






“Business growth and management costs as moderators of the inventory-performance link: Evidence from Vietnamese manufacturing firms”

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BUSINESS GROWTH AND MANAGEMENT COSTS AS MODERATORS OF THE INVENTORY-PERFORMANCE LINK: EVIDENCE FROM VIETNAMESE MANUFACTURING FIRMS

Abstract

In emerging markets such as Vietnam, where firms face rapid growth and rising operational complexity, understanding how inventory efficiency interacts with business dynamics is vital. This study aims to examine the relationship between inventory management and firm performance, with a specific focus on how this relationship is moderated by business growth and management costs. Using a balanced panel dataset of 364 manufacturing firms listed on Vietnam's stock exchanges from 2012 to 2023, this study employs panel data regression methods, including Fixed Effects Model, Random Effects Model, Feasible Generalized Least Squares, and, notably, the System Generalized Method of Moments to address issues of endogeneity and unobserved firm-level heterogeneity. Firm performance is measured by return on assets, and inventory management is proxied by average inventory days. The results show that average inventory days are negatively associated with firm performance, indicating that longer inventory cycles reduce profitability. The interaction term between inventory days and business growth is also negative, suggesting that growth exacerbates the adverse effects of inefficient inventory practices. In contrast, the interaction between inventory days and management costs is positive, implying that effective cost control can mitigate inventory inefficiency. These findings highlight the need for Vietnamese manufacturing firms to align inventory practices with growth strategies and cost management to sustain profitability in dynamic markets.

Keywords

inventory management, firm performance, business growth, management costs, Vietnam

JEL Classification

M11, D22, G32

INTRODUCTION

Inventory management remains a cornerstone of operational strategy in manufacturing firms, where it directly affects cost efficiency, liquidity, and responsiveness to market fluctuations. In rapidly developing economies such as Vietnam, manufacturing enterprises operate under heightened uncertainty, dynamic growth, and resource constraints, making inventory management even more critical. Despite its foundational role, inventory management is often examined in isolation, without sufficient integration into the broader business dynamics that shape firm performance in volatile or transitional environments.

Existing research highlights the importance of inventory management in enhancing operational and financial efficiency. Studies

such as those by Demeter (2003), Elsayed and Wahba (2016) have emphasized the role of inventory turnover in improving profitability. However, these studies often focus on developed economies or fail to account for the nuanced challenges faced by firms in dynamic growth environments. Research specific to Vietnam, including works by Nguyen et al. (2020), has shown that efficient inventory practices are critical for firm success, particularly in the manufacturing sector. Despite these insights, the combined effects of growth and management costs on inventory management remain underexplored, leaving a significant gap in the literature.

Existing studies in operations and corporate finance widely acknowledge the importance of inventory optimization for improving firm-level outcomes. However, a significant scientific problem arises from the contextual rigidity of much of the literature: most studies are grounded in developed economies, with stable markets and mature logistics systems. These conditions do not reflect the operational realities of emerging economies, where firms face accelerated expansion, underdeveloped infrastructure, and inconsistent cost structures. Consequently, there is a growing need to re-evaluate the theoretical assumptions surrounding inventory efficiency by incorporating moderating conditions, such as business growth and managerial costs, into analytical frameworks.

From a theoretical standpoint, the intersection between Lean Inventory Theory, Transaction Cost Theory, and Operating Cycle Theory suggests that inventory-performance relationships are non-linear and context-dependent. Yet, few empirical studies explicitly model these dynamics, particularly in the case of high-growth firms where rapid expansion introduces volatility into demand forecasting, production scheduling, and supply chain coordination. Similarly, management costs, both fixed and variable, can either hinder or enable effective inventory practices depending on their alignment with strategic objectives. Within this scientific gap, the key problem this study seeks to address is the lack of empirical understanding of how growth pressures and cost structures alter the effect of inventory management on firm performance, particularly in transitional markets like Vietnam. Addressing this gap is not only relevant for theory refinement but also for guiding practical improvements in financial and operational planning in emerging economies.

The primary objective of this research is to investigate how inventory management affects firm performance, and how this relationship is influenced by two moderating factors: (1) business growth, which may amplify the challenges of managing inventory due to increased demand uncertainty and operational complexity, and (2) management costs, which can either weaken or reinforce the performance outcomes of inventory strategies depending on their efficiency. This study employs panel data regression methods, including Fixed Effects Model (FEM), Random Effects Model (REM), Feasible Generalized Least Squares (FGLS), and, notably, the System Generalized Method of Moments (SGMM) to address issues of endogeneity and unobserved firm-level heterogeneity. The dataset consists of financial data from 364 manufacturing firms listed on Vietnam's stock exchanges over the period 2012 to 2023. Key variables include return on assets (ROA) as the dependent variable, average inventory days (IND) as the main independent variable, business growth (GROW), and management and selling cost (SBE) as the moderating variable.

The study contributes to the literature by offering a deeper understanding of the dynamic relationship between inventory management and firm performance, particularly under the influence of business growth. By focusing on the Vietnamese manufacturing sector, the research provides empirical insights into an emerging market context, addressing the distinct challenges of firms in these environments. The findings will offer practical recommendations for managers to enhance inventory practices in growth-intensive scenarios.

1. LITERATURE REVIEW AND HYPOTHESES

Prior studies have explored the relationship between inventory management and firm outcomes across various industry contexts and national settings. However, most have focused on direct effects and employed cross-sectional data, often overlooking temporal dynamics and contextual moderating factors. In emerging economies, where growth is rapid and infrastructure uneven, these factors become crucial. This review aims to contextualize the theoretical foundations and empirical findings relevant to inventory management, with a focus on identifying the mechanisms through which business growth and managerial costs may alter its influence on firm performance. The relationship between inventory management and firm performance is intricate, particularly in the presence of moderating factors such as business growth and management costs. This study synthesizes Lean Inventory Theory, Transaction Cost Theory, Operating Cycle Theory, and cost management principles to provide a robust theoretical framework. These theories, drawn from prior research, highlight how inventory management influences firm performance and how this relationship evolves under the pressures of growth and cost.

Lean Inventory Theory posits that minimizing waste and maintaining optimal inventory levels enhance operational efficiency and reduce holding costs (Shah & Shin, 2007). This theory suggests that efficient inventory turnover positively impacts firm performance by freeing up resources and avoiding unnecessary capital lockup in stock. However, this perspective also recognizes potential risks: in high-growth scenarios, minimizing inventory levels might lead to supply chain disruptions or an inability to meet sudden surges in demand. These challenges are further illuminated by Transaction Cost Theory, which emphasizes the trade-off between holding costs and ordering costs. As firms grow, their operational complexity increases, often leading to higher transaction costs (Firth, 1976; Williamson, 1985). This growth necessitates advanced inventory strategies to ensure efficiency while managing increased transaction costs. For example, Fullerton et al. (2003) found that firms implementing just-in-time prac-

tices experienced improved operational performance; however, this required robust supply chain coordination to mitigate risks. Similarly, Demeter (2003) highlighted that reducing inventory levels could enhance profitability but stressed that such strategies are sensitive to market and operational volatility. These studies illustrate the interaction between Lean Inventory Theory and Transaction Cost Theory, emphasizing the operational adjustments required as firms scale.

Operating Cycle Theory links inventory turnover to a firm's financial health, arguing that shorter operating cycles improve liquidity and provide capital for reinvestment (Farooq, 2019; Firth, 1976). Efficient inventory management reduces the time required to convert inventory into cash, enhancing a firm's ability to fund growth opportunities. However, rapid business growth often introduces challenges such as increased demand variability and supply chain constraints, which can strain inventory management practices. Elsayed and Wahba (2016) demonstrated that firms in high-growth contexts faced difficulties maintaining short operating cycles without compromising service levels or incurring higher costs. Cost management principles, such as those reflected in the weighted average cost of capital, further contextualize these challenges. High management costs, including administrative overhead and process inefficiencies, can offset the financial gains of effective inventory turnover (Brealey et al., 2014). Cannon et al. (2008) observed that while inventory efficiency contributes to profitability, its impact is contingent on controlling related management costs. This interaction suggests that firms must integrate cost management with inventory practices to sustain performance, particularly during growth phases.

These theoretical perspectives collectively highlight the dynamic and context-sensitive nature of inventory management. Lean Inventory Theory and Transaction Cost Theory explain the operational mechanisms driving efficiency, while Operating Cycle Theory and cost management principles emphasize the financial dimensions of these processes. Together, they form a comprehensive lens for understanding how inventory days influence firm performance and how this relationship is moderated by business growth and

management costs. In this study, the integration of these theories reveals that inventory management effectiveness depends on a firm's ability to adapt to growth pressures and manage costs. For instance, firms experiencing rapid expansion might face higher demand variability, requiring increased inventory levels to prevent disruptions, thereby challenging the principles of lean inventory management (Demeter, 2003; Vandeput, 2020). Similarly, while shorter operating cycles improve liquidity, rising management costs associated with expanded operations might diminish the financial benefits of such efficiency (Oyedokun & Somoye, 2019; Shaikh et al., 2019).

Empirical studies on inventory management and its effects on firm performance provide critical insights for understanding how these relationships evolve under the moderating influences of business growth and management costs. Research on the direct effects of inventory practices, including inventory turnover and inventory days, has consistently highlighted their importance in improving operational efficiency and financial performance. For example, Fullerton et al. (2003) and Demeter (2003) found that firms implementing lean inventory practices, such as just-in-time systems, reported enhanced profitability and operational performance. However, their findings also emphasized that the success of such strategies heavily depends on stable market conditions and effective supply chain coordination. Elsayed and Wahba (2016) extended this discussion by showing that shorter inventory days are often associated with higher profitability, though this relationship weakens in contexts of market volatility or fluctuating demand, similar to some other studies, such as Chuang et al. (2019), Rumyantsev and Netessine (2007), and Gołaś (2020). These studies provide foundational evidence but often do not explore the nuances introduced by moderating factors such as growth and costs.

The moderating role of business growth in the inventory-performance relationship has garnered attention in recent studies. Growth increases demand variability and operational complexity, challenging firms to adjust their inventory strategies accordingly. O'Regan et al. (2006) observed that firms in high-growth environments faced greater challenges in maintaining lean inventory

levels, as the need to buffer against supply chain disruptions often necessitated higher inventory levels. Similarly, Hagenimana and Rusibana (2024) highlighted that growth amplifies the intricacies of managing inventory, particularly for firms expanding into new markets or scaling production capabilities. This argument concurs with the research of Mahato et al. (2021), Song et al. (2020), and Panigrahi et al. (2021). While these studies underscore the importance of adapting inventory strategies in growth contexts, they do not quantitatively measure the interaction effects of growth, leaving a significant gap in understanding its precise moderating influence.

The influence of management costs as a moderating factor has also been explored, particularly concerning the financial implications of inventory practices. Gołaś (2020) demonstrated that high administrative and operational costs could erode the profitability gains from efficient inventory management, particularly in firms with complex operations. Furthermore, some other studies corroborated these findings, like Amponsah-Kwatiah and Asiamah (2021), Aldubhani et al. (2022), and Morshed (2020), showing that rising costs associated with scaling operations often negate the financial advantages of inventory efficiency. These studies underscore the critical role of cost management in ensuring that inventory strategies translate into improved firm performance, yet they often fail to incorporate interaction terms or dynamic market conditions, which could offer a more nuanced understanding of these effects.

Research in the Vietnamese market has extensively analyzed the dynamics between inventory management and firm performance across various industries. For instance, Nguyen et al. (2020) highlighted the positive impact of efficient working capital management, including inventory turnover, on profitability in the construction and building materials sectors. This finding aligns with Phuong and Hung (2020), who emphasized that strategic inventory management contributes to better operational performance in listed firms. Additionally, Truong (2023) shows that optimized inventory periods significantly enhance profitability by improving resource allocation efficiency. Another notable contribution is by Nguyen and Nguyen (2020), who underscored the critical role

of inventory days in determining financial success among manufacturing firms in Vietnam. Their findings revealed that firms with shorter inventory cycles tended to achieve higher returns on assets and equity, particularly in volatile market conditions.

Further studies have focused on sector-specific challenges. Nguyen et al. (2022) revealed that effective inventory control mitigates liquidity risks, directly linking shorter inventory days with improved profitability. Kawanishi et al. (2020) demonstrated that inventory efficiency significantly impacts the financial performance of listed firms by reducing operational redundancies. Similarly, Quy and Nguyen (2020) found that in the fishery sectors, effective inventory management practices are critical to maintaining profitability under competitive pressures. These sectoral insights highlight the importance of tailoring inventory practices to industry-specific challenges in Vietnam. Moreover, broader empirical analyses have considered the macroeconomic context. Ha et al. (2016) explored working capital management across industries in Vietnam and found that inventory control is particularly crucial in mitigating risks associated with demand volatility. Their work complements findings by Nguyen (2020), who examined the moderating effects of cash flow on inventory practices and found that firms with higher liquidity are better positioned to adapt to market changes.

The relationship between inventory management and firm performance, as moderated by business growth and management costs, provides a robust foundation for developing hypotheses. The integration of Lean Inventory Theory, Transaction Cost Theory, Operating Cycle Theory, and empirical evidence highlights key areas where these relationships can be quantitatively examined.

Lean Inventory Theory suggests that efficient inventory management enhances operational efficiency by minimizing holding costs and ensuring smooth resource allocation (Fullerton et al., 2003; Shah & Shin, 2007). Empirical studies, such as Gołaś (2020) and Hagenimana and Rusibana (2024), confirm that shorter inventory days are associated with improved profitability across various industries. In the context of Vietnamese man-

ufacturing firms, studies such as those by Quy and Nguyen (2020) and Nguyen (2020) emphasize the critical role of inventory days in determining financial success. Given this evidence, it is expected that a direct relationship exists between inventory days and firm performance, where shorter inventory days contribute positively to firm profitability.

Second, as highlighted by Transaction Cost Theory, business growth introduces operational complexities that influence the efficiency of inventory management (Williamson, 1985). Growth increases demand variability and supply chain challenges, potentially diminishing the positive effects of efficient inventory practices. Empirical studies in Vietnam, such as those by Truong (2023) and Phuong and Hung (2020), support the notion that high-growth firms face greater difficulty in maintaining optimal inventory levels while sustaining profitability. These dynamics suggest that business growth moderates the relationship between inventory days and firm performance, potentially weakening the benefits of shorter inventory cycles in high-growth scenarios.

Furthermore, cost management principles, particularly the Weighted Average Cost of Capital, emphasize that rising administrative and operational costs can offset the gains from inventory efficiency (Brealey et al., 2014; Cannon et al., 2008). High management costs, as observed in studies like Kawanishi et al. (2020), erode profitability even in firms with efficient inventory turnover. Vietnamese studies by Quy and Nguyen (2020) and Nguyen et al. (2022) further highlight how cost pressures in sectors like food processing and textiles constrain the ability of firms to capitalize on inventory efficiency. These findings suggest that management costs weaken the positive relationship between inventory days and firm performance.

This study investigates the relationship between inventory management and firm performance, focusing on the moderating effects of business growth and management costs in Vietnamese manufacturing firms. This study, therefore, tests the following hypotheses:

H1: Inventory days are negatively associated with firm performance.

H2: *Business growth moderates the relationship between inventory days and firm performance, weakening the positive effect of shorter inventory days as growth increases.*

H3: *Management costs moderate the relationship between inventory days and firm performance, weakening the positive effect of shorter inventory days as costs increase.*

In summary, the reviewed literature highlights that while inventory efficiency contributes to firm profitability, this relationship is not static and may vary significantly with business expansion and internal cost structures. Despite extensive research on inventory-performance linkages, few studies have quantitatively addressed these moderating influences, particularly in the context of emerging markets like Vietnam. This study aims to fill that gap by empirically investigating how business growth and management costs shape the effect of inventory management on firm performance in Vietnamese manufacturing firms.

2. METHODOLOGY

2.1. Data

The dataset for this study includes manufacturing firms listed on the Ho Chi Minh City Stock Exchange (HOSE) and the Hanoi Stock Exchange (HNX), and the Unlisted Public Company Market (UPCOM) in Vietnam. The data were sourced from the audited financial statements and annual reports of the firms, which were accessed through the database on the website <https://vietstock.vn/>. The sample period spans from 2012 to 2023, allowing for a comprehensive analysis of inventory management practices and their implications for firm performance over time. This study focuses exclusively on manufacturing firms, as inventory management plays a critical role in their operational and financial performance. Firms with missing or incomplete financial statements were also excluded to ensure the consistency and reliability of the dataset. After cleaning the data to exclude firms with incomplete or missing data and removing outliers, the final dataset comprises 364 firms, resulting in 4,368 firm-year observations.

The research employs panel data for its superior ability to account for variations across both time and individual entities. Panel data provide high variability, reduce multicollinearity among variables, and increase the degrees of freedom, leading to more robust and efficient estimation results. As noted by Gujarati and Porter (2004), this data structure is particularly suited for studies investigating changes over time, as it enables the detection and measurement of dynamic relationships more effectively than cross-sectional or time-series data.

2.2. Models

Model 1: The impact of inventory days on firm performance.

$$ROA_{i,t} = \alpha_0 + \alpha_1 IND_{i,t} + \alpha_2 LEV_{it} + \alpha_3 OCF_{i,t} + \alpha_4 SIZE_{i,t} + \alpha_5 GROW_{i,t} + \alpha_6 SBE_{i,t} + \alpha_7 COV_{-19_t} + \varepsilon_{it}, \quad (1)$$

Model 2: The moderating effect of business growth

$$ROA_{i,t} = \alpha_{01} + \alpha_{11} IND_{i,t} + \alpha_{21} LEV_{it} + \alpha_{31} OCF_{i,t} + \alpha_{41} SIZE_{i,t} + \alpha_{51} GROW_{i,t} + \alpha_{61} (IND_{i,t} \cdot GROW_{i,t}) + \alpha_{71} SBE_{i,t} + \alpha_{81} COV_{-19_t} + \varepsilon_{it}, \quad (2)$$

Model 3: The moderating effect of management costs

$$ROA_{i,t} = \alpha_{02} + \alpha_{12} IND_{i,t} + \alpha_{22} LEV_{it} + \alpha_{32} OCF_{i,t} + \alpha_{42} SIZE_{i,t} + \alpha_{52} GROW_{i,t} + \alpha_{62} SBE_{i,t} + \alpha_{72} IND_{i,t} \cdot SBE_{i,t} + \alpha_{82} COV_{-19_t} + \varepsilon_{it}, \quad (3)$$

where $ROA_{i,t}$ is the return on assets of firm i at time t . $IND_{i,t}$ is the average inventory days of firm i at time t . $GROW_{i,t}$ is the growth of firm i at time t . $IND_{i,t} \cdot GROW_{i,t}$ is the interaction term between average inventory days and the growth of firm i at time t . $SBE_{i,t}$ is the management costs of firm i at time t . $IND_{i,t} \cdot SBE_{i,t}$ is the interaction term between average inventory days and management costs of firm i at time t . $LEV_{i,t}$ is the leverage of firm i at time t . $OCF_{i,t}$ is the operating cashflow of

firm i at time t . $SIZE_{i,t}$ is the size of firm i at time t . COV_19_t is the dummy variable for the COVID-19 period at time t . α is the coefficient, $\varepsilon_{i,t}$ is the error term.

To examine the relationship between inventory days and firm performance, as well as the moderating effects of business growth and management costs, this study employs panel data regression methods, including the Fixed Effects Model (FEM), Random Effects Model (REM), Feasible Generalized Least Squares (FGLS), and, notably, the System Generalized Method of Moments (SGMM). Among them, the SGMM estimator is applied to ensure robust and unbiased parameter estimates in the presence of endogeneity and unobserved firm-level heterogeneity. The System Generalized Method of Moments (SGMM) is employed in this study to address the dynamic nature of the relationship between inventory days and firm performance, considering the moderating effects of business growth and management costs. SGMM effectively handles endogeneity issues arising from the inclusion of a lagged dependent variable and potential simultaneity between inventory management practices and firm performance. The application of SGMM in similar studies reinforces its suitability. García-Teruel and Martínez-Solano (2007) used SGMM to examine the impact of working capital management on firm profitability, highlighting its effectiveness in controlling for endogeneity. Similarly, Amahalu (2018) employed SGMM to analyze inventory management and financial performance, emphasizing its robustness in capturing the dynamic interactions

between variables. Fullerton et al. (2003) also applied SGMM to assess the relationship between just-in-time practices and financial performance, demonstrating its capacity to handle complex operational-financial linkages.

Table 1 outlines the measurement and definition of variables used in the study, providing a clear framework for how key constructs are operationalized. The dependent variable, Return on Asset (ROA), is measured as the ratio of net income to average total assets, reflecting a firm's profitability relative to its asset base. This measure is widely recognized as a comprehensive indicator of financial performance, capturing both operational efficiency and resource utilization. Average inventory days (IND), a key independent variable, measures the time taken to convert inventory into sales, offering insights into a firm's inventory management efficiency. Growth (GROWTH), measured as the change in total assets, serves as a proxy for business expansion, highlighting the firm's capacity to scale operations and leverage market opportunities.

The moderating variable, management and selling costs (SBE), is calculated as the ratio of management and selling expenses to revenue, providing a measure of operational overhead and its impact on profitability. Additional control variables include leverage (LEV), which reflects a firm's financial dependency, operating cash flow (OCF), which indicates liquidity and operational stability, and size (SIZE), measured as the natural logarithm of total assets, representing economies of scale. The

Table 1. Variables measurement

Source: Compiled by the authors.

Variables	Symbol	Measurement	References
Return on Assets	ROA	Net income / Average Total Asset	Elsayed & Wahba (2016), Farooq (2019), Hagenimana & Rusibana (2024)
Average inventory days	IND	Average inventory days	Nguyen (2020), Panigrahi et al. (2021)
Growth	GROW	Change in Total assets	Gólaś (2020), Morshed (2020), Nguyen et al. (2020)
Management & selling cost	SBE	Management & selling expenses / Revenue	Phuong & Hung (2020), Mahato, De & Mahata (2021)
Leverage	LEV	Total debt / Total assets	Truong (2023), Van & Nguyen (2022)
Operating cashflow	OCF	Operating cashflow	Shaikh et al. (2019), Oyedokun & Somoye (2019), Quy & Nguyen (2020)
Size	SIZE	Ln(Total assets)	Oyedokun & Somoye (2019), Truong (2023)
Covid period	COVID	Dummy variable, 0 indicates the normal period, 1 indicates the COVID-19 period	Nguyen (2022), Van & Nguyen (2022)

inclusion of a dummy variable for the COVID-19 period captures the pandemic's unique challenges, distinguishing its effects from normal economic conditions. Together, these variables provide a robust analytical framework, enabling the study to explore the nuanced relationships between inventory management, firm performance, and moderating factors within a dynamic and resource-constrained context.

The analysis follows this sequence: (i) Descriptive statistics and correlation matrix to explore data distribution and preliminary relationships. (ii) Multicollinearity check using Variance Inflation Factor (VIF). (iii) Panel regression diagnostics, including Breusch-Pagan LM test, Hausman test, and tests for heteroskedasticity and serial correlation. (iv) Initial estimates using FEM, REM, and FGLS. (v) Dynamic panel modeling via System Generalized Method of Moments (SGMM) to address endogeneity, unobserved heterogeneity, and dynamic relationships. Lagged dependent variables and internal instruments are used.

3. RESULTS

3.1. Descriptive analysis

As Table 2 shows, the descriptive analysis reveals significant insights into the variability of inventory management practices and their potential impact on firm performance. The mean inventory days (99.179) with a standard deviation of 81.661 reflect substantial differences in how firms handle inventory, which could stem from variations in operational strategies or industry requirements. Firms with shorter inventory cycles may benefit from enhanced efficiency and liquidity, while those with longer cycles might face challenges related to hold-

ing costs or demand planning. This highlights the critical role of inventory management in influencing firm performance and the necessity of investigating its effects further.

Firm growth (GROW) presents another key area of interest, with an average growth rate of 0.071 and a relatively widespread distribution across the interquartile range. This indicates diverse growth trajectories among firms, reflecting varying capacities to expand operations or adapt to market conditions. Growth's role as a moderating factor is particularly relevant here, as it could influence the effectiveness of inventory management practices. Additionally, the descriptive statistics for selling, general, and administrative expenses (SBE), with a mean of 0.120, underscore the importance of cost management in shaping profitability. Firms with higher SBE ratios may encounter challenges in converting operational efficiencies into financial gains, making it a crucial variable for further analysis.

The correlation heatmap in Table 3 provides valuable insights into the relationships among the study variables, with varying degrees of positive and negative correlations. Return on Assets (ROA), as a measure of firm performance, shows a negative correlation with inventory days (IND) at -0.208 and leverage (LEV) at -0.391. This indicates that higher inventory days and increased leverage are associated with reduced profitability. The strong negative relationship between ROA and LEV highlights the financial strain that excessive debt places on firms, which can diminish returns. Conversely, ROA exhibits positive correlations with operating cash flow (OCF) at 0.348, firm size (SIZE) at 0.153, and growth (GROW) at 0.183, suggesting that firms with better liquidity, larger scale, and growth opportunities tend to perform

Table 2. Descriptive analysis

Source: Authors' calculations.

Variable	count	mean	std	min	25%	50%	75%	max
ROA	4,004	0.055	0.088	-0.675	0.013	0.047	0.096	0.722
IND	4,004	99.179	81.661	0.021	48.194	78.932	124.695	598.374
LEV	4,368	0.494	0.223	0.003	0.321	0.504	0.672	0.993
OCF	4,004	0.064	0.134	-0.962	-0.005	0.054	0.136	0.743
SIZE	4,368	27.076	1.567	22.908	25.936	28.034	29.186	32.866
GROW	4,004	0.071	0.408	-0.876	-0.052	0.031	0.139	19.336
SBE	4,368	0.120	0.107	0.002	0.059	0.091	0.151	0.996

Table 3. Correlation matrix

Source: Authors' calculations.

	ROA	IND	LEV	OCF	SIZE	GROW	SBE	COV_19
ROA	1							
IND	-0.208	1						
LEV	-0.391	0.067	1					
OCF	0.348	-0.151	-0.173	1				
SIZE	0.153	0.019	0.175	0.000	1			
GROW	0.183	-0.026	0.016	-0.089	0.098	1		
SBE	-0.145	0.276	-0.172	-0.052	-0.161	-0.036	1	
COV_19	-0.092	0.076	-0.085	-0.030	0.071	-0.058	0.079	1

better. These relationships align with financial theories emphasizing the importance of operational efficiency and strategic growth in enhancing profitability.

The interactions among independent variables also reveal important dynamics. Inventory days (IND) show a moderate positive correlation with selling and administrative expenses (SBE) at 0.276, indicating that firms with longer inventory cycles may incur higher management costs, potentially due to inefficiencies in inventory handling. Meanwhile, leverage (LEV) demonstrates negative correlations with IND (-0.151) and OCF (-0.173), suggesting that higher leverage may impair inventory efficiency and cash flow generation. The weak correlations of COVID-19 (COV_19) with most variables suggest that the pandemic's direct impact on these financial metrics may be limited or mitigated by other factors. Overall, the heatmap emphasizes the interplay between inventory practices, cost management, and growth, highlighting the importance of these factors in shaping firm perfor-

mance. These findings underscore the need for further investigation into how growth and cost efficiency moderate the inventory-performance relationship.

The Variance Inflation Factor (VIF) analysis in Table 4 provides insights into multicollinearity across the three models. Most variables exhibit low VIF values (below 2), suggesting minimal multicollinearity and reliable estimation. For example, IND, LEV, OCF, and SIZE maintain consistently low VIF values across all models, reinforcing their independence from other predictors. However, interaction terms reveal higher multicollinearity. In Model 2, the interaction term $IND \cdot GROW$ has a VIF of 2.28, indicating moderate multicollinearity but still within acceptable limits. In Model 3, $IND \cdot SBE$ shows a higher VIF of 3.79, coupled with a Tolerance of 0.264, suggesting more pronounced multicollinearity due to the interaction effects. While this level is manageable, it warrants careful interpretation to avoid overstating relationships in the presence of multicollinearity.

Table 4. VIF for all models

Source: Authors' calculations.

Variable	Model 1		Model 2		Model 3	
	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance
IND	1.12	0.891	1.13	0.881	2.01	0.497
LEV	1.11	0.903	1.11	0.900	1.11	0.901
OCF	1.07	0.938	1.07	0.938	1.07	0.935
SIZE	1.07	0.931	1.07	0.931	1.08	0.928
GROW	1.02	0.976	2.30	0.435	1.03	0.975
SBE	1.15	0.867	1.15	0.867	2.47	0.405
COV_19	1.03	0.972	1.03	0.972	1.03	0.972
INDxGROW			2.28	0.439		
INDxSBE					3.79	0.264
Mean VIF	1.08		1.39		1.7	

3.2. Regression results

Table 5 presents the results of the Breusch and Pagan Lagrangian multiplier (LM) test conducted for Models 1, 2, and 3 to evaluate whether random effects are appropriate compared to the pooled OLS model. The test results indicate highly significant chi-squared values for all three models (Model 1: 2534.64, Model 2: 2525.44, Model 3: 2632.90, $p < 0.01$). These findings strongly reject the null hypothesis of no random effects, suggesting that the random effects model is more suitable than the pooled OLS model. This implies that there are significant differences across the individual units (e.g., firms) in the dataset, which must be accounted for in the analysis. The high significance levels across all models underscore the presence of unobserved heterogeneity that cannot

be ignored, reinforcing the need to move beyond OLS and consider panel data models.

Table 6 provides a comprehensive comparison of the Fixed Effects Model (FEM), Random Effects Model (REM), and Feasible Generalized Least Squares (FGLS) for Model 1, highlighting the significant determinants of ROA. Across all models, IND consistently exhibits a negative and highly significant impact on firm performance ($p < 0.01$), reinforcing the notion that inventory inefficiency undermines profitability. Similarly, LEV, SBE, and COV_19 demonstrate negative and highly significant coefficients ($p < 0.01$) in all models, underscoring their adverse effects on ROA. On the other hand, OCF, SIZE, and GROW show positive and significant coefficients across all estimations ($p < 0.01$), reflecting their essential role in improving

Table 5. Breusch-Pagan Lagrangian multiplier test for all models

Source: Authors' calculation from Stata.

Breusch-Pagan Lagrangian multiplier test	Model 1	Model 2	Model 3
chibar2(01)	2534.64***	2525.44***	2632.90***
Prob > chibar2	0.0000	0.0000	0.0000

Note: *** $p < 0.01$.

Table 6. FEM, REM, and FGLS estimates for Model 1

Source: Authors' calculations from Stata.

Models	FEM	REM	FGLS
IND	-0.000104*** [-5.83]	-0.000105*** [-6.55]	-0.000098*** [-9.61]
LEV	-0.159*** [-17.73]	-0.161*** [-23.33]	-0.140*** [-33.59]
OCF	0.0783*** [10.52]	0.0995*** [13.30]	0.0500*** [11.63]
SIZE	0.0182*** [7.02]	0.0122*** [10.02]	0.00699*** [10.55]
GROW	0.0277*** [12.02]	0.0307*** [13.19]	0.0365*** [17.32]
SBE	-0.138*** [-10.93]	-0.127*** [-10.93]	-0.0933*** [-9.24]
COV_19	-0.0208*** [-10.60]	-0.0195*** [-10.19]	-0.0121*** [-8.62]
_Cons	-0.331*** [-4.79]	-0.172*** [-5.26]	-0.0461*** [-2.60]
Observations	4004	4004	4004
Adjusted R-squared	0.2088	0.2055	
F test & Wald test	F(7,3633) = 136.96***	Wald chi2(7) = 1355.56***	Wald chi2(7) = 1743.81***
Hausman test		chi2(7) = 694.74 with Prob > chi2 = 0.0000***	
Heteroskedasticity test		chi2 (364) = 1.5e+05 with Prob > chi2 = 0.0000***	
Serial Correlation test		F(1, 363) = 36.318 with Prob > F = 0.0000***	

Note: t-statistics in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

firm performance. These consistently significant results across FEM, REM, and FGLS emphasize the robustness of the relationships between these variables and ROA, regardless of the model used.

The diagnostic tests included in Table 6 further substantiate the choice of models. The Hausman test yields a chi-squared statistic of 694.74 ($p < 0.01$), strongly rejecting the null hypothesis that REM is more appropriate than FEM, indicating that FEM should be preferred between these two models. However, the Modified Wald test for heteroskedasticity ($\chi^2 = 1.5e+05$, $p < 0.01$) and the Wooldridge test for serial correlation ($F = 36.318$, $p < 0.01$) indicate the presence of heteroskedasticity and serial correlation, both of which violate FEM and REM assumptions. These issues justify the use of FGLS, which accounts for these problems and provides efficient and unbiased estimates. The FGLS model delivers higher Wald chi-squared values (1743.81) compared to REM (1355.56), further supporting its robustness and reliability in capturing the relationship between the explanatory variables and ROA. These findings underline the critical importance of

methodological rigor in panel data analysis to ensure accurate and meaningful results.

Table 7 presents the FEM, REM, and FGLS estimates for Model 2, which includes the interaction term $IND \cdot GROW$ in addition to the main variables. Across all three models, the coefficient for $IND \cdot GROW$ is negative and highly significant ($p < 0.01$), suggesting that the adverse effect of inventory inefficiency (IND) on ROA is exacerbated in high-growth scenarios (GROW). This interaction highlights the challenges firms face in scaling operations effectively when inventory inefficiencies exist, as growth can amplify these inefficiencies' negative impact on profitability. The main variables, including IND, LEV, OCF, SIZE, GROW, SBE, and COV_19, remain consistent in direction and significance compared to Table 6. This consistency emphasizes the robustness of the findings, even when incorporating an interaction term. Importantly, the inclusion of $IND \cdot GROW$ marginally increases the explanatory power, as evidenced by a slightly higher Adjusted R-squared in FEM (0.2124 compared to 0.2088 in Table 6).

Table 7. FEM, REM, and FGLS estimates for Model 2

Source: Authors' calculations from Stata.

Models	FEM	REM	FGLS
IND	-0.000098*** [-5.52]	-0.000099*** [-6.20]	-0.000096*** [-9.36]
LEV	-0.162*** [-18.03]	-0.163*** [-23.63]	-0.141*** [-33.83]
OCF	0.0785*** [10.57]	0.0999*** [13.38]	0.0512*** [11.94]
SIZE	0.0189*** [7.30]	0.0123*** [10.16]	0.00707*** [10.66]
GROW	0.0379*** [11.18]	0.0412*** [11.95]	0.0458*** [16.51]
IND*GROW	-0.000085*** [-4.10]	-0.000087*** [-4.11]	-0.000080*** [-6.07]
SBE	-0.138*** [-10.97]	-0.128*** [-10.99]	-0.0927*** [-9.27]
COV_19	-0.0211*** [-10.73]	-0.0195*** [-10.22]	-0.0120*** [-8.61]
_Cons	-0.350*** [-5.07]	-0.175*** [-5.37]	-0.0485*** [-2.73]
Observations	4004	4004	4004
Adjusted R-squared	0.2124	0.2088	
F test & Wald test	F(8,3632) = 122.47***	Wald $\chi^2(8) = 1382.15***$	Wald $\chi^2(8) = 1765.88***$
Hausman test	$\chi^2(8) = 628.37$ with Prob > $\chi^2 = 0.0000***$		
Heteroskedasticity test	$\chi^2(364) = 1.5e+05$ with Prob > $\chi^2 = 0.0000***$		
Serial Correlation test	F(1, 363) = 36.581 with Prob > F = 0.0000***		

Note: t-statistics in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The diagnostic tests confirm the model's reliability and suitability. The Hausman test ($\chi^2(7) = 628,37$, $p < 0.01$) indicates FEM is preferred over REM. Additionally, the Modified Wald test for heteroskedasticity ($\chi^2 = 1.5e+05$, $p < 0.01$) and the Wooldridge test for serial correlation ($F = 36.581$, $p < 0.01$) both confirm the presence of heteroskedasticity and autocorrelation. These results underscore the importance of FGLS as the most appropriate model, as it effectively handles these violations. Compared to Table 6, the inclusion of $IND \cdot GROW$ enriches the model by capturing the interaction effect between inventory inefficiency and growth, providing deeper insights into how these variables interplay in determining firm performance. This added layer of analysis strengthens the study's findings and offers practical implications for firms managing growth and inventory challenges simultaneously.

Table 8 shows the FEM, REM, and FGLS estimates for Model 3, incorporating the interaction term $IND \cdot SBE$. Across all models, the interaction term $IND \cdot SBE$ is positive and highly significant

($p < 0.01$). This indicates that selling, general, and administrative expenses (SBE) can mitigate the negative impact of inventory inefficiencies (IND) on firm performance. The positive coefficient of $IND \cdot SBE$ highlights the strategic role of managerial efforts in converting inventory inefficiencies into opportunities for operational improvements or increased profitability. Notably, the significance and magnitude of $IND \cdot SBE$ are strongest in FEM and REM, with the FGLS model showing a slightly reduced but still significant effect. This finding underscores the importance of effective expense management in counterbalancing inventory inefficiencies.

The diagnostic tests further confirm the validity of the model. The Hausman test ($\chi^2(7) = 565.52$, $p < 0.01$) favors FEM over REM, suggesting that unobserved heterogeneity is correlated with the independent variables. The Modified Wald test for heteroskedasticity ($\chi^2 = 1.4e+05$, $p < 0.01$) and the Wooldridge test for serial correlation ($F = 44.442$, $p < 0.01$) reveal the presence of heteroskedasticity and autocorrelation, reinforcing the need

Table 8. FEM, REM, and FGLS estimates for Model 3

Source: Authors' calculations from Stata.

Models	FEM	REM	FGLS
IND	-0,000251*** [-10,87]	-0,000214*** [-10,27]	-0,000149*** [-10,06]
LEV	-0,161*** [-18,18]	-0,163*** [-23,71]	-0,141*** [-33,57]
OCF	0,0733*** [9,96]	0,0950*** [12,80]	0,0498*** [11,56]
SIZE	0,0196*** [7,64]	0,0126*** [10,34]	0,00707*** [10,51]
GROW	0,0262*** [11,48]	0,0297*** [12,86]	0,0370*** [17,36]
SBE	-0,265*** [-14,76]	-0,225*** [-13,50]	-0,144*** [-10,38]
IND*SBE	0,000684*** [9,83]	0,000555*** [8,12]	0,000301*** [5,00]
COV_19	-0,0205*** [-10,56]	-0,0193*** [-10,18]	-0,0122*** [-8,58]
_Cons	-0,347*** [-5,09]	-0,167*** [-5,10]	-0,0406** [-2,26]
Observations	4004	4004	4004
Adjusted R-squared	0.2293	0.2243	
F test & Wald test	F(8,3632) = 135.06***	Wald $\chi^2(8) = 1437.36***$	Wald $\chi^2(8) = 1710.41***$
Hausman test	$\chi^2(8) = 565.52$ with Prob > $\chi^2 = 0.0000***$		
Heteroskedasticity test	$\chi^2(364) = 1.4e+05$ with Prob > $\chi^2 = 0.0000***$		
Serial Correlation test	F(1, 363) = 44.442 with Prob > F = 0.0000***		

Note: t-statistics in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

for FGLS to address these issues. Compared to the previous models in Tables 6 and 7, the inclusion of $IND \cdot SBE$ significantly alters the coefficient of SBE, making it more negative, while maintaining the significance of other variables like IND, LEV, and COV_19. This suggests that selling expenses play a dual role: independently reducing firm performance but mitigating the negative impact of inventory inefficiencies when combined with strategic management. The results highlight the nuanced dynamic between expenses and inefficiency in influencing firm profitability.

The potential for endogeneity in the models arises due to various factors, such as omitted variable bias, simultaneity, and measurement errors, particularly concerning key independent variables like inventory (IND), growth (GROW), and operational cash flow (OCF). These variables are likely

influenced by unobserved factors or reverse causality that could lead to their correlation with the error term, thus biasing the estimates. To address this concern, this research employed the System Generalized Method of Moments (SGMM), a robust estimation technique for panel data that leverages lagged variables as instruments to mitigate endogeneity. By testing all models with SGMM, the study ensures that the results account for potential endogeneity and provide reliable estimates of the relationship between the dependent and independent variables.

Table 9 provides a comprehensive overview of the dynamic relationship between firm performance (ROA) and various determinants, including interaction terms in Models (2) and (3). Across all three models, the lagged dependent variable (L.ROA) is positive and highly significant (coefficients rang-

Table 9. Dynamic panel-data estimation, two-step system GMM results for all models

Source: Authors' calculations from Stata.

Models Variables	Model (1) ROA	Model (2) ROA	Model (3) ROA
L.ROA	0.358*** [10.73]	0.363*** [10.67]	0.375*** [11.39]
IND	-0.000071*** [-2.68]	-0.000056** [-2.11]	-0.000197*** [-5.07]
LEV	-0.150*** [-8.53]	-0.153*** [-8.61]	-0.151*** [-8.95]
OCF	0.0982*** [6.28]	0.0995*** [6.33]	0.0908*** [6.12]
SIZE	0.0135*** [4.01]	0.0139*** [4.06]	0.0133*** [3.87]
GROW	0.0387** [2.01]	0.0587** [2.32]	0.0375* [1.95]
SBE	-0.121*** [-3.43]	-0.121*** [-3.40]	-0.282*** [-6.09]
COV_19	-0.0145*** [-5.76]	-0.0149*** [-5.82]	-0.0145*** [-5.55]
IND*GROW		-0.000185** [-2.43]	
IND*SBE			0.00091*** [4.27]
_Cons	-0.239*** [-2.66]	-0.251*** [-2.74]	-0.214** [-2.37]
Observations	3640	3640	3640
No. groups	364	364	364
No. instruments	341	342	342
Wald's test (Prob > chi2)	0.000***	0.000***	0.000***
Arellano-Bond test for AR(1) (Prob > z)	0.000***	0.000***	0.000***
Arellano-Bond test for AR(2) (Prob > z)	0.850	0.886	0.950
Hansen test (Prob > chi2)	0.359	0.291	0.370

Note: t-statistics in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

ing from 0.358 to 0.375, $p < 0.01$). This underscores the persistence of firm performance over time, where prior performance strongly influences current outcomes, aligning with expectations for dynamic panel models. The coefficients for IND are negative and significant ($p < 0.05$) across all models, affirming that longer inventory cycles negatively impact firm performance. Specifically, the effect of IND is strongest in Model (3) (-0.000197, $p < 0.01$) compared to Model (1) (-0.000071, $p < 0.01$) and Model (2) (-0.000056, $p < 0.05$), suggesting that the inclusion of interaction terms refines the model and highlights the amplified role of inventory inefficiency under specific conditions. This finding emphasizes the critical need for efficient inventory management to avoid eroding profitability.

The interaction terms further illuminate the relationship between inventory cycles and firm performance. In Model (2), the interaction between IND and GROW is negative and significant (-0.000185, $p < 0.05$), indicating that high business growth exacerbates the adverse effects of inventory inefficiency. This is likely due to scaling challenges, as firms experiencing rapid growth may struggle to maintain optimal inventory levels, leading to inefficiencies and increased operational risks. The negative coefficient highlights the importance of integrating inventory management systems with growth strategies to minimize these disruptions.

Conversely, Model (3) reveals a positive and significant interaction between IND and SBE (0.00091, $p < 0.01$), suggesting that strategic management and selling expenses can effectively offset the detrimental effects of inefficient inventory practices. This finding implies that firms investing in well-structured management practices and targeted selling strategies can mitigate the negative impact of prolonged inventory cycles on performance. For instance, better forecasting and streamlined processes may reduce excess inventory, while effective sales strategies may improve turnover rates, enhancing overall firm efficiency.

Other variables consistently demonstrate strong relationships with firm performance. LEV negatively impacts ROA across all models (coefficients ~ -0.150 , $p < 0.01$), reaffirming the financial risks associated with higher debt. Conversely, OCF and

SIZE positively influence ROA, reflecting the advantages of liquidity and economies of scale, respectively. GROW has a significant positive relationship with ROA, particularly in Model (2), where its effect is stronger. However, SBE negatively impacts ROA significantly in all models, indicating that high management costs can hinder profitability unless effectively utilized, as evidenced by the interaction in Model (3). The dummy variable for the COVID-19 pandemic (COV_19) consistently shows a negative and significant impact ($p < 0.01$), reflecting the adverse economic disruptions during this period.

Diagnostic tests further validate the robustness of the models. The Wald test ($p < 0.01$) confirms the overall significance of the models. The Arellano-Bond tests show no evidence of second-order serial correlation (AR(2), p -values > 0.85), affirming the model's assumptions. Hansen tests (p -values > 0.29) indicate the validity of instruments, with no over-identification concerns. Together, these results highlight the interplay between inventory management, business growth, and management costs in shaping firm performance, providing actionable insights for decision-makers.

In short, *H1* is supported, as the coefficient on average inventory days (IND) is negative and statistically significant across all models (e.g., Model 1: -0.000071, $p < 0.01$), indicating that longer inventory cycles reduce profitability. *H2* is supported, with the interaction term $IND \cdot GROW$ in Model 2 being negative and significant (-0.000185, $p < 0.05$), showing that business growth exacerbates the negative effects of inventory inefficiency. *H3* is supported, as the interaction $IND \cdot SBE$ in Model 3 is positive and significant (0.00091, $p < 0.01$), indicating that effective cost management can mitigate the performance impact of inefficient inventory practices.

4. DISCUSSION

The results align with and extend prior empirical studies. The findings confirm that inventory efficiency is a critical determinant of firm performance in the Vietnamese manufacturing sector. The negative association between average inventory days and ROA supports the assertion that ex-

cessive inventory holding leads to capital lock-up, higher storage costs, and lower profitability. This is consistent with earlier studies by Demeter (2003), Fullerton et al. (2003), and Elsayed and Wahba (2016), which found that firms adopting lean inventory practices, such as just-in-time systems, experienced improved operational and financial performance.

The study contributes to the literature by examining how this relationship is conditioned by firm-level dynamics, particularly business growth. The significant negative interaction between inventory days and business growth supports Hypothesis 2 and suggests that as firms expand, they face increasing complexity in forecasting demand and managing supply chains. These findings echo the arguments of O'Regan et al. (2006) and Panigrahi et al. (2021), who emphasized that high-growth firms are more prone to inventory mismatches due to rapid shifts in scale and customer demand. The results of this study confirm that growth magnifies the adverse effect of inventory inefficiency, thereby challenging firms to adopt more adaptive inventory systems in expansion phases.

Conversely, the positive and significant interaction between inventory days and management costs offers novel insight into how cost structures moderate inventory outcomes. Although high-

er selling and administrative expenses typically erode profitability, the results suggest that when strategically deployed, these costs may help offset the negative impact of inventory inefficiency. This supports Hypothesis 3 and is consistent with findings by Gołaś (2020) and Phuong and Hung (2020), who argued that targeted investments in managerial systems, demand planning, and supply coordination can improve performance, even under suboptimal inventory conditions. In this context, management costs function as an enabling resource, rather than a drain, allowing firms to better cope with inventory challenges.

Overall, the study enhances theoretical understanding by bridging Lean Inventory Theory, Transaction Cost Theory, and Operating Cycle Theory with empirical dynamics from an emerging market context. It demonstrates that the relationship between inventory efficiency and firm performance is not static but evolves based on a firm's growth trajectory and internal cost allocation. While prior studies have primarily focused on direct effects, this research highlights the importance of contextual moderators, reinforcing that inventory strategies must be aligned with organizational scale and resource utilization. These insights offer practical implications for managers seeking to maintain profitability during periods of operational stress or expansion.

CONCLUSION

This study examines how inventory management influences firm performance and how this relationship is moderated by business growth and management costs in the context of manufacturing firms in Vietnam. By focusing on inventory days as the central indicator of inventory efficiency and applying dynamic panel data methods (SGMM), the research aimed to understand how internal and external operational factors shape firm outcomes over time. The results revealed that prolonged inventory cycles are consistently associated with lower firm performance, reaffirming the importance of efficient inventory practices. However, the study also found that this relationship is contingent upon firm-specific conditions. In high-growth firms, inventory inefficiencies have a more pronounced negative effect on profitability, highlighting the challenges of maintaining operational control during expansion. Conversely, firms that allocate resources effectively to selling and administrative functions can offset some of the performance losses caused by inefficient inventory management, indicating a compensatory role of management cost structures.

These findings suggest that inventory management cannot be treated as an isolated operational function but must be integrated into broader strategic and financial planning. Firms operating in dynamic environments, particularly those undergoing rapid growth, should align their inventory systems with both market demands and internal resource capabilities. Future research could build on these results by

incorporating qualitative assessments of supply chain practices, exploring sector-specific dynamics, or extending the analysis to other emerging economies. Additionally, examining the role of technological tools, such as ERP systems and predictive analytics, could further illuminate how firms adapt inventory strategies in response to evolving operational complexities.

AUTHOR CONTRIBUTIONS

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