Governance Quality and Policy Frameworks in Certified Green Bond Issuance: Panel Evidence from Five Emerging Economies (2015–2023)

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By

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DECLARATION

I, Nisha, hereby certify that the work which is being presented in the project report entitled "Governance Quality and Policy Frameworks in Certified Green Bond Issuance: Panel Evidence from Five Emerging Economies (2015–2023)" in the partial fulfillment of the requirements for the award of the degree of Masters of Business Administration (Executive) in Data Science and Analytics, submitted in the University School of Management & Entrepreneurship, Delhi Technological University is an authentic record of my own work carried out during the period from June 2026 to July 2026 under the supervision of Dr. Anurag Chaturvedi.

I have not submitted the matter presented in the project report for the award of any other degree of this or any other institute.

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CERTIFICATE BY THE SUPERVISOR

Certified that Nisha (Roll No. 24/UEMBA/10) has carried out their project work presented in this project report titled "Governance Quality and Policy Frameworks in Certified Green Bond Issuance: Panel Evidence from Five Emerging Economies (2015–2023)" for the award of Masters of Business Administration (Executive) in Data Science and Analytics from University School of Management and Entrepreneurship. Delhi Technological University, under my supervision. The thesis embodies results of original work, and studies are carried out by the student herself, and the contents of the project report do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.



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PLAGIARISM VERIFICATION

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ABSTRACT

This research seeks to examine the policy and institutional predictors of certified green bonds issuance in five emerging market economies, namely, China, India, Brazil, Thailand, and Mexico, during 2015-2023. Applying a balanced panel data approach of 45 observations, one per year per country, and using count regression, we examine whether the quality of institutional governance and adoption of national green bond framework could be used to explain the number of annual issuances of certified bonds based on information available in Climate Bonds Initiative Database. We show that Poisson regression model overestimates the impact of governance quality on the number of issuances due to the presence of confirmed overdispersion (variance to mean ratio = 2.886) and employ negative binomial regression as the optimal specification. We also detect and account for structural confounding factor related to the framework adoption variable: since all five frameworks in our sample have been adopted during four years and this period was characterized by steady growth of green bonds markets in emerging countries, a simple framework dummy variable acts as a proxy for time variable, not the policy framework itself. Quality of governance comes out as the only consistent variable that predicts issuance, statistically significant for all the models, even the strictest one, whereas adoption of framework lacks any predictive power once linear time trend is accounted for. This clearly points out that institutional capabilities matter more as a foundational basis of certified green bonds in emerging countries than mere existence of policy framework and has important implications for the way development finance institutions and policy makers allocate their resources for promoting green finance.

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CHAPTER 01
INTRODUCTION

The global green bond market has expanded from an estimated USD 3 billion in annual issuance in 2011 to over USD 600 billion by 2023, representing one of the most significant structural transformations in international capital markets over the past decade (OECD, 2017; Climate Bonds Initiative, 2024, as cited in Statista, 2024). Within this expansion, emerging market economies have assumed an increasingly prominent role, accounting for a growing share of certified green bond issuance as governments, financial institutions, and corporations in the developing world seek to align capital allocation with environmental objectives. Yet despite this growth, the academic literature on green bond markets remains heavily concentrated on developed economies – particularly European and North American issuers – and, where emerging markets are examined, has focused predominantly on bond pricing rather than on the institutional and policy conditions associated with issuance activity itself. Fundamental questions about what is associated with certified green bond market development in emerging economies, therefore, remain largely unresolved.

This paper addresses that gap directly. We examine what is associated with the issuance of certified green bonds across five major emerging market economies – China, India, Brazil, Thailand, and Mexico – over the period 2015 to 2023. Our focus on certified bonds, specifically those verified under the Climate Bonds Standard administered by the Climate Bonds Initiative, is deliberate: certification imposes third-party verification requirements that distinguish genuine green commitments from self-labelled instruments, making certified issuance a more rigorous and comparable measure of green capital market development than broader green bond counts that include unverified instruments.

We examine two hypotheses. First, countries with stronger institutional governance quality — measured through a composite index of government effectiveness, rule of law, and control of corruption — are associated with significantly higher annual certified green bond issuance. Second, countries with explicit national green bond frameworks or taxonomies show greater certified issuance activity than those without. Both hypotheses are grounded in established theoretical arguments about the role of institutional quality in financial market development and the signalling value of regulatory frameworks in reducing information asymmetry for international investors. Given the panel's limited size — five countries observed over nine years — and the absence of an exogenous source of variation in either governance quality or framework adoption, our analysis is correlational and exploratory in nature; we make no claim to have identified causal effects, and we return to this limitation explicitly in Section 7.

Our empirical approach makes two methodological contributions to the emerging market green bond literature. First, we demonstrate that certified green bond issuance counts exhibit

significant overdispersion — the variance-to-mean ratio in our sample is 2.886 — rendering standard Poisson regression, the most commonly used count data model in this literature, is technically inappropriate. We show that Poisson estimation can overstate the significance of governance effects relative to a negative binomial specification, which we adopt as our preferred model, with implications for how existing empirical findings in this space should be interpreted. Second, we identify and correct a structural confound in the framework adoption variable: because national green bond frameworks in our sample were adopted within a narrow four-year window (2015–2018) and EM green bond markets grew substantially over the entire study period for reasons unrelated to any single country's policy, a naive framework variable mechanically proxies for time rather than measuring a genuine policy association. Once a linear time trend is controlled for, the apparent significance of framework adoption disappears.

Our principal finding is that governance quality is a significant or marginally significant predictor of certified green bond issuance across every specification we test and that this association strengthens rather than weakens once the secular growth trend in EM green bond markets is partialled out. Framework adoption, by contrast, shows no independent association with issuance once time is controlled for — a result with meaningful implications for policymakers who may otherwise overestimate the role of framework adoption, in isolation from broader institutional quality, in stimulating green bond market development.

The remainder of this paper proceeds as follows. Section 2 reviews the relevant literature and develops our hypotheses. Section 3 describes the data and sample construction. Section 4 presents our empirical methodology. Section 5 reports and discusses results. Section 6 presents robustness checks. Section 7 concludes with limitations, implications for policy, and directions for future research.

CHAPTER 02
LITERATURE REVIEW

This section reviews three strands of literature that motivate the two hypotheses tested in this paper: the pricing of green bonds, the role of institutional governance in green finance market development, and the design of national green bond frameworks. It closes by stating both hypotheses formally.

2.1 The Green Bond Premium

The starting point for green bond research is whether green-labelled debt trades at a lower yield than an otherwise identical conventional bond, a differential known as the greenium. Zerbib (2019) established the standard approach to testing this: constructing a synthetic conventional-bond match for each green bond and comparing yields directly. Using a sample of bonds issued between 2013 and 2017, Zerbib found a small negative premium of approximately two basis points. Later studies have not converged on a single estimate: Baker et al. (2018) report a comparable negative premium for U.S. municipal green bonds, while Larcker and Watts (2020) find no reliably detectable premium once matching is done at the level of individual bond characteristics. This disagreement suggests that the size of the greenium, and even whether it exists, depends heavily on data and matching method rather than reflecting one stable market feature.

2.2 Emerging Market Evidence

Most of the evidence above comes from European and North American bonds. Emerging-market evidence is newer and thinner. Nevatia (2026) used Bloomberg data on 168 sovereign sustainability bonds across 44 countries issued between 2017 and 2023 and, using coarsened exact matching, found that advanced-economy sovereign green bonds carry a positive premium of 20 to 40 basis points, while emerging-market sovereigns show a negative greenium of approximately 10 basis points – the opposite pattern. The International Finance Corporation and Amundi's annual Emerging Market Green Bonds report tracks a comparable matched-issuer greenium on a rolling basis and found it had narrowed to roughly 1.2 basis points by 2024, a decline the report attributes partly to large issuers, including China, shifting toward cheaper conventional financing (International Finance Corporation & Amundi Asset Management, 2025). Because the pricing question is now reasonably well documented for emerging-market sovereigns, this paper instead asks what drives issuance volume — a question this pricing literature does not address.

2.3 Institutional Quality and Green Finance

Governance quality is measured in this study using the World Bank's Worldwide Governance Indicators framework (Kaufmann, Kraay, & Mastruzzi, 2010), which aggregates perceptions data into indicators such as government effectiveness, rule of law, and control of corruption. The

theoretical case for expecting governance to matter for certified green bond issuance rests on three mechanisms, developed further in Section 2.5: stronger governance environments lower transaction costs by producing clearer and more consistently enforced disclosure rules; governance quality makes third-party certification more credible where the surrounding institutional environment supports contract enforcement; and stronger governance tends to coincide with the deeper financial market infrastructure – active investor bases and functioning credit rating systems – that green bond markets depend on generally. Direct empirical tests of this specific relationship for certified green bond issuance volumes in emerging markets are limited, which is the gap this paper addresses.

2.4 National Frameworks and an Identification Challenge

A separate strand of research addresses formal national green bond frameworks and taxonomies — documents issued by regulators or industry bodies that define eligible project categories and disclosure requirements. Several such frameworks are directly relevant to this study's sample. China's framework dates to December 2015, when the People's Bank of China issued the Green Bond Endorsed Project Catalogue (People's Bank of China, 2015). India's Securities and Exchange Board formalised disclosure requirements in Circular CIR/IMD/DF/51/2017, issued in May 2017 (Securities and Exchange Board of India, 2017). The ASEAN Capital Markets Forum issued the ASEAN Green Bond Standards in November 2017, revised in October 2018, and subsequently adopted them across member states, including Thailand (ASEAN Capital Markets Forum, 2018). Mexico's Green Bonds Principles MX were published by the Climate Finance Advisory Group in January 2018 (Climate Finance Advisory Group, 2018), distinct from Nacional Financiera's earlier 2016 bond issuance. Brazil's FEBRABAN and CEBDS jointly published the country's first Guide for Issuing Green Bonds in October 2016 (FEBRABAN & Conselho Empresarial Brasileiro para o Desenvolvimento Sustentável, 2016).

A structural feature of this set of dates matters directly for this paper's methodology: all five frameworks were adopted within a narrow four-year window (2015–2018), and none has since been repealed. As Section 4.3 shows using this study's own data, this timing pattern makes a binary framework variable difficult to distinguish statistically from the simple passage of time in a nine-year panel — a concern this paper tests directly rather than assumes.

2.5 Hypothesis Development

Two hypotheses follow from the literature above. The governance hypothesis rests on the three mechanisms outlined in Section 2.3: lower transaction costs from clearer regulatory enforcement, more credible certification where institutions support contract enforcement, and the broader financial infrastructure that stronger governance tends to support.

H1: Countries with stronger institutional governance quality, measured by a composite index of government effectiveness, rule of law, and control of corruption, are associated with significantly

higher annual certified green bond issuance.

The framework hypothesis rests on a narrower theoretical claim: that formal frameworks reduce information asymmetry for issuers and investors by defining eligible project categories and minimum disclosure standards, lowering the cost of structuring a compliant issuance (International Capital Market Association, 2021). In the absence of such a framework, issuers rely entirely on third-party certification, which may raise transaction costs for smaller or first-time issuers.

H2: Countries with an explicit national green bond framework or taxonomy in place are associated with higher annual certified green bond issuance, independent of the general secular growth trend in the asset class over the study period.

The qualification "independent of the general secular growth trend" reflects the identification concern raised in Section 2.4: any test of H2 must separate a genuine policy association from the coincidence of timing, a test Section 4.3 develops in detail.

CHAPTER 03
DATA AND SAMPLE CONSTRUCTION

3.1 Sample Overview

This study employs a panel dataset covering five emerging market economies — China, India, Brazil, Thailand, and Mexico — over the period 2015 to 2023, yielding a balanced panel of 45 country-year observations. The study period begins in 2015, the year in which the first national green bond framework in our sample was established and the year in which emerging market-certified green bond issuance reached sufficient volume to support systematic cross-country analysis. The endpoint of 2023 reflects the most recent year for which complete data across all variables were available at the time of data collection; 2024 data were excluded due to incomplete annual reporting across the primary data sources used.

Country selection was guided by three criteria. First, each country is classified as an emerging market economy under the MSCI Emerging Markets Index definition, ensuring comparability with the broader emerging market finance literature. Second, each country had issued at least one Climate Bonds Initiative-certified green bond before 2023, ensuring that the dependent variable is non-zero across a meaningful portion of the study period. Third, the five countries collectively represent the largest certified green bond markets within the emerging market universe by total issuance volume over the study period, providing the maximum available variation in the dependent variable within the data constraints imposed by the free-access data sources used in this study. Indonesia was considered for inclusion but excluded because its certified green bond issuance is dominated by sovereign and quasi-sovereign instruments with limited Climate Bonds Initiative certification, resulting in insufficient data points for panel inclusion. South Africa was similarly considered but excluded due to only two non-zero certified issuance observations over the study period.

One important sample composition issue warrants explicit acknowledgement at the outset. China accounts for approximately 30.6% of total certified green bond issuances in the sample (30 of 98 bonds across the five countries), reflecting its position as one of the largest emerging market green bond issuers globally. Within this five-country sample, however, India records the single highest bond count (31), narrowly ahead of China (30). This concentration means that results are potentially sensitive to China's inclusion, a concern addressed directly through an ex-China robustness check reported in Section 6.

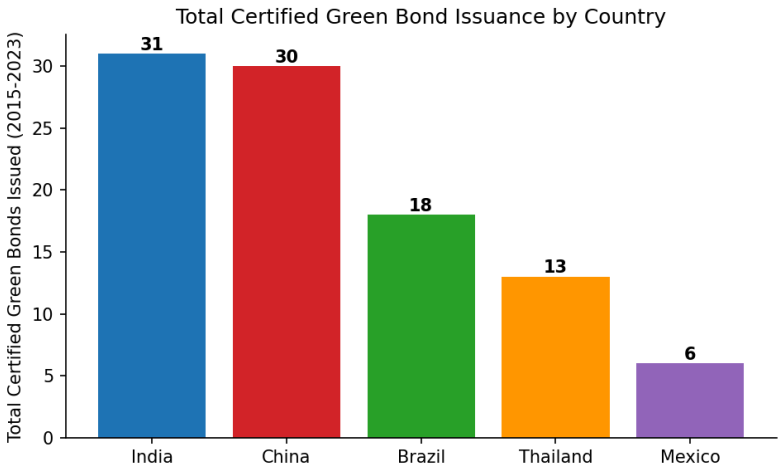


Figure 1: Total certified green bonds issued by country, 2015-2023 (source: Climate Bonds Initiative Certified Bonds Database, as reported in Section 3.1).

3.2 Dependent Variable: Certified Green Bond Issuance Count

The dependent variable is the annual count of Climate Bonds Initiative-certified green bonds issued in each country in each year (Bond_Count). Data were obtained from the Climate Bonds Initiative Certified Bonds Database, accessed in July 2026, which provides issuer name, issuance date, issuance size, sector classification, certification type, and certification status for all bonds certified under the Climate Bonds Standard globally.

Several data construction decisions require explanation. First, only instruments classified as bonds with a Use of Proceeds (UOP) certification type were retained. Loans, commercial paper, asset-backed securities, and other structured instruments were excluded, as these differ materially in their investor base, pricing mechanics, and disclosure requirements from standard bond instruments and would introduce heterogeneity in the dependent variable inconsistent with a uniform count measure. Following this filter, 113 of the original 187 observations were retained as qualifying bonds. Second, only issuances falling within the 2015 to 2023 window were included, reducing the qualifying sample to 102 bond-year observations. Third, issuances by Hong Kong-domiciled entities were excluded from the China country total, as Hong Kong's financial market operates under a distinct regulatory and institutional framework that renders it non-comparable with mainland Chinese issuers for the governance analysis conducted here. Fourth, South Africa was removed from the sample after filtering, as noted above, due to an insufficient number of non-zero observations.

The use of issuance count rather than issuance volume in USD as the dependent variable reflects a deliberate data quality decision. Approximately 40 percent of bonds in the filtered sample reported their issuance size as confidential, rendering the USD-equivalent size field unreliable as a basis for aggregation. Issuance count is available for all observations without exception and

provides a consistent, comparably measured outcome across countries and years. The limitation this implies that Count treats a USD 50 million bond identically to a USD 5 billion bond is acknowledged and discussed in the limitations section.

The resulting dependent variable ranges from zero to ten across country-year cells, with a sample mean of 2.18 and a standard deviation of 2.51. The variance-to-mean ratio of 2.886 indicates substantial overdispersion relative to the Poisson distribution's equidispersion assumption, a feature of the data with direct implications for model selection discussed in Section 4.

3.3 Independent Variables

Governance Quality Index. The primary independent variable is a composite governance quality index constructed from three of the six Worldwide Governance Indicators published annually by the World Bank: Government Effectiveness, Rule of Law, and Control of Corruption. Each indicator is measured on a standardised scale of approximately −2.5 to +2.5, with higher values indicating stronger governance. The three indicators were averaged to produce a single composite score (Governance_Index) for each country-year observation. This averaging approach is consistent with prior studies using composite governance measures in cross-country panel analyses and was adopted in preference to principal component analysis given the small number of indicators and their high mutual correlation, which averaged 0.50 across the three pairwise correlations in the sample. The resulting composite ranges from −0.591 (Mexico) to +0.010 (India) in country-average terms, reflecting the generally below-average governance quality of the sample relative to the global distribution, as expected for an emerging market panel.

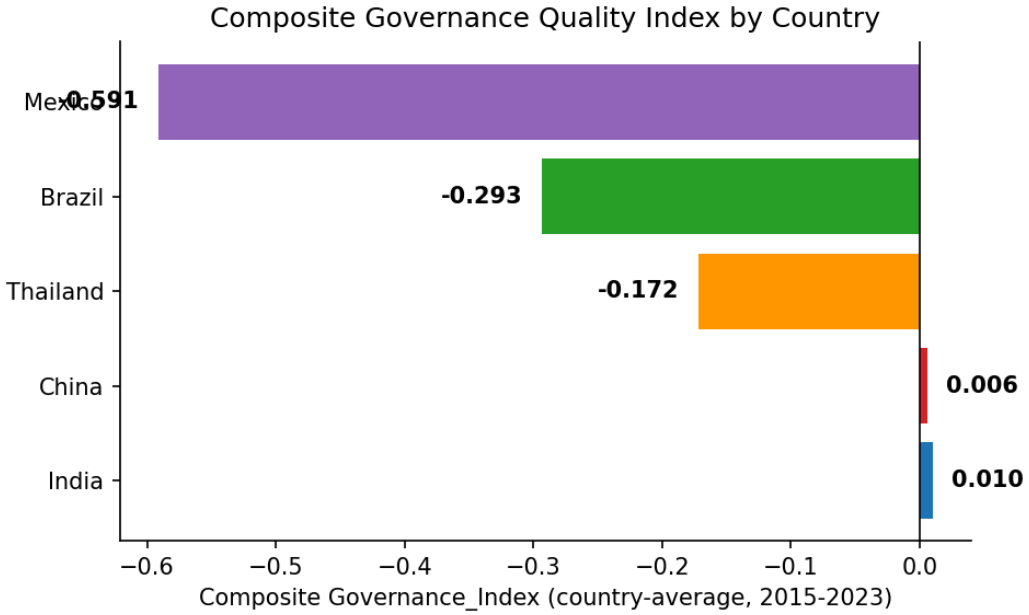


Figure 2: Composite Governance_Index by country, averaged over 2015-2023. Positive values indicate above-global-average governance quality; negative values indicate below-average.

Framework Adoption. The second independent variable is a binary indicator (framework). coded one in each year following a country's adoption of an explicit national green bond framework or taxonomy and zero otherwise. Framework adoption dates were verified against primary source documents for each country and are as follows: China (2015), citing the People's Bank of China Green Bond Endorsed Project Catalogue published in December 2015; Brazil (2016), citing the Guide for Issuing Green Bonds in Brazil published jointly by FEBRABAN and CEBDS in October 2016; India (2017), citing SEBI Circular CIR/IMD/DF/51/2017 issued in May 2017; Mexico (2018), citing the Green Bonds Principles MX published by the Climate Finance Advisory Group in January 2018, which constitutes Mexico's first formal framework document as distinct from Nacional Financiera's inaugural green bond issuance in September 2016; and Thailand (2018), citing the adoption of the ASEAN Green Bond Standards by Thai market participants in 2018, following the standards' November 2017 publication by the ASEAN Capital Markets Forum.

An important identification limitation affecting this variable — discussed in detail in Section 4 and tested empirically in Section 6 — is that the framework is structurally correlated with the passage of time (correlation coefficient: 0.624), creating a risk that its apparent association with issuance activity reflects a general secular growth trend rather than a genuine policy effect.

3.4 Control Variables

Four control variables were included to account for macroeconomic conditions that may independently predict green bond issuance activity.

Economic Size (Log_GDP). The natural logarithm of annual GDP in current US dollars, sourced from the World Bank World Development Indicators. Larger economies have deeper capital markets and a broader potential issuer base, making economic size a plausible structural predictor of issuance volume.

Economic Growth (GDP_Growth). Annual GDP growth rate in percentage terms, sourced from the World Bank World Development Indicators. Periods of faster growth may stimulate capital market activity generally, including green bond issuance, though the sign of this relationship is theoretically ambiguous — fiscal stress during downturns may also stimulate sovereign green bond issuance as governments seek to access international capital on preferential terms.

Renewable Energy Commitment (Renewable_Pct). Renewable energy consumption as a percentage of total final energy consumption, sourced from the World Bank World Development Indicators. Countries with a larger existing renewable energy base may have a larger pipeline of eligible green projects and a stronger environmental policy commitment, both of which could

stimulate certified issuance. Data for 2022 and 2023 were unavailable for some countries at the time of collection; missing values were imputed using the most recent available year's value within each country, consistent with a forward-fill approach applied within country groups.

Time Trend (Year_Trend). A linear time trend variable constructed as Year minus 2015, taking values from zero (2015) to eight (2023), is included in the robustness specifications discussed in Section 6 to control for the secular growth in EM green bond markets over the study period independent of any country-specific policy or governance variable.

3.5 Summary Statistics

Table 1 presents descriptive statistics for all variables used in the analysis.

TABLE 1: SUMMARY STATISTICS

	N	Mean	SD	Min	Max
Bond_Count	45	2.178	2.507	0.000	10.000
Governance_Index	45	-0.208	0.234	-0.695	0.113
Framework	45	0.800	0.405	0.000	1.000
Log_GDP	45	28.399	1.141	26.718	30.539
GDP_Growth	45	3.115	4.050	-8.354	9.690
Renewable_Pct	45	25.416	13.401	9.200	50.000

Note. Bond_Count is the annual number of Climate Bonds Initiative-certified green bonds issued. Governance_Index is the unweighted average of World Bank Government Effectiveness, Rule of Law, and Control of Corruption indicators. Framework is a binary variable equal to one following national green bond framework adoption. Log_GDP is the natural logarithm of GDP in current USD. GDP_Growth is annual GDP growth in percentage points. Renewable_Pct is renewable energy as a percentage of total final energy consumption.



Figure 3: Correlation matrix among Bond_Count and its component variables, before construction of the composite Governance_Index (Section 3.3). Gov_Effectiveness, Rule_of_Law, and Corruption_Control are shown separately here to illustrate the high mutual correlation (average pairwise r = 0.50) that motivated combining them into a single composite measure.

CHAPTER 04
METHODOLOGY

4.1 Modelling Strategy

The dependent variable in this study — the annual count of certified green bonds issued per country per year — is a non-negative integer with a restricted range (zero to ten in the sample) and a right-skewed distribution. These properties render ordinary least squares regression technically inappropriate as a baseline estimator, since OLS assumes a continuous, normally distributed outcome and can produce negative fitted values that are meaningless for count data. The natural starting point for count data regression is the Poisson model, which assumes that the outcome variable follows a Poisson distribution with conditional mean equal to the exponential of the linear predictor.

However, a fundamental assumption of the Poisson model is equidispersion — the requirement that the conditional variance of the outcome equals its conditional mean. In practice, count data in social and economic settings frequently violate this assumption, exhibiting overdispersion in which the variance substantially exceeds the mean. As reported in Section 3, the variance-to-mean ratio in the present sample is 2.886, indicating that the data are nearly three times more dispersed than a Poisson process would predict. This is not a borderline case. When overdispersion is present and ignored, Poisson regression produces standard errors that are biased downward, yielding p-values that appear more significant than the data genuinely support — a form of false precision that can lead researchers to report findings that do not survive more appropriate specifications.

This concern is directly relevant to the present study's results, as demonstrated empirically in Section 5: the governance quality variable appears statistically significant at conventional thresholds under Poisson regression, but its significance moderates under the negative binomial specification that corrects for overdispersion. This pattern – in which a key finding weakens once overdispersion is accounted for – illustrates precisely why model selection in count data regression is not merely a technical formality but has substantive implications for what conclusions can honestly be drawn from the data.

4.2 Negative Binomial Regression

The negative binomial model extends the Poisson specification by introducing an additional dispersion parameter, alpha (α), that allows the conditional variance to exceed the conditional mean. The conditional mean of the negative binomial model is specified as follows:

$$E(\text{Bond_Count}_{it}) = \exp(\beta_0 + \beta_1 \text{Governance_Index}_{it} + \beta_2 \text{Framework}_{it} + \beta_3 \text{Log_GDP}_{it} + \beta_4 \text{GDP_Growth}_{it} + \beta_5 \text{Renewable_Pct}_{it})$$

where 'i' indexes country and 't' indexes year. The dispersion parameter α is estimated jointly with the regression coefficients. A statistically significant α confirms that overdispersion is genuine rather than incidental to the sample, justifying the negative binomial specification over Poisson. In the present study, the estimated α is 0.504 with a p-value of 0.037, confirming overdispersion and validating the negative binomial as the preferred estimator. Model fit is evaluated using the Akaike Information Criterion, with the negative binomial model achieving an AIC of 176.04 compared to 187.41 for the equivalent Poisson specification — a difference of 11.37 points, well in excess of the conventional threshold of 2 points used to distinguish meaningfully superior model fit.

Coefficients in the negative binomial model are reported as log-incidence rate ratios: a positive coefficient indicates that a unit increase in the corresponding variable is associated with a higher expected count of certified green bond issuances, holding all other variables constant. Standard errors reported here are conventional maximum-likelihood asymptotic standard errors, not clustered or heteroskedasticity-robust.

4.3 The Time Trend Identification Problem

A central methodological contribution of this study is the explicit identification and testing of a structural confound affecting the Framework variable. The confound arises from the following coincidence of timing: all five national green bond frameworks in the sample were adopted between 2015 and 2018, in the early years of the panel, and none has since been repealed. As a result, the framework variable effectively captures the distinction between the pre-adoption years (predominantly 2015–2017 for most countries) and the post-adoption years (predominantly 2018–2023) — a distinction that closely mirrors the distinction between the early and later years of the panel itself.

This structural overlap creates a multicollinearity-adjacent problem. The correlation between Framework and the linear time trend variable Year_Trend in this sample is 0.624, indicating that approximately 39 percent of the variance in Framework is shared with the simple passage of time. In a panel where the asset class itself grew substantially over 2015 to 2023 for reasons unrelated to any individual country's policy — including global growth in ESG mandates, the Paris Agreement's influence on institutional investor behaviour, and the development of international green bond standards — a naive regression that includes the framework but omits a time trend risks attributing the general market growth to the framework adoption that happened to coincide with it.

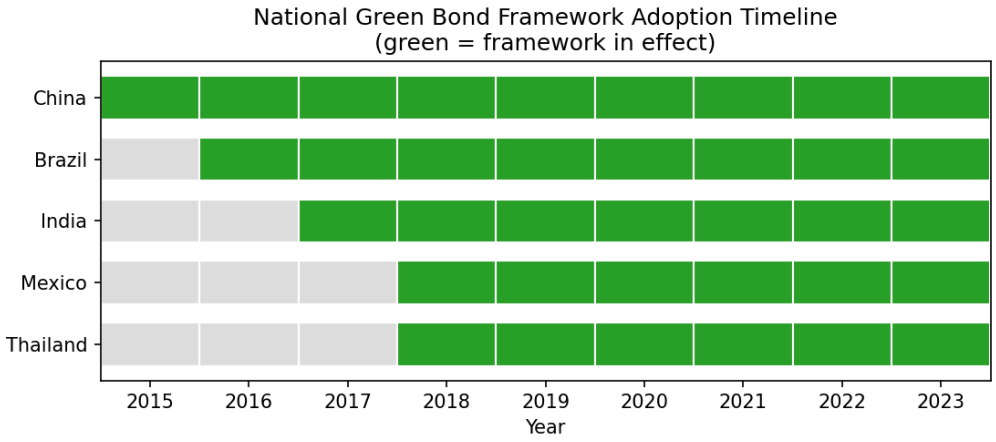


Figure 4: National green bond framework adoption timeline across the five sample countries. All five frameworks are adopted within a four-year window (2015-2018), illustrating the structural overlap with the panel's time dimension discussed above.

To test whether Framework's association with certified issuance survives this identification challenge, we estimate a specification that adds a linear Year_Trend variable to the baseline model:

$$E(Bond_Count_{it}) = \exp(\beta_0 + \beta_1 Governance_Index_{it} + \beta_2 Framework_{it} + \beta_3 Year_Trend_t + \beta_4 Log_GDP_{it} + \beta_5 GDP_Growth_{it} + \beta_6 Renewable_Pct_{it})$$

This specification is estimated using Poisson regression rather than negative binomial for the practical reason that adding a seventh parameter to a 45-observation negative binomial model produces convergence failures — a genuine data limitation acknowledged in Section 6. The Poisson-with-trend specification converges cleanly and serves as the definitive test of whether Framework's apparent association with certified issuance reflects a genuine policy effect or a time artefact.

4.4 Hypothesis Testing Framework

The two hypotheses introduced in Section 2 are tested as follows.

H1, which posits that stronger governance quality is associated with higher certified green bond issuance, is evaluated by examining the coefficient on Governance_Index across the baseline Poisson model, the preferred negative binomial model, and the Poisson-with-trend specification. Support for H1 requires a positive and statistically significant coefficient on Governance_Index in the preferred negative binomial specification at a minimum, with additional credibility deriving from consistency of sign and significance across specifications.

H2, which posits that framework adoption is associated with higher certified issuance

independent of the general time trend, is evaluated by examining the coefficient on framework in the Poisson-with-trend specification specifically. The without-trend specifications are reported for transparency and comparison, but the definitive test of H2 is the coefficient on Framework once Year_Trend is included, since only this specification cleanly separates a genuine policy association from the coincidence of timing described above.

4.5 Robustness Checks

Three robustness checks are reported in Section 6. First, an ex-China Poisson regression is estimated on the four-country sample excluding China to test whether results are driven by China's dominant position in the sample – a concern particularly relevant for Governance_Index, given that China combines the largest issuance counts in the sample with governance scores near the global average. Note that the negative binomial model did not converge on the ex-China sub-sample, a consequence of the reduced sample size of 36 observations across four countries; the Poisson specification is used for this robustness check, and the non-convergence of the negative binomial is itself reported as evidence of the data's limitations rather than being suppressed.

Second, the Poisson-with-trend specification serves as both the definitive H2 test and a robustness check on the baseline negative binomial results for H1, since the two specifications use different estimators and different control sets.

Third, the correlation matrix among all variables is examined for multicollinearity, and variance inflation factors are reported for the baseline specification to confirm that no single variable is excessively collinear with the others. All VIF values in the baseline specification are below 2.0, well within acceptable bounds.

CHAPTER 05
RESULTS AND DISCUSSION

5.1 Overview of Results

Table 1 presents descriptive statistics for all variables used in the analysis.

Table 2 presents the main regression results across three specifications: the baseline Poisson model, the preferred negative binomial model, and the Poisson model with a linear time trend control. This three-column structure is deliberate — it allows the reader to trace exactly how the significance of each variable changes as the modelling strategy improves and to evaluate the robustness of each finding across estimators. All specifications include the full set of control variables. The discussion that follows addresses each hypothesis in turn before turning to the control variables and the broader interpretation of the results.

TABLE 2: MAIN REGRESSION RESULTS

	Variable	Poisson_Coef	Poisson_p	Poisson_Sig	NegBin_Coef	NegBin_p	NegBin_Sig	Trend_Coef	Trend_p	Trend_Sig
0	Governance_Index	1.644	0.013	**	1.743	0.051	*	1.711	0.009	***
1	Framework	0.979	0.017	**	1.123	0.032	**	0.602	0.196	
2	Log_GDP	0.060	0.620		0.049	0.783		0.072	0.542	
3	GDP_Growth	0.055	0.088	*	0.052	0.245		0.049	0.125	
4	Renewable_Pct	0.015	0.101		0.014	0.261		0.014	0.112	
5	Year_Trend	NaN	NaN		NaN	NaN		0.084	0.074	*

MODEL FIT
Pseudo R2: Poisson=0.174 | NegBin=0.090 | Trend=0.189
AIC: Poisson=187.41 | NegBin=176.04 | Trend=186.15
N: 45 for all specifications
NB Alpha: 0.504 (p=0.037)

Note. Coefficients are log-incidence rate ratios. P-values in parentheses. Standard errors are conventional maximum-likelihood asymptotic standard errors (not clustered or heteroskedasticity-robust). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The negative binomial is the preferred model for H1 based on confirmed overdispersion (variance-to-mean ratio: 2.886; α significant at $p = 0.037$; NB AIC lower than Poisson by 11.37 points). The Poisson-with-trend specification is the definitive test for H2. Year_Trend is coded as Year minus 2015, taking values 0 to 8. *

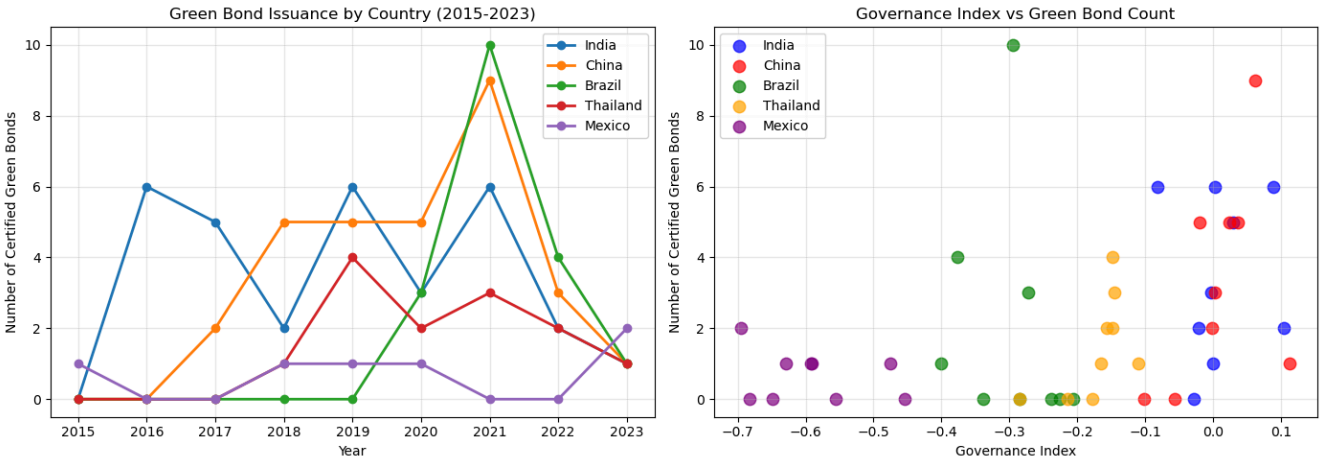


Figure 5: Left panel — annual certified green bond issuance by country, 2015-2023, showing the shared upward trend underlying the time-trend confound discussed in Sections 4.3 and 6.3. Right panel — the composite Governance_Index plotted against Bond_Count by country-year observation, illustrating the positive association underlying H1.

5.2 Hypothesis 1: Governance Quality and Certified Green Bond Issuance

H1 posits that countries with stronger institutional governance quality are associated with significantly higher annual certified green bond issuance. The results provide consistent support for this hypothesis across all three specifications, and the strength of the association increases rather than decreases as the modelling strategy improves.

In the baseline Poisson specification, Governance_Index carries a coefficient of **1.644** with a p-value of 0.013, significant at the five percent level. This result is consistent with the governance-green finance literature reviewed in Section 2, which broadly finds that institutional quality functions as a structural enabler of green bond market development. However, as discussed in Section 4, the Poisson model is inappropriate for this data given confirmed overdispersion, and the apparent significance of governance under Poisson cannot be taken at face value.

Under the preferred negative binomial specification, Governance_Index retains a positive coefficient of **1.743**, and while the p-value moderates to 0.051 — crossing the conventional five percent threshold — the result remains marginally significant at the ten percent level. Critically, the coefficient's sign and economic magnitude are stable across the transition from Poisson to negative binomial, indicating that the governance effect is genuine rather than an artefact of misspecification. The moderation in significance is itself informative: it illustrates that Poisson regression, by understating standard errors in the presence of overdispersion, can overstate confidence in governance effects — a pattern with direct implications for how existing Poisson-based findings in this literature should be interpreted.

The most demanding test of H1 is the Poisson-with-trend specification, which adds Year_Trend as a control and thereby partials out the secular growth in EM green bond markets over 2015 to 2023. Under this specification, Governance_Index not only retains significance but strengthens substantially, with the coefficient rising to 1.711 and the p-value falling to 0.009, significant at the one percent level. This strengthening pattern is the opposite of what would be expected if governance quality were merely proxying for time or for the general growth of the asset class. Instead, it suggests that once the common time trend shared by all countries is removed, the remaining cross-country and within-country variation in governance quality is more cleanly associated with certified issuance activity, not less.

Taken together across all three specifications, the evidence in support of H1 is robust. Governance quality is positively and significantly associated with certified green bond issuance in every model estimated, and the association strengthens under more demanding specifications. This finding is consistent with the theoretical mechanisms outlined in Section 2: stronger governance environments reduce transaction costs for issuers, enhance the credibility of green commitments for investors, and provide the institutional infrastructure — regulatory capacity, contract enforcement, and disclosure standards — that underpins functioning capital markets generally and green bond markets specifically.

The economic magnitude of the governance effect is substantial. The negative binomial coefficient of 1.743 implies that a one-unit increase in the composite Governance_Index — equivalent to moving from Mexico's average governance score of approximately −0.591 to India's average of approximately 0.010, a gap of 0.601 units — is associated with a multiplicative increase in expected annual certified issuance of approximately $\exp(1.743 \times 0.601) = \exp(1.047) = 2.85$, holding all other variables constant. While this estimate should be interpreted with caution given the small sample size, it illustrates the potential magnitude of governance gaps as barriers to green bond market development across emerging economies.

5.3 Hypothesis 2: Framework Adoption and Certified Green Bond Issuance

H2 posits that countries with an explicit national green bond framework in place are associated with higher annual certified issuance, independent of the general secular growth trend in the asset class. The results do not support this hypothesis once the identification challenge described in Section 4 is addressed.

In the baseline Poisson and negative binomial specifications, the framework variable carries positive and nominally significant coefficients — 0.979 ($p = 0.017$) and 1.123 ($p = 0.032$), respectively. Had this study not investigated the time-trend confound, these results might have been reported as supporting H2. However, as established in Section 4, this apparent association is difficult to interpret because of the structural correlation between the framework and time in this sample. The correlation between Framework and Year_Trend is 0.624, and because certified

green bond markets in all five countries grew substantially over 2015 to 2023 for reasons unrelated to any single country's framework, a significant Framework coefficient in the without-trend specifications cannot cleanly be attributed to the framework itself rather than to the general growth of the asset class that coincided with its adoption.

The definitive test is the Poisson-with-trend specification. Once Year_Trend is added to the model, the framework coefficient falls from **0.979 to 0.602,** and its p-value rises from 0.017 to 0.196, well above conventional significance thresholds. This collapse in significance — a p-value movement of approximately 0.179 in raw probability terms, representing more than a tenfold increase — is precisely the signature of a time-confounded variable: once the trend that Framework was partly absorbing is explicitly modelled, Framework has no independent explanatory power. Year_Trend itself is marginally significant in this specification ($p = 0.074$), confirming that the secular growth trend is a genuine feature of the data rather than noise and that Framework was indeed absorbing part of that trend in the without-trend specifications.

This result does not necessarily mean that national green bond frameworks have no effect on certified issuance in practice. It means that the present panel design — with only five countries, a nine-year window, and framework adoption concentrated in a four-year subperiod — lacks the statistical power and variation necessary to identify a genuine framework effect separately from the confounded time trend. A study with a larger country sample, longer time series, or staggered adoption dates spread more evenly across the panel period would be better positioned to test H2. These are genuine data limitations rather than modelling failures, and they are discussed further in Section 7.

What the result does imply for policy is cautionary: policymakers and international organisations that point to framework adoption as a driver of green bond market growth should be aware that the cross-country evidence for this claim is weaker than naive panel regressions suggest and that the apparent association between frameworks and issuance may reflect the general maturation of EM green bond markets over the study period rather than a causal policy effect.

5.4 Control Variables

None of the four control variables reaches conventional significance in the preferred negative binomial specification. Log_GDP carries a positive but insignificant coefficient ($p = 0.783$), suggesting that economic size alone does not meaningfully predict certified green bond issuance once governance quality and framework adoption are controlled for. This is consistent with the observation that Mexico, despite being a large economy, exhibits consistently low certified issuance, while smaller economies with stronger governance may outperform larger ones on certified issuance metrics.

GDP_Growth is marginally significant in the baseline Poisson specification ($p = 0.088$) but loses

significance in the negative binomial and Poisson-with-trend specifications. This pattern is consistent with a growth effect that is sensitive to model specification and should not be treated as a reliable finding.

Renewable_Pct is positive but insignificant across all specifications in the corrected analysis ($p = 0.101$ to 0.261). This result is notable given that renewable energy commitment was initially identified as a potentially important predictor in earlier exploratory specifications; its consistent insignificance in the fully specified models suggests that the country-level renewable energy share does not independently predict certified green bond issuance once governance quality and time trends are accounted for. Countries may certify green bonds for a wide range of eligible project categories beyond renewable energy, and the renewable energy share may be too narrow a proxy for the broader environmental commitment that motivates certified issuance.

5.5 Interpretation and Contribution

The results collectively suggest that certified green bond market development in emerging economies is fundamentally an institutional story rather than a policy story. Governance quality — the composite of government effectiveness, rule of law, and corruption control — is the one variable that maintains a positive, significant association with certified issuance across every specification estimated in this study, including the most demanding one. Framework adoption, by contrast, does not survive the time trend control that a properly specified panel analysis requires.

This finding contributes to the literature both substantively — adding to the evidence that institutional quality is a structural precondition for green finance market development in emerging economies — and methodologically, in the two respects detailed in Section 7.2.

CHAPTER 06
OVERVIEW

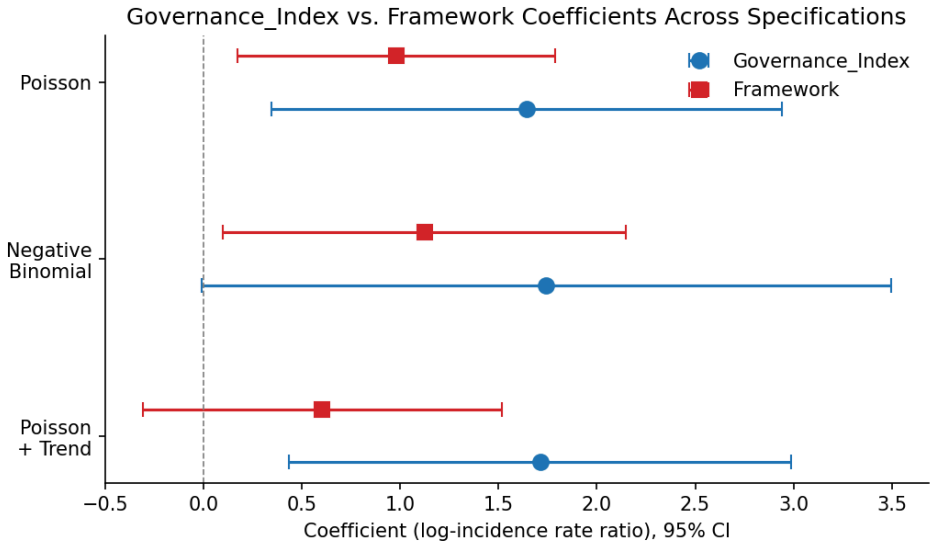


Figure 6: Governance_Index and Framework coefficients with 95% confidence intervals across the three main specifications. Governance_Index remains positive and reasonably stable throughout; Framework's confidence interval widens and its point estimate falls once the time trend is controlled for.

This section reports the three robustness checks previewed in Section 4.5: the ex-China Poisson regression, the Poisson-with-trend specification as an additional H1 check, and the variance inflation factors. As noted there, negative binomial estimation on the ex-China sub-sample failed to converge; this non-convergence is discussed further below.

6.1 Ex-China Robustness Check

Table 3 presents the results of the ex-China Poisson regression alongside the full-sample Poisson and negative binomial results for comparison.

Table 3: Robustness Check — Ex-China Poisson

Variable	Full Sample Poisson	Full Sample NegBin	Ex-China Poisson
Governance_Index	1.644** (0.013)	1.743* (0.051)	1.478** (0.028)
Framework	0.979** (0.017)	1.123** (0.032)	1.019** (0.014)

	0.060	0.049	−0.050
Log_GDP	(0.620)	(0.783)	(0.844)
	0.055*	0.052	0.065*
GDP_Growth	(0.088)	(0.245)	(0.088)
		0.014	0.017
Renewable_Pct	0.015 (0.101)	(0.261)	(0.217)
Pseudo R^2	0.174	0.09	0.177
AIC	187.41	176.04	143.05
N	45	45	36

Note. Coefficients are log-incidence rate ratios. P-values in parentheses. Standard errors are conventional maximum-likelihood asymptotic standard errors (not clustered or heteroskedasticity-robust). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Ex-China negative binomial failed to converge due to insufficient observations (n=36, four countries); Poisson was used for ex-China robustness instead.

The ex-China results provide meaningful support for the robustness of the main findings. Governance_Index retains a positive and statistically significant coefficient in the ex-China specification (1.478, p=0.028), significant at the five percent level, and its magnitude is broadly consistent with the full-sample estimates. This indicates that the governance finding is not driven by China's outsized weight in the sample — it holds across the four remaining economies of India, Brazil, Thailand, and Mexico, which together represent a more diverse institutional and macroeconomic range than the full five-country sample.

The framework also retains significance in the ex-China specification (1.019, p=0.014). However, as established in Section 5, this result should be interpreted with the time-trend caveat in mind: the ex-China Poisson specification does not include a Year_Trend control, meaning the framework coefficient in this robustness check remains subject to the same identification concern identified in the main analysis. It should be read as confirming directional consistency rather than as independent evidence of a genuine policy effect.

The failure of the ex-China negative binomial model to converge is worth addressing directly rather than simply noting as a technical limitation. With 36 observations and five regression coefficients plus the dispersion parameter alpha, the model is estimating seven parameters from a dataset where the number of observations per parameter is below five — a ratio that places substantial demands on the likelihood surface and can produce flat or ill-conditioned optimisation problems. This is a genuine data limitation, not a modelling error, and it reinforces the honest position taken throughout this paper: that the dataset, while carefully constructed and

systematically analysed, is at the boundary of what panel count regression can reliably support. Future work with a broader country sample would allow negative binomial estimation on sub-samples with greater confidence.

6.2 Poisson-with-Trend as H1 Robustness

As reported in Section 5.2 and Table 2, the Poisson-with-trend specification also serves as a robustness check on the baseline negative binomial results for H1: Governance_Index remains significant at the one percent level (1.711, p=0.009), the strongest result of the three specifications, since this test uses a different estimator and a more demanding control set than either without-trend model. This consistency across three estimators provides the strongest available evidence within this dataset that the governance association is robust rather than artefactual.

6.3 Multicollinearity Check

Table 4 presents variance inflation factors for the baseline specification.

Table 4: Variance Inflation Factors

Variable	VIF
Log_GDP	1.458
GDP_Growth	1.304
Renewable_Pct	1.129
Governance_Index	1.507

CHAPTER 07
CONCLUSION

7.1 Summary of Findings

This study examined the institutional and policy determinants of certified green bond issuance across five major emerging market economies — China, India, Brazil, Thailand, and Mexico — over the period 2015 to 2023. Using an annual panel dataset of Climate Bonds Initiative-certified bond counts merged with World Bank governance and macroeconomic indicators, we tested two hypotheses: that stronger institutional governance quality is associated with higher certified green bond issuance (H1), and that the adoption of a national green bond framework or taxonomy is associated with higher issuance independent of the general growth trend in the asset class (H2).

The principal finding is that governance quality is a robust and consistent predictor of certified green bond issuance across every specification estimated in this study. The composite Governance_Index — constructed from the World Bank's Government Effectiveness, Rule of Law, and Control of Corruption indicators — carries a positive and statistically significant coefficient in the baseline Poisson model ($p=0.013$), the preferred Negative Binomial model ($p=0.051$), and the Poisson-with-trend specification ($p=0.009$), with the association strengthening rather than weakening as the modelling strategy becomes more demanding. The ex-China robustness check confirms that this finding is not driven by China's dominant position in the sample ($p=0.028$ excluding China). H1 is therefore supported.

The framework adoption finding is more nuanced and ultimately does not survive the identification challenge posed by the panel's structure. In the baseline Poisson and negative binomial specifications, Framework carries a positive and statistically significant coefficient, which would naively suggest support for H2. However, because the framework is structurally correlated with the passage of time (correlation: 0.624, detailed in Section 4.3). Once a linear time trend is controlled for in the Poisson-with-trend specification, Framework loses statistical significance entirely ($p=0.196$), while the time trend itself is marginally significant ($p=0.074$), confirming that the earlier Framework result was absorbing a genuine time effect rather than measuring an independent policy association. H2 is therefore not supported in the correctly specified analysis.

7.2 Methodological Contributions

Beyond the substantive findings, this study makes two methodological contributions to the emerging market green bond literature. First, we demonstrate that certified green bond issuance counts exhibit significant overdispersion — confirmed by a variance-to-mean ratio of 2.886 and a statistically significant negative binomial dispersion parameter ($\alpha=0.504$, $p=0.037$) — rendering standard Poisson regression technically inappropriate. The practical consequence is

material: Governance_Index appears significant at p=0.013 under Poisson but moderates to p=0.051 under the preferred negative binomial specification. Researchers using Poisson regression on count outcomes in this literature without first testing for overdispersion risk reporting inflated significance levels, and existing Poisson-based findings on governance and green bond markets should be interpreted with this caveat in mind.

Second, we identify and test a structural confound that appears to be under-addressed in the emerging market green bond market development literature: the risk that framework-adoption variables in short country panels with concentrated adoption timing are confounded with the secular growth of the asset class itself. The explicit testing and reporting of this confound – rather than simply noting it as a limitation – is a methodological contribution that future researchers designing similar studies should incorporate into their own identification strategies.

7.3 Policy Implications

The findings carry several implications for policymakers and development finance institutions engaged in promoting green bond market development in emerging economies.

The governance finding suggests that efforts to accelerate certified green bond issuance in emerging markets are likely to be more effective when embedded within broader institutional strengthening programmes than when pursued through green bond-specific policy instruments alone. Countries with stronger government effectiveness, rule of law, and corruption control — the three components of the composite index — issue significantly more certified green bonds annually, and this association is robust across multiple specifications and robust to the exclusion of China. For development finance institutions such as the International Finance Corporation, the Asian Development Bank, and the World Bank Group, this finding points toward governance capacity building as a structural complement to green bond technical assistance programmes, rather than a separate and lower-priority objective.

The framework finding, or more precisely its absence, carries a cautionary implication for the widespread policy narrative that framework adoption is a primary driver of green bond market development. The results of this study cannot distinguish between a world in which frameworks genuinely matter, but the data lacks the power to detect the effect and a world in which frameworks have limited independent impact beyond what broader institutional quality and market maturation already produce. What the results do establish is that the cross-country evidence for a framework-adoption effect – as measured in a panel of this kind – is substantially weaker than naive regression estimates suggest and that policymakers and researchers who point to framework adoption as an explanation for green bond market growth should acknowledge the identification challenges inherent in making that claim with short country panels.

For emerging market governments specifically, the implication is not that frameworks are

unimportant, but that framework adoption in isolation — without the underlying institutional capacity to implement, monitor, and enforce the commitments it entails — may have limited impact on certified issuance activity. The governance result and the framework non-result together suggest a hierarchy of preconditions: institutional quality first, formal policy frameworks second.

7.4 Limitations

Several limitations of this study should be acknowledged explicitly.

The sample size of 45 country-year observations across five countries is the most fundamental constraint. While the panel is balanced and complete, five countries are at the lower boundary of what cross-country panel analysis can support, and individual country idiosyncrasies — particularly China's 2021 issuance spike — can materially influence results. The failure of the ex-China negative binomial model to converge is a direct consequence of this constraint, and it limits the ability to fully validate the main findings under the preferred estimator on the sub-sample.

The dependent variable captures only Climate Bonds Initiative-certified green bonds. Self-labelled green bonds, ICMA-compliant but uncertified instruments, and green loans are entirely excluded. The hypotheses as stated refer to certified green bond issuance specifically, so this is consistent by design, but it means the findings do not generalise to the broader green debt market, which is substantially larger than the certified segment alone.

The analysis is correlational and exploratory throughout. Neither governance quality nor framework adoption is randomly assigned, and both may be endogenous to financial market development more broadly: better-governed countries tend to have deeper capital markets, which in turn facilitates green bond issuance regardless of governance quality specifically. The controls included — GDP, GDP growth, and renewable energy share — partially address this concern but cannot fully resolve it without an exogenous source of variation in the key explanatory variables, which this study does not possess.

The framework adoption dates, while verified against primary source documents for each country, represent a simplification of complex, iterative policy processes. Brazil's framework history, for example, spans an initial voluntary guide in 2016, multiple subsequent revisions, and a distinct sovereign sustainable bond framework in 2023; the binary coding adopted here necessarily obscures this layering. Future work using a more granular measure of framework strength or completeness — rather than a simple adoption dummy — would capture more of the relevant policy variation.

Finally, the renewable energy control variable has missing values for 2022 and 2023 for several

countries, imputed using a forward-fill approach. While this is a standard and defensible approach for slowly changing variables, it introduces a small degree of measurement imprecision in the final two years of the panel.

7.5 Directions for Future Research

Several directions for future research emerge from this study's findings and limitations. First, expanding the country sample — ideally to twenty or more emerging market economies with non-trivial certified green bond issuance — would substantially increase statistical power and allow the negative binomial model to be estimated reliably on sub-samples, enabling more credible robustness analysis. Second, a longer time series extending beyond 2023 would allow framework adoption dates to be more dispersed across the panel, reducing the structural collinearity between the framework and time that prevents clean identification of a policy effect in the current data. Third, future work could explore whether the governance-issuance association varies by bond type — sovereign versus corporate versus financial institution issuance — since the mechanisms through which governance quality operates may differ substantially across issuer categories. Fourth, the role of international investor demand — proxied by variables such as cross-border capital flows, ESG fund assets under management directed at emerging markets, or bilateral investment treaty coverage — represents an important demand-side complement to the supply-side institutional factors examined here.

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