ((INT_02)), a "scam" ((INT_02), (INT_05)), or simply too risky due to its newness and volatility ((INT_03)).

Regulatory uncertainty and the absence of clear legal frameworks are critical barriers, particularly in regions like Brazil ((INT_02), (INT_04)) and Japan ((INT_08)). Interviewees stress that the current unregulated status poses problems and hinders institutional adoption ((INT_02), (INT_06), (INT_09)). Other risks include the potential for investing in non-credible projects or scams ((INT_04), (INT_05)) and cybersecurity concerns ((INT_05)). Some interviewees also note that Tokenization can initially complicate matters by adding another layer of technology ((INT_01), (INT_06)) or that missing infrastructure can be a barrier ((INT_06)). INT_03 also raises a unique concern about the potential for lower returns in ESG investments due to compliance requirements.

7.4.1.3 Comparison to Traditional ESG Investment Instruments: While INT_01 finds tokenized and traditional ESG investments quite similar in fundamentals, particularly for financing sustainable projects, most interviewees highlight key differences. Tokenization is seen as offering greater transparency ((INT_04)) and being "much better and it's more easier to use" ((INT_05)). The primary distinctions lie in the Tokenization aspect itself, including how tokens are developed and managed ((INT_01)), and the ability to open broader markets through fractionalization and interoperability ((INT_06), (INT_08)). INT_02, however, notes that Tokenization currently suffers from a "worse reputation" and is less understood by clients compared to traditional instruments.

7.4.1.4 Factors Encouraging Increased Exposure: The most frequently cited factor that would encourage increased exposure to tokenized assets is regulatory certainty and clear legal frameworks ((INT_02), (INT_06), (INT_09)). Government backing or insurance is also seen as a significant driver ((INT_03), (INT_08)). Increased knowledge, understanding, and clear, understandable information about tokenized assets are crucial for overcoming current skepticism ((INT_05), (INT_08)). Transparency, particularly regarding compliance and project details, is vital for investor trust, especially in cross-border investments ((INT_05), (INT_08)). S2 ((INT_06)) also emphasizes the creation of new markets and opportunities for value growth as incentives.

7.4.1.5 Specific Blockchain Features: Transparency and traceability are consistently highlighted as the most valuable blockchain features for ESG investors ((INT_03), (INT_06), (INT_07)). These features enable precise tracking of asset origins, tamper-proof data, and verification of ESG claims, which is critical for trust and combating greenwashing ((INT_06), (INT_07)). Fractionalization, enabled by Tokenization, is also deemed highly valuable for increasing accessibility and granular transactions ((INT_04), (INT_06)). While smart contracts are acknowledged for their role in timely information disclosure ((INT_07)) and automation ((INT_06)), INT_03 expresses negative sentiment towards their "self-execution" aspect, perceiving it to negatively impact investor trust. Interoperability and scalability are also seen as positive aspects that support growth and adoption ((INT_03), (INT_07)).

7.4.2 Conditions for Increasing Exposure to Tokenized ESG Assets

Investor willingness to expand exposure to tokenized assets is heavily dependent on regulatory certainty, political support, and market infrastructure. Key enablers include harmonized regulations, tax incentives, and stronger ESG verification protocols. Government backing, especially through permissive regulation and marketing flexibility, was identified as a core catalyst for broader adoption. The presence of

standardized reporting frameworks and trusted third-party auditors for ESG data were also cited as decisive factors in scaling up participation.

7.4.3 Risks and Opportunities of Tokenized ESG Assets

The Tokenization of ESG assets presents a dual landscape of risks and opportunities. Among the risks, regulatory ambiguity, technical vulnerabilities (e.g., smart contract flaws and cybersecurity threats), and greenwashing concerns were frequently raised. These barriers are particularly prominent in emerging markets like Brazil, where legal recourse and enforcement structures are still evolving. On the opportunity side, blockchain-enabled transparency, traceability, and accessibility were repeatedly highlighted. Tokenization enables fractional ownership, opens global markets, and introduces programmable logic through smart contracts that may enhance trust and compliance in ESG investments.

7.4.4 Drivers and Barriers to Tokenization Adoption

Interviewees highlighted that the diffusion of tokenized ESG assets depends on the interaction between technological capabilities, regulatory frameworks, and investor perceptions. Among the key drivers, transparency and traceability provided by blockchain technology were consistently emphasized. Several participants noted that the ability to create immutable and verifiable records can enhance trust in ESG investments by reducing information asymmetry and mitigating greenwashing risks (INT_01, INT_02, INT_04, INT_07). Blockchain-based systems allow investors to trace data back to its source and better understand project performance and environmental impact metrics (INT_05). Traceability was therefore considered one of the most valuable features of Tokenization for sustainable investments (INT_02, INT_03, INT_04, INT_06, INT_07).

Another important driver is improved accessibility to investment opportunities. Tokenization enables fractional ownership of assets, allowing investors to participate in high-value ESG projects with lower capital requirements (INT_04, INT_06). This

mechanism broadens market participation and may attract a more diverse group of investors, particularly in the context of increasing global interest in sustainable finance (INT_01).

In addition, interviewees identified technological capabilities of blockchain systems, such as smart contracts, interoperability, and scalability, as factors that can improve efficiency and facilitate the development of tokenized investment platforms (INT_02, INT_03, INT_04, INT_06, INT_07). Smart contracts were particularly valued for their ability to automate transactions and enforce compliance conditions, potentially increasing trust and reducing operational costs (INT_01, INT_04, INT_06, INT_07).

Despite these drivers, the interviews also revealed several barriers to Tokenization adoption. The most frequently mentioned challenge is regulatory uncertainty and the lack of clear legal frameworks for tokenized assets. Participants noted that inconsistent regulations across jurisdictions create challenges for cross-border investments and discourage investor participation (INT_01, INT_02, INT_06, INT_07).

Another significant barrier is the lack of knowledge and familiarity with blockchain technology among investors and market participants. Some interviewees noted that Tokenization is still poorly understood and may even be perceived as speculative or unreliable by potential investors (INT_01, INT_02, INT_04, INT_05).

Technological risks and infrastructure limitations were also mentioned as potential obstacles. Concerns related to cybersecurity vulnerabilities, hacking incidents, and the long-term resilience of blockchain systems may reduce investor confidence in tokenized financial platforms (INT_01, INT_05, INT_06).

Overall, the qualitative findings suggest that while Tokenization offers strong advantages in terms of transparency, accessibility, and efficiency, its widespread adoption will depend on the development of clear regulatory frameworks, improved investor understanding, and continued technological maturation.

7.4.5 Role of Blockchain Technology in Sustainable Investment

Blockchain is widely perceived as a key enabler of sustainable investments due to its decentralized structure, which enhances transparency and accountability in ESG reporting. Smart contracts are seen as vital tools for automating ESG metric verification and ensuring compliance with impact benchmarks. Blockchain facilitates fractional ownership, broadening investor participation and reducing lock-in periods. At the same time, cybersecurity threats, concerns about system longevity, and regulatory vacuums continue to limit its full-scale application in some regions. However, innovations such as Layer-2 chains and decentralized finance (DeFi) platforms are increasingly addressing these challenges.

CHAPTER VIII: INTEGRATION OF FINDINGS (MIXED-METHODS)

8.1 Integration Approach and Triangulation Strategy

The integration of findings in this study follows a convergent mixed-methods design (Creswell and Plano Clark, 2011), in which the qualitative and quantitative strands were collected and analyzed separately and brought together during interpretation. This design was adopted to generate a broader and more robust understanding of how Tokenization may influence the attractiveness of sustainable investments in Brazil from the perspective of international investors. In practical terms, the mixed-methods logic of this chapter is not limited to placing two sets of results side by side. Its purpose is to demonstrate how the two strands relate to one another analytically and how their interaction strengthens the study's meta-inferences.

The integration strategy is grounded in triangulation and in the explicit comparison of findings across the two strands, while triangulation in this thesis is not restricted to simple confirmation. It also includes the identification of convergence, divergence, and expansion/complementarity, recognizing that mixed-methods integration becomes most valuable when it captures both consistency and tension across data types. In this sense, the integration chapter is the key site in which the methodological value of the research design becomes visible, because it shows not only

what was found in each strand, but what can be inferred when both are interpreted together. This integration is based on the methodological rigor proposed by Denzin (1978):

Table 11: *Triangulation Methodology*

Type of Triangulation	Process	Justification
Methodological	by combining qualitative interviews and quantitative survey data to explore investor perceptions, regulatory challenges, and trust formation regarding tokenized ESG assets	Combined use of qualitative interviews + secondary quantitative data and surveys.
Data	by drawing on multiple respondent groups—including institutional investors, ESG-aligned funds, venture capitalists, and blockchain professionals—to ensure the validity and richness of findings;	Diverse profiles of interviewees (institutional investors, blockchain experts, etc.)
Theoretical	by interpreting the results through the lenses of <i>Behavioral Finance</i> (Kahneman and Tversky, 1979), Regret Aversion Theory (Loomes and Sugden, 1982) and Herding Behavior (Banerjee, 1992) —as well as <i>Institutional Investment Theories</i> , such as Institutional Isomorphism (DiMaggio and Powell, 1983) and Legitimacy Theory (Suchman, 1995).	Integrated use of Behavioral Finance, Institutional Investment Theory and Diffusion of Innovation

Source: elaborated by Author

More specifically, integration was conducted at three levels. At the first level, both strands were compared thematically around the core constructs of the study, including investor trust, ESG alignment, financial accessibility, regulatory uncertainty, technological risk, and institutional legitimacy. At the second level, findings were organized around the four research questions, allowing each question to be answered through the combined reading of quantitative patterns and qualitative interpretations. At the third level, the integrated evidence was interpreted through the theoretical lenses established in the thesis, namely Behavioral Finance, Regret Aversion Theory, Herding

Behavior, Institutional Isomorphism, and Legitimacy Theory, which were explicitly positioned in the triangulation framework of the thesis.

The role of the joint displays is therefore central rather than merely illustrative. In the current structure of the thesis, Tables 43 to 47 already summarize integrated themes by research question and highlight key points such as the importance of transparency, the relevance of ESG credibility, the centrality of regulatory uncertainty, and the trust-building role of traceability and automation. However, the present reformulation sharpens the narrative by making explicit where the evidence aligns, where it conflicts, and where one strand deepens the interpretation of the other. This is particularly important because the mixed-methods value of the study lies not only in showing consistency across strands, but also in showing why the areas of divergence and nuance are theoretically and practically meaningful.

This integration chapter should be read as the bridge between the empirical results and the later discussion chapter. The results chapters establish what each strand found independently. The current chapter moves one step further by asking a different question: What does the combined evidence mean when both strands are interpreted together? This shift from parallel reporting to meta-inference is what gives the mixed-methods design its strongest justification in the thesis.

According to (Fetters, Curry and Creswell, 2013), joint displays are key strategies that enable researchers to merge qualitative and quantitative findings in a coherent and accessible format, supporting interpretation and deepening the meaning derived from the combined data. These visual representations are presented in Section 8.3 as a foundation for the integrated discussion that follows in Section 8.4.

The integration was further supported through the use of joint displays, which allowed for visual comparison of data strands and enhanced interpretation of complex relationships. This structure enabled a robust synthesis that moves beyond parallel reporting of findings, providing a coherent narrative that reflects both the depth of qualitative insights and the generalizability of quantitative evidence. This integration approach ensures that the conclusions drawn in this research are not only empirically grounded but also multidimensional, capturing the nuances, constraints, and potential of Tokenization within Brazil's evolving sustainable finance ecosystem.

8.2 Integrated Analysis of Findings (Convergent analysis)

The integration analysis is structured around three dimensions: (i) convergence, where both strands lead to similar conclusions; (ii) divergence, where findings differ; and (iii) complementarity, where one strand provides explanatory depth to the other. The convergent analysis in this study follows the integration logic of a convergent parallel mixed-methods design (Creswell and Plano Clark, 2018), in which qualitative and quantitative data were analyzed independently and then compared and interpreted together. The purpose of this phase was to identify where the findings from each strand converge, diverge, or complement each other in response to the study's central research questions.

8.2.1 Areas of Convergence

A first and particularly strong area of convergence concerns the importance of transparency, traceability, and ESG credibility in shaping investor interest in tokenized ESG assets. In the quantitative strand, survey results showed high levels of support for features associated with transparency and asset accessibility, including the findings later synthesized in the joint displays: 72% of respondents valued transparency, 58% favored fractionalization, and 64% indicated that Tokenization increases ESG interest. In the qualitative strand, interviewees repeatedly described transparency, blockchain traceability, real-time monitoring, and ESG verification as major enablers of credibility and attractiveness. They also identified fractional ownership as an important mechanism for broadening participation and lowering access barriers.

This convergence is analytically important because it is not limited to surface agreement. The quantitative strand identifies a clear pattern of investor preference, while the qualitative strand explains the mechanism behind that preference. Together, the findings suggest that transparency matters not only because it is technologically attractive, but because it addresses a core problem in sustainable finance: the credibility gap around ESG claims. In other words, both strands independently support the argument that Tokenization becomes attractive when it is perceived as a tool for reducing information asymmetry and strengthening the verifiability of sustainability outcomes.

A second major area of convergence concerns regulatory uncertainty as a barrier to adoption. The quantitative strand showed that legal uncertainty and related institutional ambiguity were among the most frequently cited inhibitors, with the joint displays reporting that 76% identified legal uncertainty as a barrier, while 61% mentioned legal or tax-related disincentives. In the qualitative strand, interviewees repeatedly emphasized unclear legal definitions, cross-border inconsistency, weak institutional signaling, and the absence of a more mature regulatory framework as obstacles to investor confidence and wider market development.

This convergence is especially valuable because it strengthens the interpretation of regulation as more than a technical or legal issue. Both strands indicate that regulation functions as a credibility condition for tokenized markets. The quantitative data show that legal uncertainty is widely recognized as an obstacle. The qualitative data clarify why: in the absence of legal clarity, investors struggle to evaluate enforceability, asset protection, compliance expectations, and jurisdictional legitimacy. The integrated inference is therefore stronger than either strand alone. It suggests that regulatory uncertainty shapes not only risk perception but also the broader institutional readability of the market.

A third area of convergence involves the role of trust in Tokenization and ESG investment decisions. The quantitative findings associated trust-related constructs with willingness to invest and indicated that blockchain-based features such as traceability and automation are perceived positively by respondents, with the joint display noting that 69% considered blockchain to improve trust and 63% supported automation in ESG bonds. The qualitative findings converge with this pattern by emphasizing that smart contracts, auditable ESG records, automation of compliance conditions, and more reliable disclosure can strengthen investor confidence.

The convergence is more meaningful than a simple parallel confirmation. The quantitative strand shows that trust-related technological affordances matter. The qualitative strand reveals that this trust is interpreted as both technological reassurance and institutional reassurance. Investors do not simply trust because a blockchain exists. They trust more when Tokenization is associated with auditability, enforceability, better ESG verification, and institutional backing. This integrated finding already begins to show why the mixed-methods design adds value: it makes visible the layered composition of trust..

The analysis demonstrated complementarity, particularly in areas where one method expanded upon the other. For example, the qualitative data elaborated on the psychological factors influencing investor hesitation—such as regret aversion, herding behavior, and loss aversion—concepts grounded in behavioral finance theory (Kahneman and Tversky, 1979; Loomes and Sugden, 1982). These themes added explanatory depth to the survey’s more descriptive findings regarding risk perception and decision-making under uncertainty.

The framework proposed in the research design—which positions investor trust as a mediating construct—was supported through this integrated evidence. The data consistently confirmed that trust in tokenized ESG assets is shaped by both institutional legitimacy (Suchman, 1995) and technological assurances (e.g., smart contracts, auditability). This affirms the model’s relevance and applicability in emerging markets.

The convergent analysis facilitated the cross-validation of key constructs, while also surfacing meaningful tensions and complementarities. This phase served as a critical bridge between the distinct data types, ensuring that the final interpretation reflects a multi-dimensional and empirically grounded understanding of Tokenization’s role in sustainable finance in Brazil.

8.2.2 Areas of Divergence

At the same time, the convergent analysis also reveals meaningful divergences. The clearest divergence already identified in the original chapter is the difference between expert optimism and broader investor caution regarding Brazil’s role in tokenized ESG finance. The qualitative strand includes a more optimistic assessment of Brazil’s strategic potential, often anchored in its renewable resources, natural capital, and relevance to global sustainability markets. By contrast, the quantitative strand shows a more cautious posture, with lower trust in the current maturity of Brazil’s ESG-Tokenization ecosystem.

This divergence is not a weakness of the study. It is one of its most valuable insights. It suggests that different actors are not simply reporting the same phenomenon from different angles; they are positioned differently in relation to the market. Experts and insiders may evaluate Brazil through a potential-oriented lens, focusing on strategic opportunity, institutional trajectory, and first-mover advantage. Survey respondents, by contrast, appear to evaluate the same context through a risk-oriented lens, focusing on

current institutional reliability, market maturity, and investability. The mixed-methods value here lies precisely in uncovering this perception gap. A single-method design would likely have flattened the distinction.

A second divergence can be inferred in relation to technological challenges. In the qualitative strand, technological concerns such as cybersecurity, resilience, interoperability, and knowledge gaps appear clearly as obstacles to adoption. Interviewees frequently raised concerns about hacking, system longevity, and technical immaturity. Yet the quantitative strand does not always treat technological complexity as a simple deterrent. In the broader analysis of hypotheses, technological challenges did not behave as a straightforward negative driver in the expected way. This suggests that technology is interpreted heterogeneously: for some actors, it signals risk; for others, it signals innovation and long-term opportunity.

This divergence is analytically important because it prevents the chapter from making an overly linear claim about “technology as barrier.” Instead, it suggests that the meaning of technological complexity depends on actor profile, familiarity, and expectations regarding institutional maturation. The qualitative strand raises the issue as a substantive concern; the quantitative strand implies that the market response may be more differentiated than the qualitative concern alone would suggest. This is not contradiction in a problematic sense. It is a productive divergence that deepens the interpretation.

8.2.3 Complementarity and Expansion

A third type of integration is complementarity, or expansion, where one strand adds interpretive nuance to the other. While the quantitative strand is effective at identifying general patterns, for example that legal uncertainty, ESG alignment, transparency, and trust-related features matter for investment willingness, the qualitative strand then explains how and why these factors matter, especially in relation to investor psychology and institutional meaning.

For example, the quantitative strand may identify risk perception as relevant to investor hesitation, but the qualitative strand clarifies that this hesitation is not just about objective risk. It is also about anticipated regret, uncertainty regarding future institutional alignment, and the fear of appearing to back an innovation before it has become reputationally safe. Likewise, while the quantitative strand can show that

transparency is positively valued, the qualitative strand reveals that transparency matters because it reduces perceived greenwashing, increases confidence in ESG measurement, and provides a more intelligible basis for due diligence.

The convergent analysis therefore leads to a broader meta-inference: the attractiveness of tokenized sustainable investments in Brazil is shaped neither purely by technology nor purely by regulation. It emerges from the interaction between functional benefits, investor interpretation, and institutional credibility. The mixed-methods design strengthens this conclusion because each strand contributes a different kind of evidence to the same underlying explanation.

8.3 Joint Display

To visually integrate and interpret the results from both qualitative and quantitative strands of the research, this study employed the use of joint displays, as recommended by (Creswell and Plano Clark, 2011; Fetters, Curry and Creswell, 2013). A joint display is a matrix or diagram that aligns data from multiple sources in a single visual structure, facilitating the comparison, connection, and synthesis of mixed-methods findings. This technique supports meta-inferences and enhances transparency in how integration was achieved.

Joint displays were adopted to explore the intersection of themes derived from the qualitative interviews (n=9) and quantitative patterns from the survey data (n=220) and secondary market indicators related to ESG investments and blockchain adoption. The displays were structured around the four research questions, and organized using the QTT framework (Questions–Themes–Theories), allowing each research question to be addressed through converging thematic insights from both strands. This alignment enabled a meta-level interpretation of how investor hesitation is shaped not only by regulatory gaps, but also by psychological factors like loss aversion and institutional mimicry, offering a richer explanatory narrative than either method could provide alone.

This use of joint displays was essential to the validity of the integration process, allowing findings to be presented in a structured and verifiable way. Moreover, it supported the triangulation strategy outlined in the research design by aligning

empirical evidence, theoretical insights, and stakeholder perspectives across data modalities. This section therefore reads the joint displays as evidence of convergence, divergence, and complementarity across the four research questions.

Research Question 1: What key factors enhance the attractiveness of tokenized ESG assets to international investors?

For Research Question 1, the joint display identifies transparency, ESG credibility, and international attractiveness as the integrated theme, supported qualitatively by trust in blockchain transparency, the need for ESG verification, and the importance of fractionalized assets, and quantitatively by the strong positive responses to transparency, fractionalization, and Tokenization-related ESG interest.

This is a case of strong convergence. Both strands indicate that attractiveness is not driven only by return expectations or technological novelty. Instead, it is driven by the combination of verifiable ESG value, improved accessibility, and greater informational clarity. The quantitative strand confirms that these features are broadly valued by respondents. The qualitative strand adds nuance by showing that these features matter because they improve investor confidence in the credibility, usability, and legitimacy of the asset class. The integrated inference is that Tokenization becomes attractive when it is interpreted as an improvement in the governance and accessibility of sustainable finance, not just as a digital innovation.

Table 12: *Joint Display Research Question 1*

Integrated Theme	Qualitative Evidence	Quantitative Evidence	Theoretical Interpretation
Transparency, ESG credibility, international attractiveness	Trust through blockchain transparency; need for ESG verification; fractionalized	72% value transparency; 58% favor fractionalization; 64% say Tokenization	Behavioral Finance: Perceived trust reduces risk; Institutional mimicry for ESG credibility

assets widen investor base	increases ESG interest
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Source: elaborated by Author

Research Question 2: What are the primary legal, economic, and technological challenges for implementing Tokenization in Brazilian sustainable assets?

For Research Question 2, the joint display centers on regulatory uncertainty, technological risk, and market immaturity, drawing on qualitative evidence such as unclear legal definitions, cyber vulnerabilities, and infrastructure concerns, and quantitative evidence showing high concern with legal uncertainty and technological risk.

This again shows strong convergence, but also reveals the first layer of complementarity. The quantitative strand demonstrates the breadth of concern: legal and technical barriers are not marginal issues, but widely recognized inhibitors. The qualitative strand then specifies the nature of those concerns, showing that they include not only compliance ambiguity but also cross-border friction, uncertainty about enforcement, and doubts about resilience and long-term viability. The mixed-methods gain here lies in moving from “barriers exist” to “barriers operate through specific institutional and technical anxieties.”

Table 13: *Joint Display Research Question 2*

Integrated Theme	Qualitative Evidence	Quantitative Evidence	Theoretical Interpretation
Barriers: regulatory uncertainty, tech risk, economic limitations	Lack of clear legal definitions; cyber vulnerabilities; market immaturity	76% cite legal uncertainty as barrier; 68% report tech risk as inhibitor	Institutional Theory: Legitimacy blocked by legal ambiguity; Behavioral hesitation from tech fear

Source: elaborated by Author

Research Question 3: To what extent does Brazil's new regulatory framework facilitate or inhibit the adoption of Tokenization in the sustainability sector?

For Research Question 3, the joint display identifies ambiguity of the legal framework and mixed institutional signals as the central integrated theme. The qualitative strand reflects divergent views on Brazil's legal maturity and on the role of international standards and incentives, while the quantitative strand points to unclear legal terms and legal or tax-related disincentives.

This is the clearest case where divergence should be emphasized. The qualitative strand does not simply confirm a weak regulatory environment; it shows a more differentiated picture in which some experts perceive Brazil as an institutionally promising but incomplete market, while others stress the insufficiency of current legal clarity. The quantitative strand, in contrast, condenses these concerns into a broader pattern of regulatory hesitation. The integrated reading is therefore not that "Brazil's regulation is weak," but that Brazil sends mixed institutional signals: enough to generate attention, but not yet enough to eliminate caution. This is a more sophisticated mixed-methods conclusion than either strand would support on its own.

Table 14: *Joint Display Research Question 3*

Integrated Theme	Qualitative Evidence	Quantitative Evidence	Theoretical Interpretation
Ambiguity of legal framework; mixed institutional signals	Divergent views on Brazil's legal maturity; role of global standards and incentives	Majority flagged unclear legal terms, 61% mentioned tax/legal disincentives	Institutional legitimacy requires regulatory clarity and state signaling

Source: elaborated by Author

Research Question 4: How does Tokenization influence investor trust and decision-making in sustainable Brazilian projects?

For Research Question 4, the joint display highlights trust building through traceability, smart contracts, and automation, with qualitative evidence emphasizing greenwashing mitigation, automated compliance, and perceived security, and quantitative evidence showing positive responses to blockchain-enhanced trust and automation in ESG instruments.

This is a strong case of convergence plus complementarity. Both strands agree that Tokenization can strengthen trust. The quantitative strand establishes that the market recognizes this trust-building potential. The qualitative strand clarifies that trust is not abstract or purely attitudinal. It is tied to specific mechanisms: auditable records, automation of compliance conditions, greater reliability of ESG information, and stronger safeguards against opportunistic behavior. The mixed-methods contribution here is especially clear: the quantitative strand identifies the pattern, and the qualitative strand explains the trust-generating mechanisms behind it.

Table 15: *Joint Display Research Question 4*

Integrated Theme	Qualitative Evidence	Quantitative Evidence	Theoretical Interpretation
Trust building through traceability, smart contracts, automation	Transparency combats greenwashing; automation enables compliance; perceived security matters	69% say blockchain improves trust; 63% support automation in ESG bonds	Behavioral Finance: Loss aversion reduced via transparency; trust anchors ESG choices

Source: elaborated by Author

8.4 Integrated Discussion

The integrated discussion draws the strands together into broader meta-inferences. The most important integrated conclusion is that the study does not support a simplistic narrative in which Tokenization automatically increases investment attractiveness through technological efficiency alone. Rather, the combined evidence indicates that Tokenization becomes attractive to international investors when three conditions interact: functional value, perceived credibility, and institutional intelligibility.

The first integrated pattern is that functional value matters. Across both strands, Tokenization is associated with transparency, fractionalization, automation, and traceability. These are not minor features. They are central to why respondents and interviewees view Tokenization as potentially relevant for sustainable investment. Yet the integrated findings also show that these technical advantages are not self-sufficient. Their value depends on whether they translate into greater trust, reduced ambiguity, and better ESG verification.

The second integrated pattern is that perceived credibility is decisive. The study repeatedly shows that transparency is valued not in the abstract but because it addresses concerns about greenwashing, weak ESG disclosure, and unreliable monitoring. Similarly, ESG alignment is valued not only because sustainability is normatively attractive, but because global ESG standards act as signals of seriousness and reputational safety. Here, the qualitative strand adds critical depth by showing how investors interpret these features as markers of professional legitimacy and governance quality.

The third integrated pattern is that institutional intelligibility conditions market adoption. Both strands indicate that investors need to understand not only the asset but also the institutional environment in which the asset exists. Regulatory clarity, enforceability, legal recognition, and policy signaling are therefore not external issues; they are part of how the investment proposition itself is interpreted. This insight emerges most strongly from the combined reading of the regulation-related findings.

The quantitative strand shows the scale of regulatory concern, while the qualitative strand reveals the market logic through which unclear regulation becomes a problem of confidence, not only compliance.

A particularly important contribution of the integrated discussion is the recognition that divergence across strands is itself informative. The gap between expert optimism and broader investor caution reveals that adoption is still uneven across actor groups. Experts may focus on future institutional evolution and strategic positioning, while investors weigh current investability, operational confidence, and present-day risk. This divergence should therefore be interpreted as evidence of a transitional market: one in which strategic potential is visible before institutional consolidation has been fully achieved.

Another important contribution is the clarification of complementarity. The qualitative strand does not merely confirm the quantitative strand; it often explains the mechanism behind it. Where the quantitative strand identifies legal uncertainty as salient, the qualitative strand explains how legal ambiguity affects cross-border confidence, reputational risk, and the perceived maturity of the market. Where the quantitative strand shows that trust-related features matter, the qualitative strand shows that trust is linked to ESG verification, automated compliance, and governance reliability. Where the quantitative strand identifies risk sensitivity, the qualitative strand clarifies that such risk sensitivity may include loss aversion, regret aversion, and herding effects. This is precisely where the mixed-methods design adds value beyond single-method reporting.

Taken together, the integrated evidence supports the broader argument that tokenized sustainable investments in Brazil are most likely to attract international investors when the market can demonstrate not only technological capability, but also credible ESG alignment, recognizable governance standards, and a maturing institutional environment. The value of the mixed-methods design becomes especially visible here: the quantitative strand establishes the distribution and direction of market

attitudes, while the qualitative strand explains the meaning, mechanism, and conditionality of those attitudes.

This integrated reading also strengthens the later theoretical discussion. It shows that the study's findings are compatible with a dual interpretation through Behavioral Finance and Institutional Theory, as already anticipated in the thesis's triangulation logic and theoretical framework. Investors respond behaviorally to uncertainty, loss, trust, and familiarity, but these responses are shaped by institutional signals regarding legitimacy, regulation, and market normality. The integration chapter therefore serves as the point where the methodological design and theoretical model most clearly meet.

Table 16: *General Joint Display by Research Questions*

Research Question	Integrated Theme	Qualitative Evidence (Interview Themes)	Quantitative Evidence (Survey)	Theoretical Interpretation
RQ1: What key factors enhance the attractiveness of tokenized ESG assets to international investors?	Transparency, ESG credibility, international appeal	Trust through blockchain transparency; need for ESG verification; fractionalized assets widen investor base	72% value transparency; 58% favor fractionalization; 64% say Tokenization increases ESG interest	Behavioral Finance: Perceived trust reduces risk; Institutional mimicry for ESG credibility
RQ2: What are the primary legal, economic, and technological challenges for implementing Tokenization in Brazilian sustainable assets?	Barriers: regulatory uncertainty, tech risk, economic limitations	Lack of clear legal definitions; cyber vulnerabilities; market immaturity	76% cite legal uncertainty as barrier; 68% report tech risk as inhibitor	Institutional Theory: Legitimacy blocked by legal ambiguity; Behavioral hesitation from tech fear
RQ3: To what extent does Brazil's new regulatory framework facilitate or inhibit the adoption of Tokenization in the sustainability sector?	Ambiguity of legal framework; mixed institutional signals	Divergent views on Brazil's legal maturity; role of global standards and incentives	Majority flagged unclear legal terms, 61% mentioned tax/legal disincentives	Institutional legitimacy requires regulatory clarity and state signaling
RQ4: How does Tokenization influence investor trust and decision-making in sustainable Brazilian projects?	Trust building through traceability, smart contracts, automation	Transparency combats greenwashing; automation enables compliance; perceived security matters	69% say blockchain improves trust; 63% support automation in ESG bonds	Behavioral Finance: Loss aversion reduced via transparency; trust anchors ESG choices

Source: elaborated by Author

CHAPTER IX: DISCUSSION

9.1 Theoretical Discussion

This chapter interprets the empirical findings of the study through the theoretical lenses that guided the research design, namely Behavioral Finance and Institutional Theory. Rather than restating the results, the discussion seeks to explain what the findings mean conceptually and practically in relation to the adoption of tokenized sustainable investments in Brazil. The chapter is organized around four central themes that emerged consistently across the mixed-methods analysis: investor trust, ESG alignment and investment attractiveness, risk perception and behavioral responses, and the regulatory-institutional environment. These themes reflect the study's main hypotheses and provide a clearer basis for understanding how Tokenization may influence international investor interest in sustainable projects in an emerging market context.

The discussion also aims to demonstrate that the adoption of tokenized ESG assets cannot be explained by a purely technological logic. The empirical evidence suggests that Tokenization is interpreted by investors through a broader cognitive and institutional framework. Investors do not respond only to functional features such as traceability, automation, liquidity, or fractionalization. They also respond to signals of legitimacy, credibility, familiarity, and institutional reliability. In this sense, the findings support the view that Tokenization is not simply a technological innovation in financial markets, but a socio-institutional innovation whose adoption depends on how market actors interpret uncertainty, assign credibility, and assess the quality of the surrounding institutional environment.

This is particularly relevant in the Brazilian case. The study confirms that Brazil is viewed as a promising destination for sustainable finance due to its natural assets, renewable energy capacity, and potential role in global ESG markets, but that this potential is qualified by concerns regarding regulatory ambiguity, institutional stability, and market maturity. The discussion therefore advances the argument that the

attractiveness of tokenized sustainable investments in Brazil depends less on blockchain as an isolated technological solution and more on the interaction between technological affordances, investor psychology, and institutional structures.

9.1.1 Investor Trust and Tokenization Adoption (H1, H7, H9)

One of the clearest themes emerging from the research is the centrality of investor trust in the adoption of tokenized ESG assets. This finding is directly related to H1, H7, and H9. The empirical evidence provides partial support for H1, indicating that Tokenization contributes to greater willingness to invest, but not always through a stable and linear mediating effect of trust. H7 received support, showing that financial accessibility and ESG-related attributes positively influence willingness to invest. H9 received only partial support, suggesting that regulatory stability matters for investor confidence, but that its effect is more complex than initially hypothesized.

The theoretical significance of this finding is substantial. From a Behavioral Finance perspective, trust acts as a cognitive stabilizer in situations of uncertainty. Prospect Theory (Kahneman and Tversky, 1979) suggests that individuals make decisions under risk by overweighting potential losses relative to equivalent gains. In the context of tokenized ESG assets, this implies that investors are unlikely to embrace innovation simply because it offers efficiency gains. They need to perceive that the innovation reduces uncertainty in a meaningful way. Blockchain-based traceability, automated compliance, and verifiable ESG records may perform this role by reducing ambiguity around project integrity, environmental reporting, and potential greenwashing. The contribution of Tokenization, therefore, is not merely technological; it is psychological. It helps create a more legible investment environment.

At the same time, the findings also suggest that trust is not generated automatically by transparency alone. This is where Behavioral Finance must be complemented by Institutional Theory. If trust were purely cognitive, then any sufficiently transparent technology should consistently improve adoption. The results do not fully support such a simple interpretation. The partial support for H1 and H9

indicates that trust depends not only on the technological properties of blockchain, but also on whether those properties are embedded in a broader framework of institutional legitimacy. Investors appear to distinguish between technological transparency and institutional reliability. A tokenized asset may be technically traceable, but still be perceived as risky if it is issued in a jurisdiction where legal protections, enforcement mechanisms, or supervisory standards remain uncertain.

This point deepens the contribution to Institutional Theory. Following DiMaggio and Powell (1983), financial innovations gain legitimacy not simply by demonstrating efficiency, but by becoming aligned with accepted institutional norms and structures. The findings suggest that trust in tokenized ESG assets is formed at the intersection of coercive legitimacy, normative legitimacy, and mimetic reassurance. Coercive legitimacy comes from clear legal recognition and enforceable rules. Normative legitimacy comes from alignment with widely accepted ESG and reporting standards. Mimetic reassurance comes from observing reputable institutions, large funds, or advanced jurisdictions engage with tokenized models. In other words, investors trust not only because they understand the technology, but because they see signs that the market around the technology is becoming institutionally acceptable.

The findings also resonate with Regret Aversion Theory (Loomes and Sugden, 1982). In emerging and uncertain markets, investors may avoid potentially beneficial innovations not because they reject the logic of the innovation itself, but because they fear future regret associated with premature adoption. Investing in a tokenized sustainable asset before clear regulatory consensus emerges may later be perceived as a mistake, even if the asset's design was sound. This helps explain why trust does not function as a simple variable but rather as an interpretive filter through which investors weigh exposure, reputation, and uncertainty.

Practically, the discussion implies that strategies to expand tokenized sustainable investment cannot rely on “technology messaging” alone. Market participants must also build institutional trust through partnerships with credible intermediaries, robust governance structures, recognized ESG assurance mechanisms, and legal clarity

regarding token status, investor protection, and dispute resolution. For policymakers, the implication is equally important: a well-designed regulatory environment does not merely reduce legal risk; it actively creates the trust architecture required for new financial instruments to become investable.

9.1.2 ESG Alignment, Financial Accessibility, and Investment Attractiveness (H5, H6, H7)

The findings strongly support H5, H6, and H7, showing that ESG alignment, the perceived functional benefits of Tokenization, and financial accessibility all increase the attractiveness of tokenized ESG assets. This is one of the most important clusters of findings in the thesis because it identifies the positive mechanisms through which Tokenization may enhance foreign investor interest in sustainable projects in Brazil.

The support for H5 indicates that alignment with global ESG standards is not a peripheral or symbolic factor. It is central to how investors evaluate the legitimacy and attractiveness of tokenized opportunities. This has strong implications for both theory and practice. From a Behavioral Finance perspective, ESG alignment may operate as a cognitive anchor. In uncertain markets, investors use heuristics and signals to simplify decisions. ESG frameworks, especially when internationally recognized, function as such signals. They help investors infer that an opportunity is not only ethically desirable, but also professionally governed and reputationally safer. In this sense, ESG alignment reduces ambiguity by offering a familiar evaluative template.

This finding also supports and extends literature on values-based investment behavior. Investors are not motivated exclusively by expected returns; they increasingly incorporate sustainability criteria into their decision-making processes. However, the present findings suggest that ESG alignment should not be interpreted only as an expression of investor preferences. It also operates strategically as a credibility device. In the case of tokenized sustainable investments, ESG alignment reassures investors that the asset belongs within the emerging but still uncertain category of legitimate impact-oriented finance, rather than within the speculative universe often associated with digital tokens.

From an Institutional Theory perspective, this is even more significant. (Suchman, 1995) argues that legitimacy is essential for organizational acceptance and continuity. The results imply that ESG standards provide tokenized assets with borrowed legitimacy. Since Tokenization itself is still institutionally unsettled, especially in emerging markets, alignment with established ESG norms compensates for the relative novelty of the technological format. In practical terms, ESG legitimacy helps normalize Tokenization for institutional and international audiences. This is especially relevant in Brazil, where the country's sustainability potential is high, but concerns persist regarding governance, monitoring, and enforcement.

The support for H6 adds another layer to this discussion. Investors responded positively to the core advantages of Tokenization, especially transparency, traceability, and the possibility of monitoring the environmental and financial dimensions of projects more directly. This result supports the view that Tokenization can reduce information asymmetry, which is a recurring concern in sustainable finance. When sustainability claims are difficult to verify, greenwashing risks increase and investor confidence declines. Tokenization appears to address this problem by strengthening auditability and data integrity.

This connects directly with Pecking Order Theory (Myers and Majluf, 1984), which emphasizes the role of information asymmetry in financing decisions. The more opaque the underlying asset or issuer, the more hesitant investors become. By enabling real-time or more reliable disclosure of ESG-related information, blockchain-based structures may partially offset this asymmetry. The theoretical contribution here is that Tokenization can be interpreted not just as a digital wrapper for assets, but as a governance-enhancing mechanism that alters the informational basis of capital allocation.

The support for H7 further strengthens the practical relevance of the research. Financial accessibility, particularly through fractional ownership and lower entry barriers, appears to be more than a technical convenience. It reshapes the inclusiveness and investability profile of sustainable assets. From a Behavioral Finance perspective,

lower entry thresholds may reduce perceived commitment risk and thereby facilitate experimentation with new asset classes. Investors may be more willing to test tokenized ESG products when exposure can be scaled gradually. This is especially important in uncertain environments, where incremental participation can be psychologically more acceptable than large capital commitments.

At the institutional level, accessibility also broadens the potential diffusion of tokenized ESG assets. It makes these assets more compatible with a wider range of investor profiles and can support market maturation by increasing participation and liquidity. This may generate reinforcing effects over time: broader participation improves visibility, greater visibility increases legitimacy, and greater legitimacy attracts more sophisticated capital. In this sense, the findings suggest that accessibility is not merely a transactional feature; it may also be a market-building feature.

Taken together, H5, H6, and H7 indicate that tokenized sustainable investments become more attractive when they combine functional benefits with symbolic and institutional credibility. This is one of the thesis's strongest theoretical contributions. It shows that the attractiveness of Tokenization is not reducible to efficiency, nor to sustainability signaling alone. It lies in the way Tokenization combines transparency, access, and ESG legitimacy into a package that is cognitively reassuring and institutionally intelligible to investors.

9.1.3 Perceived Risk, Threats, and Investor Hesitation (H2, H4)

The study provides partial support for H2 and no support for H4, and these findings are theoretically revealing precisely because they are more complex than expected. H2 shows that perceived threats matter, but largely through indirect pathways, especially via trust. H4 was not supported because technological challenges did not behave as straightforward deterrents. In some analyses, perceived technological challenges were even positively associated with Tokenization-related interest, contrary to the original expectation.

The partial support for H2 strongly confirms the relevance of Behavioral Finance. Prospect Theory provides the most immediate explanation: investors are more

sensitive to downside exposure than to upside potential. In a context such as tokenized sustainable finance, downside exposure is not limited to financial loss. It also includes reputational risk, legal uncertainty, operational failure, and the fear of being associated with immature or unstable instruments. The fact that risk affects investment willingness indirectly through trust suggests that risk perceptions are filtered through interpretive processes rather than functioning only as objective constraints. Investors do not simply measure risk; they interpret whether the risk environment is manageable, legible, and institutionally contained.

This finding can be read more deeply through Regret Aversion Theory. Investors may avoid tokenized assets not because they believe the assets will necessarily fail, but because they fear being wrong in an environment where standards are still evolving. Regret in this context is both financial and symbolic. A professional investor who allocates capital to a tokenized asset that later faces regulatory controversy or market instability risks not only monetary loss but also reputational embarrassment. This helps explain why trust mediates the effect of perceived threats: trust reduces the anticipated emotional and professional cost of being wrong.

The non-support of H4 is especially interesting and should not be treated as a mere anomaly. It may indicate that technological complexity does not always deter adoption in the way traditionally assumed. For some investors, technological sophistication may signal innovation, exclusivity, or first-mover advantage. This is consistent with heterogeneity in behavioral responses to novelty. While some investors read complexity as danger, others read it as opportunity. The implications are theoretically important because they complicate simplistic assumptions within technology adoption narratives. Emerging financial technologies may attract as well as repel, depending on investor profile, prior familiarity, and expectations regarding institutional normalization.

This interpretation also benefits from Institutional Theory. Technological challenges do not exist in a vacuum; they are interpreted in relation to whether investors believe the surrounding system is moving toward normalization. If investors observe

signs that Tokenization is being taken seriously by regulators, major funds, infrastructure providers, or international standard-setters, then technological limitations may be seen as transitional rather than disqualifying. In this sense, the market does not assess technology only on its present technical maturity but also on its anticipated institutional trajectory.

The finding also has implications for how risk should be discussed in tokenized finance. Much of the literature treats risk as a static property of the technology or the market. The results of this study suggest that risk is better understood as relational. It is shaped by investor cognition, by the maturity of the regulatory field, by the symbolism attached to innovation, and by whether mitigating institutions are visible. This is an important conceptual refinement. It means that the same technological characteristic may be interpreted differently depending on who the investor is, what institutional signals are present, and how advanced the broader field appears to be.

Practically, this implies that reducing perceived risk requires more than better technology. It requires better framing, better assurance, and better integration with trusted market structures. Cybersecurity standards, custodial reliability, smart contract auditing, and interoperability matter, but they must be communicated in a way that transforms technical robustness into perceived investability. Likewise, investor education should not be limited to explaining how blockchain works. It should explain how risks are governed, monitored, and absorbed within the institutional design of tokenized ESG markets.

9.1.4 Regulatory Environment, Institutional Legitimacy, and Market Formation (H3, H8, H9)

The regulatory and institutional findings are among the most conceptually significant in the thesis. H3 was not supported, H8 was not supported, and H9 received partial support. At first glance, these results may appear to weaken the role of regulation. In fact, they do the opposite. They suggest that regulation matters deeply, but not always in the direct, linear way originally hypothesized.

The non-support of H3 indicates that regulatory barriers did not show a strong direct association with familiarity or adoption-related outcomes in the expected way. This does not mean that regulation is unimportant. Rather, it suggests that regulation operates indirectly, symbolically, and conditionally. Investors may not respond to regulatory details in a granular way, but they respond to what regulation signals about legitimacy, enforceability, and future direction. This is highly consistent with Institutional Theory. DiMaggio and Powell (1983) do not argue that institutions matter only through formal constraints; they matter because they shape what becomes thinkable, acceptable, and credible in a field. In this study, investors appear to read regulation not only as a set of rules, but as a signal of whether tokenized sustainable finance is becoming a legitimate market category.

The non-support of H8 is equally revealing. The expectation was that macroeconomic and regulatory conditions would moderate the relationship between Tokenization and investment willingness. The results did not confirm this in a statistically robust way. Conceptually, however, this suggests that investors may already be pricing in a frontier-market logic. In other words, they do not need macroeconomic instability to “switch on” their caution; caution is already embedded in how they approach the asset class. This finding refines the assumption that contextual instability acts as a discrete moderator. In emerging innovation settings, instability may function less as a variable that changes behavior at the margin and more as a background condition shaping the entire interpretive framework of the investor.

This is where the interplay between Behavioral Finance and Institutional Theory becomes especially important. Investors considering tokenized ESG assets in Brazil may operate under what can be called layered uncertainty: technological uncertainty, regulatory uncertainty, and emerging-market uncertainty. These layers are not necessarily additive in a simple statistical sense. Instead, they form a composite perception of field maturity. This may help explain why moderation effects were weak even though regulatory and institutional issues were repeatedly emphasized qualitatively. The institutional context matters, but not necessarily as a neat interaction

term. It matters as the ambient structure of meaning within which all other evaluations occur.

The partial support for H9 reinforces this argument. Regulatory stability and enforcement predictability do influence investor confidence, but the path is inconsistent. This suggests that regulatory legitimacy does not automatically generate trust. Investors may acknowledge that stronger rules are desirable while still doubting whether such rules will be implemented consistently, politically sustained, or effectively enforced. This distinction is important and theoretically rich. It implies that legitimacy has multiple layers: formal legitimacy, practical legitimacy, and perceived legitimacy. A country may advance formal rules without yet convincing investors that implementation will be reliable over time.

Suchman (1995) framework is especially useful here. Legitimacy is not a binary condition but a perception that actors and structures are appropriate within a socially constructed system of norms and expectations. The results suggest that Brazil may possess high potential legitimacy in sustainable finance, but only partial achieved legitimacy in tokenized ESG assets. Investors seem open to the possibility of Brazil becoming a strong ESG-Tokenization destination, yet they remain cautious because the institutional signals are still mixed. This distinction between potential and achieved legitimacy is an important interpretive contribution of the study.

The role of mimetic processes also deserves emphasis. Several qualitative indications suggest that investors observe more advanced jurisdictions before committing to new market formats. This is fully consistent with mimetic isomorphism. In uncertain environments, organizations and investors imitate models that appear successful or legitimate elsewhere. Thus, the future development of tokenized sustainable finance in Brazil may depend partly on whether Brazilian institutions can align themselves visibly with internationally respected regulatory and ESG practices. This is not merely imitation for its own sake; it is a strategy for reducing uncertainty through borrowed legitimacy.

The implication is clear. Regulatory reform should not focus only on drafting rules. It should also focus on signaling coherence, enforceability, and alignment with global standards. Regulatory sandboxes, taxonomy alignment, custodial standards, investor protection mechanisms, and recognized ESG verification frameworks may all help. What matters is not just that rules exist, but that investors can interpret them as evidence that the market is moving from experimental ambiguity toward institutional consolidation.

The empirical and institutional analysis indicates that Brazil is moderately well positioned from a legal and regulatory standpoint, yet still falls short of the level of integration, predictability, and operational efficiency required by international institutional investors. As highlighted in the analytical narrative underpinning this study, the country has already assembled key components of a regulatory ecosystem for tokenized ESG assets—ranging from the legal recognition of virtual assets to advancements in ESG disclosure and environmental markets. However, these components remain insufficiently integrated into a coherent framework capable of supporting large-scale cross-border investment .

A first critical observation is that Brazil has successfully moved beyond a regulatory vacuum. The establishment of a legal framework for virtual assets, combined with the regulatory authority granted to the Central Bank of Brazil over virtual asset service providers, represents a significant step toward formalization. The issuance of prudential rules governing these entities reduces systemic risk and aligns Brazil with global expectations regarding market supervision and financial integrity.

In parallel, the Brazilian Securities and Exchange Commission has adopted a principle-based approach to Tokenization, explicitly affirming that the use of distributed ledger technology does not alter the legal nature of financial instruments. This “substance over form” doctrine is consistent with international regulatory standards and prevents regulatory arbitrage, particularly in the structuring of sustainable financial instruments such as green securitizations, agricultural receivables, or ESG-linked investment vehicles.

Furthermore, Brazil has made substantial progress in the domain of sustainability disclosure. The alignment with standards issued by the International Sustainability Standards Board has significantly enhanced the comparability and reliability of ESG-related financial information. This is a crucial development, as international investors increasingly rely on standardized and auditable sustainability data when allocating capital to emerging markets.

Additional progress is observed in the environmental asset space. The creation of a regulated carbon market through recent legislation establishes a legal foundation for the issuance and trading of environmental instruments, which may serve as underlying assets for tokenized structures. This reduces the historical fragmentation and informality of environmental markets in Brazil, increasing their potential attractiveness to foreign investors.

Despite these advancements, the findings of this research reveal that the Brazilian regulatory environment remains structurally fragmented, particularly when analyzed from the perspective of an international institutional investor. As detailed in the analytical narrative, market participants must navigate multiple regulatory layers simultaneously, including: (i) the classification of tokens under securities law, (ii) the regulation of virtual asset service providers, (iii) the legal framework for foreign investment, (iv) sustainability disclosure requirements, and (v) sector-specific rules for environmental assets .

This multi-layered structure produces three interrelated inefficiencies:

- i. it increases transaction and compliance costs, as issuers and investors must interpret and reconcile overlapping regulatory requirements.
- ii. it generates legal and operational uncertainty, particularly for hybrid instruments combining financial and environmental attributes.
- iii. it limits cross-border interoperability, as the absence of a unified framework complicates integration with global financial infrastructures and regulatory systems.

From a theoretical standpoint, this finding reflects a misalignment between formal regulatory convergence and functional regulatory effectiveness. While Brazil demonstrates a high degree of alignment with international standards in isolation, the lack of coordination across regulatory domains undermines the overall coherence of the system.

This issue becomes particularly salient when considering global regulatory expectations. International investors operate within frameworks shaped by organizations such as the Financial Action Task Force, IOSCO, and the OECD. These frameworks emphasize not only the existence of regulation but also its operational consistency, enforceability, and cross-border compatibility. Although Brazil has made progress in areas such as AML/CFT compliance and tax transparency, the implementation of these standards within tokenized environments remains uneven and, in some cases, insufficiently tested in real market conditions.

Another critical limitation concerns market infrastructure. While initiatives such as the Drex pilot signal strong institutional commitment to financial innovation, they also reveal ongoing challenges related to interoperability, privacy, programmability, and scalability. These limitations directly affect the feasibility of cross-border settlement mechanisms and the integration of Brazilian assets with global custodial and trading systems.

Consequently, a key distinction emerges between regulatory acceptance and investment readiness. The Brazilian environment is currently adequate for experimental projects, pilot issuances, and domestic or regional investment flows. However, it remains less suited for attracting large-scale international capital, particularly from institutional investors subject to stringent due diligence, fiduciary standards, and regulatory scrutiny .

In comparative terms, Brazil appears more advanced than many emerging markets in assembling the foundational elements of a regulatory framework. Nevertheless, it still lags behind jurisdictions that have achieved higher levels of integration between capital markets, digital infrastructure, tax regimes, and

sustainability standards. As a result, Brazil is perceived not as a fully mature market, but as a regulatory system in consolidation.

The central conclusion of this diagnostic analysis is that the Brazilian framework is more developed in legal form than in operational function. While it provides a credible foundation for tokenized ESG assets, it lacks the systemic coherence required to maximize its attractiveness to foreign investors.

9.1.5 Behavioral–Institutional Interplay in a Frontier Market

Taken together, the findings support a broader theoretical claim: tokenized sustainable investment adoption in Brazil is best understood as the product of an interaction between investor psychology and institutional context, rather than as the output of isolated economic variables. This integrated interpretation is one of the thesis's main theoretical contributions.

Behavioral Finance explains why investors hesitate even when presented with apparently strong technological advantages. Uncertainty, loss aversion, regret avoidance, and reliance on heuristics all influence how novel financial instruments are evaluated. Institutional Theory explains why this hesitation cannot be reduced to private cognition alone. Investors interpret technologies through institutional structures, norms, and legitimacy signals. When a market is still forming, adoption depends on whether actors believe the field is becoming stable, governed, and socially validated.

This interaction is particularly visible in frontier or emerging settings. In established markets, technological innovation may be judged within relatively mature legal and financial frameworks. In Brazil, by contrast, the innovation itself and the institutional context evolve simultaneously. Investors are therefore not simply evaluating a product; they are evaluating an ecosystem in motion. This makes tokenized sustainable finance a compelling case for integrated theory-building. It requires a framework that can explain not only how investors think, but also how they interpret the credibility of the environment in which they are being asked to think.

The findings also suggest that adoption may follow a cumulative legitimacy process. Functional benefits create interest. ESG alignment creates normative comfort.

Institutional signaling creates legitimacy. Early adopters and recognized actors create mimicry. Over time, these layers may reinforce each other. This processual view of adoption helps explain why some hypotheses were only partially supported. In emerging markets, relationships may be contingent, evolving, and dependent on the maturity of the field. A static causal model may therefore capture only part of the phenomenon.

Conceptually, the study refines the understanding of Tokenization in sustainable finance by showing that it should not be framed simply as a disintermediating technology. In practice, Tokenization may require new forms of intermediation: certifiers, custodians, auditors, legal frameworks, ESG assurance actors, and institutional sponsors. Rather than eliminating institutions, Tokenization may intensify the need for credible institutional scaffolding. This is a particularly important insight for both theory and policy, because it challenges the common assumption that blockchain-based finance naturally reduces the relevance of formal institutions.

9.2 Comparison with Literature

This section compares the empirical findings of this research with the theoretical and empirical literature discussed in Chapter II. The objective is to evaluate the extent to which the results confirm, extend, or challenge existing knowledge regarding the relationship between Tokenization, investor behavior, and sustainable finance in emerging markets. The comparison is organized around six thematic dimensions derived from the empirical findings presented in Chapter VII and integrated in Chapter VIII:

- i. Brazil's sustainable finance market and investment factors
- ii. Conditions for increased exposure to tokenized assets
- iii. Risks and opportunities of tokenized ESG assets
- iv. Drivers and barriers to Tokenization adoption
- v. Role of blockchain in sustainable investment
- vi. Investor perceptions of Tokenization in ESG markets.

These themes are examined in relation to the theoretical lenses guiding this research, particularly Behavioral Finance and Institutional Investment Theory, which were used to interpret investor decision-making in the context of technological and regulatory uncertainty.

9.2.1 Brazil's Sustainable Finance Market and Investment Factors

The empirical findings confirm the argument presented in the literature that Brazil possesses significant structural advantages for sustainable investment due to its natural resources, biodiversity, and renewable energy capacity. Previous studies highlight Brazil as a potentially important destination for ESG-related investments, particularly in sectors such as renewable energy, carbon credits, and environmental restoration (Goel *et al.*, 2022; Montovanelli, 2023). However, the results of this study reveal a more nuanced perspective among international investors. While the country is perceived as having strong sustainability potential, investors simultaneously express concerns regarding regulatory stability, institutional credibility, and macroeconomic predictability. These findings align closely with **Institutional Theory**, which emphasizes the role of institutional legitimacy in shaping economic behavior. (DiMaggio and Powell, 1983) argue that organizations operate within institutional environments that impose regulatory, normative, and cultural expectations that influence decision-making processes.

The findings of this research support this theoretical argument. Investors evaluate Brazil not only based on project-level financial performance but also based on broader institutional signals such as regulatory predictability, governance quality, and alignment with international ESG standards. This result also supports the study's **Hypothesis H8**, which proposed that macroeconomic stability and regulatory clarity moderate investor participation in tokenized sustainable investments. The empirical results reinforce the view that institutional legitimacy is a prerequisite for large-scale foreign investment in emerging sustainable finance markets.

9.2.2 Conditions for Increased Exposure to Tokenized Assets

The empirical analysis identified several conditions that would increase investor exposure to tokenized ESG assets, including:

- i. regulatory clarity and legal recognition of tokenized assets
- ii. standardized ESG reporting frameworks
- iii. government backing or regulatory approval
- iv. reliable blockchain infrastructure
- v. liquidity through secondary markets.

These findings correspond with previous studies emphasizing the importance of regulatory alignment for financial innovation adoption. For instance, (Nogueira, 2023) argues that regulatory clarity is essential for tokenized financial markets, particularly when integrating ESG frameworks. From an institutional perspective, these results can be interpreted through the concept of coercive and normative isomorphism. Organizations adapt to regulatory requirements and professional standards in order to maintain legitimacy within their institutional environment.

In the case of tokenized ESG investments, regulatory frameworks and global ESG standards function as institutional signals that reduce uncertainty and facilitate adoption. The empirical results therefore support Hypothesis H9, which proposed that regulatory stability and enforcement predictability significantly influence investor trust. The findings extend the literature by demonstrating that regulatory clarity does not only affect compliance but also influences investor sentiment and trust formation, which act as mediating mechanisms in the investment decision process.

9.2.3 Risks and Opportunities of Tokenized ESG Assets

The findings show that investors perceive tokenized ESG assets as presenting both opportunities and risks.

Table 17: *Risks and opportunities of tokenized ESG Assets*

Key opportunities identified	Key risks identified
Enhanced transparency and traceability	Technological vulnerabilities
Improved verification of ESG impact	Smart contract security issues
Fractional ownership	Regulatory uncertainty
Increased accessibility to international investors	Liquidity risks
Reduced transaction costs	

Source: elaborated by Author

While advantages align with existing literature suggesting that blockchain technology can improve transparency and reduce information asymmetry in financial markets (Tapscott and Tapscott, 2018; Maleki, 2023), the risks are consistent with the behavioral finance literature. Prospect Theory suggests that investors tend to exhibit loss aversion, meaning that potential losses often weigh more heavily in decision-making than equivalent gains. In emerging technological markets such as blockchain finance, this effect can lead investors to delay adoption until risks become better understood. Similarly, Regret Theory explains why investors may avoid innovative financial instruments if they anticipate the possibility of future regret resulting from unsuccessful investment decisions. The findings of this study therefore support **Hypothesis H2**, which predicted that perceived threats negatively influence investor willingness to participate in tokenized assets.

9.2.4 Drivers and Barriers to Tokenization Adoption

The empirical evidence indicates that Tokenization adoption is influenced by both enabling and constraining factors.

Table 18: *Drivers and Barriers of Tokenized Adoption*

Key drivers identified	Key risks identified
Transparency and traceability	Regulatory uncertainty
Improved ESG reporting	Technological immaturity
Increased financial accessibility	Lack of investor education
Global market reach	Limited institutional adoption

Source: elaborated by Author

These findings reinforce arguments presented in the literature suggesting that technological innovations require institutional legitimacy before achieving widespread adoption. Institutional theory explains that organizations often imitate successful models in uncertain environments. This phenomenon, known as mimetic isomorphism, occurs when organizations replicate practices perceived as legitimate or successful.

The interviews conducted in this study suggest that investors often observe regulatory developments in jurisdictions such as the European Union and Singapore

before committing to tokenized investments. This behavior confirms the relevance of mimetic institutional dynamics in the diffusion of financial innovations.

9.2.5 Role of Blockchain in Sustainable Investment

The findings strongly support the literature that highlights blockchain technology as a tool for improving transparency in sustainable finance. Interview participants emphasized that blockchain can facilitate:

- i. real-time monitoring of environmental impact metrics
- ii. immutable ESG reporting records
- iii. automated compliance through smart contracts.

These mechanisms can reduce information asymmetry between project developers and investors, improving trust in ESG disclosures. From a theoretical perspective, these findings align with Pecking Order Theory, which highlights the role of information asymmetry in financial decision-making. When investors perceive greater transparency and reduced information asymmetry, they may be more willing to allocate capital to new financial instruments. The findings provide empirical support for Hypothesis H6, which predicted that blockchain traceability and transparency increase investor willingness to engage in tokenized ESG assets.

9.2.6 Investor perceptions of Tokenization in ESG Markets

Investor perceptions represent a critical factor influencing Tokenization adoption. The empirical findings indicate that investor attitudes toward Tokenization are shaped not only by objective financial considerations but also by social and psychological dynamics. Several interviewees noted that institutional investors tend to wait for market leaders or regulatory authorities to adopt new technologies before committing capital. This pattern aligns with Herding Behavior Theory, which suggests that investors often imitate the actions of others when operating in uncertain environments. Herd behavior is particularly common in emerging financial technologies, where information asymmetries and technological complexity increase decision-making uncertainty. The findings therefore support the argument that

Tokenization adoption will likely accelerate once institutional investors, regulators, or global financial institutions legitimize the market.

Table 19: Comparative Framework

Dimension	Literature	Empirical Findings	Interpretation
Sustainable finance potential	Brazil seen as major ESG investment destination	Investors recognize potential but question institutional stability	Institutional legitimacy influences investment decisions
Tokenization adoption	Regulatory clarity essential	Investors require clear legal frameworks and standards	Regulatory certainty builds investor trust
Tokenized asset benefits	Transparency and efficiency	Investors strongly value traceability and ESG verification	Blockchain reduces information asymmetry
Risk perception	Emerging technologies involve uncertainty	Investors emphasize technological and regulatory risks	Behavioral biases affect adoption
Institutional adoption	Financial innovations spread through institutional diffusion	Investors observe global regulatory leaders	Mimetic isomorphism dynamics
Investor behavior	Decision-making influenced by cognitive biases	Investors display herding and loss aversion	Behavioral finance validated

Source: elaborated by Author

9.3 Implications

The findings of this research generate several important implications for theory, public policy, and financial markets. By examining the interaction between Tokenization, investor behavior, and institutional environments, the study contributes to a deeper understanding of how technological innovation can influence sustainable investment dynamics in emerging economies. The implications of the research can be analyzed across three main dimensions: theoretical implications, policy implications, and market implications.

9.3.1 Theoretical Implications

The findings of this study contribute to theoretical development in the fields of sustainable finance, behavioral finance, and institutional theory by demonstrating how technological innovation interacts with investor psychology and institutional environments in shaping financial market outcomes.

The research advances the literature on Behavioral Finance by highlighting the central role of investor trust and risk perception in the adoption of tokenized financial instruments. While blockchain technology offers objective improvements in transparency and traceability, the results indicate that investor decision-making is still strongly influenced by behavioral factors such as loss aversion, uncertainty avoidance, and perceived technological risks. This finding reinforces the argument of Prospect Theory that individuals evaluate investment opportunities not solely based on expected returns but also on the perceived probability of losses.

The study extends behavioral finance literature by demonstrating that technological innovations such as Tokenization may partially mitigate behavioral biases when they improve information transparency. The ability of blockchain technology to provide immutable and verifiable ESG data may reduce information asymmetry and strengthen investor confidence in sustainability claims. In this sense, Tokenization can be interpreted as a technological mechanism that helps address behavioral barriers associated with uncertainty and greenwashing concerns.

The research contributes to Institutional Theory by demonstrating that the adoption of financial innovation is strongly influenced by institutional legitimacy and regulatory stability. The findings indicate that investors evaluate tokenized sustainable investments not only based on technological advantages but also on the credibility of the regulatory environment in which these assets operate. This result reinforces the argument that institutional environments play a critical role in shaping the diffusion of innovation within financial markets.

In particular, the study highlights the relevance of coercive, normative, and mimetic institutional pressures in shaping the adoption of tokenized financial instruments. Regulatory frameworks and ESG reporting standards create coercive pressures that influence organizational behavior, while international financial practices and sustainability standards generate normative pressures that guide investment decisions. At the same time, investors often observe the actions of leading markets and

institutions before adopting new technologies, reflecting mimetic processes in financial innovation diffusion.

The research contributes to the literature on sustainable finance and digital assets by proposing an integrated conceptual framework that links Tokenization, investor trust, and international capital flows. The study demonstrates that Tokenization can enhance the attractiveness of sustainable investments by improving transparency, financial accessibility, and ESG impact verification. However, these technological advantages must be supported by institutional legitimacy and regulatory clarity to generate widespread market adoption.

Overall, the findings suggest that the adoption of tokenized sustainable investments should be understood as a multidimensional process involving technological innovation, institutional frameworks, and behavioral investor dynamics. By integrating these perspectives, the study contributes to a more comprehensive theoretical understanding of how digital financial technologies may transform sustainable investment markets.

9.3.2 Market Implications

The findings of this study also have important implications for financial institutions, investment funds, Fintech companies, and developers involved in tokenized sustainable investment projects. The research highlights the importance of transparency and verifiable ESG impact data in attracting international investors. Financial institutions seeking to develop tokenized sustainable investment platforms should prioritize mechanisms that allow investors to monitor environmental performance indicators in real time. Blockchain technology can provide a powerful tool for enhancing transparency and accountability in this context.

According to the results, financial accessibility and fractional ownership models represent significant advantages of Tokenization. By lowering minimum investment thresholds, tokenized assets can broaden participation in sustainable finance markets and attract a wider range of investors, including retail participants and impact investors.

The findings suggest that institutional credibility plays a critical role in investor decision-making. Tokenized sustainable investment platforms may benefit from partnerships with established financial institutions, ESG certification bodies, and regulatory authorities to strengthen their legitimacy and attract investor confidence.

The research highlights the importance of market education and investor awareness. As Tokenization remains a relatively new financial innovation, many investors may lack familiarity with blockchain-based financial instruments. Financial institutions and technology developers should therefore invest in educational initiatives that help investors understand the benefits and risks associated with tokenized assets.

Tokenization could contribute to the development of more inclusive and efficient sustainable finance markets by enabling greater transparency, reducing transaction costs, and expanding access to investment opportunities. If supported by appropriate regulatory frameworks and technological infrastructure, Tokenization may become an important mechanism for mobilizing international capital toward sustainable development projects.

9.3.3 Policy Implications

The findings of this study provide a comprehensive basis for understanding the role of regulatory environments in shaping the development of tokenized ESG investment markets. Rather than functioning as direct constraints, regulatory conditions influence investment decisions primarily through their impact on investor trust and perceived institutional credibility. This insight suggests that regulatory effectiveness must be evaluated not only in terms of formal clarity, but also in relation to consistency, predictability, and alignment with internationally recognized standards.

From a policy perspective, the signaling role of regulation emerges as a central mechanism influencing investor behavior. In uncertain and rapidly evolving markets, investors rely on regulatory cues to assess the reliability and long-term viability of investment opportunities. This aligns with insights from Institutional Theory, which emphasize the importance of legitimacy and alignment with established norms in shaping economic behavior.

A key implication of this study concerns the need for coherent and well-defined regulatory frameworks governing tokenized financial instruments. Clear legal classification of digital tokens, well-established investor protection mechanisms, and explicit compliance requirements are essential to reduce uncertainty and foster market participation.

In addition to formal regulatory clarity, policy frameworks must address the fragmentation that often characterizes emerging digital finance ecosystems. Regulatory

inconsistencies across institutions and jurisdictions create barriers to scalability and interoperability, limiting the potential of tokenized ESG investments.

Another critical dimension relates to the standardization of ESG disclosure practices. Investors consistently emphasize the importance of reliable, comparable, and verifiable sustainability data when evaluating investment opportunities. The adoption of internationally recognized frameworks such as IFRS Sustainability Disclosure Standards (TCFD, 2017; GRI, 2021; IFRS Foundation, 2023) enhances the comparability and credibility of ESG information.

The incorporation of materiality-based and double materiality approaches further strengthens the decision-usefulness of ESG disclosures. As highlighted by Christensen et al. (2021), standardized reporting frameworks play a critical role in improving transparency and reducing information asymmetry in capital markets. Furthermore, the integration of assurance mechanisms and standardized metrics contributes to the credibility of ESG reporting. Kotsantonis and Serafeim (2019) argue that improving ESG data quality is essential for enabling informed investment decisions and reducing the risks associated with inconsistent reporting practices.

Technological innovation, particularly blockchain, offers significant potential to enhance ESG disclosure practices. By enabling traceability, auditability, and real-time verification of sustainability data, blockchain-based systems can reduce information asymmetry and mitigate risks such as greenwashing (Suchman, 1995; Yermack, 2017; Tian *et al.*, 2020; Maleki, 2023; Thetlek *et al.*, 2023; Huber, 2024). In the Brazilian context, the regulatory environment reflects both progress and ongoing challenges. Regulatory authorities such as the CVM and the Central Bank have introduced initiatives aligned with global standards, demonstrating a commitment to sustainable finance and digital innovation.

However, despite these advances, the regulatory landscape remains fragmented, with inconsistencies across institutional domains limiting investor confidence and market scalability. This fragmentation highlights the need for greater coordination between regulatory authorities and more integrated policy approaches. These findings provide the foundation for the development of the Integrated Framework for Tokenized ESG Assets. This framework conceptualizes how regulatory alignment, technological infrastructure, and ESG disclosure interact to shape investor trust and market adoption.

From a policy standpoint, fostering the development of tokenized ESG markets requires a coordinated approach that integrates regulatory clarity, international harmonization, and technological innovation. International cooperation is particularly important, as tokenized assets operate across borders and require consistent regulatory treatment to facilitate global investment flows.

9.4 Integrated Regulatory Framework for Tokenized ESG assets

Building on the policy implications discussed in the previous section, this research further examines that governments can strengthen investor confidence by promoting transparency, establishing clear compliance mechanisms, and ensuring credible enforcement of ESG reporting standards. These policy measures can help position Brazil as a competitive destination for international capital seeking sustainable investment opportunities.

The empirical findings of this study suggest that these advancements remain insufficient to generate the level of institutional trust required by foreign investors, particularly those operating under strict fiduciary obligations and multi-jurisdictional compliance frameworks. The central issue is not the absence of regulation, but rather the absence of regulatory coherence. Current rules operate across multiple layers—financial regulation, digital asset supervision, ESG disclosure, and environmental markets—without a unified framework capable of addressing the lifecycle of tokenized ESG assets.

This fragmentation produces three critical policy inefficiencies. First, it increases transaction costs, as issuers must navigate multiple regulatory regimes simultaneously. Second, it generates legal uncertainty, particularly in hybrid structures where financial and environmental attributes coexist. Third, it weakens cross-border interoperability, limiting Brazil's ability to integrate with global capital markets.

In response to these identified gaps, this research proposes an **Integrated Regulatory Framework for Tokenized ESG assets**, designed to transition Brazil from a fragmented regulatory model to a coordinated and interoperable system. The proposed framework is structured across multiple regulatory layers:

9.4.1 Governance and Coordination Layer

A key policy recommendation is the establishment of a formal inter-agency coordination mechanism involving the Central Bank of Brazil, the Brazilian Securities

and Exchange Commission (CVM), and other relevant authorities. This body would be responsible for issuing a unified regulatory rulebook and ensuring policy coherence. While informal coordination exists, the absence of a binding institutional framework limits regulatory consistency. From an Institutional Theory perspective, this lack of coordination reduces the legitimacy and predictability of the regulatory environment, which are critical determinants of investor confidence.

9.4.2 Asset Classification Layer

The study highlights the need for a functional classification system that distinguishes tokenized assets based on economic characteristics rather than technological form. Although the CVM's "substance over form" approach aligns with international best practices, its application remains largely interpretative rather than codified. This creates ambiguity, particularly for hybrid instruments combining financial returns with environmental attributes. A formal classification regime would reduce interpretative risk and enhance legal certainty.

9.4.3 Sustainability Eligibility Layer

A critical gap identified in the research is the absence of a standardized framework for verifying the sustainability credentials of tokenized assets. While ISSB-based disclosure improves financial transparency, it does not fully address the impact dimension of sustainability. This creates a regulatory blind spot in which tokenized assets may be marketed as "green" without sufficient verification. An implementation of a tiered framework combining financial materiality (ISSB-based), impact metrics, and third-party verification may ensure the integrity of sustainable assets and mitigate greenwashing risks.

9.4.4 Disclosure and Assurance Layer

The findings suggest that current disclosure practices remain fragmented, with financial, technological, and sustainability information often presented separately. This increases information asymmetry, particularly for foreign investors unfamiliar with the Brazilian regulatory environment. An Introduction of a Digital Integrated Prospectus consolidating financial, technological, and sustainability information into a single standardized document, reducing information asymmetry for foreign investors.

Expansion of assurance mechanisms to include financial, sustainability, and technological dimensions, may address key risks associated with tokenized assets.

9.4.5 Market Infrastructure Layer:

Despite advances such as the DREX pilot, the research identifies significant limitations in Brazil's market infrastructure for tokenized assets. These include challenges related to interoperability, personal data protection governance, custody, and secondary market liquidity. From a market microstructure perspective, the absence of robust infrastructure constrains price discovery and limits the scalability of tokenized instruments. Adoption of a dual-track model combining regulatory sandbox experimentation with scalable production environments, supported by robust custody, interoperability, and auditability standards addresses the infrastructure limitation, and promotion of regulated secondary markets may enhance liquidity, price discovery, and investor exit options.

9.4.6 Cross-Border Layer

One of the most significant constraints identified is the lack of a dedicated regulatory regime for cross-border investment in tokenized assets. While Brazil has established rules for foreign investment in traditional financial instruments, these do not fully accommodate the operational complexities of tokenized markets. This gap increases compliance costs and reduces Brazil's competitiveness relative to jurisdictions with more streamlined cross-border frameworks. The creation of an instrument such Regulatory Passport System may facilitate foreign investment through standardized documentation, recognition of intermediaries, and streamlined access to Brazilian markets.

9.4.7 Global Standards and Alignment

This layer represents the external normative foundation upon which the Brazilian regulatory framework for tokenized ESG assets must be anchored to achieve international credibility and cross-border interoperability and integrates key global standard-setting bodies, including the Financial Action Task Force (FATF), which establishes anti-money laundering and counter-terrorism financing requirements (including the Travel Rule for digital assets); the International Organization of Securities Commissions (IOSCO), which provides principles for investor protection,

market integrity, and the regulation of crypto-asset markets; the Organisation for Economic Co-operation and Development (OECD), which advances tax transparency through frameworks such as the Crypto-Asset Reporting Framework (CARF); and the International Sustainability Standards Board (ISSB), which defines globally comparable sustainability disclosure standards focused on financial materiality. Complementing these international pillars, the Brazilian Emission Trading System (known as SBCE) provides the domestic institutional basis for regulated environmental assets. Together, these frameworks ensure that tokenized ESG assets issued in Brazil are not only legally valid domestically but also recognizable, comparable, and investable in global markets, thereby reducing regulatory arbitrage, enhancing investor trust, and facilitating the integration of Brazilian assets into international capital flows.

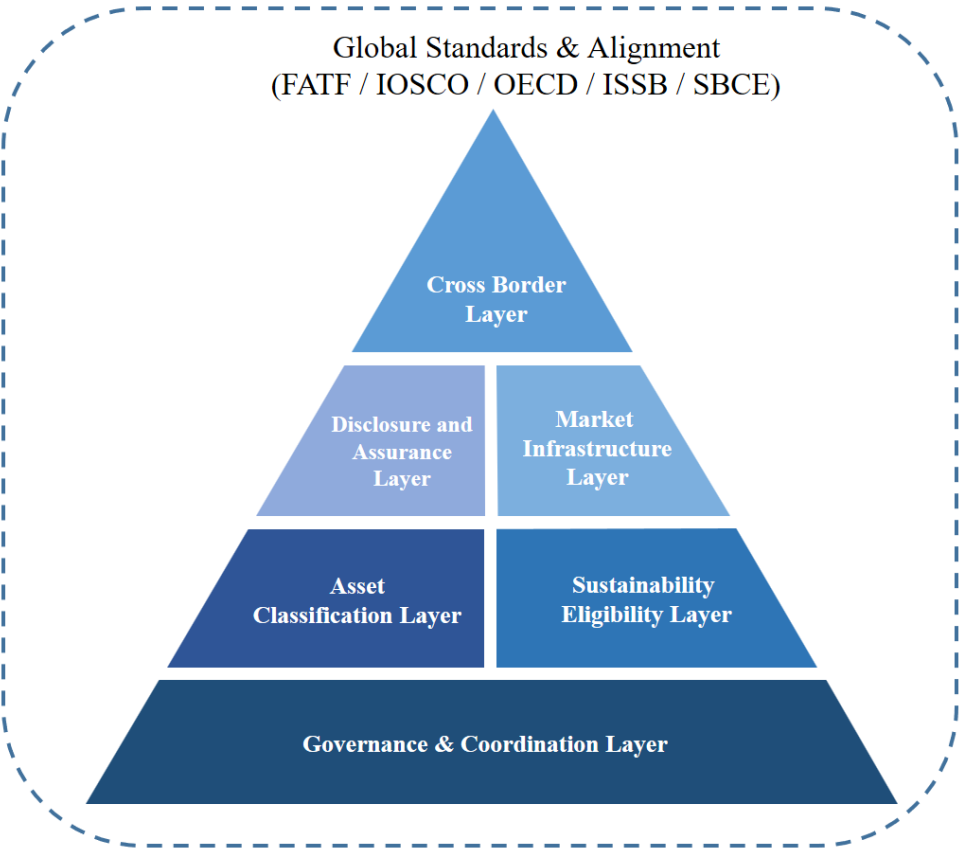


Figure 11: Integrated Regulatory Framework for Tokenized ESG assets

Source: Author's elaboration

The proposed Integrated Regulatory Framework for Tokenized ESG assets is grounded in the premise that effective regulation must move beyond sectoral silos and toward a system-level architecture, reflecting a shift from a compliance-based

regulatory model to a coordination-based model, in which the primary objective is not merely to regulate individual components but to ensure their integration into a cohesive system.

This Framework is consistent with both institutional theory and behavioral finance perspectives. Investor decision-making is influenced not only by formal regulatory alignment but also by perceptions of coherence, stability, and enforceability. In the context of tokenized ESG assets, these perceptions are amplified by the interaction of financial, technological, and environmental risks.

CHAPTER X: CONCLUSIONS

This chapter presents the main conclusions derived from the research findings and discusses the overall contributions of the study. It synthesizes the empirical results obtained through the mixed-methods approach and reflects on their theoretical, methodological, and practical implications. The chapter also acknowledges the study's limitations and outlines potential directions for future research.

10.1 Summary of Findings

This study set out to investigate the role of Tokenization in enhancing the attractiveness of sustainable investments in Brazil from the perspective of international investors. By adopting a mixed-methods approach that integrated quantitative survey data with qualitative interview insights, the research aimed to provide a comprehensive understanding of how blockchain-based Tokenization interacts with investor behavior, regulatory environments, and ESG investment frameworks.

Adopting a convergent mixed-methods design, the research combined quantitative survey data with qualitative insights from semi-structured interviews, allowing for both pattern identification and contextual interpretation. The integration of findings enabled a multidimensional understanding of how Tokenization influences investor trust, perceived risks, and investment decision-making.

The quantitative results identified statistically supported relationships between key constructs, including the positive role of Tokenization advantages, ESG alignment, and financial accessibility in shaping investor willingness to invest. At the same time,

perceived risks and regulatory uncertainty emerged as important factors influencing investor sentiment.

The qualitative findings complemented these results by providing contextual depth, highlighting how regulatory ambiguity, institutional credibility, and technological maturity influence investor confidence, particularly in an emerging market context such as Brazil.

The convergent analysis revealed areas of alignment, complementarity, and divergence between data strands. While both approaches emphasized the importance of transparency and regulatory clarity, qualitative insights further explained underlying behavioral and institutional dynamics, including trust formation, perceived legitimacy, and risk aversion. Together, these findings reinforce the central role of investor trust as a mediating mechanism in the adoption of tokenized ESG assets.

10.1.1 Influence of Tokenization on Investor Trust and Decision-Making

One of the central findings of this research is that Tokenization can positively influence investor trust in sustainable investments by enhancing transparency and traceability of ESG-related information. Blockchain technology enables immutable records of environmental impact metrics, financial flows, and project performance indicators, which can significantly reduce concerns related to greenwashing and information asymmetry.

The quantitative analysis supported this relationship by demonstrating that the perceived benefits of Tokenization—particularly transparency, fractional ownership, and increased liquidity—are positively associated with investor willingness to consider tokenized ESG assets. This finding supports Hypothesis H1, which proposed that Tokenization enhances investor trust and influences decision-making.

Qualitative findings further reinforced this result, as interview participants consistently emphasized the importance of transparency and verifiable ESG data in their investment evaluations. Many participants highlighted blockchain's capacity to provide real-time monitoring of environmental impact indicators, which can strengthen investor confidence in sustainability claims.

From a theoretical perspective, this result aligns with information asymmetry theories and Pecking Order Theory (Myers and Majluf, 1984), which suggest that

improved information transparency can facilitate capital allocation by reducing uncertainty between investors and asset issuers.

10.1.2 Impact of Perceived Risks on Tokenized ESG Asset Adoption

Despite the advantages associated with Tokenization, the findings also reveal that perceived risks remain a significant barrier to adoption. Regulatory uncertainty, technological vulnerabilities, and concerns about the maturity of blockchain infrastructure were frequently identified as factors that reduce investor willingness to participate in tokenized ESG investments.

The quantitative analysis confirmed that perceived threats negatively influence the likelihood of investing in tokenized ESG assets, supporting Hypothesis H2. These results are consistent with behavioral finance theories, particularly Prospect Theory, which suggests that investors tend to place greater weight on potential losses than on potential gains when evaluating investment opportunities. Qualitative insights also highlighted the importance of technological trust. Several interviewees noted that cybersecurity risks, smart contract vulnerabilities, and interoperability challenges can create hesitation among institutional investors, particularly in emerging markets where regulatory frameworks remain under development. These findings suggest that addressing technological risks and improving investor education will be essential to accelerating Tokenization adoption.

10.1.3 Regulatory Environment as a Determinant of Market Development

Another key finding of this study concerns the central role of regulatory frameworks in shaping the adoption of tokenized sustainable investments. Investors consistently identified regulatory clarity and legal recognition of tokenized assets as critical prerequisites for market development. The empirical results indicate that regulatory uncertainty remains one of the primary barriers to the widespread adoption of tokenized financial instruments in Brazil. This finding supports Hypothesis H3, which proposed that regulatory barriers hinder the development of tokenized sustainable finance markets. At the same time, the findings suggest that Brazil possesses the institutional capacity to become a leading market for tokenized sustainable investments if regulatory frameworks evolve to align with international standards.

From the perspective of Institutional Theory, these results highlight the importance of institutional legitimacy in shaping financial innovation. Investors rely on regulatory institutions to provide legal certainty, investor protection, and standardized market practices. Without such institutional support, technological innovations such as Tokenization may struggle to achieve widespread adoption.

10.1.4 Drivers of Attractiveness for Tokenized ESG Assets

The study also identified several key factors that enhance the attractiveness of tokenized ESG assets to international investors. These include alignment with global ESG standards, improved financial accessibility, enhanced transparency through blockchain technology, and the potential for increased liquidity through digital asset markets. The quantitative findings confirmed that ESG alignment and financial accessibility positively influence investor trust and investment willingness, supporting Hypotheses H5 and H7. These results suggest that Tokenization can democratize access to sustainable investments by enabling fractional ownership and lowering capital entry barriers. Qualitative findings further revealed that investors value the ability to track environmental impact metrics through blockchain-based systems, which can improve accountability and reduce concerns about greenwashing. Overall, these findings indicate that Tokenization can strengthen the credibility of sustainable finance markets by enhancing transparency and accountability mechanisms.

10.1.5 Role of Macroeconomic and Institutional Stability

The study also found that macroeconomic stability and regulatory predictability play an important moderating role in shaping investor sentiment toward tokenized ESG assets. Investors frequently emphasized the importance of political stability, regulatory consistency, and credible enforcement mechanisms when evaluating investment opportunities in emerging markets. These factors influence not only the perceived risks of tokenized assets but also the broader attractiveness of the Brazilian investment environment. The quantitative results support Hypothesis H8, which proposed that macroeconomic stability moderates the relationship between Tokenization and international investment.

This finding highlights that Tokenization should not be viewed in isolation but rather as part of a broader institutional ecosystem that includes financial regulation, macroeconomic governance, and investor protection frameworks.

10.2 Contributions

This research contributes to the growing body of literature at the intersection of sustainable finance, blockchain technology, and international investment behavior. By examining how Tokenization can enhance the attractiveness of sustainable investments in Brazil from an international investor perspective, the study advances theoretical understanding, methodological approaches, and practical insights relevant to policymakers, financial institutions, and sustainable finance practitioners. The contributions of this study can be categorized into four main areas: theoretical contributions, methodological contributions, policy implications, and managerial contributions.

10.2.1 Theoretical Contributions

This study contributes to the literature by demonstrating that the adoption of tokenized ESG assets is not primarily driven by technological efficiency, as often emphasized in fintech research, but by the interaction between investor trust, regulatory perception, and institutional legitimacy. The findings extend Behavioral Finance by showing that risk perception in emerging digital assets is not only a function of individual cognitive biases, but is significantly shaped by institutional signals, such as regulatory clarity and enforcement credibility.

At the same time, the study refines Institutional Theory by illustrating how legitimacy in digital financial markets is not solely constructed through formal regulatory structures, but also through technological infrastructures, such as blockchain-based transparency and traceability mechanisms. By integrating these perspectives, the study proposes that investment behavior in tokenized ESG assets is best understood as a behavioral–institutional phenomenon, where psychological responses and institutional conditions are jointly determined.

Furthermore, the study contributes to the emerging field of tokenized sustainable finance by providing empirically grounded and analytically generalizable insights into investor perceptions within an emerging market context. The integration of qualitative

and quantitative evidence strengthens the explanatory power of the proposed framework.

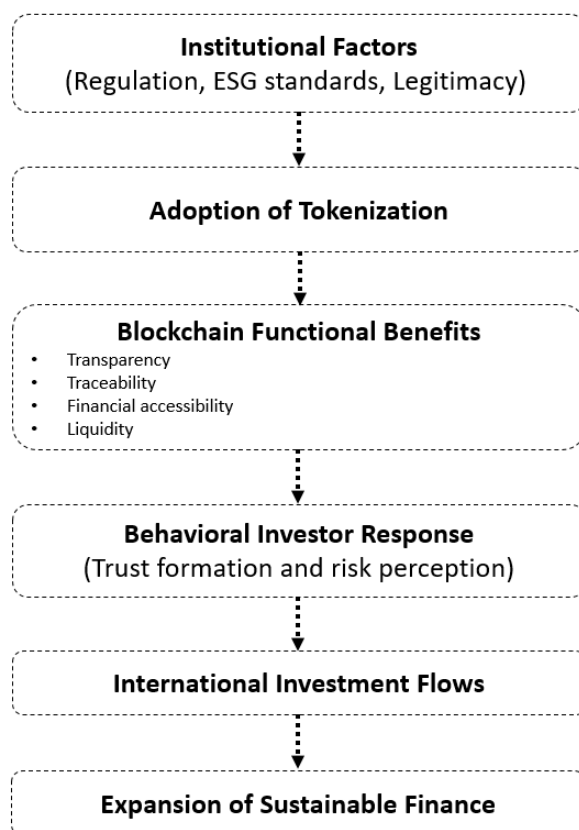


Figure 12: Integrated Behavioral–Institutional Model of Tokenized ESG Assets

Source: Author’s elaboration

The research extends Behavioral Finance literature by demonstrating that investor trust plays a mediating role between Tokenization and international investment decisions. The findings show that features associated with blockchain technology—such as transparency, traceability, and automated verification of ESG metrics—can strengthen investor confidence and mitigate concerns about information asymmetry and greenwashing. At the same time, the study confirms that behavioral biases, including loss aversion and risk perception, influence investor responses to emerging financial technologies.

The study contributes to Institutional Theory by demonstrating how institutional legitimacy shapes the adoption of financial innovation in emerging markets. The results indicate that regulatory clarity, alignment with international ESG standards, and credible institutional frameworks are essential for fostering investor trust and

facilitating the adoption of tokenized financial instruments. These findings highlight the role of institutional environments in shaping the diffusion of technological innovation within financial markets.

The research advances the literature on sustainable finance and digital assets by proposing an integrated conceptual model linking Tokenization, investor trust, and international capital flows. The study demonstrates that Tokenization can enhance sustainable investment attractiveness by reducing information asymmetries and increasing accessibility to global investors. However, it also shows that technological innovation alone is insufficient to drive market adoption without supportive institutional and regulatory environments.

Overall, the study contributes to theory by proposing an integrated behavioral–institutional framework that explains how technological innovation interacts with investor perceptions and institutional structures to shape the adoption of tokenized sustainable investments.

10.2.2 Methodological Contributions

This study contributes methodologically by demonstrating how a convergent mixed-methods design can be used not only for triangulation, but for systematically identifying convergence, divergence, and complementarity between different sources of evidence.

The findings show that while quantitative analysis captures the distribution and direction of investor attitudes, qualitative evidence is necessary to explain the underlying behavioral and institutional mechanisms driving those patterns. In particular, the study illustrates how divergence between investor survey data and expert interviews can reveal transitional market conditions, where perceptions differ across actor groups. This highlights the value of mixed-methods approaches in studying emerging financial phenomena characterized by uncertainty and institutional evolution..

The study combines quantitative survey data from international investors with qualitative insights from industry stakeholders, allowing for a comprehensive understanding of investor perceptions and market dynamics. This approach enables the triangulation of statistical findings with contextual narratives, strengthening the reliability and validity of the research conclusions.

The use of Structural Equation Modeling (SEM) represents another methodological contribution. By modeling relationships between latent constructs such

as investor trust, perceived risks, ESG alignment, and Tokenization features, the study provides empirical evidence of the mechanisms through which Tokenization influences investment behavior.

Furthermore, the qualitative component, supported by systematic coding and thematic analysis using MAXQDA, offers deeper insight into investor motivations, regulatory concerns, and technological perceptions that cannot be captured through quantitative analysis alone.

By integrating quantitative and qualitative approaches within a convergent mixed-methods framework, this study provides a methodological blueprint for future research examining financial innovation and investor behavior in emerging markets.

10.2.3 Policy Contributions

This study contributes to policy discussions by demonstrating that regulatory environments influence investment behavior primarily through trust formation mechanisms, rather than acting as direct constraints on market participation. The findings show that regulatory uncertainty reduces investment willingness by weakening perceived institutional credibility, indicating that investor responses are shaped by how regulatory signals are interpreted.

This insight refines existing perspectives on financial regulation by emphasizing its signaling role in emerging digital markets. It suggests that effective policy design must go beyond formal rule-setting and address the consistency, predictability, and international alignment of regulatory frameworks, as these elements directly influence investor confidence and market legitimacy.

In addition, the study provides evidence that alignment with internationally recognized ESG disclosure frameworks enhances perceived legitimacy and comparability. This reinforces the importance of harmonizing national regulatory systems with global standards, such as ISSB, TCFD, and GRI, as a mechanism to facilitate cross-border investment flows and attract international capital.

The findings also highlight a structural limitation in the Brazilian context: despite meaningful progress in both digital finance and sustainability disclosure, regulatory fragmentation across institutional domains continues to constrain scalability, interoperability, and investor confidence. This underscores the need for greater coordination between regulatory authorities and more integrated policy approaches.

Building on these insights, the study contributes by proposing an **Integrated Framework for Tokenized ESG Assets**, which conceptualizes how regulatory alignment, technological infrastructure, and ESG disclosure jointly shape investor trust and market adoption. Within this framework, regulation is understood not only as a formal system of rules, but as a central mechanism for signaling credibility, enabling transparency, and reinforcing the reliability of sustainability information.

From a policy perspective, this implies that fostering the development of tokenized sustainable investment markets requires a coordinated approach that integrates three key dimensions: (i) alignment with international ESG disclosure standards, (ii) clear and consistent regulatory treatment of tokenized financial instruments, and (iii) support for technological infrastructures that enhance traceability, auditability, and verification. The study highlights the role of policy experimentation in advancing this agenda. Regulatory sandboxes, pilot programs, and public–private partnerships can provide controlled environments for testing tokenized ESG investment models, allowing regulators and market participants to co-develop solutions that balance innovation with investor protection.

These contributions position regulation as a central element in the interaction between institutional conditions, technological innovation, and investor behavior, offering a more integrated understanding of how policy can support the development of sustainable digital finance in emerging markets.

10.2.4 Managerial and Market Contributions

From a market perspective, the study identifies that technological features such as transparency and fractional ownership are necessary but not sufficient to drive adoption of tokenized ESG assets. The findings indicate that investment decisions are highly sensitive to perceived regulatory stability and institutional trust. This suggests that project developers and financial intermediaries must complement technological solutions with credible governance structures, regulatory alignment, and third-party verification mechanisms.

For investors, the study highlights that perceived ESG alignment and disclosure quality play a critical role in reducing uncertainty, reinforcing the importance of standardized and verifiable sustainability information in investment decision-making.. The research highlights the importance of transparency and verifiable ESG reporting mechanisms for attracting international investors. Blockchain-based platforms that

provide real-time monitoring of environmental impact metrics can significantly enhance investor trust and reduce concerns about greenwashing.

The results demonstrate that financial accessibility and fractional ownership models enabled by Tokenization can broaden investor participation in sustainable projects. By lowering entry barriers, Tokenization allows both institutional and retail investors to participate in ESG-related investments that were previously accessible only to large financial institutions.

The study suggests that project developers should prioritize institutional partnerships and credible third-party verification mechanisms. Collaborations with established financial institutions, ESG rating agencies, and regulatory bodies can enhance the credibility of tokenized ESG assets. The research highlights the importance of investor education and communication strategies. As Tokenization remains a relatively new financial innovation, increasing awareness and understanding among investors will be essential for fostering market adoption.

10.3 Limitations

While this research provides valuable insights into the role of Tokenization in enhancing the attractiveness of sustainable investments in Brazil, several limitations should be acknowledged to ensure appropriate interpretation of the findings and to guide future research.

The qualitative component is based on a limited number of semi-structured interviews with industry experts and stakeholders (N=9) in sustainable finance, blockchain technology, and digital asset markets. Although these participants contributed informed and context-rich perspectives, the relatively small and purposively selected sample constrains the diversity of viewpoints and may overrepresented individuals more engaged with or favorable toward Tokenization. The qualitative findings should therefore be understood as exploratory and interpretative, aimed at capturing expert perceptions rather than providing statistically representative evidence.

The quantitative survey, while comprising a substantial number of international investors (N=220), relies on non-probabilistic sampling. Participants were recruited through professional networks, specialized forums, and online platforms such as Prolific, which introduces potential self-selection and platform bias. Respondents are more likely to be digitally literate and already interested in ESG investments or blockchain-related innovations. As a result, the findings provide analytically

generalizable insights within the studied sample, but cannot be considered fully representative of the broader global investor population.

Important limitations also arise from the operationalization of constructs. Key variables—such as investor trust, perceived risk, and regulatory perception—required substantial adaptation from qualitative concepts into quantitative indicators. Despite efforts to align these measures with existing literature, this process may have affected construct validity, measurement precision, and comparability with prior studies. The use of simplified or, in some cases, single-item measures may introduce measurement error and reduce the robustness of certain statistical relationships.

From a methodological perspective, constraints were observed in the application of Structural Equation Modeling (SEM), particularly regarding measurement reliability and model fit. These limitations restricted the interpretability of the SEM results, which are therefore treated as exploratory. The reliance on ordinal regression as the primary confirmatory method improves robustness; however, it also reflects the challenges of modeling complex, multi-dimensional constructs in an emerging research context.

The study is further limited by its reliance on self-reported perceptions from investors and stakeholders. While perceptions are central to understanding investment decision-making, they may not fully correspond to actual behavior. Expressed willingness to invest in tokenized assets may differ from real-world financial decisions under conditions of uncertainty and risk.

The geographical focus on Brazil as a case study also constrains external applicability. Although Brazil represents a relevant and high-potential emerging market, its regulatory environment, institutional structure, and market dynamics are not fully comparable to other jurisdictions. Differences in regulatory capacity, investor protection frameworks, and technological infrastructure may lead to different adoption patterns in other contexts.

Additionally, the study does not assess the financial performance of specific tokenized ESG assets, focusing instead on investor perceptions, institutional conditions, and technological factors. While this approach provides important insights into adoption dynamics, it does not capture realized investment outcomes or risk-return profiles associated with tokenized ESG assets.

The rapidly evolving nature of blockchain technology and digital asset markets introduces a temporal limitation. The findings reflect a specific stage in the

development of tokenized finance, and future regulatory changes, technological advancements, or broader institutional adoption may significantly alter the dynamics observed.

Despite these limitations, the mixed-methods design strengthens the study by enabling triangulation between quantitative patterns and qualitative insights, providing a more comprehensive and nuanced understanding of tokenized sustainable investments. These constraints therefore contextualize, rather than diminish, the study's contributions and highlight important directions for future research.

10.4 Future Research

The findings of this research open several promising avenues for future academic investigation. As Tokenization continues to evolve within the broader landscape of sustainable finance and digital asset markets, further studies can deepen the understanding of its implications for international investment, financial regulation, and technological innovation.

One important direction for future research involves comparative studies across different jurisdictions. While this study focuses on Brazil as a case study, other emerging markets may present different institutional environments and regulatory approaches to tokenized financial instruments. Comparative analyses between countries such as Brazil, Singapore, the United Arab Emirates, or members of the European Union could provide valuable insights into how regulatory frameworks influence the adoption of tokenized sustainable investments.

Another promising research direction concerns the empirical evaluation of tokenized ESG assets. Future studies could analyze the financial performance, liquidity dynamics, and risk characteristics of tokenized ESG assets relative to traditional ESG investment instruments such as green bonds or sustainability-linked loans. Such analyses would provide a more comprehensive understanding of the economic viability of Tokenization in sustainable finance.

Further research could also explore investor segmentation and behavioral heterogeneity in tokenized investment markets. This study focuses primarily on international investors as a general group; however, different investor categories—including institutional investors, venture capital firms, impact investors, and retail participants—may exhibit different risk perceptions and adoption patterns.

Understanding these differences could help design more targeted investment products and regulatory frameworks.

Another important avenue for future research relates to technological advancements in blockchain infrastructure, particularly in areas such as scalability, interoperability, and cybersecurity. As blockchain technologies evolve, improvements in network efficiency and security mechanisms may significantly influence investor perceptions and market adoption. Empirical studies examining how technological developments affect investor confidence and transaction costs would make a valuable contribution to the literature in this field.

Future research could also investigate the interaction between Tokenization and global ESG reporting frameworks. As international sustainability standards continue to evolve, the integration of blockchain-based systems for monitoring ESG metrics may play an increasingly important role in improving transparency and accountability in sustainable finance markets. Studies examining how tokenized ESG reporting systems interact with global sustainability frameworks could help identify best practices for market implementation.

Additional research could explore the macroeconomic implications of tokenized sustainable finance ecosystems. As digital financial markets expand, Tokenization may influence capital allocation patterns, financial inclusion, and cross-border investment flows. Understanding the broader economic impacts of tokenized sustainable investment platforms would provide valuable insights for policymakers and financial institutions seeking to promote sustainable economic development. The rapidly evolving nature of blockchain technology and sustainable finance presents numerous opportunities for future academic research. By building on the findings of this study, future investigations can further explore the institutional, technological, and behavioral dimensions shaping the development of tokenized sustainable investment markets.

APPENDIX A: SEMI STRUCTURED INTERVIEW COVER LETTER

Subject: Invitation: Academic Research Interview on Tokenized ESG Investing in Brazil

Dear [Participant's Name],

My name is Alison Aguiar Basso, and I am conducting doctorate academic research affiliated with Swiss School Business of Management (based in Geneva - Switzerland) on the emerging role of Tokenization in sustainable finance, with a particular focus on how this innovation is influencing international investment in Brazilian ESG projects.

As a recognized professional in your field, I would like to invite you to participate in a semi-structured interview lasting approximately 45–60 minutes. Your expertise as an [institutional investor/venture capital leader/impact investor – adjust as needed] will provide valuable insight into the opportunities, barriers, and strategic considerations surrounding tokenized ESG assets in emerging markets.

The research aims to include participants from three key groups:

- Institutional investors (e.g., pension funds, ESG-aligned funds);
- Venture capital firms engaged in blockchain and financial innovation;
- Impact investors focused on sustainability-driven investment models.

Your contribution will support a broader understanding of how investor sentiment, regulatory conditions, and technological developments intersect in the context of Brazil's sustainable finance market. All interviews will be conducted via Zoom or your preferred platform, and your responses will be kept strictly confidential and anonymized in accordance with research ethics protocols. You will also receive a consent form prior to the interview.

Should you be available and willing to participate, please let me know a convenient time in the coming weeks. I would be happy to accommodate your schedule.

Thank you in advance for considering this invitation. Your insights would be instrumental in shaping evidence-based recommendations for both policymakers and financial institutions in this evolving space.

Warm regards,
ALISON AGUIAR BASSO
Researcher – Doctorate Business Administration
Swiss School of Business Administration

APPENDIX B: CONSENT FORM

Title of research project: *Analyzing the Role of Tokenization in Enhancing Sustainable Investment in Brazil: A mixed-method study of International Investor Perspectives*

Being part of thesis for Doctorate Business Administration (DBA) program, the purpose of this study is to explore how Tokenization influences international investment decisions, particularly in the context of sustainable finance and blockchain innovation.

Name and position of researcher:

Alison Aguiar Basso, a researcher affiliated with SWISS SCHOOL OF BUSINESS MANAGEMENT (SSBM), based in Geneva, Switzerland.

1. Voluntary Participation

Your participation in this study is entirely voluntary. You may choose not to participate or to withdraw at any time, without facing any negative consequences or loss of benefits to which you are otherwise entitled.

2. Study Procedures

If you agree to participate, you will be asked to take part in a semi-structured interview, which will last approximately 45 to 60 minutes. The interview will be conducted via video conference or in person, depending on your preference. With your permission, the interview will be audio recorded for transcription and analysis purposes.

3. Confidentiality and Data Protection

All information collected in this study will remain strictly confidential. Your identity will not be disclosed in any report, publication, or presentation resulting from this study. Data will be anonymized and stored securely in accordance with data protection regulations.

4. Risks and Benefits

There are no anticipated risks associated with participating in this study. Although there are no direct benefits to you, your insights will contribute to research that may benefit the academic community and policy development.

5. Participant Consent Statement

By signing below, you acknowledge that:

- You have read and understood the information provided above.
- You have had the opportunity to ask questions and receive satisfactory answers.
- You voluntarily agree to participate in this research study.
- You consent to the audio recording of the interview (if applicable).

Name of Participant:	Date:	Signature:
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APPENDIX C: SEMI-STRUCTURED INTERVIEW GUIDE

Questions

1 General Perceptions of Tokenization in Sustainable Finance

- 1.1 Can you briefly describe your current role and experience with ESG investments or blockchain technologies?
- 1.2 How do you perceive the role of Tokenization in ESG investment strategies?
- 1.3 From your experience, what are the most significant organizational or market-level drivers and barriers to adoption?
- 1.4 How does blockchain technology enhance or complicate sustainable investments?

2 Regulatory Challenges & Market Adoption

- 2.1 How does the current regulatory landscape impact tokenized sustainable investments?
- 2.2 What changes in policy or governance could facilitate institutional adoption?
- 2.3 To what extent do global ESG standards (e.g., SFDR, TCFD) support or hinder tokenized ESG investment models?
- 2.4 What are the challenges of cross-border compliance when investing in tokenized ESG assets?

3 Investor Sentiment & Decision-Making

- 3.1 What key risks and opportunities do investors associate with tokenized ESG assets?
- 3.2 How does Tokenization compare to traditional ESG investment instruments?
- 3.3 What factors would encourage your firm to increase exposure to tokenized assets?
- 3.4 What is your general sentiment regarding investment in Brazilian sustainable assets?
- 3.5 How do you perceive the credibility and maturity of Brazil's sustainable finance market?
- 3.6 What factors would influence your decision to invest in tokenized ESG assets based in Brazil?
- 3.7 What specific regulatory or technological changes would increase your willingness to invest in Brazil-based tokenized ESG assets?
- 3.8 How does the transparency enabled by blockchain affect trust in ESG data or impact metrics?

4 Blockchain & Technological Considerations

- 4.1 What role does blockchain interoperability and scalability play in tokenized ESG adoption?
- 4.2 How do smart contracts and DeFi models impact investor trust?
- 4.3 What specific blockchain features (e.g., traceability, smart contract automation) are most valuable to investors in the ESG space?
- 4.4 What technical risks or shortcomings limit the adoption of blockchain for sustainable investing?

APPENDIX D: SURVEY COVER LETTER AND CONSENT FORM

Survey designed for research in Doctorate Business Administration

Researcher:

Alison Aguiar Basso

Doctoral Candidate – Swiss School of Business Management (Geneva, Switzerland)

Purpose of the Study

You are invited to participate in an academic research study aiming to better understand the perceptions, motivations, and concerns of international investors regarding tokenized ESG (Environmental, Social, Governance) investment opportunities in Brazil. Your insights will contribute to a broader understanding of sustainable finance innovation and its adoption among global investors.

Voluntary Participation

Your participation is entirely voluntary. You may withdraw from the survey at any time without penalty. There are no foreseeable risks or discomforts associated with your participation.

Confidentiality and Data Use

All responses will be treated with strict confidentiality. Data will be used solely for academic purposes and stored securely. No identifying information will be collected, and results will be reported in aggregate form only.

By participating in this survey, I agree with consent form.

APPENDIX E: SURVEY QUESTIONS

Section A: Investor Profile

1. What type of investor best describes you? (Multiple Choice)
 - Institutional investor (e.g., Pension fund, Portfolio Manager, Decision-maker in blockchain-based assets))
 - Venture Capital professional (e.g Investors funding blockchain-driven financial innovations; VC firms specializing in fintech, Web3, and tokenized assets.)
 - Impact investor (e.g Investors funding green bonds, carbon credits, and social impact projects.)
 - ESG-aligned asset manager
 - Blockchain professional working on tokenized platforms.
 - Regulatory experts specializing in financial technology, security tokens, and ESG compliance.
2. What is your primary region of investment operations? (Multiple Choice)
 - North America
 - Europe
 - Latin America
 - Asia-Pacific
 - Middle East and Africa
 - Global
3. What is the approximate size of your fund or investment portfolio? (Multiple Choice)
 - Less than USD 50 million
 - USD 50–250 million
 - USD 250–1 billion
 - Over USD 1 billion
 - Prefer not to say
4. How experienced are you in investing in ESG-aligned projects?
(Linear Scale: 1 = No experience, 5 = expert-level experience)
5. Have you ever invested in blockchain-based financial instruments?
(Yes/No/Not Sure)

Section B: Willingness to Adopt Tokenized ESG assets

6. How would you rate your familiarity with tokenized investment products (e.g., blockchain-based ESG assets)?
Linear Scale: 1 = Not familiar at all, 5 = Very familiar
7. How likely are you to invest in tokenized ESG assets in Brazil in the next 12 months?
 - Very likely
 - Likely
 - Neutral
 - Unlikely

- Very unlikely
8. What proportion of your ESG investment portfolio would you be willing to allocate to tokenized assets, assuming regulatory compliance and market stability?
- 0–10%
 - 11–25%
 - 26–50%
 - Over 50%
 - None of this stage
9. What factors would positively influence your decision to adopt tokenized ESG investment products? ☒ Checkboxes — select all that apply:
- Increased liquidity
 - Enhanced transparency and traceability (via blockchain)
 - Alignment with global sustainability standards (ESG compliance)
 - Lower transaction and operational costs
 - Access to smaller-scale projects via fractional ownership
 - Demonstrated institutional backing or regulation
 - Improved portfolio diversification

Section C: Perceived Risks (Regulatory, Economic, Technological)

10. To what extent does regulatory uncertainty in Brazil reduce your willingness to adopt tokenized ESG investments?
- Linear Scale: 1 = No impact, 5 = Strong negative impact*
11. To what extent do blockchain scalability and interoperability limitations pose a challenge to the adoption of tokenized ESG assets?
- Linear Scale: 1 = Not a challenge, 5 = Major challenge*
12. Does economic instability in Brazil affect your willingness to invest in tokenized ESG assets? (Multiple Choice)
- Yes
 - No
 - Not sure
13. What are the top 3 risks that reduce your interest in tokenized ESG investments? (Please select exactly 3 options)
- Regulatory uncertainty (e.g., unclear legal framework or lack of enforcement)
 - Lack of ESG standardization (e.g., absence of unified criteria or disclosure norms)
 - Blockchain security concerns (e.g., smart contract vulnerabilities, hacking incidents)
 - Illiquidity of tokenized assets (e.g., low secondary market activity)
 - Lack of institutional trust (e.g., unverified or unstable asset originators)
 - Macroeconomic volatility (e.g., inflation, political risk, FX instability)
 - Technological immaturity (e.g., limited interoperability, low user-friendliness)
 - Absence of credible third-party verification (e.g., external auditing of ESG claims)

Section D: ESG Alignment and Financial Accessibility

14. How important is transparent ESG disclosure (e.g., GHG emissions, governance practices, and social performance) in your investment decision-making? *(Based on SFDR Article 8 & 9 standards for sustainable investments)*
Linear Scale: 1 = Not important, 5 = Extremely important
15. Would alignment of Brazil's ESG metrics with international disclosure standards (e.g., SFDR, TCFD, ISSB) increase your confidence in tokenized sustainable investments?
(Likert Scale — Strongly Agree to Strongly Disagree)
- Strongly agree
 - Agree
 - Neutral
 - Disagree
 - Strongly disagree
16. Does blockchain's ability to provide immutable traceability of environmental and social outcomes influence your investment decisions in ESG projects?
- Yes, significantly
 - Somewhat
 - Not at all
17. Is financial accessibility (e.g., fractional ownership and lower entry barriers) a meaningful incentive for considering tokenized ESG investments?
- Yes
 - No
 - It depends

Section E: Final Comments (Optional)

18. Do you have any additional comments or suggestions regarding tokenized ESG investments in Brazil? (Paragraph – Open text response)

APPENDIX F: CFA MEASUREMENT MODEL

CFA is a SEM modeling technique that is based on covariances and is intended to empirically test whether a set of real data fits a factorial structure previously defined by theory. CFA is a modeling technique within SEM. The CFA assesses how observed variables relate to latent variables (factors), confirming whether the observed measures are, in fact, measuring the proposed theoretical construct (Neves B., 2018; Kline, 2023). In other words, the objective of latent variable measurement models is to establish the number and nature of the factors that explain the variation and covariance among a set of observed variables (Hoyle, 2012).

A factor is an unobserved variable that influences more than one observed variable and explains the correlations between these measures. Thus, observed variables are intercorrelated because they share a common factor, that is, they are influenced by this underlying construct (factor). CFA is more parsimonious than other traditional methods in the analysis of a set of variables, since the number of factors defined in the analysis is smaller than the number of observed variables (Hoyle, 2012).

The **estimation method** adopted in this study was the Weighted Least Squares Mean and Variance Adjusted – WLSMV, which is suitable for ordinal and categorical variables that are not normally distributed. It uses the matrix of polychoric/tetrachoric correlations and applies robust adjustments to standard errors, chi-square statistics, and fit indices, making it less sensitive to violations of normality and appropriate even with moderate sample sizes (Wheaton *et al.*, 1977; Hoyle, 2012; Brown, 2015; Kline, 2023).

The measurement models were evaluated using both global and local fit criteria.

Indices of **global fit** assess how well the overall theoretical model fits the data.

The following indices were used in this study:

- *Minimum fit function chi-square test – χ^2 and its p-value, and chi-square test by degrees of freedom – χ^2/df :* minimum fit function chi-square (χ^2) and its p-value, as well as the chi-square divided by degrees of freedom (χ^2/df), were inspected. Because the χ^2 statistic is highly sensitive to sample size and to other issues, the χ^2/df ratio is commonly reported as a descriptive indicator of relative fit. This ratio assesses the discrepancy between the expected model-implied covariance matrix and the sample covariance matrix observed after accounting for model complexity. Although χ^2/df lacks a strong theoretical foundation and no universal

cutoffs exist (Kline, 2023), early empirical discussions suggested that values between 2 and 3 (Carmines and McIver, 1983) or up to 5 (Wheaton *et al.*, 1977; Schumacker and Lomax, 2010) may be acceptable.

- *Comparative fit index – CFI*: compares the specified model to a baseline independence model. Values scaled over the interval 0.0–1.0, where a result ≥ 0.95 indicating good fit (Kline, 2023; Rogers, 2024).
- *Tucker-Lewis Index – TLI*: evaluates model fit relative to a baseline model while penalizing model complexity. Values scaled over the interval 0.0–1.0, where a result ≥ 0.95 indicating good fit (Kline, 2023; Rogers, 2024).
- *Standardized Root Mean Square Residual – SRMR*: is a measure of model misfit expressed on the scale of correlation residuals. A value of zero indicates no difference between the observed and predicted correlations, meaning a perfect fit. with values ≤ 0.08 generally viewed as acceptable (Kline, 2023; Rogers, 2024).
- *Root Mean Square Error of Approximation – RMSEA*: estimates how well the model would fit the population covariance matrix. Lower values indicate better fit, with values ≤ 0.06 generally interpreted as indicative of good fit. It was also considered that the upper bound of the 90% confidence interval for the RMSEA should be below 0.10, thereby avoiding the possibility that the model falls within the poor-fit region. (Schermelleh-Engel, Moosbrugger and Müller, 2003; Kline, 2023; Rogers, 2024).
- *Hoelter's Critical N*: indicates the minimum sample size required for the chi-square test not to reject the model, that is, for the model to be considered adequately fitted. Higher values suggest greater stability of the model fit, and results above 200 are generally interpreted as evidence of a stable and well-fitting model (Schumacker and Lomax, 2010; Rogers, 2024).
- *McDonald's omega coefficient*: McDonald's Ω it is a reliability measure that indicates the proportion of item variance attributable to the latent construct, distinguishing it from error or item-specific variance. McDonald's omega is particularly suitable for ordinal or nonparametric data because it does not assume equal item loadings, accounts for specific variances, and is robust to deviations from normality. Although no consensus exists, omega values ≥ 0.90 indicate excellent reliability, 0.80–0.89 good, 0.70–0.79 acceptable, and < 0.70 low (Hayes and Coutss, 2010).

Measures of **local fit** assess specific problems within the model and indicate where adjustments are needed. The following measures were used in this study:

- *Factor loadings*: they assess the fit of individual items. Factor loadings indicate how strongly each observed variable is related to the latent factor. Unstandardized loadings are raw regression coefficients expressed in the items' original units, whereas standardized loadings range from –1 to 1 and are more interpretable and comparable. In the standardized solution, factor loadings correspond to the correlation between the item and the factor, reflecting the proportion of common variance explained. In CFA, standardized loadings above 0.70 are considered strong, values around 0.50 acceptable, and those below 0.40 potentially problematic (Hoyle, 2012; Brown, 2015; Kline, 2023).
- *Standardized residual variances*: they were examined as an index of item-level misfit. It is calculated as $1 - \lambda^2$ where λ is the item's standardized factor loading, representing the proportion of variance not explained by the latent factor. Although the literature does not establish formal cutoffs, values above 0.50–0.70 are considered indicative of poor fit (Hoyle, 2012; Brown, 2015; Kline, 2023).
- *Modification indices – MI and Expected parameter change – EPC*: reflects an approximation of how much the overall model chi-square will decrease if the fixed or constrained parameter is freely estimated. A cutoff value of 3.84 was adopted for freeing parameters, indicating a statistically significant improvement in model fit at the 5% level (Hoyle, 2012; Brown, 2015). Results greater than 4.000 were considered indicative of parameters whose release could result in a statistically significant improvement in model fit ($p < .05$), though any modifications were guided by theoretical justification. MI were only evaluated when overall model fit, assessed by the chi-square statistic and its degrees of freedom, indicated inadequate fit, as MI are intended to suggest potential local improvements rather than justify modifications in already well-fitting models. EPC values, reported alongside MI, estimate how much a parameter (e.g., a covariance) would be expected to change, positively or negatively, if freely estimated in a subsequent analysis (Hoyle 2012; Brown 2015).

Structural Model

The structural model is the component of SEM that specifies the regression relationships between endogenous and exogenous variables - whether latent or observed - representing the hypothesized causal structure among the constructs and other variables included in the model (Hair *et al.*, 2021; Kline, 2023).

Initially, to assess the presence of multicollinearity among latent factors, a matrix of correlations between latent factors was constructed based on the standardized factor covariances estimated in the structural equation model, which assumes underlying continuous latent variables inferred from ordinal and categorical items. Severe multicollinearity impairs SEM estimation, especially in smaller samples or complex models (Hoyle 2012). Although there is no universally accepted cutoff, values above 0.80 are considered indicative of potential collinearity (Papageorgiou, 2022). The analysis of the initial correlations also served as a preliminary exploration of associations among latent factors.

As in the CFA, the WLSMV estimator was adopted, and global model fit was assessed using the chi-square test relative to degrees of freedom, the CFI, TLI, SRMR, RMSEA, and Hoelter's Critical N.

The results of the structural regressions were expressed as standardized structural regression coefficients (path coefficients). These coefficients represent the expected change in the unobserved continuous latent response associated with a one-standard deviation increase in the predictor, placing all variables on a comparable scale and facilitating the interpretation of the magnitude and direction of associations within the latent model. When the outcome variable is observed and ordinal, these coefficients refer to the latent propensity underlying higher categories of the observed ordinal outcome, adjusted for the other relationships specified in the structural model. In the present study, given the use of the WLSMV estimator with dichotomous and ordinal variables, the coefficients were estimated on the probit-parameterized scale of an underlying continuous latent response variable, assumed to be normally distributed (Muthén 1984; Brown 2015; Kline 2023).

The standardized covariance between the exogenous latent variables (Tokenization and Perceived threats) was freely estimated, while the correlations with the mediation variable were fixed to zero to preserve model identification. This choice improves model fit and reduces bias in the structural coefficients. Model specification and reporting

followed established guidelines for structural equation modeling (Kang & Ahn 2021; Kline 2023).

Effect modifiers specified in the theoretical model were also examined, namely mediation and moderation.

Mediation: mediation analysis aims to investigate the underlying mechanisms through which (how) an independent variable (X) is associated with a dependent variable (Y), considering the role of an intermediate variable, referred to as the mediator (M). The mediator is assumed to lie on the pathway between the predictor and the outcome, such that part or all of the association between X and Y may be explained by the presence of M. This type of analysis is particularly useful for testing theoretical models of processes and mechanisms underlying observed associations (Igartua and Hayes, 2021; Kline, 2023).

In a mediation model, the effect of X on Y is decomposed into direct, indirect, and total effects. The direct effect corresponds to the standardized coefficient of the structural path $X \rightarrow Y$ estimated in the presence of the mediator; the indirect effect is defined as the product of the standardized coefficients of the paths $X \rightarrow M$ and $M \rightarrow Y$; and the total effect is obtained as the sum of the direct and indirect effects, representing the overall association between X and Y in the model (Igartua and Hayes, 2021; Kline, 2023).

Although mediation is conceptually formulated as a causal process model, in SEM based on observational data it should be interpreted as evidence consistent with a causal hypothesis rather than as established causality (Kline, 2023).

- *Moderation:* moderation analysis aims to examine whether the strength or direction of the association between an independent variable (X) and a dependent variable (Y) varies as a function of a third variable, referred to as the moderator (Z). In this context, the moderator is not assumed to lie on the causal pathway between X and Y; instead, it specifies the conditions under which the association occurs or differs across levels of Z. This type of analysis is particularly useful for testing theoretical models that posit heterogeneity in effects across subgroups or contextual conditions (Igartua and Hayes, 2021; Kline, 2023).

In a moderation model, effect modification is typically evaluated through the inclusion of an interaction term between X and Z ($X * Z$), or alternatively by estimating models stratified by levels of the moderator or using multiple-group path analysis. A

statistically significant interaction indicates that the effect of X on Y differs according to the levels of the moderating variable (Igartua and Hayes, 2021; Kline, 2023).

In this study, moderation was initially evaluated using multiple-group path analysis, with the moderating variable specified as the grouping variable. However, the multigroup models failed to converge, likely due to insufficient sample size in some categories of the moderator and/or limitations related to data quality and model complexity.

Given these constraints, moderation was explored through stratified analyses, in which structurally identical models were estimated separately for each category of the moderating variable, using the same parameter specifications and model constraints. Differences in the estimated coefficients across strata were examined descriptively and supported by graphical displays using point estimates and confidence intervals, to assess potential patterns of effect heterogeneity across groups. These results should be interpreted as exploratory (Rothman, Greenland and Lash, 2011; Hosmer, Lemeshow and Sturdivant, 2013).

APPENDIX G: QUANTITATIVE SUPPLEMENTARY MATERIAL

Table 20: *Descriptive analysis of likelihood to invest in tokenized ESG assets in Brazil in the next 12 months, Brazil, 2025.*

Likelihood to invest	n°	%
Very Unlikely	27	12.3
Unlikely	43	19.5
Neutral	67	30.5
Likely	56	25.5
Very Likely	27	12.3
Total	220	100.0

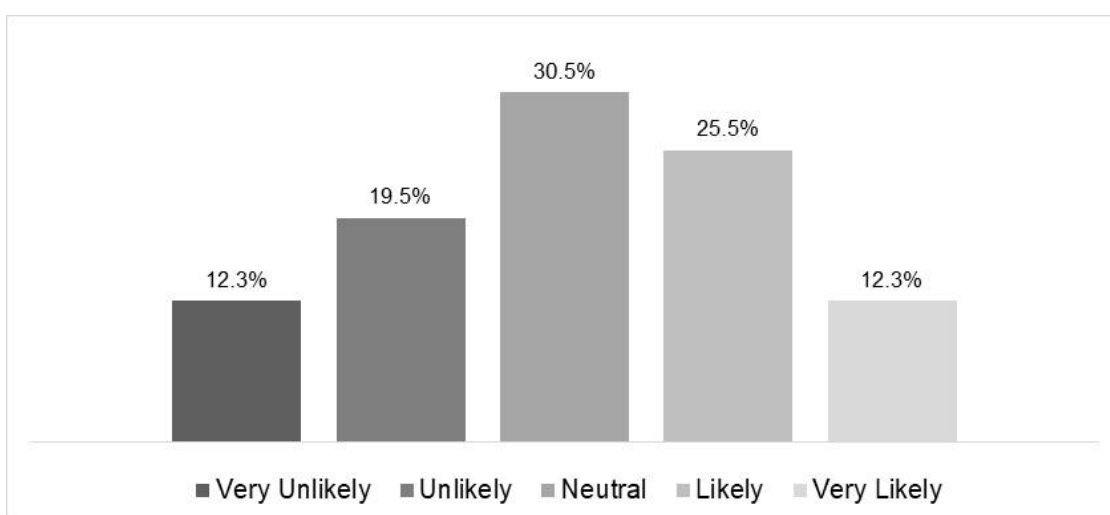


Figure 13: Likelihood (%) to invest in tokenized ESG Assets in Brazil in the next 12 months, 2025.

Source: Author's elaboration

Table 21: Descriptive analysis of aspects of willingness to adopt Tokenized ESG assets, Brazil, 2025.

Variable	n°	%
Familiarity with tokenized investment products		
Not familiar at all	14	6.4
Very low familiar	34	15.5
Low familiar	35	15.9
Medium familiar	55	25.0
Familiar	58	26.4
Very familiar	24	10.9
Proportion of ESG portfolio to allocate		
None of this stage	10	4.5
0–10%	82	37.3
11–25%	87	39.5
26–50%	31	14.1
Over50%	10	4.5
Positive influences *		
Increased liquidity	127	57.7
Enhanced transparency and traceability	121	55.0
Alignment with global sustainability standards	104	47.3
Lower transaction and operational costs	114	51.8
Smaller-scale projects via fractional ownership	75	34.1
Institutional backing or regulation	78	35.5
Improved portfolio diversification	88	40.0
Total	220	100.0

* Sum exceeds 220 (100.0%) because the same investor may have more than 1 answer

Source: elaborated by Author

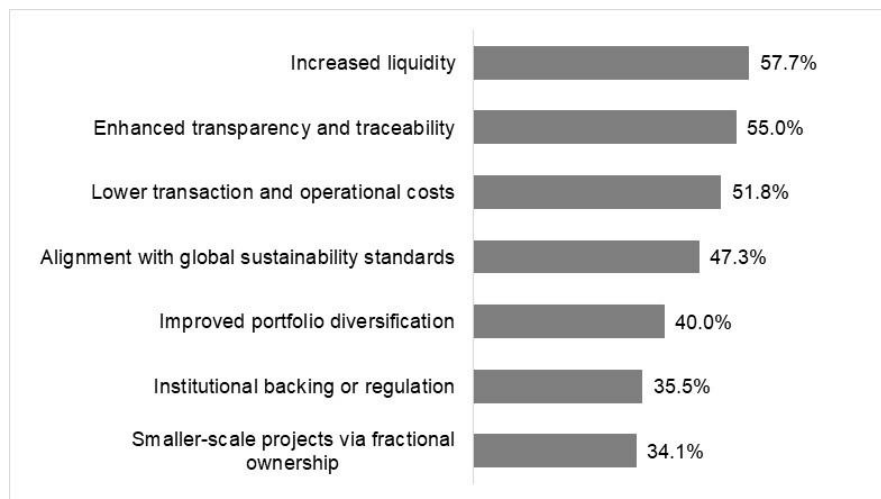


Figure 14: Distribution (%) of factors that would positively influence the decision to adopt tokenized ESG Assets, Brazil (2025)

Source: Author's elaboration

Table 22: Descriptive analysis of perceived risks against the willingness to adopt ESG Tokenized assets, Brazil, 2025.

Variable	n°	%
Regulatory uncertainty in Brazil		
No impact	14	6.4
Low impact	25	11.4
Medium impact	67	30.5
High negative impact	83	37.7
Strong negative impact	31	14.1
Blockchain scalability and interoperability limitations		
Not a challenge	10	4.5
Low challenge	82	37.3
Neutral	87	39.5
High challenge	31	14.1
Significant challenge	10	4.5
Economic instability in Brazil		
Yes	153	69.5
Not sure	19	8.6
No	48	21.8
Three top risks that reduce interest *		
Regulatory uncertainty	135	61.4
Lack of ESG standardization	87	39.5
Blockchain security concerns	92	41.8
Illiquidity of tokenized assets	78	35.5
Lack of institutional trust	90	40.9
Macroeconomic volatility	78	35.5
Technological immaturity	44	20.0
Absence of credible third-party verification	55	25.0
Total	220	100.0

* Sum exceeds 220 (100.0%) because the same investor may have more than 1

answer

Source: elaborated by Author

Table 23: Descriptive analysis of features of ESG Alignment and Financial Accessibility, Brazil, 2025.

Variable	n°	%
Importance of transparent ESG disclosure		
Not important	3	1.4
Low important	15	6.8
Neutral	45	20.5
High important	78	35.5
Extremely important	79	35.9
Alignment of with international disclosure standards		
Strongly disagree	4	1.8
Disagree	20	9.1
Neutral	50	22.7
Agree	90	40.9
Strongly agree	56	25.5
Blockchain's ability to provide immutable traceability		
Yes, significantly	90	40.9
Somewhat	117	53.2
Not at all	13	5.9
Financial accessibility		
Yes	149	67.7
Maybe	40	18.2
No	31	14.1
Total	220	100.0

Source: elaborated by Author

Table 24: Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and variables of the international investor profile, Brazil, 2025.

Variable	Unlikely		Neutral		Very Likely		Total		p *
	Nº	%	Nº	%	Nº	%	Nº	%	
Investor type									
Blockchain professional / Regulatory experts	5	16.7	16	53.3	9	30.0	30	100.0	0.017
Institutional investor	25	36.2	22	31.9	22	31.9	69	100.0	
ESG-aligned asset manager, Impact investor, Individual Investor	28	35.4	22	27.8	29	36.7	79	100.0	
Venture capital professional	12	28.6	7	16.7	23	54.8	42	100.0	
Primary region of investment									
North America	24	25.0	28	29.2	44	45.8	96	100.0	0.181
Europe	31	38.8	26	32.5	23	28.8	80	100.0	
Other regions	15	34.1	13	29.5	16	36.4	44	100.0	
Size of investment fund									

Less than USD 50 million / prefer not so say	61	40.9	45	30.2	43	28.9	149	100.0	<0.001
USD 50–250 million	4	10.3	15	38.5	20	51.3	39	100.0	
Over 250 million	5	15.6	7	21.9	20	62.5	32	100.0	
Experience in ESG-aligned projects									
No or low experience	42	63.6	21	31.8	3	4.5	66	100.0	<0.001
Medium	20	26.7	27	36.0	28	37.3	75	100.0	
Experience or highly experience	8	10.1	19	24.1	52	65.8	79	100.0	
Previous investments blockchain-based									
Not sure / no	26	63.4	10	24.4	5	12.2	41	100.0	<0.001
Yes	44	24.6	57	31.8	78	43.6	179	100.0	
Total	70	31.8	67	30.5	83	37.7	220	100.0	

* Chi-square association test.

Source: elaborated by Author

Table 25: Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and aspects of willingness to adopt Tokenized ESG assets, Brazil, 2025.

Variable	Unlikely		Neutral		Likely		Total		p *
	N°	%	N°	%	N°	%	N°	%	
Familiarity with tokenized investment products									
Low	44	53.0	28	33.7	11	13.3	83	100.0	<0.001
Medium	15	27.3	20	36.4	20	36.4	55	100.0	
Familiar	11	13.4	19	23.2	52	63.4	82	100.0	
Proportion of ESG portfolio to allocate									
None of this stage or <=10%	54	58.7	27	29.3	11	12.0	92	100.0	<0.001
11–25%	14	16.1	31	35.6	42	48.3	87	100.0	
Over 25%	2	4.9	9	22.0	30	73.2	41	100.0	
Increased liquidity									
No	40	43.0	30	32.3	23	24.7	93	100.0	0.001
Yes	30	23.6	37	29.1	60	47.2	127	100.0	
Enhanced transparency and traceability									
No	36	36.4	26	26.3	37	37.4	99	100.0	0.331
Yes	34	28.1	41	33.9	46	38.0	121	100.0	
Alignment with global sustainability standards									
No	47	40.5	34	29.3	35	30.2	116	100.0	0.008
Yes	23	22.1	33	31.7	48	46.2	104	100.0	
Lower transaction and operational costs									
No	38	35.8	29	27.4	39	36.8	106	100.0	0.420
Yes	32	28.1	38	33.3	44	38.6	114	100.0	
Smaller-scale projects via fractional ownership									
No	50	34.5	48	33.1	47	32.4	145	100.0	0.078
Yes	20	26.7	19	25.3	36	48.0	75	100.0	
Institutional backing or regulation									

No	52	36.6	44	31.0	46	32.4	142	100.0	0.051
Yes	18	23.1	23	29.5	37	47.4	78	100.0	
Improved portfolio diversification									
No	48	36.4	38	28.8	46	34.8	132	100.0	0.205
Yes	22	25.0	29	33.0	37	42.0	88	100.0	
Total	70	31.8	67	30.5	83	37.7	220	100.0	

* Chi-square association test.

Source: elaborated by Author

Table 26: Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and perceived risks against the willingness to adopt ESG Tokenized assets, Brazil, 2025.

Variable	Unlikely		Neutral		Likely		Total		p *
	Nº	%	Nº	%	Nº	%	Nº	%	
Regulatory uncertainty in Brazil									
No, low or medium negative impact	29	27.4	28	26.4	49	46.2	106	100.0	0.043
High negative impact	41	36.0	39	34.2	34	29.8	114	100.0	
Blockchain scalability and interoperability limitations									
Low challenge	17	44.7	9	23.7	12	31.6	38	100.0	0.395
Neutral	23	28.4	28	34.6	30	37.0	81	100.0	
High challenge	30	29.7	30	29.7	41	40.6	101	100.0	
Economic instability in Brazil									
No, not sure	23	34.3	13	19.4	31	46.3	67	100.0	0.052
Yes	47	30.7	54	35.3	52	34.0	153	100.0	
Regulatory uncertainty									
No	25	29.4	28	32.9	32	37.6	85	100.0	0.766
Yes	45	33.3	39	28.9	51	37.8	135	100.0	
Lack of ESG standardization									
No	49	36.8	41	30.8	43	32.3	133	100.0	0.071
Yes	21	24.1	26	29.9	40	46.0	87	100.0	
Blockchain security concerns									
No	48	37.5	40	31.3	40	31.3	128	100.0	0.037
Yes	22	23.9	27	29.3	43	46.7	92	100.0	
Illiquidity of tokenized assets									
No	46	32.4	41	28.9	55	38.7	142	100.0	0.787
Yes	24	30.8	26	33.3	28	35.9	78	100.0	
Lack of institutional trust									
No	46	34.8	35	26.5	51	38.6	132	100.0	0.386
Yes	26	28.9	32	35.6	32	35.6	90	100.0	
Macroeconomic volatility									
No	49	34.5	42	29.6	51	35.9	142	100.0	0.507
Yes	21	26.9	25	32.1	32	41.0	78	100.0	
Technological immaturity									
No	54	30.7	56	31.8	66	37.5	176	100.0	0.636
Yes	16	36.4	11	25.0	17	38.6	44	100.0	

Absence of credible third-party verification

No	43	26.1	52	31.5	70	42.4	165	100.0	0.004
Yes	27	49.1	15	27.3	13	23.6	55	100.0	
Total	70	31.8	67	30.5	83	37.7	220	100.0	

* Chi-square association test.

Source: elaborated by Author

Table 27: Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and ESG Alignment and Financial Accessibility, Brazil, 2025.

Variable	Unlikely		Neutral		Likely		Total		p *
	N°	%	N°	%	N°	%	N°	%	
Importance of transparent ESG disclosure									
Not or low important	11	78.6	0	0.0	3	21.4	14	100.0	0.040
Neutral	14	31.1	17	37.8	14	31.1	45	100.0	
High important	45	28.7	46	29.3	66	42.0	157	100.0	
Alignment of with international disclosure standards									
Disagree	14	58.3	6	25.0	4	16.7	24	100.0	0.010
Neutral	19	38.0	16	32.0	15	30.0	50	100.0	
Agree	37	25.3	45	30.8	64	43.8	146	100.0	
Blockchain's ability to provide immutable traceability									
Not at all or somewhat	56	43.1	40	30.8	34	26.2	130	100.0	<0.001
Yes	14	15.6	27	30.0	49	54.4	90	100.0	
Financial accessibility									
Maybe or no	35	49.3	21	29.6	15	21.1	71	100.0	0.001
Yes	35	23.5	46	30.9	68	45.6	149	100.0	
Total	43	25.9	67	40.4	56	33.7	166	100.0	

* Chi-square association test.

Source: elaborated by Author

Table 28: A - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and the variables of the international investor profile, Brazil, 2025.

Variable	Very Unlikely		Unlikely		Neutral		Likely		Very Likely		Total		p *
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	
Investor type													
Venture capital professional	0	0.0	12	28.6	7	16.7	16	38.1	7	16.7	42	100.0	0.001
Blockchain professional	0	0.0	1	6.7	8	53.3	5	33.3	1	6.7	15	100.0	
Regulatory experts	2	13.3	2	13.3	8	53.3	3	20.0	0	0.0	15	100.0	
Institutional investor	12	17.4	13	18.8	22	31.9	15	21.7	7	10.1	69	100.0	
Esg-aligned asset manager	2	7.1	3	10.7	5	17.9	10	35.7	8	28.6	28	100.0	
Impact investor	4	12.5	7	21.9	11	34.4	6	18.8	4	12.5	32	100.0	
Individual Investor	7	36.8	5	26.3	6	31.6	1	5.3	0	0.0	19	100.0	
Primary region of investment													
North America	7	7.3	17	17.7	28	29.2	28	29.2	16	16.7	96	100.0	0.018
Europe	16	20.0	15	18.8	26	32.5	18	22.5	5	6.3	80	100.0	
Latin America	0	0.0	1	12.5	5	62.5	2	25.0	0	0.0	8	100.0	
Asia-Pacific	0	0.0	2	22.2	0	0.0	6	66.7	1	11.1	9	100.0	
Middle East and Africa	1	50.0	1	50.0	0	0.0	0	0.0	0	0.0	2	100.0	
Global	3	12.0	7	28.0	8	32.0	2	8.0	5	20.0	25	100.0	
Size of investment fund													
Over USD 1 billion	2	20.0	0	0.0	1	10.0	5	50.0	2	20.0	10	100.0	0.008
USD 250–1 billion	0	0.0	3	13.6	6	27.3	7	31.8	6	27.3	22	100.0	
USD 50–250 million	1	2.6	3	7.7	15	38.5	14	35.9	6	15.4	39	100.0	
Less than USD 50 million	19	15.0	31	24.4	39	30.7	25	19.7	13	10.2	127	100.0	
Prefer not to say	5	22.7	6	27.3	6	27.3	5	22.7	0	0.0	22	100.0	
Experience in ESG-aligned projects													

No Experience	10	41.7	5	20.8	8	33.3	1	4.2	0	0.0	24	100.0	<0.001
Low experience	9	21.4	18	42.9	13	31.0	2	4.8	0	0.0	42	100.0	
Medium Experience	6	8.0	14	18.7	27	36.0	22	29.3	6	8.0	75	100.0	
Highly Experience	1	1.8	5	9.1	16	29.1	23	41.8	10	18.2	55	100.0	
	1	4.2	1	4.2	3	12.5	8	33.3	11	45.8	24	100.0	
Previous investments blockchain-based													
Yes	14	7.8	30	16.8	57	31.8	53	29.6	25	14.0	179	100.0	<0.001
Not sure	2	20.0	5	50.0	3	30.0	0	0.0	0	0.0	10	100.0	
No	11	35.5	8	25.8	7	22.6	3	9.7	2	6.5	31	100.0	
Total	27	12.3	43	19.5	67	30.5	56	25.5	27	12.3	220	100.0	

* Chi-square association test.

Source: elaborated by Author

Table 29: B - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and aspects of willingness to adopt Tokenized ESG assets, Brazil, 2025.

Variable	Very Unlikely		Unlikely		Neutral		Likely		Very Likely		Total		p *
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	
Familiarity with tokenized investment products													
Not familiar at all	10	71.4	2	14.3	2	14.3	0	0.0	0	0.0	14	100.0	<0.001
Very low familiar	7	20.6	16	47.1	9	26.5	2	5.9	0	0.0	34	100.0	
Low familiar	1	2.9	8	22.9	17	48.6	8	22.9	1	2.9	35	100.0	
Medium familiar	7	12.7	8	14.5	20	36.4	16	29.1	4	7.3	55	100.0	
Familiar	2	3.4	9	15.5	15	25.9	24	41.4	8	13.8	58	100.0	
Very familiar	0	0.0	0	0.0	4	16.7	6	25.0	14	58.3	24	100.0	
Proportion of ESG portfolio to allocate													
None of this stage	9	90.0	1	10.0	0	0.0	0	0.0	0	0.0	10	100.0	<0.001

0–10%	13	15.9	31	37.8	27	32.9	9	11.0	2	2.4	82	100.0	
11–25%	4	4.6	10	11.5	31	35.6	32	36.8	10	11.5	87	100.0	
26–50%	0	0.0	1	3.2	8	25.8	11	35.5	11	35.5	31	100.0	
Over50%	1	10.0	0	0.0	1	10.0	4	40.0	4	40.0	10	100.0	
Increased liquidity													
No	18	19.4	22	23.7	30	32.3	15	16.1	8	8.6	93	100.0	0.004
Yes	9	7.1	21	16.5	37	29.1	41	32.3	19	15.0	127	100.0	
Enhanced transparency and traceability													
No	15	15.2	21	21.2	26	26.3	26	26.3	11	11.1	99	100.0	0.600
Yes	12	9.9	22	18.2	41	33.9	30	24.8	16	13.2	121	100.0	
Alignment with global sustainability standards													
No	20	17.2	27	23.3	34	29.3	26	22.4	9	7.8	116	100.0	0.019
Yes	7	6.7	16	15.4	33	31.7	30	28.8	18	17.3	104	100.0	
Lower transaction and operational costs													
No	16	15.1	22	20.8	29	27.4	28	26.4	11	10.4	106	100.0	0.592
Yes	11	9.6	21	18.4	38	33.3	28	24.6	16	14.0	114	100.0	
Smaller-scale projects via fractional ownership													
No	21	14.5	29	20.0	48	33.1	35	24.1	12	8.3	145	100.0	0.074
Yes	6	8.0	14	18.7	19	25.3	21	28.0	15	20.0	75	100.0	
Institutional backing or regulation													
No	23	16.2	29	20.4	44	31.0	33	23.2	13	9.2	142	100.0	0.057
Yes	4	5.1	14	17.9	23	29.5	23	29.5	14	17.9	78	100.0	
Improved portfolio diversification													
No	14	10.6	34	25.8	38	28.8	33	25.0	13	9.8	132	100.0	0.057
Yes	13	14.8	9	10.2	29	33.0	23	26.1	14	15.9	88	100.0	
Total	27	12.3	43	19.5	67	30.5	56	25.5	27	12.3	220	100.0	

* Chi-square association test

Source: elaborated by Author

Table 30: C - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and perceived risks against the willingness to adopt ESG Tokenized assets, Brazil, 2025.

Variable	Very Unlikely		Unlikely		Neutral		Likely		Very Likely		Total		p *
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	
Regulatory uncertainty in Brazil													
No impact	6	42.9	3	21.4	1	7.1	1	7.1	3	21.4	14	100.0	<0.001
Low impact	2	8.0	6	24.0	6	24.0	6	24.0	5	20.0	25	100.0	
Medium impact	4	6.0	8	11.9	21	31.3	23	34.3	11	16.4	67	100.0	
High negative impact	7	8.4	16	19.3	32	38.6	23	27.7	5	6.0	83	100.0	
Strong negative impact	8	25.8	10	32.3	7	22.6	3	9.7	3	9.7	31	100.0	
Blockchain scalability and interoperability limitations													
Not a challenge	4	36.4	2	18.2	3	27.3	0	0.0	2	18.2	11	100.0	0.004
Low challenge	4	14.8	7	25.9	6	22.2	6	22.2	4	14.8	27	100.0	
Neutral	11	13.6	12	14.8	28	34.6	23	28.4	7	8.6	81	100.0	
High challenge	5	6.1	20	24.4	27	32.9	24	29.3	6	7.3	82	100.0	
Significant challenge	3	15.8	2	10.5	3	15.8	3	15.8	8	42.1	19	100.0	
Economic instability in Brazil													
Yes	17	11.1	30	19.6	54	35.3	37	24.2	15	9.8	153	100.0	0.021
Not sure	3	15.8	5	26.3	7	36.8	4	21.1	0	0.0	19	100.0	
No	7	14.6	8	16.7	6	12.5	15	31.3	12	25.0	48	100.0	
Regulatory uncertainty													
No	11	12.9	14	16.5	28	32.9	20	23.5	12	14.1	85	100.0	0.811
Yes	16	11.9	29	21.5	39	28.9	36	26.7	15	11.1	135	100.0	
Lack of ESG standardization													
No	21	15.8	28	21.1	41	30.8	32	24.1	11	8.3	133	100.0	0.077

Yes	6	6.9	15	17.2	26	29.9	24	27.6	16	18.4	87	100.0	
Blockchain security concerns													
No	20	15.6	28	21.9	40	31.3	28	21.9	12	9.4	128	100.0	0.118
Yes	7	7.6	15	16.3	27	29.3	28	30.4	15	16.3	92	100.0	
Illiquidity of tokenized assets													
No	19	13.4	27	19.0	41	28.9	37	26.1	18	12.7	142	100.0	0.925
Yes	8	10.3	16	20.5	26	33.3	19	24.4	9	11.5	78	100.0	
Lack of institutional trust													
No	16	12.3	28	21.5	35	26.9	36	27.7	15	11.5	130	100.0	0.607
Yes	11	12.2	15	16.7	32	35.6	20	22.2	12	13.3	90	100.0	
Macroeconomic volatility													
No	17	12.0	32	22.5	42	29.6	35	24.6	16	11.3	142	100.0	0.664
Yes	10	12.8	11	14.1	25	32.1	21	26.9	11	14.1	78	100.0	
Technological immaturity													
No	19	10.8	35	19.9	56	31.8	47	26.7	19	10.8	176	100.0	0.372
Yes	8	18.2	8	18.2	11	25.0	9	20.5	8	18.2	44	100.0	
Absence of credible third-party verification													
No	17	10.3	26	15.8	52	31.5	44	26.7	26	15.8	165	100.0	0.007
Yes	10	18.2	17	30.9	15	27.3	12	21.8	1	1.8	55	100.0	
Total	27	12.3	43	19.5	67	30.5	56	25.5	27	12.3	220	100.0	

* Chi-square association test.

Source: elaborated by Author

Table 31: D - Comparative analysis between the likelihood to invest in tokenized ESG assets in Brazil in the next 12 months and ESG Alignment and Financial Accessibility, Brazil, 2025.

Variable	Very Unlikely		Unlikely		Neutral		Likely		Very Likely		Total		p *
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	
Importance of transparent ESG disclosure													
Not important	3	100.0	0	0.0	0	0.0	0	0.0	0	0.0	3	100.0	0.001
Low important	2	13.3	6	40.0	4	26.7	3	20.0	0	0.0	15	100.0	
Neutral	8	17.8	6	13.3	17	37.8	12	26.7	2	4.4	45	100.0	
High important	7	9.0	17	21.8	25	32.1	21	26.9	8	10.3	78	100.0	
Extremely important	7	8.9	14	17.7	21	26.6	20	25.3	17	21.5	79	100.0	
Alignment of with international disclosure standards													
Strongly disagree	3	75.0	1	25.0	0	0.0	0	0.0	0	0.0	4	100.0	0.001
Disagree	6	30.0	4	20.0	6	30.0	4	20.0	0	0.0	20	100.0	
Neutral	7	14.0	12	24.0	16	32.0	9	18.0	6	12.0	50	100.0	
Agree	8	8.9	18	20.0	31	34.4	26	28.9	7	7.8	90	100.0	
Strongly agree	3	5.4	8	14.3	14	25.0	17	30.4	14	25.0	56	100.0	
Blockchain's ability to provide immutable traceability													
Yes, significantly	4	4.4	10	11.1	27	30.0	31	34.4	18	20.0	90	100.0	<0.001
Somewhat	17	14.5	30	25.6	39	33.3	23	19.7	8	6.8	117	100.0	
Not at all	6	46.2	3	23.1	1	7.7	2	15.4	1	7.7	13	100.0	
Financial accessibility													
Yes	13	8.7	22	14.8	46	30.9	44	29.5	24	16.1	149	100.0	0.001
Maybe	11	27.5	13	32.5	9	22.5	5	12.5	2	5.0	40	100.0	
No	3	9.7	8	25.8	12	38.7	7	22.6	1	3.2	31	100.0	
Total	27	12.3	43	19.5	67	30.5	56	25.5	27	12.3	220	100.0	

* Chi-square association test.

Source: elaborated by Author

Table 32: Global fit indices from the final models for Confirmatory Factor Analysis of the latent scales

Fit indices *	Expected values **	Tokenization	Latent variables Perceived threats	Investor trust
χ^2	--	0.393	0.000	4.951
χ^2 (p)	> 0.050	0.822	--	0.084
χ^2 / df	≤ 3.000	0.197	0.000	2.476
CFI	³ 0.950	1.000	1.000	0.955
TLI	³ 0.950	1.062	1.000	0.866
SRMR	≤ 0.080	0.013	2.028×10^{-9}	0.048
RMSEA (upper bound CI _{90%})	< 0.060 (<0.100)	0.000 (0.000; 0.080)	0.000 (0.000; 0.000)	0.082 (0.000; 0.176)
Hoelter's critical N ($\alpha = .05$)	> 200.000	3341.094	1.000	266.036
Hoelter's critical N ($\alpha = .01$)	> 200.000	5135.538	1.000	408.425
McDonald's W (CI _{95%})	≥ 0.900	0.497 (0.390; 0.605)	0.551 (0.423; 0.679)	0.601 (0.514; 0.688)

* Fit indices:

χ^2 = qui-square test

χ^2 (p) = p-value

χ^2 / df = ratio of the chi-square value to the degrees of freedom

CFI = comparative fit index

TLI = Tucker-Lewis Index

SRMR = standardized root mean residual

RMSEA (IC_{90%}) = root mean square error of approximation (interval confidence 90%)

Hoelter's critical N ($\alpha = 0.05$ or $\alpha = 0.01$)

McDonald's W (IC_{95%}) = McDonald's omega reliability coefficient (interval confidence 95%)

** References: Wheaton et al. 1977; Hayes & Coutts 2020; Kline, 2023; Rogers 2024

Source: elaborated by Author

Table 33: Matrix of correlations between latent factors estimated in the structural equation model

Factors	Tokenization	Perceived threats	Investor trust
Tokenization	1.000		
Perceived threats	0.413*	1.000	
Investor trust	1.141*	0.755*	1.000

* p<0.001

*Source: elaborated by Author***Table 34:** Standardized path coefficients of the Structural SEM Model

Predictor	Outcome	Std. estimate	Std. Error	z-value	p-value	Confidence Interval (95%)
Tokenization	likelihood to invest	0.200	0.480	0.416	0.677	-0.742; 1.142
Perceived threats	likelihood to invest	-0.624	0.235	-2.662	0.008	-1.084; 0.165
Investor trust	likelihood to invest	0.658	0.586	1.123	0.262	-0.491; 1.807
Tokenization	Investor trust	0.865	0.104	8.305	< 0.001	0.661; 1.069
Perceived threats	Investor trust	0.391	0.129	3.037	0.002	0.139; 0.644

*Source: elaborated by Author***Table 35:** Mediation effects in the relationships between predictors and likelihood to invest in the structural SEM model

Effect	Std. estimate	Std. Error	z-value	p-value	Confidence Interval (95%)	% of total effect mediated *
Total effect						
Tokenization → Likeli	0.769	0.104	7.390	<0.001	0.565; 0.974	74.0
Threats → Likeli **	-0.367	0.118	-3.099	0.002	-0.599; -0.135	-70.3
Indirect effect						
Tokenization → Trust → Likeli	0.569	0.505	1.127	0.260	-0.421; 0.156	

Threats → Trust → Likeli	0.258	0.199	1.296	0.195	-0.132; 0.647
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Note: Tokenization = Tokenization; Threats = Perceived threats; Trust = Investor trust ; Likeli = Likelihood to invest

* Percentage of the total effect accounted for by the standardized indirect effect through the mediating variable (investor trust), calculated as: % = (Indirect effect / Total effect) × 100.

** Negative percentages indicate indirect and total effects operating in opposite directions.

Source: elaborated by Author

Table 36: Global Fit Indices of the Structural SEM Model by Economic Instability (Moderator)

Fit indices *	Expected values **	No / not sure (n=67)	Yes (n=153)
χ^2	--	54.92	70.55
χ^2 (p)	> 0.050	0.260	0.024
χ^2 / df	≤ 3.000	1.121	1.440
CFI	³ 0.950	0.968	0.883
TLI	³ 0.950	0.956	0.843
SRMR	≤ 0.080	0.074	0.065
RMSEA (upper bound CI _{90%})	< 0.060 (<0.100)	0.043 (0.000;0.094)	< 0.054 (0.021;0.080)
Hoelter's critical N (α = .05)	> 200.000	119.593	175.168
Hoelter's critical N (α = .01)	> 200.000	134.933	197.696

* Fit indices:

χ^2 = qui-square test

χ^2 (p) = p-value

χ^2 / df = ratio of the chi-square value to the degrees of freedom

CFI = comparative fit index

TLI = Tucker-Lewis Index

SRMR = standardized root mean residual

RMSEA (CI_{90%}) = root mean square error of approximation (interval confidence 90%)

Hoelter's critical N (α = 0.05 or α = 0.01)

** References: Wheaton et al. 1977; Hayes & Coutts 2020; Kline, 2023; Rogers 2024

Source: elaborated by Author

Table 37: Standardized path coefficients of the Structural SEM Model Stratified by Economic Instability (Moderator)

Predictor	Outcome	Std. estimate	Std. Error	z-value	p-value	Confidence Interval (95%)
No, not sure (n=67)						
Investor trust	likelihood to invest	-0.179	2.792	-0.064	0.949	-5.651; 5.292
Yes (n=153)						
Investor trust	likelihood to invest	0.577	0.661	0.874	0.382	-0.718; 1.873

Source: elaborated by Author

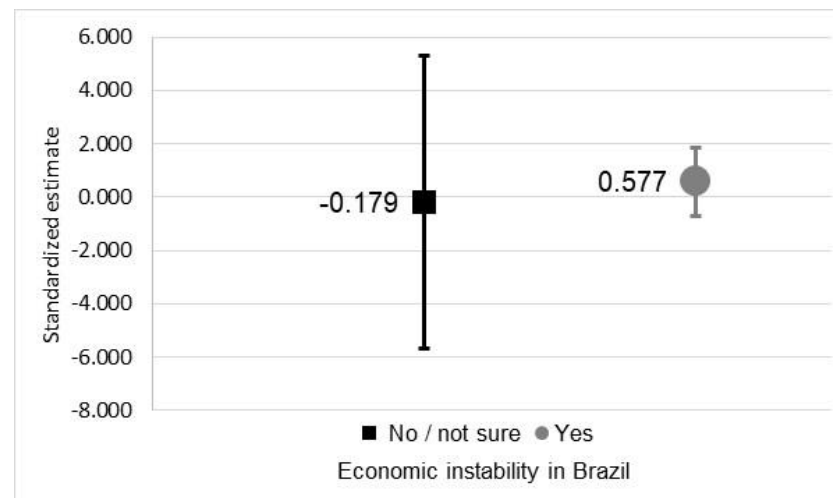


Figure 16: Point estimates and 95% confidence intervals (error bars) for standardized regression coefficients, across strata of Economic instability in Brazil

Source: Author's elaboration

Table 38: Box 1. Hypothesis 1 – Construct and Operational Variables

Construct	Component	Variable	Indicator score (points)
Tokenization	1. Familiarity with Tokenization	Familiarity Tokenization	1 to 3
		Increased liquidity	0 and 1
		Enhanced transparency	0 and 1
	2. Functional value of Tokenization	Lower transaction	0 and 1
		Fractional ownership	0 and 1
		Portfolio diversification	0 and 1
		Financial accessibility	0 and 1
	3. Traceability	Blockchain traceability	0 and 1
		Total (possible score)	
	Investor trust	8. Regulatory trust (proxy)	Alignment confidence
Disclosure importance			1 to 3
9. ESG Governance		Alignment ESG	0 and 1
		No lack ESG standardization	0 and 1
		No lack of institutional trust	0 and 1
10. Trust Institutional backing or regulation		Institutional backing or regulation	0 and 1
		No absence credible third-party verification	0 and 1
		Total (possible score)	
Likelihood to Invest	Likelihood to invest in tokenized ESG assets in Brazil in the next 12 months	Likelihood to Invest	1 to 3

Table 39: Hypothesis 1 - Direct, indirect, and total effects of Tokenization on likelihood to invest mediated by investor trust*Source: elaborated by Author*

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR	% of total effect mediated *
Structural paths						
Tokenization → Trust	0.455	0.324; 0.587	<0.001	1.577	1.369; 1.785	
Trust → Likeli	0.126	-0.061; 0.313	0.187	1.134	0.922; 1.346	
Direct effect						
Tokenization → Likeli	0.463	0.314; 0.611	<0.001	1.588	1.352; 1.825	
Indirect effect						
Tokenization → Trust → Likeli	0.057	-0.030; 0.144	0.196	1.059	0.967; 1.151	
Total effect						
Direct + indirect	0.520	0.379; 0.661	<0.001	1.682	1.445; 1.919	11.0

Notes: Tokenization = Tokenization; Trust = Investor trust; Likeli = Likelihood to invest

The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated.Robust standard errors were used. * Percentage of the total effect accounted for by the the mediating variable (investor trust) based on calculations performed on the log-odds scale, calculated as: $\% = (\text{Indirect effect} / \text{Total effect}) \times 100$.*Source: elaborated by Author*

Table 40: Box 2. Hypothesis 2 – Construct and Operational Variables

Construct	Component	Variable	Score (points)
Perceived threats	4. Regulatory Uncertainty	Regulatory_Uncertainty	0 and 1
		Risk_Regulatory_uncertainty	0 and 1
	5. Technological challenges	Tech_Challenges	1 to 3
		Risk_Technological_immaturity	0 and 1
	6. Security	Risk_Blockchain_security_concerns	0 and 1
	7. Liquidity	Risk_Illiquidity_of_tokenized_assets	0 and 1
	Total (possible score)		1 to 8
Investor trust	8. Regulatory Trust (proxy)	Alignment confidence	1 to 3
		Disclosure importance	1 to 3
	9. ESG Governance	Alignment ESG	0 and 1
		No lack ESG standardization	0 and 1
	10. Trust Institutional Backing or regulation	No lack of institutional trust	0 and 1
		Institutional backing or regulation	0 and 1
		No absence credible third-party verification	0 and 1
		Total (possible score)	2 to 11
Likelihood to Invest	Likelihood to invest in tokenized ESG assets in Brazil in the next 12 months	Likelihood to Invest	1 to 3

Source: elaborated by Author

Table 41: Hypothesis 2 - Direct, indirect, and total effects of perceived threats on likelihood to invest mediated by investor trust

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR	% of total effect mediated *
Structural paths						
Threats → Trust	0.607	0.395; 0.819	<0.001	1.835	1.446; 2.224	
Trust → Likeli	0.419	0.237; 0.600	<0.001	1.520	1.244; 1.795	
Direct effect						
Threats → Likeli	-0.166	-0.375; 0.043	0.119	0.847	0.670; 1.024	
Indirect effect						
Treats → Trust → Likeli	0.254	0.122; 0.386	<0.001	1.289	1.119; 1.459	
Total effect						
Direct + indirect	0.088	-0.124; 0.300	0.417	1.092	0.860; 1.323	289.5

Notes: Tokenization = Tokenization; Trust = Investor trust; Likeli = Likelihood to invest

The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated.

Robust standard errors were used.

* Percentage of the total effect accounted for by the the mediating variable (investor trust) based on calculations performed on the log-odds scale, calculated as: $\% = (\text{Indirect effect} / \text{Total effect}) \times 100$.

Table 42: Box 3 - Hypothesis 3 – Construct and Operational Variables

Construct	Component	Variables (not combined into an indicator)	Points
Regulatory barriers	4. Regulatory Uncertainty	Regulatory_Uncertainty	0 and 1
		Risk of regulatory_uncertainty	0 and 1
Tokenization	1. Familiarity with Tokenization	Familiarity with Tokenization	1 to 3

Source: elaborated by Author

Table 43: Hypothesis 3 - Direct effects of regulatory barriers on Familiarity with Tokenization

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR
Regulatory uncertainty → Familiarity with Tokenization *					
Cutpoint 1 (Higher vs. lowest familiarity)	0.467	-0.083; 1.017	0.096	1.595	0.920; 2.766
Cutpoint 2 (Highest vs. lower familiarity)	-0.038	-0.586; 0.510	0.891	0.963	0.556; 1.665
Risk of Regulatory_uncertainty → Familiarity with Tokenization **	0.187	-0.308; 0.682	0.460	1.205	0.735; 1.977

* The proportional odds assumption was violated (Brant test $p < 0.050$); therefore, generalized ordered logistic regression models with partial proportional odds were estimated. Robust standard errors were used Coefficients are reported separately for each cutpoint of the ordinal outcome.

Source: elaborated by Author

Table 44: Box 4. Hypothesis 4 – Construct and Operational Variables

Construct	Component	Variables	Points	
Technological challenges	Technological challenges	Technological challenges	1 to 3	
	Tokenization	1. Familiarity with Tokenization	Familiarity Tokenization	1 to 3
			Increased liquidity	0 and 1
			Enhanced transparency	0 and 1
		2. Functional value of Tokenization	Lower transaction	0 and 1
			Fractional ownership	0 and 1
			Portfolio diversification	0 and 1
			Financial accessibility	0 and 1
		3. Traceability	Blockchain traceability	0 and 1
			Total (possible score)	1 to 10

Source: elaborated by Author

Table 45: Hypothesis 4 - Direct effects of Technological challenges on Tokenization

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR
Technological challenges → Tokenization*	0.608	0.245; 0.970	0.001	1.836	1.278; 2.638

* The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated.

Robust standard errors were used.

Source: elaborated by Author

Table 46: Box 5. Hypothesis 5 – Construct and Operational Variables

Construct	Component	Variables (not combined into an indicator)	Points
Alignment of ESG metrics	8. Regulatory Trust (proxy)	Trust built through ESG alignment and regulation.	1 to 3

Source: elaborated by Author

Table 47: Hypothesis 5 - Direct effects of Alignment of ESG metrics on Likelihood to Invest

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR
Alignment of ESG metrics → Likelihood to Invest*	0.670	0.295; 1.044	<0.001	1.953	1.343; 2.841

* The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated. Robust standard errors were used

Source: elaborated by Author

Table 48: Box 6. Hypothesis 6 – Construct and Operational Variables

Construct	Component	Variables	Points
Advantages of Tokenization		Increased liquidity	0 and 1
		Enhanced transparency	0 and 1
	2. Functional value of Tokenization	Lower transaction	0 and 1
		Fractional ownership	0 and 1
		Portfolio diversification	0 and 1
	3. Traceability	Financial accessibility	0 and 1
		Blockchain traceability	0 and 1
		Total (possible score)	0 to 7
Likelihood to Invest	Likelihood to invest in tokenized ESG assets in Brazil in the next 12 months	Likelihood to Invest	1 to 3

Source: elaborated by Author

Table 49: Hypothesis 6 - Direct effects of Advantages of Tokenization on Likelihood to Invest

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR
Advantages of Tokenization → Likelihood to Invest*	0.438	0.279; 0.596	<0.001	1.549	1.322; 1.815

* The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated. Robust standard errors were used.

Source: elaborated by Author

Table 50: Box 7. Hypothesis 7 – Construct and Operational Variables

Construct	Component	Variable	Score (points)
Financial accessibility and ESG adoption (governança ESG)	2. Functional value of Tokenization	Financial accessibility	0 and 1
		Disclosure importance	1 to 3
	9. ESG Governance	Alignment ESG	0 and 1
		No lack ESG standardization	0 and 1
		Total (possible score)	1 to 6
Likelihood to Invest	Likelihood to invest in tokenized ESG assets in Brazil in the next 12 months	Likelihood to Invest	1 to 3

Source: elaborated by Author

Table 51: Hypothesis 7 - Direct effects of Financial accessibility and ESG adoption on Likelihood to Invest

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR
Financial accessibility and ESG adoption → Likelihood to Invest*	0.359	0.158; 0.561	<0.001	1.432	1.171; 1.752

* The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated. Robust standard errors were used.

Source: elaborated by Author

Table 52: Box 8. Hypothesis 8 – Construct and Operational Variables

Construct	Component	Variable	Score (points)
Tokenization	1. Familiarity with Tokenization	Familiarity Tokenization	1 to 3
		Increased liquidity	0 and 1
		Enhanced transparency	0 and 1
	2. Functional value of Tokenization	Lower transaction	0 and 1
		Fractional ownership	0 and 1
		Portfolio diversification	0 and 1
		Financial accessibility	0 and 1
	3. Traceability	Blockchain traceability	0 and 1
		Total (possible score)	1 to 10
Macroeconomic instability	11. Economic Instability	Economic instability	0 and 1
		Risk_Macroeconomic_volatility	0 and 1
Regulatory uncertainty	4. Regulatory Uncertainty	Impact of regulatory uncertainty	0 and 1
		Risk of regulatory_uncertainty	0 and 1
Likelihood to Invest	Likelihood to invest in tokenized ESG assets in Brazil in the next 12 months	Likelihood to Invest	1 to 3

Source: elaborated by Author

Table 53: Hypothesis 8 – Direct effects of Tokenization on likelihood to invest and tests of moderation by macroeconomic instability and regulatory uncertainty

Moderation variable	Effects	Log-odds	Without interaction			With interaction			
			OR	Confidence Interval (95%)	p-value	Log-odds	OR	Confidence Interval (95%)	p-value
Economic instability	Tokenization	0.523	1.687	1.464 – 1.945	<0.001	0.541	1.718	1.309 – 2.253	<0.001
	Economic instability	-0.549	0.578	0.303 – 1.101	0.095	-0.560	0.571	0.288 – 1.132	0.109
	Interaction Tokenization * Economic instability	--	--	--	--	-0.026	0.974	0.713 – 1.330	0.868
Risk of macroeconomic volatility	Tokenization	0.502	1.651	1.441; 1.892	<0.001	0.516	1.676	1.422; 1.975	<0.001
	Risk of macroeconomic volatility	0.199	1.221	0.710; 2.099	0.471	0.196	1.217	0.709; 2.090	0.477
	Interaction Tokenization * Risk of macroeconomic volatility	--	--	--	--	-0.046	0.955	0.717; 1.274	0.756
Impact of regulatory uncertainty	Tokenization	0.549	1.732	1.505; 1.993	<0.001	0.680	1.974	1.592; 2.449	<0.001
	Impact of regulatory uncertainty	-0.965	0.381	0.220; 0.658	0.001	-1.012	0.363	0.207; 0.639	<0.001
	Interaction Tokenization * Impact of regulatory uncertainty	--	--	--	--	-0.220	0.802	0.609; 1.057	0.117
Risk of regulatory uncertainty	Tokenization	0.524	1.688	1.466; 1.944	<0.001	0.441	1.555	1.219; 1.983	<0.001
	Risk of regulatory uncertainty	-0.447	0.639	0.367; 1.112	0.113	-0.412	0.663	0.378; 1.162	0.151
	Interaction Tokenization * Risk of regulatory uncertainty	--	--	--	--	0.124	1.132	0.843; 1.521	0.410

Notes: all variables were mean-centered to facilitate the interpretation of the main effects.

Source: elaborated by Author

Table 54: Box 9. Hypothesis 9 – Construct and Operational Variables

Construct	Component	Variable	Score (points)
Regulatory uncertainty	4. Regulatory Uncertainty	Regulatory uncertainty (inverted)	0 and 1
	8. Regulatory Trust (proxy)	Alignment confidence	1 to 3
		Disclosure importance	1 to 3
Investor trust	9. ESG Governance	Alignment ESG	0 and 1
		No lack ESG standardization	0 and 1
	10. Trust in Institutional Backing or regulation	No lack of institutional trust	0 and 1
		Institutional backing or regulation	0 and 1
		No absence credible third-party verification	0 and 1
		Total (possible score)	2 to 11
Likelihood to Invest	Likelihood to invest in tokenized ESG assets in Brazil in the next 12 months	Likelihood to Invest	1 to 3

Source: elaborated by Author

Table 55: Hypothesis 9 - Direct, indirect, and total effects of regulatory uncertainty on likelihood to invest mediated by investor trust

Effects	Log-odds	Confidence Interval (95%)	p-value	OR	Confidence Interval (95%) - OR	% of total effect mediated *
Structural paths						
Low uncertainty → Trust	-0.764	-1.235; -0.294	0.001	0.466	0.247; 0.685	
Trust → Likeli	0.440	0.275; 0.605	<0.001	1.552	1.296; 1.808	
Direct effect						
Low uncertainty → Likeli	0.970	0.453; 1.487	<0.001	2.638	1.275; 4.000	
Indirect effect						
Low uncertainty → Trust → Likeli	-0.336	-0.562; -0.110	0.004	0.715	0.553; 0.876	
Total effect						
Direct + indirect	0.634	0.077; 1.190	0.026	1.885	0.836; 2.934	-53.0

Note: Low uncertainty = Regulatory uncertainty; Trust = Investor trust; Likeli = Likelihood to invest

The proportional odds assumption was not violated (Brant test $p > 0.05$); therefore, proportional odds ordinal logistic regression models were estimated. Robust standard errors were used

* Percentage of the total effect accounted for by the the mediating variable (investor trust) based on calculations performed on the log-odds scale, calculated as: % = (Indirect effect / Total effect) × 100.

Source: elaborated by Author

Table 56: E - Confirmatory factor Analysis – global fit indices. With all items originally planned for each latent variable.

Fit indices *	Expected values **	Latent variables		
		Tokenization	Perceived threats	Investor trust
c^2	--	16.493	18.773	20.487
c^2 (p)	> 0.050	0.686	0.027	0.116
c^2 / df	$\leq$ 3.000	0.825	2.086	1.463
CFI	³ 0.950	1.000	0.850	0.909
TLI	³ 0.950	1.047	0.775	0.864
SRMR	$\leq$ 0.080	0.045	0.064	0.058
RMSEA (CI _{90%})	< 0.060 and CI upper bound <0.100	0.000 (0.000; 0.046)	0.070 (0.023; 0.115)	0.046 (0.000; 0.086)
Hoelter's critical N (α = .05)	> 200.000	418.078	198.374	254.180
Hoelter's critical N (α = .01)	> 200.000	499.817	253.752	312.507
McDonald's W (CI _{95%})	$\geq$ 0.900	0.493 (0.394; 0.593)	0.346 (0.223; 0.470)	0.412 (0.303; 0.521)

* Fit indices:

c^2 = qui-square test

c^2 (p) = p-value

c^2 / df = ratio of the chi-square value to the degrees of freedom

CFI = comparative fit index

TLI = Tucker-Lewis Index

SRMR = standardized root mean residual

RMSEA (CI_{90%}) = root mean square error of approximation (interval confidence 90%)

Hoelter's critical N (α = 0.05 or α = 0.01)

McDonald's W (CI_{95%}) = McDonald's omega reliability coefficient (interval confidence 95%)

** References: Wheaton et al. 1977; Hayes & Coutts 2020; Kline, 2023; Rogers 2024

Source: elaborated by Author

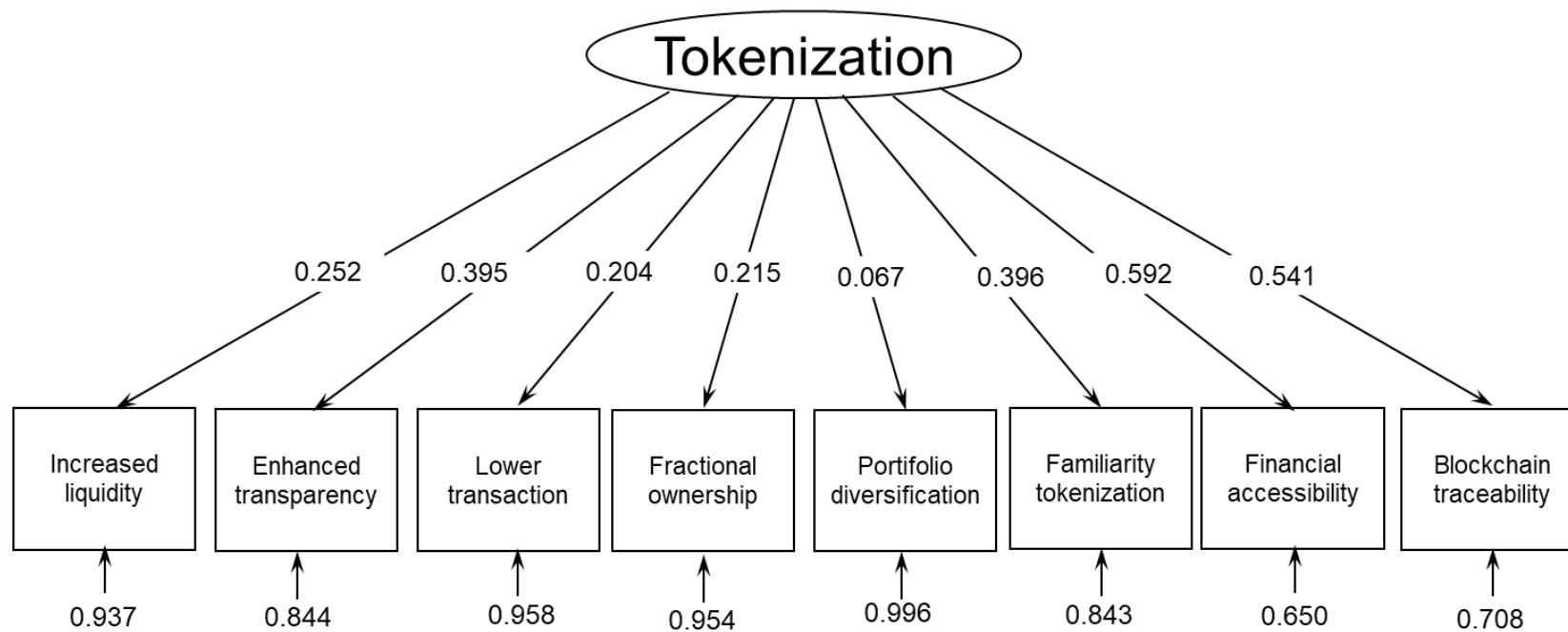


Figure 17: Confirmatory Factor Analysis of the latent scale Tokenization: global fit indices of the final model - including all originally planned items

Source: Author's elaboration

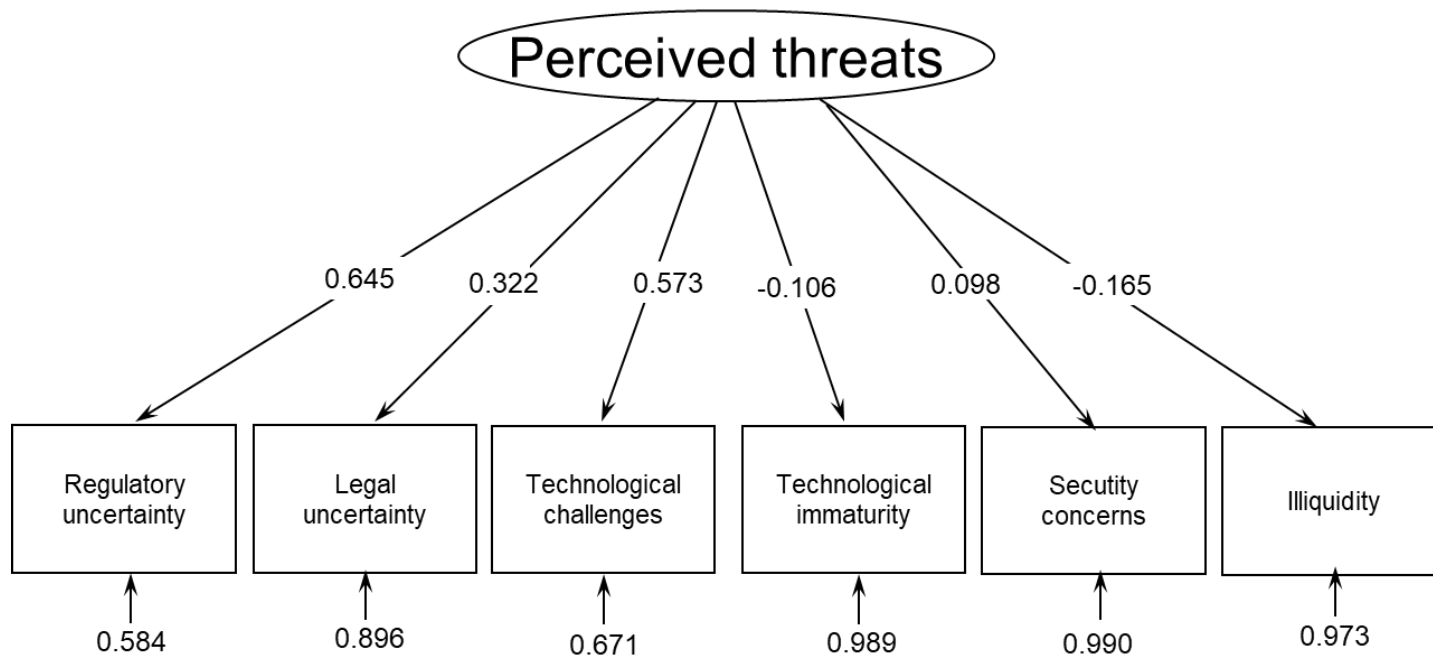


Figure 18: Confirmatory Factor Analysis of the latent scale *Perceived threats*: global fit indices of the final model - including all originally planned items

Source: Author's elaboration

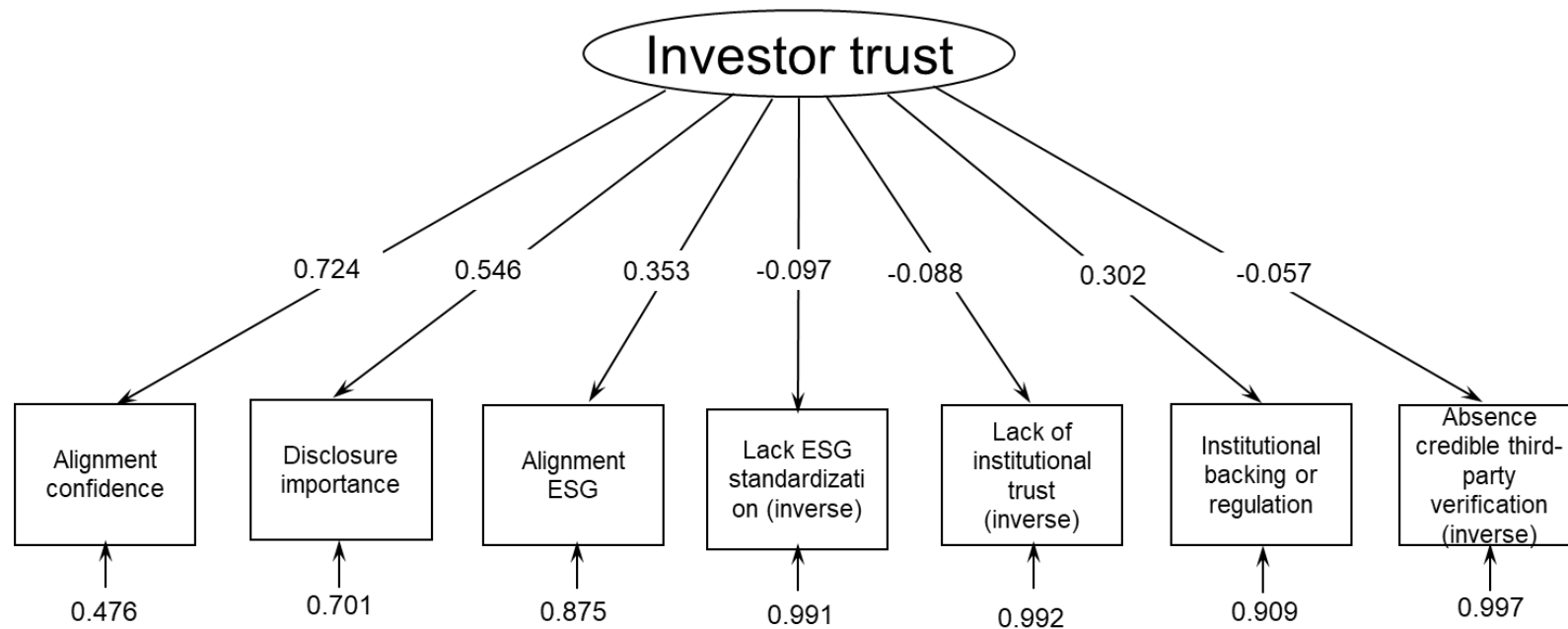


Figure 19: Confirmatory Factor Analysis of the latent scale Investor trust: global fit indices of the final model - including all originally planned items

Source: Author's elaboration

APPENDIX H: QUALITATIVE CODE LIST

Table 57: *Qualitative code list (MaxQDA)*

Code List	Frequency
Code List	1958
Drivers/Enablers	9
Secondary Market	1
Traceability	16
Diversification	13
Cost Efficiency	9
Accessibility	21
Fractional Ownership	9
Transparency	32
Liquidity	9
Barriers/Risks	1
Skill Risk	2
Technological immaturity	9
Technology Scalability	1
Low user-friendliness	0
Interoperability	3
Macroeconomic volatility	1
Illiquidity	1
Greenwashing	4
Regulatory Uncertainty	21
Lack of Trust	11
ESG Factors	5
Global ESG Disclosure standards (SFDR, TCFD)	24
Greenwashing	9
Investor Perceptions	1
Investment Strategies	13
Herd Behavior	0
Risk Aversion	6
Trust in ESG data providers	18

Sentiment	0
Positive	5
Slightly positive	9
Neutral	2
Slightly negative	2
Negative	0
No sentiment	0
Trust	19
Sentiment	0
Positive	4
Slightly positive	12
Neutral	2
Slightly negative	1
Negative	0
No sentiment	0
Regulation	2
Governance	11
International Alignment	40
Impact of regulatory landscape	16
Policy or governance changes	15
Customer Protection	16
Clarity of Rules	34
Cross-border compliance	38
Technology	23
Privacy	1
Security	14
Smart Contracts	10
Blockchain	2
Role of Tokenization in ESG strategies	18
Blockchain impact on sustainable finance	14
Organisational & market barriers	4
Organisational & market drivers	7
Sentiment regarding Brazilian sustainable assets	20
Sentiment	0

Positive	6
Slightly positive	8
Neutral	5
Slightly negative	0
Negative	0
No sentiment	0
Market maturity perception	5
Investor education & awareness	4
Brazil-specific barriers	3
Technical risks & shortcomings	12
Valuable blockchain features	42
Smart contracts & DeFi trust	38
Interoperability & scalability	8
Interoperability skepticism	0
Opportunities of tokenized ESG assets	17
Credibility & maturity of Brazil's market	9
Risks of tokenized ESG assets	7
Factors influencing investment in Brazil	14
Comparison with traditional ESG instruments	9
Credibility gap	1
Segmentos parafraseados	11

Source: Elaborated by Author from MaxQDA

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