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The Effect of Centralized Volume-Based Drug Procurement on Pharmaceutical Companies' Performance

WANG Lei

Doctor of Management

Supervisor:
PhD José Dias, Professor,
ISCTE University Institute of Lisbon
PhD Jiang Hong, Professor,
Southern University of Science and Technology

December, 2025

BUSINESS
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Marketing, Operations and General Management Department

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Abstract

Background: Launched in China in 2018, the Centralized Volume-Based Drug Procurement (CVBDP) policy has reshaped the pharmaceutical industry. However, systematic analysis of its micro-level mechanisms and heterogeneous impacts on firm performance remains lacking. This study aims to fill this gap.

Methods: This study utilizes a sample of 305 listed Chinese pharmaceutical manufacturing companies from March 2015 to December 2023. Data were sourced from the CSMAR Database. Framed by contingency theory and institutional theory, the analysis employs a multi-period Difference-in-Differences (DID) model, Propensity Score Matching (PSM), and a mediation effect model. Return on Assets (ROA) serves as the core performance indicator. R&D expense ratio and sales expense ratio are introduced as mediating variables. Heterogeneity tests are conducted across firm size, property rights, and industry dimensions.

Results: The CVBDP policy exerted a positive impact on pharmaceutical firms' performance. The DID coefficient for the full sample was 0.004 ($p=0.057$), which increased to 0.005 ($p=0.033$) after PSM matching, indicating a strengthening policy effect over time. Heterogeneity tests revealed that the positive impact was more pronounced for large-scale firms (coefficient=0.005, $p=0.046$) and chemical drug enterprises (particularly formulation manufacturers, coefficient=0.005, $p=0.031$), while the effect showed no significant difference across firms with different property rights. Mediation analysis indicated a negative correlation between the R&D expense ratio and performance ($b=-0.073$, $p<0.001$). Although the policy suppressed the sales expense ratio, this reduction did not significantly affect performance.

Conclusion: The CVBDP policy enhances pharmaceutical firm performance by compelling firms to optimize resource allocation efficiency, with effects exhibiting temporal persistence and heterogeneity across firm size and industry type. This study enriches the theoretical framework of policy impact on firm performance. Practically, pharmaceutical firms should focus on optimizing resource allocation and enhancing core competitiveness. Policymakers can refine policies by considering industry-specific heterogeneity.

Keywords: Centralized Volume-Based Drug Procurement; Firm Performance; Contingency Theory; Mediation Effect

JEL: M10; L25

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Resumo

Antecedentes: Lançada na China em 2018, a política de Aquisição Centralizada de Medicamentos com Base em Volume (Centralized Volume-Based Drug Procurement, CVBDP) reformulou a indústria farmacêutica. No entanto, ainda carece de uma análise sistemática dos seus mecanismos ao nível micro e dos seus impactos heterogéneos no desempenho das empresas. Este estudo tem como objetivo colmatar essa lacuna.

Métodos: Este estudo utiliza uma amostra de 305 empresas chinesas cotadas do setor de fabrico farmacêutico, abrangendo o período de março de 2015 a dezembro de 2023. Os dados foram obtidos da base de dados CSMAR. Enquadrada pelas teorias da contingência e institucional, a análise recorre a um modelo de Diferenças-em-Diferenças (Difference-in-Differences, DID) multiperíodo, ao Emparelhamento por Pontuação de Propensão (Propensity Score Matching, PSM) e a um modelo de efeitos de mediação. O Retorno sobre Ativos (Return on Assets, ROA) é utilizado como principal indicador de desempenho. Os rácios de despesas de investigação e desenvolvimento (I&D) e de despesas de vendas são introduzidos como variáveis mediadoras. São realizados testes de heterogeneidade nas dimensões da dimensão da empresa, dos direitos de propriedade e do setor.

Resultados: A política CVBDP teve um impacto positivo significativo no desempenho das empresas farmacêuticas. O coeficiente DID para a amostra total foi de 0,004 ($p=0,057$), aumentando para 0,005 ($p=0,033$) após o emparelhamento por PSM, o que reforça o efeito da política ao longo do tempo. Os testes de heterogeneidade revelaram que o impacto positivo foi mais pronunciado em empresas de grande dimensão (coeficiente=0,005, $p=0,046$) e em empresas de medicamentos químicos (particularmente fabricantes de formulações, coeficiente=0,005, $p=0,031$), enquanto o efeito não apresentou diferenças significativas entre empresas com diferentes regimes de propriedade. A análise de mediação indicou uma correlação negativa entre o rácio de despesas de I&D e o desempenho ($b=-0,073$, $p<0,001$). Embora a política tenha reduzido o rácio de despesas de vendas, essa redução não teve impacto significativo no desempenho.

Conclusão: A política CVBDP melhora significativamente o desempenho das empresas farmacêuticas ao compelir a otimizar a alocação de recursos, com efeitos com persistência temporal e heterogeneidade em função da dimensão da empresa e do tipo de indústria. Este

estudo enriquece o enquadramento teórico sobre o impacto das políticas públicas no desempenho empresarial. Em termos práticos, as empresas farmacêuticas devem concentrar-se na otimização da alocação de recursos e no reforço da competitividade central. Os decisores políticos podem aperfeiçoar a política de acordo com a heterogeneidade específica do setor.

Palavras-chave: Aquisição Centralizada de Medicamentos com Base em Volume; Desempenho Empresarial; Teoria da Contingência; Efeito de Mediação
JEL: M1; L25

摘　要

背景：药品集中带量采购（CVBDP）自2018年在中国正式启动，对医药行业产生深远影响。现有研究缺乏对影响企业绩效的微观机制、异质性特征进行系统性分析，本研究旨在填补这一缺口，为企业战略调整与政策优化提供实证支撑。

方法：选取2015年3月至2023年12月中国305家医药制造业上市公司为样本，数据来源于国泰安数据库。以权变理论与制度理论为框架，采用多周期双重差分法（DID）、倾向得分匹配（PSM）及中介效应模型，以资产收益率（ROA）为核心绩效指标，引入研发费用率、销售费用率为中介变量，从企业规模、产权性质、行业类型维度开展异质性检验。

结果：CVBDP政策对医药企业绩效呈显著正向影响，全样本DID系数为0.004（p=0.057），PSM匹配后系数提升至0.005（p=0.033），且政策效应随时间持续增强。异质性检验显示，政策对大规模企业（系数=0.005，p=0.046）、化学药企业（尤其制剂企业，系数=0.005，p=0.031）正向影响更显著，对不同产权性质企业影响差异不明显。中介效应表明，研发费用率与绩效呈负相关（b=-0.073，p<0.001），销售费用率受政策抑制但对绩效无显著作用。

结论：CVBDP政策通过倒逼企业优化资源配置效率，显著提升医药企业绩效，且效应具有时间持续性与规模、行业异质性。本研究丰富了政策影响企业绩效的理论体系。实践中，医药企业应聚焦资源配置优化与核心竞争力提升，政策制定者可结合行业异质性完善政策设计。

关键词：药品集中带量采购；企业绩效；权变理论；中介效应

JEL: M10; L25

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During my doctoral studies and the writing of this dissertation, I have always maintained a deep respect for my professional work while sustaining a strong commitment to continuous learning. This has not been an easy journey, especially while balancing professional responsibilities alongside academic research, where progress often required repeated reflection and constant revision. As the dissertation reaches completion, I look back on this journey with profound gratitude. Without the careful guidance of my supervisor, the encouragement and support of teachers, colleagues, and friends, and the unwavering understanding and companionship of my family, this dissertation would not have been possible. I would like to express my sincere appreciation to all those who have provided support and assistance throughout this academic journey.

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致 谢

在博士学习与论文写作的这段时间里，我始终怀着对本职工作的敬畏，也保持着对知识持续探索的热情。这并不是一段轻松的旅程，尤其是在工作与学业并行的现实条件下，研究推进常常伴随着反复推敲与不断修正。论文即将完成之际，回顾一路走来的点滴，我内心充满感激。若没有导师的悉心指导、师友的支持鼓励以及家人始终如一的理解与陪伴，这篇论文不可能顺利完成。在此，我谨向所有在这段学习与研究旅程中给予我帮助的人，致以诚挚的感谢。

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Contents

Chapter 1: Introduction 1
1.1 Motivations for research 2
1.2 Context of the study 3
1.3 Problem statement 4
1.4 Research objectives 4
1.5 Relevance 5
1.6 Structure of the thesis 6
Chapter 2: Research Background 7
2.1 Institutional background 7
2.1.1 Development of foreign drug VBP 7
2.1.2 History and development trend of pharmaceutical VBP in China 9
Chapter 3: Literature Review 19
3.1 Basic concepts of centralized volume-based drug procurement policy 19
3.2 Impact of centralized volume-based drug procurement on pharmaceutical companies 22
3.3 Corporate performance: definition and conceptualization 26
3.3.1 Definition of corporate performance 26
3.3.2 Evaluation of corporate performance 27
3.4 Theories related to the performance of pharmaceutical enterprises 30
3.4.1 Contingency theory (CT) 31
3.4.2 Institutional theory 32
3.4.3 Shareholder theory 34
3.4.4 Other complementary theories 35
3.4.5 Theoretical comparative analysis 37
3.5 Explanation of factors affecting pharmaceutical companies' performance 39
3.5.1 Application of theories in the pharmaceutical industry 39
3.5.2 Analysis of the scale economic effect of Centralized Volume-Based Drug Procurement 43
3.6 Mechanism of the impact of centralized volume-based drug procurement policy on the performance of pharmaceutical corporations 47
3.6.1 Research related to the impact of Centralized Volume-Based Drug Procurement

policy on the performance of pharmaceutical corporations on market concentration 48
3.6.2 Research related to the impact of Centralized Volume-Based Drug Procurement policy on the productivity of enterprises 50
3.6.3 Research related to the impact of Centralized Volume-Based Drug Procurement policy on corporate innovation 51
3.6.4 Research related to the impact of Centralized Volume-Based Drug Procurement policy on enterprise costs 52
3.7 Research methodology on the impact of centralized volume-based drug procurement policy on the performance of pharmaceutical corporats 53
3.7.1 DEA methodology 53
3.7.2 Difference-in-Differences method 54
3.7.3 Regression analysis 55
3.7.4 Comparison of research methods 55
Chapter 4: Research Hypotheses and Conceptual Model 57
4.1 Research hypothesis 57
4.1.1 The impact of CVBDP on the pharmaceutical company's performance 57
4.1.2 The impact of CVBDP of medicines on market orientation 59
4.1.3 Impact of CVBDP on R&D orientation 62
4.2 The conceptual model 64
Chapter 5: Research Design 65
5.1 Measurement indicators and description 65
5.2 Data collection 71
5.3 Method 71
Chapter 6: Results 79
6.1 Characterisation of the dataset 79
6.1.1 Descriptive statistics 79
6.1.2 Relevance analysis 82
6.2 PSM processing 89
6.2.1 Methods of PSM processing 89
6.2.2 Results of PSM treatment 90
6.3 Regression results 90
6.3.1 Return to baseline 91
6.3.2 PSM-DID regression 91
6.3.3 Analysis of lagged effects 92

6.3.4 Intermediary effect 93
6.4 Heterogeneity test 99
6.4.1 Test for firm size heterogeneity 100
6.4.2 Test for heterogeneity in property rights 101
6.4.3 Test for Industry heterogeneity 102
6.5 Robustness test 103
6.5.1 Parallel trend test 103
6.5.2 Placebo test 104
6.5.3 Robustness test for PSM 105
Chapter 7: Discussion and Conclusion 111
7.1 Conclusion 111
7.1.1 Analysis of the primary effects of the CVBDP policy 111
7.1.2 Analysis of heterogeneity test results 113
7.1.3 Analysis of mediating effects results 116
7.2 Policy improvement recommendations 118
7.2.1 Policy improvement directions 118
7.2.2 Establishment of a long-term mechanism 120
7.3 Limitations and Prospects 122
7.3.1 Limitations 122
7.3.2 Future research 124
Bibliography 127
Webliography 145
Other References 147
Annex A 149

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List of Tables

Table 2.1 CVBDP policy development in China, 2018-2024 10
Table 3.1 Representative performance evaluation methods 28
Table 5.1 Description of selected dependent, independent, and mediating variables 69
Table 5.2 Description of control variables 71
Table 6.1 Descriptive statistics for overall data (except dichotomous variables) 82
Table 6.2 Statistical description of categories and t-test of indicators between two groups. ... 83
Table 6.3 Pearson correlation analysis 85
Table 6.4 Full sample DID and matched sample DID model results 92
Table 6.5 Results of lag effects (1-2 quarters) 94
Table 6.6 Results of lag effects (3-4 quarters) 95
Table 6.7 Results of lag effects (5-6 quarters) 96
Table 6.8 Results of lag effects (7-8 quarters) 97
Table 6.9 Results of the mediation effect test for R&D expense ratio 98
Table 6.10 Results of the staged testing for mediating effects 99
Table 6.11 Results of the firm size heterogeneity test 100
Table 6.12 Results of the heterogeneity test for property rights structure 102
Table 6.13 Results of industry heterogeneity test 102
Table 6.14 Comparison of DID results under different matching methods 108

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List of Figures

Figure 4.1 The conceptual model 64
Figure 6.1 Nuclear density map 90
Figure 6.2 Parallel trends plot 103

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List of Abbreviations

CVBDP – Centralized Volume-Based Drug Procurement

Multi-period DID – Multi-period Difference-in-Differences

PSM – Propensity Score Matching

ROA – Return on Assets

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Chapter 1: Introduction

The study of performance has evolved from evaluating individual achievements to a comprehensive assessment of overall organizational efficiency, reflecting the deepening of enterprise management theory and practice.

Evaluation research on corporate performance focuses on developing scientific, objective, and operational performance evaluation systems to measure enterprises' achievements and efficiency over a period of time. From Frederick Winslow Taylor's scientific management theory in the late 19th century (Bgenhold, 2006) to the 20th-century Management by Objectives (MBO) approach (Drucker, 2006), the Balanced Scorecard (BSC) method, and the Triple Bottom Line concept (Elkington, 1999), performance evaluation methods have continuously evolved, collectively driving the deepening and advancement of corporate performance theory.

Research on factors influencing enterprise performance analyzes internal and external determinants, aiming to uncover mechanisms and patterns that shape performance and offer strategic and managerial guidance.

In the 1990s, increased competition spurred interest in strategic impacts on performance, with Michael Porter's competitive strategy theory highlighting that long-term performance depends not only on internal resources and capabilities but also on industry and market environment (Michael Porter, 1988). Stewart (1998) emphasized the impact of intangible assets, such as knowledge, skills, and innovation on performance in his intellectual capital concept. In the 21st century, performance factors remain widely studied. For example, Claessens et al. (2002) used data from 1,301 listed companies in eight East Asian countries to study the relationship between ownership structure and company performance, finding a positive correlation between increasing the largest shareholder's cash flow rights and company value. This supported the property rights theory and emphasized the influence of ownership structure on performance.

Notably, few scholars focus on the impact of central government policy on enterprise performance.

Policy factors significantly affect performance as government policies constrain enterprises and ensure compliance and social responsibility through effective enforcement and supervision. In countries like China, government policies often guide industry development.

For pharmaceutical companies, evaluating the impact of policy on performance is crucial. As a specialized sector, the pharmaceutical industry is subject to stringent regulation due to the unique nature of its products. Simultaneously, as a quasi-public good, drug pricing is tightly controlled by the government to ensure public accessibility and affordability.

China's Centralized Volume-Based Drug Procurement (CVBDP) policy leverages national-level centralized purchasing to negotiate prices through volume, guiding drug prices back to reasonable levels. In 2018, the launch of China’s "4+7"volume-based procurement policy had a profound impact on the pharmaceutical industry. Following the announcement of the initial bidding results, the stock prices of pharmaceutical companies in the A-shares market plummeted, with many companies experiencing the maximum allowable decline. By December 21, 2018, the market value of 23 listed companies had decreased by more than 20%, resulting in an overall market value contraction of nearly 550 billion yuan in the A-shares pharmaceutical sector. Similarly, numerous Chinese pharmaceutical companies listed on the Hong Kong Stock Exchange also saw substantial declines. Given these significant market reactions, it is crucial to gain a deep understanding of the specific mechanisms and extent to which the Centralized Volume-Based Drug Procurement policy impacts pharmaceutical companies' performance. However, current academic discussions on the effects of such policies — particularly the Centralized Volume-Based Drug Procurement policy — on pharmaceutical company performance remain insufficient. Furthermore, the industry lacks a comprehensive framework for fully evaluating pharmaceutical companies' performance.

1.1 Motivations for research

Enterprise performance directly affects survival and development. This study aims to explore volume-based procurement policy as a factor influencing pharmaceutical performance and to investigate the feasibility of integrating this factor into a comprehensive global framework for measuring pharmaceutical performance.

Existing research covers various factors affecting performance, including policy and market environment (Al Mamun et al., 2022; M. Wang et al., 2021; S. Chen & Zheng, 2022; Riaz & Saeed, 2019; Y. Wang et al., 2024a; Zhang, 2024), innovation capacity (Sudrajat et al., 2017; Xiang & Wang, 2022; Zhang, 2022;), supply chain management (H. Liu et al., 2021;Kumar et al., 2018), corporate culture (Schein, 2010; Zhang, 2022; Avcin & Balcioglu, 2017; Rahman et al., 2023), internal resources (B. Liu et al., 2023; Lv & Chen, 2022; S. Chen & Zheng, 2022;), leadership (Kotter, 1996; Lv & Chen, 2022; Schein, 2010; Srimulyani et al.,

2023; Xiang & Wang, 2022; Y. Li & Fei, 2023; Zeng et al., 2023), digitalization (H. Li et al., 2022; Y. Li & Fei, 2023; Y. Wang et al., 2024b), resilience (B. Liu et al., 2023), and firm characteristics (Kim & Kim, 2016; Zhao et al., 2021). Performance not only reflects financial performance, but also market position, productivity, and innovation capacity. Especially in the pharmaceutical industry, volume-based procurement policies are increasingly applied, significantly impacting performance.

Although some scholars have studied the impacts of CVBDP policy on pharmaceuticals, most studies focus on CVBDP policy effectiveness (Peng et al., 2020; Pentrakan et al., 2022; Walker et al., 2003; Yao & Tanaka, 2015), lacking in-depth analysis of the impact mechanisms on performance. Therefore, this study aims to analyze the impact of procurement policy on pharmaceutical performance comprehensively.

1.2 Context of the study

Enterprise growth involves utilizing different production resources to enhance efficiency (Coase, 1974). When facing environmental changes, value creation is crucial for growth (Slater & Olson, 2000) with performance as the ultimate goal. In this context, evaluating performance is vital for enterprise growth. Recently, rapid changes in the business environment have complicated and diversified factors influencing performance, ranging from policy and market environment to internal resources.

External factors include policy and market environments. Government regulations and policies directly influence pharmaceutical operations and development, while market demand changes, competitor dynamics, and overall economic conditions significantly impact performance.

Internal factors cover innovation capacity, supply chain management, corporate culture, internal resources, leadership, digitalization, resilience, and firm characteristics. Innovation determines technological and product competitive advantages; supply chain efficiency affects costs and production capacity; corporate culture shapes work attitudes and cohesion; resource allocation impacts operational efficiency; leadership influences decision-making and development; digitalization affects information management and process optimization; resilience reflects crisis response and recovery capacity; firm characteristics such as scale and brand influence competitiveness and performance. In a changing business environment, enterprises must adapt to policy changes and optimize internal management to tackle challenges and opportunities. Particularly in policy-sensitive industries, identifying policy trends and

adjusting strategies is essential for competitiveness and sustainable development.

Specifically in the pharmaceutical industry, policy changes are significant. Governments continually introduce regulations to lower drug prices, with “volume-based procurement” being widely promoted to address issues, such as limited market size, technical capacity, and production incentives (Embrey, 2013; Espín et al., 2016; Nemzoff & Chalkidou, 2019). Especially during the COVID-19 pandemic, the adoption of procurement mechanisms increased globally. Buyers in Europe (Mcevoy & Ferri, 2020), Africa (Munshi, 2020), and America (Lal et al., 2022), and the global COVAX initiative (Eccleston-Turner & Upton, 2021) have collectively procured vaccines and medical products, exerting a significant impact internationally.

Recently, China’s volume-based procurement policy has significantly affected its pharmaceutical industry. In 2018, the announcement of the first batch of selected drugs led to market panic, causing pharmaceutical stock prices to plummet, with leading domestic firm Hengrui Medicine's stock dropping over 20% within one week (Li S. & Shen, 2020). Procurement involves high-use drugs covering common outpatient diseases and major diseases (Lu et al., 2023), significantly influencing industry competition, lowering drug prices, and saving medical insurance funds, but also reshaping the industry, prompting market consolidation (Tan & Chen, 2020; Tan & Fan, 2019).

1.3 Problem statement

Compared to internal factors, the impact of external factors on performance is less studied but still significant. Michael Spence (1978) 's signaling theory suggests that government policies can deliver intentions regarding economic development, industry regulation, and competition, influencing business decisions and investment, thereby affecting performance. Focusing on pharmaceutical volume-based procurement, the new policy's impact on performance lacks systematic theoretical frameworks and empirical studies. Thus, this study's research question examines how volume-based procurement affects pharmaceutical industry performance.

1.4 Research objectives

The main objective of this study is to establish a comprehensive framework integrating procurement as a key performance factor in the Chinese pharmaceutical industry. Specific objectives include:

1. Define performance metrics: Explore performance definitions and contexts, identifying commonly used metrics such as financial indicators, market share, and customer satisfaction through literature review.

2. Analyze traditional internal and external factors: Review internal factors such as resources, management practices, innovation, and capabilities, and external factors such as market competition, economic environment, policies, and supply chain relationships.

3. Explore procurement's specific impact on performance: Clarify procurement's impact mechanisms through theoretical and empirical research, studying its effects on cost control, supply chain management, risk diversification, and varying effects across firms.

4. Measure the impact of procurement controlling other factors: Assess procurement's relative importance to performance compared to other factors using statistical methods and empirical data, exploring interactions and synergies.

5. Propose a comprehensive framework: Integrate results into a framework including procurement and other factors, explaining overall influences on performance and offering strategic guidance for enhanced performance.

6. Through achieving these objectives, this study aims to provide theoretical and practical guidance for managers to understand and apply procurement strategies, improving overall performance.

1.5 Relevance

Understanding performance factors is crucial for holistic development. Studies show that examining multiple dimensions and their interactions helps enterprises understand and improve operations, enhancing performance and promoting growth (Betto et al., 2022; Fu, 2017).

A key challenge is designing a comprehensive framework to explain the determinants of performance. This framework can help the international pharmaceutical industry measure performance and promote high-level development.

Despite the existing research on the impact of various factors on pharmaceutical company performance, studies specifically examining the effects of policies, particularly volume-based procurement policies, on firm performance are limited. Additionally, there is no unified framework to comprehensively measure the performance of companies in the pharmaceutical industry. Integrating procurement into performance evaluation facilitates a comprehensive assessment of operations, market competitiveness, and long-term potential, providing accurate performance evaluations.

Consequently, this study has both academic and managerial relevance. In academic terms, this study enriches the existing theoretical framework of corporate performance research by introducing the factor of centralized procurement. The literature has not covered or synthesized the impact of different factors on pharmaceutical performance. This study aims to understand these impacts in depth, offering new insights and practical recommendations for enhancing performance. Hence, this research project holds academic significance by contributing to a deeper understanding of the connection between these dimensions.

The managerial relevance of this research lies in providing concrete strategic recommendations for international pharmaceutical company managers. These recommendations can help them optimize corporate management through volume-based procurement, thereby improving firm performance.

1.6 Structure of the thesis

The structure of this article is arranged as follows:

Chapter 1: Introduces research background, motivation, problem statement, and research objectives.

Chapter 2: Introduces background on the characteristics of China's pharmaceutical industry, detailed policies, and corporate performance.

Chapter 3: Reviews the literature, discussing the definition and influencing factors of firm performance, and analyzing the concept and role of volume-based procurement in detail.

Chapter 4: Introduction to research hypotheses and conceptual model.

Chapter 5: Research Design, describing indicator measurement and data collection methods, and elaborating on the research methodology.

Chapter 6: Research Findings, presenting and analyzing the research results.

Chapter 7: Discussion and Proposals, comparing and discussing research findings, proposing strategies for enhancing corporate performance through centralized procurement, and suggesting future research directions.

Chapter 2: Research Background

The pharmaceutical industry, as a special industry, is strictly regulated due to the unique attributes of its products, drugs. The government regulates the research and development, production, and pricing of medicines through various policies to protect public health and maintain market order. To address the affordability and availability of quality-assured medicines, the Centralized Volume-Based Drug Procurement (CVBDP) policy has been particularly promoted. The use of Centralized Volume-Based Drug Procurement mechanisms has increased, especially during the Covid-19 pandemic. Buyers in Europe (Mcevoy & Ferri, 2020), Africa (Munshi, 2020), the America (Lal et al., 2022), and at the global level, the Covax Initiative (Eccleston-Turner & Upton, 2021) have joined forces to centralize the procurement of medicinal products.

This chapter will introduce in detail the policies related to the Centralized Volume-Based Drug Procurement policy at home and abroad, sort out their development and changes as well as the relevant institutional situation, point out the problems and contradictions brought about by the institutional changes, and discuss the impact of the Centralized Volume-Based Drug Procurement policy on corporate performance based on the current context.

2.1 Institutional background

Countries across the globe are constantly striving to implement effective health policies to increase access to health services, achieve universal health coverage, and improve people's health and well-being.

2.1.1 Development of foreign drug VBP

Most developed countries have national drug procurement systems as part of their national health insurance. Different drug procurement mechanisms are designed to ensure a balance between competitive procurement prices and compliance with national industry and procurement policies. The dramatic increase in global funding for specific medicines (e.g., new medicines for malaria, tuberculosis, and AIDS), while funding for other essential medicines (e.g., contraceptives and traditional vaccines) is shrinking, has prompted countries to respond

to underfunding through Centralized Volume-Based Procurement, which has also fuelled the development of Centralized Volume-Based Drug Procurement (Huff-Rousselle, 2012). Essentially, the Centralized Volume-Based Drug Procurement (also known as joint purchasing, volume purchasing, group purchasing, cooperative purchasing, or collaborative purchasing) is a collaborative initiative of the buyer by consolidating purchases (Pazirandeh & Herlin, 2014). As early as the 1980s, the Eastern Caribbean Drugs Directorate (ECDS) had implemented a Centralized Volume-Based Drug Procurement mechanism to procure vaccines for 17 countries (Huff-Rousselle & Burnett, 1996). In the late 1990s, similar mechanisms were used to purchase antiretroviral drugs (ARVs) in the United States President's Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund to Fight AIDS, Tuberculosis, and Malaria (Global Fund) (Huff-Rousselle, 2012). The recent Covid-19 pandemic has increased the use of Centralized Volume-Based Drug Procurement. In the context of supply chain disruptions and predatory competition among buyers, the World Health Organization (WHO) has recommended that procurement of health supplies be managed centrally to avoid wastage and stock-outs (World Health Organization, 2020), European (Mcevoy & Ferri, 2020) and Covax at the global level (Eccleston-Turner & Upton, 2021) also advocates for buyers to co-purchase vaccines and personal protective equipment.

The Centralized Volume-Based Drug Procurement policy, as part of drug procurement policies, aims to correct imbalances in market leverage between supply and demand by consolidating purchasing power into a buyer's monopoly to better achieve public health objectives. There are different models of Centralized Volume-Based Drug Procurement policy depending on the level of cooperation, the highest level of which involves collective purchasing by a purchasing office on behalf of a group of facilities, health systems, or countries, with members agreeing to the group's exclusive purchase of certain medicines, such as in Denmark (Bartels, 2016), where a central contracting and purchasing model is adopted, with a central purchasing agency purchasing medicines for all public hospitals. There are other models of Centralized Volume-Based Drug Procurement policy, such as collective purchasing in hospitals (e.g., France) (Toulemon, 2017) or regional purchasing (e.g., Spain) (Castro et al., 2018). In addition, public purchasers from different countries can also cooperate (transnational procurement) (Vogler et al., 2022).

Studies have shown that Centralized Volume-Based Drug Procurement policies can reduce the unit price of purchased medicines, improve quality assurance, and reduce or eliminate corruption in the procurement of medicines (Huff-Rousselle, 2012). Pierre Dubois and co-authors analysed a wide range of essential drugs in 16 therapeutic areas in seven low- and

middle-income countries (LMICs) and found that Centralized Volume-Based Drug Procurement mechanisms reduced drug prices by an average of 15%. They hypothesised that the price reductions could be due to the increased bargaining power of buyers as well as increased purchases. However, when the supply side is more concentrated (i.e., there is less supplier competition), the observed price-reduction effect of Centralized Volume-Based Drug Procurement becomes smaller (Dubois et al., 2021). Wang and Zahur (2025) also found that although Centralized Volume-Based Drug Procurement reduced prices, the effect of the price reductions varied. International Centralized Volume-Based Drug Procurement was most effective for small buyers and concentrated markets. At the same time, domestic Centralized Volume-Based Drug Procurement was most effective for large buyers and unconcentrated markets. Centralized Volume-Based Drug Procurement reduces delays, but at the cost of longer expected delivery times. Centralized Volume-Based Drug Procurement is more effective for older-generation drugs than patent pools for newer medicines. Vogler et al. (2022) assessed Centralized Volume-Based Drug Procurement in Portugal as contributing to greater transparency in processes and governance, improving equity of access to medicines across the country, and reducing the workload of some users. In addition, Hamzah et al. (2020) argued that introducing a Centralized Volume-Based Drug Procurement option in the drug procurement system and continuous monitoring of the efficiency of purchases would be conducive to improving prices between local and foreign suppliers and increasing the efficiency of drug purchases.

2.1.2 History and development trend of pharmaceutical VBP in China

In China, the Government attaches great importance to reforming the pharmaceutical sector as a breakthrough to alleviate the problem of “difficult and expensive access to health care”. Of these, the Centralized Volume-Based Drug Procurement policy, as an important policy tool, aims to reduce drug prices, optimize the structure of health insurance expenditure, and promote competition and sustainable development in the pharmaceutical market through large-scale purchasing. This policy is a major reform task deployed by the Party Central Committee and the State Council of the People's Republic of China. Since June 20, 2018, ten batches of drug VBP have been conducted at the national level in accordance with the working principles of "national organization, alliance procurement, and platform operation".

From an institutional design perspective, China's CVBDP policy is not merely a price-compression tool but a systematic framework encompassing procurement organization methods, price formation mechanisms, oversight of implementation, and supporting policy arrangements.

Under this CVBDP framework, the national medical insurance authorities either organize uniformly or spearhead the establishment of joint procurement bodies to aggregate drug demand previously dispersed across different medical institutions. They then engage in centralized price negotiations with pharmaceutical manufacturers based on clearly stipulated procurement volumes. Selected manufacturers gain stable, predictable market share while facing stricter requirements regarding pricing, quality, and supply assurance. Moreover, centralized procurement is not implemented in isolation but advances in tandem with policies such as medical insurance payment reforms, drug quality oversight, and clinical drug management. On one hand, quality thresholds, such as consistency evaluation, have raised market access standards to some extent through centralized procurement. On the other hand, by establishing the preferred status of selected drugs, the enforcement rigor of procurement outcomes has been strengthened.

Therefore, since its implementation, the CVBDP policy for pharmaceuticals has reduced drug prices through large-scale procurement, optimised the structure of health insurance expenditure, and promoted competition and sustainable development in the pharmaceutical market. After three years of effort, the Centralized Volume-Based Drug Procurement reform entered a new phase of normalisation and institutionalisation in China in early 2021 and has achieved specific results in terms of drug use and accessibility of medicines. The government will continue to explore the establishment of a standardised system of Centralized Volume-Based Drug Procurement and the use of medicines, and the table below describes the development of China's centralised VBP policy (Table 2.1).

Table 2.1 CVBDP policy development in China, 2018-2024

Point	Period	Thrust
	2018.5.31	National HealthCare Security Administration Established
The first VBP projects appeared in the "4+7" (4 municipalities and 7 cities directly under the central government) and expanded the scope of implementation of pilot projects	2018.6.20	On June 20, Premier Li Keqiang presided over a State Council executive meeting to deploy a national pilot program for the Centralized Volume-Based Drug Procurement policy to achieve a significant reduction in drug prices
	2018.7.6	NHSA held a workshop on the Centralized Volume-Based Drug Procurement policy in Shanghai, which was attended by officials from Beijing, Shanghai, Tianjin, Chongqing, Jiangsu, Zhejiang, Anhui, Jiangxi, Fujian, Shandong, Guangdong and others
	2018.7.31	Hu Jinglin, Director of NHSA, went to the Shanghai Municipal Medical Insurance Center, Shanghai Pharmaceutical Centralized Bidding Procurement Management Office, and Shanghai Medical Insurance Supervision and Inspection Institute to learn more about the Centralized Volume-Based Procurement policy for medicines, medical insurance information system construction and fund supervision.

Point	Period	Thrust
	2018.8.2	NHSA held a national workshop on Centralized Volume-Based Procurement policy for medicines in Shanghai
	2018.9.11	NHSA organized A symposium on pilot joint procurement in Shanghai, which was attended by officials from Beijing, Shanghai, Tianjin, Chongqing, Guangzhou, Shenzhen, Shenyang, Dalian, Xi'an, Xiamen, and Chengdu
	2018.11.14	The Fifth Meeting of the Central Committee for Comprehensively Deepening Reforms deliberated and approved the pilot program of Centralized Volume-Based Drug Procurement in state organizations, determining that the VBP will be carried out in four municipalities, namely, Beijing, Shanghai, Tianjin, and Chongqing, as well as in seven cities including Shenyang, Dalian, Xiamen, Guangzhou, Shenzhen, Chengdu, and Xi'an, and that the VBP involves the purchase of 31 designated species
	2018.11.15	The Joint Procurement Office issued documents on Centralized Volume-Based Drug Procurement policy in "4+7"
	2018.11.21	Shanghai Pharmaceutical Centralized Bidding Procurement Management Office issued a supplemental document on Centralized Volume-Based Drug Procurement policy in "4+7"
	2018.12.6-8	The bidding for the "4+7" Centralized Volume-Based Drug Procurement policy was opened, and the winning bids were announced. A working meeting on pilot centralized procurement was held, and a press conference was held
	2018.12.7	The Joint Procurement Office publicized the results of the bids and the list of varieties offered
	2018.12.25	“Notice from the National Medical Products Administration on Strengthening Drug Supervision during the Pilot Period of Centralized Procurement and Use of Drugs”(National Medical Products Administration[2018] No. 57) (National Medical Products Administration, 2018)
	2019.1.17	General Office of the State Council issued “Notice of The General Office of the State Council on the issuance of the Pilot Program for The Centralized Purchase and Use of Drugs by the State Organization” (General Office of the State Council[2019] No. 2) (General Office of the State Council, 2019)
	2019.1.21	General Office of the State Council issued “Notice of The General Office of the State Council on the issuance of the Pilot Program for The Centralized Purchase and Use of Drugs by the State Organization” (General Office of the State Council [2019] No. 77) (National Health Commission of the People’s Republic of China, 2019)
	2019.09.01	Sunshine Medical Procurement All-In-One issued “Union Area Centralized Volume-Based Drug Procurement Documents” (Joint Procurement Office for National Centralized Drug Procurement,2019a)
	2019.09.24	The winning bids for the Centralized Volume-Based Drug Procurement in the Union area were announced, and a press conference was held
	2019.09.25	The National Healthcare Security Administration and nine departments issued “on the implementation of The national organization of centralized drug procurement and use

Point	Period	Thrust
		pilot expansion of regional scope"(Medicare issue[2019]No.56) (National Healthcare Security Administration et al., 2019)
	2019.09.30	The Joint Procurement Office has announced the winning bids for the Alliance's regional Centralized Volume-Based Drug Procurement
	2019.11.29	Notice of the Office of the State Council Medical Reform on Policy Measures to Further Deepen the Reform of the Medical and Healthcare System with the Breakthrough of Centralized Volume-Based Drug Procurement and Use of Medicines
	2019.12.29	Announcement of the Joint Procurement Office of the State Organization of Centralized Volume-Based Drug Procurement and Use issued "the National Document on Centralized Drug Procurement"(GY-YD2019-2)(Joint Procurement Office [2019] No. 1) (JPO,2019b)
	2020.01.16	Before the State organized the second batch of Centralized Volume-Based Drug Procurement, the National Health Security Administration, together with four other departments, issued the "Notice on carrying out the second batch of Centralized Volume-Based Drug Procurement and Use of drugs organized by the State "(Medical Insurance Issue [2020] No. 2 (National Healthcare Security Administration et al., 2020)
	2020.01.17	The second batch of Centralized Volume-Based Drug Procurement organized by the State, witnessed the opening of tenders
	2020.02.06	The National Healthcare Security Administration issued a notice on the Bullet Points of Healthcare Security in 2020. There are twelve main points of work, including: 5. Deepen the reform of the Centralized Volume-Based Drug Procurement mechanism for drugs and consumables.
second batch VBP	2020.02.25	According to "Views of the State Council and the CPC Central Committee on Strengthening the Reform of the Medical Security System" (The CPC Central Committee and the State Council, 2020), recommends giving full play to the leading role of Centralized Volume-Based Drug Procurement and medical consumables, deepening the supply-side reform of pharmaceutical services, advancing the integration of health insurance, medical care and pharmaceutical reforms, strengthening policy and management synergies, and guaranteeing the public's access to high-quality and affordable pharmaceutical services
	2020.04	The Department of Drug Pricing and Bidding and Procurement of the National Healthcare Security Administration (NHSA) has published its key tasks for 2020
	2020.07.15	The relevant departments of the National Healthcare Security Administration convened a seminar to listen to the views and suggestions of experts on the Centralized Volume-Based Drug Procurement policy for medicines of biological products (including insulin) and Chinese patented medicines, and to study and improve procurement policies in the relevant areas

Point	Period	Thrust
Deepening and normalizing VBP	2020.07.29	Announcement of the Joint Procurement Office of the State Organization of Centralized Volume-Based Drug Procurement and Use issued “the National Document on Centralized Drug Procurement”(GY-YD2020-1)(Joint Procurement Office [2020] No. 1) (JPO, 2020)
	2020.08.20	The third batch of Centralized Volume-Based Drug Procurement witnesses bid opening
	2020.08.24	The third batch of Centralized Volume-Based Drug Procurement selected results of the national collection and procurement announced; the first time to include foreign-funded original research drugs, to promote the price of imported drugs, “cliff-style” decline
	2020.12.25	The fourth batch of Centralized Volume-Based Drug Procurement l announcement
	2021.01	The Opinions of the General Office of the State Council on Promoting the Normalisation and Institutionalisation of the Centralized Volume-Based Drug Procurement (Guo Ban Fa [2021] No. 2) clarifies the direction of the normalisation of the collection and procurement of medicines by stipulating that at least two batches of collection and procurement of medicines will be carried out each year, covering chemical medicines, biopharmaceuticals and proprietary Chinese medicines
	2021.02.08	The results of the fourth batch of Centralized Volume-Based Drug Procurement of selected results announced; 45 varieties, new inhalers, eye drops and other dosage forms
	2021.06.23	The fifth batch of Centralized Volume-Based Drug Procurement witnesses bid opening
	2021.06.28	The fifth batch of selected results of Centralized Volume-Based Drug Procurement announced; 61 varieties, covering anti-infective, digestive diseases and other areas
	2021.09.23	The General Office of the State Council issued the “14th Five-Year Plan for Universal Healthcare Protection”, which specifies the goal of expanding the scope of procurement of consumables, and encourages local alliance procurement (e.g., “the Eight Provinces and Two Regions Alliance”, “the Beijing-Tianjin-Hebei Alliance, and the Beijing-Tianjin-Hebei Alliance”)
	2021.11.04	Office of the National Healthcare Security Bureau “on doing a good job of the state organisation of Centralized Volume-Based Drug Procurement agreement after the expiry of the continuation of the work of the notice” to regulate the collection and procurement of expiring varieties of renewal of the contract rules, and to encourage the determination of the successful enterprise through competitive bidding, request for quotations, or a comprehensive evaluation method
	2021.11.30	The successful results of the sixth batch of Centralized Volume-Based Drug Procurement (insulin special) were officially announced
	2022.01.10	The executive meeting of the State Council decided to regularise and institutionalise the Centralized Volume-Based Drug Procurement and high-value medical consumables, making it clear that it is necessary to promote the regularisation and institutionalisation of Centralized Volume-Based Drug Procurement and to speed up the expansion of its

Point	Period	Thrust
		coverage, so as to continue to reduce the prices of medicines and to benefit the patients.
	2022.07.12	Seventh batch of Centralized Volume-Based Drug Procurement witnesses bid opening
	2022.07.18	The results of the seventh batch of Centralized Volume-Based Drug Procurement were formally announced; the "one province, two supplies" model further safeguards supply
	2023.03.01	The National Health Insurance Bureau issued the Circular on the Centralized Volume-Based Drug Procurement and Price Management of Pharmaceuticals in 2023, specifying that by the end of 2023, the Centralized Volume-Based Drug Procurement number of nationally and provincially collected medicines in each province should reach 450, of which the number of provincially collected medicines should reach 130, and that there should be coverage of chemical medicines, proprietary Chinese medicines, and biologically based medicines
	2023.03.01	The National Healthcare Security Administration issued the Circular on the Centralized Volume-Based Drug Procurement and Price Management of Pharmaceuticals in 2023, which specifies that the eighth batch of nationally-organised collective purchasing of pharmaceuticals will be carried out
	2023.04.11	Winning results of the eighth batch of Centralized Volume-Based Drug Procurement announced
	2023.04.22	Shandong Province publicly released the "Notice on Strengthening the Management of the Whole Process of Centralized Volume-Based Drug Procurement of Drugs and Medical Consumables", identifying 2023 as the "Quality Year for the Implementation of the Centralized Volume-Based Drug Procurement Policy for Drugs and Medical Consumables", and carrying out a three-year "look-back" action on the implementation of the centralised purchasing policy
	2023.11.06	Ninth batch of Centralized Volume-Based Drug Procurement witnesses bid opening
	2023.11.16	Ninth batch of national organisation drug collection winning results announced, winning results to be implemented in March 2024
	2024.05.20	The National Health Insurance Bureau issued the Notice on Strengthening Regional Collaboration to Improve the Quality and Expand the Coverage of Centralized Volume-Based Drug Procurement in 2024, stressing the need to strengthen co-ordination, focus on key areas, and improve the implementation mechanism, to enhance the effect of the Centralized Volume-Based Drug Procurement
	2024.06.06	The General Office of the State Council issued the "Deepening Reform of the Medical and Health System 2024 Key Tasks", which clearly promotes the quality and expansion of Centralized Volume-Based Drug Procurement of drugs and medical consumables, strengthens the implementation of pooled purchasing, implements the policy of retaining the balance of Centralized Volume-Based Drug Procurement healthcare funds, and improves the incentives and constraints mechanism.

Point	Period	Thrust
	2024.11.22	The Office of Joint Procurement of Medicines by State Organisations issued the National Centralized Volume-Based Drug Procurement of Medicines Document (GY-YD2024-2), and the tenth batch of Centralized Volume-Based Drug Procurement by state organisations was formally opened, involving 62 species
	2024.12.30	The successful results of the 10th batch of Centralized Volume-Based Drug Procurement of state-organised medicines were officially announced and are expected to be implemented in April 2025

From the perspective of policy evolution, the CVBDP policy reform has generally progressed through a phased process: from pilot exploration to nationwide rollout, and then to the establishment of a normalized institutional framework. The early centralized procurement, exemplified by the “4+7” pilot program, primarily aimed to validate the feasibility of centralized price negotiation mechanisms. It tested procurement rules, implementation pathways, and their impact on drug pricing and supply security within a limited scope. This phase emphasized steady progress, adopting a relatively cautious approach in aspects such as product selection, winning criteria, and implementation cycles.

The CVBDP policy has gradually entered a phase of accelerated expansion based on the experience of pilot. At the national level, the scope of selected products and coverage areas are being expanded in batches, with dynamic adjustments to selection rules, price formation mechanisms, and compliance oversight requirements based on practical experience. Notably, starting from the third batch and beyond, foreign-invested original drugs, biological products, and medications in different dosage forms have been progressively included in centralized procurement. This shift signifies that the policy objectives have evolved from purely price reduction toward institutional consolidation and structural optimization.

By around 2021, with the intensive release of relevant policy documents, the CVBDP policy gradually established a normalized and institutionalized development trajectory. Centralized procurement began operating continuously on an annual and batch basis, significantly reducing policy uncertainty. The defining characteristics of this phase were more stable rules and clearer enforcement constraints, which also exerted a more profound influence on enterprises' long-term operational decisions.

While the government is promoting the standardization of the Centralized Volume-Based Drug Procurement policy that has passed consistency evaluations at the national level, local governments have begun to expand pilot projects to include medicines that have not passed consistency evaluations, traditional Chinese medicines, and biological medicines. The overall trend in the development of the batch procurement policy has been characterized by the

continued expansion of pilot regions, an increase in the number of drug types, the gradual refinement of rules, and an increasingly robust safety mechanism.

“Notification on Further Deepening the Reform of the Healthcare System by Taking the Centralized Volume-Based Drug Procurement and Use of Medicines as a Breakthrough” (National Healthcare Reform Fa [2019] No. 3) (State Council Leading Group for Deepening the Reform of the Medical and Health System, 2019) and “Notification on Key Work Points for Correcting Unethical Behaviors in Drug Procurement, Sales, and Medical Services in 2020”(National Health Medical Letter [2022] No. 84) (National Health Commission et al., 2022) encourage local governments to promote bulk purchasing. Following the national-level procurement, provincial-level procurement has also been carried out in Shanghai, Anhui, Hebei, Fujian, Shanxi, and Qinghai. Additionally, city-level procurement has been conducted in Jinhua, Wuhan, Puyang, Anqing, and Hefei, as well as by the Sanming Alliance in Fujian Province.

As the centralized procurement system continues to advance, its impact extends beyond mere drug pricing to permeate deeper dimensions such as corporate behavior, market structure, and industrial development models. On one hand, the significant price reductions for selected drugs have compressed profit margins for some enterprises, compelling them to reassess their product portfolios and cost structures. On the other hand, stable procurement volumes and clear market expectations have also mitigated market uncertainty to a certain extent, providing new constraints for certain enterprises to adjust their long-term development strategies.

Currently, volume-based procurement has gradually entered a stage of standardized development. The central government conducts volume-based procurement of medicines that have passed consistency evaluations and encourages local governments to procure medicines that have not passed consistency evaluations. The rules, implementation, and related supporting policies for the Centralized Volume-Based Drug Procurement policy at the national level are relatively straigthforward, transparent, and sound, with fewer legal and technical disputes. In contrast, the Centralized Volume-Based Procurement policy for medicines at the provincial and municipal levels is characterized by a lack of clear policy guidelines and objective, fair and quantifiable rules, technical standards, and tools, a situation that will exist for a long time.

In October 2022, the Twelfth Party Congress proposed that the overall goal of China's continueed deepening of the reform of the medical and healthcare system is to “promote the collaborative development and governance of healthcare insurance, medical care, and pharmaceuticals.” Centralized Volume-Based Drug Procurement involving multiple stakeholders in health insurance, healthcare and pharmaceuticals has become a breakthrough and an important handhold in China's medical and healthcare system reform, assuming the

mission of promoting the reform of the medical and healthcare system and the healthy development of the pharmaceutical industry, and helping to usher in a healthier and more orderly development of the pharmaceutical industry. In the future, all parties must work together, continue to explore and improve, to solve the real problems, to ensure that the Centralized Volume-Based Drug Procurement can continue to play a positive role in promoting China's pharmaceutical and healthcare undertakings to a new level.

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Chapter 3: Literature Review

This chapter reviews relevant literature to summarize the multidimensional definitions and evaluation methods of corporate performance currently in use. Drawing on contingency theory, it provides an in-depth analysis of the internal and external factors influencing corporate performance, with a particular focus on how centralized volume-based procurement policies impact corporate performance through the effect of economies of scale.

3.1 Basic concepts of centralized volume-based drug procurement policy

The provision of affordable, quality-assured medicines remains an enduring challenge with complex root causes, including a global economic structure that rewards monopolistic behavior, and information asymmetries resulting from underinvestment in health systems, corruption, and a lack of transparency in prices and costs (Pisani et al., 2019).

A "Centralized Volume-Based Procurement" approach has been developed to address several problems with the affordability and quality assurance of medicines, such as the small size of the buyer's market, limited technical and human resources, and the lack of incentives to manufacture or supply a particular medicine or vaccine (*MDS-3,* 2014). Essentially, Centralized Volume-Based Procurement (also known as joint, bulk, group, cooperative, or collaborative purchasing) can be defined as a collaborative initiative in which purchasers consolidate their procurement activities (Pazirandeh & Herlin, 2014). In this study, Centralized Volume-Based Procurement is defined as the organization of executive agencies to implement the procurement of projects in the centralized government procurement catalog and to complete large-volume purchases that consolidate multiple requirements by following centralized government procurement procedures, organizing and implementing the procurement of projects in the centralized procurement catalog, and training centralized procurement operations staff.

The implementation of centralized procurement is expected to achieve multiple objectives, including price reductions due to increased demand (Karjalainen, 2011; Nollet & Beaulieu, 2005; Trautmann et al., 2009), improved procurement efficiency and quality standards through the sharing of technical capabilities and human resources (Espín et al., 2016), and enhanced availability and supply sustainability by incentivizing suppliers (DeRoeck et al., 2006).

In this study, the important actors in Centralized Volume-Based Drug Procurement mechanisms are classified as purchasers, centralized purchasing organizations, and suppliers. Buyers range from healthcare organizations (primary healthcare institutions, hospitals, and others) to states. If external funders are involved, the buyer's role is split between the financial buyer (the funder) and the physical beneficiary (the recipient) (Ripin et al., 2014). Centralized purchasing organizations (CPOs), which are established to carry out the actual procurement, are responsible for coordinating the interests of various actors within the mechanism, including buyers and suppliers. Suppliers, such as producers, wholesalers, and distributors, provide products to the Centralized Volume-Based Drug Procurement mechanisms.

The structure of Centralized Volume-Based Drug Procurement mechanisms can evolve from a third-party organization representing the buyer in procurement, such as the Global Drug Facility (GDF), to more buyer-owned, cooperative mechanisms, like the pooled procurement system of the Organization of Eastern Caribbean States (OECS) (Bakker et al., 2006; Kenis & Provan, 2009; Schotanus & Telgen, 2007). Centralized procurement can be conducted at provincial, national, inter-national, and global levels, covering a range of pharmaceuticals from single-source (patented products), single-disease (tuberculosis, HIV/AIDS, malaria), single-product type (vaccines, orphan drugs, pediatric medicines), to multi-product categories (essential medicines) (Nemzoff, 2019).

The operation of Centralized Volume-Based Drug Procurement mechanisms has evolved and matured since their inception as a promising solution to the problem of access to medicines for patients and the use of high-quality medicines. Beginning in 1978, when the World Health Assembly first emphasized centralized purchasing to reduce the cost of medicines, the first international joint purchasing mechanisms, such as the Gulf Cooperation Council (GCC) and the Pan-American Health Organization Revolving Fund (PAHORF), were established to jointly purchase medicines and vaccines. The first international joint procurement mechanisms, such as the Gulf Cooperation Council (GCC) and the Pan-American Health Organization Revolving Fund (PAHORF), were established to jointly procure medicines and vaccines. As global attention to pandemics such as AIDS increased, global health organizations such as the Global Drug Facility (GDF), the President's Emergency Plan for AIDS Relief (PEPFAR), the Global Alliance for Vaccines and Immunization (GAVI), and the International Health Organization (IHO) were established to procure drugs and vaccines. The Global Alliance for Vaccines and Immunization (GAVI) and other organizations were established in the late 20th and early 21st centuries to provide access to affordable and quality medicines through the principle of centralized purchasing. These organizations have contributed to the spread of Centralized

Volume-Based Drug Procurement globally, particularly in the face of the COVID-19 pandemic.

Within the global context of healthcare system reform, centralized volume-based drug procurement has emerged as a critical strategy for optimizing resource allocation, reducing healthcare costs, and enhancing patient welfare, becoming a focal point of in-depth research in both academic and policy circles. The formulation of centralized volume-based drug procurement policies is typically grounded in the practical needs and strategic considerations of a nation's healthcare system. The centralized volume-based drug procurement mechanism is complex, multi-component, and context-specific, varying across structural forms (from buyer-owned/inter-buyer to third-party), operational levels (subnational, national, inter-national, and global), and product types (patented products, disease-specific products, vaccines, or various essential medicines) (Parmaksiz et al., 2022). Structurally, they encompass both third-party organizations procuring on behalf of buyers and buyer-owned mechanisms (Parmaksiz et al., 2023). Huff-Rousselle and Burnett (1996) conducted an in-depth analysis of group purchasing from an economic perspective, highlighting that its greatest advantage lies in “volume-based price negotiation”—that is, securing price reductions through the volume-based procurement of pharmaceuticals.

Due to differences in national systems, centralized volume-based drug procurement systems also vary significantly. In the United States, the centralized volume-based drug procurement system is primarily implemented by third-party purchasing groups, which are not government entities. According to a 2018 report, from 2017 to 2021, U.S. third-party group purchasing organizations (GPOs) reduced healthcare expenditures by $19.79 billion per share. It is projected that over the decade extending to 2026, these organizations will save $456.6 billion in healthcare costs (DaVanzo, 2018). Germany's centralized volume-based drug procurement is divided into centralized procurement for innovative drugs and centralized procurement for generic drugs (Dylst et al., 2011), with procurement processes similar to third-party purchasing in the United States. China's centralized volume-based drug procurement mechanism operates under a buyer-owned model. As the world's largest pharmaceutical group purchasing organization, it secures ultra-low-priced, price-capped drug supplies by leveraging a market representing nearly half of the country's healthcare system (Xing et al., 2022). Furthermore, centralized volume-based drug procurement was first mentioned at the national policy level as a management tool aimed at controlling costs and ensuring drug quality (Tang et al., 2019).

Centralized volume-based drug procurement has restructured the pharmaceutical pricing system, exerting a significant impact on drug prices. Some scholars argue that centralized

volume-based drug procurement has effectively reduced drug prices, enhancing patient access to medications and affordability while alleviating the financial burden of medical care (Chen et al., 2020; Yuan et al., 2021). Burns and Lee (2008) assessed public satisfaction with centralized volume-based drug procurement models, revealing that over 80% of respondents believed this procurement approach helps reduce drug procurement costs.

A widely accepted view holds that the “group purchasing” mechanism significantly enhances the bargaining power of pharmaceutical buyers, thereby promoting the optimization of the pharmaceutical supply market structure. This aims to achieve lower drug prices through economies of scale. However, the sufficiency of this theoretical pathway has yet to be fully validated in practice. Researches by Dubois et al. (2021), and Wang and Zahur (2025) reveal that market concentration in pharmaceutical supply plays a crucial moderating role in the complex dynamics of how centralized procurement strategies affect drug prices, providing valuable empirical evidence for further exploration in this field. The significant substitutability of pharmaceuticals in clinical practice implies that drugs with a substitution relationship to the target drug will experience fluctuations in demand and price alongside policy adjustments. Therefore, adopting a holistic perspective that comprehensively considers price changes in substitutes is crucial for accurately observing the impact of drug pricing and deeply revealing the intrinsic patterns of the pharmaceutical market.

The implementation of centralized volume-based procurement policies in the pharmaceutical market has profoundly impacted the stability of drug supply. Centralized procurement addresses supply chain challenges by consolidating drug purchases, improving supply-demand forecasting, and increasing commitments to process and resource optimization. Simultaneously, it ensures the sustainability of the pharmaceutical supply chain while reducing drug shortages and the influx of substandard medications (Kamere et al., 2023). In preventing drug shortages, centralized procurement promotes capacity consolidation and optimized resource allocation among pharmaceutical manufacturers. This helps ensure adequate supplies of essential medicines, enables healthcare institutions to fulfill agreed procurement commitments during contract periods, and safeguards both drug quality and supply reliability (Lu et al., 2022).

3.2 Impact of centralized volume-based drug procurement on pharmaceutical companies

The Centralized Volume-Based Drug Procurement policy clarifies the procurement price and

the supply quantity of the winning enterprises through bidding, to manage the problems of recruitment and procurement separation before the reform, “secondary bargaining”, “inflated drug prices”, “sales with gold”, and corruption in the drug distribution field, significantly reducing the winning bid price of drugs (Luo et al., 2022) and alleviate the pressure on the National Health Insurance Fund. Obviously, the effect of the Centralized Volume-Based Drug Procurement policy has a far-reaching impact on pharmaceutical enterprises in terms of market structure and corporate behaviour (Tan & Chen, 2020; Tan & Fan, 2019).

Firstly, in terms of market structure, the Centralized Volume-Based Drug Procurement policy has substantially increased the market share of winning enterprises and raised the industry’s market concentration. This “quantity-for-price” procurement model has succeeded in lowering the price of medicines and greatly increasing their accessibility. Pharmaceutical companies have gained market share through competitive bidding, which has resulted in compressed profit margins of traditional high-priced medicines, and competition in the pharmaceutical market has changed drastically. Pharmaceutical enterprises that have won the bidding for collective procurement will obtain stable sales in the vast medical market of public hospitals through the policy and rapidly increase their share in the pharmaceutical market. In contrast, enterprises that have not won the bidding will withdraw from the market of public hospitals and face a significant decline in sales, and the pressure of competition will increase. China’s pharmaceutical industry has long been in a situation of “many, scattered and small” (Yang et al., 2024), however, due to a low concentration of the pharmaceutical industry, it is difficult to form excellent market competitiveness. It is not conducive to improving the allocation efficiency of market resources. The implementation of the Centralized Volume-Based Drug Procurement policy may lead to a reduction in the number of existing enterprises, promote the centralised supply of drugs, lead to a tilt in market share towards the winning enterprises, accelerate industry consolidation, and thus optimise the structure of China's pharmaceutical industry (Yang et al., 2024). By analysing the changes in drug usage, expenditure, and prices after the implementation of the policy, Luo et al. (2022) found that the winning drugs captured more market share, further squeezing the market space of the non-winning drugs.

In terms of firms’ behaviour, the Centralized Volume-Based Drug Procurement policy reduces pharmaceutical firms' selling expenses (Zhang et al., 2022), and promotes pharmaceutical firms' R&D investment. The Centralized Volume-Based Drug Procurement has brought about a drastic change in the pharmaceutical industry's drug sales model, with the winning drugs from the collectivisation going directly to hospitals and taking up a large part of people's drug use. The remaining drug purchase and sales channels are concentrated in retail

pharmacies, online pharmacies, and other non-collecting channels. This will further promote industry concentration, eliminate backward and inefficient production capacity in competition, and foster the pharmaceutical industry's innovative and transformational development. Following the implementation of the Centralized Volume-Based Drug Procurement policy, some studies have raised concerns about corporate R&D investment amid substantial price reductions and compressed profit margins (Wang et al., 2025). Still, Lei et al. (2024) argue that the expansion and continuation of Centralized Volume-Based Drug Procurement have not dampened the enthusiasm of pharmaceutical companies to invest in R&D after the regulatory reform. The overall level of R&D remained even higher than before after Centralized Volume-Based Drug Procurement was throughout the observation period. In addition, they see increased investment in R&D as a distinctive feature of Chinese chemical-pharmaceutical companies, as they position themselves to be more competitive in the marketplace. Meanwhile, Gu and Zhuang (2023), in their study of data from a sample of A-share-listed pharmaceutical companies in Shanghai and Shenzhen from 2015 to 2021 using the double-difference method, also found that the Centralized Volume-Based Drug Procurement policy significantly increased the intensity of innovation inputs in China's pharmaceutical industry. In terms of regional and firm-level heterogeneity, seven provinces across the three economic zones were found to have a greater increase in the intensity of firms' innovation investment than other regions. The rise in innovation input intensity among state-owned enterprises is greater than that of private enterprises. In addition, they found that the cost of goods sold ratio has a nearly 10% of biased mediating effect on the innovation investment intensity of listed companies, and a negative mediating effect on operating profit through the mechanism test.

As external factors, government regulations and policies will directly affect enterprises' operations and development directions. Based on the general characteristic of "focusing on marketing but not on R&D" in China's pharmaceutical industry (Liu & Jiang, 2021), government departments have conducted a series of institutional explorations in order to promote market competition and enhance the overall effectiveness of the pharmaceutical industry. To promote market competition and enhance the overall efficiency of the pharmaceutical industry, government departments have carried out a series of institutional explorations. Thus, the Centralized Volume-Based Drug Procurement policy came into being. How will this policy change affect the performance of pharmaceutical companies?

On the one hand, the Centralized Volume-Based Drug Procurement policy positively impacts the performance of pharmaceutical enterprises. The Centralized Volume-Based Drug Procurement policy follows the principle of "integration of procurement and solicitation and

linkage of volume and price", which helps address the problem of subsequent hospital admissions of selected medicines and reduces the cost of sales for enterprises (Wang et al, 2022). Huang and Tao (2020) point out that the Centralized Volume-Based Drug Procurement policy has increased incentives for pharmaceutical companies to pursue economies of scale, thereby enhancing their R&D and resource integration capabilities. Sun et al. (2023) used the implementation of China's national Centralized Volume-Based Drug Procurement policy as a quasi-natural experiment and developed a double difference model to estimate the changes in financial performance after the implementation of the policy based on the financial data of listed pharmaceutical companies in China, and found that the financial performance of winning companies significantly improved. Song et al. (2022) used the PSM-DID model to analyse the impact of the Centralized Volume-Based Drug Procurement system on the performance of "winning" enterprises. They found that the Centralized Volume-Based Drug Procurement system had a significant positive impact on the long-term performance of "winning" enterprises. The increase in drug sales volume, the decrease in selling expenses, and the enhancement of R&D are the main drivers of the increase in long-term performance.

On the other hand, the policy of Centralized Volume-Based Drug Procurement sometimes hinders the development of pharmaceutical enterprise performance. The Centralised purchasing of medicines can significantly reduce the price of the winning drug (Tang et al., 2019; Yao & Tanaka, 2015), and leads to a significant drop in the profit of the drug, which seriously squeezes the profit margin of pharmaceutical enterprises (Hu, 2019; You et al., 2018), which may reduce their investment in research and development due to the drop in profitability (Maniadakis et al., 2018; Petrou & Talias, 2015), which is not conducive to the healthy development of pharmaceutical enterprises. Hua et al. (2022) argue that the negative impact of China's Centralized Volume-Based Drug Procurement policy on firms' net profits is not evident in the short term, but it gradually emerges and intensifies over time with the implementation of the policy. Firms need to respond to this challenge by increasing R&D investment and launching OEM products, while the policy also significantly affects firms' willingness to participate in Centralized Volume-Based Drug Procurement and long-term profitability. In addition, studies have shown that price control-related policies negatively affects the profitability of pharmaceutical companies (Kakkar, 2021). Ke et al. (2024a) conducted empirical analyses using PSM-DID and other methods, and found that the Centralized Volume-Based Drug Procurement policy for pharmaceuticals had a significant negative impact on the operating performance of bidding listed drug manufacturers, indicating that the increase in sales of competitively priced drugs could not fully compensate for the loss of profits brought about by

price reductions in the short term.

The research on the impact of Centralized Volume-Based Drug Procurement policy on corporate performance at this stage is somewhat controversial and complex. The impact of the policy change on the performance of different firms varies greatly, generating an asymmetric surplus management effect, where winning firms manage earnings upwards and losing firms manage earnings downwards (Xu & Wu, 2023). Therefore, more theoretical research and empirical support are needed in the related field, and empirical evidence on the effect of Centralized Volume-Based Drug Procurement policies on firm performance needs to be increased urgently.

3.3 Corporate performance: definition and conceptualization

Research on corporate performance can be categorized into two aspects: the definition of corporate performance and the evaluation of corporate performance.

3.3.1 Definition of corporate performance

At present, corporate performance is understood in both narrow and broad senses. Narrowly, it is based on accounting and financial indicators, evaluating economic objectives and business results such as asset operation and financial efficiency, represented by indicators such as profitability of total assets, return on investment, sales revenue growth rate, and earnings per share (Lebas, 1995). Meanwhile, it also includes financial indicators reflecting the enterprise's value and market situation, such as the market value ratio and Tobin's Q (Venkatraman & Ramanujam, 1986).

Broadly, corporate performance encompasses financial aspects and highlights the role of non-financial indicators such as corporate learning and innovation, in driving financial outcomes (Wang & Zhou, 2003). The broad definition of corporate performance to identify performance drivers and key factors for performance improvement, informing future strategy development and implementation. Xie et al. (2013) used the concepts of financial and non-financial performance of corporations to study the interactive relationship between the intellectual capital of the executive team, strategic flexibility, and corporate performance. In their study, they distinguished the role of strategic flexibility in influencing corporate performance, specifically differentiating its impacts on financial and non-financial performance. Responsive flexibility positively affects both financial and non-financial performance, whereas prior flexibility affects only non-financial performance positively.

One potential explanation for this phenomenon is that the acquisition of proactive flexibility necessitates the allocation of substantial corporate resources (Xie & Wang, 2012). These resources may encompass the development of novel products, the implementation of new competitive strategies, the exploration of new markets, and the modification of industry regulations. The implementation of such proactive behaviours carries a degree of risk that may result in a significant increase in the cost of the firm. Furthermore, achieving short-term benefits is challenging. Consequently, proactive flexibility has been shown to have no direct impact on the firm's financial performance.

A possible explanation is that acquiring first-mover flexibility requires significant resource investment by firms (Xie & Wang, 2012). This includes activities such as developing new products, implementing new competitive strategies, exploring new markets, and altering industry rules. These first-mover actions often entail substantial risks, potentially leading to a sharp increase in costs while offering limited short-term returns. Consequently, first-mover flexibility may not directly affect firms' financial performance.

Different research perspectives emphasize various aspects of corporate performance. In terms of production, business performance focuses on production results and their effectiveness (Debreu, 1951). Drucker (2006) also defines performance as direct results. Bernardin (1992) argued that corporate performance was a combination of work results, namely customer satisfaction, return on investment, and strategic objectives. From a behavioral and capability perspective, corporate performance is considered an action that reflects organizational or individual behavior and capabilities related to organizational objectives (Hu & Feng, 2005). Some scholars, from the perspective of the social nature of corporations, proposed that corporate performance included social connotations, such as values, spirituality, reputation, culture, and credibility (Wei, 2017). In strategic management, Venkatraman and Ramanujam (1986) argued that corporate performance included financial performance, operational performance, and organizational effectiveness.

In summary, corporate performance refers to the actual benefits achieved by an enterprise within a specific operating cycle, or the overall effectiveness of its business activities. It can also be understood as the quantity, quality, efficiency, and profitability of the enterprise's task completion during that period.

3.3.2 Evaluation of corporate performance

In the 20th century, performance evaluation evolved, with notable contributions including the DuPont analysis method introduced by DuPont in 1915, the Balanced Scorecard (BSC)

framework proposed by Robert S. Kaplan and David P. Norton in 1992 (Dorf & Raitanen, 1997) and the Performance Trigonometry developed by Prof. Andy Neely and colleagues in 2001 (Neely et al., 2005). A summary of the most representative studies is shown in Table 3.1.

Table 3.1 Representative performance evaluation methods

Period	Author	Thrust
1915	Donaldson Brown	DuPont Analytics: A financial performance driver framework based on ROI. Integrate several financial metrics such as sales revenue, costs, and investment.
1932	James O.McKinsey	Consider the internal and external performance of the business, combining financial performance drivers with non-financial factors such as strategy and management.
1979	Persen, Lezzig	Metrics include sales margins, earnings per share (EPS), and embedded rate of return (IRR).
1992	Robert S. Kaplan, David P. Norton	Balanced Scorecard: A comprehensive evaluation of corporate performance in four dimensions: financial, customer, internal process, and learning and innovation. It crystallizes the strategic objectives of the corporation and provides a comprehensive evaluation of the corporation's performance.
1991	Stern Stewart Consulting	Economic Value Added (EVA): an indicator of economic value added, which represents the value added over time.
2001	Andy Neely and coauthors	Performance prism: It has two dimensions and three sides. The two dimensions are stakeholder satisfaction, stakeholder contribution, and the three dimensions are strategy, process and capability.

Numerous scholars have highly regarded the balanced scorecard framework proposed by Robert S. Kaplan and David P. Norton and have applied it across various research fields. For example, Hansen and Schaltegger (2016) expanded the balanced scorecard's scope by introducing environmental, social, and ethical dimensions and constructing a sustainability balanced scorecard to explore the deeper links between corporate performance, strategic objectives, and organizational value systems. Keramati and Shapouri (2016) emphasized that the learning and growth dimension of the balanced scorecard was crucial in customer relationship management for Internet service firms, significantly impacting other metrics and highlighting key factors such as organizational capital, human capital, customer retention, perceived customer value, and customer expansion. Collectively, these studies have enriched the application of the Balanced Scorecard. Tan et al. (2017) utilized data envelopment analysis and balanced scorecard techniques to deeply analyze the service performance of cross-regional automotive firms, identifying directions for service quality optimization and efficiency bottlenecks. Malagueño et al. (2018) explored the balanced scorecard's contribution to financial performance and innovation outcomes for SMEs through a survey of 201 SMEs in Spain, finding that firms adopting the balanced scorecard for forward-looking management achieved

better financial performance and innovation outcomes. Singh et al. (2018) combined a fuzzy analytic hierarchy process and a fuzzy inference system to propose a new approach to sustainability assessment for manufacturing SMEs, based on the balanced scorecard framework, enhancing the comprehensiveness and accuracy of the assessment. Additionally, Sandkuhl and Seigerroth (2019) proposed a methodology to improve the balanced scorecard based on information needs analysis and studied its practical application in an industrial setting. Hájek et al. (2020) combined the balanced scorecard with a fuzzy-set qualitative comparative analysis approach to study the modeling of corporate strategic performance and innovation paths.

Although research on corporate performance in China began late, it has developed rapidly in recent years, primarily drawing on advanced international theories for localized innovation. With the introduction of foreign performance research methods, domestic scholars have actively explored new paths for corporate performance evaluation, particularly within the balanced scorecard framework, which has been optimized and expanded.

Focusing on innovation, Zhang (2002) has modified the Balanced Scorecard to incorporate non-financial metrics such as innovation, customer experience, internal operations, and employee development, thereby creating a more comprehensive performance evaluation system. Furthermore, as the balanced scorecard has developed in China to suit the country’s specific conditions, its application has extended to environmental performance, leading to the creation of a specialized balanced scorecard framework for environmental performance to address sustainable development needs (Song & Zou, 2010). Additionally, Wang and Sun (2017) retained the original balanced scorecard framework while innovatively adding a supplier dimension and using the hierarchical analysis method to accurately assign weights, creating a more scientific and reasonable performance evaluation system for retail corporations. For state-owned enterprises (SOEs), Ge and Zhang (2011) expanded the balanced scorecard dimensions from a social responsibility perspective by adding two key indicators: stakeholder satisfaction and contribution. They proposed a comprehensive performance evaluation method based on social responsibility. Additionally, Meng and Ge (2013) conducted an extensive comparative analysis of various performance evaluation methods, focusing on integrating advanced concepts such as economic value added (EVA) and the performance prism into the balanced scorecard. They innovatively constructed a generalized balanced scorecard model applicable to state-owned enterprises, further enriching the theoretical framework and practical tools for evaluating state-owned enterprise performance. These studies not only promote the in-depth development of research on corporate performance in China but also provide strong support for the sustainable development of corporations.

It is evident that the balanced scorecard has greatly enriched the study of corporate performance and that its research methodology is highly suitable for corporate performance evaluation.

Numerous scholars have explored the measurement of corporate performance from a stakeholder perspective. Brulhart et al. (2019) employed structural equation modeling to reveal a positive correlation between stakeholder orientation and firm profitability, highlighting the importance of focusing on key stakeholder groups. The system dynamics model proposed by Rebs et al. (2019) revealed the varying impacts of different stakeholder pressures on corporate and supply chain performance. Ali and Cottle (2021) analysed stakeholder capabilities. They enhanced the understanding of corporate performance, providing insights into both the economic and non-economic impacts of entrepreneurship on a broad network of firm stakeholders. As a significant aspect of stakeholder orientation, the impact of corporate social responsibility (CSR) on corporate performance has garnered considerable attention. Hu et al. (2016) showed that CSR positively affects brand recognition and market share through consumer perception. Li et al. (2018) focused on high-tech corporations, pointing out that CSR helped build strong external relationship networks and promoted technological innovation.

In addition, the combination of balanced scorecard and stakeholder theory opens a new path for evaluating corporate performance. For instance, Mao et al. (2017) utilized an enhanced balanced scorecard framework to outline the content and logical relationships of the social responsibilities undertaken by a given corporation. They designed a strategic, goal-oriented CSR evaluation index system based on the demands of various stakeholders. Zheng and Jiang (2019), leveraging stakeholder theory and contingency theory, researched the strategic-level business performance of corporations. They integrated the main stakeholders of corporations with the four dimensions of the balanced scorecard, constructing a comprehensive and dynamic strategic performance evaluation system for a thermal corporation based on two weighting factors: the corporate life cycle and industry background.

3.4 Theories related to the performance of pharmaceutical enterprises

As the core concern of entrepreneurs and related stakeholders, corporate performance is a hot topic in management research. In the pharmaceutical industry, corporate performance exerts a dual influence on economic efficiency and public health and social welfare. So far, academics have explored the factors influencing corporate performance from various theoretical perspectives. Contingency theory and institutional theory, as important frameworks in

management studies, offer a more comprehensive perspective for corporate management of pharmaceutical enterprises. They assist firms in better adapting to environmental changes, enhancing the flexibility and accuracy of decision-making, and improving corporate performance by optimizing institutional environments. Therefore, this thesis explores contingency theory and institutional theory to frame the research.

3.4.1 Contingency theory (CT)

Contingency theory is firmly rooted in systems theory. Early scholars primarily emphasised that a firm's management style should be aligned with the external environment. For example, Burns and Stalker (1961) proposed flexible and mechanized management styles for dynamic and static external environments, respectively. Thompson (1967) suggested that organizations should develop effective performance incentives that are aligned with the changing external environment and internal elements to enhance performance. Fred Fiedler (1967)'s contingency theory provided a new perspective on the root causes of business success or failure. After the 1970s, contingency theory continued to develop and gained widespread attention from academia and industry. During this period, Luthans (1973) noted that the new approach of contingency theory could be applied to different contexts.

Traditional contingency theory includes three core variables: external environment, internal factors, and the leader's incentive structure. From this theoretical perspective, the external environment – as a contingency variable—remains largely beyond an organization's active control. Yet it provides both incentives and constraints for strategy implementation while establishing the foundational framework for strategic choices. Internal elements of contingency theory include organizational characteristics, strategy, and behavior. A leader's incentive structure, such as compensation, benefits, and career development, can influence their leadership style. According to Fiedler (1967), task-oriented leaders focus on task completion, while relationship-oriented leaders focus more on team relationships. He stated that the former was more likely to achieve superior performance, while the latter may perform poorly.

Contingency theory is the dominant school of thought for analyzing the link between organizations' functioning and performance (Donaldson, 1999). Performance needs to be understood as a product of the fit between the organization's functioning and a set of contingency factors such as organizational size, age, and environmental predictability (Contandriopoulos et al., 2018). From an organizational performance's perspective, contingency theory suggests that performance is affected by internal elements (such as culture, structure, and resources) and external environmental factors (such as the competitive

environment). Therefore, organizations should develop effective performance incentives that account these internal and external factors to improve performance.

For corporations, contingency theory provides direction and guidance for orderly operation and sustainable development. The operation and development of corporations are affected by many external environmental factors, and they need to accurately recognize changes in the external environment and adjust their strategies accordingly. Therefore, contingency theory can guide companies in responding effectively to internal and external changes. By integrating theory and practice closely, companies can adapt to local conditions to improve production and operational efficiency and enhance their competitive advantage (Steinbach et al., 2017).

Contingency theory provides a flexible management approach for firms to improve performance and competitive advantage by effectively responding to changes in internal and external environments and developing effective performance through incentives. The empirical-structural design approach employed in Walter Amedzro St-Hilaire (2020)’s study effectively addresses unobserved endogeneity and heterogeneity in firms, thereby achieving rich empirical conceptualisation. The study establishes a direct link between the productivity of firms' technology projects and the applied governance configuration variables, weighting factors optimising productivity mechanisms. This provides a theoretical basis for the development of firms' technology projects and the establishment of effective incentives. Safari and Saleh (2020) analysed the various determinants of SMEs' entry into or expansion of their international market transactions based on the theory of contingency, using the resource and market perspectives, and identified their significant impact on the firm's export performance. This analysis reflected the significance of the theory of contingency for the firm's understanding of the new external environment, and helped SMEs to cope with the setting up of their organisational structure and the establishment of incentives for their transactions in the international markets more effectively. Enterprises employ the theory of Contingency Change to analyse their internal and external environments. This analysis enables the development of flexible management strategies that enhance the enterprise's capacity for adaptation to environmental changes. Furthermore, the implementation of effective performance incentives is instrumental in maintaining the enterprise's competitiveness in complex environments, thereby strengthening the development of its competitive advantage.

3.4.2 Institutional theory

The origins of institutional theory can be traced back to 19th-century research in economics, politics, and sociology, which emphasized the influence of institutions on organizational

decision-making and behavior (Wu et al., 2016). Meyer and Rowan (1977) constructed a theoretical framework grounded in the legitimacy mechanism, known as the new institutional theory. This theory underscores that while organizations strive for technical adaptability, they are also deeply constrained by the institutional environment; it points out that legitimacy is the key driver shaping organizational institutions and behaviors. Dimaggio and Powell (1983) argue that organizations tend to become homogeneous through processes of mimicry, normalization, and coercive mechanisms, a process termed "isomorphism." They introduced the concepts of constraint and legitimacy from the new institutional theory into organizational research and, more importantly, developed concepts such as organizational fields and institutional isomorphism, along with three types of isomorphic mechanisms. These contributions have made the new institutional theory a viable analytical tool. Marsden and Scott (1996) introduced three pillars in institutional theory: normative, cultural-cognitive, and regulatory pillars, which collectively influence organizational and social structures.

The development of institutional theory has led to the emergence of four main schools of thought: (1) Institutional Isomorphism, represented by DiMaggio and Powell (1983), is grounded in organizational sociology. It explains how organizations, facing uncertainty, acquire institutional legitimacy from stakeholders through processes of isomorphism; (2) Institutional Economics, led by Lott and North (1992), views institutions as formal and informal rules of the game. It primarily studies external institutional environmental constraints and operating costs, as well as the role of adaptation costs related to operations and overcoming market uncertainties in different institutional environments; (3) Institutional Sociology, based on the concept of institutional isomorphism, Marsden and Scott (1996) proposed the three-system model of institutions; and (4) Institutional Logics, early in its development, assumes that organizations are influenced by multiple, competing, and sometimes contradictory institutional forces. As it matured, it recognized that due to differences in resources and capabilities, historical and cultural heterogeneity, and varying organizational practices, institutions have different impacts on different organizations (Greenwood et al., 2011).

Scholars studying institutional theory generally agree that "legitimacy" is central to the establishment of enterprises. The enterprise or organization's legitimacy within the institutional environment determines its survival and success. To obtain legitimacy in this environment, enterprises and organizations must comply with relevant laws, regulations, and institutional norms. This compliance brings stable resources, a good reputation, and sufficient support, helping enterprises establish a firm foundation in an increasingly competitive environment. However, if enterprises focus too much on the core status of legitimacy, they may

overlook innovation and efficiency, thereby limiting their flexibility and adaptability to a certain extent. This can gradually erode an enterprise's future competitiveness. Therefore, enterprise managers need to find a suitable balance for their companies, keep pace with the times, and enhance corporate performance through reform and innovation.

Therefore, institutional theory offers a scientifically sound and comprehensive framework of systems and rules. By achieving legitimacy within the institutional environment, firms can secure sufficient government support, thereby improving their performance.

3.4.3 Shareholder theory

Stakeholders refer to any individuals or groups that can influence or be influenced by an organization (Parmar et al., 2010). Typical stakeholders include shareholders, employees, customers, suppliers, governments, communities, and the environment. Stakeholder Theory, first proposed by R. Edward Freeman (1984), highlights that organizations should consider the needs of all stakeholders in their decision-making processes, not just shareholders. Stakeholder theory emphasizes that enterprises should not only create value for shareholders but also be accountable to other stakeholders. This diversified responsibility encompasses economic, legal, ethical, and philanthropic considerations, requiring enterprises to balance the needs of different groups in their business decisions.

Since its introduction, this theory has sparked extensive discussion and research, particularly regarding the relationship between stakeholders and corporate performance. Donaldson and Preston (1995) have systematically classified and summarized stakeholder theory, proposing three distinct perspectives: descriptive, normative, and instrumental. Jones (1995) further proposed the instrumental stakeholder theory, emphasizing that managing stakeholders within an ethical framework can enhance corporate performance. Hillman and Keim (2001) explored the relationship between stakeholder management and corporate performance, finding that managing stakeholders positively impacts a firm's financial performance. Barnett (2007) introduced the concept of stakeholder influence, arguing that when firms effectively manage and mobilize stakeholders, social responsibility activities are more likely to yield financial returns. Harrison and Bosse (2013) discussed the "generosity" of firms in dealing with stakeholders, addressing whether firms should unconditionally satisfy all stakeholder demands. Tantalo and Priem (2016) put forward the concept of stakeholder synergies, with research indicating that through cooperation and collaboration among stakeholders, firms can achieve higher performance, especially in diversified and complex market environments.

Effective stakeholder management plays a crucial role in corporate performance (Patel et al., 2016). Research shows that by establishing trust and cooperation with stakeholders, enterprises can reduce transaction costs, improve operational efficiency, and subsequently enhance financial performance. Furthermore, effective stakeholder management can strengthen a firm's competitiveness and innovation capabilities, helping it maintain a leading position in a dynamic market environment.

A company's reputation and trust are also enhanced through stakeholder management (Kim & Ferguson, 2019). When enterprises treat employees fairly, fulfill their social responsibilities, and prioritise environmental protection, their external image and reputation improve, attracting more customers and investors. This not only enhances their market competitiveness but also boosts their resilience in times of crisis.

Stakeholder theory also emphasizes the importance of long-term sustainable development for enterprises (Adewole, 2024). By establishing long-term cooperative relationships with various parties, enterprises can cope with market changes, regulatory updates, and external challenges. This flexibility enables them to adjust strategies promptly in complex market environments, thereby avoiding financial losses due to external pressures.

In summary, stakeholder theory provides enterprises with a more comprehensive management framework. By effectively managing relationships with different groups, enterprises can not only improve short-term performance but also achieve long-term sustainable development.

3.4.4 Other complementary theories

Two important theories – Population ecological theory and resources-based view theory – will complement each other in framing this research.

According to Campbell (1965), the following specific explanations are provided for variation, selection, and retention. Variation refers to innovation within a firm or organization and is the process by which an organization or firm selects for its own evolution through the environment. This process occurs continuously across all business populations or organizations increases the complexity of firms or organizations in the business environment. Selection means the environment favors organizations that can adapt to change, allowing them to survive and gain resources, while others that fail to adjust perish. Only a few variants of organizations or firms are selected by the environment to survive. Retention refers to the survival of an organization, where the environment values certain traits that may become dominant in future environmental changes.

Research in population ecology theory of corporate organization focuses on two main directions: studying the mechanisms linking the environment and the corporation, and examining the relationships among corporate communities in light of environmental influences. The theory provides a unique perspective for studying the relationship between corporations and their external and internal environments.

Population ecology theory is a framework that applies concepts and methods from biological population ecology to the study of organizations, corporations, and other social systems. The basic concept of population ecology theory originates from Darwin's theory of evolution, emphasizing the principle of natural selection, "the survival of the fittest". The application of this theory to the study of firms was first proposed by Hannan and Freeman (1977). Before their theory, Campbell (1965) had proposed a theory concerning the three stages of environmental adaptation in a firm or organisation: variation, selection, and retention. Hannan and Freeman drew upon and expanded upon Campbell's theoretical framework, applying it to the study of firms. This extension led to the creation of a more systematic analytical tool.

Resource-based view theory is the most dominant framework for studying resource elements in corporate strategic management. The theory views the corporation as a collection of resources and emphasizes analyzing its economic activities from the perspective of the resources it comprises. Wernerfelt (1984) formalized the concept of the resource-based view. On this basis, resource-based theory has evolved from the traditional view to the dynamic resource-based view. C. K. Prahalad and Gary Hamel proposed the concept of core competency in 1990, which they viewed as a unique and coordinated set of resources and capabilities within an enterprise. From their perspectives, core competency has the potential to generate value across multiple business domains; it is not a static entity, and instead, necessitates continuous evolution to align with shifts in market demand and environmental conditions. Resource-based view theory was further complemented by the dynamic capability framework proposed by Teece et al. (1997). Barney (1991) emphasized that for a firm to gain and maintain a competitive advantage, its resources must be valuable, rare, inimitable, and non-substitutable.

The resource-based view serves as a framework explaining how resources enhance corporate capabilities and motivate new actions. Firms pool resources to create capabilities, which they then utilize to create value (Helfat & Peteraf, 2003; J. Barney et al., 2001; Mahoney & Pandian, 1992). The dynamic resource-based view addresses the limitations of the static traditional resource-based view by introducing dynamic capability theory, emphasizing that firms should adapt to dynamic environments. It posits that rational and efficient resource

allocation can enhance corporate capabilities. Firms should respond promptly to environmental changes and integrate, coordinate, or reconfigure internal and external resources and capabilities to enhance competitiveness and sustainable development.

Population ecology theory and resource-based theory, as important frameworks in organizational studies, emphasize that adequate resource utilization and management are crucial to an organization's success. These two theories complement each other, offering firms a new perspective and approach to better understand and navigate complex environments, thereby enhancing corporate performance and achieving sustainable development.

3.4.5 Theoretical comparative analysis

Using contingency theory to study the impact of centralized volume-based procurement of medicines on corporate performance has significant advantages and broad applicability. First, the theory emphasizes that management practices should match environmental conditions (Birken et al., 2017), which aligns well with the complex and changing market and policy environment that corporations face after the implementation of the centralized volume-based procurement policy. The theory can comprehensively consider changes in the internal and external environments of corporations, and how these changes interact to affect performance (Donaldson, 2001). This provides strong theoretical support for analyzing the specific impact of the centralized volume-based procurement policy on corporations. Second, contingency theory emphasises flexibility and dynamism, encouraging corporations to make adaptive adjustments according to environmental changes (Powell et al., 2015). Under the centralized volume-based procurement policy, corporations need to continuously adjust their production, sales, and R&D strategies to adapt to the new market environment. Contingency theory is a vital tool to guide corporations in making these adaptive adjustments. Finally, contingency theory emphasizes the diversity and variability of management practices, meaning different firms may adopt different management strategies in response to the same environmental changes (Rostamzadeh et al., 2018). This makes contingency theory more explanatory and applicable in accounting for performance differences among firms under the centralized volume-based procurement of medicines.

As mentioned above, traditional contingency theory includes three main variables: the external environment, internal factors, and the leader’s incentive structure. Given practical research conditions, it is not easy to obtain quantitative data and standardize the leader’s style, abilities, and decision-making style. Certain existing variables also partially substitute for the role of leader/manager factors. For example, variables such as firm size and marketing strategy

reflect the extent to which management and leadership decisions have some influence. Larger firms tend to have more sophisticated management and leadership teams, and their marketing strategies also reflect managers' decision-making ability. Additionally, the setup of external environmental factors and internal elements already covers the main aspects of corporate performance impact. Adding the leader/manager factor may complicate the model, leading to multicollinearity and affecting the model's stability and explanatory power (Taboga, 2017). Moreover, within the context of the centralized volume-based procurement of medicines, the policy itself may have a far greater impact on corporate performance than individual leaders/managers. The implementation of macro policies and changes in the market environment have a broad, and far-reaching impacts on firms. In contrast, the influence of individual firm leaders may be relatively limited.

Institutional theory constitutes a system of tangible and intangible frameworks and rules, endowed with the legitimacy, universality, and enforcement of public policies. In the context of the centralized volume-based procurement policy for pharmaceuticals, the government establishes explicit procurement rules and standards, thereby imposing regulatory constraints on the behavior of pharmaceutical enterprises. These institutional constraints not only impact the procurement behavior of pharmaceutical enterprises but also profoundly influence their production, sales, research and development, and other aspects. Consequently, institutional theory provides significant theoretical support for understanding the impact of policies on the pharmaceutical enterprises' performance.

Institutional theory can explain how policy changes affect corporate strategic choices and behavioral patterns. Under the centralized volume-based procurement policy for pharmaceuticals, pharmaceutical enterprises need to adjust their strategies to adapt to these policy changes. For instance, enterprises may need to reassess their product lines, adjust production scales, optimize sales channels, and so forth. Institutional theory can analyze the reasons and motivations behind these strategic adjustments, revealing how policy changes influence corporate decision-making processes and behavioral patterns. This is of great significance for understanding the direct impact of policies on corporate performance and how enterprises adapt to policy changes.

Furthermore, institutional theory can explore the long-term impact of policies on corporate performance. The centralized volume-based procurement policy for pharmaceuticals not only affects the short-term performance of pharmaceutical enterprises but also has far-reaching implications for their long-term development. For example, the policy may alter the competitive landscape of the pharmaceutical industry, reshuffling the driving industry and consolidation.

Institutional theory can analyze the institutional factors underlying these long-term impacts, revealing how policy changes shape the future development trends. This is of great significance for predicting industry trends, formulating corporate development strategies, and evaluating policy effects.

Stakeholder theory is significant in analyzing the conflict and coordination mechanisms among multiple stakeholders involved in centralized volume-based procurement policies for pharmaceuticals, including governments, hospitals, pharmaceutical companies, and patients. It reveals the interactions among these stakeholders and aids in understanding the pathways through which policies impact corporate performance. It assesses enterprises' abilities to balance the interests of all parties in response to policy changes, as well as the impact of such balance on their social performance and long-term development. While stakeholder theory is crucial for understanding multi-party relationships in corporate operations, this study focuses more on the direct impact of policies on corporate performance. Therefore, although stakeholder theory is valuable, it is not this study's core theoretical foundation.

Population ecology theory focuses on the survival, development, and evolution of enterprise populations in different environments. However, the theory is deficient in explaining variations in the individual enterprises' performance, thus serving best as a supplementary theoretical framework. Conversely, resource-based view theory places greater emphasis on the impact of internal resource allocation and utilisation on firm performance and explains how firms can respond to policy challenges and enhance performance by optimising resource allocation. However, it lacks a direct analysis of policy-environment changes and cannot fully explain the direct impact of policy on firm performance.

In summary, contingency theory has significant advantages and broad applicability in studying the impact of centralized volume-based procurement of medicines on the performance of pharmaceutical enterprises, making it an essential theoretical tool for in-depth analysis of this topic. In the subsequent study, we will focus on the external and internal factors of contingency theory to explore the key factors affecting the performance of pharmaceutical corporations in the context of the centralized volume-based procurement of medicines.

3.5 Explanation of factors affecting pharmaceutical companies' performance

3.5.1 Application of theories in the pharmaceutical industry

Based on the preceding analysis, this section will study the application of relevant theories in

the pharmaceutical industry, aiming to deepen understanding of the factors influencing corporate performance from multiple theoretical perspectives.

(1) Contingency Theory

Contingency theory emphasizes that organizations need to dynamically adjust their strategies in response to uncertainties in internal and external environments (Otley, 2016). Uncertainty is at the core of contingency theory and is typically divided into two categories: uncertainty arising from technological generalizability and uncertainty arising from the external environment (Granlund & Lukka, 2017). In the pharmaceutical industry, uncertainty about technological generalizability is more prevalent during drug discovery and development, which may involve the effectiveness of compounds and the realization of target mechanisms of action. Uncertainty from the external environment may include changes in regulatory policies, patent expirations, and market competition. Markus Granlund and Kari Lukka identified four types of uncertainties in drug development: first, the uncertainty of drug discovery and functionality, that is, whether the compound can work in a specific way in the human (or animal) body; second, the market uncertainty of new drugs, that is, whether the new drug has commercial value; the third factor is related to the rigorous regulatory requirements typical of the drug development business; and finally, financial uncertainty, such as financing for the company and the entire financial market (Granlund & Lukka, 2017). Therefore, pharmaceutical companies need to flexibly adjust their strategies in response to changes in internal and external environments to achieve their long-term growth aspirations and address strategic R&D risks, technical uncertainties in drug discovery and development, and external uncertainties.

First, in terms of internal organizational elements, the pharmaceutical industry's organizational structure may include size, scope of business, degree of internationalization, and alliance characteristics (Lin & Darling, 1999). These characteristics shape enterprises' operational methods and resource utilization efficiency, thereby affecting their market performance, profitability, and long-term development potential, and significantly impacting on corporate performance. Euh and Lee (2021), through meta-frontier analysis and detailed evaluation of production efficiency indicators, believe that pharmaceutical companies can address the productivity crisis by diversifying into the medical device field. They suggest that pharmaceutical companies seek integration with homogeneous companies to improve performance and generate corporate synergies through mergers and expansion into heterogeneous industries. Mittra (2007) found that pharmaceutical companies can ensure their competitiveness in the innovation field by adopting diversified strategies, including mergers and acquisitions, strategic alliances, and licensing agreements, while combining internal R&D

activities.

Corporate behavioral variables, including employee behavior, R&D investment, and management practices, indirectly affect corporate performance by influencing internal operational efficiency and innovation capabilities. In terms of R&D investment, to maintain a foothold in the fiercely competitive product patent era and capture potential market shares in the global generic drug market, many pharmaceutical companies have significantly increased their R&D expenses, making R&D a major competitive factor in the pharmaceutical industry. Nandy (2022) found that long-term R&D activities have a significant positive impact on the pharmaceutical companies' financial performance. He proposed a novel conceptual framework (RDiFPF), suggesting that it may ignite and motivate pharmaceutical business leaders and entrepreneurs to engage in R&D and innovation in the pharmaceutical business and obtain substantial economic returns by providing healthcare solutions for treating new diseases and conditions. From a management perspective, global pharmaceutical companies acknowledge that talent is a key driver of competitive advantage, a key factor in driving business performance during economic recessions, and a crucial lever for helping companies develop at the beginning of a recovery. Therefore, most pharmaceutical companies prioritize talent management and focus on technical, regulatory, and leadership talents, as these align with the company's strategic priorities and are particularly important for achieving strategic goals (Garavan, 2012).

Second, in terms of external influencing factors, in addition to coping with the global economic recession, pharmaceutical companies must also deal with a range of complex external factors, such as increased regulation, the expiration of blockbuster drug patents, poor drug pipelines, consumer demand for cheaper drugs, and the emergence of powerful competitors due to mergers (Khanna, 2012). Over the past 20 years, the return on investment in R&D in the pharmaceutical industry has been in continuous decline, with basic R&D costs gradually increasing, which has also led to a decline in productivity. The industry is facing unprecedented industrial challenges and regulations (Schuhmacher et al., 2023). Khalil and Onyango (2022) analysed low-income countries' innovative multinational pharmaceutical companies facing patent expirations, including Pfizer, GSK, Bayer, and Sanofi Aventis. The results showed that patent expiration led to a significant decline in the financial performance of innovative pharmaceutical companies, slowed branded drug sales, and further reduced their profitability. In addition, the merger of biotechnology with similar R&D environments has introduced various uncertainties into pharmaceutical companies' performance improvement (Danzon et al., 2007).

(2) Institutional Theory

The pharmaceutical industry's product — drugs — is unique. Approving such products requires the highest standards of expertise and caution, and its regulatory approval procedures are also stricter. In addition to facing high costs and global competition, pharmaceutical companies must also comply with legislative and regulatory barriers (Dixit et al., 2019). Moreover, institutional changes in the pharmaceutical industry attract more attention from practitioners and researchers because they can help the pharmaceutical industry enhance its competitiveness and interact with other participants in the organizational field (Monticelli & Wegner, 2022). Töller (2017) believes that the application of institutional theory in the pharmaceutical industry is reflected in the industry's voluntary regulation. Through rational choice institutionalism and normative institutionalism, he identified the driving forces and causal mechanisms behind the voluntary regulation of pharmaceutical companies, arguing that there are two reasons for the voluntary regulation of the pharmaceutical industry: first, the "shadow of hierarchy," and second, social norms and social pressure. Zhang (2024), using A-share listed companies in the biomedical industry on the Shanghai and Shenzhen stock markets from 2012 to 2020 as research objects, the study found that increasing tax incentives and raising the proportion of equity financing methods have a significant impact on the high innovation performance of biomedical companies. In addition, industrial policies play a very important role in innovation performance, and government support for emerging industries through policies is an essential force in promoting innovation.

(3) Stakeholder Theory

The stakeholders of the pharmaceutical industry are more complex and diverse than those of other industries, including patients, health professionals, scientific and patient associations, media, regulatory agencies, and various forms of non-governmental organizations (Min et al., 2017), and are closely related to public health. According to stakeholder theory, pharmaceutical companies should balance the needs of all stakeholders and develop drugs to extend and improve human life. However, there is a widespread social suspicion that the pharmaceutical industry charges excessively high prices for drugs and does not provide affordable products to the world, especially developing countries (Min et al., 2017). Therefore, some scholars believe that pharmaceutical companies should fulfill their responsibilities to stakeholders, including disclosing social responsibility information to meet stakeholders' needs, and argue that fulfilling social responsibilities is beneficial for pharmaceutical companies to improve corporate performance (Qomariah et al., 2021).

Leading pharmaceutical companies have made efforts to adopt stakeholder theory, publicize their contributions to the economy, society, and environment, and integrate corporate

social responsibility into their corporate culture. Bornsen et al. (2008) used stakeholder theory to study the media strategy of the Synthroid producer (currently Abbott Laboratories) and found that during the COVID-19 pandemic, its sustainability reporting adjustments were primarily stakeholder-oriented, especially stakeholder groups related to the pandemic. Mike Bourne believes that the pharmaceutical industry should incorporate the needs and expectations of stakeholders into its performance management system and use that system to manage the development of new products. For example, in the "discovery and development pipeline" model, when screening a few potential products from many initial compounds and further verifying them through trials and tests, it is necessary to consider the needs and expectations of stakeholders. This involves not only internal R&D teams but also external stakeholders (such as investors, regulatory agencies, and patients.

3.5.2 Analysis of the scale economic effect of Centralized Volume-Based Drug Procurement

This section focuses on the economies of scale of centralized purchasing, with a view to providing theoretical support and practical guidance for understanding the Centralized Volume-Based Drug Procurement policy.

(1) Economies of Scale Theory

Economies of scale are an economic phenomenon in which the average cost per unit of product declines as the scale of production in a firm or industry increases. Smith (1776), considered the founder of the theory of economies of scale, argued in his magnum opus, The Wealth of Nations, that the division of labor improves productivity. Still, the size of the market limits its effect, and as the size of the market expands, the division of labor is further promoted. Adam Smith emphasized that the division of labor is based on mass production at a certain scale, which implies the idea of economies of scale. According to Adam Smith's concept of economies of scale, as a firm's horizontal scale expands continuously, it can reduce production costs and improve the efficiency of asset utilization, thereby enhancing corporate performance. However, as the firm’s scale continues to grow, especially through vertical expansion, it may lead to increased management costs and a decline in corporate performance, resulting in diseconomies of scale. For example, Dhawan (2001), using panel data analysis of U.S. listed companies, compared the average profit margins of small, medium, and large firms and found that small and medium-sized enterprises are more efficient.

Alfred Marshall was the first to explicitly introduce the concept of “economies of scale” and to discuss its connotation and extension in depth. He distinguished between internal and

external economies of scale and their sources and analysed the pattern of change in the remuneration of different factors of production. In addition, Marshall (1890) also emphasized the key role of organization in the formation of economies of scale and, for the first time, pointed out the conflict between economies of scale and market monopoly, that is, the famous "Marshall conflict".

After that, the concept of economies of scale has been inherited and developed by many scholars, and its theoretical system has been gradually improved and expanded. Young (1928) further revealed the reasons for the emergence of scale economy, emphasized the importance of the division of labor triggered by the expansion of the scale of production, and pointed out that the roundabout or indirect mode of production contributed to the increase of returns to scale. He deeply analysed the dynamic evolution of the cumulative cycle between the deepening of the division of labor, increasing returns to scale, and economic growth, thereby enriching Adam Smith's theory on the division of labor limited by the scope of the market, and put forward the famous "Smith-Young theorem". The theorem states that the division of labor depends on the size of the market, which in turn depends on the division of labor, and that the possibility of economic progress is embedded in this mutually reinforcing process. Samuelson (1970) established criteria for evaluating increasing, constant, and decreasing returns to scale as determined by the production function.

Traditional economies-of-scale theory emphasizes cost reduction and efficiency improvements resulting from scale expansion. However, Harvey Leibenstein (1966)'s concept of "X inefficiency" suggests that increasing scale does not necessarily lead to greater efficiency. As enterprise scale expands, issues such as bureaucracy, internal coordination difficulties, and inefficient information transmission may arise, resulting in resource misallocation and reduced efficiency.

In Principles of Economics, Marshall (1890) detailed the formation of economies of scale, categorizing them into internal and external economies, each explaining different mechanisms by which enterprises reduce costs through scale expansion. Internal economies of scale are the phenomenon of falling unit costs within a firm as production increases. This type of economies of scale stems mainly from efficiency gains and cost dilution within the firm. It involves several functions and links across the enterprise, such as production, procurement, management, financing, and marketing. When an enterprise improves its efficiency by expanding its production scale, it usually achieves cost reductions in these internal links; external economies of scale refer to unit cost reductions arising from the expansion of the industry or economic environment in which the enterprise operates. External economies of scale do not depend on

the scale expansion of individual firms, but rather stem from changes in external factors, such as industry agglomeration effects, improvements in public facilities, and the development of the job market. These external factors provide enterprises with better resources and conditions, enabling them to realize cost reductions in the broader economic and social environment.

(2) Economies of scale in the pharmaceutical markets

The pharmaceutical market is characterized by significant economies of scale. Internal economies of scale are reflected in the production and R&D process of pharmaceuticals, where large-scale production can dilute fixed costs and reduce unit production costs. External economies of scale, on the other hand, are reflected in the industry's agglomeration effect and the utilization of public facilities and services (Hernandez-Villafuerte et al., 2017). These features enable significant cost savings and competitive advantages in the pharmaceutical market, especially for large pharmaceutical companies.

Internal economies of scale are particularly evident in the pharmaceutical market. Pharmaceutical manufacturers can reduce unit production costs in various ways as they scale up production. For example, large-scale production enables firms to invest in more efficient production techniques and equipment, which leads to increased productivity and product consistency. The firm's fixed costs (for example, inputs to production facilities and equipment) are spread across a larger number of production units, which further reduces the cost of production of individual drug products (Henderson & Cockburn, 1993). At the same time, as production scales increase, companies are often able to obtain more favorable purchasing terms, such as volume discounts, which not only reduce the cost of purchasing raw materials but also optimize supply chain management. Large-scale production and sourcing also allow companies to reduce logistics and distribution costs by utilizing centralized purchasing (Tvaliashvili et al., 2024).

External economies of scale in the pharmaceutical market are more focused on optimizing the industry and market environment (Schuhmacher et al., 2021). Firms in the pharmaceutical market tend to be concentrated in specific regions, such as pharmaceutical manufacturing bases or pharmaceutical industrial parks, which brings significant market agglomeration effects, while fragmented distribution is not conducive to the realization of economies of scale (Tvaliashvili et al., 2024). Public resources and policy support provided by the government, such as infrastructure development and tax incentives, also create favorable conditions for pharmaceutical firms, further reducing the industry's overall operating costs. Industry agglomeration also facilitates the flow of technology and knowledge, and cooperation and competition among firms make technological innovation and knowledge sharing more efficient,

thus further reducing R&D and production costs.

(3) Economies of scale in the Centralized Volume-Based Drug Procurement policy

The Centralized Volume-Based Drug Procurement policy leverages economies of scale to reduce significantly procurement costs through centralized purchasing. The implementation of this policy relies not only on internal economies of scale, such as improved productivity and cost control, but also on external economies of scale, such as market agglomeration and integration of public resources. This dual economy of scale enhances the competitiveness of the drug market and reduces overall costs.

The application of internal economies of scale is evident in pharmaceutical manufacturers' ability to realize cost savings by expanding production. Hill et al. (2020), during the COVID-19 pandemic, suggested that drug production could be made cost-effective through mass production, and that when drugs are produced on a large scale, the product costs are further reduced, meaning the cost per unit decreases as volume increases. Countries can order drugs together through pooled procurement (pooled procurement) to take advantage of economies of scale and thus improve access to drugs. Huang and Tao (2020) demonstrate that volume procurement further incentivizes enterprises to achieve economies of scale. The Centralized Volume-Based Drug Procurement policy pushes pharmaceutical firms to expand production to meet demand for large-scale purchases. This scale expansion enables firms to achieve greater efficiency in production and reduce production costs by up-grading production equipment and technology. Expansion of production scale not only reduces per-unit production costs but also enables enterprises to control operating costs more effectively. In addition, centralized purchasing enables enterprises to obtain more favorable raw material purchase conditions, such as bulk purchase discounts, a purchasing advantage that can further reduce costs.

The application of external economies of scale is reflected in the Centralized Volume-Based Drug Procurement policy in the market environment. The policy promotes the agglomeration effect in the drug market (Yang et al., 2023), enabling companies to share public resources and infrastructure, thereby reducing the industry's overall operating costs. The government-led centralized procurement policy enhances price transparency and market fairness by establishing a unified procurement platform and standards. This policy helps reduce healthcare costs, improve the efficiency of the drug supply chain, and promote fair competition in the market. At the same time, the Centralized Volume-Based Procurement has led to more regulated market competition, through which the state can negotiate lower prices with suppliers, thus optimizing the market environment, and centralized procurement processes have led to more regulated market competition, which promotes the efficient functioning of the pharmaceutical market

(Bulthuis et al., 2019).

By applying these internal and external economies of scale, the Centralized Volume-Based Drug Procurement policy has not only achieved significant cost reductions but has also improved the overall operational efficiency and competitiveness of the pharmaceutical market. Such a policy helps reduce healthcare costs, improve the efficiency of the drug supply chain, and promote fair competition in the market.

However, the impact of policy on corporate performance is multifaceted. In addition to firm size, it also affects the industry environment, corporate innovation, production costs, and other aspects. The introduction and implementation of the Centralized Volume-Based Drug Procurement policy have significantly affected market concentration in the pharmaceutical procurement market. Under this policy, the market share of winning companies has increased dramatically. In the centralized procurement market, the concentration rates of the top 4 (CR4) and top 8 (CR8) pharmaceutical companies increased from 23.9% and 39.0% in 2020 to 32.2% and 48.4% in 2021, respectively (Yang et al., 2023). Therefore, the impact of policy changes on corporate performance is multifaceted, and further analysis is needed to understand the specific changes.

3.6 Mechanism of the impact of centralized volume-based drug procurement policy on the performance of pharmaceutical corporations

As a key method of enterprise resource management, the impact of centralized volume-based procurement mechanisms on corporate performance has long been a focal point for both academia and the business community. Opinions vary regarding the effects of the CVBDP policy on companies. Some scholars contend that the CVBDP policy may stifle the development of pharmaceutical companies, while others argue that they will incentivize innovation within these firms. Currently, a substantial body of research exists examining the CVBDP policy and their relationship to pharmaceutical company performance.

Existing literature examining the impact of the CVBDP policy on pharmaceutical companies presents two prevailing viewpoints. One perspective argues that the CVBDP policy exert negative effects on enterprises, while the other contends that such policy do not hinder pharmaceutical companies' development but rather stimulate “reverse pressure transmission,” thereby promoting technological innovation within these firms. As a governmental regulatory tool, the CVBDP policy demonstrably exerts negative impacts on pharmaceutical enterprises and social welfare. However, government regulation does not invariably impede

pharmaceutical companies; under certain conditions, it can foster corporate innovation and elevate social welfare levels (Bolton, 2014).

To comprehensively understand the far-reaching impact of the Centralized Volume-Based Drug Procurement policy on the pharmaceutical corporations' performance, this section will systematically review and analyze existing studies, aiming to reveal the mechanism by which the Centralized Volume-Based Drug Procurement policy affects the performance of pharmaceutical corporations.

3.6.1 Research related to the impact of the Centralized Volume-Based Drug Procurement policy on the performance of pharmaceutical corporations on market concentration

Market concentration is a measure of the degree of concentration within an industry's market structure, often used to describe the distribution of buyers and sellers sizes in a specific industry or market, with a focus on market competition and monopoly. The earliest research on industrial organization related to market concentration was primarily conducted in developed Western countries. In 1951, Bain selected the profit margins of the eight largest enterprises in each industry and compared them with the industry average, conducting pioneering research on the relationship between market concentration and profit margins. Michael (1966) further verified Bain's viewpoint by using data from 1950 to 1960 and proposed that the average profit rate of groups with higher market concentration is greater than that of groups with lower market concentration. Chinese scholars gradually began conducting empirical research on market concentration across various industries after the 1980s. Through empirical analysis, Qi (1998) proposed that there is a positive correlation between industrial concentration and economic performance within a certain range. Geng and Chen (2011) empirically analysed forestry concentration, efficiency and performance as well as the relationship between the three using forestry industry data from the northeastern state-owned forest area, and concluded that market concentration has a positive impact on the market performance and management efficiency of the forest industry enterprises, and at the same time, the improvement of the management efficiency and the efficiency of the scale also improves the market performance of the forest industry enterprises. Based on the theoretical framework of the relationship between logistics industry concentration and performance, Liu (2016) empirically analysed the relationship between the two with the time sample of 2005-2015, and found that the level of logistics industry concentration has a close relationship with market performance, and that the improvement of the former is conducive to accelerating the turnover of funds, enhancing the market performance, and improving the efficiency of the logistics enterprises.

The concept of market concentration has also been widely applied in the pharmaceutical industry. Many scholars at home and abroad have done similar studies. Zhang (2020) assessed the trend of the use of oral contraceptive pills (OCPs) over time, and found that the drug market concentration of OCPs increased from 2011 to 2014, and that for every percentage point increase in the market share of OCPs, their price would rise by $3.12. Yang et al. (2024) empirically assessed the impact of China's national volume-based purchasing policy on drug market concentration at hospital terminals from the perspective of industry structure. The DID model shows that China's national volume-based procurement (NVBP), a centralized volume-based purchasing policy has a significant positive effect on market concentration. Md Hamzah and See (2021) examined the diffusion of New Chemical Entities (NCEs) into the public and private healthcare markets in Malaysia between 2010 and 2014, and identified the factors that explain the diffusion, and found that market concentration is negatively related to the use of NCEs.

Many scholars in China have also analysed the impact of the volume-based purchasing policy on pharmaceutical manufacturing enterprises from the perspective of market concentration. Tan and Fan (2019) proposed that centralized banded purchasing of medicines will be an opportunity for reshuffling in China's pharmaceutical industry, with large enterprises that have won the bid seizing market share, squeezing the survival space of small and medium-sized enterprises (SMEs), and increasing the degree of market concentration in the pharmaceutical industry, while those that have not won the bid may change their original corporate competitive strategies, step up innovation to improve product quality for the remaining market, and strive to develop overseas markets. Huang and Tao (2020) argued that from the perspective of industrial economics, the centralized procurement policy possesses the necessary conditions to enhance the industrial concentration, and at the same time, by drawing on the historical experience of the U.S. drug group purchasing, it can be speculated that there is a tendency for the future concentration of China's pharmaceutical industry to be enhanced. Yang et al. (2023) concluded through the study of literature collation, market structure, after the collective procurement policy, the winning enterprise market share increased significantly, the industry concentration increased significantly, and the Centralized Volume-Based Drug Procurement policy has a positive role in optimizing the market structure, guiding the behavior of enterprises, and improving the performance of the industry.

3.6.2 Research related to the impact of Centralized Volume-Based Drug Procurement policy on the productivity of enterprises

The Centralized Volume-Based Drug Procurement system operates on the core principle of "volume-based price negotiation," achieving significant reductions in drug prices through large-scale purchase orders. Under this policy framework, winning bidders often enhance their profitability by improving generic drug production efficiency and optimizing cost structures to maintain reasonable profit margins. Regarding research on productivity measurement, Regarding research on productivity measurement, Skėrė et al. (2023) developed a decision support method for dynamic production planning (DSM DPP) to optimize production processes in SMEs, addressing the need for dynamic and rapid responses in production operations. The final validation demonstrated that implementing this method in SMEs can significantly improve productivity and ultimately profitability. Pan et al. (2022) explored the impact of carbon trading on firms' total factor productivity (TFP) and found that the pilot carbon emission trading scheme (CETS) has a statistically significant positive effect on TFP, with this positive effect persisting for six years since its inception.

Some scholars have theoretically analysed the impact of the Centralized Volume-Based Drug Procurement policy on the productivity levels of enterprises. Zhang and Wang (2023) conducted qualitative and quantitative research on the impact of the Centralized Volume-Based Drug Procurement policy on pharmaceutical enterprises and the pharmaceutical market, finding that the policy encourages pharmaceutical enterprises to focus on drug R&D, quality improvement, and R&D innovation. Lv. et al. (2012) suggested that the Centralized Volume-Based Drug Procurement policy can expand the scale advantages of Huahai Pharmaceuticals, thereby promoting its enthusiasm for R&D. Li et al. (2022) pointed out that the Centralized Volume-Based Drug Procurement policy can regulate competition in the pharmaceutical procurement market, enhance the operational efficiency of the pharmaceutical supply chain, and promote a new pattern of high-quality development in pharmaceutical procurement that benefits all parties, based on their study of the policy's operational problems and optimization.

The main method used for productivity measurement is data envelopment analysis (DEA), which was introduced in 1978 by operations researchers Charnes et al. Lacko et al. (2022) used the DEA and the Malmquist Productivity Index (MPI) to compare the efficiency and productivity of healthcare systems across EU states. Their findings indicated stagnation in Western countries and a decline in productivity in Central and Eastern European countries. Chai et al. (2021) similarly used the DEA and Malmquist productivity index techniques to analyze

productivity and efficiency performance, explored the impact of China's new round of healthcare reforms in 2009 on the performance of the health system, specifically assessing the productivity and efficiency of health production before and after the reforms, and the results of the study suggest that by strengthening financial security, optimizing the allocation of health resources, especially between human resources for health and hospital beds, and expanding the health sector with cost-effective technologies can improve efficiency and productivity.

Currently, most scholars use the Data Envelopment Analysis (DEA) model to study scale efficiency and total factor productivity in the pharmaceutical manufacturing industry. Zhang et al. (2019) studied the R&D contribution of listed pharmaceutical enterprises in Southwest China using the DEA model, finding that R&D investment significantly increases the operational efficiency of these enterprises and is positively correlated with their overall efficiency. Li and Meng (2022) based on the data envelopment analysis of slack variables (DEA-SBM) model to evaluate the technological innovation efficiency of the pharmaceutical manufacturing industry in 28 provinces in China obtained that the overall comprehensive innovation efficiency of the pharmaceutical manufacturing industry under the role of the government incentive policy is at a relatively low level, and the efficiency of technological research and development (R&D) is higher than the efficiency of the transformation of results, and the government incentive policy can improve the efficiency of technological R&D in a better way.

3.6.3 Research related to the impact of the Centralized Volume-Based Drug Procurement policy on corporate innovation

The Organization for Economic Co-operation and Development (OECD) categorizes innovation into technological and non-technological innovation. This study focuses on technological innovation—specifically, the technological advancements and product innovations enterprises achieve through R&D. As a key driver of sustainable corporate development, technological innovation capability profoundly impacts long-term competitiveness. Under the Centralized Volume-Based Drug Procurement policy, the pharmaceutical manufacturing sector’s innovation ecosystem may undergo structural adjustments. On one hand, this policy may prompt winning bidders to prioritize mass production and cost control, potentially weakening their R&D investment through a “price-for-volume” strategy. On the other hand, non-winning bidders, facing shrinking market share and limited profitability in generic drug operations, may shift from their previous reliance on sales promotion to increased investment in R&D. This could drive individual companies and the

entire industry toward innovation-driven transformation.

Based on data from a sample of A-share listed pharmaceutical companies in Shanghai and Shenzhen from 2015 to 2021, Gu and Zhuang (2023), using the double-difference method and a series of robustness tests, found that the Centralized Volume-Based Drug Procurement policy significantly contributed to the increase in the intensity of innovation investment in China's pharmaceutical industry. The study by Hu et al. (2021) investigated the impact of the Centralized Volume-Based Drug Procurement policy on pharmaceutical firms' innovation. Combining event studies and double-difference methods, the study found that the abnormal return (the abnormal return, AR) of firms with high R&D intensity was lower than that of firms with low R&D intensity during the event window, and the results indicated that the "4+7" procurement policy was introduced The results suggest that the negative impact of high R&D intensity on AR during the "4+7" procurement policy is stronger among large and innovative pharmaceutical companies.

Many scholars who measure the innovation ability of enterprises in the existing studies at home and abroad. Li and Meng (2022), by analyzing the technological innovation efficiency of China's pharmaceutical manufacturing industry across 28 provinces, pointed out that the improvement of technological R&D efficiency can be achieved through government incentive policies, and that government capital investment is less effective in enhancing the technological R&D efficiency in the eastern and central parts of the country. Zhang et al. (2023), by studying the relationship between executives from a pharmaceutical background and R&D investment and corporate innovation, they pointed out that executives with a pharmaceutical background help to increase the company's R&D investment, which in turn improves the R&D performance and enhances the innovation competitiveness of pharmaceutical companies. Xia et al. (2023) assessed that receiving inputs from innovation subsidies has a contributing effect on the quality of innovation of the firms through the study of the classification of patent applications.

3.6.4 Research related to the impact of Centralized Volume-Based Drug Procurement policy on enterprise costs

The cost structure of the pharmaceutical industry differs significantly from that of other sectors, with production costs accounting for a relatively low share of total expenses, while expenditures on market promotion, sales, and distribution channels are notably substantial. Consequently, many domestic and international scholars analyzing the impact of centralized procurement policies on pharmaceutical manufacturers' performance often focus on cost control and savings.

At the inter-country level, foreign scholars have examined the impact of procurement

mechanisms on firms. Seidman and Atun (2017) analysed the cost savings achieved through pooled procurement mechanisms at various levels, including local, national, and inter-country levels. Huff-Rousselle (2012) described the broader effects of pooled procurement mechanisms at inter-country and global levels, noting benefits such as cost savings, quality improvements, reduced corruption, more efficient procurement processes, and increased access to medicines.

Many scholars at home and abroad have analysed the role of Centralized Volume-Based Drug Procurement policy in reducing costs for pharmaceutical manufacturing enterprises. Zhang et al. (2020) explored the implications of this policy based on transaction cost theory, pointing out that it directly reduces costs related to searching, negotiating, and contracting, and indirectly lowers the selling price of medicines. Jiang et al. (2021) analysed the role of the Centralized Volume-Based Drug Procurement policy in reducing transaction costs through the lens of Coase's theorem. They suggested that bulk purchasing is specifically designed to minimize transaction costs. Through their study, Zhao (2018) found that the emergence of the centralized purchasing model for drugs reduced pharmaceutical companies' costs in academic promotion and sales, thereby significantly mitigating the impact of price reductions on profits. Li and Bai (2019), on the other hand, reducing high sales costs and expenses can trigger a chain reaction, leading to further reductions in drug prices.

3.7 Research methodology on the impact of centralized volume-based drug procurement policy on the performance of pharmaceutical corporations

In the pharmaceutical industry, numerous studies on corporate performance have been conducted, which can be broadly categorized into three types: Data Envelopment Analysis (DEA), Difference-in-Differences (DID) approach, and Regression Analysis (RA).

3.7.1 DEA methodology

Data Envelopment Analysis (DEA) is a method used to evaluate organizational efficiency by assessing the relative efficiency of Decision-Making Units (DMUs) in the production process through a linear programming model (Banker et al., 1989). DEA is widely employed to assess the efficiency of nonprofit organizations, government agencies, educational institutions, healthcare providers, and others. It assists managers and decision-makers in evaluating and improving organizational efficiency and optimizing resource utilization.

The DEA approach is widely used in corporate performance studies. Pentrakan et al. (2022)

analysed the performance of 37 listed companies in the pharmaceutical manufacturing industry using a DEA-Tobit model, based on panel data from 2002 to 2009, and found that technological changes were the primary driver of aggregate productivity growth. Ding (2021) evaluated the technological efficiency of China's pharmaceutical manufacturing industry in 2010 using the DEA methodology and concluded that external R&D expenditures, experimental funds, and the number of patent applications were the two most important influencing factors.

3.7.2 Difference-in-Differences method

The Difference-in-Differences (DID) method, also known as the double-difference method, is used to assess the effects of public policies. In the 1970s, economists began using this method to evaluate policy impacts. The classic DID approach estimates policy effects by comparing changes in treatment and control groups before and after policy implementation. During the 1980s and 1990s, the DID method became widely used in labor economics, public policy, and health economics.

Over time, researchers have recognized that the impacts of many policies are not limited to a single point in time before and after policy implementation, but must be assessed over a longer period. This realization led to the development of multi-period DID models. The most significant difference between the multi-period DID method and the traditional DID method is that in the traditional DID model, the treatment groups experience the policy shock at a single, unique time point, whereas in the multi-period DID model, there are multiple time points of policy shocks. Additionally, compared to the classical DID model, the multi-period DID model is more complex, requiring consideration of both individual and time fixed effects, and handling more data and variables.

The DID method has been widely used to study policy effects before and after implementation because it can address time-invariant variables through differencing. This approach allows for the estimation of causality by comparing naturally occurring control groups with their own time trends. The foundational work of scholars such as Heckman established the main structure and areas of application for the model, particularly in estimating the effects of social policy implementation (Heckman & Robb, 1985, 1986).

Compared to the traditional DID model, the multi-period DID model enablesanalysis across different time horizons, making it suitable for more complex policy evaluations. Lu and co-authors used this model to analyze changes in medicine utilization within Chinese public healthcare institutions under China's "4+7" centralized drug procurement policy. The study found that during the 1-year procurement period, healthcare providers showed strong

compliance with the "4+7" policy, fulfilling contracted procurement volumes. Moreover, the policy promoted the gradual concentration of drug consumption on winning drugs, generic drugs, and ensured drug quality (Lu et al., 2022). Hua et al. (2022) examined whether the profitability of Chinese pharmaceutical companies improved after participating in centralized procurement, using a multi-period DID model. These studies demonstrate that the multi-period DID model, grounded in real-world data analysis, provides insights into the impacts of each policy across different sectors, laying the foundation for more targeted and effective management, and the optimization and improvement of future policies.

3.7.3 Regression analysis

Regression analysis is a statistical methods that describes the relationship between variables by reducing a complex data set to a few key statistics (regression coefficients) and building a quantitative model to describe that relationship. Regression analysis is applied to a variety of data sets to predict and analyze relationships between variables (Fisher, 1992)

Due to its reliance on data, predictability, flexibility, and objectivity, regression analysis can establish mathematical models to assess corporate performance, enhancing the accuracy of assessments, providing a scientific and systematic approach for corporate performance evaluation, and serving as a foundation for corporate decision-making. Ke et al. (2024) employed baseline regression and other methods to evaluate the impact of centralized purchasing on listed pharmaceutical enterprises in China. The results reveal that the policy currently has a negative impact on the sample firms, primarily reflected in declining corporate profits, reduced investor expectations for future profits, and falling stock prices. Similarly, Sun et al. (2023) used China's CVBDP policy as a quasi-natural experiment to evaluate the impact of policy participation on the financial performance of pharmaceutical firms, employing a double-difference model and regression analysis. Zhang et al. (2022) conducted an empirical study using descriptive statistics and regression analysis to examine the impact of the CVBDP policy on the innovation performance of China's pharmaceutical manufacturing industry, drawing on panel data on listed pharmaceutical manufacturing companies in Shanghai and Shenzhen A-shares between 2016 and 2020.

3.7.4 Comparison of research methods

The DEA method is suitable for assessing the relative efficiency of enterprises by constructing a linear programming model. While it is effective for evaluating production efficiency, it

struggles with time-varying effects and causal inference when assessing policy effects. The DID method effectively assesses the causal effects of policies, with the multi-period DID model handling complex policy assessments. However, it requires adherence to the strict parallel trend assumption and demands high-quality data. Regression analysis is flexible, simple, and applicable to various datasets, providing predictive results. However, it must address concerns such as linearity assumptions, omitted variable bias, and endogeneity issues.

The research in this thesis focuses on the impact of CVBDP policy on the performance of pharmaceutical corporations. Since the pilot and development phases have different timelines, leading to inconsistent policy-shock timings, the multi-period DID method is employed to ensure robust conclusions. The multi-period DID model accommodates policy shocks at different times for different individuals, effectively controlling individual and time fixed effects, thus accurately assessing the causal effects of the policy and avoiding the problem of parallel trend assumption bias that may exist in the traditional DID method.

In addition, as this study needs to explore how much influence CVBDP policy has relative to other influencing factors, regression analysis methods can then be used as a base model to provide an overall description and prediction of the relationship. Because of its broad applicability and simplicity, regression analysis can flexibly handle different types of independent and dependent variables, build quantitative models to assess enterprise performance, and provide objective and systematic analysis results for policy effects.

In summary, this thesis will combine the methods of the multi-period double difference method and regression analysis to systematically study the impact of CVBDP policy on the performance of pharmaceutical corporations. The multi-period DID model ensures the rigor of causal inference and the robustness of the results, while the regression analysis provides strong support for the overall relational description and prediction of corporate performance. By combining these two methods, this thesis aims to provide an in-depth analysis of the actual effects of the CVBDP policy, offering a scientific basis for policy formulation and corporate decision-making

Chapter 4: Research Hypotheses and Conceptual Model

Based on the previous literature review, this chapter analyses the impact of CVBDP on pharmaceutical company performance and the hypothesised impact mechanism, drawing on economies of scale, Institutional theory, and Contingency theory. In addition, based on Contingency theory, it explores the company's performance and its influencing factors, as well as the measurement indices of the variables. It defines and selects the relevant index to illustrate the concept. Finally, the specific ideas of the multi-period double difference model are introduced in the context of this study, and the theoretical model of data processing applicable to the empirical analysis of this thesis is constructed.

4.1 Research hypothesis

4.1.1 The impact of CVBDP on the pharmaceutical company's performance

CVBDP relies on the principle of inverse variation in price and output, as well as the law of diminishing marginal cost, to achieve economies of scale. Assuming the prices of production factors remain stable, the cost per unit of output tends to decrease as production expands. Marx (1885) further pointed out that the greater the scale of advanced capital, the higher the overall efficiency of the production system, thereby providing more robust momentum for the process of expanded reproduction. In other words, the market share held by a firm affects the scale of production, and the larger the market share held, the greater the incentive for the firm to expand its production scale (Krugman, 1980).

The mechanism of CVBDP is based on the law of diminishing marginal cost, and the CVBDP strategy, by aggregating fragmented demand and forming large-scale orders, incentivises companies to adopt the approach of "quantity price". Specifically, public healthcare institutions, with their significant and apparent purchasing demand, motivate the selected companies to take advantage of the cost benefits brought by diminishing marginal costs, and return to consumers through price reductions, thus realising a win-win situation for both the pharmaceutical companies and the patients.

CVBDP sets clear procurement cycles and quantities for drug manufacturers, which not only helps the selected companies to quickly share the high fixed costs of research and

development, equipment and plants, but also, due to the clarity of the purchasing volume and supply time, prompts the companies to formulate a more scientific production plan and build an intelligent inventory management system, thereby minimising the unit cost of storing and distributing the medicines and enhancing the company's economic benefits (He et al., 2020).

The centralized volume-based procurement mechanism effectively eliminates barriers in the distribution chain by integrating and standardizing procurement processes, thereby significantly reducing costs and related financial expenditures incurred during product circulation and market transactions. This model achieves seamless efficiency across the entire chain—from bidding and procurement to supply, utilization, and payment settlement. Winning bidders can directly contract with medical institutions based on predetermined prices and procurement volumes, eliminating additional marketing expenses. Consequently, this policy substantially compresses intermediate distribution channels and lowers overall circulation and transaction costs. At the same time, the model sets a clear timeframe for the payback of drug prices, ensuring a stable payback period, thereby effectively reducing financial pressure on the selected companies.

Institutional theory suggests that organisations and management practices are the product of social rather than economic pressures; that is, organisations' behavioural decisions are not entirely based on rational choices but are influenced by external institutional pressures. As a significant institutional change in the external environment of companies, the impact of the CVBDP policy on company performance will also be manifested through three kinds of institutional pressures: coercive pressure, imitative pressure, and normative pressure (DiMaggio & Powell, 1983).

Compulsory pressure originates from laws, regulations, and policy provisions promulgated by the government, which directly affect companies' decision-making processes. Under the CVBDP policy for medicines, the government mandates the selected companies to adjust to the new standards by setting procurement rules, price limits, and other conditions. This pressure compels companies to reassess their production costs, pricing strategies, and market positioning to adapt to the policy requirements. In the short term, this may result in compressed profit margins and even survival difficulties for some companies. However, in the long run, the coercive pressure also prompts companies to strengthen internal management and improve production efficiency, thereby gaining a competitive advantage in the new market environment, which, in turn, positively impacts company performance.

Imitation pressure arises from firms' perception of the behaviour of other organisations or competitors in the industry. After the implementation of the CVBDP policy for medicines, some

firms may successfully respond to the challenge by innovating strategies and optimising processes, and achieve good market performance. At this point, other firms tend to observe these success stories and become motivated to imitate them. Imitational behaviour can spread quickly across the industry, creating a trend that drives the industry towards greater efficiency and quality. However, imitation can also lead firms to overlook their own characteristics and market environment and to follow trends blindly, making decisions that are detrimental to performance.

Finally, normative pressure comes from the normative rules defined and disseminated by professional associations, as well as from external scrutiny triggered by public opinion and news media coverage. In the pharmaceutical industry, professional associations and the public have incredibly high expectations and demands regarding the quality, price, and stability of the medicine supply. The implementation of the CVBDP policy for medicines has further strengthened these expectations and needs. To meet these prescriptive requirements, companies have had to invest more resources in improving product quality, optimising service processes, and enhancing communication with the community. While these efforts may increase a company’s operating costs, they also help enhance the company’s reputation and brand image, as well as consumers’ trust and loyalty. Trust and loyalty are the cornerstones of long-term business development, profoundly impacting company performance.

Based on the above analysis, the first research hypothesis of this study is proposed:

H_1: The CVBDP policy has a positive impact on the pharmaceutical company’s performance.

4.1.2 The impact of CVBDP of medicines on market orientation

Market orientation is widely recognised as a key driver for enhancing company performance (Kohli & Jaworski, 1990). The pharmaceutical industry is characterised by high capital investment, significant risks, long development cycles, knowledge intensity, and stringent regulations. These inherent traits make a market-oriented strategy particularly critical.

The CVBDP policy for pharmaceuticals transforms previously fragmented and uncertain market demand into concentrated, predictable, planned purchases. The primary purchasers of drugs shift from dispersed hospitals, physicians, and patients to a single super-purchasing entity wielding absolute bargaining power (Wang et al., 2023). For pharmaceutical companies, the winning bidder's medicine sales volume is more reliably guaranteed, and they no longer need to invest as many resources in marketing as before to compete for uncertain market share (Ke et al., 2024b). This has led enterprises to gradually shift their strategic focus from the traditional

market orientation centered on customer needs toward a “policy orientation” and “cost orientation” approach centered on policy compliance and cost control.

The CVBDP policy emphasises quality and price as the principal competitive factors, rather than marketing efforts. In the past, companies built differentiated advantages through various means, such as brand reputation, academic promotion, channel coverage, and customer service (Greenslit, 2007). With the implementation of the CVBDP policy, the significance of these factors has been dramatically diminished. Zhao (2018) found that the emergence of a CVBDP model for medicines reduced the costs of pharmaceutical companies in terms of academic promotion and sales, thus significantly reducing the impact of price reductions on profits. Quotations have become the decisive factor in whether a company can gain market access. As the purchasing entity, the government’s core requirement is for standardized, cost-effective pharmaceuticals (Liu, 2024). Whether a drug wins a bid depends primarily on passing the consistency evaluation and offering sufficiently low pricing. This makes companies focus more on product quality improvement and cost control, rather than relying solely on high promotional expenses to open the market.

Therefore, the CVBDP policy for pharmaceuticals systematically guides the strategic behavior of pharmaceutical companies, causing them to deviate from traditional market-oriented approaches at multiple levels. This enables them to focus more intently on enhancing production quality and strengthening cost control, thereby positively impacting the pharmaceutical company’s performance.

Based on the above analysis, the second research hypothesis of this study is:

H_2: The CVBDP policy will weaken the market orientation of pharmaceutical companies.

For pharmaceutical companies, an excessive market orientation manifests as overreliance on marketing and promotion, prioritizing short-term sales growth while neglecting long-term R&D investment (Majeed et al., 2022).

The imbalanced investment structure serves as the most direct evidence of an “excessively market-oriented” approach, with pharmaceutical companies directing limited resources toward activities that yield rapid sales returns. However, the relationship between selling expenses and performance is not linear and straightforward, and over-investment may lead to diminishing marginal effects (Schoukroun-Barnes et al., 2018). Bao (2014) applied a quantitative statistical analysis method to empirically study the impact of advertising expenses on profits of pharmaceutical companies and found that there is an inverted U-shaped trend between the two, indicating an inflection point of the impact coefficient. The impact of selling expenses on profits exhibits an increasing trend prior to the point. At this point, when selling expenses exceed, the

impact of selling expenses on profits is reduced; therefore, reasonable selling expenses are the best solution for companies to achieve performance maximisation. Wang et al. (2023) also argued that it is essential to develop plans to rationalise the allocation of sales staff and cost expenditures to ensure that companies can achieve better benefits. However, China's pharmaceutical industry is characterised by a "heavy marketing, light research and development" phenomenon. Data indicate that in 2021, 30 A-share listed companies in the pharmaceutical manufacturing industry generated sales that accounted for more than 30 percent of the 137 (Ren et al., 2023). Excessive sales expense ratios have clearly hurt the company's performance. Huang et al. (2018) used annual data from listed manufacturing companies in Shanghai and Shenzhen from 2007 to 2015 to empirically test the impact of marketing effects on company performance. They found that the current year's sales expense ratio was significantly negatively correlated with the financial company's performance in the current year, and that the previous period's sales expense ratio had no impact on the company's performance in the current year. Yan (2019) also found that there is a significant negative correlation between China's sales expense ratio and company financial performance, and showed that, under the premise of constant control variables, a 1% increase in the sales expense ratio will result in a 0.27% decrease in the corresponding return on equity.

An excessively market-oriented approach tends to be more cautious toward long-term, high-risk R&D activities that are crucial to a company's future. This can erode a company's capacity for innovation and undermine the sustainability of its performance (Christensen & Bower, 1996). Ren et al. (2023) use Hengrui Medicine and Harbin Pharmaceutical Co. as two typical companies to illustrate the differences in risk-resistant ability and performance sustainability between the two companies under different marketing and R&D strategies. They found that although Harbin Pharmaceutical Co. relies on increasing sales expenses to improve its performance in the early stage, due to the high sales expenses crowding out R&D inputs, it is not sufficiently innovative in the mid- and late stages and lacks high-value-added new products. The gross profit margin and net profit margin are significantly lower than the industry average, and the operating income has declined after a short period of increase, which seriously restricts the development of Harbin Pharmaceutical Group's performance.

An excessively market-oriented approach leads to an irrational investment structure, resulting in the wasteful allocation of corporate resources and undermining the company's competitiveness and long-term performance.

Based on the above analyses, the third hypothesis of this study is:

H_3: An excessive market orientation in pharmaceutical companies has a negative impact on

the pharmaceutical company’s performance.

4.1.3 Impact of CVBDP on R&D orientation

The Organisation for Economic Co-operation and Development (OECD) divides innovation into technological innovation and non-technological innovation. The innovation discussed in this research is technological innovation, which companies can achieve through technology research and development.

Scholars have reached inconsistent conclusions regarding the impact of CVBDP on R&D orientation. Some argue that the CVBDP policy has drastically reduced drug prices, negatively impacting the profitability of pharmaceutical companies. The R&D costs of innovative drugs are enormous, so companies usually take cost-saving measures and reduce their R&D expenditures (Wang et al., 2019; Xu & Liao, 2022; Zhao et al., 2022). Other scholars believe that the CVBDP policy contributes to rational competition in the pharmaceutical industry (Golec & Vernon, 2008). Faced with the challenges of sustainable business operations and cost control, companies will pay more attention to R&D and take the initiative to transform into innovative technology-based companies (Li & Shen, 2020). The main reason for this discrepancy lies in uncertainty about whether firms’ profits can cover R&D expenditures. Lowering the price of the winning drug directly affects future profits and thus affects their future development strategies and R&D investments.

Although existing research has debated whether the CVBDP policy promotes corporate R&D investment, most studies examine only the direct effects of the policy on R&D expenditures and lack systematic verification of the mechanism by which enterprises transform their strategic orientation.

Therefore, this study theoretically positions R&D orientation as a mediating variable within a “policy-strategic transformation-performance” analytical framework, revealing that the CVBDP policy not only impacts the ‘quantity’ of R&D investment but also drives a “qualitative shift” in corporate strategy. Methodologically, we employ a combined empirical strategy of multi-period DID and mediation effects models to rigorously identify the causal pathway of policy effects on R&D orientation.

This study argues that volume-based procurement significantly reduces drug prices, compressing corporate profit margins. Under these conditions, enterprises must increase R&D investment to develop new products or enhance the quality of existing product to maintain competitiveness. Winning bidders gain substantial market share through volume-based procurement, thereby providing greater resources for R&D. Non-winning firms experience

widespread declines in market share, with profit margins from generic drug production and sales narrowing. Consequently, pharmaceutical companies may shift from market-driven to R&D-driven strategies, thereby fostering innovation within the industry.

Based on the above analyses, the fourth hypothesis is:

H_4: The CVBDP policy for medicines will strengthen the R&D orientation of pharmaceutical companies.

In today's highly competitive pharmaceutical market, R&D investment has become a key factor for pharmaceutical companies in enhancing their core competitiveness and achieving sustainable development. Numerous studies have shown that a strong R&D orientation in pharmaceutical companies significantly improves their performance.

At a theoretical level, R&D orientation can bring technological progress and product innovation to companies. By increasing R&D investment, pharmaceutical companies can develop new drugs that are more efficacious and safer, thereby meeting the unmet medical needs, expanding market share, and increasing sales revenue. Cao and Yi (2017) found that R&D investment is significantly positively correlated with performance, and that appropriate R&D investment can improve the financial performance of a company, but this effect is lagged. This suggests that current R&D investments by pharmaceutical companies, while they may not immediately translate into economic benefits, can provide sustained revenue growth over the long term.

R&D orientation helps improve production efficiency and operational management of companies. In the R&D process, companies not only focus on product innovation, but also optimise the production process, quality control, and other aspects. This helps reduce production costs and improve product quality, which in turn enhances companies' market competitiveness. For example, Ben (2017)'s research shows that lag two R&D expenditure investment has a significant positive effect on company performance. This suggests that pharmaceutical companies' initial R&D investment, after a specific period of accumulation and precipitation, can be transformed into economic benefits and enhance the overall company performance in the subsequent stages by optimising the production process and improving production efficiency.

In addition, government subsidies have, to a certain extent, promoted pharmaceutical companies' R&D investment and improve their performance. By providing R&D financial support, tax incentives, and other policies, the government reduces the R&D costs and risks of companies and incentivises them to increase R&D investment. As Yang et al. (2022) point out that government subsidies can promote companies to increase R&D investment, and the

continuity of government subsidies has a positive moderating effect on R&D investment and company performance. This suggests that continued government support can create a favourable R&D environment for firms to focus more on R&D activities, thereby promoting technological innovation and performance improvement.

Based on the above analyses, the fifth hypothesis of this study is:

H_5: A strong R&D orientation in pharmaceutical companies has a positive impact on their performance.

4.2 The conceptual model

This figure (Figure 4.1) summarises the conceptual model of this research. It illustrates the proposed mechanism through which the Centralized Volume-Based Drug Procurement (CVBDP) policy impacts pharmaceutical company performance. The study posits that the CVBDP policy serves as an exogenous shock, which directly influences company performance (H1). Furthermore, it operates through two key mediating pathways: by weakening firms' Market Orientation (H2) and by strengthening their R&D Orientation (H4). The model also hypothesizes the subsequent impacts of these strategic orientations on performance, suggesting that a high Market Orientation negatively affects performance (H3), whereas a strong R&D Orientation has a positive effect (H5). Thus, the model visually represents the chain of effects from policy implementation to ultimate performance outcomes via internal strategic shifts.

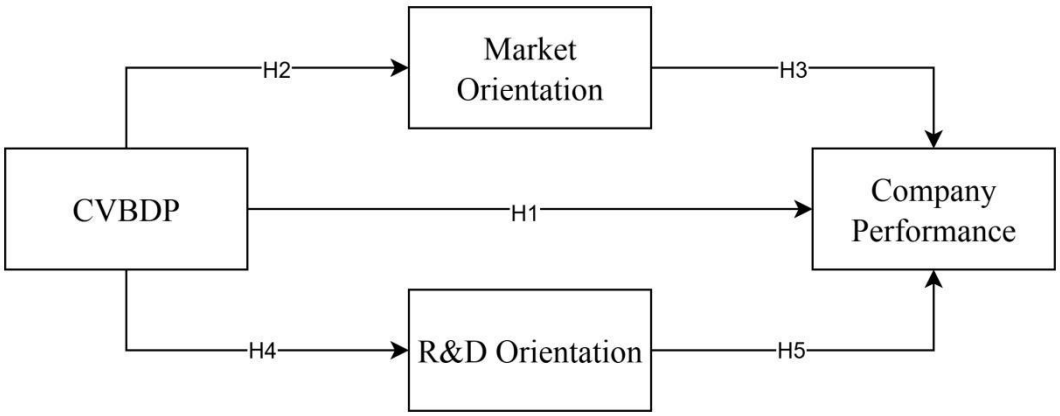


Figure 4.1 The conceptual model

Chapter 5: Research Design

This chapter describes the research design of this study, including the measurement and description of indicators, as well as data collection and processing methods. Specifically, this chapter clarifies the selection criteria and measurement methods for the dependent, independent, mediating, and control variables used in the study. It details the data sources, sample screening process, and final sample composition. Furthermore, it elaborates on the theoretical foundations, model specification, and testing procedures for the multi-period difference-in-differences model, propensity score matching, and mediation effect model employed in the research, laying the methodological groundwork for subsequent empirical analysis.

5.1 Measurement indicators and description

Dependent variables. To address overly simplistic performance evaluation metrics in contemporary enterprises, a highly adaptive performance appraisal system should be developed based on contingency theory. Contingency theory emphasizes that in dynamic and complex environments, there are no universally applicable, and static management control methods or evaluation standards. Therefore, only by adopting a composite indicator system can the management requirement of “varying according to the situation” be achieved. A composite system refers to the comprehensive use of multiple indicators to measure and evaluate corporate performance. Its characteristics are reflected in its coverage of both financial and non-financial indicators, thereby forming a multidimensional evaluation framework. From the perspective of the relationship between company development and changes in the social environment, the Contingency theory’s indicator system comprises two types: long-term and short-term performance indicators.

This study integrates the approaches of Cheng (2004) and Mei (2019) with ROA tending to reflect a company's short-term performance, while Tobin's Q may be more inclined to measure long-term performance relative to ROA. Therefore, ROA is primarily used as the core indicator in the analysis, but Tobin's Q is also used for supplementary verification during the basic testing phase, serving as a replacement for return on assets (ROA).

In summary, this study primarily uses ROA as the sole financial indicator, with Tobin's Q serving only as an auxiliary verification tool.

(1) Net rate of return on total assets (ROA)

The Return on Assets (ROA) method is often used as a proxy for a company's financial performance. ROA is the ratio of a company's net profit to its assets over a given period, reflecting the ability and effectiveness of the company's assets to generate net income. It is calculated using the following formula:

$$\textbf{ROA=Net profit/Total assets} \quad (5.1)$$

ROA reflects the company's ability to utilise all its assets to generate profit and is an indicator of the overall effectiveness of the company's asset use; the higher the ratio, the better the use of the company's assets.

(2) Tobin Q

In the field of research on company performance measures, Tobin's Q is among the most widely used indicators for evaluating a company's value. It is calculated as the ratio of the company's market value (including liabilities and stock) to its replacement cost. However, in practice, obtaining accurate replacement cost data is difficult, so the book value of assets is often used as a substitute. The unique value of the Tobin Q metric is that it effectively compensates for the shortcomings of relying on a single market or financial data to measure company performance. It has become a widely accepted key tool among academics and practitioners for measuring company performance, thanks to its comprehensive assessment characteristics.

The expression is as follows:

$$\textbf{Tobin Q=(MVE+PS+DEBT)/TA} \quad (5.2)$$

MVE represents the market value of outstanding shares, PS denotes the value of preferred shares, DEBT corresponds to the net liability value, and TA represents the book value of total assets.

If Tobin Q is greater than 1, it indicates that the market believes the company will be able to create more value in the future than the replacement cost of its assets; i.e., the market has a high expectation of its future profitability, which to some extent reflects good company performance.

Mediating variables. The mediating variables of the study are mainly chosen to measure the sales expense ratio and the R&D expense ratio indicators, which are analysed around the company's R&D and sales expenses. The sales expense ratio represents the proportion of sales expenses relative to total operating revenue and directly measures the efficiency of the resources invested to generate sales. A higher ratio indicates greater expenditure on market development and maintenance; conversely, a lower ratio may suggest an efficient sales model or a stable

market position. The research and development expense ratio represents the proportion of R&D expenditure relative to total operating revenue, reflecting an enterprise's emphasis on technological innovation and future product competitiveness. A higher ratio indicates the company's commitment to technology-driven long-term growth; conversely, a lower ratio may suggest greater reliance on existing technologies or business models.

Independent variables. The explanatory variables in this research primarily consist of the group dummy variable Treat and the time dummy variable Post. Specifically, Treat is divided into an intervention group (Treat=1) and a control group (Treat=0). The intervention group (Treat=1) comprises enterprises designated as winning bidders under the Centralized Volume-Based Drug Procurement (CVBDP) policy for pharmaceuticals, while the control group (Treat=0) consists of non-winning enterprises. Post represents the implementation status of the CVBDP. All non-winning enterprises are assigned to the control group (Post=0). For winning enterprises, they are further divided into two subgroups based on the timing of their winning bid: quarters before the winning are coded as Post=0, and quarters after the winning are coded as Post=1. The final explanatory variable is formulated as did = $Treat_i$ * $Post_t$.

Table 5.1 summarizes the dependent, independent, and mediating variables selected for this research.

Table 5.1 Description of selected dependent, independent, and mediating variables

Variable Classification	Variable Name	Indicator Name	Indicator Symbol	Indicator Description
Dependent variables	-	Tobin Q	tobinq	The ratio of a company's market value to the replacement cost of its assets, which is used to measure a company's performance or its growth, and reflects the market's expectation of its future profitability.
	earning capacity	Net profit margin on total assets	roa	Reflects the company's ability to use all assets to generate profits, a measure of the effectiveness of asset use. The higher the ratio, the greater the effectiveness of asset use.
Independent variables	dummy variable	Grouping dummy variable	Treat	Companies that win the Centralized Volume-Based Drug Procurement of medicines are set up in the intervention group (Treat=1), and those that have not won the bid are set up in the control group (Treat=0).
		Time dummy variable	Post	On behalf of the implementation of the centralised band purchasing

Variable Classification	Variable Name	Indicator Name	Indicator Symbol	Indicator Description
				policy for medicines, companies that have never won the bid are set as the control group (Post=0); winning companies are divided according to the time of winning the bid, with Post=0 for the quarter before winning the bid and Post=1 for the quarter after winning the bid.
		Interaction term	$Treat_i*Post_t$	The final explanatory variable used to analyse whether there is an interaction between the grouping dummy variable and the time dummy variable.
Mediating variables	sales	sales expense ratio	sales_ratio	The ratio of selling expenses to operating revenues, which reflects the proportion of costs spent by the company in the sales process to revenues, can be used to analyse the cost-effectiveness of the company's sales strategy.
	research and development (R&D)	R&D expense ratio	RD_ratio	R&D expenses as a percentage of operating revenue, which measure the company's investment in R&D and reflect its emphasis on innovation and future development.

Control variables. The selection of control variables in this study is made in strict accordance with the principle of systematicity, based on the analysis framework of factors influencing company performance, which was constructed on the basis of the Contingency theory. Specifically, drawing on the theoretical basis of the three dimensions of external influences, internal influences, and leader incentive structure, we further consider the representativeness of indicators, data availability, and the orthogonality between variables, as well as other empirical requirements, and finally determine the following system of control variables. This screening process not only ensures the completeness of the theoretical logic but also meets the strict data-quality requirements of the econometric model, thereby laying a robust foundation for the subsequent causal inference.

The variable chosen for external factors is “environmental uncertainty”, which mainly considers the impact of epidemics on the company’s performance. A dummy variable is created for this indicator, taking the value 1 if the company is in an epidemic and 0 otherwise, reflecting the impact of outbreaks on the company’s business environment.

The selection of internal influencing factors encompasses organisational structure,

company governance, firm-specific characteristics, organisational resources, solvency, and operational capacity, comprising a total of six variable types. The organisational structure is chiefly measured by indicators such as the percentage of independent directors, the status of two positions, the proportion of shares held by the largest shareholder, and the sum of proportions held by the top ten shareholders. The variable of company governance is measured by two indicators: the nature of shareholding and the degree of foreign investor dominance. The firm's own characteristics are calculated using the indicator age-at-listing. The age-at-listing is a reliable indicator of a company's performance level, reflecting its development status and maturity. The consideration of organisational resources is measured by four indicators: total assets (size), number of employees (staffnumber), capital and technology intensity (rjzb), and Profit per Employee (profitpercapita). Solvency is measured by the gearing ratio, which is the ratio of total liabilities to total assets, reflecting the company's long-term solvency and its potential financial risk. Regarding operational capacity, the inventory turnover ratio is selected for analysis. This ratio indicates the cost of goods sold relative to an average inventory balance over a specified period, reflecting the efficiency of the company's inventory management and turnover. A higher indicator suggests a stronger inventory turnover capacity and sales capacity.

The remuneration factor is analysed primarily through the indicator of total annual remuneration of the supervisory level. This indicator accurately reflects the level of remuneration incentives provided by the Company to its supervisory staff. For the shareholding analysis, the indicator of the total number of directors holding shares in the Company was selected. Directors' shareholdings can influence the company's decision-making, potentially leading to a greater alignment with shareholders' interests.

Table 5.2 summarizes the control variables selected for this research.

Table 5.2 Description of control variables

Variable Name	Indicator Name	Indicator Symbol	Indicator Description
environmental uncertainty	Epidemic situation	covid19	Dummy variables can be set to 1 during the epidemic and 0 during the non-epidemic period to capture the outbreak's impact on the company's business environment.
organisation structure	Percentage of independent directors	indr	Number of independent directors/board size, reflecting the board's independence and ability to monitor checks and balances.
	Situation of double-hatting	concurren tposition	If a listed pharmaceutical company in which the chairman of the board of directors is also the general manager, the value is taken as 1; in other cases, the value is taken as 0, reflecting the characteristics of the company's governance structure.
	Shareholding	shrcr1	The number of shares held by the most important

Variable Name	Indicator Name	Indicator Symbol	Indicator Description
company governance	ratio of the largest shareholder		shareholder/number of ordinary shares, which measures the degree of equity concentration and influences company decision-making and governance.
	Sum of shareholdings of top ten shareholders	shrcr4	The sum of the shareholdings of the top ten shareholders/number of ordinary shares reflects the degree of shareholding concentration from another perspective.
	Nature of equity	equityture id	The private, state-owned, foreign, other, or different nature of equity affects the company's access to resources, decision-making mechanisms, etc.
	Foreign investor-led	qfiiholdproportion	Refers to the existence of a foreign shareholder holding as a percentage of the total number of shares, which affects the internationalisation and governance model of the company.
characteristics of the company itself	Listing age	age	Takes logarithms to measure the impact of listing length on company performance, reflecting the stage of firm development.
	Number of staff	staffnumber	Number of employees, reflecting the scale of manpower and operational capacity of the company.
organisational resources	Total asset turnover ratio	Total Asset Turnover	The ratio of operating income to average total assets, which comprehensively reflects the operating quality and utilisation efficiency of all the company's assets, the higher the ratio, the higher the operating efficiency of the company's assets.
	Capital (technology) intensity	rjzb	Capital per capita, in logarithms, indicates capital intensity, reflecting the level of technological equipment and the company's competitiveness.
	Per capita income generation	profitpercapita	Net profit/number of employees.
debt-servicing capacity	Asset-liability ratio	Debt-to-Asset Ratio	Total liabilities/total assets is a measure of a firm's long-term solvency and reflects its financial risk.
operational capability	Inventory turnover ratio	Inventory Turnover Ratio	Used to measure the turnover speed of the company's inventory, reflecting the efficiency of the company's inventory management and inventory occupied funds, the higher the turnover rate, indicating that the faster the turnover of inventory, the stronger the company's sales capacity.
emoluments	Total annual remuneration of regulators	sumsalary	Including the total annual remuneration of the Company's supervisory personnel, such as directors, supervisors, and senior management, reflecting the level of remuneration incentives provided by the Company to the supervisory personnel.
shareholding status	Total number of directors holding shares in the Company	directorholdsharesnum	Reflects company directors' shareholdings in the company, which may affect their decision-making behaviour and alignment with shareholders' interests.

5.2 Data collection

This study employs a quasi-natural experiment design, treating the implementation of the Centralized Volume-Based Drug Procurement policy as an exogenous shock. It examines the policy's impact on the operating performance of winning bidders among listed companies, thereby evaluating its effectiveness within the pharmaceutical manufacturing sector. Data are sourced from quarterly and annual financial reports of listed companies in the Cathay Pacific database. As of the fourth quarter of 2023, there were 495 listed companies in the pharmaceutical manufacturing sector. After screening out samples with less than six months of financial records, the final sample comprised 305 listed companies. The time span covered March 2015 to December 2023, forming a panel dataset spanning 36 quarters. Among these, 77 companies were successful bidders, while 228 were unsuccessful bidders or did not participate in the bidding. This dataset comprises key financial indicators (such as revenue, costs, and profits) alongside variables reflecting corporate characteristics (including registered capital and establishment date), yielding a final sample of 10,956 observations.

5.3 Method

To investigate the relationship between Centralized Volume-Based Drug Procurement and pharmaceutical companies' performance of , as well as the factors that influence it, this study uses a multi-period DID model, a PSM (Propensity Score Matching) model, and an intermediary effects model to conduct the empirical analysis.

(1) Multi-cycle DID model

The double difference method, also known as the difference-in-differences (DID) method, is a classic method of evaluating the net effect of policy implementation (Lu, 2022). It is primarily used to assess the impact of public policies. The core idea is to treat the "policy shock" as an exogenous intervention and construct a "quasi-natural experiment" framework to identify causal relationships. This involves dividing the research sample into treatment and control groups and comparing the difference in the trends in the outcome variables before and after policy implementation to estimate the policy's impact. The foundational work of Heckman and Robb (1985, 1986) established the model's primary structure and its application to evaluate the implementation effects of social public policies.

The "parallel trends assumption" is the core premise that ensures DID is unbiased and consistent. This assumption requires that the results of the treatment and control groups follow

the same time evolution path during periods when policies are not in effect. Only when this assumption is met can the difference between the groups after the policy is implemented be subtracted from the difference between the groups before the policy is implemented, and the result be reliably interpreted as the net effect of the policy (Zhou, 2025).

However, as time went on, researchers recognized that the impact of many policies extends beyond the time periods immediately before and after their implementation (Shen, 2025). This realization led to the development of DID methods, specifically multi-period DID models. The most significant difference between multi-period DID and traditional DID is that the treatment group sample in traditional DID has a single, unique policy impact time point. In contrast, the multi-period DID uses multiple time points for policy impact. Furthermore, multi-period DID models are more complex than classic DID models because they require consideration of individual and time fixed effects, enabling them to address more complex policy evaluation issues.

To assess the impact of the CVBDP policy on the operating performance of listed pharmaceutical manufacturers, this study employs a multi-period difference-in-differences model. By leveraging differences in the timing of companies' winning bids, the model divides the sample into a treatment group (winning bidders) and a control group (non-winning or non-participating firms). It identifies the net policy effect by comparing performance changes between these groups before and after policy implementation. Specifically, the model performs two successive differences: within groups (before and after policy implementation) and between groups (winning versus non-winning firms). This approach effectively controls for time trends and inherent group differences, enabling accurate estimation of the policy intervention's impact.

The underlying multiple DID model is:

$$\mathbf{Y_{it} = \alpha + \beta Treat_i \times Post_t + \varepsilon Control_{it} + \lambda_t + \gamma_i + \delta_{it}} \quad (5.3)$$

firms as the treatment group ($Post_t$=1). The explanatory variable of this thesis is the interaction term $Treat_i \times Post_t$, $Treat_i \times Post_t$=1 means that the listed company i is the winning company of Centralized Volume-Based Drug Procurement and is in the policy processor, i.e., the listed company is affected by the policy at this stage; otherwise, $Treat_i \times Post_t$=0. The coefficient of the interaction term is the focus of this research.

The model under consideration is a primary regression model, with Y_{it} as the dependent variable (ROA), namely, company performance. Return on Assets (ROA) and Tobin Q provide complementary perspectives on corporate performance. ROA, as an indicator of short-term operational efficiency, focuses on how effectively management utilises existing assets to

generate accounting profits in the current period, and is also the main observed dependent variable in this study. Tobin Q, meanwhile, reflects market expectations of a company's long-term growth potential and value-creation capabilities, reflecting investors' confidence in the firm's prospects (Puopolo, 2016). In this study, it is used as an alternative dependent variable to conduct a robustness check of the research results. α is the intercept term, $Control_{it}$ denotes the control variables employed, including environmental uncertainty, organisational structure, company governance, firms' own characteristics, organisational resources, solvency, operational capacity, remuneration, and shareholding. Additionally, δ_{it} denotes the error term, λ_t denotes the time fixed effect, and γ_i denotes the individual fixed effect.

(2) Propensity Matching Score Model PSM

Although the double difference method can effectively control for observable and unobservable time-invariant factors, the reliability of its estimated results may be challenged by systematic differences between the treatment and control groups before the policy (Bentivogli & Mirenda, 2017; Chen et al., 2025). To address this issue and strengthen the robustness of the DID model's conclusions, this study introduces propensity score matching (PSM) as an additional identification strategy (Worack, 2018).

Propensity score matching (PSM) is a standard method used in observational studies to reduce selection bias (Rosenbaum & Rubin, 1983). Its core concept is to construct a control group of companies as similar as possible to the treatment group in terms of pre-policy characteristics, thereby simulating random assignment and improving comparability between group. This method can effectively control for confounding factors in observational studies and provide a more accurate assessment of treatment effects. PSM is widely used in medicine, economics, and the social sciences, and is an essential tool for analysing non-random experimental data (Stuart, 2010). Its key assumption is the conditional independence assumption (CIA), which states that, after controlling for observable covariates, the treatment status and potential outcomes are independent.

Early matching methods encountered significant challenges in handling multiple covariates. In instances where multiple covariates were present, identifying matches with precise values for all covariates was challenging, and ensuring balance between groups was also tricky. Rosenbaum and Rubin (1983) introduced the concept and method of propensity score matching, thereby transforming the approach to matching. Propensity score matching (PSM) can reduce multidimensional covariates to a single scalar, thereby overcoming the issue of high-dimensional matching. Furthermore, it serves as a balancing score, ensuring that the covariates of the treatment and control groups converge post-matching. This revolutionary breakthrough

also established the foundation for subsequent research.

PSM has been increasingly applied over time, and specific optimisations have been made in matching algorithms and balance diagnostic criteria. In the optimisation of the matching algorithm, Rosenbaum and Rubin (1985) proposed a hybrid matching strategy (Mahalanobis within propensity score calipers) that combines Mahalanobis distance matching with propensity score to enhance the accuracy of covariate balance. The Coarse Exact Matching (CEM) approach, proposed by Iacus et al. (2012), involves the discretisation of the covariates, thereby simplifying the matching process and enhancing the capture of nonlinear relationships. Software such as Matchit and CEM automate PSM with balance optimisation, and machine learning methods such as Generalised Enhancement Model (GBM) and CART further enhance model flexibility, making PSM one of the mainstream tools. In terms of balance diagnostic criteria, Rubin (2001) proposed the threshold of standardised difference and variance ratio as quantitative indicators of matching quality. Meanwhile, the development of graphical diagnostic tools (e.g., mean-standardised difference plots) has also helped to assess the matching effect in a more intuitive way (Stuart, 2010). PSM has gradually become the core of the causal inference method.

Heckman et al. (1997) applied PSM to economic evaluation, thereby promoting its use in economic policy research. Song et al. (2022) utilised the PSM-DID model to analyse the impact of the Centralized Volume-Based Drug Procurement on the short-term and long-term performance of “winning” companies. The study showed the PSM-DID system exerted a substantial negative influence on the short-term performance of “winning” pharmaceutical companies and a significant positive influence on their long-term company performance. Concurrently, Marc Höglinger et al. (2022) assessed the impact of the Diabetes Disease Management Programme (DMP) on diabetic patients in a primary care setting in Switzerland. PSM and double differencing were also employed when assessing the impact of the Diabetes Disease Management Programme (DMP) on individuals with diabetes in a primary care setting, concluding that DM had a positive effect on the quality of diabetes care. These studies suggest that combining DID modelling and PSM methods can control for confounding factors in studies and more effectively assess the effects of economic policies.

In practice, the first step is to identify the key variables that may affect the allocation and outcome, calculate the probability that each individual receives a specific treatment, i.e. the propensity score, and then use the propensity score as the basis for equalising the distribution of confounders by matching accordingly, dividing the individuals into a treatment group (which receives specific treatments or interventions) and a control group (which does not receive

treatments or interventions), so that the two groups are on the key variables comparable on key variables.

In practice, to accurately evaluate the net effect of the procurement policy on pharmaceutical companies' performance, this study uses propensity score matching to mitigate potential systematic biases between the treatment and control groups. First, the key confounding covariates that influence the pharmaceutical companies' decision-making process and performance are identified and selected. These variables may include company size, profitability, research and development expenditure, and historical market performance. Then, the model estimates the probability that each company will enter the treatment group, i.e., the propensity score to select the appropriate matching algorithm. This algorithm selects the background characteristics of the control group most similar to those of the treatment group. Through multiple iterations, the optimal matching scheme is determined, balancing match quality and sample loss. After matching, a rigorous balancing test will be performed to ensure that the two groups have small standardized bias for all confounding variables, and t-test or chi-square test results show no significant statistical differences. This confirms that the matching effectively eliminates initial imbalances in observed characteristics, creating a more comparable "counterfactual" framework before policy implementation. Finally, we estimate DID on the matched sample to obtain a more robust estimate of the policy treatment effect.

(3) Mediation Effects Model

Based on the significant causal effect of Centralized Volume-Based Drug Procurement on enterprise performance, the study further constructs a mediation-effect model to reveal the mechanism of "policy shock – mediator variable – performance result." Mediation is defined as the indirect influence of the independent variable X on the dependent variable Y through the mediator variable M (Gennetian et al., 2002). It aims to verify whether X influences specific key M, which then indirectly affects Y. The value is equal to the product of the paths a and b (a*b).

In the past 30 years, the stepwise method has become the most popular method to test the mediating effect since Baron and Kenny (1986) proposed to test the mediating effect by the causal step method. The stepwise regression method of testing regression coefficients to test for mediating effects was described in detail by Zhao (2010) as a joint significance test in which the following conditions must be met: (i) the coefficient of total utility c is significant, (ii) the coefficient of the independent variable to the mediator variable a is significant, (iii) the coefficient of the mediator variable to the dependent variable b is significant, and (iv) the direct effect after controlling for the independent variable (c') is insignificant.

However, in recent years, the stepwise method has been the subject of considerable criticism and debate, with arguments that the Bootstrap method is better suited to directly testing the significance of the coefficients. Khosravi et al. (2021) introduced the Bootstrap sampling method, which enhanced the validity of the test for small samples. The steps of the mediation effect test were modified from the three-step method to the four-step method following the integration of the bootstrap sampling method. The test of significance was transitioned from the Sobel test to the bootstrap confidence interval (BCI). The nonparametric nature of the bootstrap is more realistic for small samples.

Current methods for testing mediation effects are still in an ongoing stage of development. Tibbe and Montoya (2022) advanced the argument that the equilibrium and steadiness of specific methodologies for small samples, such as bias-corrected bootstrap confidence intervals (BCBCIs), may be more pronounced. Conversely, large samples (e.g., n=500) are unable to address the bias correction issue. Davood and Kelley (2019) utilised simulation experiments to demonstrate discrepancies in the efficacy of small versus large samples across diverse statistical methodologies. They further emphasised that the employment of small samples in specific methods (e.g., bootstrap confidence intervals for bias correction) might be more suitable for non-normal data, while larger sample sizes result in more precise confidence intervals, thereby increasing the likelihood of excluding the true parameter.

This study will use Stata 18, referring to the mediation effect analysis procedure proposed by Zhao et al. (2010), and study whether the mediating variables mediate the relation between the pooling policy and company performance through three regression equations. The specific regression equations are as follows:

$$\mathbf{Y_{it}} = \boldsymbol{\alpha_1} + \mathbf{cTreat_i} \times \mathbf{Post_t} + \boldsymbol{\varepsilon_1 Control_{it}} + \boldsymbol{\lambda_t} + \boldsymbol{\gamma_i} + \boldsymbol{\delta_{it}} \quad (5.4)$$

$$\mathbf{M_{it}} = \boldsymbol{\alpha_2} + \mathbf{aTreat_i} \times \mathbf{Post_t} + \boldsymbol{\varepsilon_2 Control_{it}} + \boldsymbol{\lambda_t} + \boldsymbol{\gamma_i} + \boldsymbol{\delta_{it}} \quad (5.5)$$

$$\mathbf{Y_{it}} = \boldsymbol{\alpha_3} + \mathbf{c'Treat_i} \times \mathbf{Post_t} + \mathbf{bM_{it}} + \boldsymbol{\varepsilon_3 Control_{it}} + \boldsymbol{\lambda_t} + \boldsymbol{\gamma_i} + \boldsymbol{\delta_{it}} \quad (5.6)$$

M represents the mediating variables – the sales expense rate and the R&D expense rate – and Y represents the explained variable. Model (5.4) tests the effect of drug collection policy on company performance. Model (5.5) is a mediating mechanism model that investigates the centralised band purchasing policy for drugs by affecting this mediating variable, which in turn affects company performance. Model (5.6) tests the joint test effect of the centralised procurement policy and the mediating variable on company performance. This study will introduce two mediator variables, one at a time, into the mediation effect model for separate testing.

Based on the model in Equations (5.4), (5.5), and (5.6), this study identifies the type of

mediation effect according to the following criteria: If in Equation (5.4) the coefficient of the policy interaction term (c) is significant, in Equation (5.5) the coefficient of the policy interaction term (a) is significant (indicating that the policy has an impact on the mediating variable (M)), and in Equation (5.6) the coefficient of the policy interaction term (c') is not significant while the coefficient of the mediating variable (b) is significant, then a complete mediation effect exists. This indicates that the policy's effect on firm performance is entirely transmitted through the mediating variable (M). If in Equation (5.4) (c) is significant, in Equation (5.5) (a) is significant, and in Equation (5.6) both (c') and (b) are significant but ($|c'| < |c|$), then a partial mediation effect exists. This means that the policy affects firm performance both directly and indirectly through the mediating variable (M). If in Equation (5.5) (a) is not significant, in Equation (5.6) (b) is not significant, or the product of (a) and (b) is not significant, then no mediation effect exists, suggesting that the mediating variable (M) does not play a mediating role in the relationship between the policy and firm performance.

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Chapter 6: Results

In this chapter, the empirical study uses a dataset of pharmaceutical companies from the Cathay Pacific database to test the hypotheses. This chapter first provides a descriptive analysis of the study's results, secondly conducts a heterogeneity test to study whether different types of pharmaceutical enterprises are affected differently by the policy, and finally validates the results through a robustness test.

6.1 Characterisation of the dataset

6.1.1 Descriptive statistics

In this study, 495 biomedical enterprises in the A-share market are initially screened. During data cleaning, ST enterprises face the risk of delisting, and their performance and financial status may differ substantially from those of general enterprises; therefore, ST/ST* enterprises were excluded from the preliminary data cleaning process. In addition, because some enterprises' quarterly reports are not yet published, this study excludes data whose financial statements are less than half a year old. A total of 305 listed companies in the pharmaceutical manufacturing industry has been selected to constitute the panel, comprising 36 quarterly financial statements from March 2015 to December 2023, for 10,956 data points. Data were winsorized during the data processing. The overall data is shown in Table 6.1.

The mean return on assets (ROA) was 2.7%, with a median of 1.7%. The standard deviation (3.6%) exceeded the mean, indicating that while the overall asset profitability of the sample companies was moderate, significant internal variation existed, with many companies exhibiting profitability below the average.

Among the mediating variables, the R&D expense ratio (RD ratio, R&D expenses/operating revenue) had a mean of 7.2% and a median of 5.0%, confirming the biopharmaceutical industry's characteristic of high R&D investment as a technology-intensive sector. Its right-skewed distribution (with a maximum of 40.1%) highlights strategic differences within the industry, with some companies placing extreme emphasis on innovation. The sales expense ratio (sales ratio, sales expenses/operating revenue) averaged 31.5% with an exceptionally high standard deviation (46.5%). This reflects both the industry's prevalent high-

sales-investment model and substantial divergence in marketing strategies across different segments or business models.

Among the controlled variables, the average debt-to-asset ratio (total liabilities/total assets) was 30.3%, indicating a relatively stable level. The mean total asset turnover (Total Asset Turnover, Revenue/Average Total Assets) was 0.252, while the mean inventory turnover ratio (Inventory Turnover Ratio) was 2.538 but exhibited an extremely high standard deviation (4.332). The latter figure again strongly indicates the fundamental heterogeneity in supply chain and inventory management models across biopharmaceutical sub-sectors.

Corporate governance and equity structure variables provided rich detail. The average independent director ratio (indr, independent directors/board members) was 38.0%, meeting regulatory requirements with a concentrated distribution. Regarding equity concentration, the average shareholding ratio of the largest shareholder (shrcr1, in percentage) was 33.2%. In contrast, the average shareholding ratio of the top ten shareholders (shrcr4, in percentage) was 62.1%, indicating widespread equity concentration across the sample. The average board size (directornumber, in persons) was 21.7, exhibiting minimal variation.

Human resources and incentive variables revealed significant company-size differences. Employee counts (staffnumber, in persons) ranged from 122 to 40,370, with an average of 2,548, reflecting the industry's span from startup R&D institutions to large manufacturing enterprises. The mean total executive compensation (sumsalary, actual total executive compensation/1000, unit: RMB ¥) was 8,993.3, with a highly right-skewed distribution. The average profit per capita (profit per capita, net profit/number of employees/1000, unit: RMB/person) was 91.6, but the standard deviation reached 392.1 with negative values present. This extreme variation indicates significant disparities in per capita efficiency among enterprises.

Among other control variables, the mean age of listing (age, years) was 2.632. Both firm size (size, natural logarithm of year-end total assets) and technological intensity (rjzb, natural logarithm of capital per employee) had a mean of 7.78, with relatively wide distribution ranges.

Table 6.1 Descriptive statistics for overall data (except dichotomous variables)

Variable name	N	Mean	SD	Min	p25	p50	p75	Max
roa	10956	0.027	0.036	-0.134	<0.001	0.017	0.043	0.185
sales ratio	10956	0.315	0.465	<0.001	0.092	0.245	0.408	3.995
RD ratio	10956	0.072	0.067	0.007	0.030	0.050	0.091	0.401
Debt-to-Asset Ratio	10956	0.303	0.168	0.009	0.170	0.282	0.407	0.850
indr	10956	0.380	0.074	0.188	0.333	0.364	0.429	0.769
sumsalary	10956	8993.262	8025.199	784.800	3994.250	6615.400	10725.700	43635.575
directorholdsharesnum	10956	2.645	1.949	<0.001	1.000	3.000	4.000	12.000
staffnumber	10956	2547.944	3767.459	122.000	628.000	1257.000	2779.000	40370.000

Variable name	N	Mean	SD	Min	p25	p50	p75	Max
profitpercapita	10956	91.629	392.09	-1393.676	36.017	105.765	196.199	1569.151
Inventory Turnover Ratio	10956	2.538	4.332	-0.005	0.730	1.570	3.043	49.127
Total Asset Turnover	10956	0.252	0.253	<0.001	0.003	0.190	0.391	1.194
shrcr1	10956	33.208	13.760	3.370	22.715	31.519	40.633	74.341
shrcr4	10956	62.109	15.002	17.101	51.324	63.456	73.571	92.976
age	10956	2.632	1.667	1.068	1.570	2.087	3.019	10.479
size	10956	1.904	0.478	1.000	2.000	2.000	2.000	4.000
rjzb	10956	7.779	8.224	1.000	1.000	4.000	13.000	31.000
directornumber	10956	21.712	1.109	18.359	20.985	21.660	22.394	25.061

Categorically (Table 6.2), the mean value of return on total assets (ROA) is significantly higher for firms participating in Centralized Volume-Based Drug Procurement than for non-participating firms ($p<0.001$). Nevertheless, care should be taken with significance, as observations are not entirely independent. Meanwhile, the key indicators of inventory turnover (Inventory Turnover Ratio), shareholding concentration (shrcr1, shrcr4), number of employees (staffnumber), total annual supervisory salary (sumsalary), and total number of directors holding the Company's shares (directorholdsharesnum) between the treatment and control groups are all statistically significant different ($p< 0.05$). To avoid the interference of pre-existing systematic differences between the treatment and control groups in the dimensions of capital structure, governance model and size characteristics on causal inference, the propensity score matching (PSM) method needs to be applied to the nature of equity (equitytureid), size of the firm (size), technological intensity (rjzb), gearing ratio (Debt-to-Asset Ratio) and total asset turnover ratio (Total Asset Turnover) as core covariates for sample balancing.

Table 6.2 Statistical description of categories and t-test of indicators between two groups.

Variable name	Participation in Centralized Volume-Based Drug Procurement			Not involved in Centralized Volume-Based Drug Procurement			Mean difference
	N	Mean	SD	N	Mean	SD	
roa	201	0.041	0.035	10755	0.026	0.036	0.015***
sales ratio	201	0.287	0.124	10755	0.316	0.469	-0.029**
RD ratio	201	0.089	0.064	10755	0.072	0.067	0.017***
Debt-to-Asset Ratio	201	0.34	0.166	10755	0.303	0.168	0.037**
indr	201	0.377	0.069	10755	0.38	0.074	-0.003
sumsalary	201	12998.165	9464.829	10755	8918.415	7977.228	4079.750***
directorholdsharesnum	201	2.98	1.863	10755	2.638	1.95	0.342*
staffnumber	201	5638.602	6386.489	10755	2490.182	3676.767	3148.420***
Profitpercapita	201	108.059	189.865	10755	91.322	394.885	16.737
Inventory Turnover Ratio	201	1.728	1.417	10755	2.553	4.367	-0.825***

Variable name	Participation in Centralized Volume-Based Drug Procurement			Not involved in Centralized Volume-Based Drug Procurement			Mean difference
	N	Mean	SD	N	Mean	SD	
Total Asset Turnover	201	0.369	0.23	10755	0.249	0.253	0.120***
shrcr1	201	30.167	11.772	10755	33.265	13.789	-3.098***
shrcr4	201	57.126	14.043	10755	62.202	15.005	-5.076***
age	201	2.59	1.834	10755	2.632	1.664	-0.042
size	201	11.965	7.885	10755	7.701	8.21	4.264***
rjzb	201	22.507	1.063	10755	21.697	1.104	0.810***
directornumber	201	14.459	0.467	10755	14.516	0.66	-0.057

6.1.2 Relevance analysis

According to the results of Pearson correlation analysis (Table 6.3), total assets (size) and staff number show a strong positive correlation with each other (0.667*), indicating consistent organizational scaling. In terms of governance structure, the shareholding of the top ten shareholders (shrcr4) exhibits a strong negative correlation with the shareholding of the first-largest shareholder (shrcr1) at -0.526*, indicating a substitution effect in ownership concentration. Notably, the largest shareholder’s ownership (shrcr1) shows a positive correlation with ROA (0.077), while the board independence (indr) shows weak negative correlations with multiple governance indicators. In summary, the correlation coefficient indicates a high degree of association between the indicators.

Table 6.3 Pearson correlation analysis

Variable	indr	shrcr1	shrcr4	age	size	staffnumber	Total Asset Turnover	rjzb	profitpercapita	Debt-to-Asset Ratio	Inventory Turnover Ratio	sumsalary	directorholdsharesnum	RD ratio	sales ratio	roa	directornumber
indr	1.000	0.019	-0.006	-0.007	0.074	0.018	0.000	-0.035	0.085	0.011	-0.009	0.021	-0.129	0.083	-0.061	0.012	-0.100
shrcr1		1.000	0.595***	-0.187	-0.024	0.060	-0.014	-0.123	0.080	0.029	-0.010	-0.126	-0.081	-0.101	0.030	0.077	-0.141
shrcr4			1.000	-0.526***	-0.164	-0.081	-0.191	0.011	0.094	-0.093	0.043	0.029	-0.041	0.183	0.065	-0.033	-0.194
age				1.000	0.517***	0.464**	0.298	-0.048	0.049	0.206	-0.098	0.078	-0.150	-0.340*	-0.108	0.155	0.293
size					1.000	0.667***	0.134	0.287	0.093	0.176	-0.115	0.468**	-0.024	-0.147	0.031	0.197	0.299
staffnumber						1.000	0.257	-0.184	0.022	0.225	-0.069	0.391*	0.020	-0.183	-0.069	0.180	0.299
Total Asset Turnover							1.000	-0.235	0.183	0.012	0.038	-0.041	0.064	-0.290	-0.145	0.526***	0.089
rjzb								1.000	-0.027	-0.098	0.024	0.258	-0.083	0.241	0.202	-0.139	-0.038
profitpercapita									1.000	-0.166	-0.104	-0.186	0.043	-0.260	-0.383*	0.265	-0.115
Debt-to-Asset Ratio										1.000	0.125	-0.000	-0.074	-0.153	0.006	-0.225	0.043
Inventory Turnover Ratio											1.000	-0.026	-0.022	-0.024	0.020	-0.081	-0.046

Variable	indr	shrcr 1	shrcr 4	age	size	staff number	Total Asset Turnover	rjzb	profitpercapita	Debt-to-Asset Ratio	Inventory Turnover Ratio	sumsalary	directorholdsharesnum	RD ratio	sales ratio	roa	directornumber
sumsalary												1.000	0.016	0.256	0.179	-0.000	0.266
directorholdsharesnum													1.000	0.043	-0.010	0.125	0.090
RD ratio														1.000	0.246	-0.188	-0.017
sales ratio															1.000	-0.113	0.036
roa																1.000	0.047
directornumber																	1.000

* $p < 0.05$ and $0.3 < |r| \leq 0.4$; ** $p < 0.05$ and $0.4 < |r| \leq 0.5$; *** $p < 0.05$ and $|r| > 0.5$.
No stars for $|r| \leq 0.3$ due to large sample considerations.

6.2 PSM processing

6.2.1 Methods of PSM processing

In this study, the propensity score matching (PSM) method is used to construct experimental and control groups to assess the net effect of the Centralized Volume-Based Drug Procurement policy on company performance. The treatment group comprises firms that participated in Centralized Volume-Based Drug Procurement at least once during the sample period, while the control group comprises firms that never participated. Based on pre-policy firm characteristics, core covariates such as nature of equity (equitytureid), firm size (size), technology intensity (rjzb), gearing ratio (Debt-to-Asset Ratio), and total asset turnover ratio (Total Asset Turnover) are selected for matching. Near-neighbour 1:1 matching (caliper value 0.05) is used to balance matching efficiency and sample utilisation while mitigating bias arising from differences in sample sizes between the treatment group (77 firms) and the control group (228 firms).

6.2.2 Results of PSM treatment

(1) Sample with a common range of values

The common support domain test shows that nine firms (11.7%) in the treatment group are excluded because their propensity scores fall outside the overlap region. The total effective sample size after matching is 297 (68 in the treatment group and 229 in the control group), accounting for 88.3% of the original treatment group sample, suggesting that most of the firms satisfy the common support assumption.

(2) Balance between treatment and control groups before and after matching

After matching (See Appendix Table 1 Comparison of covariate balance before and after matching), the standardised deviation (%bias) of the main covariates decreased by an average of 16.70%, with the median deviation decreasing by 7.40%. Although some variables still have residual bias (Debt-to-Asset Ratio: 33.10%), their variance ratios (0.90→0.81) are significantly optimised, supporting the conclusion that “systematic differences between groups can be controlled after matching”.

(3) Distribution verification of matched samples

The propensity score distribution plot shows (Figure 6.1) that the overlap in the distribution of scores between the treatment and control groups improved significantly after matching, but the scores of the treatment group were still concentrated in the high probability region (0.20-

0.60), and the control group was concentrated in the low probability region (0.10-0.30), with a significant difference in the density of distributions in some regions. Despite the distributional shifts, the Likelihood Ratio Test (LRT) showed a substantial decrease in the predictive power of the covariates for treatment status after matching (pseudo-R^2 decreased from 0.24 to 0.19, $p<0.001$), supporting the plausibility of the co-support assumption.

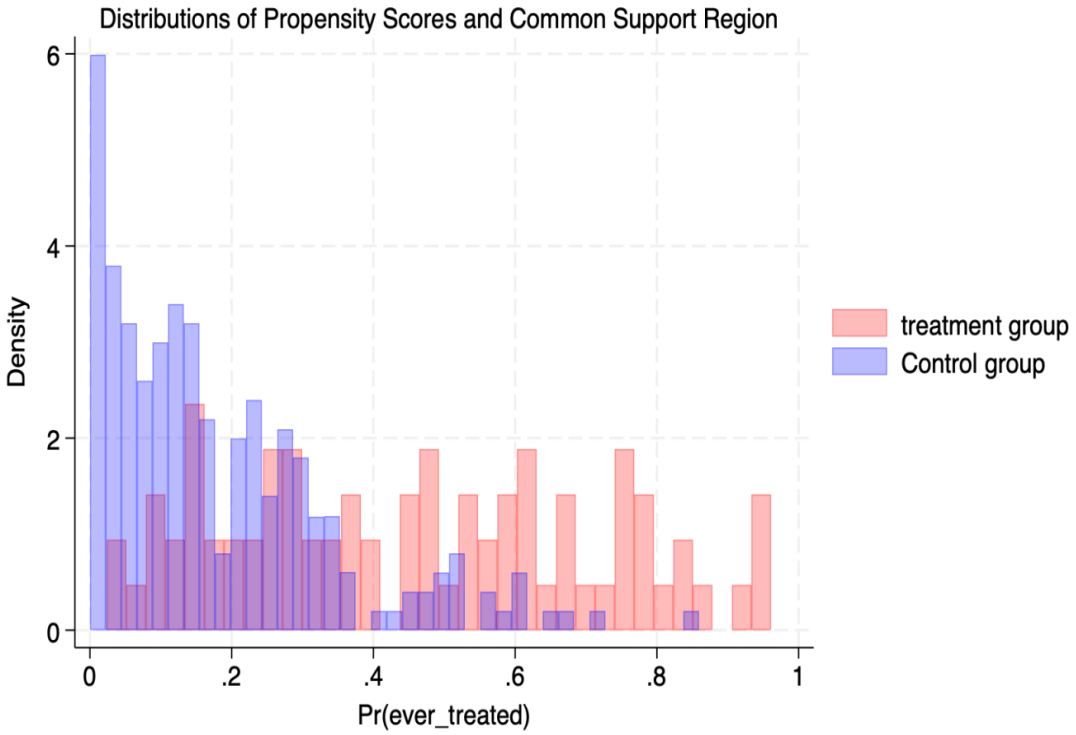


Figure 6.1 Nuclear density map

The Love Plot visualisation test further verifies that the absolute value of standardised deviations of all covariates after matching is less than 50%, and 83% of the variables have a reduction in deviation of more than 10%. Although technology intensity (rjzb) and total asset turnover (Total Asset Turnover) still exhibit substantial residual deviations, their t-test p-values are significantly higher than those before matching, suggesting that the residual differences are mainly driven by the endogenous characteristics of the variables rather than matching failure. In summary, the PSM method effectively controls for selection bias from the observable variables and satisfies the premise assumptions of the subsequent DID analysis.

6.3 Regression results

Regression analyses were performed on the processed data. Traditional DID (without PSM matching) and PSM-DID were mainly used, and lagged and mediation effects were analysed

based on PSM-DID.

6.3.1 Return to baseline

The full sample double-difference (DID) results show that the impact of Centralized Volume-Based Drug Procurement policy on company performance (ROA) is not significant at the 5% level (p=0.057). Among the control variables, firms' age at listing (age) is significantly negatively related to ROA (coefficient -0.003, p<0.01), nature of equity (equitytureid) is positively significant (coefficient 0.003, p<0.05), while gearing ratio (Debt-to-Asset Ratio) significantly suppresses ROA (coefficient -0.026, p<0.01), and total asset turnover (Total Asset Turnover) contributes the most to company performance improvement (coefficient 0.070, p<0.01). Notably, the epidemic variable (covid19) has a coefficient of 0.004 (p<0.1) in the full sample, suggesting that epidemic shocks may have a weak positive disturbance on ROA, but this needs to be further verified in conjunction with the matching results.

6.3.2 PSM-DID regression

After constructing the balanced sample through nearest-neighbour/caliper matching, the matched sample DID results (Table 6.4) show a positive effect of Centralized Volume-Based Drug Procurement policy on company performance (ROA) with a coefficient of 0.005(p=0.033), suggesting that the policy's net effect is pronounced after eliminating the initial difference between the experimental and control groups. The direction of the core control variable is consistent with the full sample. Still, the statistical significance of firm size (size) decreases (coefficient 0.007, p=0.071), suggesting that the effect of size heterogeneity is mitigated after matching. The coefficient on the epidemic variable remains 0.004 but is no longer significant (p=0.102), suggesting that the epidemic disturbance in the full sample may partly stem from sample selection bias.

The two types of models show that the Centralized Volume-Based Drug Procurement policy coefficients are stable in the 0.004-0.005 range, with consistent direction and limited fluctuations in significance, validating the robustness of the findings. The matched-sample DID showing positive effect corroborates that the traditional DID may underestimate the policy effect due to sample selection bias. Among the control variables, financial structure variables such as gearing ratio, inventory turnover ratio, and total asset turnover ratio are highly significant (p<0.01) in both methods, highlighting the key role of firms' endogenous characteristics on performance.

Table 6.4 Full sample DID and matched sample DID model results

Variables	Full sample DID				Matching sample DID			
	Estimate	S.E.	p-value		Estimate	S.E.	p-value	
did	0.004	0.002	0.057		0.005	0.002	0.033	*
Age	-0.003	0.001	<0.001	***	-0.003	0.001	<0.001	***
Equitytureid	0.003	0.001	0.021	*	0.003	0.001	0.021	*
Size	0.008	0.004	0.044	*	0.007	0.004	0.071	
Rjzb	-0.004	0.004	0.337		-0.003	0.004	0.436	
Indr	-0.012	0.009	0.156		-0.012	0.009	0.187	
Debt-to-Asset Ratio	-0.026	0.005	<0.001	***	-0.026	0.005	<0.001	***
Directornumber	-0.000	<0.001	0.161		-0.000	<0.001	0.144	
Sumsalary	-0.000	<0.001	0.617		-0.000	<0.001	0.428	
Concurrentposition	-0.000	0.002	0.966		-0.000	0.002	0.815	
Directorholdsharesnum	0.001	<0.001	0.108		0.001	0.001	0.099	
Staffnumber	<0.001	<0.001	0.55		<0.001	<0.001	0.457	
Profitpercapita	<0.001	<0.001	<0.001	***	<0.001	<0.001	<0.001	***
Qfiiholdproportion	-0.000	0.001	0.884		-0.001	0.001	0.796	
Inventory Turnover Ratio	-0.002	<0.001	<0.001	***	-0.002	<0.001	<0.001	***
Total Asset Turnover	0.07	0.005	<0.001	***	0.072	0.005	<0.001	***
shrcr1	-0.000	<0.001	1		-0.000	<0.001	0.794	
shrcr4	<0.001	<0.001	0.161		<0.001	<0.001	0.13	
covid19	0.004	0.002	0.079		0.004	0.003	0.102	
Observations	10956	-	-		10632	-	-	
R-squared	0.58	-	-		0.58	-	-	

* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001

6.3.3 Analysis of lagged effects

Based on the PSM-DID method, this study further analyzes the lagged effect of Centralized Volume-Based Drug Procurement policy on company performance. The results show that the policy effect is characterised by dynamic heterogeneity.

As shown in Tables 6.5 to 6.8, the coefficients of the policy effects in lag 1, 2, and 3 quarters are 0.007 (p=0.009), 0.007 (p=0.013), and 0.007 (p=0.021) respectively, indicating an immediate boosting effect on company performance within 1 year of the implementation of the policy; the coefficient of the lag 4 quarters drops to 0.006 (p= 0.059); The lagged 5-quarter effect is weakened to 0.006 (p=0.078), and the lagged 6- and 7-quarter effects are restored to 0.007 (p=0.019, 0.014), suggesting that enterprises may enter a period of strategic adjustment; the lagged 8-quarter effect is significantly strengthened to 0.009 (p=0.002).

The results for the remaining control variables remained highly stable across all eight lag models. Specifically, the coefficient for firm age consistently stood at -0.003 ($p < 0.001$), indicating a stable negative association with firm performance. The coefficient for equity structure (Equitytureid) is 0.003 (p-values ranging from 0.021 to 0.022), revealing a stable

positive relationship. The coefficient for firm size (Size) is 0.007 (p-values ranging from 0.070 to 0.072), indicating a positive relationship but with relatively weaker statistical certainty.

The Debt-to-Asset Ratio coefficient is -0.026 ($p<0.001$), indicating a highly significant negative relationship. Profit per capita (Profit per capita) coefficient <0.001 ($p<0.001$) and total asset turnover (Total Asset Turnover) coefficient 0.072 ($p<0.001$) both exhibit extremely strong positive correlations. The coefficient for Inventory Turnover Ratio was -0.002 ($p<0.001$), indicating a stable negative correlation.

Additionally, coefficients for independent director ratio (Indr, p-value approx. 0.18), board member count (Directornumber, p-value approx. 0.15), total executive compensation (Sumsalary, p-value approx. 0.43), and shareholding concentration (shrcr1, shrcr4, p-values both >0.13) showed no statistically significant correlations (p-values all >0.05).

Regarding overall model explanatory power, the R-squared values for all eight models remained stable within the range of 0.579 to 0.580, indicating consistent model specification and inclusion of key explanatory variables influencing corporate performance.

Table 6.5 Results of lag effects (1-2 quarters)

Variable	1 season behind				2 season behind			
	Estimate	**S.E.**	**p-value**		**Estimate**	**S.E.**	**p-value**	
did_lag	0.007	0.003	0.009	**	0.007	0.003	0.013	*
Age	-0.003	0.001	<0.001	***	-0.003	0.001	<0.001	***
Equitytureid	0.003	0.001	0.022	*	0.003	0.001	0.022	*
Size	0.007	0.004	0.07		0.007	0.004	0.071	
Rjzb	-0.003	0.004	0.438		-0.003	0.004	0.438	
Indr	-0.012	0.009	0.187		-0.012	0.009	0.184	
Debt-to-Asset Ratio	-0.026	0.005	<0.001	***	-0.026	0.005	<0.001	***
Directornumber	-0.000	<0.001	0.147		-0.000	<0.001	0.147	
Sumsalary	-0.000	<0.001	0.429		-0.000	<0.001	0.43	
Concurrentposition	-0.000	0.002	0.812		-0.000	0.002	0.809	
Directorholdsharesnum	0.001	0.001	0.102		0.001	0.001	0.101	
Staffnumber	<0.001	<0.001	0.457		<0.001	<0.001	0.457	
Profitpercapita	<0.001	<0.001	<0.001	***	<0.001	<0.001	<0.001	***
Qfiiholdproportion	<0.001	0.001	0.795		<0.001	0.001	0.799	
Inventory Turnover Ratio	-0.002	<0.001	<0.001	***	-0.002	<0.001	<0.001	***
Total Asset Turnover	0.072	0.005	<0.001	***	0.072	0.005	<0.001	***
shrcr1	-0.000	<0.001	0.809		-0.000	<0.001	0.812	
shrcr4	<0.001	<0.001	0.133		<0.001	<0.001	0.133	
covid19	0.004	0.003	0.102		0.004	0.003	0.102	
Observations	10632	-	-		10632	-	-	
R-squared	0.58	-	-		0.58	-	-	

* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001

Table 6.6 Results of lag effects (3-4 quarters)

Variable	3 season behind				4 season behind			
	Estimate	S.E.	p-value		Estimate	S.E.	p-value	
did_lag	0.007	0.003	0.021	*	0.006	0.003	0.059	
Age	-0.003	0.001	<0.001	***	-0.003	0.001	<0.001	***
Equitytureid	0.003	0.001	0.021	*	0.003	0.001	0.022	*
Size	0.007	0.004	0.071		0.007	0.004	0.072	
Rjzb	-0.003	0.004	0.438		-0.003	0.004	0.443	
Indr	-0.012	0.009	0.185		-0.012	0.009	0.183	
Debt-to-Asset Ratio	-0.026	0.005	<0.001	***	-0.026	0.005	<0.001	***
Directornumber	-0.000	<0.001	0.145		-0.000	<0.001	0.147	
Sumsalary	-0.000	<0.001	0.431		-0.000	<0.001	0.434	
Concurrentposition	-0.000	0.002	0.815		-0.000	0.002	0.812	
Directorholdsharesnum	0.001	0.001	0.101		0.001	0.001	0.102	
Staffnumber	<0.001	<0.001	0.457		<0.001	<0.001	0.449	
Profitpercapita	<0.001	<0.001	<0.001	***	<0.001	<0.001	<0.001	***
Qfiiholdproportion	<0.001	0.001	0.805		<0.001	0.001	0.805	
Inventory Turnover Ratio	-0.002	<0.001	<0.001	***	-0.002	<0.001	<0.001	***
Total Asset Turnover	0.072	0.005	<0.001	***	0.072	0.005	<0.001	***
shrcr1	-0.000	<0.001	0.811		-0.000	<0.001	0.816	
shrcr4	<0.001	<0.001	0.133		<0.001	<0.001	0.134	
covid19	0.004	0.003	0.101		0.004	0.003	0.101	
Observations	10632	-	-		10632	-	-	
R-squared	0.58	-	-		0.579	-	-	

* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001

Table 6.7 Results of lag effects (5-6 quarters)

Variable	5 season behind				6 season behind			
	Estimate	**S.E.**	**p-value**		**Estimate**	**S.E.**	**p-value**	
did_lag	0.006	0.003	0.078	-	0.007	0.003	0.019	*
Age	-0.003	0.001	<0.001	***	-0.003	0.001	<0.001	***
Equitytureid	0.003	0.001	0.021	*	0.003	0.001	0.022	*
Size	0.007	0.004	0.072	-	0.007	0.004	0.072	-
Rjzb	-0.003	0.004	0.44	-	-0.003	0.004	0.438	-
Indr	-0.012	0.009	0.185	-	-0.012	0.009	0.186	-
Debt-to-Asset Ratio	-0.026	0.005	<0.001	***	-0.026	0.005	<0.001	***
Directornumber	-0.000	<0.001	0.146	-	-0.000	<0.001	0.146	-
Sumsalary	-0.000	<0.001	0.432	-	-0.000	<0.001	0.432	-
Concurrentposition	-0.000	0.002	0.812	-	-0.000	0.002	0.81	-
Directorholdsharesnum	0.001	0.001	0.1	-	0.001	0.001	0.099	-
Staffnumber	<0.001	<0.001	0.451	-	<0.001	<0.001	0.453	-
Profitpercapita	<0.001	<0.001	<0.001	***	<0.001	<0.001	<0.001	***
Qfiiholdproportion	<0.001	0.001	0.81	-	<0.001	0.001	0.807	-
Inventory Turnover Ratio	-0.002	<0.001	<0.001	***	-0.002	<0.001	<0.001	***
Total Asset Turnover	0.072	0.005	<0.001	***	0.072	0.005	<0.001	***
shrcr1	-0.000	<0.001	0.812	-	-0.000	<0.001	0.811	-
shrcr4	<0.001	<0.001	0.134	-	<0.001	<0.001	0.134	-
covid19	0.004	0.003	0.101	-	0.004	0.003	0.102	-
Observations	10632	-	-	-	10632	-	-	-
R-squared	0.579	-	-	-	0.579	-	-	-
* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001								

Table 6.8 Results of lag effects (7-8 quarters)

Variable	7 season behind				8 season behind			
	Estimate	S.E.	p-value		Estimate	S.E.	p-value	
did_lag	0.007	0.003	0.014	*	0.009	0.003	0.002	**
Age	-0.003	0.001	<0.001	***	-0.003	0.001	<0.001	***
Equitytureid	0.003	0.001	0.022	*	0.003	0.001	0.022	*
Size	0.007	0.004	0.072	-	0.007	0.004	0.072	-
Rjzb	-0.003	0.004	0.439	-	-0.003	0.004	0.44	-
Indr	-0.012	0.009	0.185	-	-0.012	0.009	0.183	-
Debt-to-Asset Ratio	-0.026	0.005	<0.001	***	-0.026	0.005	<0.001	***
Directornumber	-0.000	<0.001	0.146	-	-0.000	<0.001	0.147	-
Sumsalary	-0.000	<0.001	0.432	-	-0.000	<0.001	0.435	-
Concurrentposition	-0.000	0.002	0.811	-	-0.000	0.002	0.81	-
Directorholdsharesnum	0.001	0.001	0.099	-	0.001	0.001	0.101	-
Staffnumber	<0.001	<0.001	0.449	-	<0.001	<0.001	0.452	-
Profitpercapita	<0.001	<0.001	<0.001	***	<0.001	<0.001	<0.001	***
Qfiiholdproportion	<0.001	0.001	0.806	-	<0.001	0.001	0.806	-
Inventory Turnover Ratio	-0.002	<0.001	<0.001	***	-0.002	<0.001	<0.001	***
Total Asset Turnover	0.072	0.005	<0.001	***	0.072	0.005	<0.001	***
shrcr1	-0.000	<0.001	0.806	-	-0.000	<0.001	0.805	-
shrcr4	<0.001	<0.001	0.133	-	<0.001	<0.001	0.132	-
covid19	0.004	0.003	0.101	-	0.004	0.003	0.101	-
Observations	10632	-	-	-	10632	-	-	-
R-squared	0.579	-	-	-	0.58	-	-	-

* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001

6.3.4 Intermediary effect

a) R&D expense ratio

Table 6.9 shows that the direct effect (c' = 0.006, p = 0.045) is significantly positive at the 5% level, indicating that the CVBDP policy can directly enhance corporate performance even after controlling for the R&D expense ratio. Path a (CVBDP policy → R&D Expense Ratio) has a coefficient of 0.011 (p = 0.148), which is not significant, suggesting the policy does not significantly influence the intensity of corporate R&D investment. Path b (R&D expenditure ratio → corporate performance) has a coefficient of -0.073 (p<0.001), which is significantly negative at the 0.1% level. This indicates that higher R&D intensity is associated with a significant decline in corporate performance. The indirect effect (a×b=-0.001) is statistically insignificant and has an extremely small coefficient, suggesting that the R&D expenditure ratio does not play a significant mediating role between the CVBDP policy and corporate performance in the current period.

Table 6.9 Results of the mediation effect test for R&D expense ratio

Path	Coefficient	p	Significance
CVBDP policy→R&D Expense Ratio (a)	0.011	0.148	
R&D Expense Ratio→corporate performance (b)	-0.073	0.000	***
Direct effect (c')	0.006	0.045	*
Indirect effect (a×b)	-0.001	-	-
* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001			

Examining the test results from lag periods 1 to 8 (Table 6.10), the total effect (c) exhibits a significant or marginally significant positive relationship across most lag periods (except period 4), with coefficients ranging from 0.006 to 0.009 and p-values below 0.05 or 0.01. This indicates that the promotional effect of the CVBDP policy on corporate performance persists over an extended period. The direct effect (c') was significantly positive across all lag periods (p<0.05 or p<0.01), further confirming the cross-period stability of the CVBDP policy's independent positive impact on corporate performance. Although the coefficients for path a were all positive (0.006–0.011), none were statistical significance across any lag period, indicating that the CVBDP policy did not exert a significant influence on the R&D expenditure ratio during the lagged periods. In contrast, path b exhibited highly significant negative effects across all periods (coefficients consistently ranging from -0.073 to -0.074, p<0.001), indicating that the negative impact of R&D investment on corporate performance is highly stable and persistent. The indirect effect (a×b) was close to zero (-0.001 to -0.000) and statistically insignificant across all lag periods. Combined with the insignificant results for path a, the

mediation effect test supports the conclusion of "no mediation effect."

Table 6.10 Results of the staged testing for mediating effects

Lag	Total effect(c)	Path a	Path b	Direct effect(c')	Indirect effect(a×b)	mediation_type
1	0.007**	0.009	-0.074***	0.008**	-0.001	disintermediation effect
2	0.007*	0.008	-0.074***	0.008**	-0.001	disintermediation effect
3	0.007*	0.010	-0.074***	0.008*	-0.001	disintermediation effect
4	0.006	0.010	-0.073***	0.007*	-0.001	disintermediation effect
5	0.006	0.011	-0.073***	0.006*	-0.001	disintermediation effect
6	0.007*	0.006	-0.073***	0.007*	-0.000	disintermediation effect
7	0.007*	0.006	-0.073***	0.008*	-0.000	disintermediation effect
8	0.009**	0.007	-0.073***	0.010**	-0.000	disintermediation effect
* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001						

b) Sales expense ratio

The empirical results of the sales expense ratio show that the Centralized Volume-Based Drug Procurement policy has a significant negative impact on the sales expense ratio, with an effect coefficient of -0.027 (p=0.048), indicating that the implementation of the policy significantly reduces the enterprise's sales expense expenditure, which is in line with the theoretical expectation of "band purchasing reduces marketing demand". However, the coefficient for the impact of the sales expense ratio on corporate performance (ROA) is only 0.001 (p=0.600), which is not statistically significant, implying that the indirect effect (a×b) approaches zero.

The lagged effect test shows that the inhibitory effect on selling expenses exhibits a dynamic pattern: it initially enhances and then weakens. The effect coefficient peaked at -0.027 (p=0.021) in the 5th quarter after the policy implementation and fell back to -0.011 (p=0.192) in the 8th quarter.

6.4 Heterogeneity test

This subsection employs a multi-dimensional heterogeneity analysis framework to systematically examine the differential impact of the Centralized Volume-Based Drug Procurement policy on the pharmaceutical manufacturing industry. Utilising a triple-test system, the structural characteristics of the policy effect are revealed through the analysis of quarterly panel data from a sample of listed pharmaceutical companies. This system explores the extent to which firms with varying enterprise sizes, property rights, and industry classifications are affected by the policy shock.

6.4.1 Test for firm size heterogeneity

The present study hypothesises that the impact of the Centralized Volume-Based Drug Procurement policy on pharmaceutical enterprises will generate scale heterogeneity, driven by the deep-seated differences in enterprise resource endowment and market structure. To validate this mechanism, this study employs a PSM-DID model to identify the critical threshold of scale through heterogeneity tests and analyze its causal pathways, thereby providing theoretical foundations for optimizing policy design.

In this study, the total assets variable is used as a metric of enterprise size, and the sample is divided into three categories using the three-quartile method: $320 million is the 33% quartile of the asset size data, and $850 million is the 66% quartile. Therefore, small-scale enterprises refer to those with asset sizes less than or equal to $320 million, and the volume of data for this part of the enterprise is 3547 entries; medium-scale enterprises are those with asset size between $320 million and $850 million (with $320 million and $850 million excluded and included, respectively), with a data volume of 3569. Large-scale firms are those with assets exceeding $850 million, totaling 3508 entries in this category. The regression results are displayed in Table 6.11 below.

The findings indicate that the beneficial impact of Centralized Volume-Based Drug Procurement on the performance of large-scale firms is considerably more pronounced than that observed in smaller firms. This discrepancy is statistically significant, with an empirical p-value for the policy interaction term less than 0.05. A similar analysis for small- and medium-scale firms reveals that, as size decreases, the positive effect of Centralized Volume-Based Drug Procurement on company performance, measured by return on assets (ROA), becomes increasingly smaller. The positive response exhibited by large-scale firms confirms the hypothesis of economies of scale, which suggests that this is due to the reduction of unit fixed costs through intensive production and the acquisition of bargaining advantages in bandwagon negotiations. Conversely, small-scale firms may encounter limitations due to inadequate capacity utilisation, which hinders their ability to mitigate the policy-induced revenue decline, exhibiting a non-significant negative trend.

Table 6.11 Results of the firm size heterogeneity test

Enterprise size	did	p	se	N
Small-sized enterprises	-0.008	0.182	(0.006)	3547
Medium-sized enterprises	0.005	0.118	(0.003)	3569
Large-sized enterprises	0.005*	0.046	(0.003)	3508
* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001				

6.4.2 Test for heterogeneity in property rights

The present study hypothesises that the Centralized Volume-Based Drug Procurement policy for medicines will have a differential impact on company performance across different property rights, depending on the interaction between institutional environment and market logic. To further investigate whether there is a difference in the impact of the Centralized Volume-Based Drug Procurement policy on state-owned enterprises and non-state-owned enterprises, this study further analyses the nature of the enterprises' property rights.

In conducting the test of heterogeneity in property rights, the grouping criteria are first clarified. Based on the type of business registration, the enterprises are divided into four categories. Among them, there are 61 state-owned enterprises, 250 private enterprises, 17 foreign-funded enterprises, and eight other types of enterprises. The specific regression results are shown in Table 6.12 below.

Based on the PSM-DID heterogeneity test results, the overall effect trend of the CVBDP policy on companies' performance with different ownership structures exists, but statistical significance is generally weak.

Specifically, the DID coefficient for state-owned enterprises is 0.004, with a p-value of 0.084, exceeding the 0.05 significance threshold. This indicates that the positive impact of the CVBDP policy on state-owned enterprises' performance is not statistically significant. Nevertheless, the relatively low p-value may reflect a certain positive trend, potentially attributable to factors such as state-owned enterprises' informational advantage in policy implementation and benefits from market standardization. However, characteristics like their diverse performance objectives and regulation by non-market factors may have weakened the statistical significance of the performance response.

For private enterprises, the DID coefficient was 0.003 with a p-value of 0.164, far exceeding 0.05 and not statistically significant. This indicates the CVBDP policy has no discernible impact on private enterprise performance. As the largest sample group, this result suggests the policy has yet to produce a statistically identifiable improvement in the overall performance of private enterprises.

The DID coefficient for foreign-funded enterprises was below 0.001, with no valid p-value reported. Given the sample size of 516, the impact of the CVBDP policy on their performance is considered negligible and statistically insignificant.

The DID coefficient for other enterprises was 0.007 with a p-value of 0.064, still exceeding the 0.05 significance threshold and thus not statistically significant. Given the extremely small

sample size (N=76), this result is not robust. It merely suggests that such enterprises may be more sensitive to policy changes due to structural flexibility but does not support broader generalizations.

Table 6.12 Results of the heterogeneity test for property rights structure

Type of enterprise	did	p	Se	N
state-owned enterprise	0.004**	0.084	(0.002)	740
private enterprise	0.003	0.164	(0.002)	8612
foreign enterprise	<0.001	.	(.)	516
other enterprise	0.007**	0.064	(0.003)	76

criteria misclassification to the firm level, *** p<0.001, **p<0.01, *p<0.05

6.4.3 Test for Industry heterogeneity

Based on the division of labour in the industrial chain and the technical characteristics of the industry, this study argues that the Centralized Volume-Based Drug Procurement policy of drugs will have different impacts on different types of pharmaceutical enterprises. To reveal the mechanism underlying this heterogeneity, an industry-grouping test is required.

In this study, the test for industry heterogeneity is based on the China Securities Index (CSI) Industry Classification System (Version 2021), which uses three-level (3-digit) and four-level (4-digit) industry classification criteria to examine the heterogeneous impact of the Centralized Volume-Based Drug Procurement policy on company performance. Focusing on the segmentation of the chemical pharmaceutical manufacturing industry (3-digit code 352020), we identify the transmission differences of the policy effect in different industrial chain segments.

The results show that in the chemical pharmaceutical manufacturing industry (352020), the policy effect shows significant intra-industry differences, with a policy interaction term coefficient of 0.005 (p=0.031), suggesting that the industry is affected by the Centralized Volume-Based Drug Procurement policy to a greater extent than other pharmaceutical sub-industries. That is, the policy has a more decisive intervention on the pricing mechanism of preparation products directly facing medical institutions. Further deconstruction reveals that the policy effect is statistically significant in the pharmaceutical formulation manufacturing process (four-digit code 35202020). The specific results are shown in Table 6.13 below.

Table 6.13 Results of the industry heterogeneity test

Industry Code	Industry Name	did	p	N
352030	Chinese medicine	0.001	0.003	0.671
352040	Pharmaceutical and biotechnology services	-0.007	0.007	0.357
352010	Biopharmaceuticals	0.007	0.013	0.611

Industry Code	Industry Name	did	p	N
352020	Chemical medicine	0.005*	0.002	0.031
35202020	Pharmaceutical preparation	0.006***	0.002	0.006

* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001

6.5 Robustness test

6.5.1 Parallel trend test

In this study, the multi-period double-difference (Multi-period DID) method is employed to evaluate the dynamic impact of the Centralized Volume-Based Drug Procurement policy on company performance. As illustrated in Figure 6.2, a dynamic window comprising three periods before the policy (pre_3 to pre_1), the current policy period (t=0), and six periods after the policy (post_1 to post_6), is constructed. The challenge of sparsity in long-run effects is addressed by merging the post-4-6 periods. The model setup strictly controls for firm- and time-fixed effects, and the standard error clustering at the firm level is consistent with Bertrand and coauthors' measurement specification for policy evaluation (Bertrand et al., 2004).

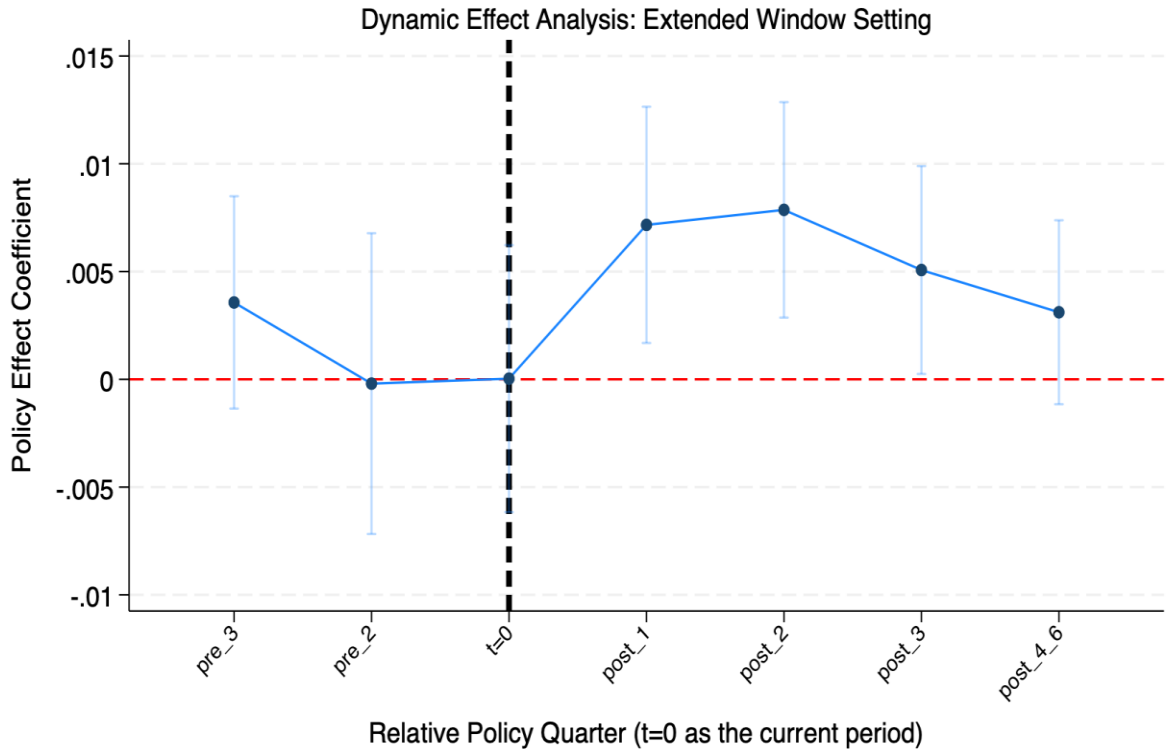


Figure 6.2 Parallel trends plot

The empirical results demonstrate that the coefficients for the pre-policy periods (pre_3=-0.002, pre_2=0.001) are insignificant (p>0.1), thereby satisfying the assumption of parallel

trends. This finding indicates that the treatment and control groups are comparable before the policy shock. Following the implementation of the policy, a conventional 'inverted U-shape' dynamic effect is observed: ROA increases significantly in post_1, peaks in post_2, falls in post_3, and the coefficients drop to insignificance in post_4-6. This trend is supported by the joint test (testparm) (p=0.357 before the policy, p=0.007 after the policy), which confirms that the policy effect has the characteristic of timeliness.

The short-term enhancement in performance in the early stages of the policy (post_1-3) is indicative of the economies of scale achieved by winning bidders through “price for volume” (Cutler et al., 1998). The diminishing effect in post_4-6 may be attributable to the evolution of the market’s competitive structure, with the advent of new entrants intensifying competition in the industry with the advancement of subsequent procurement batches (Bloom et al., 2013). Furthermore, marginal profit compression offsets the initial scale effect. As Acemoglu and Linn (2004) demonstrate marginal profit compression offsets the initial scale effect, and innovator firms may adjust their R&D investment in the later stages of the policy, resulting in an ROA indicator that reflects the trade-off between short-term financial performance and long-term investment. This finding is consistent with the dynamic process of “policy shock - market adjustment - new equilibrium”.

6.5.2 Placebo test

This investigation entailed a triple placebo test system - incorporating a temporal placebo test, a spatial placebo test, and a virtual treatment test - collectively forming a comprehensive falsification framework (Imbens & Rubin, 2015).

The time placebo test employs forward-shifted treatment points to construct four sets of pseudo-treatment variables by artificially advancing the time of policy implementation by 8-20 quarters (2-5 years). Bertrand et al. (2004) proposed the forward-shifted treatment points method, which is effective in identifying the presence of time-trend disturbances in the model. The key results indicate that the pseudo treatment effect coefficients for all forward-shifted periods are insignificant (p-values between 0.170-0.177) and the coefficient values are stable between 0.0026-0.0027, suggesting that time trends do not lead the actual observed policy effects. In terms of model setting, by comparing the industry trend control model (R^2=0.587) with the firm fixed-trend model (R^2=0.570), the more tightly controlled firm fixed-trend model was finally chosen as the benchmark, whose policy treatment coefficients were significant at the true treatment time point (P=0.026), in contrast to the results of the placebo test.

The randomised treatment group coefficient was found to be 0.003 (p=0.117), and the

standard error (0.002) was found to be like the baseline model, thus confirming that treatment group selection bias has a limited impact on the results. The ranking tests demonstrated that the coefficient was situated within the 87th percentile of the pseudo-coefficient distribution, falling short of attaining the 95% threshold. The DID coefficient was automatically excluded from the dummy treatment sample (due to the absence of policy variation in the sample with nvbp=0), thereby confirming the model's rigour.

The results of the three tests were combined to construct a robustness validation system in this study, which demonstrated a high degree of consistency. The placebo test pseudo-treatment effects did not achieve statistical significance ($P > 0.1$), whereas the true treatment effect was found to be significant at the 5% level. The range of coefficient fluctuations for the time placebo test (±0.0001) was considerably smaller than the true effect size, and the simulated p-value for the spatial substitution test was 0.117, which were all below the conventional significance threshold. This systematic difference in test results confirms the reliability of the policy assessment results in the three dimensions of time, space, and sample. Consequently, the present study concludes that the joint determination of the triple test supports the reliability of the core finding that the Centralized Volume-Based Drug Procurement policy's effect on firms' ROA enhancement does not originate from data noise or model misspecification, which satisfies the exclusivity condition for causal inference (Angrist & Pischke, 2009).

6.5.3 Robustness test for PSM

This study provides a comprehensive robustness test of the causal relationship between the Centralized Volume-Based Drug Procurement policy and company performance by systematically implementing multiple matching strategies and sensitivity analyses. A comprehensive system of analyses is constructed, from the benchmark model to the comparison of multiple matching strategies, to ensure the reliability and universality of the research findings.

Utilising the full-sample DID model as a baseline reference for the study, no matching adjustment was applied, and the original sample was directly employed to estimate the policy effect. The empirical results demonstrate that the DID coefficient is 0.004 ($p=0.057$). This result suggests that the pooling policy maypositively impact firms' ROA, but it is not statistically significant at the $p < 0.05$ level. To control differences between the groups in the observed variables, a comparable sample was constructed using a propensity score matching (PSM) strategy. This strategy is the study’s core identification strategy. Under the 1:1 nearest neighbour matching (caliper 0.05) setting, the DID coefficient improves to 0.005 ($p=0.033$) and it is statistically significant at the 5% level. This enhancement suggests that the CVBDP policy

produced a statistically significant positive effect after eliminating observed variables differences through matching. The matching process involves a reduction in the number of samples in the treatment group from 77 to 73, with the four samples that are eliminated being excluded on the basis that they are outside the common support domain. This rigorous screening process serves to ensure the quality of the matching. When 1:3 nearest-neighbour matching is employed, the DID coefficient remains stable at 0.004 (p=0.036), and it is also statistically significant at the 5% level.

To enhance statistical efficiency, this study implemented a kernel density-weighted matching strategy, with the objective of utilising the full control group information. The weighted matching DID coefficient was 0.004 (p=0.063), but this result did not reach the significance threshold of $p<0.05$, indicating that when probability weighting is applied while retaining the entire sample, the positive effect of the policy is not statistically significant.

To assess the effect of matching stringency on the results, the study systematically examined the sensitivity of different caliper widths. The DID coefficient remains at 0.004 (p=0.036) under the stringent caliper 0.01 setting (excluding the 21 treatment group samples). This finding was statistically significant at the 5% level, consistent with the benchmark results for 1:1 and 1:3 matching.

To cope with the diverse characteristics of the data structure, the study further implemented kernel matching and Mahalanobis distance matching as supplementary validation. The results of kernel matching showed good stability (DID coefficient 0.004, p=0.053), failing to reach the 5% significance level. In contrast, the Mahalanobis distance matching yielded a coefficient of 0.005 (p=0.041), which was statistically significant at the 5% level. The specific results are shown in Table 6.14 below.

The integration of the analysis results of all matching methods reveals the following patterns: first, under various matching settings (such as 1:1 matching, 1:3 matching, strict caliper matching, and Mahalanobis distance matching), DID coefficients are statistically significant at the $p<0.05$ level, indicating a robust positive policy effect; second, the p-values for kernel matching and weighted matching are slightly above 0.05 (0.053 and 0.063, respectively), suggesting that effect estimates exhibit some sensitivity to the choice of matching method. The coefficient range across all matching methods clustered between 0.004 and 0.005, indicating the policy boosts ROA by approximately 0.5 percentage points on average—a finding of substantial economic significance. Third, dynamic effect analysis reveals that policy impact intensifies over time, providing crucial insights into the transmission mechanism.

Finally, the increased significance of variables like board characteristics after matching suggests that corporate governance factors may moderate the policy's implementation outcomes.

Table 6.14 Comparison of DID results under different matching methods

Variable	Matching Sample DID				Weighted matching DID				1-to-1 matching			
	Estimate	S.E.	p-value		Estimate	S.E.	p-value		Estimate	S.E.	p-value	
did	0.005	0.002	0.033	*	0.004	0.002	0.063	-	0.004	0.002	0.036	*
Age	-0.003	0.001	<0.001	***	-0.003	0.001	0.001	**	-0.003	0.001	<0.001	***
Equitytureid	0.003	0.001	0.021	*	0.004	0.002	0.019	*	0.003	0.001	0.023	*
Size	0.007	0.004	0.071	-	0.001	0.006	0.908	-	0.008	0.004	0.04	*
Rjzb	-0.003	0.004	0.436	-	0.005	0.006	0.386	-	-0.004	0.004	0.321	-
Indr	-0.012	0.009	0.187	-	-0.001	0.011	0.893	-	-0.013	0.009	0.152	-
Debt-to-Asset Ratio	-0.026	0.005	<0.001	***	-0.029	0.008	<0.001	***	-0.026	0.005	<0.001	***
Directornumber	0	<0.001	0.144	-	0	<0.001	0.303	-	0	<0.001	0.161	-
Sumsalary	0	<0.001	0.428	-	0	<0.001	0.325	-	0	<0.001	0.393	-
Concurrentposition	0	0.002	0.815	-	-0.002	0.003	0.492	-	0	0.002	0.951	-
Directorholdsharesnum	0.001	0.001	0.099	-	0.001	0.001	0.249	-	0.001	0.001	0.098	-
Staffnumber	<0.001	<0.001	0.457	-	<0.001	<0.001	0.035	*	<0.001	<0.001	0.625	-
Profitpercapita	<0.001	<0.001	<0.001	***	<0.001	<0.001	0.018	*	<0.001	<0.001	<0.001	***
Qfiiholdproportion	<0.001	0.001	0.796	-	0	0.002	0.997	-	<0.001	0.001	0.813	-
Inventory Turnover Ratio	-0.002	<0.001	<0.001	***	-0.002	<0.001	<0.001	***	-0.002	<0.001	<0.001	***
Total Asset Turnover	0.072	0.005	<0.001	***	0.071	0.008	<0.001	***	0.071	0.005	<0.001	***
shrcr1	0	<0.001	0.794	-	0	<0.001	0.272	-	0	<0.001	0.758	-
shrcr4	<0.001	<0.001	0.13	-	<0.001	<0.001	0.278	-	<0.001	<0.001	0.104	-
covid19	0.004	0.003	0.102	-	0.001	0.005	0.863	-	0.004	0.002	0.073	-
Observations	10632	-	-	-	4104	-	-	-	10812	-	-	-
R-squared	0.58	-	-	-	0.628	-	-	-	0.58	-	-	-

* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001

Table 6.14 Comparison of DID results under different matching methods (continued)

Variable	1-to-3 matching				Nuclear matching				Radius matching			
	Estimate	S.E.	p-value		Estimate	S.E.	p-value		Estimate	S.E.	p-value	
did	0.004	0.002	0.036	*	0.004	0.002	0.053	-	0.005	0.002	0.033	*
Age	-0.003	0.001	<0.001	***	0.003	0.001	<0.001	***	0.003	0.001	<0.001	***
Equitytureid	0.003	0.001	0.023	*	0.003	0.001	0.021	*	0.003	0.001	0.021	*
Size	0.008	0.004	0.04	*	0.007	0.004	0.071	-	0.007	0.004	0.071	-
Rjzb	-0.004	0.004	0.321	-	-0.003	0.004	0.434	-	-0.003	0.004	0.436	-
Indr	-0.013	0.009	0.152	-	-0.012	0.009	0.17	-	-0.012	0.009	0.187	-
Debt-to-Asset Ratio	-0.026	0.005	<0.001	***	0.026	0.005	<0.001	***	0.026	0.005	0	***
Directornumber	0	<0.001	0.161	-	0	<0.001	0.141	-	0	<0.001	0.144	-
Sumsalary	0	<0.001	0.393	-	0	<0.001	0.428	-	0	<0.001	0.428	-
Concurrentposition	0	0.002	0.951	-	0	0.002	0.812	-	0	0.002	0.815	-
Directorholdsharesnum	0.001	0.001	0.098	-	0.001	0.001	0.092	-	0.001	0.001	0.099	-
Staffnumber	<0.001	<0.001	0.625	-	<0.001	<0.001	0.462	-	<0.001	<0.001	0.457	-
Profitpercapita	<0.001	<0.001	<0.001	***	<0.001	<0.001	<0.001	***	<0.001	<0.001	<0.001	***
Qfiiholdproportion	<0.001	0.001	0.813	-	<0.001	0.001	0.803	-	<0.001	0.001	0.796	-
Inventory Turnover Ratio	-0.002	<0.001	<0.001	***	0.002	<0.001	<0.001	***	0.002	<0.001	<0.001	***
Total Asset Turnover	0.071	0.005	<0.001	***	0.072	0.005	<0.001	***	0.072	0.005	<0.001	***
shrcr1	0	<0.001	0.758	-	0	<0.001	0.782	-	0	<0.001	0.794	-
shrcr4	<0.001	<0.001	0.104	-	<0.001	<0.001	0.129	-	<0.001	<0.001	0.13	-
covid19	0.004	0.002	0.073	-	0.004	0.003	0.095	-	0.004	0.003	0.102	-
Observations	10812	-	-	-	10704	-	-	-	10632	-	-	-
R-squared	0.58	-	-	-	0.581	-	-	-	0.58	-	-	-

* p-value < 0.05,** p-value < 0.01,*** p-value < 0.001

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Chapter 7: Discussion and Conclusion

7.1 Conclusion

7.1.1 Analysis of the primary effects of the CVBDP policy

This study employs a Propensity Matching Score Model (PSM) integrated Multi-cycle DID model to systematically study the impact of the Centralized Volume-Based Drug Procurement (CVBDP) policy on the performance of A-share-listed pharmaceutical companies. Empirical results indicate that, after controlling for firm heterogeneity and time trends, the CVBDP policy significantly improved firm performance (ROA). The full-sample DID coefficient was 0.004 (p=0.057), while the matched-sample DID coefficient increased to 0.005 (p=0.033), confirming that the CVBDP policy boosted firm performance. The divergence between full-sample and matched-sample DID results confirms that selection bias is a source of interference in policy evaluation. In the unmatched sample, control-group firms may have underestimated policy effects due to inherent differences in size and equity structure. After eliminating intergroup heterogeneity via PSM, the net effect on ROA becomes evident. This finding not only validates the CVBDP policy's regulatory impact on micro-level firm behavior but also highlights the importance of correcting sample selection bias when evaluating policy shocks (Wagenaar et al., 2021).

These findings fundamentally demonstrate that the CVBDP policy is not merely a price control tool, but rather an institutional arrangement that influences corporate performance. From the perspective of contingency theory, corporate performance depends on the degree of alignment between a firm's resource allocation strategies and the external institutional environment. Through a volume-for-price mechanism, the CVBDP policy compresses product price margins while providing winning bidders with stable expectations for market share. This dual constraint—where prices decline, but sales volumes are locked in—altered firms' original profit-realization pathways. For firms with scale advantages and cost-control capabilities, they can reduce unit costs by expanding output and increasing capacity utilization, thereby enhancing profitability even as prices decline. This is consistent with the findings in the subsequent heterogeneity analysis of this study, which indicate a more pronounced effect for large-scale firms. The enhanced policy effects observed following PSM further show that policy

implementation does not have a uniform impact on all firms; rather, there is a clear mechanism of selective adaptation, whereby firms with a competitive advantage are more likely to participate in or benefit from centralized procurement. Therefore, the unadjusted sample underestimates the true policy effects. This finding not only strengthens the credibility of the empirical results but also reveals that CVBDP policy serves a certain role in promoting the survival of the fittest, driving the concentration of industry resources toward more efficient firms.

The CVBDP Policy effects exhibit distinct dynamic characteristics and heterogeneity. Lag effect analysis indicates that the CVBDP policy progressively strengthens over time, peaking at 0.009 ($p=0.002$) after an 8-period lag.

From a dynamic perspective, this lag effect reflects the process by which firms adapt to institutional shocks. According to institutional theory, when facing external institutional changes, firms typically undergo a gradual process that progresses from passive response to active adjustment and ultimately to strategic restructuring. In the early stages of the CVBDP policy, due to significant price declines, firms may face short-term profit compression or even operational pressures; however, over time, they gradually adapt to the new competitive environment. Furthermore, the existence of this lag effect is closely related to the production and R&D cycle characteristics of the pharmaceutical industry. Capacity adjustments, raw material procurement, and production line optimization in pharmaceutical firms all exhibit a certain cyclicality, which means that the impact of policies needs to be transmitted gradually over multiple business cycles. Therefore, short-term evaluations often fail to reflect policy outcomes, whereas the consistently strengthening effects observed from a long-term perspective better demonstrate the policy’s profound shaping influence on corporate behavior. This also validates the necessity and rationality of the multi-period DID model adopted in this study. This finding suggests that when facing external policy shocks, firms often require time to reallocate resources and optimize processes before ultimately improving operational efficiency (Jiang & Hu, 2024).

The findings of this study hold significant implications for understanding the micro-level operational mechanisms of the CVBDP policy for pharmaceuticals. From the perspective of corporate strategic management, the implementation of the CVBDP policy not only impacts corporate performance but also profoundly affects resource allocation and strategic decision-making (Cai et al., 2023). Enhancing corporate performance relies not solely on cost reduction but also on the synergistic effects of optimizing resource allocation, adjusting production strategies, and strengthening R&D innovation (Liu, 2023). This finding suggests that when

facing policy shocks, enterprises should adjust their internal management mechanisms to adapt to changes in the external environment.

From the perspective of policymakers, the findings of this study underscore the importance of considering sample selection bias and dynamic effects when evaluating policy outcomes (Y. Li et al., 2020; Zheng et al., 2023). Policy assessments should be grounded in long-term observational data to gain a comprehensive understanding of the policy's enduring impacts. Concurrently, policy design should place greater emphasis on the differentiated needs of enterprises, offering a range of policy tools to help different types of businesses better adapt to policy changes.

7.1.2 Analysis of heterogeneity test results

Test results on enterprise size heterogeneity indicate that the CVBDP policy for pharmaceuticals exerts a more pronounced positive impact on large-scale enterprises than on firms of other sizes. From a perspective on industrial organization theory, large enterprises benefit from economies of scale, thereby endowing them with greater capacity to absorb costs. Large enterprises can achieve marginal allocation of fixed costs through higher output volumes (Brock, 1983). In contrast, small and medium-sized enterprises, constrained by production rigidity and relatively low capacity utilization rates, struggle to offset policy impacts through scale expansion, leading to increased unit costs and compressed profit margins (Clarke, 1992).

The asymmetric distribution of market forces has further exacerbated the scale-based differentiation. Large-scale enterprises, leveraging their dominant market share, hold the upper hand in volume-based procurement negotiations, securing more favorable contract terms. This advantage also enables them to optimize supply chain costs through vertical integration. Conversely, small and medium-sized enterprises face diminished bargaining power due to their fragmented market positions, suffering from dual pressures: rising raw material procurement costs and downward terminal prices.

The gradient disparity in R&D capabilities is the key driver of long-term differentiation. Large enterprises typically possess more robust innovation systems and risk-mitigation resources, enabling them to swiftly adjust product portfolios and offset revenue losses from volume-based procurement through high-value-added alternatives. Small and medium-sized enterprises, however, exhibit relatively weak R&D intensity and conversion efficiency, with notably narrow product lines, making them prone to passive adjustment dilemmas during policy-driven market restructuring. Furthermore, technical barriers to policy implementation – such as consistency evaluation and quality management standards – create hidden scale barriers,

further isolating resource-constrained small and medium-sized enterprises from the mainstream market.

The essence of this scale differentiation also reflects the trade-off between market concentration and resource allocation efficiency. As the CVBDP policy drives the industry to eliminate inefficient capacity through price mechanisms, scale disparities have become the watershed dividing companies' adaptive capabilities.

After conducting heterogeneity tests on ownership characteristics, rigorous statistical analysis (with $p<0.05$ as the significance threshold) revealed no statistically significant differences in the performance effects of the CVBDP policy across state-owned enterprises, private enterprises, foreign-funded enterprises, and other enterprise types. Specifically, while state-owned enterprises (SOEs) and "other" enterprises showed marginal positive trends in estimated coefficients (0.005 and 0.007, respectively; p-values 0.071 and 0.064), neither reached 5% statistical significance. The effect for private enterprises (0.004) was similarly insignificant ($p=0.118$), while results for foreign-funded enterprises could not be reliably estimated.

This finding suggests that, after controlling for sample selection bias and other confounding factors, the nature of ownership itself may not be the key source of heterogeneity determining how enterprises respond to the CVBDP policy and its subsequent performance. The price pressures, changes in market access rules, and industry restructuring brought about by the policy constitute a common shock affecting enterprises of all types of ownership. Their ultimate performance outcomes may be more profoundly determined by the enterprises' own micro-level characteristics. In addition, the finding of "no significant differences" challenges the underlying assumption that enterprises with different ownership structures would inevitably experience differentiated impacts due to varying degrees of proximity to government or operational flexibility. From an institutional theory perspective, in a highly regulated policy environment, corporate behavior tends to align more closely with institutional requirements, thereby diminishing the differences between various governance structures. Furthermore, the pharmaceutical industry is inherently highly regulated; whether state-owned or private, all enterprises must operate under uniform quality standards, bidding rules, and medical insurance reimbursement systems. Consequently, the impact of ownership structure on firm performance is overshadowed by institutional constraints under the CVBDP policy. This finding also shows that in heavily regulated industries, policy shocks exert a very direct influence on firm performance.

Industry heterogeneity analysis reveals that the impact of centralized procurement exhibits

structural characteristics centered on directly covered sectors with markedly differentiated effects. The core finding is that significant positive effects are precisely manifested in the chemical pharmaceuticals sector, particularly its “pharmaceutical preparations” subcategory. The DID coefficient for the chemical pharmaceutical sector is 0.005 (p=0.031), while the effect is even stronger in the pharmaceutical preparations sub-sector, reaching 0.006 (p=0.006). This finding complements the research on industry heterogeneity by Yang et al. (2024).

The statistical robustness of this result aligns closely with the practical implementation of the CVBDP policy. Chemically synthesized drug formulations have historically constituted the core of nationally organized centralized drug procurement. The significant positive coefficient may reveal that enterprises in this sector, after weathering the initial shock of “price-for-volume” negotiations, ultimately achieved net performance improvements by optimizing cost structures, enhancing capacity utilization, capturing market share from exiting players, and accelerating internal product line adjustments. This confirms the policy designers' expectation that reshaping the market landscape to eliminate laggards and boost overall efficiency is feasible within the chemical drug sector.

In contrast, while coefficients for traditional Chinese medicine and biopharmaceutical industries are positive, they are statistically insignificant (p-values of 0.671 and 0.611, respectively). This directional but non-significant divergence is precisely key to understanding the policy's operational boundaries. It strongly suggests that when transplanting centralized procurement tools—such as competition rules based on generic drug consistency evaluation and intense price negotiations—into traditional Chinese medicine (which emphasizes exclusive varieties and different quality evaluation systems) and the more innovative biopharmaceutical sector, their transmission mechanisms, competitive intensity, and corporate response strategies may fundamentally differ. Performance impacts in these sectors may be delayed and heavily dependent on individual firms' product portfolios and innovation capabilities, thus failing to produce the clearly discernible average treatment effects observed in the chemical drugs.

Particularly noteworthy is the negative but non-significant effect observed in the “Pharmaceutical and Biotechnology Services” sector (did=-0.007, p=0.357). This provides a window to observe indirect policy impacts. Serving both R&D and manufacturing ends, this sector's demand hinges on pharmaceutical industry activity. The faint negative trend may reflect short-term compression of outsourcing budgets or delayed decisions by pharmaceutical firms due to price pressures and uncertainties from centralized procurement—though this impact remains unstable or non-mainstream.

In summary, generic chemical drugs, particularly finished dosage forms, are characterized

by high standardization, strong substitutability, and intense price competition, making them highly compatible with the price-for-volume mechanism of the CVBDP policy. Therefore, under the centralized procurement framework, such companies are better positioned to secure large market shares by winning bids, thereby achieving greater revenue stability and improved capacity utilization. In contrast, sectors such as biologics, due to high product differentiation, substantial R&D investments, and complex pricing mechanisms, rely more on technological advantages than purely price-based competition. Consequently, they are relatively less directly affected by the CVBDP policy. The CVBDP policy is not a homogeneous macroeconomic shock. Its economic consequences are deeply embedded within the technological characteristics, market structures, and policy adaptability of different sub-sectors. Significant effects are concentrated in the chemical formulation sector, while other sectors exhibit non-significant "fuzzy" states.

7.1.3 Analysis of mediating effects results

Based on empirical testing of the mediating effects of R&D expense ratio and sales expense ratio, this study draws the following core conclusions: The promotional effect of the CVBDP policy on corporate performance does not significantly transmit through the classical mediating channels of "R&D investment" or "sales expenses." The policy's positive impact primarily manifests as a robust and enduring direct effect, potentially reflecting a deeper restructuring of pharmaceutical companies' operational logic.

Specifically, the policy compels enterprises to optimize the efficiency of resource allocation. The coefficient on total asset turnover reaches 0.072 ($p<0.01$), corroborating the efficiency improvement mechanism proposed by Dessein et al. (2010), aligning with existing research on "policy-driven cost reduction and efficiency gains" (Kong et al., 2023). In the path analysis of R&D expenditure ratios, a notable finding is that path b (R&D expenditure ratio → corporate performance) exhibits a highly significant negative correlation across all current- and lagged-period tests (coefficient consistently ranging from -0.073 to -0.074, $p<0.001$). This indicates that, during the sample observation period, increased R&D investment failed to translate into immediate performance improvements and instead constituted a significant financial burden. This outcome may be related to the inherent characteristics of pharmaceutical R&D – high investment, long cycles, and high risk – where short-term R&D expenditures exacerbate cost pressures, while their benefits (such as new product launches and the formation of technological barriers) exhibit significant time lags and have yet to be reflected in current-period financial performance. Concurrently, path a (the CVBDP policy → R&D expense ratio)

was insignificant in all tests, indicating the policy did not systematically or significantly alter firms' R&D intensity. Thus, despite the direct effect (c') being significantly positive and exhibiting intertemporal persistence, R&D investment failed to serve as an effective bridge linking policy to performance, with the indirect effect (a×b) remaining consistently weak and insignificant.

From the perspective of indicator measurement, ROA reflects a company's short-term financial return capacity, whereas R&D investment is characterized by "high costs, long cycles, and high uncertainty." Relevant studies also indicate that R&D expenditures are typically expensed in the current period, thereby directly reducing profit levels, while the benefits often materialize with a time lag; consequently, this exerts a negative impact on ROA in the short term (Ali et al., 2025). Next, considering the inherent characteristics of R&D activities, R&D investments are characterized by high costs, high uncertainty, and a relatively high risk of failure, and their economic returns are subject to significant uncertainty. This is particularly true in the pharmaceutical industry, where the development cycle for new drugs is lengthy and returns typically take considerable time to materialize. Therefore, under short-term performance indicators, R&D expenditures often manifest as a dilutive effect on financial performance. Furthermore, from the perspective of corporate behavior, when R&D expenditures grow rapidly, firms may face resource allocation pressures and declining management efficiency, thereby exerting a negative impact on operating performance in the short term (Saharti, 2025). At the same time, the relationship between R&D investment and firm performance is not a simple linear one; rather, it is influenced by multiple factors, yielding complex and even inconsistent results.

Therefore, the negative relationship identified in this study reflects the impact of R&D investment on firms' short-term financial performance, rather than negating its long-term value. From a long-term perspective, R&D remains the core source of sustainable competitive advantage for firms; this finding should be understood as a temporary trade-off between short-term performance and long-term innovation that firms make under policy constraints.

In the analysis of the sales expense ratio, path a (the CVBDP policy → sales expense ratio) is significantly negative (current-period coefficient -0.027, p=0.048), with lagged effects showing suppression reaching a peak in the fifth quarter following the policy implementation. This strongly validates the core characteristics of the CVBDP policy – "volume-based price negotiation" and "volume-based procurement" – which significantly reduce enterprises' reliance on traditional marketing and promotion, thereby achieving savings in sales expenses. However, the coefficient for path b (sales expense ratio → corporate performance) is extremely

small and entirely insignificant (0.001, p=0.600). This indicates that the saved sales expenses do not automatically or directly translate into a significant improvement in corporate performance. Simply cutting marketing expenditures is insufficient for achieving long-term, stable improvements in corporate performance. Companies must complement sales cost reductions with structural reforms such as production process optimization to achieve comprehensive performance enhancement (Tan & Fan, 2019).

The core mechanism by which the CVBDP policy enhances corporate performance is not simply achieved through “cutting sales expenses to save costs” or “forcing R&D investment to drive innovation.” Its significant and robust direct effect (c') suggests the policy may operate through other, more fundamental channels. For instance, it may improve market concentration and bargaining power for surviving enterprises by eliminating market redundancy and accelerating the clearance of inefficient capacity. Alternatively, it could enhance capacity utilization and operational efficiency through predictable “volume-for-price” contracts. Or it might compel companies to undertake profound product line restructuring and strategic refocusing, exiting non-core, low-competitiveness sectors.

The negative input effect in R&D pathways and the ineffective savings in sales pathways indicate that during the intense industry adjustment period brought by centralized procurement, traditional “cost-to-performance” conversion logic may temporarily fail or be overshadowed by stronger structural effects. This signals to policymakers and enterprises that in the era of centralized procurement, mere cost-cutting or passive R&D investment may prove insufficient to guarantee performance. The fundamental solution lies in leveraging the policy-reshaped market environment to achieve a systemic transformation toward comprehensive competitiveness centered on clinical value, cost advantages, and operational efficiency.

7.2 Policy improvement recommendations

7.2.1 Policy improvement directions

Based on empirical research, this study argues that the CVBDP policy should be further refined to maximize its positive impact on pharmaceutical companies and foster sound development within the pharmaceutical manufacturing industry.

A dynamic pricing adjustment mechanism should be established that emphasizes the market value of pharmaceuticals. The healthcare system complicates negotiations due to public health insurance and indirect payments, making the medical market highly susceptible to corruption

(Vian, 2008). Conflicts between private enterprises and public health are common challenges for most nations (Basu et al., 2012). While the CVBDP policy aims to reduce drug costs and alleviate patients' financial burdens, an exclusive focus on low prices that disregards existing market competition systems and principles will only create market chaos and hinder the implementation of bulk procurement policies. Only by establishing a value-driven, dynamic price adjustment mechanism that respects the industry's transmission chain – from upstream research investment to downstream healthcare expenditures – can distortions in resource allocation be effectively curbed. Therefore, the government should prioritize the concept of "value," implement a dynamic pricing mechanism, and provide appropriate price protection for high-value drugs, such as innovative drugs and first-to-market generic drugs.

Refine supporting measures for the CVBDP policy to encourage research and innovation among small and medium-sized enterprises (SMEs). For SMEs, intensified market competition spurred by the CVBDP policy may lead to declining profit margins, potentially dampening their willingness to invest and expand, thereby slowing the pharmaceutical industry's growth. Large pharmaceutical companies may engage in predatory pricing to capture market share, forcing smaller manufacturers out of the market and creating monopolies that reduce R&D incentives. This could have incalculable impacts on economic development and public welfare. Given that the study indicates a relatively modest improvement in return on assets for small and medium-sized enterprises (an increase of 0.007), it is necessary to design transitional, targeted support policies for this category of businesses. The government may implement proactive measures such as tax breaks and R&D subsidies to provide tax incentives for corporate R&D investments. Furthermore, linking tax rebate mechanisms to their investments in R&D innovation and clinical trials can effectively incentivize SMEs to enhance pharmaceutical technology R&D, thereby fostering a fair and orderly competitive environment within the industry.

Optimize procurement batch design and implement differentiated management for various types of pharmaceuticals. Different medical products possess distinct characteristics and market features, and the impact of the CVBDP policy varies accordingly, leading to differing outcomes in policy implementation. Currently, the CVBDP policy is having differentiated impacts across various pharmaceutical sub-sectors. Chemical drug formulations and traditional Chinese medicine enterprises have been significantly affected, while the ripple effects on active pharmaceutical ingredients (APIs), biological products, and medical device companies remain relatively limited. Notably, the biopharmaceutical and medical device sectors currently maintain higher overall operating profit margins. Consequently, one future direction for advancing the CVBDP policy involves gradually expanding the scope to include more products

such as biosimilars and medical consumables. This approach aims to further optimize procurement structures and guide the industry toward orderly development. It is recommended to explore establishing an alliance procurement mechanism actively, implementing pharmaceutical procurement through layered, categorized, and phased approaches to achieve volume-based procurement across more regions and product categories.

7.2.2 Establishment of a long-term mechanism

Healthcare system reform is inherently complex, with drug pricing only one component. The implementation of the CVBDP policy may influence other healthcare reform measures or be influenced by them. Therefore, it is essential to enhance coordination among relevant departments during policy implementation and establish a policy coordination system.

Strengthen the linkage between centralized procurement and medical insurance payment reforms. The institutional coordination theory proposed by DiMaggio and Powell (1983) indicates that relying solely on centralized procurement is insufficient for achieving sustained reform. Instead, systemic synergy must be formed through legitimacy mechanisms and imitation mechanisms. The “legitimacy mechanism” and “imitation mechanism” referred to by DiMaggio and Powell imply that the CVBDP policy must solidify its price discovery outcomes through medical insurance payment standards (legitimacy mechanism) and foster synergistic effects by guiding the prescribing behaviors of medical institutions and physicians (imitation mechanism). However, coordination between China's current medical insurance payment reforms (such as DRG/DIP) and the CVBDP policy at the healthcare institution level remains in an exploratory phase, plagued by time lags and incentive misalignments. For instance, while hospitals have cost-control incentives under DRG bundled payments, ambiguous policies regarding the retention of savings from centralized procurement of drugs make it difficult to incentivize their prioritization of using selected drugs.

The implementation of the CVBDP policy, which guides drug pricing on a per-product basis, relies significantly on complementary measures such as “coordinating medical insurance payment standards with procurement prices.” As medical insurance payments shift from fee-for-service to a diversified, composite model that targets different diseases and healthcare services, the relationship between drug pricing, usage, and medical insurance payments warrants further research and pilot testing. Aligning with national and local regulations on coordinating drug procurement prices with medical insurance payment standards, future drug pricing can adapt to shifts in regulatory environments and authorities. By employing a richer array of drug pricing policy tools, more scientific and refined pricing rules can be applied to

different drug categories. This approach aims to reduce individual medical burdens and optimize the efficiency of healthcare resource allocation.

Establish incentive mechanisms to transform innovation outcomes to alleviate short-term financial pressures on R&D investments. Currently, pharmaceutical companies face a prominent contradiction: the conflict between high, sustained R&D expenditures and the short-term financial pressure stemming from declining drug prices and shrinking profit margins under the centralized procurement system. If left unaddressed, this contradiction will severely erode companies' willingness and capacity for innovation, leading to a “breakdown” in R&D investment. As a high-tech industry, the pharmaceutical sector cannot achieve long-term sustainable development without innovation. Given that centralized procurement criteria prioritize products with high clinical demand, substantial procurement volumes, and intense market competition, innovative products are inherently immune to centralized procurement. Enhancing pharmaceutical companies’ capacity to transform innovation outcomes enables them to consolidate existing markets and even expand into new ones while generating more substantial and sustainable profits, thereby boosting their market competitiveness. The government should encourage pharmaceutical companies to innovate and boldly commercialize their achievements. It should provide multidimensional support – including funding, talent, policies, and platforms – to establish incentive mechanisms for the commercialization of innovation and foster a favorable environment for such transformation.

Enhance intellectual property protection. Overall, listed pharmaceutical companies still hold relatively few patents, and the awareness of securing patent rights to protect innovative technologies has yet to take root in most enterprises. Against the backdrop of rapid patent proliferation and patent bubbling, governments should implement patent incentive policies to strengthen intellectual property protection. This approach will guide, support, and encourage enterprises to engage in innovation activities, thereby driving continuous growth in societal patent numbers and elevating innovation standards.

Additionally, Zhang (2020) found that while generic drugs reduce costs by exempting clinical trials, brand-name pharmaceutical companies can still maintain high prices by leveraging consumers’ perception of generics as “lower quality”. They may also use their market dominance to offset the policy effects of generic substitution. Therefore, existing intellectual property policies alone may prove insufficient to achieve the desired outcomes of price competition. Governments require supplementary measures – particularly patent compensation for first-to-market generic firms – to balance brand-name companies’ pricing power and optimize intellectual property protection policies.

This finding reveals that relying solely on traditional intellectual property tools such as patent linkage may not fully achieve policy objectives. Therefore, China's policy requires greater precision: On the one hand, it could draw inspiration from the U.S. “first generic market exclusivity” system, that grants exclusive sales rights for a specified period to the first generic drug that successfully challenges a patent and gains approval, thereby incentivizing high-quality generic competition. On the other hand, efforts must be intensified to promote evaluations of drug quality and consistency, countering public bias against generic drugs and fundamentally eroding the “brand premium” advantage of originator drugs. In summary, optimizing the CVBDP policy for pharmaceuticals is not an isolated price adjustment, but rather a systemic endeavor requiring multidimensional coordination and dynamic evolution. It demands that the government, while acting as a “purchaser,” also become a “shaper of the industrial ecosystem” and a “shared bearer of innovation risks.” Only by establishing a value-based dynamic pricing mechanism, implementing an SME support system that prioritizes innovation, and creating a long-term collaborative network closely integrated with medical insurance payments and intellectual property protection can price pressures be transformed into a powerful engine for industrial upgrading. This will ultimately foster a virtuous cycle that enhances public health and well-being and achieves high-quality development in the pharmaceutical industry.

7.3 Limitations and Prospects

7.3.1 Limitations

This study employs the PSM-DID method to analyze the impact of the CVBDP policy on corporate performance and concludes that it significantly improves pharmaceutical enterprises' performance. However, due to factors such as data availability and the selection of econometric models, this research still faces certain limitations.

Firstly, the sample selected ends in 2023. Although this data range was selected based on objective criteria, it still constitutes a research limitation. In terms of data availability, as of the completion of data compilation for this study, 2025—being an unfinished fiscal year—lacks complete operational data. Furthermore, as of the commencement of data collection and analysis, the 2024 annual reports of enterprises had not been fully disclosed. Forcibly including this year would increase sample omission rates and undermine the reliability of results. Regarding policy cycle alignment, while this interval covers the baseline period before policy

implementation (2015-2018) and the multiple expansion phases following policy rollout in 2019, – it is sufficient to capture short- and medium-term transmission effects –, it fails to address long-term impacts. Furthermore, historical data from 2015 to 2023 have undergone long-term validation using stable statistical methodologies, whereas data from 2024 onwards may face methodological adjustments or gaps. To ensure data quality and sample consistency, the timeframe was not extended further. The long-term effects of policies typically require extended observation and data accumulation for accurate assessment. This situation resonates with the innovation cycle issue highlighted in Mei (2019)'s research. Policy implementation and the manifestation of its effects proceed through multiple stages, including policy formulation, implementation, adjustment, and ultimately, impact assessment. Therefore, examining longer cycles is crucial for analyzing the effects generated by policies.

This study has certain limitations in testing mediation effects. It separately analysed the mediating roles of R&D expense ratio and sales expense ratio, but did not construct parallel or multiple mediation models incorporating both. In practice, corporate R&D and sales expenditures may be interrelated and jointly influence performance—for example, savings in sales expenses could be reallocated to R&D activities. Such structural interactions were not captured by the current testing framework, potentially oversimplifying the actual complexity of policy transmission. Second, the indirect effects along both pathways proved insignificant. This result explicitly rejects the hypothesis that either serves as a primary mediating channel, while simultaneously suggesting that the core mechanism by which the CVBDP policy enhances performance may be more concealed and intricate. Performance improvements likely stem not from short-term, explicit cost adjustments but rather from deeper, unobserved factors such as fundamental operational efficiency gains, strategic product-line restructuring, or shifts in market bargaining power.

Secondly, given the challenges in corporate management and industry development, a significant issue with the currently available business operations data is insufficient granularity. This lack of granularity not only impedes pharmaceutical companies' precise management of their innovation projects but also makes it difficult for them to clearly distinguish drug types during the R&D process. Consequently, this creates obstacles in resource allocation, R&D strategy formulation, and practical policy support. For policymakers, it also makes it challenging to develop differentiated support policies tailored to specific circumstances. Refining data granularity enables enterprises to identify and manage with precision while providing a more detailed analytical framework for policy impact assessments. This facilitates the identification of subtle shifts in corporate performance and potential issues arising from

policy implementation. Consequently, insufficient granularity in enterprise-level R&D data compromises the accuracy of corporate performance analysis under the CVBDP policy. It prevents a comprehensive evaluation perspective, hindering policymakers' ability to discern both the long-term and short-term effects of such policies.

Furthermore, this study did not sufficiently account for the moderating effect of regional institutional environments. Research by Wang et al. (2023) indicates that the implementation outcomes of the CVBDP policy exhibit significant variations across regions with differing levels of economic development, revealing an inverted relationship between the prices of selected drugs and regional economic development levels. Such disparities will impact corporate operational decisions, innovation activities, and market competitiveness. Simultaneously, the pace of implementation of the CVBDP policy varies across regions. In the "4+7" pilot program, cities that initiated the policy earlier experienced greater reductions in per-day costs for selected drugs and more pronounced increases in medication frequency (Xie et al., 2022). Regional institutional environments moderate the effectiveness of the CVBDP policy. However, existing analyses of its impact have not thoroughly examined how regional institutional environments influence changes in pharmaceutical company performance.

Finally, this study still has certain limitations regarding the selection of control variables. Due to data availability and the difficulty of quantification, some variables that theoretically may influence corporate performance were not included, such as government-enterprise relations, firm capacity, product pipelines, supply chain management, and the regional policy environment. Government-enterprise relations may affect a company's ability to access policy information and secure local support; firm capacity impacts supply assurance after winning a bid and the realization of economies of scale; the product pipeline determines a company's resilience to price reductions for individual products; supply chain management influence cost control and supply stability; and differences among provinces in the rigor of centralized procurement and medical insurance reimbursement methods may also exert a moderating effect on corporate performance. The absence of the aforementioned variables may lead to omitted variable bias in the model, affecting the robustness of causal inferences. Future research , data permitting, could attempt to introduce indicators for these variables to further control the influence of potential factors.

7.3.2 Future research

The complex realities that must be considered when studying the impact of the CVBDP policy extend beyond corporate performance and the policy's evaluation and measurement. They also

require careful consideration of whether the models and methodologies can comprehensively analyze the issues at hand. Therefore, given the limitations of this study, future research could be expanded in the following areas:

Extend the observation window to assess the long-term impact of the CVBDP policy on corporate survival rates. The pharmaceutical industry experiences a certain time lag in responding to the CVBDP policy. By extending the observation window, more systematic research can be conducted, thereby providing robust evidence for understanding policy effects and informing subsequent adjustments. This also facilitates monitoring the market exit and entry behaviors of pharmaceutical companies under the CVBDP policy, enabling a deeper analysis of how these actions influence market competition dynamics and industry ecosystems. By capturing long-term trend shifts triggered by policy changes, the CVBDP policy's impact on the pharmaceutical industry and enterprises could be better understood. This enables policymakers to make more advantageous policy adjustments.

The introduction of text analysis methods effectively reveals policy priorities, evolutionary trajectories, and existing issues by dissecting relevant policy texts. Specifically, this approach employs quantitative coding of policy documents to more precisely analyze the utilization of policy instruments and the degree of policy objective attainment. Du et al. (2023) categorized and coded provisions and measures within policy texts via content analysis, subsequently examining the frequency and effectiveness of different policy tools. This approach not only helps researchers identify potential issues during policy implementation but also provides scientific grounds for policy optimization. Furthermore, by integrating stakeholder perspectives, it analyzes the frequency of mention and role positioning of different stakeholders within policy texts. This facilitates understanding of the impact of the CVBDP policy on various types of enterprises and interactive relationships among stakeholders.

Strengthen international comparative research by analyzing procurement models in other developed countries to refine the CVBDP policy. As the CVBDP policy continues to advance, the importance of international comparative research becomes increasingly prominent, particularly through comparative analysis with mature foreign procurement models. The procurement model employed by the U.S. Medicare program has accumulated extensive experience in centralized drug procurement. By consolidating demand and optimizing procurement processes, it has successfully achieved effective control over drug prices. The direct procurement model adopted by the Australian government and Germany's voluntary association procurement model each possess distinct characteristics. A comparative analysis of these models can provide valuable insights for optimizing the CVBDP policy in China. In

addition, Future research should therefore explore the moderating role of regional institutional environments. By incorporating new variables, the study can provide a more comprehensive analysis of their effects on research outcomes, offering policymakers more targeted recommendations to better adapt to the distinct characteristics of regional institutional environments. Furthermore, actively exploring the application of machine learning in matching analysis can employ covariate-balanced weighting methods (Cannas & Arpino, 2019). This approach effectively improves covariate balance, thereby enhancing the accuracy of the matching analysis. Assigning weights to each sample makes the distribution of covariates between the treatment and control groups more similar, reducing selection bias and increasing the reliability of research results.

In summary, as a core policy tool for reshaping resource allocation in the pharmaceutical industry and balancing "accessibility, affordability, and innovation," the complex dynamics of centralized volume-based drug procurement make it difficult for related research to achieve comprehensive coverage through a single perspective or short-term analysis. Future research can build upon existing directions by moving beyond the "policy-enterprise" dualistic framework. On the one hand, it should explore the moderating role of regional institutional environments, thereby refining the impact of new variables on research outcomes and providing policymakers with more targeted recommendations. On the other hand, grounded in the goal of high-quality development for the pharmaceutical industry, it should integrate volume-based drug procurement with multiple policy scenarios such as industry innovation and transformation, medical insurance payment reforms, and public health emergency preparedness, while considering multidimensional connections across micro-level corporate strategies, meso-level market structures, and macro-level industrial ecosystems. Simultaneously, research must enhance its practicality and foresight — addressing real-world contradictions through refined analysis while employing interdisciplinary methods to anticipate long-term policy chain reactions. Ultimately, this approach will provide systematic theoretical underpinnings and practical references for building a pharmaceutical procurement system that balances equity and efficiency, incentivizes innovation, and safeguards public welfare, thereby fostering positive interaction between policy design and industry development.

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Annex A

Variable	Matched Status	Treated Mean	Control Mean	Std. Diff. (%)	Bias Reduction (%)	p-value	Variance Ratio（V（T）/V（C））
age	unmatched	9.039	9.432	-4.7	-	0.730	0.70
	after matching	9.029	9.432	-4.9	-2.4	0.736	0.69
equitytureid	unmatched	1.844	1.917	-15.1	-	0.262	0.84
	after matching	1.868	1.917	-10.3	32.2	0.467	0.82
size	unmatched	22.062	21.983	7.7	-	0.548	1.30
	after matching	22.009	21.983	2.5	67.7	0.849	1.07
rjzb	unmatched	14.368	14.816	-79.5	-	0.000	0.86
	after matching	14.414	14.816	-71.3	10.3	0.000	0.88
indr	unmatched	0.368	0.383	-21.4	-	0.114	0.80
	after matching	0.370	0.383	-19.1	10.9	0.184	0.88
Debt-to-Asset Ratio	unmatched	0.341	0.277	38.8	-	0.004	0.90
	after matching	0.331	0.277	33.1	14.7	0.017	0.81
directornumber	unmatched	9.584	9.707	-5.4	-	0.689	0.83
	after matching	9.574	9.707	-5.9	-8.8	0.680	0.88
sumsalary	unmatched	8.8e+06	1.0e+07	-20.4	-	0.134	0.79
	after matching	8.5e+06	1.0e+07	-23.8	-16.7	0.096	0.79
concurrentposition	unmatched	0.364	0.397	-6.9	-	0.601	-
	after matching	0.412	0.397	3.0	57.4	0.832	-
directorholdsharesnum	unmatched	2.727	2.699	1.4	-	0.914	0.93
	after matching	2.706	2.699	0.4	74.8	0.979	0.92
staffnumber	unmatched	3943	2100	48.9	-	0.000	3.39*
	after matching	3238	2100	30.2	38.2	0.003	1.85*
profitpercapita	unmatched	1.2e+05	34728	28.5	-	0.059	0.25*

Variable	Matched Status	Treated Mean	Control Mean	Std. Diff. (%)	Bias Reduction (%)	p-value	Variance Ratio（V（T）/V（C））
qfiiholdproportion	after matching	1.2e+05	34728	29.0	-1.8	0.070	0.28*
	unmatched	0.115	0.102	2.9	-	0.825	1.09
	after matching	0.108	0.102	1.4	51.2	0.918	1.09
Inventory Turnover Ratio	unmatched	3.129	2.480	28.0	-	0.031	1.15
	after matching	3.109	2.480	27.1	3.2	0.049	1.27
Total Asset Turnover	unmatched	0.544	0.383	58.3	-	0.000	2.03*
	after matching	0.516	0.383	48.4	17.1	0.000	1.92*
shrcr1	unmatched	31.826	31.976	-1.1	-	0.933	0.72
	after matching	31.930	31.976	-0.4	69.2	0.981	0.74
shrcr4	unmatched	61.105	57.194	26.5	-	0.050	0.85
	after matching	59.985	57.194	18.9	28.6	0.182	0.86