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Frugal Innovation and Entrepreneurial Resilience under Institutional Constraints: Evidence from Congolese SMEs Using WBES 2024

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Abstract

This study examines the relationship between institutional constraints and the adoption of frugal innovation among formal SMEs in the Democratic Republic of Congo, using data from the 2024 World Bank Enterprise Survey (WBES). Based on a sample of 27 firms operating in trade, services, and light industry, the results show that nearly 70% of SMEs report implementing frugal innovation practices. Logistic regressions, t-tests, and chi-square tests reveal positive but statistically non-significant associations between perceived institutional constraints (licenses, access to land, regulatory delays) and frugal innovation. Although the limited sample size reduces statistical power, the findings highlight the adaptive capacity of Congolese SMEs in a restrictive institutional environment. The study recommends combining quantitative and qualitative approaches to better understand frugal innovation dynamics in sub-Saharan Africa and calls for public policies that recognize and support these practices as drivers of sustainable development.

Subject Areas

Innovation Management, Development Economics, Entrepreneurship, Institutional Economics

Keywords

Frugal Innovation, Institutional Constraints, SMEs, Resilience, WBES, Democratic Republic of Congo

1. Introduction

Small and medium-sized enterprises (SMEs) play a central role in the socioeco-

nomic transformation of African economies. According to the African Union [1], SMEs represent more than 90% of the continent's formal business sector and generate up to 60% of jobs in sub-Saharan Africa. Despite their importance, these firms operate in environments characterized by structural uncertainties, including administrative burdens, fiscal instability, weak legal enforcement, and limited access to formal financing.

The Democratic Republic of Congo (DRC) illustrates these challenges particularly well. The World Bank's Doing Business 2020 report [2] ranks the DRC among the most difficult countries in which to start or operate a formal business, due to complex procedures, land insecurity, and regulatory inefficiencies. The 2024 World Bank Enterprise Survey (WBES) [3] confirms this situation: 40% of firms report operating permits as a "severe or very severe" constraint, while 64% cite access to land as a major obstacle.

Yet, despite these constraints, many Congolese SMEs demonstrate remarkable adaptability. They develop forms of frugal innovation, defined by Radjou, Prabhu and Ahuja [4] as the ability to "do more with less" by creatively mobilizing limited resources. This innovation logic is particularly relevant in contexts where formal R&D investment is low: although only 12.4% of Congolese firms invested in R&D in the previous year, 15.4% introduced a new product or service (WBES [3]).

This study investigates how institutional constraints influence the adoption of frugal innovation among Congolese SMEs. It mobilizes institutional theory (North [5]; Williamson [6]) and recent research on frugal innovation in developing economies (Weyrauch & Herstatt [7]; Agarwal & Brem [8]). The central research question is:

How do Congolese SMEs manage to innovate and adapt despite highly constrained institutional environments?

To address this question, the study analyzes WBES 2024 data [3] and tests three hypotheses related to frugal innovation, institutional constraints, and entrepreneurial resilience. In this study, entrepreneurial resilience is discussed conceptually as an interpretive lens rather than an operationalized variable, since the WBES does not include direct resilience indicators.

2. Literature Review

Frugal innovation has emerged as a significant field of research in contexts characterized by resource scarcity, institutional weaknesses, and socioeconomic instability. Radjou, Prabhu and Ahuja [4] define frugal innovation as the ability to "do more with less" by creatively mobilizing limited resources to produce simple, robust, and affordable solutions. This approach differs from traditional innovation models that rely on intensive R&D, advanced technologies, and stable institutional environments.

In developing economies, frugal innovation is often a response to structural constraints. Haudeville and Le Bas [9] describe it as a technological paradigm shaped by environments where formal institutions are weak or failing. Zeschky,

Winterhalter and Gassmann [10] distinguish frugal innovation from low-cost innovation by emphasizing its transformative nature: instead of merely reducing costs, frugal innovation redesigns products and processes to fit local constraints.

Institutional constraints play a central role in shaping entrepreneurial behavior in Africa. Naudé [11] highlights that regulatory instability, land insecurity, and administrative burdens hinder formal business development but simultaneously stimulate adaptive strategies. Chebbah [12], studying SMEs in the MENA region, shows that heavy regulations and bureaucratic delays encourage firms to develop informal, flexible, and often innovative practices.

Recent studies emphasize the link between institutional weaknesses and frugal innovation. Agarwal and Brem [8] argue that uncertain regulatory environments push entrepreneurs to adopt low-cost, flexible business models. Leliveld, Knorringa and Fort [13], drawing on cases from the DRC and Kenya, demonstrate that institutional voids foster community-based ingenuity and local co-construction of solutions. Cunha *et al.* [14] introduce the concept of "improvisational capability," showing that entrepreneurs in unstable environments develop the ability to innovate under pressure and uncertainty.

Overall, the literature suggests that frugal innovation is not merely a response to scarcity but a form of entrepreneurial resilience, shaped by institutional constraints and local socioeconomic realities. This study contributes to this body of work by examining how Congolese SMEs adopt frugal innovation strategies in response to regulatory, administrative, and land-related constraints.

3. Conceptual Framework

This study is grounded in institutional theory and the literature on frugal innovation in resource-constrained environments. Institutional theory (North [5]; Williamson [6]) posits that firms operate within formal and informal rules that shape their strategic choices. In developing economies, institutional constraints such as administrative burdens, land insecurity, and regulatory delays influence entrepreneurial behavior and limit access to resources.

Frugal innovation emerges as a strategic response to these constraints. Radjou, Prabhu and Ahuja [4] define frugal innovation as the ability to "do more with less" by creatively mobilizing limited resources to produce simple, robust, and affordable solutions. Weyrauch and Herstatt [7] identify three core characteristics of frugal innovation: substantial cost reduction, focus on core functionalities, and optimized performance under resource scarcity.

In contexts like the Democratic Republic of Congo, institutional voids (Khanna & Palepu [15]) create uncertainty but also stimulate adaptive capabilities. Entrepreneurs develop improvisational skills (Cunha *et al.* [14]) and resilience mechanisms that allow them to innovate despite limited access to formal financing, infrastructure, or stable regulations.

Based on this theoretical foundation, the conceptual model of this study proposes that:

Institutional constraints (licenses, access to land, regulatory delays) → influence Entrepreneurial resilience (adaptive capacity, improvisation, informal problem-solving) → which in turn supports Frugal innovation (low-cost, flexible, resource-efficient solutions).

This conceptual framework guides the empirical analysis using WBES 2024 data and supports the development of the study's hypotheses.

Based on the conceptual framework, the following testable hypotheses are formulated:

H1: Higher perceived licensing and permit constraints are positively associated with the likelihood of adopting frugal innovation.

H2: Higher perceived constraints related to access to land increase the probability that SMEs adopt frugal innovation.

H3: Greater administrative time spent dealing with regulations is positively associated with the adoption of frugal innovation.

4. Methodology

This study adopts a quantitative research design based on secondary data from the 2024 World Bank Enterprise Survey (WBES) [3] for the Democratic Republic of Congo. The WBES provides firm-level data on business environment constraints, innovation practices, and firm characteristics. It is widely used in development economics and entrepreneurship research due to its standardized methodology and cross-country comparability.

Sample selection: The 2024 WBES dataset for the DRC includes 535 surveyed firms, of which 112 are formal SMEs (5 - 99 employees). After excluding firms with missing responses on innovation variables and institutional-constraint indicators, the final analytical sample consists of 27 SMEs. This selection ensures internal consistency and comparability across variables used in the empirical analysis.

4.1. Data Source

The analysis relies on the WBES 2024 [3] dataset, which includes information from formal SMEs operating in trade, services, and light manufacturing. From the full dataset, a subsample of 27 firms was extracted based on the following criteria:

- the firm is classified as a small or medium-sized enterprise (5 - 99 employees);
- the firm provided complete responses to innovation-related questions;
- the firm provided complete responses to institutional constraint indicators.

This subsample is consistent with the limited number of formal SMEs surveyed in the DRC and reflects the structural characteristics of the Congolese private sector.

4.2. Variables

Dependent variable: Frugal Innovation Frugal innovation is measured using the WBES item indicating whether the firm introduced a new or significantly improved product or service in the previous year, despite limited investment in formal R&D. This operationalization aligns with the literature on frugal innovation

in resource-constrained environments.

Independent variables: Institutional Constraints Three institutional constraints were selected based on theoretical relevance and data availability:

- Licenses and permits (severity of administrative procedures)
- Access to land (difficulty in obtaining or securing land)
- Regulatory delays (time required to comply with regulations)

Each variable is coded on a scale from 0 ("no obstacle") to 4 ("very severe obstacle").

Control variables Firm size, sector, and age were included as controls to account for structural differences among SMEs.

A firm is coded as a *frugal innovator* (1) if it answered "Yes" to WBES item D1 ("Has the firm introduced a new or significantly improved product or service in the last year?") while reporting zero or very low R&D expenditure in item D7. Firms that did not introduce such innovations are coded as 0. This proxy captures the "do more with less" logic characteristic of frugal innovation.

4.3. Analytical Strategy

The empirical analysis combines descriptive statistics and inferential tests:

- Descriptive statistics to assess the prevalence of frugal innovation and the distribution of institutional constraints.
- Chi-square tests to examine associations between categorical variables.
- Independent samples t-tests to compare mean constraint levels between innovators and non-innovators.
- Binary logistic regression to estimate the probability of adopting frugal innovation as a function of institutional constraints and control variables.

Given the small sample size, statistical significance is interpreted cautiously, and emphasis is placed on effect sizes and directional trends rather than strict p-value thresholds.

4.4. Limitations

The main limitation of this methodology is the reduced sample size (n = 27), which affects statistical power and generalizability. However, the WBES remains the most reliable dataset available for formal SMEs in the DRC, and the analysis provides valuable exploratory insights into innovation dynamics in highly constrained institutional environments.

5. Presentation of Results

5.1. Capacity of Congolese SMEs to Mobilize Frugal Innovation in the Face of Institutional Constraints

The descriptive statistics presented in Table 1 summarize the institutional constraints faced by Congolese SMEs and the prevalence of frugal innovation within the sample. As shown in Figure 1, approximately 70% of SMEs report adopting frugal innovation.

Table 1. Descriptive statistics of institutional constraints and frugal innovation.

Variable	Average	Median	Max
Management time devoted to regulation	19.4 days/year	17.5	71.8
Time frame for obtaining a license (*cleaned*)	19.17 days	18.5	29.3
Health and safety inspection (%)	23.14%	18.2	49.8%
License-related constraints (%)	38.54%	40.3	66.4%
Constraints related to access to land (%)	26.88%	25.8	73.8%
Land perception index (*out of* 100)	64.42	64.8	87.2
Frugal innovation rate (*binary*)	70.37%	1	1

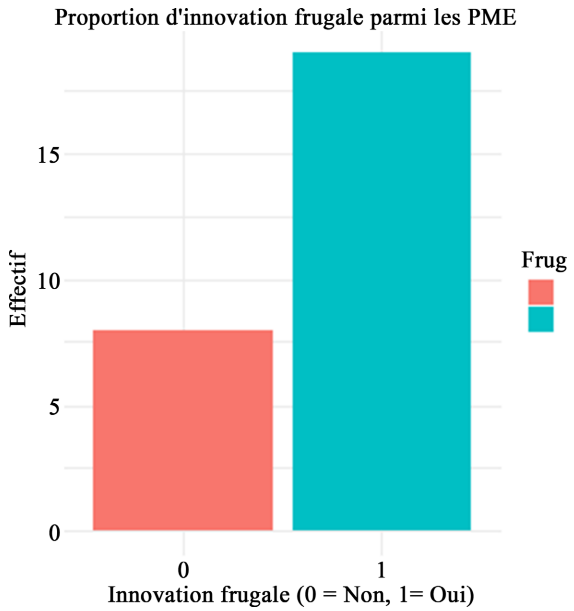

Figure 1. Proportion of SMEs adopting frugal innovation.

Despite a complex and unfavorable institutional environment, the majority of Congolese SMEs surveyed implement forms of frugal innovation, whether in response to administrative delays, limited access to land, or heavy regulations. Although statistical analyses did not reveal significant links between each constraint and frugal innovation, the trend is consistent with the hypothesis: in a formally unfavorable context, Congolese businesses deploy adaptation, optimization, and ingenuity strategies typical of frugal innovation. This aligns with the findings of Leliveld, Knorringa, and Fort [13], who demonstrated, through case studies in the DRC and Kenya, that institutional constraints foster the local co-creation of frugal solutions, often based on informal knowledge and community-based approaches.

5.2. SMEs' Perception of Institutional Constraints When Adopting Frugal Innovation

1) Logistic Regression

The coefficients are positive, which suggests that the more constraints an SME

perceives, the more it tends to innovate frugally. However, no variable is significant ($p > 0.05$), so we cannot statistically conclude this with your sample.

Control variables (firm size, age, and sector) were included in the logistic regression but did not show meaningful effects. Their coefficients were small and statistically non-significant ($p > 0.10$), confirming that institutional constraints remain the main exploratory focus of the model.

As shown in Table 2, all coefficients are positive, suggesting that SMEs perceiving stronger constraints tend to adopt frugal innovation, even though none of the effects reach statistical significance.

Table 2. Logistic regression results on frugal innovation adoption.

Explanatory factor	Coefficient	p-value	Interpretation
Licenses/permits perceived as a Constraint	+0.063	0.209	Positive trend, but not significant
Land access perceived as a constraint	+0.009	0.763	No measurable association
Administrative time spent on regulation	+0.018	0.677	No noticeable influence

Exploratory logistic regression: Odds ratios (OR) and 95% confidence intervals (CI) were computed to emphasize effect sizes: Licenses/permits constraint: OR = 1.065, 95% CI [0.94; 1.21]; Land-access constraint: OR = 1.009, 95% CI [0.85; 1.18]; Administrative time: OR = 1.018, 95% CI [0.92; 1.14]. All effects are positive but statistically non-significant ($p > 0.05$), consistent with the exploratory nature of the analysis.

2) Differences in Mean

Table 3. Differences in mean between frugal and non-frugal SMEs.

Perceived constraint	Average (not frugal)	Average (frugal)	p-value	Conclusion
Licenses/permits	34.1%	40.4%	0.229	No significant difference
Access to land	25.7%	27.4%	0.731	No effect measured
Administrative time	17.4 days	20.3 days	0.474	No significant difference

The statistical results presented in Table 3 suggest a positive association between the perception of institutional constraints and the tendency of SMEs to adopt frugal innovation strategies. The regression coefficients are all positive, indicating that the more constraints are perceived, the more firms tend to gravitate toward simple, robust, and accessible solutions.

However, statistical significance ($p > 0.05$) was not reached, which prevents any formal causal interpretation. This aligns with the findings of Chebbah [12], who argues that heavy regulations encourage SMEs to adopt non-standardized, often invisible but effective innovation processes. SMEs thus perceive these constraints

as opportunities for innovation aimed at ensuring their survival in the market.

3) Overview of Statistical Findings

Table 4. Results of statistical analyses on frugal innovation.

Analysis	Independent variable	Estimate/average	p-value	Interpretation
Logistic regression	Intercept	−2.08	0.332	Basic (low) probability without constraints
	% constraints related to licenses/permits	+0.063	0.209	Positive but not significant effect
	% land constraints	+0.0095	0.763	No influence detected
	Time spent on regulation (days/year)	+0.0181	0.677	No significant link
t-test—licenses/permits	Avg. non-frugal: 34.09% Avg. frugal: 40.42%	Difference ≈ +6 pts	0.229	No significant difference
t-test—access to land	Avg. non-frugal: 25.65% Avg. frugal: 27.40%	Difference ≈ +1.75 pts	0.731	No significant difference
t-test—administrative time	Avg. non-frugal: 17.36 days Avg. frugal: 20.26 days	Difference ≈ +2.9 days	0.474	No significant difference

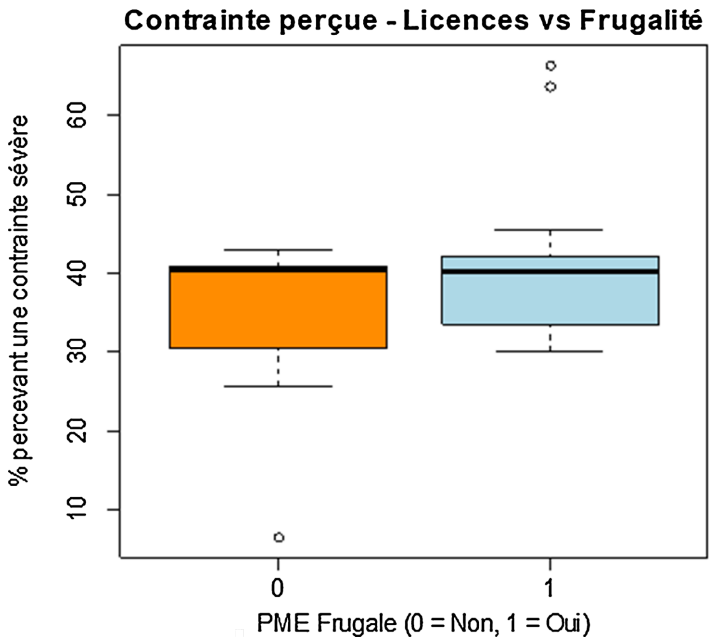

Figure 2. Perceived licensing constraints among frugal and non-frugal SMEs.

The combined results presented in Table 4 summarize the logistic regression coefficients and the mean-comparison tests. All coefficients are positive, indicating that higher perceived constraints tend to be associated with a greater likelihood of adopting frugal innovation. However, none of these effects reach statistical significance ($p > 0.05$), confirming the exploratory nature of the anal-

ysis.

The boxplot in Figure 2 compares the perception of licensing and permit constraints between frugal and non-frugal SMEs. A visual trend is observed, suggesting that firms adopting frugal innovation perceive licensing constraints slightly more acutely (higher median). However, this difference remains moderate and is not statistically significant (Student's t-test, $p = 0.229$). This suggests that, despite the absence of formal statistical evidence, frugality may emerge as an adaptive strategy in response to a restrictive institutional environment.

Overall, all variables tested in the logistic model show positive effects on the propensity to innovate frugally, but none are significant at the 5% level. These results indicate a potential trend, but the limited sample size ($n = 27$) likely reduces statistical power. This supports the need for complementary qualitative approaches or future quantitative extensions.

5.3. Exploratory Association Tests by Size, Sector, and Location

Table 5. Chi-square test results for associations between frugal innovation and firm characteristics.

Element	Value
Chi^2	5.14×10^{-32}
DDL (df)	1
p-value	1,000
Message	"The Chi^2 approximation may be incorrect."

The results of the association tests presented in Table 5 show no statistical relationship between frugal innovation and firm characteristics such as size, sector, or location. The Chi-square test yields a p-value of 1, indicating that the observed distribution is fully consistent with the assumption of independence.

The visual comparison further illustrates the absence of a clear pattern between perceived licensing constraints and the adoption of frugal innovation. Although a slight difference in medians can be observed, the variation remains moderate and statistically non-significant.

These results suggest that frugal innovation does not follow a rigid segmentation based on structural firm characteristics. Instead, the diversity of resilience contexts calls for the development of an exploratory typology grounded in qualitative or field-based approaches. This perspective highlights that frugality depends less on size or sector than on the degree of autonomy, creativity, and interaction with local constraints.

5.4. Frugal Innovation and Entrepreneurial Resilience in the Context of Institutional Constraints

The results of the logistic regression model presented in Table 6 allow us to examine the relationship between the institutional constraints perceived by Congo-

lese SMEs and their propensity to adopt a frugal innovation approach. All coefficients are positive, suggesting that the stronger the constraints, the more an SME tends to adopt frugal innovation.

Table 6. Logistic regression results on frugal innovation and institutional constraints.

Independent variable	Coefficient (estimate)	p-value	Interpretation
(Intercept)	−2.08	0.332	Low basic probability
Constraint—Licenses/permits	+0.063	0.209	Positive trend not significant
Constraint—Access to land	+0.0095	0.763	Negligible influence
Time direction regulation (days/year)	+0.0181	0.677	Slight, insignificant effect

Although these trends are consistent with the theoretical framework (Radjou *et al.*, 2012; Agarwal & Brem, 2021), none of the variables reach statistical significance ($p > 0.05$). The constraint related to licenses and permits shows the highest coefficient (+0.063; $p = 0.209$), followed by administrative time (+0.0181; $p = 0.677$), while access to land exhibits only a marginal influence (+0.0095; $p = 0.763$). The model's AIC (38.35) indicates a simple but informative structure, suitable for an exploratory study.

These results, while not formally validating the main hypothesis, support a conceptually robust interpretation. Frugal innovation can be understood as a driver of entrepreneurial resilience, deployed in response to a restrictive institutional environment. In the absence of stable formal resources, SMEs develop resourceful, creative, and adaptable solutions based on improvisation and local optimization.

Thus, although the identified constraints do not exert statistically significant effects, they appear to activate entrepreneurial adaptation strategies in which frugality becomes a tangible form of resilience. This dynamic justifies a more in-depth qualitative investigation of innovative behaviors in informal or sub-institutionalized settings, where emerging practices often defy traditional quantitative modeling.

6. Discussion and Conclusion

This study provides exploratory evidence on the relationship between institutional constraints and frugal innovation among Congolese SMEs using WBES 2024 data [3]. Although all estimated coefficients show positive directional trends, none reach statistical significance, mainly due to the small sample size. The findings nonetheless suggest that firms operating under licensing, land, and regulatory pressures may adopt adaptive, low-cost innovation strategies consistent with frugal innovation theory.

A key policy implication is that public institutions should recognize and support these grassroots innovation practices by simplifying administrative proce-

dures and improving land governance. The main limitation of the study is the restricted sample (n = 27), which reduces statistical power. Future research should combine quantitative and qualitative approaches to better capture the mechanisms through which SMEs innovate under institutional constraints.

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Conflicts of Interest

The author declares no conflicts of interest.

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