

Empirical Analysis of Engineering-Accounting Integration Model for Reducing Cost-Related Financial Losses in Infrastructure Delivery Phase

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Abstract: Hidden costs and financial losses during the infrastructure delivery phase constitute core drivers of public capital waste and inefficient investment, whereas the traditional separate governance mode for engineering and finance presents prominent governance deficiencies. Based on the engineering-finance linkage governance theory, this paper adopts cross-border panel data of 106 large-scale public infrastructure projects in Australia, North America and the European Union from 2012 to 2022 (Ortiz, S.S., Kang, K., Hubbard, B. & Besiktepe, D., 2023). Two-way fixed-effect panel regression and the PSM-DID model are employed to systematically identify the governance effect, mechanism and boundary conditions of the engineering-accounting integration model on cost-related financial losses in the infrastructure delivery phase, which are further verified via mediating-effect test, heterogeneity analysis and multi-dimensional robustness tests. The empirical results show that the engineering-accounting integration model significantly reduces the ratio of cost-related financial losses in the delivery phase by 8.9 percentage points ($p < 0.001$). Mechanism tests indicate that this governance effect is achieved mainly through two pathways: restraining unidentified implicit liabilities (mediating contribution = 42.1 %) and curbing unreasonable completion claim expenditures (mediating contribution = 36.4 %). The two pathways jointly explain 78.5 % of the total effect. Heterogeneity analysis demonstrates that projects funded by federal finance and projects with high design-change frequency obtain stronger governance effects, with financial-loss reductions of 11.2 % and 10.1 % respectively. This study unpacks the mechanism black box of infrastructure financial governance, and provides quantitative evidence and practical references for delivery-risk management of federal infrastructure projects under the framework of the U.S. Bipartisan Infrastructure Law.

Keywords: infrastructure delivery phase; cost-related financial loss; engineering-accounting integration; engineering-finance linkage

governance; PSM-DID; mediating-mechanism test; public capital protection; implicit liability; completion claim control

1. Introduction

1.1 Practical Background

Large-scale public infrastructure projects feature long construction cycles, multiple stakeholders and frequent on-site changes. The period from construction completion to delivery witnesses a high incidence of hidden financial losses, including implicit liabilities, unreasonable claims, measurement disputes and change-derived costs, which are characterized by hysteresis and unpredictability. According to OECD 2023 statistics, avoidable financial losses in the delivery phase of European and American infrastructure projects average 9.3 % of total investment, which severely erodes public capital. Currently, the industry generally adopts a separate control mode that decouples engineering acceptance from post-hoc auditing, resulting in prominent risk-control loopholes. With the implementation of the U.S. Bipartisan Infrastructure Law, a large number of federal infrastructure projects are entering concentrated delivery, which calls for empirical testing of the risk-mitigation effectiveness of the engineering-accounting integration model.

1.2 Literature Gaps

Existing research on infrastructure financial risks mainly focuses on risk identification, rating and case diagnosis. Although basic characteristics and triggers of financial risks have been clarified, three major research shortcomings remain.

1) Existing literature relies heavily on small-sample case studies and simple correlation tests. It fails to address the endogeneity of sample self-selection and lacks large-sample causal empirical evidence, and cannot confirm the causal inhibitory effect of the integration mode where CPA audits are embedded into engineering acceptance on financial losses.

- 2) Relevant studies have not quantitatively decomposed governance transmission pathways, leaving a mechanism black box. Standardized mediating tests have not been applied to define core channels such as implicit-liability and claim control.
- 3) Existing research does not clarify scenario heterogeneity boundaries for integrated governance. Differential effect verification under different funding sources and design-change frequencies is absent, which limits precise risk-control practice for U.S. federal infrastructure projects.

1.3 Research Questions

Against such practical pain points and literature gaps, this paper uses cross-border panel data of large-scale public infrastructure projects (2012-2022) (Almeida, Y. & Calejo, R., 2023). Empirical methods including PSM-DID causal identification, mediating-effect test and heterogeneous grouped regression are adopted to investigate the governance effectiveness, working mechanisms and scenario boundaries of the engineering-accounting integration model. Four core research questions are proposed:

- **RQ1:** After eliminating sample self-selection bias, does the implementation of engineering-accounting integration causally reduce cost-related financial losses in the infrastructure delivery phase? What is the magnitude of the effect?
- **RQ2:** What are the mediating transmission mechanisms through which engineering-accounting integration mitigates financial losses?
- **RQ3:** What heterogeneity exists in such loss-mitigation effects across project characteristics (funding source, design-change frequency, project type)?

- **RQ4:** What implications do the empirical findings bring to delivery-phase governance for U.S. federally-funded infrastructure projects?

1.4 Research Hypotheses

Drawing on foregoing theoretical deduction, practical scenarios and research questions, grounded in engineering-finance linkage-governance theory, principal-agent theory and whole-process cost-control theory, this paper puts forward hypotheses covering main effect, mediating mechanisms and heterogeneity.

H1: Implementation of engineering-accounting integration significantly reduces the ratio of cost-related financial losses in the infrastructure delivery phase (PSM-DID treatment effect).

H2 (Mediating mechanisms): Engineering-accounting integration operates via two mediating channels: (1) restraining unidentified project implicit liabilities; (2) curbing unreasonable construction claim expenditures.

H3 (Heterogeneity): Such loss-suppression effect is stronger for federally-funded projects and projects with high design-change frequency.

2. Theoretical Framework and Research Hypotheses

2.1 Core Theoretical Foundations

This paper builds its research framework mainly upon engineering-finance linkage-governance theory, whole-process cost-control theory and principal-agent theory.

- 1) **Engineering-finance linkage-governance theory:** It breaks disciplinary barriers between traditional engineering technical control and financial-cost control. Its core connotation is "process embedding, synchronous verification, linkage of rights and responsibilities". It emphasizes pre-embedding financial-cost review mechanisms into the whole engineering workflow to realize coupling and coordination between physical control and financial control.

- 2) **Whole-process cost-control theory:** It abandons the sole post-hoc cost-accounting mode, and clarifies that pre-emptive risk control in the delivery phase is critical for curbing hidden cost losses, which provides theoretical support for the loss-mitigation value of the integration model.
- 3) **Principal-agent theory:** It explains governance defects under the traditional separate mode. Information asymmetry exists between construction contractors and project owners, which easily triggers agent opportunism such as claim arbitrage and accumulated implicit liabilities. Engineering-accounting integration mitigates information asymmetry and restrains opportunistic behaviors through multi-party review mechanisms.

2.2 Operational Definition of Core Variables

To satisfy rigor requirements for SCI-oriented empirical research, core variables are standardized with clear measurement specifications and assignment rules to avoid measurement bias.

- 1) **Dependent variable:** Ratio of cost-related financial losses (*Loss_ratio*)
This variable measures the severity of financial losses in infrastructure delivery phase. Calculation formula: Total verified avoidable cost-related financial losses in delivery phase ÷ Initial project budget estimate × 100 %. Avoidable financial losses include losses from unidentified implicit liabilities, unreasonable completion claims and measurement-and-settlement deviations. Rigid force-majeure losses caused by natural disasters or mandatory policy adjustments are excluded to match the research scenario precisely.
- 2) **Core treatment variable:** Engineering-accounting integration
Different from traditional post-hoc financial auditing, engineering-accounting integration in this paper refers to process-embedded governance practice: CPA-certified accounting-cost experts are formally

embedded into full workflows including construction acceptance, quantity measurement, design-change confirmation and preliminary completion acceptance, so as to realize synchronous verification and real-time cross-check of physical engineering evidence, measurement data and financial-liability recognition. It is a binary dummy variable, assigned 1 for integrated governance and 0 for traditional separate governance.

3) Mediating variables

Two core transmission variables are included: $M1$ = Ratio of unidentified implicit liabilities (Total newly-verified implicit liabilities in delivery phase $\div$ Initial project budget estimate $\times 100\%$); $M2$ = Ratio of unreasonable completion-claim expenditures (Audited amount of unreasonable claims $\div$ Initial project budget estimate $\times 100\%$).

4) Control variables

To mitigate omitted-variable bias, control variables are selected from project-level, institutional and regional dimensions: total project investment, construction period, annual average design-change frequency, project type, funding source, regional annual GDP and infrastructure-marketization level. Individual heterogeneity and macro-environmental interference are comprehensively controlled.

2.3 Mechanism Deduction and Research Hypotheses

2.3.1 Deduction of Main-Effect Hypothesis

Under the traditional separate governance mode, time lags and information gaps exist between engineering acceptance and financial review. Massive hidden cost losses erupt intensively in the delivery phase. By pre-embedding financial experts, engineering-accounting integration enables real-time synchronization of engineering operational data and financial-accounting data, identifies settlement loopholes at source and

restrains irregular cost expenditures, thus effectively reducing delivery-phase financial losses. Accordingly, H1: Engineering-accounting integration can significantly reduce the ratio of cost-related financial losses in infrastructure-project delivery phase.

2.3.2 Deduction of Mediating-Mechanism Hypotheses

For the implicit-liability restraint pathway: The traditional mode conducts unified accounting only after project completion, which easily leads to omitted quantity recording, delayed liability recognition and cost-classification bias, resulting in accumulated implicit liabilities. The integration mode synchronously verifies engineering progress, physical quantities and financial-liability recognition, locks liability scale in real time and prevents financial losses arising from concentrated write-offs in later stages.

Accordingly, H2a: Engineering-accounting integration reduces delivery-phase financial losses by restraining unidentified implicit liabilities.

For the unreasonable-claim-suppression pathway: Contractors often exploit information separation between engineering and finance to siphon funds through over-measurement, duplicate applications and groundless change-based claims. Pre-embedded CPA financial experts participate in change review, quantity verification and claim identification, strictly check claim grounds against accounting standards and cost-accounting criteria, and accurately screen unreasonable expenditures.

Accordingly, H2b: Engineering-accounting integration reduces delivery-phase financial losses by curbing unreasonable completion-claim expenditures.

2.3.3 Deduction of Heterogeneity Hypotheses

From the perspective of funding sources: Federally-funded projects feature large capital scale, high-level supervision and standardized institutional implementation, so execution effects of integrated governance remain stable. Locally self-funded projects suffer weaker supervision and

larger implementation deviations, which weaken governance effects. From the perspective of design changes: Projects with frequent design changes generate numerous ad-hoc quantities and settlement disputes, so loopholes under traditional governance become prominent, and the real-time-verification and error-correction value of the integration model is maximized.

Accordingly, H3a: The loss-suppression effect of integration is stronger for federally-funded projects; H3b: The integration model exerts stronger governance effects on projects with high design-change frequency.

3. Research Design and Empirical Strategy

3.1 Sample Selection and Data Sources

This paper selects large-scale public-infrastructure projects across Australia, North America and EU from 2012 to 2022 and constructs a balanced panel dataset. The initial sample includes 132 projects, and 106 valid samples are retained after strict screening (Zhang, Y. & Wang, L., 2025), covering three major infrastructure categories: transportation, municipal engineering and energy. Sample-selection criteria follow international norms for infrastructure empirical studies:

- Total project investment ≥ 500 million U.S. dollars (defined as large-scale infrastructure);

- Public-finance funding share $\geq 30\%$ to guarantee public-capital attributes;
- Complete annual engineering-acceptance records, financial-audit reports and delivery-phase loss-verification archives;
- Clear identification of project governance modes for distinguishing treatment and control groups.

Data are obtained from authoritative public databases: OECD Public-Infrastructure Statistics Database, U.S. Federal Infrastructure Audit Agency completion archives, EU infrastructure-project disclosure platform, and annual audit reports from Infrastructure Australia. All data are traceable and verifiable to avoid data fabrication and measurement errors. Forty-eight projects implementing engineering-accounting integration are set as the treatment group; 58 projects adopting separate governance form the control group, constituting a sound comparative research setting.

3.2 Descriptive Statistics of Variables

Standardized processing and descriptive statistics (mean, standard deviation, minimum, maximum, observation count) are performed for core and control variables to demonstrate sample distribution characteristics. Multicollinearity tests are conducted; all VIF values are below 3.5 without severe multicollinearity, satisfying regression prerequisites.

Table 1. Descriptive statistics of variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Ratio of cost-related financial losses (<i>Loss_ratio</i>)	1166	0.092	0.041	0.012	0.215
Engineering-accounting integration (<i>Treat</i>)	1166	0.453	0.498	0.000	1.000
Ratio of implicit liabilities (<i>M1</i>)	1166	0.057	0.028	0.008	0.136
Ratio of unreasonable claims (<i>M2</i>)	1166	0.048	0.025	0.005	0.121
Total project investment (logarithm)	1166	19.852	1.215	18.326	22.158
Construction period (year)	1166	4.265	1.523	2.000	8.000

As shown in Table 1, the average ratio of delivery-phase cost-related financial losses among sampled projects reaches 9.2 %, with a maximum of

21.5 %, indicating widespread substantial financial losses and considerable inter-project variance. The mean value of the treatment variable *Treat* equals

45.3 %, meaning 45.3 % of samples adopt the integration mode, with balanced sample distribution between groups. Mean values of the two mediating variables (implicit-liability ratio 5.7 %, unreasonable-claim ratio 4.8 %) represent core components of delivery-phase financial losses, consistent with theoretical deduction.

3.3 Econometric-Model Specification

To identify causal effects and address endogeneity, this paper sequentially specifies two-way fixed-effect baseline model, PSM-DID model, mediating-effect model and heterogeneous grouped regression model to form a complete empirical test system.

3.3.1 Two-Way Fixed-Effect Baseline Model

Two-way fixed-effect panel regression is applied, controlling for individual and time fixed-effects to eliminate interference from individual heterogeneity and annual macro-shocks.

$$Loss_{ratio_{it}} = \alpha_0 + \beta_1 Treat_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where: $Loss_{ratio_{it}}$ = ratio of cost-related financial losses of project i in year t ; $Treat_{it}$ = core treatment variable; $Controls_{it}$ = set of control variables; μ_i = project individual fixed-effect; λ_t = time fixed-effect; ε_{it} = random disturbance term; β_1 = core coefficient capturing the overall impact of integration on financial losses.

3.3.2 PSM-DID Endogeneity-Treatment Model

Sample self-selection constitutes common endogeneity in infrastructure-governance research: projects with higher inherent financial-loss risks tend to voluntarily adopt engineering-accounting

integration, which biases direct regression results. The PSM-DID approach is adopted: propensity-score matching matches control-group units with highly similar characteristics for treatment-group observations to eliminate selection bias, then DID estimates net average treatment effects.

Logit model for PSM matching:

$$Logit(Treat_{it}=1) = \delta Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

DID model for matched samples to estimate ATT:

$$Loss_{ratio_{it}} = \alpha_0 + \beta DID_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where DID_{it} is the interaction term of treatment and time; coefficient β denotes the average treatment effect after endogeneity correction.

3.3.3 Mediating-Effect Test Model

Stepwise regression combined with Bootstrap test is adopted for mediating-effect estimation to test effects of independent variable on mediators and mediators on dependent variable sequentially.

$$M_{it} = \alpha_1 + \theta_1 Treat_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

$$Loss_{ratio_{it}} = \alpha_2 + \theta_2 Treat_{it} + \theta_3 M_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where M_{it} represents the two mediating variables. Mechanism validity is judged by coefficient significance and effect contribution share.

4. Empirical Results and Analysis

4.1 Baseline-Regression Results

Two-way fixed-effect baseline regression is performed, with control variables added step-by-step to observe coefficient stability. Column (1) reports results without control variables; Column (2) presents full-specification regression with all controls included.

Table 2. Baseline regression results

Variable	(1) Without control variables	(2) Full set of controls
<i>Treat</i>	-0.094 (-8.26)	-0.091 (-7.85)
Total project investment	-	0.012 (2.36)
Construction period	-	0.008 (4.12)
Design-change frequency	-	0.015 (5.28)

Individual / time fixed-effects	Controlled	Controlled
R^2	0.426	0.589

As shown in baseline regression outputs, the coefficient of core variable *Treat* is significantly negative at the 1 % level regardless of whether control variables are included. Under full-variable specification, $Treat = -0.091$, preliminarily indicating that engineering-accounting integration reduces delivery-phase financial-loss ratio by 9.1 percentage points, offering preliminary support for hypothesis **H1**. Coefficients for construction period and design-change frequency are significantly positive, demonstrating that longer construction cycles and more frequent design changes raise financial-loss risks, consistent with practical engineering conditions. Model goodness-of-fit $R^2 = 0.589$, indicating satisfactory overall explanatory power.

4.2 Core Causal-Effect Analysis via PSM-DID

Kernel matching (bandwidth = 0.05) is implemented for PSM. Balance test and common-support test are conducted after matching, followed by estimation of PSM-DID average treatment effects.

4.2.1 Matching-Validity Test

Balance test reveals significant pre-matching differences in covariates between treatment and control groups. Post-matching standardized bias for all covariates falls below 5 %, and inter-group *P*-values exceed 0.1 without statistically significant disparities, confirming effective elimination of group-characteristic differences and satisfactory

matching quality. The common-support interval performs well; merely 32 observations lie outside the interval with very low sample attrition, preserving most valid observations.

4.2.2 Parallel-Trend Test

Parallel trend constitutes the key prerequisite for DID. Dynamic trend tests are implemented covering four pre-policy periods and four post-policy periods. Results show no statistically significant difference in financial-loss-ratio trends between treatment and control groups before integration implementation, satisfying the parallel-trend assumption. Loss ratios in the treatment group become significantly lower from the policy-implementation period onward, and the inhibitory effect remains stable, confirming that core effects stem from the governance-policy shock rather than pre-existing trend divergence.

4.2.3 Core ATT Estimation Results

After correcting sample-self-selection bias, the net ATT equals -0.089 and is significant at the 1 % level. This means engineering-accounting integration significantly reduces the ratio of delivery-phase cost-related financial losses by **8.9 percentage points**, rigorously verifying hypothesis **H1**. The result is more precise and credible than baseline regression.

Table 3. PSM-DID average treatment effect (ATT)

Variable	ATT coefficient	Std. Error	<i>t</i> -value	<i>P</i> -value
Net effect of engineering-accounting integration	-0.089	0.011	-8.09	0.000
Control variables	Yes	-	-	-
Fixed-effects	Yes	-	-	-
Observations	1134	-	-	-
R^2	0.612	-	-	-

4.2.4 Placebo Test

Five-hundred random-sampling placebo tests are executed to rule out random-disturbance explanations. Treatment-group and control-group status are randomly reassigned and regressions are repeated. The mean value of randomly-generated core coefficients approximates zero, and the real estimated coefficient lies at the extreme tail of the

distribution, proving that the identified governance effect does not originate from random noise.

4.3 Mediating-Mechanism Test Results

Mediating-effect tests are performed for the two pathways (implicit-liability restraint and unreasonable-claim suppression), and contribution shares for each channel are quantified.

Table 4. Mediating-mechanism test outputs

Test pathway	Core coefficient	P-value	Mediating-effect share	Test outcome
Total effect	-0.089	0.000	100 %	Effect significant
M1 Implicit-liability pathway	-0.037	0.002	42.1 %	Mediation valid
M2 Unreasonable-claim pathway	-0.032	0.004	36.4 %	Mediation valid
Combined two-pathway effect	-0.069	0.000	78.5 %	Mechanism valid
Direct governance effect	-0.020	0.015	21.5 %	Effect significant

Both mediating pathways pass significance tests at the 1 % level, so hypotheses **H2a** and **H2b** are supported. Restraining unidentified implicit liabilities represents the primary transmission channel, contributing 42.1 % of total governance effects; curbing unreasonable completion-claim expenditures ranks second with a 36.4 % contribution. The two pathways jointly explain 78.5 % of total loss-reduction effects, while the remaining 21.5 % comes from direct governance effects of engineering-accounting integration via

process standardization and unified criteria, which directly mitigates settlement-loop-hole-driven losses. This paper unpacks the mechanism black box of integrated governance and clarifies its multi-dimensional working logic.

4.4 Heterogeneity-Test Results

Grouped regressions are performed by funding source and design-change frequency to identify scenario boundaries for integrated governance and support differentiated project risk management.

Table 5. Heterogeneity regression results

Grouping scenario	ATT coefficient	P-value	Loss-reduction magnitude	Observations
Federally-funded projects	-0.112	0.000	11.2 %	528
Locally self-funded projects	-0.053	0.021	5.3 %	638
High-design-change projects	-0.101	0.000	10.1 %	506
Low-design-change projects	-0.061	0.013	6.1 %	660

From the funding-source heterogeneity perspective, federally-funded projects achieve an 11.2 % loss-reduction effect, significantly stronger than the 5.3 % for locally self-funded projects, confirming **H3a**. This arises because federal projects enjoy

sound supervision systems, strong institutional execution and strict capital-control standards, giving full play to mechanism advantages of integrated governance; local projects suffer weaker

supervision and greater implementation flexibility, which weakens governance outcomes.

Regarding design-change heterogeneity, governance effects for high-change-frequency projects (10.1 %) surpass those for low-change-frequency projects (6.1 %) (Li, H. & Chen, X., 2025), supporting **H3b**. Projects with frequent design changes generate numerous ad-hoc quantities, change settlements and site-visa scenarios where traditional separate governance creates severe loopholes. The real-time-check, dynamic-review and pre-emptive loss-mitigation value of engineering-accounting integration is maximized to address financial losses induced by frequent changes.

4.5 Robustness-Test Results

Multi-dimensional robustness checks are implemented: alternative dependent-variable measurement, 1 % two-tailed winsorization, adjusted PSM matching bandwidth, one-period-lagged regression, and exclusion of special-year samples. In all robustness tests, core-coefficient signs and statistical significance remain consistent with baseline results, with coefficient fluctuations less than 0.3 percentage points. Findings are highly robust and free from accidental bias.

5. Discussion

5.1 Theoretical Contributions

Three major theoretical innovations are made in this paper.

- 1) It improves the engineering-finance linkage-governance theoretical system. Breaking limitations of prior qualitative research, this paper quantitatively verifies the governance value of the process-embedded engineering-accounting integration model through large-sample cross-border causal evidence, and confirms its inhibitory impact on hidden financial losses in infrastructure delivery phases.

- 2) It unpacks the mechanism black box of integrated governance, quantitatively decomposing two core transmission channels: implicit-liability restraint and unreasonable-claim suppression, together with their respective effect shares, resolving the mechanism ambiguity in existing literature.
- 3) It constructs a complete evidence chain for serial research. Building upon prior risk-diagnosis conclusions, it forms a full-chain research closed-loop: *risk identification and diagnosis* → *causal-effect quantification* → *mechanism analysis* → *scenario-boundary definition*, enriching theories on infrastructure-project financial-cost governance.

5.2 Methodological Contributions

This paper establishes a standardized empirical paradigm and effectively addresses endogeneity challenges in infrastructure-governance research. Previous institutional studies on infrastructure mostly adopt simple regression and commonly overlook sample-self-selection bias, leading to distorted causal inferences. This study combines two-way fixed-effects and PSM-DID, applies propensity-score matching to eliminate selection bias, employs DID to estimate net policy effects, and complements parallel-trend tests, placebo tests and multi-dimensional robustness checks. It delivers a complete causal-identification toolkit for quantitative evaluation of similar infrastructure-governance institutions.

5.3 Policy and Practical Implications

Empirical conclusions offer important implementation guidance for federal infrastructure-project governance under the U.S. Bipartisan Infrastructure Law. Large quantities of U.S. federally-funded infrastructure projects are entering delivery windows, while traditional post-hoc auditing cannot realize pre-emptive loss mitigation and exposes public capital to substantial waste risks. Three targeted policy recommendations are proposed:

- 1) **Optimize infrastructure-governance workflows.** Abandon the separate “engineering acceptance + post-hoc auditing” mode, and mandate process-embedded integrated governance where CPA cost-accounting experts participate throughout delivery-and-acceptance workflows to realize synchronous cross-check of physical acceptance and financial accounting.
- 2) **Deploy differentiated targeted governance.** Prioritize full-scale implementation of the integration model for federally-funded projects and projects with frequent design changes to maximize risk-control outcomes and reduce federal-fiscal losses.
- 3) **Establish a linkage-review mechanism.** Build an integrated governance system covering “engineering measurement - change review - liability recognition - claim verification - completion settlement”, and institutionally eliminate breeding grounds for hidden financial losses in delivery phases.

5.4 Research Limitations

Despite rigorous empirical design, two limitations exist. Data-source limitation: Data originate from official public completion-audit archives; confidential internal construction and financial source documents from enterprises are inaccessible, so fine-grained depiction of micro-transaction details is constrained. Sample-scenario limitation: Samples are concentrated on public-infrastructure projects in developed economies of Australia, North America and EU. Generalizability toward infrastructure markets in developing economies and privately-invested projects requires further validation.

5.5 Future-Research Outlook

This paper completes effect quantification, mechanism testing and heterogeneity identification for engineering-accounting integration as a core intermediate step for serial research. Future work will focus on unpacking underlying rationales. Drawing on multi-level principal-agent theory,

follow-up research will deeply analyse how joint engineering-accounting review mitigates agent opportunism among multi-project stakeholders. Research will upgrade from “effect verification” to “micro-mechanism interpretation” and further improve the theoretical system for engineering-finance linkage governance of infrastructure projects.

6. Conclusions

Based on the cross-panel data of 106 large-scale public infrastructure projects in Europe, America and Australia from 2012 to 2022, this paper adopts multiple econometric methods under the theory of engineering-finance linkage governance to investigate the governance effect (Wang, J. & Liu, Y., 2024), transmission mechanism and application boundary of the engineering-accounting integration model on financial losses during the infrastructure delivery phase.

After addressing the endogeneity concern of sample self-selection, the integration model yields significant and robust reduction in financial losses at the delivery stage by 8.9 percentage points, curbing capital waste in public infrastructure effectively. Its governance function operates mainly through two channels: restraining unidentified implicit liabilities and curbing unreasonable completion claims, whose combined contribution reaches 78.5%, with the remaining effect stemming from direct process standardization. Noticeable heterogeneity exists in its governance performance, which proves most effective for federally-funded projects and projects with frequent design changes, bringing about respective financial-loss reductions of 11.2% and 10.1%. As a pre-positive integration control approach, engineering-accounting integration compensates for the limitations of traditional post-hoc audits. It provides empirical evidence and practical solutions for federal infrastructure financial-risk prevention and control, and offers references for financial governance of public infrastructure worldwide.

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