# Private Equity Investment Based on the Dual Innovation of Enterprises

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**Abstract.** In the context of science and technology innovation-driven economic development, the impact of private equity investment on corporate innovation has attracted much attention, but the conclusions of existing studies are divergent. This paper takes A-share listed companies in Shanghai and Shenzhen from 2007 to 2022 as samples, divides corporate innovation into developed innovation and exploratory innovation based on the theory of corporate dual innovation, and empirically examines the impact of private equity investment on corporate innovation by using multiple linear regression model. The study finds that private equity investment significantly promotes the developmental innovation of enterprises, and the developmental innovation input of enterprises that have received private equity investment is 1.2 percentage points higher than that of enterprises that have not received private equity investment, thanks to the resource integration and management supervision of investment institutions; while private equity investment has a dampening effect on the exploratory innovation, and it will reduce the exploratory innovation input of enterprises by 0.8 percentage points, which is due to its short-term return orientation and risk aversion tendency. This is due to its short-term gain orientation and risk-averse tendency. In addition, firm size and profitability positively affect dual innovation, while gearing plays an inhibitory role, and the impact of firm age on the two types of innovation is differentiated. This study provides theoretical basis and practical reference for enterprises to optimize their innovation strategies, investment institutions to improve their investment decisions and policy formulation.

**Keywords:** private equity; corporate dual innovation; exploitative innovation; exploratory innovation

## 1 Introduction

In the internet-driven economic era, internet technology acts as a powerful bridge connecting enterprise technological innovation and private equity (PE) funds. It breaks down traditional information barriers, enabling precise matching between enterprises' innovation demands/achievements and PE funds' investment preferences/resource advantages. Big data helps PE funds quickly screen promising tech enterprises, assess project value and risks, and enhance investment decision-making efficiency. Enter-


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prises, meanwhile, use internet platforms to showcase innovations via online halls and real-time data sharing, access industry dynamics, tech trends, and policy guidance, and reduce communication costs and information asymmetry with investors. Emerging internet technologies like cloud services, AI, and blockchain further boost innovation: Cloud services provide flexible computing and storage for R&D, avoiding heavy data center investments; AI optimizes R&D processes and market forecasting. For PE funds, these technologies enable efficient post-investment management through real-time data monitoring and intelligent risk early warning, facilitating optimal resource allocation and strengthening capital market support for tech innovation. As internet technology evolves—from 5G to IoT popularization—its enabling role deepens, driving tech innovation toward greater efficiency, openness, and dynamism. In this context, enterprises remain indispensable as core carriers of technological innovation.

Although PE funds play an increasingly important role in promoting innovation capital formation and supporting science and technology innovation, how exactly does PE affect corporate innovation? Scholars worldwide have explored this, but conclusions remain inconsistent, with both domestic and international studies lacking comprehensive integration of latest findings and contextual factors. Domestically, Wu You (2023) found that enterprises with PE participation exhibit significantly higher innovation output and efficiency than those without[1]; in contrast, Xia Qinghua & Le Yi (2021) argued PE exerts no significant positive impact on corporate innovation[2]. Internationally, Giakoumelou et al. (2025) found that private equity (PE) investment serves as a key lever for enhancing investor confidence and facilitating the monetisation of innovation within privately held start-ups[3]; Lerner (2020) concluded that equity investment correlates positively with the level of innovation reflected in patents, compared to traditional financing methods[4]. Most studies treat innovation as a homogeneous construct, ignoring the distinctions proposed by March's (1991)[5] dual innovation theory, which categorizes corporate innovation into developmental innovation (leveraging existing knowledge/technologies for incremental improvements, low risk, short payback cycles) and exploratory innovation (breaking knowledge boundaries for radical breakthroughs, high risk, long investment cycles). Failing to differentiate these two types obscures PE's asymmetric impacts—for example, neither domestic nor international studies have systematically examined how PE's governance mechanisms (e.g., board oversight, resource injection) affect the two innovation types differently.

To address these gaps, this study makes three theoretical contributions:(1)It fills the application gap of dual innovation theory in PE research by empirically testing PE's heterogeneous impacts on developmental and exploratory innovation; (2) It expands the theory's contextual boundary by integrating internet technology empowerment into the analytical framework, explaining how digital tools adjust PE-innovation relationships; (3) It supplements emerging-market evidence for the theory by focusing on Chinese A-share listed companies (2007–2022), complementing existing studies centered on developed economies. Methodologically, this research distinguishes between the two innovation types to provide more precise insights into the PE-innovation nexus.

## 2 Research Hypotheses

In the internet-permeated environment, private equity institutions have enhanced efficiency in industry resources, management, and market channels through internet integration. Via internet-based industry databases and resource platforms, they quickly access technical patents, R&D talents, etc., for enterprises' innovation needs, breaking regional and industrial barriers to expand resource integration scope and efficiency. Supported by internet tools like remote collaboration systems and project management software, professional teams real-time track enterprise innovation progress, control R&D nodes, and adjust strategies. For example, they leverage global internet tech networks to introduce advanced technologies/equipment for enterprises, cutting communication and development costs via online collaboration. In market expansion, private equity's extensive channels integrate with internet marketing: Big data analyzes consumer demands and trends, enabling precise marketing via e-commerce and social media to accelerate commercialization of innovations. Additionally, internet monitoring systems allow real-time data tracking and dynamic management of enterprises. Digital performance evaluation supervises operations, prompting enterprises to boost efficiency and focus resources on development-oriented innovation, forming a virtuous cycle of innovation input and output. Therefore, Hypothesis H1 is proposed: private equity investment has a significant positive promotion effect on enterprise exploratory innovation.

Exploratory innovation is characterized by high risk, long cycle and strong uncertainty, and its innovation results are difficult to achieve profitability in the short term, and may even face the risk of failure[6]. Private equity investment institutions usually have clear investment term and return objectives, and are more inclined to pursue short-term financial returns. For the sake of risk avoidance and short-term interests, private equity may limit the investment of resources in exploratory innovation, and guide enterprises to allocate more resources to lower-risk and faster-return projects such as developmental innovation. In addition, exploratory innovation requires firms to have a high degree of autonomy and innovativeness, and the involvement of private equity may increase the complexity of firms' decision-making and limit the flexibility of firms in exploratory innovation. As a result, hypothesis H2 is proposed: private equity investment has a significant negative inhibitory effect on firms' exploratory innovation.

## 3 Empirical Research

### 3.1 Data Sources

This paper takes the A-share listed companies in Shanghai and Shenzhen from 2007-2022 as the initial research sample, and the data mainly come from the database of Cathay Pacific (CSMAR) and the database of Vantage (Wind). In order to ensure the validity and accuracy of the data, the initial sample is processed as follows: first, the listed companies in the financial industry are excluded because the business model and

innovation characteristics of the financial industry are significantly different from those of the non-financial industry, and their innovation activities are mostly centered on financial product design and risk management, which is difficult to be directly analogous to the concept of bi-dimensional innovation studied in this paper; second, the listed companies in the category of ST, *ST are excluded because such companies usually face financial difficulties or other abnormalities. companies usually face financial difficulties or other abnormal situations, and their business decisions and innovation behaviors may be interfered by special factors, which cannot reflect the normal state of the enterprise; thirdly, the samples with serious missing data are excluded, so as to avoid bias in the research conclusions due to incomplete key data. After screening, we finally get there are 3074 annual data. For some of the missing data, mean interpolation is used to supplement the data to ensure the completeness of the data. Meanwhile, in order to reduce the influence of extreme values on the research results, all continuous variables were subjected to 1% and 99% quantile shrinkage.

### 3.2 Model Construction and Variable Description

To examine the impact of private equity (PE) on corporate dual innovation, the following multiple linear regression model is constructed, with developed innovation (DI) and exploratory innovation (EI) as the explanatory variables, respectively, the variables are detailed in Table 1 below:

Developed Innovation Model:

$$DI_{i,t} = \beta_0 + \beta_1 PE_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 AGE_{i,t} + \beta_5 ROA_{i,t} + \sum \beta_j INDUSTRY_{i,t} + \sum \beta_k YEAR_{i,t} + \varepsilon_{i,t}$$

Exploratory Innovation Modeling:

$$EI_{i,t} = \gamma_0 + \gamma_1 PE_{i,t} + \gamma_2 SIZE_{i,t} + \gamma_3 LEV_{i,t} + \gamma_4 AGE_{i,t} + \gamma_5 ROA_{i,t} + \sum \gamma_j INDUSTRY_{i,t} + \sum \gamma_k YEAR_{i,t} + \varepsilon_{i,t}$$

**Table 1.** Description of variables

| Type of variable | Variable symbol | Definition of variables |
|---|---|---|
| Explained Variables | $DI_{i,t}$ | Firm i's exploratory innovation input/operating revenue in year t |
| | $EI_{i,t}$ | Exploratory innovation inputs/operating income in year t of firm i |
| Core Explanatory Variables | $PE_{i,t}$ | Whether firm i received private equity investment in year t (1 = yes, 0 = no) |
| Control Variables | $SIZE_{i,t}$ | Natural logarithm of total assets at the end of year t of firm i |
| | $LEV_{i,t}$ | Total liabilities/total assets of firm i in year t |
| | $AGE_{i,t}$ | Number of years from inception to year t of firm i |
| | $ROA_{i,t}$ | Net profit/average total assets of firm i in year t |

| | | |
|---|---|---|
| Dummy variable | $INDUSTRY_{i,t}$ | Dummy variables set by SEC 2012 industry classification |
| | $YEAR_{i,t}$ | Dummy variables set by year |
| Error term | $\varepsilon_{i,t}$ | Randomized disturbance term, satisfying the assumption of independent and identically distributed |

## 3.3 Empirical Results

### 3.3.1 Descriptive Statistics.

Table 2 shows the descriptive statistics of the main variables. The mean value of developed innovation is 0.068 with a standard deviation of 0.042, indicating that the overall level of enterprises' developed innovation investment is moderate, but there are large differences between different enterprises; the mean value of exploratory innovation is 0.035 with a standard deviation of 0.028, indicating that exploratory innovation investment is generally lower than that of developed innovation, and the fluctuation is small. The mean value of private equity investment is 0.321, which means that 32.1% of the firms in the sample have received support in that year. As for control variables, the mean value of enterprise size is 21.56, the mean value of gearing ratio is 0.453, the mean value of enterprise age is 12.7 years, and the mean value of return on total assets is 0.048, which are all in line with the general characteristics of A-share listed companies.

**Table 2.** Descriptive statistics of main variables (N=3074)

| Variables | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| DI | 0.068 | 0.042 | 0.005 | 0.213 |
| EI | 0.035 | 0.028 | 0.001 | 0.156 |
| PE | 0.321 | 0.467 | 0 | 1 |
| Size | 21.56 | 1.28 | 19.32 | 25.47 |
| Lev | 0.453 | 0.217 | 0.052 | 0.894 |
| Age | 12.7 | 5.4 | 3 | 32 |
| ROA | 0.048 | 0.062 | -0.185 | 0.234 |

### 3.3.2 Correlation Analysis.

Table 3 shows the Pearson correlation coefficients between the variables. The correlation coefficients of the core explanatory variable PE with developed innovation are 0.213 ($p<0.01$) and with exploratory innovation (EI) - 0.157 ($p<0.01$), which initially support the hypotheses of H1 and H2. Among the control variables, firm size is significantly positively correlated with DI and EI (0.321, 0.256, $p<0.01$), indicating that large-scale firms are more inclined to bimodal innovation; the gearing ratio is significantly negatively correlated with DI and EI (-0.189, -0.124, $p<0.01$), suggesting that high indebtedness inhibits innovation investment; the profitability is positively

correlated with the DI and EI are positively correlated (0.287, 0.215, p<0.01), indicating that enterprises with good profitability are more capable of supporting innovation. In addition, the correlation coefficients between variables are less than 0.5, and no serious multicollinearity problems are found.

**Table 3.** Pearson correlation coefficients between variables

| Variables | DI | EI | PE | Size | Lev | ROA |
|---|---|---|---|---|---|---|
| DI | 1 | 0.372** | 0.213** | 0.321** | -0.189** | 0.287** |
| EI | | 1 | -0.157** | 0.256** | -0.124** | 0.215** |
| PE | | | 1 | 0.198** | -0.117** | 0.163** |
| Size | | | | 1 | -0.235** | 0.312** |
| Lev | | | | | 1 | -0.278** |
| ROA | | | | | | 1 |
| Note: *p<0.05, **p<0.01 (two-tailed test). | | | | | | |

### 3.3.3 Analysis of Regression Results.

Table 4 shows the regression results of the fixed effects model. In the developed innovation model, the coefficient of PE is 0.012 (t=3.87, p<0.01), which is significantly positive, indicating that the developed innovation input of firms with private equity investment is 1.2 percentage points higher than that of firms without PE, supporting H1. In the exploratory innovation model, the coefficient of PE is - 0.008 (t=-2.56, p<0.05), which is significantly negative, indicating that PE participation reduces firms' exploratory innovation investment by 0.8 percentage points, validating H2.

**Table 4.** Regression results of fixed-effects models

| Variables | DVariables | Exploratory Innovation |
|---|---|---|
| PE | 0.012*** (3.87) | -0.008** (-2.56) |
| Size | 0.009*** (5.62) | 0.005*** (3.21) |
| Lev | -0.015*** (-4.17) | -0.011*** (-3.05) |
| Age | 0.002* (2.13) | -0.003*** (-3.78) |
| ROA | 0.087*** (7.45) | 0.063*** (5.28) |
| Industry Dummy Variables | Control | Control |
| Year dummy variables | Control | Control |
| Constant term | -0.125*** (-3.14) | -0.093** (-2.35) |
| N | 3074 | 3074 |
| $R^2$ | 0.432 | 0.358 |
| Note: *p<0.05, **p<0.01, ***p<0.001; t-values in parentheses, standard errors clustered to firm level. | | |

### 3.3.4 Robustness Tests.

(1) Replacement of core variables measurement method

To avoid the bias of conclusions caused by the single way of variable measurement, the core variables are re-measured. On the measurement of enterprises' developed innovation and exploratory innovation, the original study used the ratio of innovation input to operating income, which is replaced with an innovation output indicator this time.For private equity , in addition to the original dummy variable measurement, the new “private equity shareholding” is added as a proxy variable, which takes the proportion of the enterprise's shareholding in the private equity institution, and reflects the degree of influence of private equity on the enterprise in a more detailed way.

The regression analysis reveals (see Table 5) that the regression coefficient between the proportion of private equity ownership and the output of developmental innovation is 0.035, which is still significantly positive, indicating that the higher the proportion of private equity ownership, the more significant the output of developmental innovation of the enterprise, and the hypothesis H1 is robust; while the regression coefficient between the proportion of private equity ownership and the output of exploratory innovation is -0.021, which is significantly negative, and further verifies the hypothesis H2, indicating that a higher proportion of private equity participation will suppress the output of exploratory innovation. The regression coefficient of private equity ownership and exploratory innovation output is - 0.021, which further validates hypothesis H2, indicating that a higher proportion of private equity participation will inhibit firms' exploratory innovation activities.

**Table 5.** Robustness results of the core variables replacement measures

| Variables | Developmental Innovation | Exploratory Innovation |
|---|---|---|
| PEH | 0.035*** (2.89) | -0.021** (-2.13) |
| Size | 0.010*** (5.81) | 0.006*** (3.42) |
| Lev | -0.016*** (-4.32) | -0.012*** (-3.21) |
| Age | 0.003* (2.35) | -0.004*** (-3.91) |
| ROA | 0.092*** (7.81) | 0.068*** (5.63) |
| Industry Dummy Variables | Control | Control |
| Year dummy variables | Control | Control |
| Constant term | -0.132*** (-3.35) | -0.101** (-2.51) |
| N | 3074 | 3074 |
| $R^2$ | 0.456 | 0.382 |
| Note: *p<0.05, **p<0.01, ***p<0.001; t-values in parentheses, standard errors clustered to firm level. | | |

(2) Changing the sample interval

The original study selects the A-share listed companies in Shanghai and Shenzhen from 2007 - 2022 as the sample, and the sample interval is adjusted in order to test whether the research conclusions are affected by the specific time period. On the one hand, the sample interval is shortened by selecting the data from 2010 - 2018 to re-conduct the empirical analysis, which avoids the special impact of the early stage

of the global financial crisis in 2008 and the intensive impact of capital market reforms in recent years, focusing on the relatively stable economic environment; on the other hand, the sample interval is extended to 2023 to incorporate the latest data, in order to test the applicability of the conclusions in the new economic situation and policy environment. On the other hand, the sample interval is extended to 2023 to include the latest data to test the applicability of the findings under the new economic situation and policy environment.

The results show (see Table 6) that in the regression with shortened sample interval, the coefficients of PE on developed innovation are 0.010 and on exploratory innovation are -0.007; after the sample interval is extended, the coefficients of PE on developed innovation are 0.013, and on exploratory innovation are -0.009. The coefficient of PE on exploratory innovation is - 0.009. The sign of the coefficient and the significance level of the core explanatory variable PE do not change substantially under different sample intervals, suggesting that the findings are robust across time and are not disturbed by the choice of a particular sample interval.

**Table 6.** Robustness results for changing sample intervals

| Variables | Shorter sample intervals (2010Year-2018Year) | | Extended sample interval (2018Year-2023Year) | |
|---|---|---|---|---|
| | Developmental Innovation | Exploratory Innovation | Developmental Innovation | Exploratory Innovation |
| PE | 0.010*** (3.12) | -0.007** (-2.31) | 0.013*** (3.68) | -0.009** (-2.65) |
| Size | 0.008*** (5.41) | 0.004*** (3.05) | 0.011*** (6.12) | 0.005*** (3.34) |
| Lev | -0.014*** (-3.98) | -0.010*** (-2.89) | -0.017*** (-4.51) | -0.013*** (-3.42) |
| Age | 0.002* (2.05) | -0.003*** (-3.56) | 0.003** (2.51) | -0.004*** (-4.12) |
| ROA | 0.085*** (7.21) | 0.061*** (5.02) | 0.090*** (8.03) | 0.065*** (5.81) |
| Industry / Year dummy variable | Control | Control | Control | Control |
| Constant term | -0.118*** (-2.98) | -0.089* (-2.13) | -0.130*** (-3.42) | -0.098** (-2.45) |
| N | 2245 | 2245 | 3321 | 3321 |
| $R^2$ | 0.428 | 0.349 | 0.445 | 0.371 |
| Note: *p<0.05, **p<0.01, ***p<0.001; t-values in parentheses, standard errors clustered to firm level. | | | | |

# 4 Research Conclusion and Countermeasure Suggestions

## 4.1 Research Conclusion

Based on the data of A-share listed companies in Shanghai and Shenzhen from 2007 to 2022, this paper distinguishes corporate innovation into developmental innovation and exploratory innovation, and empirically examines the differential impacts of private equity investment. The results show that:

Firstly, PE significantly promotes the developmental innovation of enterprises, which is reflected in the effect of resource integration and management supervision;

Secondly, PE has an inhibitory effect on the exploratory innovation, which originates from its short-term gain orientation and risk aversion tendency;

Thirdly, enterprise size and profitability have a positive effect on the binary innovation, while the gearing ratio plays an inhibitory role, and the effect of enterprise age on the two types of innovation is differentiated.

## 4.2 Countermeasure Suggestions

For enterprises, when introducing PE, they should balance the short-term gain and long-term innovation, Open innovation can enhance efficiency by leveraging PE's Internet resources: relying on industrial collaboration platforms to link technology and supply chains, using cloud tools for joint research and development, and relying on big data case libraries to accurately grasp demands and shorten the implementation cycle.

For investment institutions, PE should establish the concept of long-term value investment, appropriately support high-risk exploratory innovation, and improve the mechanism of innovation risk-sharing; Through online industry forums, expert webinars and other forms, PE can have in-depth exchanges with top researchers and industry pioneers, more accurately assess the prospects of exploratory innovation, and thereby moderately and strategically support high-risk exploratory innovation.

For policy suggestions, the regulators can set up investment subsidies for PE, through online policy release platforms and e-government systems, subsidy information is quickly conveyed to investment institutions, guiding capital to flow into breakthrough technology fields such as artificial intelligence underlying algorithms and quantum communication, and accelerating the research and development process of cutting-edge technologies.

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