Whether the public procurement policy can increase R&D innovation in the pharmaceutical enterprises

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ABSTRACT. In November 2018, with the implementation of drug quantity Purchase in ' 4 + 7 ' pilot cities, China 's drug purchase system stepped into a new level. With the continuous advancement of China 's drug public procurement policy, the situation of the pharmaceutical industry has changed tremendously. The days when companies rely on generic drugs to obtain high profits are gone, and innovation has become the only way for pharmaceutical companies to develop. By selecting the data of listed companies in the pharmaceutical industry from 2015 to 2021 as a sample, this paper uses the SRD to study the correlation between the drug public procurement policy and the R&D innovation of the pharmaceutical enterprises. And the empirical result shows that the public procurement policy has a positive effect on them, and it is still established after a series of robustness tests. Based on the results, we put forward some policy recommendations.

KEYWORDS: Public procurement policy, Pharmaceutical enterprises, R&D investment, Regression discontinuity design

1 INTRODUCTION

Since the reform and opening up, China 's pharmaceutical industry has ushered in a golden period of development. The pharmaceutical manufacturing industry has risen rapidly, and it has shown a rapid growth trend in terms of industry revenue scale, total profit and pharmaceutical production technology level. However, it is worrying that although the development of the pharmaceutical industry is obvious to all, it also derives many problems.

Firstly, although the scale of the pharmaceutical industry continues to expand, the development of the industry has been in an unbalanced state for a long time, and the basic R & D capabilities are weak. Due to the large amount of capital investment required in the early stage of new drug research and development, most enterprises choose to avoid risks to do generic drugs, resulting in the whole industry falling into the quagmire of homogenization and low-level generic competition[1,2]. Secondly, in 2020, China 's total medical and health expenses exceeded 7 trillion yuan, and GDP accounted for 7.12 %. With the continuous aging of the population, China 's medical expenses continue to grow, which has brought great pressure to China 's medical

B. K. Kandel et al. (eds.), *Proceedings of the 2023 3rd International Conference on Business Administration and Data Science (BADS 2023)*, Atlantis Highlights in Computer Sciences 19,
https://doi.org/10.2991/978-94-6463-326-9_6

insurance funds and patients. Therefore, reducing costs and improving innovation have become an urgent problem for the pharmaceutical industry.

Luckily, the public procurement policy came into being. The centralized procurement system with quantity refers to the negotiation of drug procurement by the government on behalf of public hospitals. Through the " collective bidding " mode of pharmaceutical enterprises in the bidding process, the implementation of centralized procurement with quantity can play a " quantity for price " role, and the price of related winning drugs has been greatly reduced[3]. Whether it is from the reaction of the capital market or the changes in the operation of pharmaceutical companies, the impact of the policy on the pharmaceutical enterprises is undoubtedly profound and complex. But can public procurement take the responsibility of reducing costs and enhancing innovation? From the perspective of foreign experience, Jani Saastamoinen et al. ' s data analysis of several low and middle-income countries found that public procurement will lead to a decline in drug prices[4,5]. Scholars such as Yuanyuan An et al. have found that the six rounds of drug control by 2022 have involved thousands of drugs, and the average price of the winning drugs has been reduced by more than 50 %. The effect of cost control is very significant [6]. For the latter, it is the problem to be discussed later in this article.

Research significance: Innovation is the lifeblood of enterprise development, especially for the pharmaceutical enterprises. Compared with foreign countries, the innovation ability of Chinese pharmaceutical enterprises is very low. According to the data, in 2018, the overall R & D investment of China 's top 100 pharmaceutical companies was only about 40 billion yuan, which was less than the R & D investment of a foreign pharmaceutical company such as Novartis and Roche. The public procurement policy is a major decision for the country to deepen the medical reform, and its great purpose is to promote the research and innovation of the pharmaceutical enterprises. For more than two years, what is the specific effect of the implementation of the public procurement policy? We need to explore and verify. Here, we focus on the relationship between them, which has strong practical significance.

2 THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

Nowadays, science and technology have the most productivity. In order to achieve high-quality development, R & D innovation should be put in the first place. Combined with the theory of enterprise innovation and the theory of core competitiveness[7,8], it is applied to high-tech industries such as medicine. Its core competitiveness is usually reflected in drug innovation. Innovative drugs are the core advantage of pharmaceutical enterprises. However, R & D innovation in pharmaceutical enterprises is a ' high investment, high risk, high profit ' activity. The early investment of R & D is not only huge, and there is almost no possibility of recovery, the cost of the failure is huge. However, once innovative drugs are developed, the returns to the enterprise are also rich. Therefore, for pharmaceutical enterprises, in order to form core competitiveness, they must actively invest in R & D and successfully convert R & D investment into output.

It can be learned from the introduction that the implementation of the public procurement policy has greatly reduced the price of generic drugs, and the original operating environment of enterprises has been damaged. If enterprises do not build their own core competitiveness and take more market share and profits from R & D innovation, enterprises will be more and more difficult to survive. In this background, almost all the scholars have a consistent view on the relationship between the public procurement policy and the R & D innovation of enterprises, that is, the public procurement policy has a positive driving effect on R & D innovation in the pharmaceutical enterprises. For example, Min Luo believe that the pharmaceutical industry is deeply affected by the policy. the public procurement policy has greatly reduced the profit space of generic drugs. The situation of surviving on generic drugs alone is becoming more and more severe. Enterprises have to accelerate the pace of transformation and increase R & D investment [9]. Based on the theory of countervailing power, Jiabin Ding clearly explained that the buyer 's countervailing power of the procurement platform reduced the wholesale price of drugs and the profits of pharmaceutical companies, thus forcing pharmaceutical companies to improve innovation efficiency[10]. In summary, whether it is active innovation or passive innovation, innovation has become an unavoidable proposition for every pharmaceutical enterprise.

Based on the research and theory of various scholars, this paper puts forward the research hypothesis H1: the public procurement policy can improve the R&D innovation in the pharmaceutical enterprises.

3 RESEARCH DESIGN

3.1 Sample selection and data sources

All the data used in this paper are from the CSMAR database, and the relevant data of A-share listed companies in the pharmaceutical manufacturing industry from 2015 to 2021 are selected, including R & D expenses, total assets, total liabilities, owner 's equity, operating revenue, net profit and monetary funds. In addition, in data processing: (1) this paper eliminates ST and * ST enterprises; (2) In order to ensure that the sample size is sufficient and the integrity of the data indicators, some enterprises with serious lack of data indicators are deleted. (3) In order to ensure the rationality and fairness of the sample, some pharmaceutical companies such as Yunnan Baiyao and PianZaiHuang can be almost identified as not affected by the policy. The sales terminals of the enterprises represented by the former are located in pharmacies rather than public hospitals, while the enterprises represented by the latter rely on exclusive patent to monopolize the market. Both are not meet the public procurement conditions. Finally, a total of 225 listed companies were selected as samples, and 1456 unbalanced panel data were obtained. Data is processed and analyzed by stata17.

3.2 Variable measurement

3.2.1 Explanatory variable. The core explanatory variable is set as the time when the collection policy is first implemented, and the dummy variable D_i is introduced to

indicate whether company i is affected by the procurement policy. The year of company i 's R & D investment is recorded as x, and c = 2018 is taken as the time node.

3.2.2 Explained variable. We consider R & D investment, and select the ratio of current R & D investment to main business income as the proxy variable of the explanatory variable, the symbol is rnd.

3.2.3 Control variables. In order to minimize the measurement errors caused by endogenous problems, and refer to the selection methods of Qiuyu Zhang's related research[11], five other variables that may affect R & D of the enterprises are selected as control variables, including enterprise size (size), asset-liability ratio (lev), return on net assets (roe), capital intensity (cap) and monetary capital (cash).

In summary, the main variables and explanations selected in this paper are shown in Table 1.

Table 1. Variable Definition

Type	Name	Variable	Definition
Explanatory Variable	Public procurement policy is implemented	D_i	2018 is the breaking point
Explained Variable	R&D expenditure	rnd	R & D expenses / operating revenue
Control Variables	Enterprise scale	size	Ln(total assets)
	Asset-liability ratio	lev	Total liabilities / total assets
	Return on net assets	roe	Net profit / owner 's equity
	Capital intensity	cap	Total assets / operating revenue
	Capital intensity	cash	Monetary funds / total assets

3.3 Model selection

In order to verify the hypothesis, this paper uses sharp regression discontinuity for empirical research, and the regression model is following:

$$rnd_i = \alpha + \beta (x_i - c) + \delta D_i + \gamma (x_i - c) D_i + \sum_{k=1}^{5} \lambda_k Z_{k\,i} + \varepsilon_i \quad (i=1,\ldots, n) \tag{1}$$

Z is a series of control variables, and ε is white noise. In order to allow the slopes of the regression lines on both sides of the breakpoint to be different, the interaction term $\gamma(x_i\text{-c})\ D_i$ is introduced, and the equation is linearized and regressed. The estimator of the local average treatment effect (LATE) at x = c is obtained.

4 EMPIRICAL RESULTS AND TESTS

4.1 Descriptive statistic

Table 2 is the descriptive statistical results of sample data, including mean, standard deviation, minimum, maximum and sample number. It can be seen that the situation between the pharmaceutical enterprises is largely different, which indicates that the sample is representative to a certain extent. It can be seen from the standard deviation

that compared with the control variables, the fluctuation degree of the dependent variables is smaller, it indicates that different enterprises have certain similarities in R & D behavior, which verifies the rationality of the policy 's influence on the whole industry.

Table 2. Descriptive Statistic

Variables	Mean	Sd	Min	Max	N
lev	0.309	0.164	0.0143	0.886	1,456
cash	0.188	0.120	0.000729	0.676	1,456
size	21.91	1.051	18.62	25.26	1,456
roe	0.0742	0.232	-6.580	0.666	1,456
cap	2.442	2.274	0.143	43.63	1,456
rnd	0.0516	0.0404	0.00259	0.243	1,456

4.2 Main effect regression

Figure 1 shows the annual change table of R & D investment in China 's pharmaceutical industry. It can be seen that the upward trend of R & D investment was relatively stable before 2018, but there was a significant rise in 2018. Although the explained variable index is the ratio of R & D investment to operating revenue, the discontinuity effect is foreseeable when the industry 's operating revenue remains stable.

Figure 2 is the linear fitting and quadratic fitting results of the result variable and the driving variable of the sample data. From the diagram, it can be clearly seen that the result variable skips at the breakpoint, which further verifies the possibility of discontinuity effect.

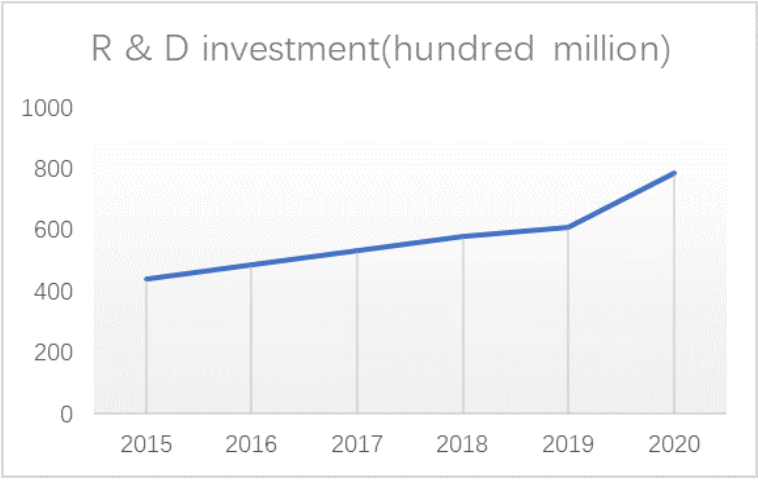

Fig. 1. Annual Change Table of R & D Expenditure in Pharmaceutical Industry

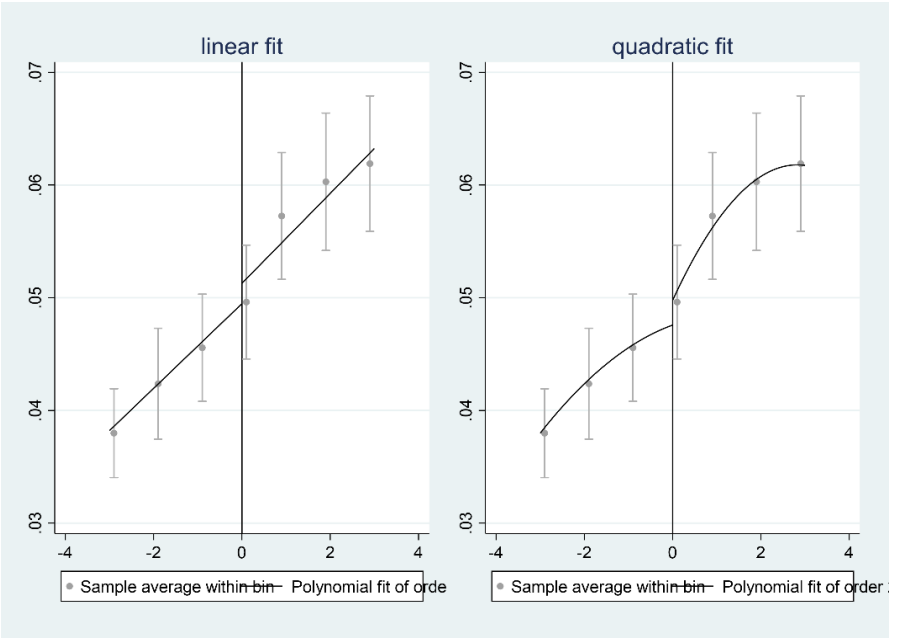

Fig. 2. Linear fitting and Quadratic fitting Results of Outcome Variables and Driving variables

Table 3 is the main effect regression results. It can be found that in the absence of control variables, the coefficient value of the dependent variable rnd is 0.016, and the significance level is 1 %. After adding control variables, the coefficient value of the dependent variable rnd becomes 0.0066, and the significance level remains unchanged. Whether or not the control variables are added, there is a significant positive effect. Therefore, the above hypothesis is preliminarily verified: that is, the public procurement policy has a positive driving effect on the R & D behavior of the pharmaceutical enterprises.

Table 3. Main Effect Regression

	(1) rnd	(2) rnd
RD_Estimate	0.018***	0.00661***
	(0.000)	(0.00321)
Control variables	No	Yes
N	1456	1456

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4.3 Robustness test

In order to ensure the robustness of the results, this paper will continue to report the following contents by referring to the general practice of regression discontinuity design robustness test:

(1)Smoothness test: to ensure that the density function of the control variables has continuity at the breakpoint, if the control variables skip at the breakpoint, then even if the dependent variable skips at the breakpoint, it cannot be reasonably explained, thus losing the effectiveness of empirical research. Therefore, it is necessary to further perform the regression discontinuity test on the control variables.

Table 4. Smoothness Test

	(1)	(2)	(3)	(4)	(5)
variables	size	lev	cash	roe	cap
lwald	0.220	0.0195	0.000451	-0.0425	-0.176
	(0.178)	(0.0266)	(0.0207)	(0.0303)	(0.310)
lwald50	0.110	0.0171	-0.00827	-0.0427	-0.182
	(0.103)	(0.0150)	(0.0113)	(0.0307)	(0.206)
lwald200	0.129	0.0320	-0.00279	-0.0479*	-0.165
	(0.131)	(0.0197)	(0.0153)	(0.0252)	(0.280)
Observations	1,456	1,456	1,456	1,456	1,456

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

From the regression results of table 4, it can be found that the local average treatment effect coefficients value of each control variable are not significant in the smoothness regression test under the optimal bandwidth, 0.5 times the optimal bandwidth and 2 times the optimal bandwidth. It shows that the control variables are smooth at the breakpoint and there is no skip, which preliminarily verifies the authenticity of the breakpoint.

(2) Placebo test: The public procurement policy was implemented in 2018, so it is reasonable to choose 2018 as the cutoff value. In this paper, the placebo test can reasonably select different cutoff values, that is, 2016 and 2017 are selected as placebo breakpoints for regression discontinuity. The principle can be explained as follows: if there are also skips on both sides of the placebo breakpoint, the authenticity of the breakpoint selected by the main regression is questionable; if there are no significant skips on both sides of the placebo breakpoint, the authenticity of the breakpoint can be verified.

Table 5. Placebo Test

	(1)	(2)
	2017	2016
Variables	rnd	rnd
lwald	0.00298	0.00579
	(0.00455)	(0.00392)
lwald120	0.00298	0.00577
	(0.00455)	(0.00389)
lwald200	-0.00322	0.00529
	(0.00755)	(0.00351)
Observations	1,456	1,456

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

From the regression results of table 5, it can be found that the treatment effect coefficients are not significant when 2017 and 2016 are selected as breakpoints in the case of optimal bandwidth, 1.2 times optimal bandwidth and 2 times optimal bandwidth, respectively, indicating that there is no significant correlation between the placebo breakpoints and the R & D investment of the pharmaceutical enterprises, excluding the interference of other relevant background and policy factors on the main regression results, and further verifying the authenticity of the breakpoint.

(3) Kernel function replacement: In the case that the rdrandinf command defaults to the uniform kernel function, the regression discontinuity is performed again using the triangular kernel function and the quadratic kernel function to perform the robustness test.

Table 6. Robust Regression Results

	(1) triangular kernel	(2) quadratic kernel
RD_Estimate	0.009***	0.010***
	(0.000)	(0.000)
Control variables	No	No
N	1456	1456

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

From the regression results of table 6, it can be found that the regression coefficients based on triangular kernel function and quadratic kernel function are 0.009 and 0.012, respectively, and the significance level both reaches 1 %. The results are consistent with the previous regression conclusion, indicating that the regression discontinuity design is robust and effective.

5 CONCLUSION AND SUGGESTIONS

5.1 Conclusion

Based on 1456 unbalanced panel data of 225 A-share listed companies from 2015 to 2021, this paper uses the regression discontinuity design to empirically test and analyze the correlation between the public procurement policy and the R&D innovation in the pharmaceutical enterprises, and concludes that the public procurement policy can increase the R&D innovation in the pharmaceutical enterprises.

5.2 Suggestion

Based on the above conclusion, this paper puts forward the following suggestions: First, grasp the scale of drug quantity purchase. Unscrupulously lowering drug prices may lead to reduced corporate profits, deterioration of cash flow, and even affect their normal state of operation, thereby inhibiting R & D investment in new drugs. A reasonable reduction in drug prices is more conducive to guiding and regulating the development of the pharmaceutical enterprises. Second, the implementation of complementary

subsidy policy. In the case that the public procurement policy will affect the operation of enterprises extently, there may be enterprises that reduce investment in other aspects such as R & D investmennt in order to get out of the operating dilemma, which deviates from the intention of the policy. Therefore, the government can appropriately implement preferential subsidy policies for corporate R & D expenses, which can not only encourage enterprises to increase R & D investment, but also balance the trauma of enterprises suffering from the impact of public procurement. Third, improve the protection of intellectual property rights. Strengthening the intellectual property system is an important guarantee for enterprises to establish core competitive advantages. Especially for the pharmaceutical enterprises, innovative drugs are the only way to enhance the core competitiveness of enterprises. Without patent protection, there will be no innovation.

REFERENCES

1. The Industrial Development Dilemmas and Policy Recommendations of Generic Drugs in China/QIAN Gui-ming, LI Xiang//Chinese Health Economics, 2019,38(7):11-14
2. SHU Qian, YAO Zheng-rong, WANG Yan-hui, WANG Dan-dan Stakeholder Analysis of Drug Consumption Policy[J]. Health Economics Research,2019,36(08):8-9+12. DOI: 10.14055/j.cnki.33-1056/f.2019.08.00
3. Sitian Cao. Influence of Quantity Purchase on Pharmaceutical Enterprises [J]. Times of Fortune,2021(06):45-46. 2,
4. Jani Saastamoinen, Helen Reijonen, Timo Tammi, Should SMEs pursue public procurement to improve innovative performance? Technovation, Volume 69, 2018, Pages 2-14, ISSN 0166-497
5. Fiona A. Miller, Pascale Lehoux, The innovation impacts of public procurement offices: The case of healthcare procurement, Research Policy, Volume 49, Issue 7, 2020, 104075, ISSN 0048-7333,
6. An Yuanyuan, Ruan Yihong, Zhou Hui, Chen Dandi. The Evolution of China's Drug Procurement Systems and the Implementation and Improvement of the Current Quantity Procurement System [J]. Chinese Pharmaceutical Affairs, 2021, 35(08): 847-855. DOI: 10. 16153/j.1002-7777.2021.08.001.
7. SHEN Guobing, MENG Caixia & SHEN Bin-chao. The Effect of Innovation Mode and Intellectual Property Protection on R&D Innovation of Pharmaceutical Firms: An International Comparison [J]. Journal of Shanghai University of International Business and Economics,2022,29(01): 56-76. DOI: 10.16060/j.cnki.issn2095-8072.2022.01.005.
8. TANG Shao-liang, WANG Gao-ling. AnAnalysis on Process of Innovation in Pharmaceutical Enterprise Markets and Elevation of Core Competitive Power [J]. Journal of Nanjing University of Traditional Chinese Medicine(Social Science Edition),2008(01):39-44.
9. Min Luo, Research on how pharmaceutical enterprises respond to challenges under the new policy of drug volume procurement [J]. Business,2021(12):198-200.
10. Jiabin Ding. The impact of drug quantity procurement on the innovation efficiency of pharmaceutical enterprises - Based on the view of buyer countervailing power [J]. Business & Economy,2021(09): 144-147.DOI:10.19905/j.cnki.syjj 1982.2021.09.049
11. Qiuyu Zhang, Xiaolong Lu. The Impact of Centralized Drug Procurement Policy on the Innovation Performance of Listed Pharmaceutical Manufacturing Enterprises in China [J]. Medicine and Society,2022,35(12):17-23. DOI:10.13723/j.yxysh.2022.12.004.