Debt Structure and Interest Payment Burden in China's Local Governments: Evidence from Mixed-Effects, System GMM, and Policy Shock Models

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Abstract. This study employs a sample of 31 provincial-level local governments in China from 2015 to 2023, utilizing mixed-effects models, system GMMs, and interaction term models to systematically analyze the mechanism by which debt structure influences interest payment costs. Findings indicate that hidden debt serves as the primary driver of interest payment pressures. Its high cost and insufficient repayment constraints significantly exacerbate local fiscal burdens. In contrast, budgetary debt exerts limited influence under most conditions but functions as a fiscal stabilizer during special periods such as deleveraging campaigns and pandemics. Further analysis reveals significant inertia in interest payment costs, manifesting as "short-term relief but long-term accumulation", exposing path dependence in local governments' rolling debt issuance. By examining three dimensions—overall, dynamic, and policy shocks—this study uncovers the dynamic evolution mechanism of local debt risks. It enriches existing understanding of debt sustainability and provides valuable empirical insights for optimizing local government debt governance and fiscal policies in emerging economies.

Keywords: Local government debt, interest payment costs, system GMM, fiscal sustainability, policy shocks.

1. Introduction

1.1. Research Background

As the world's second-largest economy, China's local government debt has become a core issue in its fiscal system and growth model, impacting both domestic sustainable development and international expectations regarding the fiscal soundness of emerging economies [1]. In recent years, the outstanding balance of local debt has risen rapidly. Between 2019 and 2020, special-purpose bonds exceeded 12 trillion yuan, accounting for over half of the total for the first time. Their annualized interest payment costs have surpassed 10%, significantly increasing fiscal pressure.

Unlike mature economies, China's local debt structure features both "explicit" and "implicit" components. Budgetary debt exhibits high transparency, while implicit debt relies on financing platforms, PPPs, and non-market channels. Its massive scale and governance challenges exacerbate fiscal soft constraints [2]. Against this backdrop, interest expenses not only directly reflect the debt burden but also amplify risks through their cumulative nature. Examining the role of both budgetary and hidden debt in shaping interest expenses helps unravel the evolution of fiscal risks and offers insights for debt governance.

1.2. Research Objectives and Significance

This paper aims to systematically analyze the formation mechanism of local government interest payment costs: not only comparing the effects of budgetary and hidden debt, but also revealing its driving factors from both dynamic and shock perspectives.

The significance of this research lies in two aspects: First, existing literature predominantly focuses on debt stock and its relationship with economic growth or risk measurement, while lacking systematic empirical evidence on interest payment costs. Second, by integrating dynamic modeling

with policy shock analysis, this study meticulously uncovers the heterogeneous sources of interest payment costs. Consequently, it not only complements research on local government debt but also provides insights for debt governance and policy optimization in emerging economies.

1.3. Research Status

1.3.1 Local Government Debt Research

International literature predominantly adopts a fiscal federalism perspective, emphasizing the incentive effect of implicit central government guarantees on local borrowing. Domestic Chinese research focuses on fiscal decentralization and performance evaluations, arguing that insufficient institutional constraints lead to expanded implicit debt and heightened governance challenges [2].

1.3.2 Debt Risk Research

Scholars generally attribute debt risks to the mismatch between expanding debt scales and weak fiscal revenue growth [1, 3], noting its dual fiscal and public governance dimensions [4]. Regarding measurement and early warning, existing studies employ spatial panel analysis [5] and machine learning methods [6], revealing regional disparities and the importance of identifying hidden debt. Regarding risk impacts, studies indicate that moderate local debt can stimulate growth and generate spatial spillover effects, but excessive borrowing undermines fiscal sustainability and threatens financial stability [7-9].

1.3.3 Hidden Debt Research

Hidden debt is a focal point in China's local debt research. Existing findings reveal its expansion is closely linked to institutional factors such as officials' promotion incentives [10] and financing platform impulses [11], while highlighting its high-cost and risk premium characteristics [12, 13].

1.3.4 Interest Payment Cost Research

Although relevant literature is limited, existing studies indicate that interest burdens have become a significant constraint on fiscal sustainability [14, 15]. Overall, systematic empirical testing of interest payment costs remains lacking, creating research space for this paper's debt structure perspective.

2. Theoretical Analysis and Hypotheses

2.1. Theoretical Analysis

The core of local government debt risk lies in the tension between fiscal revenue-expenditure constraints and debt expansion incentives. The IMF and existing research generally agree that this primarily manifests as a mismatch between debt servicing capacity and debt growth, coupled with excessive borrowing under fiscal soft constraints [2]. In the Chinese context, fiscal decentralization and development pressures intensify local borrowing incentives, while interest expenditures serve as the key channel transmitting debt risks to fiscal sustainability.

Within this mechanism, interest payment costs more directly reflect the erosion of fiscal liquidity than the debt stock itself. Their cumulative nature and rigid payment characteristics further amplify the impact of debt on fiscal sustainability. Therefore, interest payment costs serve not only as a crucial indicator of debt risk but also as a core variable in the dynamic evolution of risk.

The distinctiveness of China's local debt lies in its dual structure of on-budget debt and hidden debt. The former, financed through government bonds, is legally constrained and relatively transparent; the latter primarily relies on financing platforms, PPP projects, and non-market channels. It is massive in scale, challenging to govern, carries higher financing costs, and exhibits greater repayment uncertainty [2]. This structural difference provides theoretical support for Hypothesis 1: the effects of the two main debt types on interest costs differ.

From a dynamic perspective, interest costs may exhibit significant inertia. Literature indicates that elevated interest burdens often perpetuate through rolling debt, fostering path-dependent characteristics [1], leading to Hypothesis 2.

Furthermore, policy and macroeconomic shocks can alter debt effects. Deleveraging (2017-2019) significantly constricted financing space, while the COVID-19 pandemic (2020-2022) boosted debt demand. These event-driven factors may influence the direction and intensity of the relationship between debt and interest payment costs, providing a practical basis for Hypothesis 3.

In summary, the interplay among debt risk, interest payment costs, structural differences, and macroeconomic shocks collectively forms the theoretical framework of this paper and underpins subsequent empirical testing.

2.2. Hypothesis Formulation

Based on the theoretical analysis above, this paper proposes the following three testable research hypotheses:

Hypothesis 1 (Structural Differences): Local government interest costs are driven by their debt, and the effects of two distinct types of primary debt on interest costs differ.

Hypothesis 2 (Dynamic Inertia): Local government interest costs exhibit significant dynamic inertia, meaning that the level of interest costs in earlier periods will persistently influence interest costs in later periods.

Hypothesis 3 (Policy and Shock Effects): Policy orientations and macroeconomic shocks during specific periods significantly alter the mechanism through which debt affects interest payment costs. For instance, the “deleveraging” policy from 2017 to 2019 and the COVID-19 pandemic shock from 2020 to 2022 may both exert structural impacts on debt effects.

3. Data Description and Measurement Methods

3.1. Data Description

This paper selects data from 2015 to 2023 covering 31 provincial-level administrative regions in mainland China (excluding Hong Kong, Macao, and Taiwan), encompassing local debt, interest payment costs, fiscal revenue, and macroeconomic indicators.

3.1.1 Local Government Debt

Local debt is categorized into budgetary debt and hidden debt. The former primarily consists of general bonds and special bonds issued on behalf of the Ministry of Finance; the latter mainly comprises interest-bearing municipal bonds issued by local government financing vehicles (LGFVs). This paper defines:

$$\text{BudgetaryDebtBalance} = \text{GeneralBondBalance} + \text{SpecialBondBalance} \quad (1)$$

$$\text{HiddenDebtBalance} = \text{InterestBearingMunicipalBondBalance} \quad (2)$$

$$\text{TotalDebtBalance} = \text{BudgetaryDebt} + \text{HiddenDebt} \quad (3)$$

3.1.2 Interest Payment Costs

Interest costs for budgetary debt are readily available. Hidden debt, however, presents challenges due to diverse maturities and rating types, necessitating estimation. This paper estimates hidden debt interest costs through the following steps:

Step1: Construct a benchmark interest rate using the government bond yield curve (annual average);

Step2: Calculate the average spread between municipal bonds and government bonds for each province, assuming it remains stable;

Step3: By adding the average spread between municipal bonds and treasury bonds to the benchmark interest rate, the paper derive the estimated yield for municipal bonds. This estimated

yield is then multiplied by the outstanding balance of interest-bearing municipal bonds in each province to calculate the interest payment costs of hidden debt.

Step4: Therefore:

$$\text{TotalInterestExpense} = \text{BudgetedInterestExpense} + \text{HiddenInterestExpense} \quad (4)$$

3.1.3 Fiscal Revenue

Fiscal revenue encompasses general public budget revenue, government fund revenue, and state-owned capital operating revenue, calculated at the "provincial level + prefecture-level city" scope.

3.1.4 Control Variables

Provincial GDP and urbanization rate are introduced as proxy indicators for economic growth and structural transformation, respectively. Data sources include the National Bureau of Statistics and relevant databases.

3.2. Data Sources and Scope

The data utilized in this paper primarily originates from the following channels:

Wind Database, iFind Database, and Ministry of Finance website: These sources provide provincial government bond balances, fiscal revenue and expenditure, and other core macroeconomic indicators, serving as the primary basis for obtaining budgetary debt and fiscal revenue data in this study.

Enterprise Early Warning Database: Used to obtain data on provincial urban investment platforms, particularly the yield spread between urban investment bonds and government bonds, serving as a key reference for estimating implicit debt interest costs.

DM Database: Provides supplementary indicators related to urban investment platforms to complement and validate data from the Enterprise Early Warning Database, ensuring the robustness of estimates.

The study covers all 31 provincial-level administrative regions in mainland China (excluding Hong Kong, Macau, and Taiwan) over the period 2015-2023. This timeframe encompasses critical phases including local debt expansion, deleveraging policies, and the COVID-19 pandemic impact, providing a comprehensive sample for analyzing interest cost evolution under varying institutional and event contexts.

3.3. Variable Setup

This paper constructs the following variable system:

3.3.1 Dependent variable: PayRatio_{it}

Local government interest payment pressure, defined as the ratio of interest expenses to total fiscal revenue:

$$\text{PayRatio}_{it} = \frac{\text{InterestExpense}_{it}}{\text{TotalFiscalRevenue}_{it}} \quad (5)$$

A higher value indicates heavier local government debt burden pressure.

3.3.2 Core explanatory variables: BudgDebtGDP_{it} and CbondDebtGDP_{it}

BudgDebtGDP_{it} represents the ratio of on-budget debt stock to GDP, measuring explicit debt scale. CbondDebtGDP_{it} represents the ratio of implicit debt balance (primarily interest-bearing municipal bonds) to GDP, measuring the scale of implicit debt. Together, these two variables reflect the structure of local government debt.

3.3.3 Control variables: RevGrowth_{it}, GdpGrowth_{it}, UrbanRate_{it}

RevGrowth_{it} denotes the growth rate of provincial-level local government fiscal revenue:

$$\text{RevGrowth}_{it} = \frac{\text{FiscalRevenue}_{it}}{\text{FiscalRevenue}_{i,t-1}} - 1 \quad (6)$$

$\mathrm{GDPGrowth_{it}}$ represents the provincial-level local government's GDP growth rate:

$$\mathrm{GDPGrowth_{it}} = \frac{\mathrm{GDP_{it}}}{\mathrm{GDP_{i,t-1}}} - 1 \tag{7}$$

$\mathrm{Urbanrate_{it}}$ denotes the urbanization rate of provincial-level local governments.

The fiscal revenue growth rate and GDP growth rate control for the cycle and income expansion effects, while the urbanization rate reflects structural development factors.

3.4. Empirical Methodology

To systematically test the three research hypotheses proposed earlier, this paper sequentially employs mixed-effects models, System Generalized Method of Moments (System GMM) models, and interaction term models. These correspond to the overall effect, dynamic inertia, and policy shock perspectives, respectively. The following briefly outlines the methodological settings and their applicability:

3.4.1 Mixed-Effects Model

To test Hypothesis 1—whether interest payment costs primarily stem from budgetary debt or hidden debt—the following specification is adopted:

$$\mathrm{PayRatio_{it}} = \alpha + \beta_1 \cdot \mathrm{BudgDebtGDP_{it}} + \beta_2 \cdot \mathrm{CbondDebtGDP_{it}} + \gamma \cdot \mathrm{X_{it}} + \mathrm{u_i} + \epsilon_{\mathrm{it}} \tag{8}$$

Where $\mathrm{u_i} \sim \mathrm{IID}(0, \sigma_u^2)$, $\epsilon_{\mathrm{it}} \sim \mathrm{IID}(0, \sigma_\epsilon^2)$, and X_{it} represents control variables, including $RevGrowth_{it}$, $GDPGrowth_{it}$ and $UrbanRate_{it}$.

The mixed-effects model incorporates both fixed effects (controlling for unobservable individual heterogeneity) and random effects (assuming individual effects are independent of explanatory variables). In this study, this approach helps identify the relative roles of budgetary debt and hidden debt. Model selection is performed via the Hausman test, multicollinearity is assessed using VIF, and coefficient significance is determined by p-values:

$$H_0: \beta_1 = 0, \beta_2 = 0 \qquad H_1: \beta_1 \neq 0 \; or \; \beta_2 \neq 0 \tag{9}$$

3.4.2 System GMM Model

To test Hypothesis 2-whether interest payment costs exhibit inertia-the paper specifies the following dynamic panel model:

$$\begin{gathered} PayRatio_{it} = \alpha + \varphi \cdot L.PayRatio_{it} + \beta_1 \cdot BudgDebtGDP_{it} + \beta_2 \cdot CbondDebtGDP_{it} + \\ \gamma_1 \cdot RevGrowth_{it} + \gamma_2 \cdot GDPGrowth_{it} + \mu_i + \epsilon_{it} \end{gathered} \tag{10}$$

Where $\mathrm{L.PayRatio}$ denotes the lagged interest payment cost.

Dynamic panel models capture the inertia of the dependent variable, but OLS and FE estimates exhibit bias. System GMM (Arellano–Bover/Blundell-Bond) combines the horizontal equation with the difference equation, using lagged endogenous variables as instrumental variables, effectively mitigating endogeneity and weak instrument issues. This study employs a two-stage System GMM, utilizing collapse to reduce the number of instruments. Tests include AR(1) and AR(2) autocorrelation tests, as well as Hansen and Sargan instrument validity tests.

3.4.3 Interaction Term Regression Model

To test Hypothesis 3-whether policy or event shocks alter the debt transmission mechanism-specify:

$$\begin{gathered} PayRatio_{it} = \beta_1 \cdot BudgDebtGDP_{it} + \beta_2 \cdot CbondDebtGDP_{it} + \\ \gamma_1 \cdot RevGrowth_{it} + \gamma_2 \cdot GDPGrowth_{it} + \\ \delta_1 \cdot (CbondDebtGDP_{it} \times D_t^{1719}) + \delta_2 \cdot (CbondDebtGDP_{it} \times D_t^{2022}) + \\ \theta_1 \cdot (BudgDebtGDP_{it} \times D_t^{1719}) + \theta_2 \cdot (BudgDebtGDP_{it} \times D_t^{2022}) + \mu_i + \lambda_t + \epsilon_{it} \end{gathered} \tag{11}$$

Where D_t^{1719} is the dummy variable for the "deleveraging" period (2017-2019), and D_t^{2022} is the dummy variable for the COVID-19 pandemic period (2020-2022).

The interaction term regression captures structural shifts under policy shocks during specific periods by incorporating the product term of time dummies and debt indicators. Estimation employs two-way fixed-effects OLS with HC3 robust standard errors to control for heteroskedasticity. Robustness checks include VIF, Breusch-Pagan heteroskedasticity tests, and joint significance tests for fixed effects.

4. Empirical Results

4.1. Empirical Evidence for Hypothesis 1

At the aggregate level, VIF tests indicate no severe multicollinearity among variables; Hausman tests support the fixed-effects specification, hence subsequent analysis is based on FE results. Regression findings reveal that on-budget debt exerts no significant effect on interest payment costs, whereas off-budget debt consistently shows significant positive effects across different settings, confirming it as the primary driver of local governments' interest burdens. Among the control variables, fiscal revenue growth rate exhibits a significant negative effect in some models, while GDP growth rate and urbanization rate predominantly show positive relationships. Overall, Hypothesis 1 is validated, confirming that hidden debt is the core driver of interest payment costs. Relevant regression results are presented in Table 1. Baseline Results: Debt Structure and Interest Payment Burden (Model 1).

Table 1. Baseline Results: Debt Structure and Interest Payment Burden (Model 1)

Variables	(1) RE	(2) FE
BudgDebtGDP	0.0169 (1.4336)	-0.0224 (-1.6015)
CbondDebtGDP	0.1287*** (14.584)	0.0854*** (9.2146)
RevGrowth	-0.0118 (-1.6711)	-0.0147** (-2.3973)
GDPGrowth	0.0575*** (2.8588)	0.0591*** (3.3973)
UrbanRate	0.2302*** (10.239)	0.4056*** (15.453)
Constant	-0.1208*** (-8.2124)	-0.1984*** (-13.139)
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Observations	279	279
R^2	0.6573	0.7377
R^2 (Within)	0.6843	0.7377
R^2 (Between)	0.4858	-0.5739
R^2 (Overall)	0.5232	-0.3264
Hausman (p-val.)	—	0.000
Notes	1. Robust SEs in parentheses; *** p<0.01, ** p<0.05, * p<0.1. 2. Hausman test: $p < 0.05$ suggests FE is preferred; $p \geq 0.05$ suggests RE is consistent. 3. Panel regression estimated with fixed-effects (FE) and random-effects (RE) models.	

4.2. Empirical Evidence for Hypothesis 2

System GMM results reveal significant inertia in interest payment costs: L.pay_ratio is positively significant at the 1% level. Budgetary debt exhibits a negative relationship, indicating it partially

substitutes for high-cost financing; hidden debt is not significant in the current period but shows pronounced lagged effects. Fiscal revenue growth alleviates interest payment pressure, while GDP growth increases the burden.

Diagnostics indicate AR(1) significance and AR(2) insignificance. The Hansen test supports the exogeneity of the instrumental variables. The Sargan test fails, but this test is unreliable under robust errors and thus does not affect the main conclusions. After incorporating lagged municipal bond debt (L.CbondDebtGDP), results reveal its dual effect of short-term relief and long-term intensification of interest payment pressures, while the mitigation role of on-budget debt remains robust.

Regarding robustness checks, multiple variable combinations show consistent directions, though the Hansen test p-values are low and should be used for reference only. Results using a streamlined instrument set and ivstyle configuration align with the benchmark, further strengthening the conclusions. Overall, Hypothesis 2 is validated: interest payment costs exhibit path dependence, with hidden debt demonstrating "short-term relief and long-term accumulation" characteristics, while budgetary debt provides mitigation. Full results are presented in Table 2. System GMM Estimates of Local Government Debt Service Costs (Model 2).

Table 2. System GMM Estimates of Local Government Debt Service Costs (Model 2)

Variables	(1) Baseline (no L.Cbond)	(2) With L.Cbond
L.PayRatio	0.887*** (17.683)	0.592*** (2.898)
BudgDebtGDP	-0.062** (-2.044)	-0.058** (-2.392)
CbondDebtGDP	-0.035 (-0.365)	-0.181** (-2.141)
RevGrowth	-0.029*** (-3.253)	-0.033** (-2.348)
GDPGrowth	0.074** (2.647)	0.014 (0.326)
L.CbondDebtGDP	—	0.237*** (2.247)
Constant	0.050 (1.170)	0.044* (1.754)
Observations	248	248
AR (1) (p-val.)	0.046	0.029
AR (2) (p-val.)	0.430	0.291
Hansen (p-val.)	0.141	0.603
Sargen (p-val.)	0.000	0.068
Notes	1. Robust SEs in parentheses; *** p<0.01, ** p<0.05, * p<0.1. 2. Hansen p > 0.05 indicates valid instruments. 3. AR(1) p < 0.05, AR(2) p > 0.05 confirms model specification. 4. Two-step System GMM with robust standard errors and small-sample correction.	

4.3. Empirical Evidence for Hypothesis 3

After introducing the policy shock interaction term, results show that hidden debt consistently and significantly increases interest payment pressures. Its mechanism remains stable and does not change significantly during either the deleveraging or pandemic phases. In contrast, the interaction term for on-budget debt is significantly positive in both phases, indicating its role as a fiscal stabilizer providing a "safety net" during critical periods.

Sensitivity tests confirm that core findings remain consistent regardless of whether the time window is narrowed or expanded: the long-term burden effect of hidden debt is robustly present, while the stabilizing function of budgetary debt significantly intensifies during critical periods. In specific windows, hidden debt exhibited a short-term negative effect during the pandemic phase, potentially reflecting a "borrowing new to repay old" buffer, but this does not alter its long-term pressure.

In summary, Hypothesis 3 is supported: hidden debt creates long-term interest pressure, while on-budget debt exhibits more pronounced stabilizer functions during policy tightening and external

shocks. Relevant results are presented in Table 3. Interaction Effects of Government Debt and Major Events (Model 3).

Table 3. Interaction Effects of Government Debt and Major Events (Model 3)

Variables	(1) Baseline (2017-2019, 2020-2022)	(2) Narrow Window (2018-2019, 2020-2021)	(3) Extended Window (2016-2019, 2020-2023)
BudgDebtGDP	-0.0288* (-1.7295)	-0.0297* (-1.7538)	-0.0448** (-2.3595)
CbondDebtGDP	0.0903*** (4.5040)	0.0924*** (5.4576)	0.0877*** (2.7111)
RevGrowth	-0.0151 (-1.2830)	-0.0176 (-1.5681)	-0.0162 (-1.4711)
GDPGrowth	0.0102 (0.4406)	0.0137 (0.6431)	0.0185 (0.8510)
BudgDebtGDP×D1719	0.0184*** (2.7895)	0.0165** (2.2694)	0.0267** (2.2428)
BudgDebtGDP×D2022	0.0185*** (3.1633)	0.0134*** (2.8769)	0.0287** (2.3380)
CbondDebtGDP×D1719	0.0064 (0.6597)	-0.0070 (-0.5845)	0.0061 (0.2707)
CbondDebtGDP×D2022	0.0019 (0.1839)	-0.0167** (-2.1947)	0.0135 (0.6025)
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Obsevations	279	279	279
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
FE joint F-test (p-val.)	0.000	0.000	0.000
Notes	1. Robust SEs in parentheses; *** p<0.01, ** p<0.05, * p<0.1. 2. All regressions are estimated by OLS with province and year fixed effects. 3. No constant term is shown since fixed effects absorb the baseline.		

5. Conclusion

Using 31 provincial-level local governments in China from 2015 to 2023 as our sample, this paper systematically analyzes the mechanism by which debt structure influences interest payment costs, yielding the following conclusions. First, hidden debt consistently serves as the primary driver of interest burden escalation, while budgetary debt does not manifest as a significant pressure source. This highlights the high cost and insufficient repayment constraints associated with hidden debt. Second, interest payment costs exhibit significant inertia, manifesting as path dependence. Hidden debt produces a dual effect of "short-term relief and long-term accumulation," while budgetary debt plays a mitigating role. Third, during major shocks (deleveraging and pandemic periods), the functioning of hidden debt remains stable, whereas the marginal effect of budgetary debt significantly increases, demonstrating its "fiscal cushioning" function during critical phases.

This study contributes in three theoretical and practical dimensions: First, it reveals debt risk transmission mechanisms through the lens of interest payment costs, expanding research on local government debt sustainability. Second, dynamic analysis emphasizes path dependence in risk evolution, moving beyond traditional reliance on static stock indicators. Third, by integrating institutional factors and event shocks, it demonstrates the "stabilizer" function of budgetary debt, providing empirical evidence for debt governance in emerging economies.

The study has several limitations: First, the estimation method for implicit debt may introduce biases in the true risk level. Second, the specification of the system GMM instrumental variable remains uncertain. Third, the analysis relies solely on provincial-level data, failing to capture

variations at the prefecture-level city or individual high-risk entities. Fourth, the study period ends in 2023, excluding recent policy and regulatory changes.

Based on these findings, policy priorities should focus on: strengthening hidden debt governance by reducing high-cost hidden financing and enhancing transparency; increasing the proportion of budgetary debt by gradually replacing hidden financing with standardized bonds to establish a controllable structure; and leveraging budgetary debt as a stabilizer during macroeconomic shocks or policy tightening to alleviate local fiscal pressures.

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