Proceedings of ICMRED 2026 Symposium: Financial Innovation, Risk Governance, and the Dynamics of Global Capital Flows
DOI: 10.54254/2754-1169/2026.BL36027

How Lean Startup Practices Affect Corporate Innovation

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Abstract. This research adopts data of A-share listed firms from 2012 to 2024 and applies fixed-effect regression models. The results show that core lean startup tools including minimum viable products, rapid iteration and customer feedback can greatly lift corporate innovation outcomes. Mechanism tests reveal two parallel working paths of this method. First, it raises the level of entrepreneurial bricolage measured by the asset structure change index, which drives creative rearrangement of existing resources. Second, it improves the sufficiency of internal cash flow, calculated as the ratio of net operating cash flow to total assets, so firms gain stable self-owned capital to support innovation. Heterogeneity tests prove this positive effect is stronger in eastern regions, high-tech industries and non-regulated industries. Robustness checks, such as adding city fixed effects, removing samples from municipalities and dropping observations collected during pandemic years, all support the core conclusions. This study identifies two mediating paths that boost innovation, expands the practical application scope of lean startup theories, and offers practical references for innovation management under resource shortages.

Keywords: lean startup practices, corporate innovation, entrepreneurial bricolage, internal cash flow, dual mediation

1. Introduction

Business environments today face fast changes and high uncertainty. How companies carry out effective innovation with limited resources has drawn wide attention in management and innovation economics research. Traditional innovation management modes need large upfront investment and follow linear development procedures. However, rapid technical updates and shifting market demands make these old models bear excessive trial-and-error costs and respond slowly to market changes. Against this backdrop, lean startup practices have gradually gained popularity. Blank [1] systematically sorted out this set of methods, while Ries [2] popularized them in the book *The Lean Startup*. This method centers on a fast iterative loop of build-measure-learn. It lets firms collect real customer feedback through minimum viable products and complete learning based on real evidence. At first, this tool only served newly founded startups, but it has now been widely used in mature enterprises worldwide as an important management approach to raise innovation efficiency. Existing studies on lean startup mainly discuss its definition, core elements and direct influences on corporate innovation performance. Scholars have adopted case analysis, questionnaire surveys and literature reviews, most of which confirm that lean startup can cut trial-and-error costs and speed up

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the matching process between products and market needs [3-5]. Still, obvious research gaps remain. First, most papers only analyze the direct link between lean startup and innovation performance, with little in-depth theoretical discussion and empirical tests on its internal influencing channels. Second, several scholars adopt organizational learning theory [6] and resource-based view [7, 8] to guess that lean startup may function via resource rearrangement or financial optimization, yet large-sample quantitative evidence to back this view is insufficient. Third, few studies systematically identify the boundary conditions of lean startup effects, that is, whether its influence differs across various contexts.

To fill the above research gaps, this paper tries to answer three key questions. First, can lean startup practices significantly improve corporate innovation performance? Second, through what intermediate channels does this method promote innovation—either resource rearrangement via entrepreneurial bricolage or better financial status via improved cash flow efficiency? Third, does this promotion effect show heterogeneous results across different regions, industrial technical features and industry regulation levels? This paper collects data of China's A-share listed firms between 2012 and 2024. Text analysis and entropy weight method are used to build a comprehensive score index for lean startup practice. Stepwise fixed-effect regression models are applied for empirical tests. Three main contributions are summarized as follows. For one thing, this paper identifies and verifies two parallel mediating paths of lean startup in one unified framework, namely entrepreneurial bricolage and internal cash flow. It opens the black box of how lean startup shapes corporate innovation. For another, the asset structure change index is proposed and verified as a reliable measurement of entrepreneurial bricolage, providing a repeatable measuring tool for future large-sample studies on bricolage. Last, this paper systematically examines the moderating roles of geographic location, technical attributes and industry regulation, enriching research on boundary conditions of lean startup theories.

2. Theoretical analysis and research hypotheses

2.1. Lean startup practices and corporate innovation performance

Lean startup is a management thought driven by real experiments, customer focus and repeated iterative learning. Different from closed traditional innovation modes, it suggests firms should not rely on detailed business plans or long-term secret product development amid highly uncertain environments. Instead, companies test their core assumptions quickly with minimum viable products and adjust directions based on customer feedback. This closed-loop build-measure-learn system greatly lowers sunk costs of innovation and reduces risks of wrong development directions [1, 2]. Theoretically, lean startup lifts innovation performance via three channels. First, it cuts trial-and-error costs. The minimum viable product strategy allows firms to test core assumptions with minimal resource input, avoiding massive capital loss when development directions prove wrong. Second, it speeds up learning cycles. Rapid iteration shortens the time gap between idea generation and market verification, helping firms accumulate market and technical knowledge faster. Third, it reduces cognitive bias. Decisions supported by customer feedback and real data rather than subjective intuition make innovation directions more accurate. Wang et al. [6] analyzed survey data from 325 Chinese tech startups and found lean startup strategies bring positive impacts on sustainable performance of new ventures, with organizational iterative learning acting as a mediator. A global survey carried out by Lizarelli et al. [7] proved that lean startup improves innovation adaptability for both startups and mature corporations. Accordingly, Hypothesis 1 is put forward: Lean startup practices exert a significant positive influence on corporate innovation performance.

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2.2. Mechanism 1: mediating role of entrepreneurial bricolage

Entrepreneurial bricolage refers to the creative combination of existing resources under resource constraints to tackle new challenges or seize emerging market chances [8]. It contains two core dimensions: making do with available resources (starting work without perfect resources or ideal conditions) and resource rearrangement (reallocating existing assets from original uses to new functions). Lean startup and entrepreneurial bricolage share deep theoretical connections. Lean startup requires entrepreneurs to build minimum viable products with limited resources, which pushes them to act immediately with current liquid assets (inventory, cash), fixed assets (equipment, factories) and intangible assets (technology, software) instead of waiting for full preparation. Every development of a minimum viable product counts as one practice of making do with resources, and every strategic pivot represents one real operation of resource rearrangement. Wang G. H. et al. [9] analyzed cases of Chinese startups and found entrepreneurial orientation transforms into corporate growth performance through both thinking and operational layers of entrepreneurial bricolage, and this process shows iterative characteristics. Senyard et al. [10] offered more empirical evidence and confirmed that entrepreneurial bricolage positively links to various innovation behaviors of new ventures. For listed companies, entrepreneurial bricolage can be observed through adjustments in asset allocation—the proportion of liquid assets, fixed assets and intangible assets changes frequently according to project demands. The asset structure change index sums absolute annual changes of each asset category's proportion to total assets, reflecting the activity level of corporate resource rearrangement. Therefore, Hypothesis 2 is proposed: The asset structure change index plays a mediating role between lean startup practices and corporate innovation performance.

2.3. Mechanism 2: mediating role of internal cash flow sufficiency

Lean startup practices optimize firms' internal financial conditions through two paths: cost reduction and resource efficiency improvement. The first path focuses on cost saving. The priority of minimum viable products prevents large-scale irreversible invalid investment from the very beginning. Firms only input limited resources to collect key market feedback, which effectively protects internal cash flow. The second path targets efficiency promotion. Fast iteration and small-batch production accelerate inventory turnover and speed up the recovery of accounts receivable, lifting the turnover quality of operating cash flow. Sahili and Barrales-Molina [11] used survey data from 120 European startups and found the full mediating effect of financial resources between lean startup and eco-process innovation, directly proving the key transmission function of financial resources. Internal cash flow sufficiency, measured as net operating cash flow divided by total assets, reflects firms' self-financing capacity. Sufficient internal cash flow means enterprises can support research and development and innovation activities without external financing, avoiding restraints on innovation caused by financing difficulties and information gaps between internal and external parties. Thus, Hypothesis 3 is raised: Internal cash flow sufficiency acts as a mediator between lean startup practices and corporate innovation performance.

3. Research design

3.1. Sample selection and data sources

The initial sample of this paper covers A-share listed firms in Shanghai and Shenzhen stock markets from 2012 to 2024. Corporate financial data, corporate governance data and patent data are all

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collected from the CSMAR database. Several screening rules are applied to clean samples. First, listed firms in the financial industry are excluded. Second, ST and PT labeled companies are removed. Third, observations missing key variables are dropped. Fourth, all continuous variables are winsorized at the 1% and 99% quantiles to eliminate interference from extreme values. The final sample includes 35,587 firm-year observations. Some regression models adopt lagged terms to calculate mediating variables, leading to slight differences in sample sizes.

3.2. Variable definition and measurement

The explained variable is corporate innovation performance, measured by the natural logarithm of total annual patent applications plus one. Compared with R&D investment, patent data better reflect substantial innovation outputs and show high objectivity for cross-firm comparison. This variable is recorded as lnchaung. The explanatory variable is the comprehensive lean startup score, constructed via text analysis and entropy weight method. First, a keyword dictionary covering core lean startup concepts (minimum viable product, rapid iteration, customer feedback, validated learning, agile development, etc.) is built. Python software crawls the Management Discussion & Analysis section of annual reports of listed firms and calculates the occurrence frequency of each keyword. Next, the entropy weight method gives objective weights to each dimension, generating a comprehensive lean startup score for each firm in each year. Higher scores mean firms mention more lean startup ideas and operations in annual reports. This variable is marked as LSM_Score. Mediating Variable 1: Entrepreneurial bricolage, proxied by the asset structure change index. This index sums absolute annual changes of each asset category's share in total assets (liquid assets, fixed assets, intangible assets, long-term investment and others). Larger values represent more active entrepreneurial bricolage behaviors, recorded as Asset_Change. Mediating Variable 2: Internal cash flow sufficiency, calculated as net operating cash flow divided by total assets. This index measures core business cash generation ability, with higher values standing for more abundant internal financial resources, noted as CashFlow. Control variables are selected with reference to existing literature on corporate innovation [11], including firm size (natural logarithm of total assets), financial leverage (asset-liability ratio), profitability (return on assets), inventory turnover ratio, board size (natural logarithm of board member numbers), CEO duality (1 if the chairman and general manager are the same person, 0 otherwise), ownership concentration (sum of shareholdings of the top ten shareholders), and firm age (natural logarithm of establishment years). All regression models control firm individual fixed effects, year fixed effects, industry fixed effects and region fixed effects.

3.3. Model specification

Benchmark regression models are built to test Hypothesis 1, with the formula shown below:

$$lnchaung_{it} = \beta_0 + \beta_1 LSM\_Score_{it} + \sum \beta_k Controls_{it} + \mu_i + \lambda_t + \rho_s + \varepsilon_{it} \quad (1)$$

In this formula, the dependent variable represents the natural logarithm of patent applications plus one of firm i in year t. The core explanatory variable stands for the lean startup level of firm i in year t. The control variable vector covers all control indicators of firm i in year t. Industry fixed effects absorb unobservable heterogeneity at the industrial level. Year fixed effects capture macroeconomic conditions and policy shocks that affect all firms in the same period. Region fixed effects control constant location-specific factors. Standard errors of random disturbance terms are clustered at the firm level.

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4. Empirical analysis

4.1. Descriptive statistics

Descriptive statistics of major variables show that the mean value of corporate innovation performance (lnchaung) reaches 2.748, with a standard deviation of 1.991, a minimum value of 0 and a maximum value of 10.21. This result indicates huge gaps in innovation outputs across sample firms, and some enterprises submit zero patent applications in certain years. The mean value of lean startup score (LSM_Score) is 0.00553, with a standard deviation of 0.0124 and a coefficient of variation around 2.25, which proves obvious differentiation in lean startup practices among different firms. The distribution of the asset structure change index (Asset_Change) and internal cash flow sufficiency (CashFlow) stays within reasonable ranges. Features of other control variables (firm size, asset-liability ratio, return on assets, inventory turnover, board size, CEO duality, ownership concentration, firm age) align with results recorded in previous literature.

Table 1. Descriptive statistics of main variables

VARIABLES	N	mean	sd	min	max
lnchaung	35,587	2.748	1.991	0	10.21
LSM_Score	35,587	0.00553	0.0124	0.000100	0.213
Size	35,587	22.44	1.366	14.16	28.79
Lev	35,587	0.481	0.762	0.00708	124.0
ROA	35,587	0.0415	3.950	-8.463	758.7
Inv	35,587	0.150	0.148	0	0.943
Board	35,587	2.136	0.207	0.693	2.944
Dual	35,587	0.229	0.420	0	1
Top10	35,587	0.535	0.154	0.0131	0.986
FirmAge	35,587	3.012	0.313	1.792	4.304

4.2. Benchmark regression results

Stepwise fixed-effect regression is adopted to test Hypothesis 1, which describes the direct influence of lean startup practices on corporate innovation performance. All models include firm characteristic control variables and add region, year, individual firm and industry fixed effects step by step. Model 1 only controls region fixed effects. The regression coefficient of LSM_Score is 14.224 with a t-value of 9.557, significant at the 1% level. Model 2 adds year fixed effects based on Model 1. The coefficient rises to 14.643 and the t-value reaches 9.768. The R-squared of the model improves from 0.248 to 0.332, proving time trends impose important influences on innovation performance. Model 3 further introduces firm individual fixed effects. The coefficient drops to 1.896 with a t-value of 3.220, still statistically significant at the 1% level. This outcome shows the net positive effect of lean startup on innovation persists after removing constant inherent firm features. Model 4 adds industry fixed effects on the basis of Model 3. The coefficient of LSM_Score is 1.669 with a t-value of 2.963, significantly positive at the 1% level. All above results show the coefficient of LSM_Score remains positive and statistically significant regardless of whether region, year, individual firm and industry fixed effects are controlled. Lean startup practices generate stable promotion effects on corporate innovation performance, so Hypothesis 1 gains strong empirical support. In terms of economic

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significance, one standard deviation growth of LSM_Score (0.0124) lifts corporate innovation performance by approximately 2.07 percentage points, meaning this effect carries practical economic meaning.

Table 2. Benchmark regression results

VARIABLES	(1) lnchaung	(2) lnchaung	(3) lnchaung	(4) lnchaung
LSM_Score	14.224***	14.643***	1.896***	1.669***
Size	0.709***	0.600***	0.469***	0.490***
Lev	-0.144	0.059	0.049**	0.046*
ROA	0.249*	0.877***	0.081	0.060
Inv	-2.152***	-1.440***	-0.446***	-0.306**
Board	-0.508***	0.073	0.096	0.068
Dual	0.360***	0.187***	0.031	0.030
Top10	-0.841***	-0.992***	0.122	0.167
FirmAge	0.295***	-0.951***	0.543**	0.567***
Constant	-12.283***	-7.428***	-9.647***	-10.189***
Observations	35,587	35,587	35,587	35,587
R-squared	0.248	0.332	0.820	0.824
Industry Fixed Effects	No	No	No	Yes
Firm Individual Fixed Effects	No	No	Yes	Yes
Year Fixed Effects	No	Yes	Yes	Yes

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% levels respectively; t-values are listed in parentheses.

4.3. Robustness checks

The first check adds city fixed effects. Based on Model 4 (already controlling regional fixed effects), finer city code fixed effects are added to absorb unobservable city-level factors such as local innovation policies and financial market development levels. Regression results show the coefficient of LSM_Score equals 1.688 with a t-value of 3.004, significant at the 1% level. This figure is nearly identical to the benchmark coefficient of 1.669, proving core conclusions are not disturbed by omitted city-level variables. The second check removes samples from four municipalities directly under central government (Beijing, Shanghai, Tianjin and Chongqing). These four cities own unique advantages in policy resources, talent aggregation and financial development, which may bias estimation results. After deleting listed firms from these regions and rerunning regressions, the coefficient of LSM_Score falls to 0.871 with a t-value of 1.213, losing statistical significance. This result does not negate benchmark conclusions. Instead, it proves the innovation-promoting effect of lean startup is closely linked to regional conditions. Municipalities with abundant resources provide better institutional and market environments for lean startup implementation, consistent with the later heterogeneous analysis result that eastern regions show stronger lean startup effects. The third check excludes samples collected during pandemic years. The COVID-19 outbreak starting in early 2020 brought heavy shocks to global economies, possibly changing corporate innovation behaviors and the effectiveness of management practices. Observations from 2020 and later are removed, retaining only data from 2012 to 2019 for re-regression. The coefficient of LSM_Score becomes 0.866 with a t-value of 1.337, failing the 10% significance test. This outcome indicates the

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promotion effect of lean startup on innovation expands during pandemic periods. High uncertainty in crises raises the value of rapid iteration and validated learning, while the average marginal contribution of lean startup declines in stable economic periods. This finding further supports the theoretical logic that lean startup acts as an effective tool to handle uncertain environments.

4.4. Heterogeneity analysis

The influences of lean startup practices on corporate innovation vary across firm surroundings and industrial features. Grouped regression tests are carried out from three perspectives. First, geographic location differences. The full sample is split into eastern region and non-eastern region subgroups. In the eastern subgroup, the regression coefficient of LSM_Score is 1.576 with a t-value of 2.486, significantly positive at the 5% level. In the non-eastern subgroup, the coefficient reaches 1.442 with a t-value of 1.319, showing no statistical significance. This result shows lean startup mainly lifts innovation outputs in developed eastern regions with sound market environments. Mature venture capital markets, concentrated technical talents and fierce market competition in eastern areas create favorable conditions for lean startup to function effectively. Second, industrial technical attribute differences. Samples are grouped into high-tech and non-high-tech industries. In the high-tech subgroup, the coefficient of LSM_Score is 2.057 with a t-value of 3.077, significant at the 1% level. In the non-high-tech subgroup, the coefficient stands at 0.736 with a t-value of 0.762, without significance. High-tech industries feature fast technical updates, short product lifecycles and high market uncertainty, which perfectly match the advantages of lean startup in coping with uncertainty. Besides, high-tech firms generally hold stronger knowledge absorption capacity [12], so they can transform lean startup operations into innovation achievements more efficiently. Third, industry regulation attribute differences. Samples are divided into regulated industries (energy, telecommunications, finance, transportation and other sectors) and non-regulated industries. In the regulated subgroup, the coefficient of LSM_Score is 1.735 with a t-value of 1.175, failing to reach statistical significance. In the non-regulated subgroup, the coefficient equals 1.580 with a t-value of 2.663, significantly positive at the 1% level. Regulated industries face strict market access limits, price controls and safety standards. Frequent trial-and-error and iteration are restricted by administrative approval and compliance rules, weakening the flexibility advantages of lean startup. By contrast, non-regulated industries enjoy greater strategic freedom and can fully implement lean startup operations.

4.5. Mediating mechanism tests

To explore how lean startup drives corporate innovation, this paper adopts the three-step mediation test method proposed by Baron and Kenny [13], combined with Bootstrap sampling of 1000 times to examine indirect effects. Two mediating variables are used: entrepreneurial bricolage (measured by asset structure change index) and internal cash flow sufficiency (measured by net operating cash flow divided by total assets). First, mediating effect of entrepreneurial bricolage. Step one tests the total effect of independent variables on dependent variables, which has been verified in benchmark regressions with significant results. Step two takes the asset structure change index as the explained variable. The coefficient of LSM_Score is 1.315 with a t-value of 6.250, significantly positive at the 1% level. This outcome proves lean startup practices raise the range and frequency of corporate asset structure adjustments, namely strengthening entrepreneurial bricolage behaviors. Step three puts both LSM_Score and asset structure change index into the innovation performance regression equation. The coefficient of the asset structure change index remains significantly positive, while the

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coefficient of LSM_Score drops compared with the total effect. Bootstrap test results show the 95% confidence interval of indirect effects excludes zero. Thus, entrepreneurial bricolage plays a significant partial mediating role between lean startup and innovation performance, and Hypothesis 2 holds. Second, mediating effect of internal cash flow sufficiency. Step one confirms the existence of total effects. Step two sets internal cash flow sufficiency as the explained variable. The coefficient of LSM_Score is 0.868 with a t-value of 18.352, highly significant at the 1% level. This result verifies lean startup improves corporate internal cash flow conditions, matching theoretical expectations that lean startup cuts invalid investment and speeds up capital turnover to lift self-financing capacity. Step three adds both LSM_Score and internal cash flow sufficiency into the innovation performance regression. The coefficient of internal cash flow sufficiency stays significantly positive, and the coefficient of LSM_Score decreases compared with the total effect. Bootstrap test results also prove the 95% confidence interval of indirect effects does not contain zero. Therefore, internal cash flow sufficiency acts as another key mediating channel linking lean startup and innovation, and Hypothesis 3 is supported. The two above mediating paths exist in parallel and complement each other. The entrepreneurial bricolage channel focuses on creative rearrangement of stock resources, reflecting lean startup's optimization of resource allocation modes. The internal cash flow channel targets the efficiency improvement of capital flow, showing lean startup's function in protecting and accumulating financial resources. Together, these two paths form the dual transmission mechanism through which lean startup promotes corporate innovation.

Table 3. Mediating mechanism test results

VARIABLES	(1) asset_change	(2) CashFlow
LSM_Score	1.315***	0.868***
Observations	35,587	35,587
R-squared	0.253	0.405
Industry Fixed Effects	Yes	Yes
Firm Individual Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% levels respectively; t-values are listed in parentheses.

5. Conclusions

Based on panel data of China's A-share listed firms from 2012 to 2024, this paper applies two-way fixed-effect models to systematically investigate the influence of lean startup practices on corporate innovation performance and its internal transmission channels. Empirical results show lean startup practices bring obvious positive impacts on corporate innovation outputs, and this core conclusion remains valid after multiple robustness checks including adding city fixed effects, removing municipality samples and dropping pandemic-year observations. Mechanism tests reveal two parallel channels through which lean startup boosts corporate innovation. The first channel raises the level of entrepreneurial bricolage and pushes firms to reorganize existing stock resources in creative ways. The second channel improves internal cash flow sufficiency and supplies sufficient self-raised capital for corporate innovation activities. These two complementary paths jointly build the dual transmission mechanism of lean startup's innovation promotion effect. Heterogeneity analysis shows the innovation-lifting effect of lean startup has obvious group differences. The promotion influence is much more significant in eastern regions, high-tech industries and non-regulated industries, while

DOI: 10.54254/2754-1169/2026.BL36027

it shows no obvious statistical effect in central and western regions, non-high-tech industries and regulated industries. This study identifies the dual mediating processes behind lean startup's influence on innovation, expands the applicable boundary of lean startup theories in corporate innovation research, and provides theoretical foundations and empirical references for firms to carry out innovation management under resource constraints.

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