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External Shocks, Management Control, and Financial Resilience Treasury Management and Organizational Agility in Moroccan Firms: An Econometric Research Design and Simulation-Based Validation

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ABSTRACT

External disruptions threaten firms through operating cash-flow losses, funding constraints, and delayed managerial responses. This paper develops an implementation-ready

research design linking management control, treasury capability, and organizational agility to financial resilience in Moroccan nonfinancial firms. A structured, non-exhaustive synthesis integrates management accounting, corporate liquidity, dynamic capabilities, and panel econometrics. The proposed prospective design combines baseline capability

audits with quarterly accounts and predetermined exposure to externally measured shocks. Firm and time fixed effects identify differential shock responses; local projections examine recovery, while mechanism analyses remain explicitly conditional rather than automatically causal. Because no observed firm dataset is available, the quantitative evidence comprises 7,000 executed synthetic panel estimations across fourteen design cells, not estimates for Morocco. With 450 synthetic firms and sixteen quarters, the mean control-buffering estimate is 0.079 against an assigned coefficient of 0.080; nominal 95% interval coverage is 92.6%, and the null rejection rate is 7.2%. Capability measurement error reduces the mean estimate to 0.044, whereas an omitted shock-aligned confounder raises it to 0.161. These findings validate reproducibility and expose identification weaknesses rather than establish substantive effects. The paper specifies measurement rules, baseline comparisons, ablations, inference safeguards, and ethical data-access conditions for a future empirical study.

Keywords: external shocks; management control; cash management; financial resilience; agility; Morocco; panel econometrics. JEL: G32, M41, C23.

1. Introduction

1.1. Problem framing and motivation

A firm can report accounting profits and still fail to meet payroll when customers delay payments, imported inputs become more expensive, or credit becomes unavailable. Financial resilience therefore concerns the continuity and recovery of payment-generating capacity, not simply profitability or a large cash balance. Research on financial flexibility supports the importance of pre-crisis balance-sheet conditions, while research on smaller firms documents their vulnerability to disruptions (Bartik et al., 2020; Eggers, 2020; Fahlenbrach et al., 2021). The unresolved managerial question is whether control routines and rapid, informed treasury decisions explain different responses among otherwise comparable firms.

1.2. Research question and contribution

The central question is whether pre-existing management control, treasury capability, and organizational agility moderate the relationship between externally measured shocks and subsequent financial outcomes. A second question asks whether improved information and shorter decision delays are plausible mechanisms. The distinction matters: observing that well-managed firms survive a crisis does not establish that introducing a dashboard would cause the same

improvement. Managerial quality, banking relationships, and market position can influence both capability adoption and outcomes.

The proposed contribution is a falsifiable integration rather than a claim that these concepts have never been connected. Roffia and Dabić (2024) already associate budgeting, continuity tools, and supplementary financial resources with SME resilience. This paper extends that logic through temporally separated measurement, document verification, heterogeneous exposure, and explicitly differentiated statistical and causal estimands. It also provides an executed simulation diagnostic showing when a plausible panel specification succeeds or fails. No survey has been administered, no firms have been recruited, and no Moroccan treatment effect is reported.

2. Background and Related Work

2.1. Management control: information versus rigidity

Management control is a package of planning, measurement, administrative, and cultural arrangements rather than a single software purchase (Malmi & Brown, 2008). Diagnostic use compares realized outcomes with targets, whereas interactive use directs attention toward uncertainty and strategic learning (Henri, 2006). Under an external disruption, frequent variance review may reveal a liquidity shortfall early enough to act. Conversely, punitive adherence to obsolete targets may delay adaptation. The relevant hypothesis is therefore about information use and response routines, not an unconditional benefit from tighter control.

Table 1: Related evidence and its implications for the proposed design.

Research stream	Supported insight	Unresolved issue addressed here
Control and SME resilience (Roffia & Dabić, 2024)	Budgeting, continuity planning, and available finance are positively associated with resilience.	Retrospective survey associations do not isolate intervention effects.
Corporate liquidity (Almeida et al., 2004; Opler et al., 1999)	Cash policies reflect constraints and precautionary financing needs.	Cash stocks must be distinguished from treasury processes.

Financial flexibility (Fahlenbrach et al., 2021)	Pre-crisis financial conditions matter during a revenue disruption.	Listed-firm evidence does not directly identify Moroccan SME mechanisms.
Capabilities (Duchek, 2020; Teece, 2007)	Sensing, reconfiguration, and adaptation provide a process-based lens.	Capability definitions require independent outcome measurement.

2.2. Treasury capability, working capital, and agility

Liquidity research explains why firms retain cash and adjust saving behavior when external finance is costly (Almeida et al., 2004; Opler et al., 1999). Working-capital research links receivables, inventories, and payment cycles with profitability, but its observational associations should not be recast as universal instructions to postpone supplier payments (Deloof, 2003). Treasury capability is defined here as the ability to observe, forecast, mobilize, and allocate cash. Initial cash holdings are a separate resource, included among baseline covariates. This separation avoids defining a resilient firm as one that possesses the very liquidity measure used as its explanatory capability.

Agility concerns the speed and quality of resource reallocation, whereas resilience concerns functioning under disruption and subsequent recovery. Strategic sensitivity and resource fluidity offer mechanisms for adaptation (Doz & Kosonen, 2010; Teece, 2007). However, speed can amplify mistakes when signals are noisy. Duchek (2020) distinguishes anticipation, coping, and adaptation; Linnenluecke (2017) show that resilience research spans heterogeneous traditions. Accordingly, the design does not combine agility and resilience items into one scale. Financial outcomes remain independently measured from accounts and payment records.

2.3. Evidence gap and falsifiable hypotheses

The closest empirical comparator is Roffia and Dabić (2024), whose full text reports 143 valid Italian SME questionnaires and a smaller follow-up with 46 responses. This is useful evidence for managerial associations, not a Morocco-specific causal estimate. The gap targeted here is the joint assessment of distinct baseline capabilities against observed cash-flow dynamics, with predetermined exposure and explicit alternatives to the preferred explanation. Moroccan relevance is a reason to test transportability rather than assume it.

Hypothesis H1 predicts that greater adverse exposure lowers operating cash flow. H2 predicts that stronger baseline management control attenuates this loss. H3 predicts

attenuation by treasury capability after conditioning on initial cash resources. H4 predicts attenuation by agility, subject to reliable information. H5 proposes that control and treasury are complementary; it is exploratory because a three-way interaction requires substantially more precision. A null or harmful agility interaction would contradict the simple proposition that faster decisions are always protective.

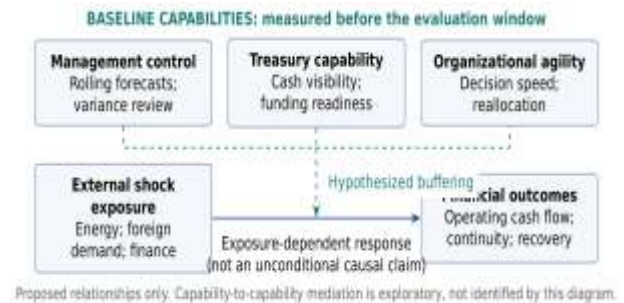


Figure 1: Proposed architecture.

Capabilities are measured before the evaluation window and moderate exposure dependent financial responses. Dashed connections indicate hypotheses, not established causal relations. The diagram deliberately does not identify a causal mediation chain.

3. Methods and Approach

3.1. Study design, population, and access conditions

The empirical study would prospectively recruit approximately 450 formal nonfinancial firms, targeting 10–249 employees and stratifying by sector, region, and size. This employee rule is an operational eligibility definition, not a claim to reproduce every Moroccan legal SME classification. Casablanca–Settat would be a feasible initial recruitment region, but national generalization requires a national frame. A consortium with professional associations and participating banks is proposed, not secured. Sixteen quarterly accounting observations would combine eight documented historical quarters and eight prospective quarters, subject to consent and record availability. Only the prospective window supports genuinely baseline capability measurement; historical capability claims require dated archival evidence.

The World Bank’s Morocco Enterprise Survey 2023 provides an independently documented benchmark for finance, management practices, and firm characteristics (World Bank Group, 2025). Its catalogue describes formal private establishments with at least five employees and stratified sampling. It is not assumed to contain the proposed treasury audit, quarterly account panel, or identical firm identifiers.

Access conditions, questionnaire coverage, and permitted linkages must be checked before any analysis. The research team would obtain its own sampling frame; the public catalogue is not a recruitment list.

Table 2: Operational definitions and separation of constructs.

Construct	Proposed operational measure	Source and timing
Control (Ci0)	Mean of four audited, anchored items: rolling forecast, variance review, scenario budget, escalation ownership.	CFO questionnaire plus dated documents at enrollment.
Treasury (Ti0)	Cash visibility, forecast reconciliation, committed-line documentation, collections workflow; four items.	Treasury respondent and independent evidence review at baseline.
Agility (Ai0)	Delegation, decision turnaround, reallocation readiness, cross-functional response; four items.	Operations respondent; dated process examples.
Cash-flow outcome (Yit)	Quarterly operating cash flow divided by total assets measured at enrollment.	Reconciled accounts; fixed denominator avoids contemporaneous scaling feedback.
Continuity / recovery	Any overdue payroll or debt payment; time to regain 90% of pre-event operating cash flow.	Payment logs; recovery rule only for positive pre-event reference flow.
Adverse exposure (Sk it)	Baseline exposure share multiplied by an externally measured adverse innovation.	Input invoices, export destinations, debt repricing schedules; external series.
Baseline covariates	Cash/assets, leverage, size, age, sector, region, export status, ownership.	Enrollment accounts and registry verification.

3.2. Measurement validation and data quality

Each capability item would use a five-point behavioral anchor from absent to documented and routinely reviewed; respondents must identify the associated practice, owner, and date. Two independent raters would score a masked document subset, reporting weighted agreement and disagreements rather than silently accepting self-reports. Approximately

twenty cognitive interviews and a separate sixty-firm pilot would refine wording in French and Arabic with translation reconciliation. Pilot firms would not enter the confirmatory sample. These sample sizes are planning choices, not completed recruitment.

A three-factor ordinal confirmatory model would compare control, treasury, and agility against one-factor and merged-factor alternatives. Loadings, factor correlations, ordinal omega, residuals, and convergent/discriminant evidence would be reported. Invariance across language, size, and time would be examined when cell sizes allow. A predeclared equal-weight index, standardized using enrollment means and standard deviations, is the primary exposure moderator; factor-score and item-level models are sensitivity analyses. If the constructs cannot be separated, their individual coefficients will not be interpreted as distinct mechanisms. Split respondents, document audits, and accounting outcomes reduce common-method dependence; a single-factor statistical test alone cannot resolve it (Podsakoff et al., 2003).

Accounts would be reconciled to bank-summary totals where consent permits, with a log of discrepancies and manual resolutions. Negative operating cash flow is economically meaningful and would not be discarded. Verified extreme values remain in the primary analysis; prespecified robust and 1st/99th-percentile sensitivity estimates would quantify their influence. Missing covariates would be multiply imputed under a documented model, preserving interactions and time structure. Closure is an outcome, not a missing observation to impute as business as usual.

3.3. Shock construction and research estimands

The primary shock channel is energy-cost exposure. Let wE_{i0} be energy expenditure divided by total operating input costs, measured before the prospective window. Define

$$S_{it}^E = \frac{E_{it}^E}{\sigma_{E_{it}^E}}, \quad u_t^E = \Delta \log P_t^E - \hat{E}_{t-1}[\Delta \log P_t^E]. \quad (1)$$

The forecasting rule would be frozen using only pre-window data; a parsimonious autoregression with seasonal terms is a benchmark, not proof of structural exogeneity. World Bank Pink Sheet series are a candidate global-price source (World Bank, n.d.). Price currency, local pass-through, contract structure, and hedging must be documented. Export-demand exposure and debt-repricing exposure are secondary channels with independently documented sources; they would not be collapsed into an arbitrary common index.

The primary estimand is the difference in the energy-exposure response associated with a one-baseline standard-deviation difference in control. It is a conditional moderation contrast. A causal interpretation requires external innovations to be uncorrelated with unobserved differential outcome trends, conditional on the design. Residualizing a price series, lagging a regressor, or adding firm effects does not itself establish that requirement.

3.4. Primary panel specification and identification

The confirmatory specification uses firm and calendar-quarter effects:

$$Y_{it} = \alpha_i + \lambda_t + \beta S_{it}^E + \theta_C S_{it}^E C_{it} + \theta_T S_{it}^E T_{it} + \theta_A S_{it}^E A_{it} + \delta'(S_{it}^E \mathbf{X}_{it}) + \gamma' \mathbf{W}_{i,t-1} + \varepsilon_{it} \quad (2)$$

Here $\mathbf{X}_{i0}$ includes initial cash, leverage, size, and export status; $\mathbf{W}_{i,t-1}$ contains only prespecified variables not judged to be consequences of the evaluated shock. The total-response model excludes contemporaneous credit use, agility changes, and collections changes because they may be mediators. A minimally adjusted specification and an exposure-interacted baseline-covariate specification would both be reported. Common macroeconomic levels are absorbed by λ_t , and baseline capability levels are absorbed by α_i . Neither can be separately estimated in this model.

Identification comes from differences in predetermined exposure interacted with common innovations and baseline capabilities. Thus, quarter effects do not absorb $\mathbf{W}_{i0}$ when exposure varies across firms, but they do absorb the uninteracted $\mathbf{u}_{i,t}$. If all exposure variation is at sector level, sector-by-quarter effects absorb the energy regressor; the preferred robustness model therefore requires verified within-sector exposure variation. An exposure-concentration audit and overlap plots precede estimation. Unsupported extrapolation to highly exposed firms without low- or high-capability comparators is prohibited.

For standardized capabilities c , t , a , the conditional marginal response is:

$$\frac{\partial E(Y_{it})}{\partial S_{it}^E} = \beta + \theta_C c + \theta_T t + \theta_A a + \delta' \mathbf{x}_{it} \quad (3)$$

A positive θ_C indicates a less negative shock response, not necessarily a positive net response or the effect of implementing a new control system. Complementarity adds θ_{CT} SE it $C_i T_{i0}$ and the lower-order $C_i T_{i0}$ term, the latter

absorbed by firm effects. This extension is exploratory and would retain all estimable lower-order terms.

3.5. Dynamic recovery through local projections

Following Jordà (2005), the study would estimate separate horizon equations for $h = 0, 4$:

$$Y_{i,t+h} = \alpha_i^h + \lambda_t^h + \beta_h S_{it}^E + \theta_h'(S_{it}^E \mathbf{B}_{i0}) + \mathbf{q}_h' \mathbf{L}_{i,t-1} + \varepsilon_{it}^h \quad (4)$$

3.6. Inference, endogeneity, and alternative estimators

Firms share exposures and lenders, so independent-observation standard errors are inappropriate (Cameron & Miller, 2015). Primary reporting would show firm clustering, exposure-group clustering, and feasible multiway corrections, together with the number and concentration of independent shock units. With a common global energy series, hundreds of firms do not generate hundreds of independent global shocks. Eight prospective quarters are especially restrictive. Shift-share inference is relevant only when its shock/share assumptions and an adequate number of component shocks can be defended (Adão et al., 2019). Otherwise, confidence intervals remain conditional and descriptive, and a longer panel is preferable to overstated precision.

Wild cluster bootstrap and leave-one-exposure-group-out estimates would be prespecified sensitivity checks; neither rescues an unidentified model or a handful of independent shocks. A two-sided 5% test of $\theta_C = 0$ is the primary inferential target. Treasury and agility tests form a Holm-adjusted secondary family; complementary interactions and heterogeneity are exploratory. Estimates, units, confidence intervals, exact tests, and uncertainty in marginal effects take precedence over significance stars. The simulation below assesses only a simpler one-way exposure-group correction, not this entire inferential plan.

A dynamic-panel robustness model may add lagged Y , but fixed-effects estimates then suffer finite-time bias. Difference GMM and system GMM require defensible serial-correlation and moment assumptions (Arellano & Bond, 1991; Blundell & Bond, 1998). If used, lag depth would be restricted, instruments collapsed, instrument count kept comfortably below firm count, and AR(1), AR(2), Hansen, and difference-in-Hansen diagnostics disclosed. Instrument proliferation can undermine such diagnostics (Roodman, 2009). GMM is not the default solution to endogenous management quality, and internal lags do not automatically identify capability interactions.

3.7. Mechanisms and implementation modules

The architecture has five executable modules. The intake module harmonizes identifiers, consent, currencies, and quarter ends. The measurement module produces audited capability indices and a locked codebook. The shock module freezes baseline shares and external-series transformations. The estimation module fits Equation 2, local projections, and declared sensitivity models. The reporting module exports coefficient tables, marginal-response plots, exclusion logs, and reproducibility checks. Tabular data can be processed on a standard workstation; secure record linkage and audit effort, rather than specialized hardware, are the binding implementation constraints.

Mechanism analysis would relate baseline control to later forecast error and decision turnaround, then relate those variables to subsequent cash outcomes. Temporal ordering improves interpretation but does not remove mediator–outcome confounding. Indirect paths are therefore descriptive unless a separate randomized encouragement or credible quasi-experiment is introduced. A future staggered adoption evaluation would use cohort specific treatment effects under explicit parallel-trend and no-anticipation assumptions rather than mechanically interpret heterogeneous two-way fixed-effects coefficients (Callaway & Sant’Anna, 2021). Software candidates include linear models for panel models and PyFixest for absorbed effects and wild-bootstrap support (linear models developers, n.d.; PyFixest developers, n.d.); production use requires a pinned version and independently checked test cases.

4. Experimental Design and Evaluation

4.1. Baselines, ablations, and primary comparisons

The empirical analysis would compare a pooled descriptive regression, a firm-and-quarter-effects exposure model, and the fully adjusted interaction model. Pooled regression is a benchmark for confounding, not a preferred causal estimator. The main comparison tests whether adding each capability explains heterogeneity beyond initial cash resources and leverage. Predictive comparisons would use forward-chaining time splits, all preprocessing fitted on training data, and firm-separated validation where feasible. An autoregressive forecast and a cash-reserve-only model are practical prediction baselines; lower forecast error does not establish causality.

Table 3: Prespecified empirical validation matrix; not completed field experiments.

Experiment	Comparison / diagnostic	Outcome and interpretation
Main moderation	Exposure only versus three capability interactions; cash and leverage interactions retained.	θC primary; treasury and agility secondary. Report conditional marginal effects.
Module ablations	Remove control, treasury, or agility; compare audited versus questionnaire-only indices.	Coefficient stability and forward prediction; no causal attribution to deletion.
Dynamic response	Local projections, horizons 0–4; alternate lag length and sample windows.	Response profile, cumulative flow loss, simultaneous uncertainty bands.
Shock robustness	Energy first; demand and financing separately; raw price changes versus frozen forecast innovations.	Direction and sensitivity; no omnibus shock index selected by significance.
Identification checks	Pre-event exposure leads; baseline balance; sector trends; leave-one-group-out.	Detect violations, concentration, and influential groups; nonrejection does not prove validity.
Distributional checks	Low initial cash, high leverage, export status; continuous interactions preferred.	Prespecified heterogeneity; exploratory quantile models if support is adequate.
Operational validation	Rolling forecast versus seasonal naive and autoregressive baselines.	MAE and RMSE in cash-flow/asset units; Brier score for payment failure.

4.2. Sample planning, mixed-method validation, and decision rules

The sample target of 450 is provisional. Before recruitment, pilot-based simulations would vary attrition, clustering, capability reliability, shock concentration, and economically meaningful effects. A standardized coefficient of 0.08 in the present synthetic exercise is an assigned diagnostic value, not an estimated Moroccan effect or a currency-unit policy threshold. Recruitment proceeds only if plausible scenarios

support useful precision; otherwise, the scope, horizon, or number of independent shocks must change.

Approximately twenty-four purposively selected interviews would examine discordant cases, pairing high control/weak-outcome firms with low-control/strong-outcome firms within exposure strata. Coding would distinguish delayed information, delayed authorization, unavailable funding, and implementation failure. Negative cases would be retained. The qualitative component can explain process plausibility, not estimate population effects. Empirical validation would require both credible measurement and identification diagnostics; a significant interaction alone is insufficient.

5. Results and Evidence: Executed Synthetic Validation

5.1. Data-generating process and reproducibility

The completed numerical analysis is a Monte Carlo design study, not a Moroccan survey. Following the simulation-reporting logic of Morris et al. (2019), its aims, generating mechanism, estimator, targets, and performance measures are explicit. Four principal scenarios use $N = 150, 300, 450$ firms and sixteen quarters, with 500 replications per cell. Two additional 450-firm cells evaluate a true-null control interaction and ten rather than thirty exposure groups. The total is fourteen cells and 7,000 fitted panels. Seed 20261016, every replication, one example panel, and environment information are supplied.

Baseline capability vectors are drawn from a trivariate normal distribution with unit variances and pairwise covariance 0.35, plus independent group components with standard deviation 0.4, then standardized within each panel. A shuffled balanced assignment gives thirty exposure groups. Group shocks follow $z_{gt} = 0.35z_{g,t-1} + v_{gt}$ from a zero-pre-period value, with independent unit-normal innovations; $S_{it} = q_{izgt}$ and $q_i \sim U(0.4, 1.6)$. Firm effects correlate with control and treasury; quarter effects are independent normal draws. The generated outcome is

$$Y_{gt} = \alpha_i + \lambda_t - 0.35S_{it} + 0.08S_{it}C_i + 0.06S_{it}T_i + 0.04S_{it}A_i + 0.20X_{gt} + \varepsilon_{gt} + \eta_{gt}. \quad (5)$$

The idiosyncratic disturbance follows an AR(1) with coefficient 0.5 and unit innovation variance; η_{gt} has standard deviation 0.6. X is independent standard normal. Coefficients and outcome scale are synthetic and not calibrated to Moroccan accounting ratios. Crucially, independent group shocks are more favorable for inference than a single global energy series; this exercise does not validate the empirical common-shock design.

5.2. One-panel estimates and statistical recovery

Alternating firm/time demeaning followed by OLS implements the simplified model. Exposure-group clustered CR1 standard errors use a t_{G-1} critical value. Table 4 reports the first 450-firm reference replication, selected by its fixed index rather than its statistical outcome. All assigned slope values fall within the reported intervals in this example. This is a coding check, not evidence that these parameters describe real firms.

Table 4: One synthetic panel: 450 firms, 16 quarters, 30 exposure groups.

Term	Assigned	Estimate	Cluster SE	95% interval
Shock	−0.350	−0.353	0.023	[−0.400, −0.305]
Shock × control	0.080	0.073	0.013	[0.046, 0.100]
Shock × treasury	0.060	0.085	0.013	[0.057, 0.112]
Shock × agility	0.040	0.044	0.015	[0.014, 0.075]
Independent covariate	0.200	0.196	0.012	[0.171, 0.221]

Note. Synthetic coefficients in arbitrary outcome units. CR1 includes $G/(G-1)$ and $(n-1)/(n-k)$ corrections after absorbed effects. No observed business data enter this table.

5.3. Monte Carlo sensitivity and interval calibration

Table 5 summarizes the 450-firm cells. The reference mean of 0.079 is close to the assigned control-buffering coefficient of 0.080, but 92.6% coverage falls below the nominal 95% target. In the true-null cell, rejection is 7.2%, with Monte Carlo standard error 1.16 percentage points. The approximate 95% Monte Carlo interval is 4.9–9.5%; hence the exercise indicates imperfect calibration without proving a precisely quantified size distortion. Ten-group coverage is 93.8% in its separate run; this does not demonstrate that fewer clusters improve inference.

Measurement error adds independent baseline noise with variance $1/0.60-1$ to control. The resulting mean estimate is 0.044 and coverage of the original latent target is 26.6%.

Because treasury and agility correlate with control, attenuation need not equal exactly 0.60×0.08 . Selective attrition removes quarters 9–16 with probability $\logit^{-1}(-1.15 - e^{-Y_{i,1:8}})$, leaving a mean 6,200.8 observations. Bias remains small under this particular rule; this is not assurance against failure-related missingness. The confounding cell adds 0.08SitCi as an unobserved aligned process: its mean becomes 0.161 and coverage of the designated structural target is 1.2%. The regression cannot distinguish this omitted pathway from buffering.

Table 5: Executed simulation diagnostics for the control interaction, $N = 450$.

Scenario	Target	Mean	RMSE	Coverage	Reject H_0
Reference	.080	.079	.021	92.6%	96.0%
Measurement error	.080	.044	.039	26.6%	86.0%
Selective attrition	.080	.079	.022	92.8%	95.0%
Aligned confounding	.080	.161	.083	1.2%	100.0%
True null	.000	-.001	.021	92.8%	7.2%
Ten exposure groups	.080	.079	.023	93.8%	90.0%

Note. 500 replications per row. *Reject H_0* is power only under a valid nonzero-target design; with measurement error/confounding it is not evidence of accurate inference. The confounding target excludes the imposed omitted pathway.

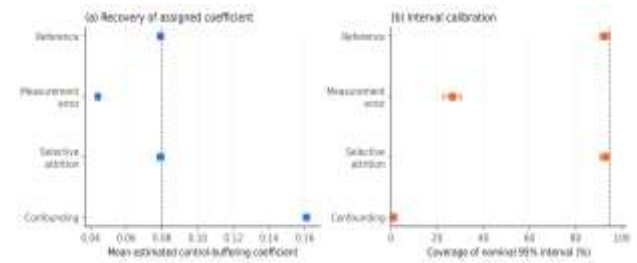


Figure 2: Synthetic recovery and coverage at $N = 450$.

Left: mean coefficient and 95% Monte Carlo uncertainty of that mean; dashed line marks 0.08. Right: empirical interval coverage and 95% Monte Carlo uncertainty; dashed line marks 95%. These are repeated-simulation diagnostics, not empirical firm effects.

5.4. Precision, validation boundaries, and untested components

In the reference design, rejection increases from 74.4% at 150 firms to 92.4% at 300 and 96.0% at 450. With measurement error, rates are 52.0%, 76.4%, and 86.0%, respectively. Figure 3 shows the associated Monte Carlo uncertainty. Larger samples improve detection but do not repair a mismeasured target: coverage under error falls as biased intervals become narrower. In the confounding cell, additional precision reinforces an incorrect structural interpretation. These results motivate investing in baseline verification and identification rather than maximizing sample size alone.

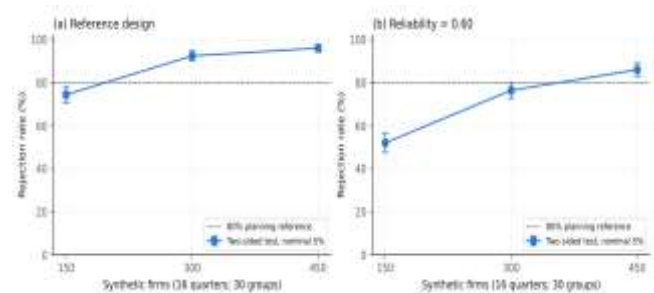


Figure 3: Two-sided rejection rates from executed synthetic panels.

Error bars show approximate 95% Monte Carlo intervals; the dashed line is an 80% planning reference. Panel (b) detects a relationship using a noisy moderator, not accurate recovery of the latent 0.08 coefficient. Every point uses 500 replications and thirty independent exposure groups.

The code has not estimated empirical local projections, causal mediation, survival models, system GMM, wild-bootstrap corrections, or predictive operational gains. Those remain proposed experiments. The Monte Carlo model has no lagged

dependent variable, no latent-scale estimation stage, and no endogenous capability adoption. Its arithmetic precision must not be confused with realism. Most importantly, its group-specific innovations create more independent information than the prospective energy-price application; pilot simulations must replicate the actual exposure and shock structure before a defensible power calculation is possible.

6. Discussion

6.1. Interpretation and competing explanations

Theoretical and prior empirical evidence support studying the joint role of information, resources, and adaptation (Duchek, 2020; Henri, 2006; Roffia & Dabić, 2024). The current numerical results support a narrower conclusion: an audited, separated measurement design is preferable to an imprecise self-report composite, and fixed effects alone cannot distinguish shock-aligned confounding from a protective capability. They do not establish that Moroccan firms with stronger control perform better during shocks.

Rival explanations include customer diversification, relationship lending, ownership support, and sector specific pass-through. A firm may look agile because it already has financing, rather than obtain financing because it is agile. Initial cash and leverage interactions, matched exposure support, archived decision dates, and discordant-case interviews can assess these accounts. None eliminates all unobserved confounding. Agreement across accounting outcomes, process evidence, and sensitivity checks would strengthen plausibility; disagreement should be analyzed rather than concealed through outcome selection.

6.2. Managerial implications, risks, and safeguards

The proposed managerial intervention is a testable decision protocol, not an expensive technology prescription. A lightweight rolling thirteen-week cash forecast, weekly reconciliation, documented authorization thresholds, and contingency funding contacts can operationalize the architecture. Expected benefits are earlier detection, fewer unresolved payment exceptions, and shorter response delays; these benefits remain hypotheses requiring validation. An ERP purchase is neither necessary nor sufficient. Aggressive collections or payment extensions can shift risk to customers and suppliers, so continuity evaluation must include overdue obligations rather than cash balances alone (Deloof, 2003; Opler et al., 1999).

Table 6: Principal implementation and validity risks.

Failure mode	Consequence	Mitigation / reporting rule
Self-selection and weak linkage	Capable volunteers differ from nonparticipants.	Compare frame strata, document consent rates, weight only with defensible inclusion probabilities.
One common shock / short panel	False precision despite many firm observations.	Extend periods or shock components; disclose effective units; avoid strong causal language.
Capability overlap or noisy scores	Unstable or attenuated interactions.	Masked audits, ordinal factor checks, reliability sensitivity; report unresolved overlap.
Closures and selective missingness	Resilience overstated among survivors.	Track closure separately; attrition weighting, pattern-mixture bounds, survivor-only labeling.
Endogenous adaptation / spillovers	Reverse causality and contaminated comparisons.	Baseline moderators, documented networks, separate total-response and mechanism models.
Data confidentiality	Financial or commercial harm.	Encrypted linkage keys, role-based access, aggregate release, explicit participant consent.

6.3. Feasibility, ethics, and reporting commitments

A feasible proposal schedule allocates months 1–3 to agreements, ethics review, and pilot testing; months 4–6 to recruitment and baseline audits; and months 7–30 to eight prospective quarterly observations. Historical records are assembled in parallel. Institutional authorization, informed consent, and applicable Moroccan data-protection requirements must precede collection; no approval is claimed here. Funding, conflicts, and contribution roles require confirmation from the named authors. Their supplied names and affiliation identify the requested draft, not independently verified authorship consent.

7. Conclusion

Financial resilience is best studied as a dynamic financial outcome supported, potentially, by distinct control, treasury, and agility capabilities. This proposal provides operational measures, identifiable contrasts under stated assumptions, advanced panel extensions, and a reproducible synthetic stress test. Its central warning is that measurement quality and independent shock variation matter more than econometric complexity alone. The next empirical step is to secure access and preregister a realistic design, not present the simulated coefficients as Moroccan findings.

Data and code availability. Reproducible simulation code, synthetic panel data, replication-level diagnostics, evidence ledger, and figure sources accompany this paper. No confidential or observed firm-level data were used. Funding and competing interests. Not supplied; author confirmation is required before submission.

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