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Corporate Financing Constraints, Working Capital Management, and Corporate Investment—An Analysis Based on Manufacturing Industry Data of A-share Listed Companie

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Abstract. The paper selects 11 years of data from A-share listed companies in China from 2001 to 2021 as the research sample, with a focus on the manufacturing industry. The aim is to analyze the relationship between financing constraints, working capital management, and corporate innovation activities, intending to explain the reasons for the continuous increase in innovation activities by Chinese companies from the end of the last century to the present. Due to the high adjustment costs and unstable financing sources restricting corporate innovation activities, this paper particularly examines the role of working capital in alleviating innovation constraints. The research reveals that working capital plays a significant role in buffering fluctuations in corporate innovation investments, and this effect is closely related to the degree of financing constraints faced by the companies.

Keywords: Financing constraints; working capital smoothing effect; investment behavior.

1. Introduction

Innovation has always been a crucial topic for national progress. General Secretary Xi Jinping pointed out in the report of the 19th National Congress that innovation is the primary driving force for development and also the strategic pillar for building a modern economic system. With China's economy entering a new normal, increasing innovation input and enhancing innovation capabilities have become the new engines driving China's economic development.

Despite China's remarkable catch-up speed in R&D investment, the gap with developed countries at the forefront of technological innovation remains significant. The transformation from an "innovative country" to an "innovative powerhouse" is a daunting task for China. Considering that enterprises are the main drivers of innovation activities, increasing enterprise innovation investment has become the key to addressing China's insufficient innovation investment and enhancing its innovation capabilities.

Facing the dual pressures of high adjustment costs and limited funds, ensuring the sustained stability of innovation investment has become an urgent issue for enterprises to achieve innovative development. In this context, research on mechanisms to smooth innovation investment becomes particularly important. Current studies generally indicate that cash holdings can serve as a "funding buffer" to smooth innovation investment. Apart from cash holdings, what other factors can smooth innovation investment? Abundant overseas research has shown that working capital can also smooth innovation investment. In contrast, domestic scholars mainly focus on the smoothing effect of working capital on fixed asset investment, with relatively less research on its effect on innovation investment, lacking sufficient evidence. Therefore, it is necessary to further explore this issue in the Chinese capital market to provide supplementary evidence for research in this field.

2. Literature References

Foreign scholars, such as Brown and Petersen, were among the first to directly study the mechanisms of innovation investment smoothing. They conducted research on U.S. manufacturing firms using dynamic regression models. The study found that the phenomenon of using cash to smooth R&D expenses does exist [1]. Other researchers focused on Korean firms and divided R&D investment into cost-based R&D investment and asset-based R&D investment. They examined the smoothing effect of cash holdings on these two types of R&D investments. Through comparison, it

was found that cash holdings have a more significant smoothing effect on asset-based R&D investment compared to cost-based R&D investment [1]. Brown and Floros explored the relationship between venture capital, cash reserves, and innovation activities, and concluded that after obtaining venture capital, firms first establish cash reserves to provide financial support for innovation activities when facing financing constraints [3]. After discussing cash holdings, researchers extended their perspective to the level of working capital management and its smoothing effect on R&D investment. Brown and Petersen studied the priority order of competitive real investments for firms facing negative financial shocks and concluded that during recent financial crises, firms are more inclined to protect R&D investment through working capital management compared to fixed investments [4]. The aforementioned studies consistently indicate that firms can smooth R&D investment through effective working capital management.

Following the footsteps of foreign scholars, domestic researchers have gradually started studying the mechanisms of innovation investment smoothing and focused on the smoothing effect of cash holdings on R&D investment. Han Peng and Tang Jiahai conducted an empirical test on the smoothing effect of cash holdings on R&D investment using high-tech firms listed on the SME board from 2008 to 2010. The research results showed that when facing more severe financing constraints, firms are more inclined to use cash reserves for R&D smoothing management, demonstrating a stronger motivation. This study paved the way for domestic scholars in the field of innovation investment smoothing mechanisms [5]. Subsequently, domestic researchers used different sample data and approached the topic from different angles to delve deeper into the discussion on the "smoothing effect of cash holdings on R&D investment." Some scholars examined the smoothing effect of cash holdings on R&D investment and found that it only applies to financially constrained firms, while it does not hold true for non-financially constrained firms [6].

All of the above literature focuses on the perspective of cash holdings when discussing the mechanisms of innovation investment smoothing. Additionally, some scholars have attempted to introduce other new smoothing factors to enrich the emerging topic of innovation investment smoothing mechanisms. Ju Xiaosheng et al. were the first to introduce working capital elements and found that working capital has a significant smoothing effect on buffering innovation investment volatility, which strengthens as the level of financing constraints intensifies [7]. Li Jian et al. introduced government subsidies and explored their smoothing effect on innovation investment. The study showed that government subsidies help alleviate external financing constraints and thus smooth innovation investment volatility [8].

In summary, the research by domestic and foreign scholars indicates that due to the high liquidity, high realizability, and low adjustment costs of working capital, firms will spontaneously adjust their working capital to smooth fixed capital investment and innovation investment under financing constraints.

3. Research Design

3.1 Sample Selection

This paper selects data from A-share listed companies in China from 2001 to 2021 as the sample, covering an 11-year period. Manufacturing companies are chosen as the research sample for several reasons: due to the large proportion of investment in fixed assets, manufacturing companies typically require significant capital investment for purchasing and maintaining fixed assets such as production equipment and factories. Thus, the investment scale of manufacturing companies is relatively large, reflecting the characteristics of physical investment. Additionally, asset investments in manufacturing companies often have long recovery cycles. For instance, developing new products or constructing production lines typically takes a considerable amount of time to generate returns. This feature makes investment decisions in manufacturing companies more crucial and long-term. Moreover, assets in manufacturing companies are usually specialized for production purposes and are not easily transferable or sold, leading to the irreversibility of investment decisions. Therefore, investment

decisions in manufacturing companies tend to be more cautious and carry higher risks. Furthermore, manufacturing industries exhibit significant differences in capital expenditure compared to sectors like finance and real estate. Therefore, selecting manufacturing companies as the research sample can more accurately reflect the characteristics of physical investment. Additionally, manufacturing industries hold the highest proportion among listed companies in China and cover various sub-industries such as automobile manufacturing, electronic equipment manufacturing, and textile manufacturing. Thus, selecting manufacturing companies as the research sample provides strong representativeness and better represents the physical investment situation of the entire economy. This approach enables better research into the characteristics of physical investment and the impact of financing constraints on investment decisions in manufacturing companies. Furthermore, T-type listed companies that were in *ST, ST, or PT status between 2000 and 2021 are excluded. For missing values, interpolation methods are used for imputation, and data not suitable for interpolation are removed. This process results in a final sample size of 2899 groups for analysis.

3.2 Model Setting

3.2.1 Financing Constraint Measurement

According to the relevant literature, the earliest scholar who applied multivariate analysis to construct a financing constraint index used the method of multivariate discriminant analysis to construct the ZFC financing constraint index. Based on this index, the research sample was divided into groups to analyze the relationship between financing constraints and corporate investment [9]. Another scholar selected financial variables such as operating cash flow, Tobin's Q, leverage ratio, dividend payout ratio, and cash holdings to conduct ordered logit regression analysis and used the estimated coefficients to construct the KZ index [10]. Furthermore, some scholars selected long-term debt-to-asset ratio, dummy variable for dividend payments, sales revenue growth rate, natural logarithm of total assets, industry sales growth rate, and cash flow-to-total asset ratio as indicators for constructing the WW index, which serves as a proxy variable for external financing shadow cost [11]. However, a common problem with these methods is that they all include many endogenous financial variables. To avoid interference, some scholars constructed the SA index using two variables, firm size and firm age, which have little change over time and strong exogeneity [12].

3.2.2 Testing Ideas and Setting of the Innovation Investment Model

Euler's equation can be used to describe the growth process of assets. Its fundamental logic is that the growth rate of assets is directly proportional to the current value of the assets.

$$Innov_{it}/K_{it} = \beta_0 + \beta_1(Innov/K)_{it-1} + \beta_2(Innov/K)^2_{it-1} + \beta_3(Y/K)_{it-1} + \beta_4(CF/K)_{it-1} + \beta_5(\Delta wk/K)_{it} + \varepsilon_{it}$$

For investment expenditure Innov_{it}, this paper uses the "cash paid for fixed asset investment" from the cash flow statement. Additionally, the investment expenditure Innov_{it} is standardized by dividing it by the initial total assets to remove the scale effect. As for K_{it}, this paper uses the initial total assets. The variable Y_t represents the main business income in period (t), CF_t denotes the net cash flow from operating activities of the enterprise in period (t), and finally, the fluctuation of working capital Δwk is calculated as the difference between the current period and the previous period's working capital.

When companies face negative shocks and encounter limitations in their primary financing channels, they may experience a shortage of funds. To avoid losses resulting from cutting or interrupting innovation investment, companies need to find ways to bridge the funding gap. When companies are not subject to financing constraints, they can seek external financing to supplement the required investment funds. This implies that they can obtain additional capital through methods such as debt financing or equity financing.

However, when companies face severe financing constraints, they may not easily secure external financing. This compels them to explore alternative methods to address the funding shortage. A

common practice is to smooth other investments by adjusting working capital, prioritizing limited funds for innovation investment projects with higher adjustment costs. By optimizing the use of existing funds, companies can maintain the continuity of innovation investment to the maximum extent in financially tight situations.

The smoothing effect of a company's working capital on innovation investment is closely related to the degree of financing constraints it faces. To capture this impact, this paper introduces a financing constraint dummy variable and the interaction term between the financing constraint and the fluctuation of working capital on top of the model mentioned earlier, constructing the model.

$$\begin{aligned}\mathrm{Innov}_{it}/K_{it} = {} & \beta_0 + \beta_1(\,\mathrm{Innov}/K)_{it-1} + \beta_2(\,\mathrm{Innov}/K)^2_{it-1} + \beta_3(Y/K)_{it-1} + \beta_4(CF/K)_{it-1} \\ & + \beta_5(\Delta wk/K)_{it} + \beta_6(\Delta wk/K)_{it} * FC_i + \varepsilon_{it}\end{aligned}$$

Where FC_i represents the virtual variable indicating the financing constraints faced by the company. This paper divides the financing constraints of companies into four levels, with each level generating a virtual variable. As analyzed earlier, the stronger the financing constraints faced by a company, the greater the smoothing effect of working capital on innovation investment. This is manifested in the model by β_6 being negative, and the absolute value increasing with the strength of financing constraints.

4. Empirical Results Analysis

Table 1 presents the descriptive statistics of the main variables. Regarding the financing constraint index SA, Hadlock and Pierce point out that financial constraints tend to decrease with the growth of young and small companies. Therefore, we do not take the absolute value of the SA index. Instead, we directly arrange and categorize it to obtain the financing constraint dummy variable FC_i. After standardizing the investment expenditure Innov_{it}, Y_t, CF_t, and the fluctuation of working capital Δwk by K_{it}, the comparability between companies is enhanced. From the descriptive statistics table, it can be observed that the mean of Innov/K is 0.105, which is greater than the median of 0.009, indicating that the majority of companies have investments greater than the median of 0.092. For Y/K, the standard deviation of 0.538 indicates significant differences in the main business income among companies, leading to variations in their investments. The large difference between the maximum and minimum values of operating cash flow net CF/K suggests diversity in the financial conditions of companies. The Tobin's Q values reveal variations in the growth prospects among companies.

Table 1 Descriptive Statistics of Key Variables

	Valid	Mean	Median	Std. Dev	Minimum	Maximum
SA Index	31,852	3.844	3.514	0.704	-1.439	4.863
Innov/K	31,852	0.105	0.009	0.018	0.065	0.600
Y/K	31,852	0.723	0.720	0.538	-0.045	6.082
CF/K	31,852	0.062	0.061	0.108	-0.392	0.677
Tobins Q	31,852	1.864	1.864	1.870	0.125	22.760
$\Delta wk/K$	31,852	0.012	0.157	0.203	0.008	0.231

4.1 The Impact of Working Capital Fluctuations on Investment

Table 2 presents the estimation results of the dynamic model. The first two columns use random effects and fixed effects models for estimation, the third column employs the difference GMM, and the fourth column uses the limited information maximum likelihood estimation method.

From the estimation results in the table, it can be observed that in the random effects model, the coefficients of cash flow and working capital are biased towards higher values. This bias is related to measurement errors, indicating an overestimation of variables positively correlated with proxy variables. A Hausman test was conducted, and the results rejected the null hypothesis, suggesting that

fixed effects are correlated with explanatory variables, recommending the use of a fixed effects model. The variance of explanatory variables is observed to generally increase, aligning with the characteristics of instrumental variable methods, sacrificing efficiency for consistency.

Next, we will analyze the smoothing effect of working capital. In each column, the coefficient of the working capital fluctuation term is significantly negative, indicating that the direction of working capital changes is opposite to that of innovation investment. This is further emphasized by observing that the coefficient of working capital fluctuation in the random effects model is higher compared to other columns.

Table 2 The Impact of Working Capital Fluctuations on Investment

	Random effects	Fixed effects	Difference GMM	Limited Information Maximum Likelihood (LIML)
$\text{Innov}_{i,t-1}$	1.261*** (0. 008)	1.151*** (0.003)	0.812** (0.005)	0.816*** (0.002)
$\text{Innov}_{i,i-1}^2$	-4.55*** (1. 118)	-3.47*** (0.002)	-3.321*** (0.006)	-2.987*** (0.004)
$Y_{i,t-1}$	0.013*** (3.870)	0.103* (0.001)	0.132*** (0.003)	0.128** (0.006)
$CF_{i,t-1}$	0.014** (0. 002)	0.013*** (0.007)	0.008*** (0.014)	0.007*** (0.016)
$\Delta wk_{i,t}$	-0.019*** (0. 006)	-0.025*** (0.012)	-0.024** (0.011)	-0.023** (0.009)
Annual	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	31,852	31,852	21,732	21,732
Adj.R^2	0.26	0.21	0.31	0.27

4.2 The impact of financing constraints on working capital smoothing

When cash flow fluctuates, companies adjust working capital to smooth innovation activities. Does this smoothing effect increase with the severity of financing constraints? To investigate the impact of financing constraints on working capital smoothing, this study categorizes companies into four groups based on the degree of financing constraints, represented by three dummy variables FC1, FC2, and FC3, indicating weak, heavy, and severe financing constraints, respectively.

Introducing these virtual variables and their interaction terms with working capital volatility into the previous model forms a new model. The estimation results reveal, similar to the previous model, that the random effects model overestimates cash flow and working capital volatility. With the addition of interaction terms, both the coefficient for working capital and the interaction term are negative. This implies that compared to companies with weaker financing constraints, those facing stronger constraints exhibit higher coefficients for working capital volatility. These findings indicate that the role of working capital in smoothing innovation expenditures strengthens with the severity of financing constraints on companies.

Table 3 The impact of financing constraints on working capital smoothing

	Random effects	Fixed effects	Difference GMM	Limited Information Maximum Likelihood (LIML)
$\text{Innov}_{i,t-1}$	1.261*** (0. 008)	1.151*** (0.003)	0.812*** (0.005)	0.816*** (0.002)
$\text{Innov}_{i,i-1}^2$	-4.55*** (1. 118)	-3.47*** (0.002)	-3.321** (0.006)	-2.987** (0.004)
$Y_{i,t-1}$	0.013*** (3.870)	0.103* (0.001)	0.132** (0.003)	0.128** (0.006)
$CF_{i,t-1}$	0.004** (0. 002)	0.013*** (0.007)	0.008*** (0.002)	0.007*** (0.001)

$\Delta wk_{i,t} * FC1$	-0.0016 (0.001)	-0.0026 (0.002)	-0.0034*** (0.002)	-0.0032*** (0.002)
$\Delta wk_{i,t} * FC2$	-0.0027 (0.002)	-0.0047 (0.002)	-0.0061** (0.003)	-0.0052** (0.002)
$\Delta wk_{i,t} * FC3$	-0.0033 (0.001)	-0.0034 (0.001)	-0.0053*** (0.003)	-0.0049* (0.003)
Annual	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	31,852	31,852	21,732	21,732
Adj.R^2	0.28	0.26	0.34	0.31

4.3 Robustness test

To ensure the validity of the results, we recharacterize innovation investment behavior using Tobin's Q model. We reintroduce the working capital volatility term and the interaction terms between working capital and financing constraint dummy variables into the Tobin's Q model. We also control for industry, fixed effects, and time effects and employ difference GMM estimation.

The results are similar to the previous findings. The coefficient for the working capital volatility term is significantly negative. The coefficient for the FC2 interaction term is negative but not significant. However, the coefficients for the FC3 and FC4 interaction terms are both significantly negative and similar in magnitude, indicating that the conclusions drawn in this study are not affected by equation selection.

Thus, it can be observed that if companies are not subject to financing constraints, the smoothing effect of working capital on corporate innovation sustainability is not significant. However, if companies face severe financing constraints, working capital plays an important role in smoothing corporate innovation sustainability. In other words, the more severe the financing constraints, the stronger the smoothing effect of working capital. Therefore, we believe that since 2001, the steady increase in innovation activities of Chinese companies without significant fluctuations is due to the smoothing effect of working capital on innovation investment by enterprises.

Table 4 Robustness test

	Tobin's Q model
$\text{Innov}_{i,t-1}$	1.254*** (0.004)
Q	0.004** (0.001)
$CF_{i,t-1}$	0.004** (0. 002)
$\Delta wk_{i,t}$	0.0013*** (0.001)
$\Delta wk_{i,t} * FC1$	-0.0014*** (0.001)
$\Delta wk_{i,t} * FC2$	-0.0022*** (0.002)
$\Delta wk_{i,t} * FC3$	-0.0033*** (0.001)
Annual	Yes
Industry	Yes
N	21,732
Adj.R^2	0.27

5. The conclusion

The importance of working capital in smoothing innovation investment is self-evident. It helps alleviate financing constraints, thus smoothing the fluctuations in corporate innovation investment and avoiding the high adjustment costs associated with innovation investment fluctuations, ensuring the continuous conduct of innovation investment activities. The ability of working capital to smooth innovation investment mainly lies in its relatively low adjustment costs and greater flexibility compared to innovation investment. The economic significance of this conclusion is that when companies face temporary economic shocks, they can support innovation activities by appropriately adjusting working capital, thereby ensuring the smooth progress of innovation activities.

Therefore, working capital management plays a crucial role in corporate innovation investment, and its smoothing effect has profound implications for the long-term development of enterprises.

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