# Research on the Granular Economic Effect of Top Enterprises on Industry Innovation under External Shock

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**Abstract.** Top enterprises are in the leading position of the industry, which has become an important reference source to measure the level of the industry, but the macro-influence effect of this micro power is still to be studied, therefore, this paper constructs a regression model based on the annual data of 31 industries under the manufacturing standard of the Industrial Classification of National Economy (ICNEA) from 2002-2021 and the micro data of A-share listed companies, to study the external shocks from a granular economic perspective The impact of top enterprises on the innovation level of the industry. It is found that top firms have a significant positive effect on the innovation level of the industry they work in, in which the promotion effect of strategic innovation is more obvious than that of substantive innovation, and this promotion effect will be weakened under external shocks. Further heterogeneity tests reveal that innovation in labor-intensive industries is most likely to be affected by top firms and external shocks, while capital-intensive industries are affected by top firms to a lesser extent. Finally, this paper puts forward policy suggestions to cope with external shocks in order to give full play to this facilitating role of top firms, for example, when state-supported industries are subjected to external shocks, taking into account their inhibitory effect on top firms, appropriate measures can be taken to promote technological innovation in the industry, such as tax relief and R&D subsidies.

**Keywords:** external shocks; top firms; industry innovation; granular economic effects

## 1 Introduction

The issue of industry innovation has attracted many scholars in China, but the main focus has been on incentives[1], macro-environment[2][3], government inputs[4], international knowledge spillovers[[5], servicification[6][7] and informatization[8], there is a lack of literature examining the impact of microeconomic factors on industry innovation. In the central government's proposal to speed up the construction of world-class enterprises, the top enterprises are in the leading position in the industry, and have become an important reference source for the level of innovation in the industry, and the influence of the top enterprises on the industry's innovation is still to be researched, and the top enterprises are the first to be challenged

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by the impact under the external impact, and the measures they take have a certain guiding significance for their industries, which is a good way to cope with the problem of the "stranglehold" and to improve enterprises' innovation of China. The measures taken by them have certain guiding significance for their industries, and have certain reference value for coping with the "necklace" problem and improving the international competitiveness of China's enterprises. In view of this, this paper is based on the micro-level top enterprises, based on Gabaix's "granular hypothesis"[9], to study the impact of external shocks top enterprises on industry innovation.

Existing research has already explored the issue of industry innovation, the development of top firms, and the impact of external shocks on the economy to some extent, but domestic research from a granular economy perspective is still in its infancy, with very little literature of the relevant type, as well as a lack of literature examining the impact of microeconomic factors on industry innovation. Although there have been studies focusing on the micro-origins of macroeconomic fluctuations, there is still a gap in the research on the granular economic effects of top firms on industry innovation in the face of external shocks. The purpose of this paper is to fill the gap in existing research by conducting an in-depth study on the granular economic effects of top firms on industry innovation in the face of external shocks, analyzing the role of top firms on industry innovation and whether this role is affected in the face of external shocks, in order to provide new theoretical and empirical support for the formulation of relevant policies.

## 2 Research design

### 2.1 Modeling

In order to examine the impact of top firms on industry innovation under external shocks, the following econometric model is set to test the research question based on the granular economy perspective:

$$Innovation_{j,t} = \beta_0 + \beta_1 Top^3_{j,t} + \beta_2 Shock_{j,t} + \beta_3 Shock_{j,t} \times Top^3_{j,t} + X\alpha + \mu_j + \varphi_t + \varepsilon_{j,t} \quad (1)$$

where the explanatory variable$Innovation_{j,t}$ represents the technological innovation capability of the industry, subscript$j$ and$t$ denote the industry where the firm is located, and the year, respectively. $Top^3_{j,t}$ represents the $j$ industry's first $t$ year of the top firm, the $Shock_{j,t}$ represents$j$ external shocks in the first year of the industry, and$t$ external shocks to the industry in the first year, and$Shock_{j,t} \times Top_{j,t}$ represents the cross-multiplier of the external shock to the industry and the industry's top firms, which is designed to test the ability of the size of the industry's top firms to hedge against the risk posed by the external shock under the external shock, so as to analyze the impact effect on the industry's innovation.$X$ are control variables, including industry profitability, industry asset size, total industry employees, industry sales, capitalized expenditures, GDP, M2 and other variables;$\mu_j$ denotes industry fixed effects, the$\varphi_t$ denotes year-fixed effects, and$\varepsilon_{j,t}$ denotes the random perturbation term.

### 2.2 Selection of variables

Explained variables. Drawing on Li and Shi[10], this paper chooses the sum of the number of patent applications in the industry to measure the level of technological innovation in the industry and categorizes it into two types: substantive innovation and strategic innovation. Specifically, the sum of the number of patent applications per year in the industry is used as an indicator of total innovation ($patent$), and the number of invention patent applications per year as the indicator of substantive innovation ($patent1$), which measures the quality of innovation in the industry; and the sum of the number of utility model patents and design patents in the industry as a strategic innovation indicator ($patent2$).

Explanatory variables. The core explanatory variables are $Top_{j,t}^3$ and $Shock_{j,t}$ that $Top_{j,t}^3$ is the $j$ the ratio of the sum of sales of the top three top firms in the industry to the total sales of the industry, and the measure of external shocks to the top firms, which refers to the methodology of Aghion[11], is as follows:

$$Shock_{j,t} = \frac{M_{j,t} - M_{j,t-1}}{\frac{1}{2}(M_{j,t} + M_{j,t-1})} \tag{2}$$

of which$M_{j,t}$ represents the industry$j$ in the first$t$ total sales sold during the year, the$M_{j,t-1}$ is the industry $j$ in the year$t-1$ total sales sold during the year. Taking the external shock of the automobile manufacturing industry in 2021 as an example, the total sales of the industry in 2021 was 2.59 trillion yuan and 2.3 trillion yuan in 2020, and the external shock received in 2021 was measured as 0.11861.

Control variables. With reference to existing studies, this paper selects the industry size of the target industry ($asset$ ), profitability ($profit$ ), total number of employees ($employee$ ), total sales ($all\_sale$ ), capitalized expenditure ($cap\_ex$ ) as well as gross domestic product ($GDP$ ), broad money ($M2$ ) and other indicators are used as control variables.

### 2.3 Data sources and sample selection

This paper is based on the data of listed companies, based on the division of the National Economic Industry Classification (GB/T 4754-2017), the manufacturing industry is selected as the research sample, which contains a total of 31 major categories, and the period of data selection is 2002-2021. The data are obtained from Cathay Pacific (CSMAR) database, WIND database and National Bureau of Statistics. The samples are treated as follows during data processing: financial categories and enterprises treated by ST and *ST are excluded when calculating the quantitative index of head enterprises; samples with serious data missing during the study period are excluded. This paper finally obtains 556 industry-annual observations. The selection data of the head enterprises takes the metal products industry in 2018 as an example, and the top three in the industry by sales in that year are Subor, Juxing Technology and Jianlang Hardware, and these three represent the head companies for follow-up research.

## 3 Empirical results and analysis

### 3.1 Benchmark regression

In the regression model analysis, we first apply the OLS method to detect the correlation between the explained variables and the explanatory variables. The specific results are presented in Table 1, and the regression results show that the top firms coefficient is positive, and the external shock to the industry coefficient is also positive, while the cross-multiplier of the two coefficient is negative.

The positive coefficient of leading companies implies that an increase in their market share drives industry innovation. From the perspective of the Matthew effect, the market position and advantages of the top enterprise promote them to have greater ability and resource investment in innovation. This, in turn, further strengthens the market position and advantages of the head enterprises. A positive cycle has been formed, allowing leading enterprises to dominate industry innovation. The external shock coefficient is positive. It shows that the external shock of the industry has a positive impact on the overall industry innovation. From the perspective of the horsefly effect, when the industry suffers external shocks, in order to cope with adjustments and seek opportunities, enterprises must enhance their competitiveness and innovation. This will also enhance the overall innovation ability of the industry.

And the cross-multiplier of the two coefficient is negative. It shows that when the top enterprises and the external shocks of industries increase at the same time, the promotion effect of the top enterprises will be weakened. Top firms are more inclined to protect their own interests and existing market share when facing external shocks. They are unwilling to risk more innovation or are unwilling to share resources with other small and medium-sized enterprises for innovation cooperation. Therefore when the top firms face a large external shock, the motivation for innovation may weaken, resulting in a decline in the level of industry innovation.

**Table 1.** Benchmark regression results

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | patent | patent1 | patent2 |
| Top | 5,970.7373*** | 1,852.6381*** | 7,823.3750*** |
| | (3.2779) | (2.8340) | (3.2103) |
| Shock | 10,782.2363** | 3,483.8328** | 14,266.0693** |
| | (2.2431) | (1.9709) | (2.2004) |
| Top×Shock | -12,221.6572** | -4,039.0203* | -16,260.6768** |
| | (-2.0294) | (-1.8333) | (-2.0061) |
| asset | 0.0000*** | 0.0000*** | 0.0000*** |
| | (3.2529) | (3.6221) | (3.4143) |
| profit | -1,408.2097*** | -334.5144*** | -1,742.7242*** |
| | (-3.8150) | (-3.0351) | (-3.7227) |
| employee | 0.0396*** | 0.0064*** | 0.0460*** |
| | (4.2003) | (3.0435) | (4.2569) |
| all_sale | -0.0000*** | -0.0000*** | -0.0000*** |
| | (-4.9594) | (-4.8903) | (-5.0478) |
| cap_ex | -117.3953*** | -42.7585*** | -160.1538*** |
| | (-3.0054) | (-3.9759) | (-3.3622) |
| GDP | 1,014.7194 | 1,772.7219 | 2,787.4414 |
| | (0.1325) | (0.6917) | (0.2795) |
| M2 | 923.2858 | -1,267.2803 | -343.9944 |
| | (0.1413) | (-0.5737) | (-0.0403) |

| | | | |
|---|---|---|---|
| Constant | -37,734.1406 | -9,840.8428 | -47,574.9844 |
| | (-1.1353) | (-0.9260) | (-1.1175) |
| Observations | 506 | 506 | 506 |
| R-squared | 0.6658 | 0.5659 | 0.6534 |
| Year | containment | containment | containment |

### 3.2 Heterogeneity analysis

Industry Heterogeneity Test. Regarding the classification of manufacturing industries, this paper intends to classify manufacturing industries into four categories: labor-intensive, capital-intensive, technology-intensive and resource-intensive, where labor-intensive industries add other manufacturing industries and comprehensive utilization of waste resources industries. The technology-intensive type adds metal products, machinery and equipment repair industry on the basis of the above.

The results of the regression of heterogeneity of different types of industries are shown in Table 2. The results show that only the regression results of labor-intensive industries are significant. This indicates that compared with other industries, labor-intensive manufacturing industries are more likely to be influenced by top enterprises and the macro environment, and the industry micro-factors have a more significant impact on industry innovation. For other types of manufacturing industries, the relationship between the explanatory variables and the explanatory variables is relatively weak.

**Table 2.** Heterogeneity regression results for different types of industries

| | labor-intensive | capital-intensive | technology-intensive | resource-intensive |
|---|---|---|---|---|
| | patent | patent | patent | patent |
| Top | -816.419* | -1734.118* | 7954.661 | 526.043 |
| | (-1.912) | (-1.794) | (0.674) | (0.241) |
| Shock | 1973.177** | -196.395 | 23461.866 | 511.646 |
| | (2.321) | (-0.196) | (1.632) | (0.100) |
| Top×Shock | -2377.133** | 920.191 | -25238.365 | 429.220 |
| | (-2.100) | (0.730) | (-0.970) | (0.066) |

## 4 Conclusions

Top firms have a significant positive promotion effect on technological innovation in the industry. Top firms have a more obvious effect of promoting strategic innovation than substantive innovation in the industry. The promotion effect of top firms is weakened by external shocks. For key industries supported by the state, the government can reduce the tax burden of leading companies in the industry through tax breaks and R&D subsidies, so that they have more funds for research and development, so as to play a positive role in promoting the technological progress and development of the entire industry.

In terms of industry heterogeneity, the innovation level of labor-intensive manufacturing industries is more likely to be affected by top firms and external shock factors than other industries, capital-intensive manufacturing industries are affected by top firms to a lesser extent, while technology-intensive and resource-intensive manufacturing industries have no significant impact. Therefore, policymakers need to take appropriate policy measures to promote the development of technological innovation in different manufacturing industries according to their characteristics and influencing factors.

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## References

[1] ZHANG C,ZHANG Y. The Impact of Multinational Enterprises' R&D Activities in China on Innovation in China's High-Tech Industry-An Analysis Based on Panel VAR[J]. World Economic Research,2012,(02):57-63+88-89. DOI:10.13516/j.cnki.wes.2012.02.006.

[2] JIANG K,TENG YH. Analysis of the impact of environmental regulation on industry technological innovation in China - A panel data analysis based on 20 pollution-intensive industries in China[J]. Ecological Economy,2014,30(06):90-93.
https://kns.cnki.net/kcms/detail/detail.aspx?FileName=STJJ201406020&DbName=CJFQ2014

[3] ZHOU MC,LIU GY. Research on the impact of environmental regulation on innovation technology in coal industry under the perspective of regional heterogeneity[J]. Science and Technology for Development,2020,16(12):1570-1578.
https://kns.cnki.net/kcms/detail/detail.aspx?FileName=KJCJ202012015&DbName=CJFQ2020

[4] SUN W,JIANG SL. Analysis of the impact of government input on innovation efficiency of industrial sector under environmental regulation[J]. Soft Science,2016,30(07):19-23.
DOI:10.13956/j.ss.1001-8409.2016.07.05.

[5] SUN Y. Research on the impact of international knowledge spillover on the innovation output of China's industrial industry[D]. Northeast Normal University,2021.
DOI:10.27011/d.cnki.gdbsu.2021.000022.

[6] Zhang HX,Zhang YG. Research on the impact of manufacturing and productive service industry synergy on industry innovation efficiency[J]. Jiangxi Social Science,2022,42(02):137-148.
https://kns.cnki.net/kcms/detail/detail.aspx?FileName=JXSH202202013&DbName=DKFX2022

[7] XING H,CHEN YY,GAO SY. The impact of manufacturing servitization on industry innovation performance - based on the mediating role of technology absorptive capacity[J]. Modern Management Science,2022(04):73-81.
https://kns.cnki.net/kcms/detail/detail.aspx?FileName=XDGL202204008&DbName=CJFQ2022

[8] He Y,Song L. The impact of informatization on innovation efficiency in Chinese industrial sectors[J]. Research Management,2022,43(04):20-28. DOI:10.19571/j.cnki.1000-2995.2022.04.003.

[9] Gabaix,X. The Granular Origins of Aggregate Fluctuations[J]. Econometrica, 2011,79: 733-772. https://doi.org/10.3982/ECTA8769

[10] LI XY,SHI YY,HAO WW. Impact of social insurance fee reduction policy on technological innovation of enterprises[J]. Research Management,2022,43(04):192-200. DOI:10.19571/j.cnki.1000-2995.2022.04.022

[11] Aghion P, Bergeaud A, Lequien M, et al. The Heterogeneous Impact of Market Size onInnovation: Evidence from French Firm-Level Exports[J]. NBER Working Paper, 2019.