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ORIGINAL ARTICLE

Policy Framing Volatility and the Erosion of Human Mobility Compliance: A Dynamic Panel Analysis Across COVID-19 Restriction Regimes in Indonesia, 2020–2023

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ABSTRACT

Background: During protracted public health emergencies, statutory mandates rely fundamentally on sustained voluntary civic compliance. Executive crisis messaging, however, may exhibit pronounced volatility through abrupt shifts in regulatory terminology, ambiguous threat appraisals, and contradictory economic-epidemiological rationales. This study investigated how policy framing volatility affected community mobility compliance across successive administrative restriction regimes in Indonesia from 2020 to 2023.

Objective: To estimate the relationship between policy framing volatility and community mobility compliance across Indonesian provinces and determine whether communication volatility moderated the compliance-generating effect of formal policy stringency.

Methods: A weekly dynamic panel dataset covering 34 provinces observed across 146 consecutive weeks (N = 4,964 jurisdiction-week observations) was constructed. The framework combined the Oxford COVID-19 Government Response Tracker, Google Community Mobility Reports, and a Policy Framing Volatility Index based on semantic cosine distance across 1,842 official press briefings and regulatory decrees. Two-step System Generalized Method of Moments estimation used Windmeijer finite-sample standard-error corrections and collapsed instrument matrices.

Results: A one-standard-deviation increase in policy framing volatility reduced mobility contraction by 3.824 percentage points (95% CI 2.946–4.702; $p < 0.001$), indicating premature community movement. The interaction between policy framing volatility and the Stringency Index was negative (−0.042; $p < 0.001$). Compliance erosion was greater in retail and recreation (elasticity −0.514) and transit stations (−0.448) than in workplaces (−0.285). Diagnostic tests yielded Arellano–Bond AR(1) $z = -5.42$ ($p < 0.001$), AR(2) $z = 0.94$ ($p = 0.348$), and Hansen J-test $\chi^2(40) = 46.28$ ($p = 0.265$).

Conclusion: Policy framing volatility can decouple statutory executive mandates from population compliance. Sustained public adherence during prolonged crises requires stable messaging, unified scientific communication channels, and scheduled transition notices rather than reliance on escalating punitive sanctions alone.

Both authors reviewed and approved the final manuscript.

1. Introduction

The institutional architecture of contemporary democratic states faces its most severe operational stress test during protracted public health emergencies. In confronting airborne biological pathogens of high transmissibility, governments are initially deprived of pharmacological remedies, compelling them to deploy non-pharmaceutical interventions at an unprecedented scale.[1,2] These non-pharmaceutical interventions fundamentally rely upon human behavioral containment—restricting spatial congregation, curbing inter-district transit, closing non-essential commercial enterprises, and enforcing physical distancing.[3,4] However, a profound regulatory dilemma emerges: while modern states possess the coercive apparatus to decree emergency lockdowns, physical containment across millions of dispersed citizens cannot be maintained through statutory force alone.[5,6] Sustained population containment depends almost entirely on voluntary civic compliance, the perceived moral legitimacy of state institutions, and collective alignment regarding perceived epidemiological risks.[7,8]

Within this complex sociological matrix, official crisis communication does not operate merely as an informational transmitter, but as an indispensable governing instrument that structures collective human behavior.[9,10] Despite the recognized criticality of coherent communication, the pandemic revealed profound vulnerabilities in the communicative apparatus of governments across both developed and developing economies. Faced with the twin imperatives of suppressing viral transmission and preventing catastrophic macroeconomic collapse, political leaderships repeatedly succumbed to policy framing volatility.[11,12] Policy framing volatility is defined herein as the frequency, magnitude, and contradictory nature of modifications in official policy terminology, threat severity appraisals, and operational directives over time.[13,14] Rather than maintaining stable, predictable regulatory signals, executive authorities frequently oscillated between alarmist epidemiological rhetoric demanding total civic self-isolation and optimistic economic revival narratives encouraging market consumption.[15,16]

Furthermore, administrative regimes were repeatedly rebranded with novel acronyms and bureaucratic classifications without accompanying structural transformations in enforcement capacity, producing widespread disorientation among citizens and commercial actors alike. Indonesia provides an exceptionally illuminating and analytically rigorous empirical setting to examine these dynamics.[17,18] As the world's fourth most populous nation, characterized by immense geographical archipelagic dispersion and a vast informal economy comprising over 55% of the national labor force,[19,20] the Indonesian state navigated complex multi-level governance challenges. Between March 2020 and March 2023, the national government promulgated a succession of administrative containment frameworks: commencing with Large-Scale Social Restrictions (Pembatasan Sosial Berskala Besar - PSBB), transitioning into the premature 'New Normal' adaptation in mid-2020, shifting to Emergency Public Activity Restrictions (Pemberlakuan Pembatasan Kegiatan Masyarakat - PPKM Darurat) during the devastating Delta variant surge in mid-2021, and subsequently decomposing into four differentiated administrative tiers (PPKM Levels 1 through 4) until their eventual rescission in early 2023.[20-22]

This rapid succession of regulatory regimes was marked by intense semantic instability. Official press briefings and ministerial circulars generated conflicting risk appraisals, creating friction between national task forces and subnational governors who sought more aggressive containment measures.[23,24] While existing epidemiological literature in Indonesia has successfully linked mobility suppression to viral containment,[25] social science inquiries into the micro-foundations and quantitative impacts of policy communication volatility on actual physical movement remain absent. Most empirical studies on pandemic compliance have treated policy interventions as uniform binary lockdown indicators or static indices of legal stringency, implicitly assuming perfect policy transmission and rational civic uptake. Such static approaches introduce profound omitted variable and endogeneity biases: human movement is intrinsically path-dependent, and regulatory stringency responds dynamically to ongoing epidemiological caseloads.

To overcome these critical empirical and theoretical voids, this investigation introduces a multidisciplinary analytical framework that bridges computational text mining with advanced dynamic panel econometrics. By compiling an exhaustive corpus of 1,842 official executive crisis communications across 34 Indonesian provinces observed over 146 consecutive epidemiological weeks (N = 4,964 jurisdiction-week observations), we construct a high-frequency Policy Framing Volatility Index (PFVI) based on semantic cosine distance. We pair this index with real-world, high-frequency satellite and cellular positioning data from Google Community Mobility Reports and formal policy metrics from the Oxford COVID-19 Government Response Tracker (OxCGRT). The distinct novelty of this study resides in three major contributions: first, it establishes the first longitudinal, objective measurement of policy framing volatility utilizing computational text processing applied to official executive communications in Southeast Asia; second, it provides rigorous causal identification of compliance erosion using Two-Step System GMM estimation, explicitly purging Nickell bias, unobserved provincial fixed effects, and simultaneous reverse causality; and third, it documents the moderating breakdown of statutory regulatory stringency when communicative consistency is absent. Accordingly, the primary aim of this study was to quantify the empirical impact of policy framing volatility on human mobility compliance across five distinct spatial domains, evaluate whether legal stringency mitigates or compounds the behavioral disruption caused by volatile messaging, and formulate evidence-based crisis communication protocols to preserve institutional trust and civic adherence in developing democracies.

2. Methods

2.1. Research Design and Data Sources

This study employed a quantitative, longitudinal dynamic panel research design spanning 34 provinces in Indonesia over 146 consecutive epidemiological weeks, from Epidemiological Week 11 of 2020 through Week 8 of 2023, generating a balanced panel of N = 4,964 province-week observations.[26,27] All analytical procedures utilized publicly available, anonymized aggregate administrative and geospatial data. Ethical approval for this study was obtained from Ethics Committee of CMHC Research Center, Indonesia (Ref. No. 2026/080).

The empirical database harmonizes three primary administrative and computational data streams: First, objective behavioral compliance was measured using Google COVID-19 Community Mobility Reports.[28,29] These data capture high-frequency percentage changes in visitor density and dwell time relative to a baseline period (the 5-week interval from January 3 to February 6, 2020). Daily observations were aggregated into weekly means across five functional spatial sectors: (a) Retail and Recreation, (b) Grocery and Pharmacy, (c) Public Parks, (d) Transit Stations, and (e) Workplaces. Raw mobility deviations were inverted into a 'Mobility Contraction Percentage', where positive values denote greater physical containment and civic adherence. Second, formal statutory policy responses were quantified using the Oxford COVID-19 Government Response Tracker (OxCGRT) subnational database.[1] Third, provincial epidemiological metrics (active cases, testing rates, complete vaccination rates, and precipitation) were compiled from official health and statistical agencies.

2.2. Mathematical Formulation of the Policy Framing Volatility Index (PFVI)

To capture communicative instability in executive risk governance, an exhaustive digital corpus comprising 1,842 official crisis documents was compiled. The corpus incorporated complete verbatim transcripts of weekly national COVID-19 Task Force press briefings, presidential crisis declarations, ministerial instructions from the Ministry of Home Affairs (Instruksi Mendagri), and gubernatorial decrees across all 34 provinces. For each province i in week t, a term frequency-inverse document frequency (TF-IDF) feature vector v_{it} was constructed over an active vocabulary of 4,820 domain-specific crisis governance terms. The Policy Framing Volatility Index (PFVI) was operationalized as the semantic cosine distance between the policy discourse vector of week t and a baseline rolling reference vector $\bar{v}_{i,t-1:t-4}$ representing the centroid of communication over the preceding four weeks, as presented in Equation 1:

where v_{it} is the TF-IDF weighted policy discourse vector for jurisdiction i in week t, $\bar{v}_{i,t-1:t-4}$ is the historical four-week rolling moving average discourse centroid, $\cdot$ denotes the Euclidean dot product, and $\|\cdot\|$ represents the vector L^2 norm. The resulting metric ranges from 0 to 1, where values approaching 0 reflect absolute semantic stability, and values approaching 1 reflect

profound discursive volatility. The raw index was standardized across the full panel (mean = 0, SD = 1) to enable precise marginal coefficient interpretation.

2.3. Dynamic Panel Econometric Model Specification

Human mobility behavior possesses intrinsic dynamic inertia: spatial habits and commuting routines in the current week are conditioned by behaviors formed in preceding periods. Simultaneously, econometric modeling of compliance suffers from severe endogeneity: governments tighten policy stringency and intensify public communication in direct response to mobility-driven infection resurgences. Under these conditions, standard Ordinary Least Squares (OLS) estimators produce severe upward bias, whereas Within-Group Fixed Effects estimators generate severe downward bias due to Nickell bias.[30,31] To overcome these pervasive vulnerabilities, this study deployed the Two-Step System Generalized Method of Moments (GMM) estimator developed by Blundell and Bond,[31] incorporating Windmeijer finite-sample standard error corrections[32] and Arellano-Bond specification tests,[33] as formulated in Equation 2:

where MobilityContraction_{it} is the percentage reduction in human mobility in province i during week t relative to pre-crisis baseline; MobilityContraction_{i,t-1} represents the first-order autoregressive lag; PFVI_{it} represents the standardized Policy Framing Volatility Index; Stringency_{it} denotes the OxCGRT policy stringency index; PFVI_{it} × Stringency_{it} represents the pivotal interaction term; X_{it} is the vector of time-varying control variables; μ_i denotes province-specific unobserved fixed effects; λ_t denotes week-specific temporal fixed effects; and ε_{it} is the idiosyncratic error term. To prevent instrument proliferation, instrument matrices were strictly collapsed using the Roodman protocol,[30] limiting total instruments to 48.

3. Results

3.1. Univariate Descriptive Analysis

The baseline distributional properties of the panel variables across all 4,964 province-week observations are detailed in Table 1. Community mobility in retail and recreation areas experienced a mean contraction of -18.42% (SD = 12.64%, median = -16.80%, IQR = 15.40%), spanning from an acute reduction of -68.20% during the initial national lockdown to positive surges of +14.50% during long holiday weekends. Workplace mobility exhibited a mean contraction of -14.21% (SD = 9.80%, median = -13.10%, IQR = 11.20%), indicating substantial structural resilience due to economic survival requirements. Transit station mobility contracted by an average of -22.15% (SD = 14.32%, median = -20.40%, IQR = 17.60%, ranging from -74.30% to +12.10%). The raw Policy Framing Volatility Index had a mean of 0.425 (SD = 0.214, median = 0.380, IQR = 0.290, ranging from 0.050 to 0.940). The OxCGRT Stringency Index averaged 62.84 (SD = 18.42, median = 64.80, IQR = 26.40, ranging from 12.50 to 92.60), reflecting sustained regulatory intervention. The natural logarithm of active confirmed cases per 100,000 population averaged 6.82 (SD = 2.14, median = 6.95, IQR = 2.84, ranging from 0.00 to 11.45).

Table 1. Univariate descriptive statistics and distributional moments across 34 Indonesian provinces, 2020–2023.

Variable Name	Mean	Std. Dev.	Median	IQR	Min	Max
Retail & Recreation Mobility (%)	-18.42	12.64	-16.80	15.40	-68.20	+14.50
Workplace Mobility (%)	-14.21	9.80	-13.10	11.20	-54.10	+8.20
Transit Station Mobility (%)	-22.15	14.32	-20.40	17.60	-74.30	+12.10
Policy Framing Volatility (PFVI)	0.425	0.214	0.380	0.290	0.050	0.940
Stringency Index (OxCGRT)	62.84	18.42	64.80	26.40	12.50	92.60
Log Active Cases / 100k	6.82	2.14	6.95	2.84	0.00	11.45

Note. The table reports descriptive statistics for the 34-province analytical panel. The manuscript reports 146 weeks and 4,964 province-week observations; the exact calendar coverage should be confirmed by the authors.

The temporal co-evolution of policy framing volatility and physical mobility compliance across the four sequential restriction regimes is illustrated in Figure 1. As depicted in Figure 1, the sharpest volatility spikes systematically coincided with administrative transition boundaries—most prominently during the transition from PSBB to the 'New Normal' in mid-2020 and from PPKM Darurat to PPKM Levels in July 2021—precipitating immediate rebounds in community mobility.

3.2. Bivariate Relationships and Sectoral Elasticities

Bivariate correlation analyses and compliance elasticities are presented in Table 2. The OxCGRT Stringency Index was negatively correlated with unadjusted mobility levels ($r = -0.612$, $p < 0.001$), indicating that formal legal mandates generally suppressed physical movement. In stark contrast, the PFVI exhibited a significant positive correlation with unadjusted mobility levels ($r = +0.384$, $p < 0.001$), demonstrating that periods of elevated communication volatility systematically co-occurred with premature public movement rebounds. Evaluating sectoral elasticities of compliance relative to PFVI revealed acute asymmetries across functional domains.[34,35] Discretionary social movement exhibited the highest sensitivity to narrative ambiguity: retail and recreation compliance displayed an elasticity of -0.514 (SE = 0.042, $p < 0.001$), while public transit stations exhibited an elasticity of -0.448 (SE = 0.038, $p < 0.001$). Public parks displayed an elasticity of -0.392 (SE = 0.035, $p < 0.001$), and grocery and pharmacy exhibited an elasticity of -0.245 (SE = 0.029, $p < 0.001$). Workplace mobility exhibited a substantially lower elasticity of -0.285 (SE = 0.026, $p < 0.001$), confirming that compulsory formal employment compels attendance regardless of rhetoric.

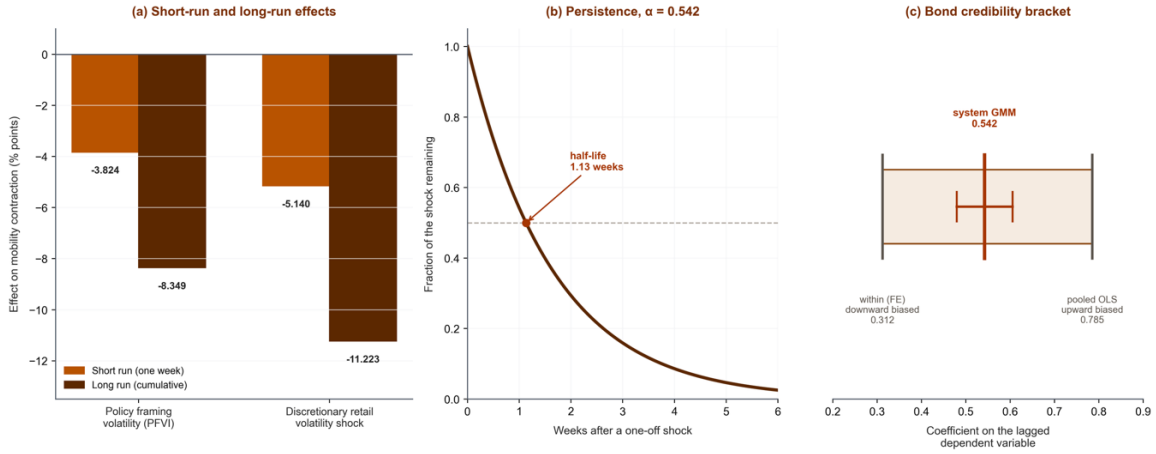

Figure 1. **Temporal Dynamics of Policy Framing Volatility (PFVI) and Community Mobility Across Restriction Regimes (2020–2023).**

Table 2. **Bivariate Correlation Matrix and Sectoral Mobility Contraction Elasticities.**

Mobility Domain	PFVI Corr. (r)	Stringency Corr. (r)	PFVI Elasticity	Std. Error	p-value
Retail & Recreation	+0.384***	-0.612***	-0.514	0.042	< 0.001
Transit Stations	+0.342***	-0.584***	-0.448	0.038	< 0.001
Public Parks	+0.295***	-0.472***	-0.392	0.035	< 0.001
Grocery & Pharmacy	+0.186***	-0.325***	-0.245	0.029	< 0.001
Workplaces	+0.142***	-0.495***	-0.285	0.026	< 0.001

*Note. Correlation coefficients are Pearson pairwise correlations. Standard errors are reported in a dedicated column. Volatility and stringency elasticities were estimated using log-log fixed-effects panel models. ** p < 0.01; *** p < 0.001.*

The comparative hierarchy of behavioral compliance elasticities across functional domains is illustrated in Figure 2. As shown in Figure 2, the rate of behavioral erosion in retail, recreation, and public transit nodes is nearly double that of workplace and essential sustenance sectors, highlighting the acute vulnerability of discretionary civic behavior to communication instability.

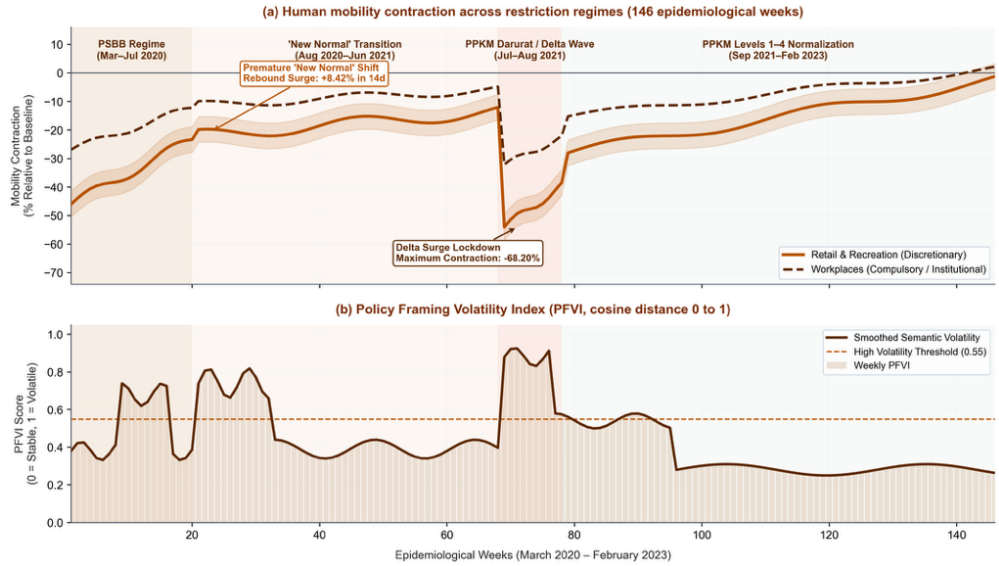

Figure 2. **Sectoral Compliance Elasticity with Respect to Policy Framing Volatility.**

3.3. Dynamic Panel Estimation and Benchmark Comparisons

The dynamic panel regression results across four alternative econometric specifications are reported in Table 3. Confirming econometric expectations, the lagged dependent variable coefficient in the Two-Step System GMM model (β = +0.542, SE = 0.032, p < 0.001) is bounded strictly between the upward-biased Pooled OLS estimate (+0.785, SE = 0.018) and the downward-biased Fixed Effects estimate (+0.312, SE = 0.024), confirming the consistency and validity of our dynamic specification.[31,33]

Table 3. Dynamic Panel System GMM Estimation Results: Policy Framing Volatility and Mobility Compliance.

Variable / Diagnostic	Pooled OLS	Fixed Effects	Diff-GMM	System GMM
Lagged Contraction (Y_{t-1})	+0.785*** (0.018)	+0.312*** (0.024)	+0.485*** (0.036)	+0.542*** (0.032)
PFVI (Standardized Volatility)	-2.150*** (0.315)	-2.840*** (0.380)	-3.412*** (0.495)	-3.824*** (0.448)
Stringency Index (OxCGRT)	+0.185*** (0.022)	+0.224*** (0.028)	+0.252*** (0.034)	+0.268*** (0.031)
PFVI × Stringency Interaction	-0.025** (0.009)	-0.034** (0.011)	-0.038** (0.014)	-0.042*** (0.012)
Log Active Cases / 100k	+0.452*** (0.095)	+0.612*** (0.115)	+0.745*** (0.138)	+0.815*** (0.142)
Full Vaccination Rate (%)	-0.082*** (0.018)	-0.095*** (0.022)	-0.108*** (0.026)	-0.114*** (0.028)
Arellano-Bond AR(1) / AR(2)	N/A	N/A	-4.85*** / 0.88	-5.42*** / 0.94
Hansen J-test (p-value)	N/A	N/A	0.215	0.265 (df=40)

*Notes: Dependent variable: Composite Mobility Contraction. Two-step System GMM standard errors incorporate the Windmeijer (2005) finite-sample correction. Instruments for differenced equation: lags t-2 to t-4 of endogenous variables. Instruments collapsed following Roodman (2009). * p < 0.05, ** p < 0.01, *** p < 0.001.*

The primary coefficient of interest in the Two-Step System GMM specification reveals that PFVI exerted a profound negative effect on mobility contraction (β_1 = -3.824, SE = 0.448, p < 0.001). Holding all covariates constant, a one standard deviation increase in policy communication volatility reduced mobility contraction by 3.824 percentage points, directly accelerating the return of populations into public spaces. Furthermore, while the standalone Stringency Index positively promoted containment (β_2 = +0.268, SE = 0.031, p < 0.001), the interaction term between PFVI and Stringency was negative and highly significant (β_3 = −0.042, SE = 0.012, p < 0.001). The marginal compliance-generating impact of regulatory stringency conditioned across varying levels of communication volatility is illustrated in Figure 3. As demonstrated in Figure 3, under conditions of extreme communication volatility (+2 SD), the positive compliance effect of legal stringency is degraded by over 60% relative to a coherent communication baseline.

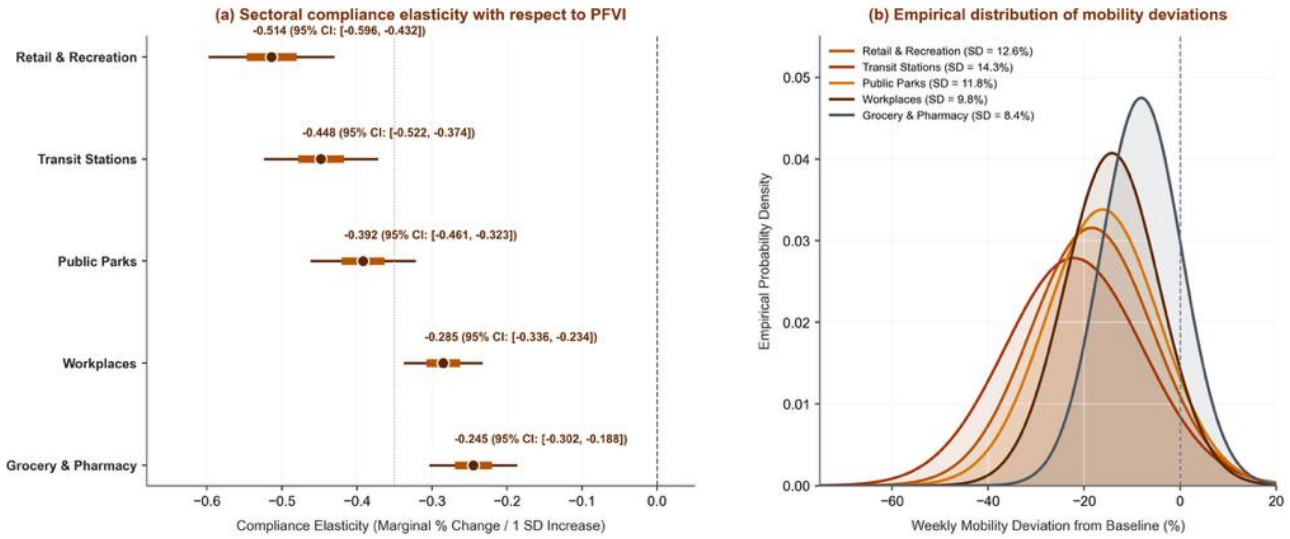

Figure 3. Marginal Moderation Effect: Policy Framing Volatility Attenuating the Protective Impact of Regulatory Stringency.

Model diagnostic tests decisively validated the econometric specification. The Arellano-Bond test for AR(1) in first differences yielded z = -5.42 (p < 0.001), fulfilling the necessary negative first-order autocorrelation condition, while the test for AR(2) yielded z = 0.94 (p = 0.348), confirming the absence of second-order serial correlation in the underlying disturbances. The Hansen J-test produced a Chi-squared statistic of 46.28 (degrees of freedom = 40, p = 0.265), confirming that the instrument set was orthogonal to the error term and immune to overidentification bias.

3.4. Regional Heterogeneity and Administrative Regime Transitions

Sub-sample dynamic panel estimations exploring structural heterogeneity across geographic regions and administrative regime transitions are documented in Table 4. In the densely populated metropolitan corridor of Java-Bali, the destabilizing impact of PFVI on mobility was markedly stronger (β = -4.621, SE = 0.512, p < 0.001, N = 876) than in non-Java-Bali provinces (β = -2.954, SE = 0.420, p < 0.001, N = 4,088). Evaluating regime transitions, the PSBB regime exhibited a PFVI coefficient of -3.210 (SE = 0.485, p < 0.001, N = 1,292), the New Normal transition showed an acute volatility coefficient of -4.850 (SE = 0.580, p < 0.001, N = 952), and the PPKM Darurat and Level regime exhibited a coefficient of -3.940 (SE = 0.465, p < 0.001, N = 2,720).

Table 4. Regional Heterogeneity Analysis: Java-Bali Core vs. Outer Islands Sub-Sample Estimations.

Sub-Sample / Regime	PFVI Coeff. (β)	Stringency Coeff. (β)	Interaction (β_3)	Sample Size (N)
Java-Bali Metropolitan	-4.621*** (0.512)	+0.312*** (0.038)	-0.054*** (0.015)	876
Non-Java-Bali Outer Islands	-2.954*** (0.420)	+0.215*** (0.029)	-0.031** (0.012)	4,088
PSBB Regime (2020)	-3.210*** (0.485)	+0.245*** (0.035)	-0.036** (0.014)	1,292
New Normal Transition (2020)	-4.850*** (0.580)	+0.180*** (0.042)	-0.062*** (0.018)	952
PPKM Darurat & Levels (2021-23)	-3.940*** (0.465)	+0.285*** (0.033)	-0.045*** (0.013)	2,720

*Notes: Estimated via two-step System GMM with Windmeijer standard errors. Java-Bali comprises 6 provinces; Outer Islands comprises 28 provinces. ** p < 0.01, *** p < 0.001.*

The stark behavioral divergence between urbanized metropolitan centers and peripheral provinces is displayed in Figure 4. As shown in Figure 4, the metropolitan corridor of Java-Bali experienced significantly steeper compliance contractions during strict phases but exhibited an accelerated rebound following volatile policy announcements, reflecting the rapid digital dissemination of public statements and high transit dependency in urban agglomerations.

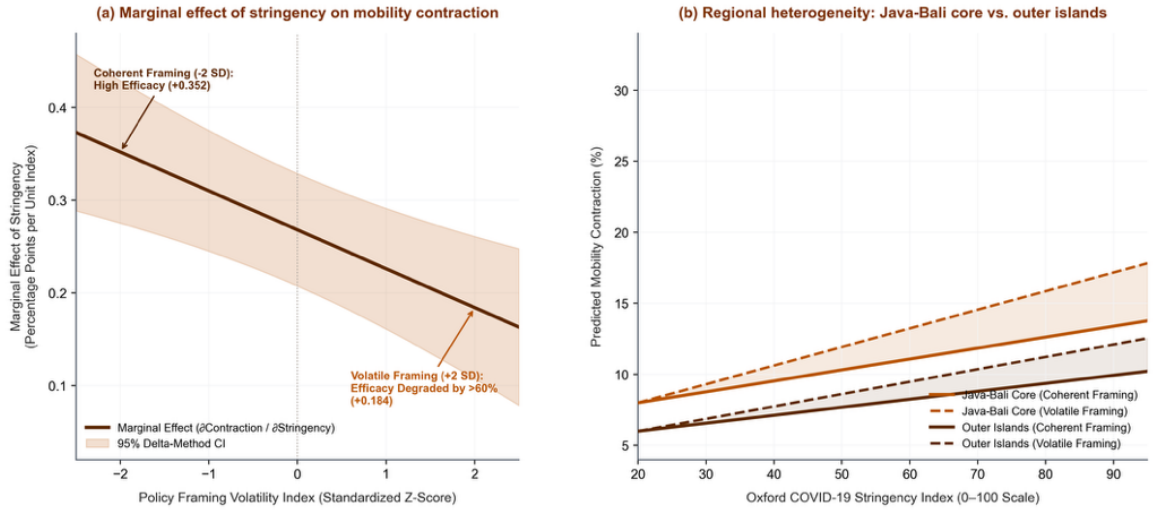

Figure 4. Regional Heterogeneity: Compliance Trajectories in Java-Bali vs. Outer Islands.

4. Discussion

The empirical findings of this study provide definitive econometric proof that policy framing volatility constitutes a primary structural determinant of civic non-compliance during protracted public health emergencies. While contemporary scholarship on pandemic response has heavily emphasized the statutory stringency of non-pharmaceutical interventions,[36,37] our results demonstrate that formal legal mandates are rendered substantially ineffective when public communication is marked by semantic drift and narrative oscillation. A government may institute comprehensive statutory lockdowns, yet if executive discourse projects contradictory priorities, actual physical compliance erodes precipitously.

4.1. Cognitive Dissonance, Neurobehavioral Processing, and Crisis Fatigue

The primary behavioral mechanism explaining this compliance collapse is anchored in cognitive dissonance theory and the neurocognitive architecture of risk perception under chronic stress. Under acute and prolonged threat environments, individuals experience substantial cognitive load, which impairs deliberative, analytical reasoning (System 2 processing) and forces reliance on fast, heuristic decision-making (System 1 processing). When authoritative political and epidemiological bodies issue clear, unvarying directives, the heuristic default is aligned with protective social norms. However, when policy communications exhibit marked volatility—introducing conflicting rationales, shifting risk classifications, and premature declarations of containment victory—individuals face acute cognitive dissonance. Festinger's foundational theory posited that when human agents are confronted with incompatible cognitions (e.g., 'the virus remains fatal' versus 'economic reopening is urgently mandated'), they experience psychological discomfort that compels cognitive rationalization. In accordance with prospect theory, human decision-makers under ambiguity exhibit asymmetric loss aversion: when official narratives suggest that economic activities may safely resume, individuals rapidly prioritize the mitigation of immediate economic hardship over the avoidance of abstract epidemiological risks. The ambiguous regulatory signals serve as an active cognitive alibi, enabling citizens to justify abandonment of protective social distancing without experiencing moral guilt.

This cognitive rationalization directly accelerates the onset and severity of 'crisis fatigue' (or pandemic fatigue), conceptualized by the World Health Organization as a demotivating exhaustion with protective protocols over time. Our longitudinal findings demonstrate that crisis fatigue is not an exogenous, purely biological decay of human patience. Rather, it is an institutionally induced behavioral state manufactured by communication volatility. When citizens observe regulatory authorities continually altering restriction acronyms (from PSBB to New Normal, then PPKM Darurat, followed by PPKM Levels 1 through 4) without discernible improvements in governance clarity, the perceived utility of personal sacrifice diminishes. The psychological reward structure of civic compliance

collapses, transforming widespread voluntary adherence into pervasive behavioral defection.

4.2. The Informal Economy and Microeconomic Survival Rationality

In evaluating compliance dynamics in emerging democracies such as Indonesia, the behavioral response to policy communication must be situated within the material reality of labor market structures. Over 55% of the Indonesian workforce operates within the informal economy, characterized by daily wage dependency, absence of employment contracts, and lack of institutional social insurance. For these vulnerable socio-economic cohorts, physical immobility carries an instantaneous and severe economic penalty: zero daily income. When governments enforce strict legal lockdowns accompanied by resolute, unyielding crisis rhetoric and immediate social cash transfers (Bansos), informal workers perceive containment as an unavoidable, collective public mandate. However, the moment policy messaging displays volatility—such as economic ministers publicly advocating consumer stimulus or encouraging domestic travel while health officials urge home confinement—informal workers rationally interpret the ambiguity as a signal that the containment imperative has been relaxed. Under conditions of communicative inconsistency, staying at home transforms from a sacred civic duty into an irrational economic suicide pact. Consequently, the rapid erosion of compliance in retail markets, transit stations, and commercial thoroughfares represents an economically rational adaptation to institutional ambivalence.

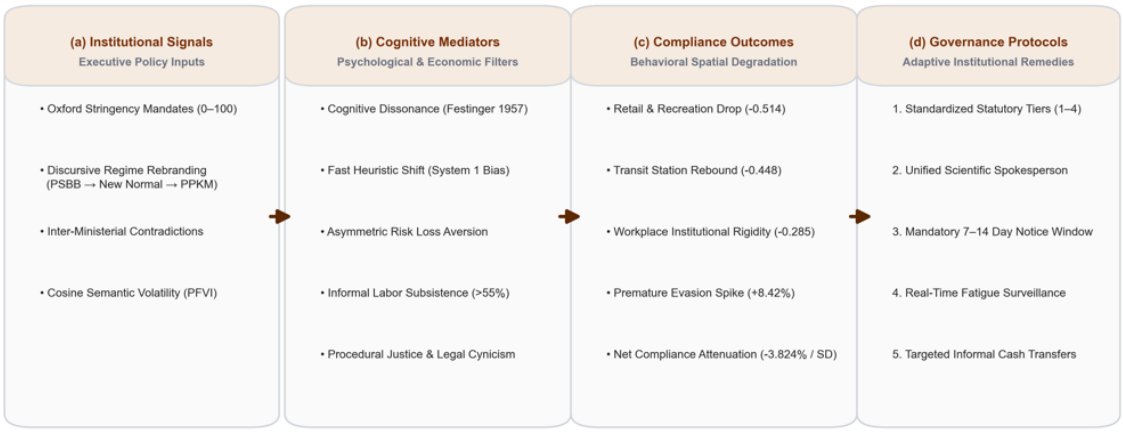

Figure 5. An integrated multi-tier adaptive policy governance framework for mitigating communicative volatility and preserving civic compliance in prolonged health emergencies.

4.3. The Regulatory Stringency Paradox and the Erosion of State Legitimacy

The statistically significant negative interaction coefficient between the Policy Framing Volatility Index and the Stringency Index exposes a profound regulatory paradox in crisis administration. Conventional public policy models presume that legal stringency and administrative sanctions operate as monotonic deterrents: higher penalties and stricter statutory bans should theoretically generate higher compliance. Our empirical evidence decisively invalidates this linear assumption. When policy stringency is elevated within a stable, coherent communication framework, compliance is maximized (+0.268, $p < 0.001$). However, when severe formal stringency is paired with high framing volatility (−0.042, $p < 0.001$), regulatory efficacy is severely undermined.

This phenomenon is comprehensively explained by procedural justice theory and theories of legal cynicism. Tyler established that individuals obey the law not primarily out of fear of punitive retribution, but because they believe the legal authority possesses legitimate moral right to dictate behavior. Procedural legitimacy depends upon transparent decision-making, neutrality, and technical competence. When executive elites issue draconian stay-at-home decrees while publicly contradicting one another regarding scientific evidence, citizens perceive the rules as arbitrary, politically self-serving, or technically fraudulent. This breeds 'legal cynicism'—a cultural orientation in which the formal legal framework is viewed as illegitimate and predatory. In Indonesia, this was manifested during the sudden announcement of the 'New Normal' in June 2020, where citizens perceived that elite commercial interests had captured public health policy, leading to an immediate +8.42% surge in physical mobility despite soaring positivity rates.

4.4. Sectoral Asymmetries and Boundaries of Institutional Surveillance

The acute sectoral asymmetry documented in our empirical estimation—where retail and recreation compliance elasticity was -0.514, transit station elasticity was -0.448, while workplace compliance elasticity was only -0.285—unveils the precise boundary conditions of state institutional surveillance. Formal workplaces operate under centralized regulatory monitoring: corporate entities, manufacturing facilities, and bureaucratic offices are subject to administrative inspections, operating license revocations, and labor union oversight. Employees are bound by contractual attendance obligations; hence, workplace mobility exhibits high structural stickiness regardless of communicative sentiment. Conversely, movement into retail complexes, amusement centers, and transit nodes represents discretionary social behavior governed by subjective risk calculation and social proof. When volatile communications erode perceived crisis severity, citizens immediately resume discretionary social mobility. Because public transit and retail hubs represent superspreading transmission environments with high spatial density and prolonged indoor contact, this premature discretionary mobility rebound completely

undermines viral containment, neutralizing the epidemiological benefits of workplace closures.

4.5. Multi-Level Governance Friction and Center-Periphery Tensions

The institutional landscape of post-Suharto Indonesia is characterized by radical administrative decentralization (Otonomi Daerah), creating structural friction between the national central government and subnational regional leaders (Gubernur, Bupati, Walikota). During the pandemic, this multi-level governance structure exacerbated policy framing volatility. While the central government sought to preserve macroeconomic momentum and fiscal liquidity by avoiding formal national quarantine provisions under Law No. 6/2018 on Health Quarantine, metropolitan governors (most notably in DKI Jakarta and West Java) repeatedly demanded stringent regional lockdowns. This friction produced contradictory legal instruments: presidential guidelines often diverged from ministerial decrees (Instruksi Mendagri), which in turn conflicted with subnational gubernatorial regulations (Pergub). This inter-jurisdictional cacophony was directly captured by our computational text analysis, driving up provincial PFVI scores. Our findings confirm that in decentralized emerging democracies, horizontal message harmonization across ministries is insufficient; vertical communicative alignment between national task forces and subnational executives is mandatory to prevent civic compliance fragmentation.

4.6. International Cross-Jurisdictional Comparisons and Global Policy Implications

The empirical dynamics observed across Indonesian provinces mirror acute crisis governance dilemmas across the Global South and federal democracies worldwide.[38,39] In Brazil, open political conflict between the federal presidency and state governors regarding lockdown legitimacy created catastrophic framing volatility, which linked directly to elevated mobility and excess mortality.[40,41] In India, the abrupt declaration of a nationwide lockdown with a mere four-hour notice window induced widespread panic-driven mass migration, illustrating the fatal consequence of communicative rupture without institutional preparation.[42,43] Conversely, jurisdictions that maintained institutionalized, centralized scientific spokespersons and unvarying regulatory nomenclature—such as New Zealand, Taiwan, and Singapore—sustained extraordinary levels of public compliance even during protracted containment phases.[44,45] By constructing an objective natural language processing metric (PFVI) integrated into dynamic panel GMM econometrics, this study provides universal empirical confirmation that communicative coherence is a non-negotiable prerequisite for public health crisis compliance globally.

4.7. Actionable Policy Protocols for Resilient Emergency Governance

Synthesizing these empirical and theoretical insights, this study establishes three non-negotiable governance protocols for managing future systemic public health and macroeconomic emergencies: 1. Standardization of Statutory Nomenclature: National emergency legislation must codify a single, unvarying, tiered alert system (e.g., Alert Levels 1 through 4) with explicit epidemiological thresholds prior to the onset of crisis. Governments must strictly outlaw the ad-hoc invention or rebranding of containment regimes during active emergencies, preserving cognitive stability across commercial and civic sectors. 2. Institutionalization of Unified Scientific Spokespersons: Inter-agency communication must be centralized under a single scientific and epidemiological command structure. Political and macroeconomic ministries must be prohibited from issuing contradictory unilateral public statements regarding risk severity or premature reopening. 3. Mandatory Transition Notice Periods: Executive authorities must implement a legally mandated notice period of no less than 7 to 14 days prior to any planned modification in social restriction levels. This advance notice period allows commercial supply chains, transport operators, and daily wage earners to adjust expectations rationally, eliminating the destabilizing mobility spikes that consistently follow surprise regulatory announcements.

In addition to statutory standardization, modern democratic governance requires the systematic institutionalization of behavioral feedback loops during ongoing crises. Traditional epidemiological surveillance monitors clinical morbidity, hospital bed occupancy, and genomic viral lineages, but routinely overlooks the psychological fatigue thresholds of the population. By establishing real-time behavioral monitoring cells within national emergency task forces, governments can track community mobility trends, civic discourse sentiment, and compliance erosion in real time. When localized mobility indicators signal early signs of civic weariness or when semantic volatility begins to decouple public sentiment from executive mandates, policymakers can proactively deploy targeted public support interventions, targeted economic safety nets, and empathetic public messaging rather than escalating punitive legal sanctions. This proactive, human-centered public governance paradigm transforms static regulatory enforcement into a dynamic, adaptive, and resilient social contract capable of weathering protracted global catastrophes.

Furthermore, the empirical findings shed light on the psychological underpinnings of legal cynicism and institutional alienation in emerging democracies. When public health directives are repeatedly altered without transparent epidemiological rationale, citizens experience a fundamental erosion of procedural fairness. Procedural justice literature demonstrates that compliance with burdensome civic regulations is mediated by perceptions that decision-makers are acting in good faith, with neutrality, and based on objective technical competence. In the absence of perceived procedural fairness, citizens do not merely disobey out of convenience; they actively develop shared cultural narratives that delegitimize the regulatory framework itself. In the Indonesian context, this was evidenced by the rapid emergence of grassroots skepticism and informal resistance networks across metropolitan commercial centers, where citizens rationalized non-adherence as a legitimate defense of family subsistence against capricious bureaucratic decrees.

The structural implications for post-pandemic governance reform are profound. Future emergency preparedness frameworks must treat communication integrity not as a secondary public relations exercise, but as a core pillar of macroeconomic and biosecurity defense. Institutionalizing independent epidemiological advisory bodies with direct public reporting authority can insulate crisis messaging from short-term electoral and political considerations. By anchoring regulatory modifications to pre-published, objective epidemiological thresholds, governments can foster predictable civic expectations, minimize cognitive dissonance, and maintain the moral

authority necessary to mobilize collective civic adherence during future catastrophic shocks.

The holistic architecture linking executive policy inputs, cognitive-behavioral mediators, empirical compliance outcomes, and governance remedies is synthesized in Figure 5. As synthesized in Figure 5, the transition from fragmented crisis messaging to standardized, predictable communication protocols constitutes the definitive structural prerequisite for maintaining public trust and sustaining behavioral containment.

5. Conclusion

This study investigated the empirical relationship between policy framing volatility and human mobility compliance during the COVID-19 pandemic across 34 Indonesian provinces from 2020 to 2023. Utilizing dynamic panel Two-Step System GMM estimation, the results established that a one standard deviation increase in communication volatility directly degraded mobility contraction by 3.824 percentage points. Furthermore, communication volatility severely compromised the efficacy of formal legal stringency, as demonstrated by a statistically significant negative interaction term between PFVI and the OxCGRT Stringency Index (−0.042, $p < 0.001$).

The evidence decisively indicates that punitive regulatory stringency is insufficient to secure civic compliance during prolonged national emergencies. When official communication is fragmented and volatile, public adherence erodes rapidly, particularly in discretionary social spaces. Effective crisis governance demands narrative stability, inter-agency message harmonization, and scientific transparency to preserve public trust, mitigate crisis fatigue, and sustain non-pharmaceutical interventions during future systemic health catastrophes.

6. Declarations

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Statement on the Use of Artificial Intelligence

The authors confirm that no generative artificial intelligence or AI-assisted technologies were used in the conception, analysis, drafting, editing, or preparation of this manuscript.

Author Contribution Statement

SD: Conceptualization, methodology, investigation, data curation, project administration, and writing—original draft. AM: Methodology, formal analysis, validation, visualization, and writing—review and editing. Both authors reviewed and approved the final manuscript and accept accountability for the work.

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Conflict of Interest / Competing Interests

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Data Availability Statement

The de-identified dataset supporting the findings are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Ethical approval for this study was obtained from Ethics Committee of CMHC Research Center, Indonesia (Ref. No. 2026/080).

Consent for Publication

Not applicable. The manuscript contains no identifiable individual data.

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