REGULATORY ENVIRONMENT AND CRYPTOCURRENCY ADOPTION: A CROSS-COUNTRY STATISTICAL ANALYSIS

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Abstract

Regulatory design may shape cryptocurrency adoption by altering legal access, market legitimacy, and enforcement risk, yet cross-country evidence remains limited. This paper examines grassroots cryptocurrency adoption across four regulatory environments: comprehensive, partial, restrictive, and banned, using the top 30 countries in the Chainalysis Geography of Cryptocurrency Reports for 2021–2025. Regulatory classifications are constructed from FATF targeted updates, IMF AREAER, and national regulatory sources. The pooled dataset contains 150 country-year observations covering 48 countries. Kruskal–Wallis and Welch's ANOVA tests indicate significant differences in adoption rank across tiers ($H = 18.08$, $p < .001$; $F = 11.58$, $p < .001$). Partial-framework countries have the best mean rank (13.6), while comprehensively regulated countries have the weakest (21.6). A linear Spearman correlation is not significant ($\rho = -.11$, $p = .20$), which is consistent with a non-monotonic tier pattern rather than a simple linear gradient. A country-collapsed robustness check preserves the tier ordering but is not significant, showing that pooled significance partly reflects repeated observations. The findings are therefore interpreted as descriptive associations, not causal effects, and highlight the need to separate regulatory design from income, institutional capacity, and index construction.

Key words: cryptocurrency adoption, regulatory environment, cross-country analysis, digital asset governance, emerging economies

JEL Code: G18, G15, O33

Introduction

Cryptocurrency adoption has become a material issue for monetary governance, financial stability, consumer protection, and payment-system policy. International standard setters have promoted risk-based oversight of virtual assets, but national implementation remains heterogeneous: jurisdictions range from dedicated licensing and market-conduct regimes to partial AML/CFT registration, transactional restrictions, and outright bans (Financial Action

Task Force [FATF], 2021–2024; International Monetary Fund [IMF], 2022). Adoption also differs sharply across countries and is often strongest where inflation, capital controls, remittance needs, or weak confidence in conventional institutions increase demand for alternative financial channels (Alnasaa et al., 2022; Bhimani et al., 2022).

Existing research largely examines individual adoption intentions or specific regulatory systems. Micro-level studies and meta-analytic evidence identify trust, usefulness, perceived risk, and social influence as important correlates (Shahzad et al., 2018; Steinmetz et al., 2021; Bommer et al., 2023), while country-level studies connect adoption to development and institutional conditions (Bhimani et al., 2022). Regulation may simultaneously increase legitimacy and compliance costs; accordingly, a simple permissive-versus-restrictive dichotomy is unlikely to capture the relationship. This paper compares grassroots adoption across four regulatory environments using the full annual Chainalysis country rankings for 2021–2025. It contributes a longitudinal descriptive test, transparent tier coding, and robustness checks that explicitly address repeated country observations. The objective is not to identify a causal regulatory effect, but to determine whether adoption ranks display a stable tier-related pattern.

The empirical question is therefore whether adoption rankings differ systematically across regulatory environments and, if so, whether the ordering resembles a simple linear gradient or a categorical pattern. Two expectations guide the analysis. First, partial and restrictive systems may display comparatively high grassroots adoption because they preserve access while coexisting with macroeconomic and institutional pressures that increase demand. Second, comprehensive regimes and bans may both be associated with weaker rankings, but for different reasons: the former because mature financial systems reduce necessity-driven use, and the latter because formal access is constrained. These expectations are evaluated as associational propositions rather than causal hypotheses.

1 Literature Review

Regulation can affect adoption through legal certainty, consumer protection, market access, enforcement risk, and institutional trust. (Van der Linden and Shirazi, 2023) argue that clear legal status may reduce uncertainty, although formal regulation need not automatically accelerate adoption. (Schaupp et al., 2022) similarly identify regulation as a pathway shaping individual acceptance, while (Recskó and Aranyossy, 2024) show that trust and social infrastructure remain central even in technology-specific adoption settings. These findings imply that regulatory comprehensiveness and adoption may not move monotonically: stronger

rules can support institutional participation while discouraging informal or high-risk retail activity.

Macro evidence points to a second mechanism. Crypto use is associated with corruption, capital controls, development conditions, and unmet financial needs (Alnasaa et al., 2022; Bhimani et al., 2022). The Chainalysis index is deliberately weighted toward grassroots activity relative to purchasing power, so emerging economies with stronger necessity-driven demand can outrank highly regulated, high-income markets. Conversely, bans may restrict formal access without eliminating peer-to-peer or offshore activity. The expected pattern is therefore categorical rather than linear: partial and restrictive environments may retain high grassroots adoption, whereas comprehensive regimes and bans may occupy different positions for different structural reasons.

A further distinction concerns what regulation measures. Formal legal status captures whether activities are licensed, restricted, or prohibited, whereas perceived regulatory clarity affects adoption through legitimacy, trust, and expected consumer protection. Evidence on individual behaviour shows that users respond not only to the existence of rules but also to the credibility and consistency of oversight (Schaupp et al., 2022; Steinmetz et al., 2021). Meta-analytic evidence likewise places trust and perceived risk among the central adoption mechanisms (Bommer et al., 2023). The cross-country approach used here cannot observe these micro-level channels directly, but it can test whether broad regulatory categories correspond to distinct adoption distributions and thereby identify patterns that warrant subsequent multilevel analysis.

2 Data and Methodology

2.1 Data sources

Adoption data come from the complete country-ranking tables in the 2021–2025 Chainalysis Geography of Cryptocurrency Reports. The reports contain 157, 146, 155, 151, and 131 ranked entries, respectively, giving broader coverage than the abbreviated top-20 summaries commonly cited in public discussions. The analysis uses the overall ordinal rank (1 = highest grassroots adoption) for the top 30 countries in each year. Chainalysis combines centralized-service and decentralized-finance activity and scales transaction measures by purchasing-power-adjusted income. This construction is suitable for comparing grassroots intensity within a year, but the rank is relative rather than cardinal: a movement of several places does not imply a proportionate change in transaction activity. The 2025 edition also changed the sub-index composition, which limits strict year-to-year comparability.

Regulatory tiers are coded from FATF targeted updates on virtual assets and virtual-asset service providers, IMF AREAER legal-status information, and national regulatory sources for dated changes. The coding distinguishes rules in force in each sample year, including Nigeria's transition from restrictive to partial regulation in 2024 and the movement of South Korea, the United Kingdom, and EU member states toward comprehensive regimes. A source note is retained for every country-year observation.

2.2 Sample and tier definitions

The top 30 countries in each annual ranking produce an unbalanced panel of N = 150 country-year observations covering 48 unique countries. Four mutually exclusive regulatory tiers are applied:

Tab. 1: Regulatory-tier definitions

Tier	Definition
1 – Comprehensive	Dedicated VASP licensing regime with market-conduct and consumer-protection rules in force (e.g., EU MiCA from Dec 2024, Japan FSA, South Korea VAUPA from Jul 2024, UK FCA from Jan 2024).
2 – Partial	AML/CFT VASP registration applies but no comprehensive market-conduct regime yet (e.g., United States, India, Brazil, Indonesia, Nigeria from 2024).
3 – Restrictive	Trading legal but subject to significant formal barriers: banking restrictions, payment bans, or capital-control limits without a full trading ban (e.g., Türkiye, Russia, Nigeria pre-Dec 2023, Pakistan, Vietnam through 2024).
4 – Banned	Cryptocurrency trading and/or mining prohibited by law (e.g., China from Sep 2021, Bangladesh, Afghanistan, Nepal, Yemen, Egypt).

Source: Authors' classification based on FATF (2021–2024), IMF (2022), and national regulatory sources.

The tier distribution is: comprehensive, n = 23; partial, n = 79; restrictive, n = 33; and banned, n = 15. Several countries appear in more than one tier over time because their legal regimes changed. Nigeria moves from restrictive to partial regulation from 2024, while South Korea and the United Kingdom move into the comprehensive category as dedicated frameworks enter into force. EU member states are coded comprehensively only when the relevant MiCA provisions become applicable. The classification therefore represents country-year conditions rather than a permanent country attribute. It records the dominant formal regime in force, not enforcement intensity, regulatory quality, or the availability of offshore and peer-to-peer channels.

2.3 Analytical methods

The analysis reports tier-specific means, medians, standard deviations, and sample sizes. The primary omnibus test is Kruskal–Wallis because adoption is ordinal, two tiers depart from normality, and variances are unequal (Levene p = .002). Welch's ANOVA provides a

parametric robustness check, Spearman correlation assesses a linear ordinal association, and Mann–Whitney tests compare the partial tier with each alternative. Because countries recur across years, a country-collapsed check uses each country's mean rank and modal tier. The 2025 index change and the observational design preclude causal interpretation. Calculations were performed in Python using scipy.stats.

The top-30 restriction keeps the sample focused on countries with material measured adoption, but it also creates selection effects: low-adoption comprehensive and banned jurisdictions outside the ranking are not observed. The pooled tests treat country-years as separate observations and are therefore potentially over-precise when countries recur. The country-collapsed specification is included specifically to show how the conclusions change when each country contributes only once. Taken together, the pooled and collapsed estimates provide a transparent descriptive range rather than a single definitive test.

3 Results

3.1 Descriptive overview

The pooled descriptive statistics show a clear but non-monotonic ordering: partial and restrictive environments have the strongest average rankings, banned jurisdictions occupy an intermediate position, and comprehensive regimes have the weakest mean rank in the selected top-30 sample.

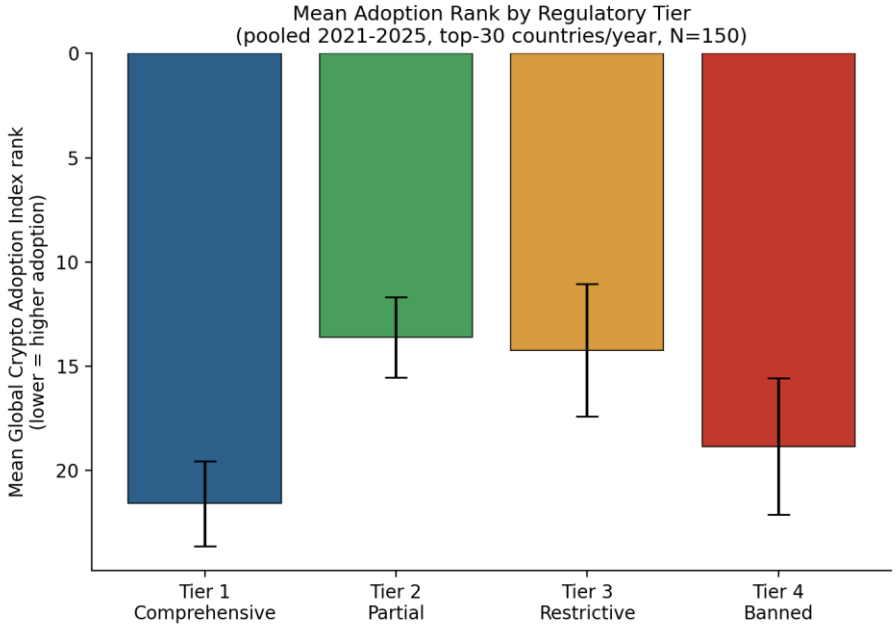
Tab. 2: Adoption rank by regulatory tier

Tier	N	Mean rank	Median	SD	Note
1 – Comprehensive	23	21.61	22.0	4.98	Weakest mean adoption
2 – Partial	79	13.61	13.0	8.75	Strongest mean adoption
3 – Restrictive	33	14.24	12.0	9.30	Close second to Tier 2
4 – Banned	15	18.87	17.0	6.47	Better than Tier 1 in this sample

Note: Pooled 2021–2025; N = 150 country-year observations; lower rank denotes stronger grassroots adoption.
Source: Authors' calculations from Chainalysis rankings and the regulatory-tier dataset.

Tier 2 has the best mean rank (13.61), followed closely by Tier 3 (14.24); Tier 4 averages 18.87 and Tier 1 averages 21.61. The medians reinforce the same broad ordering, although dispersion is substantial in the partial and restrictive groups. This ordering is descriptive, not a regulatory effect: comprehensive-tier observations are concentrated among high-income economies whose grassroots activity is mechanically less prominent in a purchasing-power-weighted index. The relatively wide variation within Tiers 2 and 3 also indicates that formal regime type alone cannot explain country positions.

Fig. 1: Mean adoption rank by regulatory tier



Note: Error bars show 95% confidence intervals; the inverted y-axis means that taller bars indicate stronger adoption. Source: Authors' calculations.

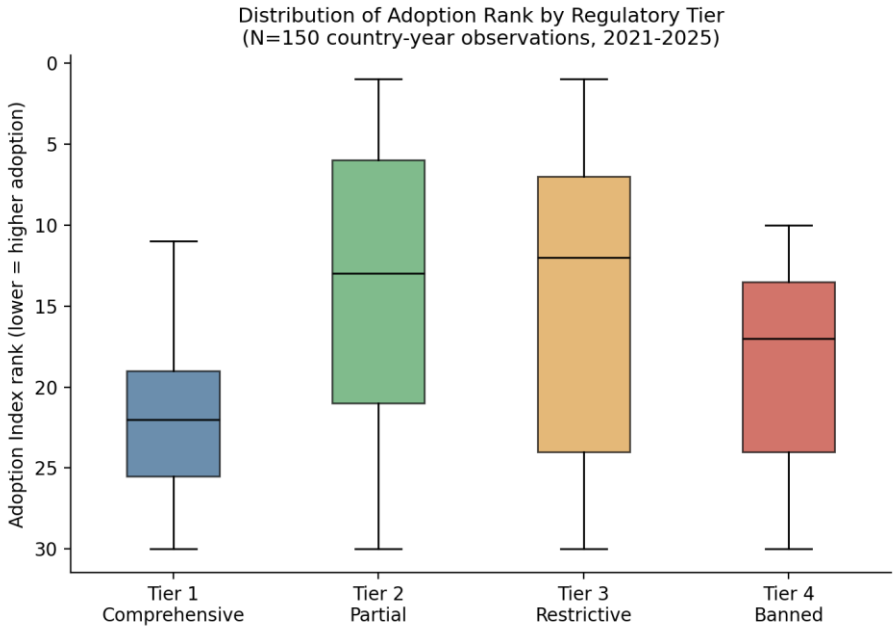
3.2 Inferential tests

The Kruskal–Wallis test rejects equality of rank distributions across the four tiers ($H(3) = 18.08$, $p < .001$). Welch's ANOVA yields the same inference, $F(3, 49.4) = 11.58$, $p < .001$. The estimated effects are moderate (Kruskal–Wallis $\varepsilon^2 = 0.10$; $\eta^2 = 0.12$), indicating that tier membership accounts for a meaningful but far from dominant share of rank variation.

Pairwise Mann–Whitney tests show that Tier 2 has significantly stronger ranks than Tier 1 ($U = 433.0$, $p < .001$) and Tier 4 ($U = 375.5$, $p = .025$), but does not differ from Tier 3 ($U = 1248.5$, $p = .73$). The empirically supported contrast is therefore between the combined partial/restrictive group and the comprehensive tier, with banned jurisdictions in an intermediate position.

The linear Spearman association between tier number and adoption rank is weak and not significant ($\rho = -.11$, $p = .20$). This result is compatible with, but does not by itself prove, the non-monotonic categorical pattern shown by the group tests. In the country-collapsed sample ($N = 48$), the tier ordering is preserved but the Kruskal–Wallis statistic is not significant ($H = 4.32$, $p = .23$). Pooled significance therefore partly reflects repeated observations, and the estimates are interpreted as a recurrent descriptive regularity rather than an independent country-level effect.

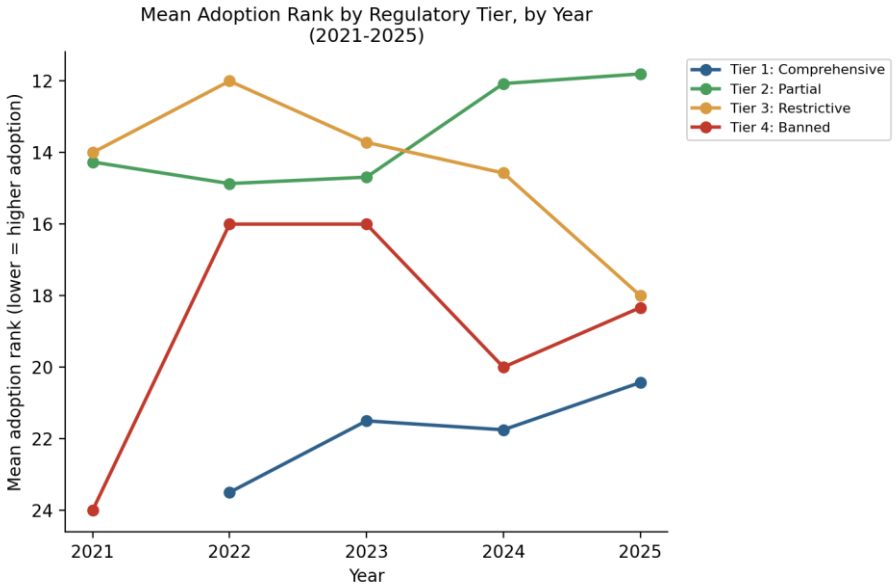
Fig. 2: Distribution of adoption rank by regulatory tier



Note: Boxplot of pooled 2021–2025 adoption ranks (N = 150 country-year observations). Source: Authors' calculations.

Figure 2 shows substantial overlap between the partial and restrictive distributions, consistent with their non-significant pairwise difference. The comprehensive group is more tightly concentrated toward weaker ranks, whereas banned jurisdictions remain represented across a relatively broad part of the top-30 range. This overlap cautions against treating the four tiers as sharply separated adoption regimes.

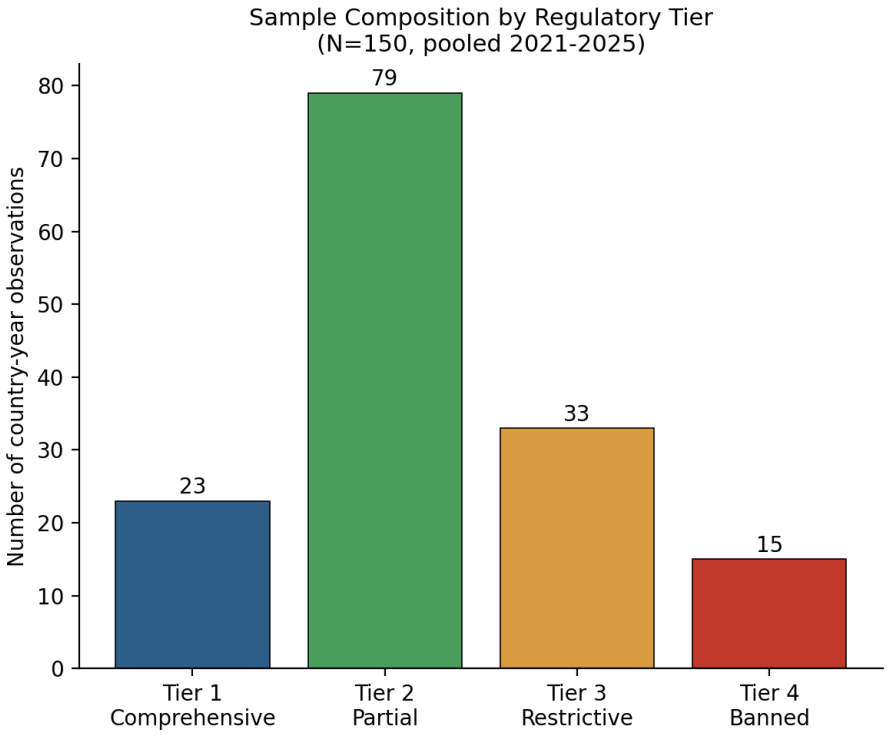
Fig. 3: Mean adoption rank by tier and year, 2021–2025



Note: Tier 2 records the best or near-best mean rank in four of five years; Tier 1 is weakest where observed. Source: Authors' calculations.

The annual profiles are not identical, but the pooled ordering is not generated by a single exceptional year. Tier 2 records the strongest or near-strongest mean rank in four of the five editions, while Tier 1 is weakest whenever it is represented. This persistence supports the interpretation of a recurring structural association, although changes in country composition and index construction prevent the year lines from being treated as a balanced longitudinal trajectory.

Fig. 4: Sample composition by regulatory tier



Note: Distribution of the N = 150 country-year observations across tiers: comprehensive, n = 23; partial, n = 79; restrictive, n = 33; banned, n = 15. Source: Authors' calculations.

4 Discussion

The pooled ordering is consistent with a "regulated access plus necessity" mechanism. Partial-framework countries combine legal or operational access with macroeconomic conditions that can raise demand for alternative savings, investment, and remittance channels. This interpretation corresponds to cross-country evidence linking crypto adoption to capital controls, institutional weaknesses, and development conditions (Alnasaa et al., 2022; Bhimani et al., 2022). It also complements behavioural evidence that regulation influences adoption partly through trust and perceived legitimacy rather than through legal permissiveness alone (Schaupp et al., 2022; Bommer et al., 2023).

Comprehensive-tier countries are mostly high-income economies with stronger conventional financial alternatives, lower remittance dependence, and lower purchasing-power-

weighted grassroots intensity. Their weaker average rank should therefore not be interpreted as evidence that comprehensive regulation suppresses adoption. Regulation may encourage institutional participation and safer formal-market activity even when grassroots use remains comparatively modest. The tier variable is entangled with income, institutional quality, market maturity, financial access, and the construction of the Chainalysis index.

The presence of banned jurisdictions among highly ranked adopters likewise cautions against treating formal prohibition as equivalent to zero use. Restrictions may redirect activity toward peer-to-peer markets, offshore services, or informal channels that remain visible in transaction-based estimates. The annual pattern suggests that these structural differences persist across changing market conditions, but the non-significant country-collapsed test shows that repeated observations amplify pooled precision. For policy, the evidence favours neither maximal permissiveness nor maximal restriction. It instead supports attention to regulatory clarity, credible enforcement, consumer protection, and the channels through which users substitute away from formal services.

Several limitations remain. First, the 2025 Chainalysis methodology changed its sub-index composition, limiting strict intertemporal comparability. Second, tier coding involves judgment for regulatory transitions and was not independently double-coded. Third, the design does not control for income, inflation, capital controls, remittance dependence, digital infrastructure, enforcement intensity, or institutional trust. Fourth, the top-30 sampling rule and strongly unequal tier sizes, including only 15 banned-country observations, constrain generalisability and precision. Future work should combine a multidimensional regulatory index with country covariates, year effects, and dependence-aware panel estimation, and should link objective regulatory indicators to individual perceptions of trust, risk, and legitimacy.

Conclusion

Across 150 country-year observations, adoption ranks differ significantly among regulatory tiers in the pooled sample. Partial-framework countries have the strongest mean ranking, comprehensive-tier countries the weakest, and restrictive countries are statistically indistinguishable from partial countries. The insignificant linear Spearman coefficient is compatible with this non-monotonic categorical pattern, but it does not by itself establish non-linearity. The country-collapsed robustness test retains the ordering but not statistical significance.

The analysis therefore does not identify an optimal regulatory regime or a causal effect of regulation. It shows that substantial grassroots adoption can coexist with comprehensive

rules, partial oversight, restrictions, and bans, and that formal legal status alone is an incomplete predictor of use. The same observed ranking can arise from different mechanisms, including legitimacy and consumer protection in regulated markets, necessity-driven use under partial oversight, and substitution toward informal channels under restrictions.

Policy assessment should consider regulatory clarity and enforcement together with income, financial access, macroeconomic instability, remittance needs, and market infrastructure. The next analytical step is a continuous, multidimensional regulatory-quality measure embedded in a dependence-aware panel design with structural country controls. Such a design would permit the present descriptive regularity to be tested more directly and would clarify whether regulatory transitions alter adoption after broader country characteristics are taken into account.

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