# Research on the Influence of Dual Innovation Capability on Enterprise Performance

Yan Xiang[1] Jianxin Zhao[2] Xiaoyu Bie[1] Pengbin Gao[1]

[1] *School of Economics and Management, Harbin Institute of Technology, Weihai, Weihai, Shandong 264200, China*
[2] *SunRui Marine Environment Engineering Co, Ltd, Qingdao, Shandong 266101, China*

**ABSTRACT**
In the era of knowledge economy, manufacturing enterprises are an important position for innovation activities and affect the operation of the national economy. Therefore, it is of great practical significance to give full play to the positive role of dual innovation ability of manufacturing enterprises. Based on dual theory, this paper selected the Shanghai and Shenzhen A-share manufacturing enterprises of Chinese listed companies from 2015 to 2019 as research samples, and used Heckman two-stage model to study the effect of dual innovation capability on the lag of enterprise performance. The results show that the dual innovation capability can have a positive impact on enterprise performance. Based on the research results, effective countermeasures and suggestions are also put forward.

***Keywords:*** *Dual innovation capability, Enterprise performance, Heckman two-stage model.*

## 1. INTRODUCTION

Affected by the law of diminishing marginal utility, the improvement of manufacturing operation efficiency is under pressure. The development of China's manufacturing industry urgently needs to switch to an efficiency-driven model of relying on factor quality improvement. Standing at a new historical starting point and facing the unprecedented changes in a century, it is of great strategic significance to cultivate and develop the innovative ability of manufacturing enterprises. If the good momentum of manufacturing industry during the 13th Five-Year Plan period is to be maintained during the 14th Five-Year Plan period, it is imperative to enhance the technological innovation capability. Therefore, for manufacturing enterprises, it is an important part of the development to make them realize the role of exploratory and exploitative two innovative capabilities.

In the ability of independent innovation, dual innovation theory has gradually become a research hotspot in recent years. Scholars have confirmed that exploratory innovation and exploitative innovation will more or less affect corporate performance [1][2][3]. In view of this, the impact of dual innovation capability on corporate performance has also become a research hotspot, and it can be specifically considered from the following two points. First, improvement and promotion can be carried out to form exploitative innovation based on the existing knowledge system and resource architecture, further improve the efficiency of resource utilization, improve product performance and effectively increase market share[4][5]; Second, cross-domain technology based on the existing innovation capabilities forms the exploratory innovation. Under the catch-up of technology, through the accumulation of knowledge system, organizational structure re-integration and application form a path jump and further improve enterprise performance through scale effects[6][7]. For the measurement of innovation capability, most scholars measure the technological innovation capability of enterprises by the index of the number of patents[8][9]. However, based on the background of technological diversification, patents cannot completely replace innovation capability if they are not properly classified, so at the current stage of rapid change, Chinese enterprises urgently need to conduct in-

depth analysis of this correlation. Therefore, it is imperative to enrich the research on enterprise innovation from the perspective of dual theory.

## 2. RESEARCH HYPOTHESES

Dual theory believes that enterprises need to find a balance between two different capability models in order to maximize their interests. But due to the limitations of actual resources and conditions, few enterprises can achieve a good balance between them. Most of them are in a state of mutual restraint. If companies want to gain a competitive edge, they need to maintain a dynamic balance in their dual innovation capabilities.

Exploratory innovation capability is a gathering type of high-risk and high-revenue. It can help enterprises to timely adjust products to better cope with market changes through innovating different types of products and services[10]. It can show the adventurous spirit, flexible strategy and anti-risk ability of a company in innovative activities. It is the cornerstone for enterprises to discover new opportunities and gain new advantages and maintain their development potential in today's competitive market. Therefore, although it has a high risk in reality and even damages the enterprise, its breakthrough and targeted advantages can make the enterprise always maintain its vitality in the rapidly changing market. Once successful, it will increase the company's income significantly. Therefore, the hypotheses are put forward:

- H1: Exploratory innovation capability has significant positive impact on enterprise performance.

Exploitative innovation capabilities tend to be more robust and risk-averse. Therefore, the emergence often makes enterprises more willing to adopt the method of improving products and services to win the competition, and then avoid the technological innovation research with large investment and high risk. The reason why it has many advantages such as low cost and quick profit is that enterprises can obtain higher operating benefits through various low-risk activities in terms of existing capabilities, equipment and technology[11][12]. Research and development (R&D) investments acts on all aspects of enterprise innovation. By acquiring dual innovation capabilities, enterprises can complete the R&D and improvement of products and services, and increase marginal profits and competition barriers to improve operating profits[13]. Therefore, the exploitative innovation capability requires more accumulation of similar knowledge, so as to further develop and excavate the existing knowledge and technology, and it can expand the existing market depth and customer demand. It can improve the existing operational efficiency or pursue a better user experience to create a model that can better meet the existing market demand[14]. So it has certain significance for the improvement of enterprise performance. Therefore, this paper hypothesises that:

- H2: Exploitative innovation capability has significant positive impact on enterprise performance.

## 3. RESEARCH DESIGN

### *3.1 Data Sources*

The subject of this study is the Shanghai and Shenzhen A-share manufacturing enterprises of Chinese listed companies, excluding ST companies and companies listed in 2014. The data range are from 2015 to 2019 (considering that performance has a lagging effect [15][16], the company performance is selected as 2016 to 2019, and other variables are treated as 2015 to 2018 with one lag period). A total of 1994 listed companies were collected, with a total sample size of 7358. The data are unbalanced panel data. There are three main sources: the personal information of executives and the financial data of listed companies come from the Cathay Pacific database, human capital data of listed companies are from wind database (institutional side), and the patent data of listed companies come from the Cnrds database of China's research data service platform. In order to prevent the impact of extreme values on the analysis, the data are condensed at 0.1 level. The data analysis is implemented through stata16.0.

### *3.2 Variable Definitions*

#### *3.2.1 Independent Variable*

The independent variable is the company's dual innovation capability, namely exploratory innovation capability (EPLR) and exploitative innovation capability (EPLI). Previous studies have pointed out that patents mainly include invention patents, utility patents and appearance patents[17][18][19]. The invention patents are actually the external expression of EPLR, which has a breakthrough for the higher technical innovation requirements. Utility patents and appearance patents are mostly improvements and

perfections, so they are external expression of EPLI. Therefore, this study measures EPLR by the number of annual invention patent applications, and measures EPLI by the annual number of utility patents and appearance patents applications. On this basis, in order to make the data smoother and eliminate the heteroscedasticity existing in the data itself, it is modified by logarithm. The paper considers that many patents have zero number and do not logarithm. So this paper adds a logarithm to the number of applications.

### *3.2.2 Dependent Variable*

The dependent variable is firm performance (BP). This study divides BP into profitability, shareholder profitability and growth capacity[20]. Profitability measured by net profit ratio on total assets (ROA) and return on equity (ROE), Using earnings per share (EPS) to measure shareholder profitability, and growth capacity is measured using net profit growth rate (RG) and net profit margin (RI). Because it does not take into account the long-term performance TOBIN Q, this study has been modified based on it, replacing RI with long-term performance TOBIN Q.

### *3.2.3 Control Variables*

According to the previous research results, this study selected research and development (RD), company size(SIZE), asset-liability ratio (LEV), inventory turnover rate (IT), sales expense rate (SERATE), company age (FIRMAGE), shareholding ratio of the largest shareholder (HHI), capital accumulation rate (CARATE), consolidated tax rate (CT) and year control (YEAR) as the control variables.

## *3.3 Model Design*

In order to control the sample endogeneity problem caused by the heterogeneity of enterprises, this paper will use Hekman's two-stage selection model proposed by Hekman (1971)[21] to examine the process of enterprise innovation.

In this paper, the Heckman model is completed in two steps. First, the selection model is estimated, which is the innovative selection model in this paper. The paper set the variable Y(Y=1, there is patent output; Y=0, no patented output), and analyze through the binary Probit model, the model formula is shown in formula (1):

$$Y_{i,t} = \alpha_0 + \gamma_1 X_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

X includes all Independent variables,$\varepsilon_{i,t}$ is the error term, and estimate the resulting $\gamma_1$ according to the first step. Then the paper calculate the inverse Mills ratio value for each individual company i. Which is different from the ordinary least square method, this value is used to overcome the selective deviation of the sample. The first is to get $\gamma_1$ through the regression of the first stage and then added to the linear estimation model in the second stage. Since $\gamma_1$ is linear with sample error ui-E (ui|expi=1) and has 0 mean, and it ensures that the estimation results are unbiased. The calculation formula is shown in formula (2):

$$\varphi_{i,t} = \phi(X_{i,t-1}\gamma_1) / \psi(X_{i,t-1}\gamma_1) \quad (2)$$

The numerator $X_{i,t-1\gamma1}$ in the formula is expressed as the standard normal distribution density function of the variable, and the denominator $X_{i,t-1\gamma1}$ is the cumulative density function of the variable. On the basis of the previous step, this paper uses the selected sample of Y=1 to carry out regression analysis, and the regression model has been sorted out in the previous section. The output model of this paper can be obtained by adding $\varphi_{i,t}$ estimation to the model mentioned above, which is also the regression model for hypothesis testing.

# 4. DATA ANALYSIS

## *4.1 Descriptive Statistics and Correlation Analysis*

Descriptive statistical analysis was performed with Stata16.0, and the results are shown in "Table 1". There is no missing and no abnormal value in the sample size data. There is basically no case where the standard deviation is larger than the mean. And the standard deviation of the data is within the acceptable range, so the next analysis can be effectively performed.

Table 1. Descriptive statistics

| Index | N | Mean | S.E. | Min | Median | Max |
|---|---|---|---|---|---|---|
| ROA | 7358 | 0.06 | 0.05 | -0.08 | 0.05 | 0.21 |
| ROE | 7358 | 0.09 | 0.07 | -0.18 | 0.08 | 0.30 |
| TOBIN Q | 7358 | 2.14 | 1.22 | 0.88 | 1.75 | 7.76 |
| EPS | 7358 | 0.49 | 0.53 | -0.53 | 0.34 | 2.90 |
| RG | 7358 | -0.29 | 5.45 | -38.32 | -0.10 | 19.17 |
| EPLR | 7358 | 1.03 | 1.16 | 0 | 0.69 | 5.05 |
| EPLI | 7358 | 1.55 | 1.53 | 0 | 1.39 | 5.81 |
| RD | 7358 | 0.03 | 0.02 | 0.01 | 0.02 | 0.09 |
| SIZE | 7358 | 22.05 | 1.14 | 20.07 | 21.92 | 25.60 |
| LEV | 7358 | 0.37 | 0.18 | 0.06 | 0.35 | 0.77 |
| IT | 7358 | 4.30 | 3.62 | 0.47 | 3.28 | 22.36 |
| SERATE | 7358 | 0.09 | 0.10 | 0.01 | 0.053 | 0.50 |
| FIRMAGE | 7358 | 2.82 | 0.31 | 2.08 | 2.83 | 3.43 |
| HHI | 7358 | 33.90 | 13.65 | 9.87 | 32.07 | 71.24 |
| CT | 7358 | 0.03 | 0.02 | 0.00 | 0.02 | 0.17 |
| CARATE | 7358 | 0.21 | 0.36 | -0.21 | 0.08 | 1.91 |

The results of correlation analysis are shown in "Table 2". The correlation of the independent variable and dependent variable and control variables is kept in good condition. The absolute value of the correlation coefficient between the independent variable and the control variables is less than 0.7, indicating that there is no high variable correlation problem.

Table 2. Correlation analysis

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BP | 1 | | | | | | | | | | | |
| RD | 0.16*** | 1 | | | | | | | | | | |
| EPLR | 0.06*** | 0.25*** | 1 | | | | | | | | | |
| EPLI | 0.06*** | 0.15*** | 0.54*** | 1 | | | | | | | | |
| SIZE | 0.03** | -0.12*** | 0.28*** | 0.22*** | 1 | | | | | | | |
| LEV | -0.23*** | -0.06*** | 0.12*** | 0.14*** | 0.55*** | 1 | | | | | | |
| IT | 0.07*** | -0.02 | 0.01 | 0.01 | 0.16*** | 0.11*** | 1 | | | | | |
| SERATE | 0.12*** | 0.10*** | -0.02 | -0.04*** | -0.10*** | -0.20*** | -0.24*** | 1 | | | | |
| FIRMAGE | -0.03** | -0.07*** | -0.01 | -0.02 | 0.16*** | 0.11*** | 0.07*** | 0.02** | 1 | | | |
| HHI | 0.18*** | -0.02 | 0.04*** | 0.06*** | 0.07*** | -0.02 | 0.06*** | 0.03*** | -0.03*** | 1 | | |
| CARATE | 0.26*** | -0.01 | -0.01 | -0.03** | -0.07*** | -0.11*** | -0.02* | -0.02* | -0.15*** | 0.01 | 1 | |
| CT | 0.44*** | -0.20*** | -0.08*** | -0.06*** | -0.02* | -0.32*** | -0.20*** | 0.25*** | 0.01 | 0.11*** | 0.10*** | 1 |

a * p < 0.1 * * p < 0.05 * * * p < 0.01

This paper tests the collinearity of the relationships among variables. The VIF values are all less than five, indicating that there is no collinearity problem.

## *4.2 Analysis of Regression Results*

This study uses Stata16.0 to analyze dual innovation capability (EPLR / EPLI) as an independent variable, and analyze corporate performance (BP) as dependent variable. The results are shown in "Table 3".

Table 3. Analysis of regression results

| Model effect | BP | | BP | |
|---|---|---|---|---|
| stage | output | selection | output | selection |
| L.EPLR | 0.03 | 0.87*** | | |
| | (1.06) | (28.19) | | |
| L.EPLI | | | 0.05*** | 0.69*** |
| | | | (3.48) | (30.17) |
| L.RD | 14.12*** | -0.85 | 14.44*** | 5.18*** |
| | (13.9) | (-0.56) | (14.8) | (3.46) |
| L.SIZE | 0.10*** | -0.14*** | 0.09*** | -0.07*** |
| | (5.02) | (-5.60) | (5.32) | (-2.9) |
| L.LEV | -0.64*** | 0.16 | -0.67*** | -0.26 |
| | (-5.7) | (0.99) | (-6.0) | (-1.56) |
| L.IT | 0.05*** | -0.02*** | 0.05*** | -0.02*** |
| | (10.65) | (-2.93) | (10.36) | (-2.6) |
| L.SERATE | 0.26 | -0.24 | 0.25 | 0.18 |
| | (1.56) | (-1.03) | (1.52) | (0.79) |
| L.FIRMAE | 0.01 | -0.15** | 0.01 | -0.08 |
| | (0.22) | (-2.09) | (0.25) | (-1.11) |
| L.HHI | 0.01*** | 0.00 | 0.01*** | -0.00 |
| | (8.94) | (0.94) | (8.79) | (-0.15) |
| L.CARATE | 0.31*** | -0.07 | 0.31*** | -0.04 |
| | (7.92) | (-1.28) | (7.81) | (-0.63) |
| L.CT | 16.53*** | 0.98 | 16.45*** | 0.22 |
| | (23.4) | (1.02) | (23.3) | (0.21) |
| _Cons | -3.39*** | 3.70*** | -3.37*** | 2.00*** |
| | (-8.7) | (6.64) | (-9.5) | (3.55) |
| N | 3867 | 5106 | 3867 | 5106 |
| LR | 0.54 | 0.22 | 3.73* | 7.52*** |

a * p < 0.1 * * p < 0.05 * * * p < 0.01 ( ) is t value

First, the study tests the effect of exploratory innovation capability on enterprises' performance. From the output model, the results of EPLR show that the regression coefficient is equal to 0.0301 and does not show any level of significance. From the selection model, the regression coefficient of EPLR with one lag period is equal to 0.8679, and has a significant positive predictive effect. It shows that EPLR of the company in the early stage can promote the improvement of the corporate performance in the later stage. Hypothesis 1 holds.

Second, the study further tests the effect of exploratory innovation capability on enterprises' performance. From the output model, EPLI has a significant positive impact on operating performance, the regression coefficient is equal to 0.05, and shows a significant level of 0.01. From the selection model, the regression coefficient of EPLI with one lag period is equal to 0.69, and has a significant positive predictive effect, It shows that EPLI of the company in the early stage can promote the improvement of the corporate performance in the later stage. Hypothesis 2 holds.

## 5. CONCLUSION

This paper conducted an empirical analysis on the impact of dual innovation capability on corporate performance. The two-stage model test shows that the dual innovation capability can effectively improve corporate performance.

Form a practical point of view, managers need to combine their existing innovation ability level and market conditions to decide to adopt the innovation mode of "favoring one over the other" or "rain and dew", so as to maximize the effectiveness of organizational innovation ability. On the one hand, enterprises should increase the proportion of investment in cultivating dual innovation capabilities, increase investment in EPLR, and

improve the cultivation of EPLI. On the other hand, small-scale enterprises can focus on EPLI in the early stage. While large-scale enterprises have the ability to take risks, they can consider EPLR to seize market share.

There are two limitations in this research. First, the moderating dimension of dual innovation capability needs to be improved. Second, the research sample needs to be expanded. On the one hand, the research focuses on manufacturing enterprises, and other industries can be selected for further testing in the future. On the other hand, the range of sample selection can also be expanded.

## AUTHORS' CONTRIBUTIONS

Yan Xiang was responsible for experimental design, Jianxin Zhao wrote the manuscript, Xiaoyu Bie analysed data, and Pengbin Gao contributed to revising and editing.

## REFERENCES

[1] E.X. Hou and J. Shi, "A review on the dynamic mechanism of enterprise collaborative innovation," Chinese Journal of Management Science, vol.23,2015, pp.711-717.

[2] T.Swift, "The perilous leap between exploration and exploitation," Strategic Management Journal, vol.37,2016, pp.1688-1698.

[3] M.Sol ś-Molina, M.Hern ández-Espallardo, A.Rodr íguez-Orejuela, "Performance implications of organizational ambidexterity versus specialization in exploitation or exploration: The role of absorptive capacity," Journal of Business Research, vol.91,2018, pp.181-194.

[4] K.W. Artz, P.M. Norman, D.E. Hatfield, L.B. Cardinal, "A Longitudinal Study of the Impact of R&D, Pantents, and Produvt Innvation on Firm Performance," Jounal of Product Innovation Management, vol. 27,2010,pp.725-740.

[5] A.Venugopal, T.N.Krishnan, R.S.Upadhyayula, M.Kumar, "Finding the microfoundations of organizational ambidexterity — Demystifying the role of top management behavioural integration," Journal of Business Research, vol.106,2020, pp.1-16.

[6] E.M. Pertusa-Ortega, J.F. Molina-Azor ń, "A Joint Analysis of Determinants and Performance Consequences of Ambidexterity," BRQ Business Research Quarterly, vol.21,2018, pp.81-98.

[7] B.Zou, H.Y. Wu, F.Guo, Y.X. Li, "The Formation of Generative Capability based on Competitor Orientation and Its Effect on Innovation Performance," Science of Science and Management of S.& T., vol.39,2018,pp.81-93.

[8] M.M. Li, H.J. Xiao, J.X. Fu, "Financial Policy, Enterprises' R&D Expenditure and Technological Innovation Capabilities — Empirical Study from the Listed Companies in China's Strategic Emerging lndustries," Management Review, vol.26, 2014,pp.135-144.

[9] S.X. Yu, S.B. Lu, "Impact of FDI and R&D on technological innovation capability of Chinese automobile industry: Considerations made with lagged-effect included," Science Research Management, vol.39,2018,pp. 1-6.

[10] H. Xu, W. Li, "Empirical Study on Relationship between Organizational Learning and Ambidextrous Innovation in High-tech Enterprises," Journal of Management Science, vol.26,2013, pp. 35 - 45.

[11] Y.L. Sun, X.H. Dang, J. Song, "Impacts of Ambidextrous Competence on Cooperative Innovation Performance Based on Network Routines," Journal of Management Science, vol.27,2014,pp. 38-47.

[12] H. Gong, S. Peng, "lmpact of scientific research on achievements transformation in university from the perspective of dual innovation," Science Research Management, vol.42,2021,pp.121-129.

[13] S.A. Fernhaber, P.C. Patel," How do young firms manage product portfolio complexity? The role of absorptive capacity and ambidexterity," Strategic Management Journal,,vol. 33,2012,PP.1516-1539.

[14] Y.L. Sun, X.H. Dang, J. Song, "Impacts of ambidextrous competence on network routines," Journal of Management Science, vol.27,2014, pp.38-47.

[15] Z.Y. Sun, L. Wang, X.Z. Li, S.J. Zhao, "Dynamic Relationship between R&D Investment and Corporate Performance-Based on the Moderating Effects of Internal Control Effectiveness," Soft Science, vol.33,2019, pp. 51-57.

[16] C. Vithessonthi, O.C. Racela, "Short and long-run effects of internationalization and R&D intensity on firm performance," Journal of Multinational Financial Management, vol. 34,2016, PP. 28- 45.

[17] N. Xu, N.N. Jiang, J. Zhang, "A study of the influence of equity incentive on ambidextrous innovation strategy of SMEs," Science Research Management, vol.40,2019, pp. 163-172.

[18] J. Zhou, S. Yang, W.F. Guo, "A Study of the Impact of GEM Private Enterprises' Strategic Decision-making Mechanism on Corporate Performance," Journal of Management Science, vol.27,2014, pp. 1-14.

[19] S.M. Chen, R. Li, "Research on the Relationship between Dual Technology Strategy and Enterprise Performance — An Empirical Study Based on China's Electronic Information Manufacturing Industry," Science & Technology Progress and Policy,vol.30,2013,pp. 70-74.

[20] S.M. Liu, P. Hou, Y.Y. Zhao, "Protection of Intellectual Property Right and Innovation Capacity of China's Industry," The Journal of Quantitative & Technical Economics, vol.32,2015, pp. 40-57.

[21] J.J. Heckman, "Sample Selection Bias as a Specification Error," Econometrica: Journal of the Econometric Society, vol. 47,1979, pp.153-161.