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**The effects of venture capital, R&D and technology on the IPO underpricing:**

**Evidence from China**

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# **The Effects of Venture Capital, R&D and Technology on the IPO Underpricing: Evidence from China**

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**ABSTRACT:** This paper is a preliminary attempt to investigate the effects of technology and R&D expenditure, and the moderating effect of venture capital through interaction of technology and R&D on underpricing of IPO in China A-share market. Using the 997 IPOs sample from 2013 to 2018 in China A-share market, I apply a cross-product residual centering approach to explore the relationships among factors. I find that venture-backing IPOs experience less underpricing; technology requirement increases IPO underpricing; R&D expenditure helps to reduce tech-IPOs underpricing. The striking observation to emerge from the data is that IPO underpricing caused by technology requirement can be moderated by the participation of venture capital. The finding highlights that strengthening the supervision role of venture capital in the invested company and improving the R&D information disclosure level in technology company can effectively reduce the degree of IPO underpricing.

**Keywords:** *Initial public offerings; venture capital; technology; R&D expenditure; underpricing; VC-backed IPO.*

## I. INTRODUCTION

Initial public offering (IPO) underpricing has generated significant interests of practitioners in the past. Since Ibbotson (1975) discovered this phenomenon for the first time in 1975, many scholars have studied stock markets in different periods and in different regions, and found that IPO underpricing is a very usual phenomenon in all capital markets all over the world, but the degree of underpricing is different, usually IPO underpricing in developing country stock markets is more serious than in developed countries. Most of models and theories account for the phenomenon based on information asymmetry and agency theory.

Due to the role of government, China IPO market has certain characteristics compared to other stock markets. China Securities Regulatory Commission plays an essential role in the IPO pricing process. China's domestic research on IPO underpricing is mainly divided in two parts: Jiang et al. (2006) and Liu et al. (2005) combined the China's institutional background to investigate IPO underpricing, showing that institutional factors are the main reason for the high underpricing of IPO in China; while Su (2004) and Liu et al. (2009) followed western researches, finding that the level of information asymmetry also significantly affects the level of underpricing of China IPOs.

Among the factors that influence IPO underpricing, R&D expense, venture capitalists and technology have been examined by some scholars. In a research on the USA listed companies, Heeley and Jain (2007), and Guo et al. (2006) found that as R&D input increase, IPO underpricing changes in the same pattern. According to Guo et al. (2006), the reason that R&D such intangible assets, will cause IPO underpricing is that accounting assessment methods restricts R&D input on the financial statements. In addition, following the agency theory, Jensen and Smith (2000) demonstrate that some managers may increase their own compensation through engage in R&D investments. As a result, R&D not only improves the future value of a company, but also brings extra costs to the company. Venture capitalist not only provide money for a startup, but also bring more lasting influence on portfolio company. According to Megginson and Weiss (1991), VC monitors the performance of firm's manager, thus certifying the true value of the company and reduce IPO underpricing. The "grandstanding hypothesis" theory proposed by Gompers (1996) suggests that VCs would like to afford the underpricing cost since a good reputation of a VC is essential for future. Moreover, Lowry and Schwert (2002) indicate that a high degree of information asymmetry usually exists in technology IPOs, which causes a relatively huge IPO underpricing.

Although Chin et al. (2006) and Guo et al. (2006) have explored the relationship between R&D investment and underpricing of IPO, Megginson and Weiss (1991) investigate the relationship between venture capitalists and IPO underpricing, and Jiang et al. (2014) examine the role of VCs in China listed companies, no such paper examined the role of technology in IPO underpricing and the moderating influence of venture capital, R&D and technology on underpricing of IPO. This paper aims to fill this gap. This paper examines the impacts of R&D on IPO underpricing with the reciprocal effects of venture capitalists and technology. The research questions include whether the correlation between R&D and IPO underpricing, and the correlation between technology and IPO underpricing are influenced by venture capitalists,

and whether technology requirement or R&D investment cause the interaction between R&D expenditure and technology.

On November 5, 2007, the most profitable company in Asia, PetroChina returned to the A-share. The initial return of the company peaked at 163%, however, its stock price gradually dropped after IPO, depreciating by 76% over just three months. As a result, a large amount of PetroChina shareholders experienced a huge loss. In China A-share market, the companies in IPO like PetroChina are common. By studying 570 A-share IPOs in China, Chan et al (2004) finds the average underpricing for A-share is 178%. Compared with developed countries, the venture capital in China is in the development stage, with small scale and insufficient standardization (Han and Shen 2017). Therefore, whether China's venture capital can provide effective support and services for enterprises is unclear and deserves detailed study. In addition, more and more high-tech firms emerge in China and help the economy growth. As a result, China A-share market provides a good data sample for the research.

By using the cross-product residual-centering methodology and studying a sample of 997 China A-share IPOs during 2013-2018, I find that venture capital plays a moderating role on tech-IPO underpricing. The result illustrates that tech-IPOs experienced higher underpricing, while R&D expenditure does not put influence on the underpricing; but R&D does increase the underpricing rate for technology IPOs. This study also brings a new point to the existing literature, demonstrating the interaction effect between technology and venture capitalist.

This paper is the first study that examine the effects of venture capital backing, technology background, R&D, and the interaction relationships among them on IPO underpricing in China. Previously, western researchers investigated the role of venture capital, R&D and high-technology on underpricing of IPO in the mature stock market, but Chinese stock market is not mature enough, and given the government and institutional factors, Chinese stock market most likely to show a very different situation. In addition, some Chinese researchers explored the explore the R&D and venture capital effects on IPO underpricing based on data from China Growth Enterprise Board, there is still considerable uncertainty on the interaction effects of technology and venture capital, R&D and venture capital, and technology and R&D on IPO underpricing, which are explained in my study; my research also discusses the moderating effect of venture capitalist, rather than focuses only on the independent effects of those three factors. My results suggest that technology has a positive relationship with IPO underpricing, while venture capitalist help reduce such positive effect; moreover, for technology IPOs, the more investment in R&D expenditure, the higher their underpricing.

The remaining part of the research paper is organized as follows. Section 2 develops the literature review and hypotheses; Section 3 introduces the empirical methodology and results; Section 4 discusses and analyses the results; my conclusion is drawn in Section 5.

## **II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT**

In the prior paper, Chin (2006) and Guo (2006) explore the relation between R&D expenditure and IPO underpricing; the result indicates that the innovation capital such as R&D spending, award patent, and patent citations could be treated as the signals of IPO underpricing, those companies that have higher R&D expenditure experiences a severe underpricing. Megginson and Weiss (1991) investigate the certification role played by VC in IPO and find that venture-backing companies have a remarkable lower first-day return. In the study of the

role of VCs in SME (small and medium-sized enterprise) IPOs conducted by Jiang et al., they conclude that venture capitalists appear as an important function in facing asymmetries of capital markets. There is no paper examine the moderating effect of VCs through interaction of technology and R&D on underpricing of IPO in China financial market.

### **IPO underpricing**

Ibbotson (1975) demonstrates that mystery of IPOs leads to significant positive initial return in IPO. After that, Ritter (1991) indicates that the average IPO initial return is 14.3% for the 1526 IPOs sample between 1975 and 1984. Information asymmetry hypotheses is the most popular explanation for IPO underpricing. Rock (1986) suggests that such information asymmetry appears between acquainted investors and those who are uninformed. Underwriters have to underprice IPOs in order to hold these uninformed investors. Beatty (1986) states that the uncertainty on IPOs decides the degree of underpricing: when the unsureness is higher, the expense of accessing information is higher, and thus the underpricing will be higher.

### **China stock market**

China has SSE (Shanghai Securities Exchange) established in 1990, and the SZSE (Shenzhen Stock Exchange) established in 1991, two stock exchanges. Each of them serves as main board. Unlike other states' stock market, the China stock market has some distinctions in several aspects: first, the outstanding shares have segmented ownership; it is classified as state-owned shares, personal-own shares and publicly shares. Second, China stock market is separated as A- and B-share markets. Third, the cycle between offering and listing is usually long in China stock market. Moreover, state-owned shares account for a large proportion before and after company going public. These features make this study on China stock market meaningful and unique.

China IPO system experiences several stages in the past three decades. From 1990 to 1995, the China Securities Regulatory Commission claimed that under the strict IPO listing quota system, regulators would decide which company can go public and at what offer price. From 1995 to 2000, the China Securities Regulatory Commission required IPO firm's P/E multiple should not exceed 15. This restriction resulted in an extremely high over-subscription rate and huge IPO initial returns. Since 1999, the commission applied a new market-oriented system under which the lead underwriters give a price range first, and then the offer price would be determined by individual investors transaction within the range. However, this method caused a high P/E ratio in the stock market. Since 2006, the book building approach with "Window Guidance" set the P/E multiple has an upper limit of 30; Since 2012, this approach required IPO firm's P/E ratio should below 25% of the average P/E multiple of industry peers. After that, the IPO pricing system in China formally become market-oriented (Jiang et al. 2014).

### **Hypotheses Development**

#### **Technology and IPO underpricing**

Ritter (1991) documents that IPO underpricing phenomenon occurs in many countries. Chen et al. (2004) finds that the average IPO underpricing in A-share market is 178%, which is significant. Information asymmetry is usually applied to explain the underpricing. Lowery

and Schwert (2002) demonstrate that high-technology IPOs tend to have higher underpricing because they usually take a higher risk for investors. The serious underpricing in high-technology IPOs is connected with the company's future growth opportunities (Lowry and Shu 2002). Chen et al. (2007) prove the Lowry, Schwert, and Shus' argument, as well as suggest that in Taiwan stock market the IPOs of high-technology firms experience the higher underpricing than other industries.

**Hypothesis 1:** High-tech firms experience higher IPO underpricing.

### **Venture capital, technology and IPO underpricing**

According to Barry et al (1990), venture capital equips a monitor function on firm's manager, thus certifying the portfolio's value. Megginson and Weiss (1991) demonstrate that VCs have a certification role, which increases the firm value, lessens the information asymmetry, and reduces the underpricing of IPO. Because of the high uncertainty about future, high-technology IPOs need to undergo the underpricing. However, venture capitalists can provide the assistance to decrease the uncertainty and therefore reduce the underpricing. As a result, I get Hypotheses 1.1 and 1.2 based on above information:

**Hypothesis 2:** Venture capital can help reduce the high-technology IPOs underpricing by reduce the uncertainty concerned with tech-IPOs.

### **R&D and IPO underpricing**

Aboudy and Lev (2000) claim that the fundamental reason of information asymmetry is R&D expenditure. Guo et al. (2006) confirm the statement, arguing the R&D spending is the primary source of that asymmetry. By using evidence from Taiwan, Chin et al. (2006) support Guo's argument, showing that IPOs with large R&D spending are underpriced more because of the financial information asymmetry that is a result of innovation capital standards.

**Hypothesis 3:** IPOs with higher R&D expenditure experience higher IPO underpricing.

### **Venture capital, R&D and IPO underpricing**

R&D has a strong relationship with patent counts (Hausman et al. 1984). The statistics of patents is one of the measurements that decide whether R&D expenditure is effective. According to Chin et al. (2006), the pre-IPO R&D, numbers of awarded patents, and patents citations have a relationship with IPO underpricing. Although R&D brings the asymmetry information, increases the risk faced by investors and thus reduce the firm's value, the patent citations can help increase firm value at some point. Loughran and Shive (2010) also state that the companies owned more granted patents can usually attract venture capitalists and receive more fund, inversely venture capital can stimulate the innovations of the companies.

Gomez-Mejia et al. (2003) suggest that VCs play a supervisor role which monitor the changes between R&D expenditure and performance of the firm. Venture capitalists' participation implies the true worth of R&D, therefore reduce the asymmetric information comes from R&D. Therefore, I make the following two Hypotheses:

**Hypothesis 4:** Venture capital can help release the uncertainty faced by IPOs with high R&D and reduce the underpricing of such IPOs.

### III. RESEARCH METHODOLOGY

#### Data source and sample

The data was from all IPOs in China A-share market from Shanghai and Shenzhen Stock Exchanges during 2013 to 2018. My sample includes total 997 IPOs, excluding financial company IPOs and IPOs that data is not integrated. Chi and Padgett (2005) implied that there were no significant contradictions of underpricing degree on the two stock exchanges. The IPO data index cover company name, lead underwriter, offer price, offer date, offer size, turnover rate, industry sector, offer to 1<sup>st</sup> close, filing date, firm age, revenue, and R&D expense. Those data were obtained using *Wind*, which is the China leading financial terminal. The data of IPOs with venture capital investment background was acquired from *ChinaVenture* database. Data analysis was performed by using *Stata 15.1 SE*.

#### Measurement of variables

In this paper, I follow Lu et al. (2012) to measure the dependent and independent variables in testing the effects of R&D, venture capital and technology on Taiwan IPO underpricing. I follow their measurements of variables.

1. IPO underpricing (*MAR*): IPO underpricing is calculated by using the first-day closing price minus offer price and divided by the offer price:

$$MAR = \frac{P_{NH} - P_F}{P_F} \quad (1)$$

In the function,  $P_{NH}$  denotes the first-day closing price,  $P_F$  represents the offer price

2. Market returns before IPO filing date (*MKT*): Lowery and Schwert (2002) depict that investors usually concern the IPO offer price according to the public information such as the market situation prior filing date. Following Lu, I use the CSI 300 index 30 days before filing date to represent the stock market condition before IPO (The CSI 300 index is a component stock index compiled from 300 A-share companies selected from the Shanghai and Shenzhen stock markets. It covers about 60% of the market capitalization of the Shanghai and Shenzhen Stock Exchanges and has good market representation):

$$MKT = \frac{I_F - I_{F-30}}{I_{F-30}} \quad (2)$$

Where  $I_F$  presents the market index on filing date,  $I_{F-30}$  is the market index 30 days before filing date.

3. Turnover ratio (*TURV*): the turnover ratio is the ratio of the first day trading volume to the total number of shares issued on the IPO day. The turnover ratio demotes the degree of investor's recognition of the stock value in the secondary market. Based on the studies of Lijungqvist et al (2006). and Su (2004), controlling the IPO turnover rate is necessary when examining the underpricing rate.

$$TURV = \frac{\text{The first day trading volume}}{\text{Number of outstanding shares}} \quad (3)$$

4. Offer size (*PROC*): considering that information asymmetry is from not only the R&D, Lu et al. use offer size, underwriter reputation and firm age as control variables. The previous study proves offer size is related to IPO underprice, the offer size is larger, the risk of asymmetric information is smaller and IPO underpricing is lower (Beatty and Ritter, 1986). The logarithm of IPO proceed denotes *PROC*.
5. Underwriter reputation (*UNDR*): Carter and Manaster (1990) assert that if the underwriter has a higher reputation, it can release the information asymmetry at a certain degree. Han and Shen (2017) also use underwriter reputation as a dummy control variables when examining R&D, venture capital and IPO underpricing on China Growth Enterprise Board; following Han and Shen, based on the underwriter ranking in Bloomberg, the top 10 underwriter is defined as *UNDR*=1, otherwise *UNDR*=0
6. IPO firm age (*AGE*): prior research indicates that the longer a company exists, the more effectively the market can assess its performance, and therefore decrease the information asymmetry. Following Lu et al.(2012), I apply the logarithm of years from firm's establishment to IPO filing date plus one as a proxy variable
7. Venture capital (*VC*): if an IPO is venture-backing, *VC*=1; otherwise *VC*=0
8. Demand on technology (*TECH*): following Lu et al.(2012)s' model, a technology industry dummy variable is used as a proxy. *TECH*=1 if an IPO is in technology sector according to Bloomberg's categories; otherwise *TECH*=0.
9. R&D intensity (*RD*): Following Lu et al.(cited in Wallin and Gilman, 1986),the ratio of R&D expense to sales during the time before issuing is used to value the company's R&D, which is defined as:

$$RD = \ln \left( 1 + \frac{RDE}{SALES} \times 100 \right) \quad (4)$$

In the function, *SALES* and *RDE* are sales and R&D expense of the year prior to IPO. If the data of R&D and sales one year before issuing are not available, I use the data two years prior issuing date.

### Empirical Model

This paper applies the cross-product residual-centering methodology, which is provided by Lance (1988). In addition, Lu et al. use the same approach to examine the moderating effects of VCs in Taiwan IPO underpricing. The benefit of this methodology is to eliminate the multicollinearity phenomenon in the regression analysis model. In order to explore the moderating influence on the relationship between the independent and dependent variables, I use the interaction terms among variables in the model. This lightening effects is reflected by the interaction terms. However, if there is correlation between the main and cross-product

variable, multicollinearity often occurs at this time. Therefore, applying the cross-product residual-centering approach would be helpful in getting more accurate result.

Regression (5) mainly examines the effect of control variables on IPO underpricing, which include market conditions using CSI 300 index 300 days before filing (*MKT*), turnover rate(*TURV*), the IPO age(*AGE*), IPO proceeds(*PROC*), and underwriter reputation(*UNDR*)

$$MAR = \alpha_0 + \alpha_1MKT + \alpha_2TURV + \alpha_3AGE + \alpha_4PROC + \alpha_5UNDR + \varepsilon \quad (5)$$

In an attempt to explore the independent influence of the above three variables on the underpricing. I apply regression (6) containing the moderating variables, venture capital background (*VC*), technology sector dummy (*TECH*), and R&D expense (*RD*).

$$MAR = \beta_0 + \beta_1MKT + \beta_2TURV + \beta_3AGE + \beta_4PROC + \beta_5UNDR + \beta_6VC + \beta_7TECH + \beta_8RD + \nu \quad (6)$$

Regression (7) introduces the interactions variable of tech-IPO and venture capitalist to explore whether the use of VC can lessen the uncertainty faced by technology company, and then reduce the tech-IPO underpricing.

$$MAR = \gamma_0 + \gamma_1MKT + \gamma_2TURV + \gamma_3AGE + \gamma_4PROC + \gamma_5UNDR + \gamma_6VC + \gamma_7TECH + \gamma_8RD + \gamma_9VC \times TECH + \mu \quad (7)$$

The following regression model (8) investigates that whether venture capitalist can bring the inverse effect on IPO underpricing if R&D expense would cause a higher underpricing.

$$MAR = \lambda_0 + \lambda_1MKT + \lambda_2TURV + \lambda_3AGE + \lambda_4PROC + \lambda_5UNDR + \lambda_6VC + \lambda_7TECH + \lambda_8RD + \lambda_9VC \times TECH + \lambda_{10}VC \times RD + \nu \quad (8)$$

Regression (9) includes all the independent variables and interaction terms to examine whether the demand on technology can reduce the information asymmetry led by R&D and then decrease the IPO underpricing of firms with high R&D expenditures, or inversely, whether high R&D investment can remit the information asymmetry caused by technology and lower the tech-IPOs' underpricing.

$$MAR = \theta_0 + \theta_1MKT + \theta_2TURV + \theta_3AGE + \theta_4PROC + \theta_5UNDR + \theta_6VC + \theta_7TECH + \theta_8RD + \theta_9VC \times TECH + \theta_{10}VC \times RD + \theta_{11}TECH \times RD + \omega \quad (9)$$

### Descriptive statistics and correlation

Table 1 presents the descriptive statistics for the full variables. Column 1 of Table 1 are the dependent and independent variables. The average IPO underpricing in China is 43.9%, which significantly higher than the IPO underpricing level in mature capital markets by 10% -20%. The average turnover rate is 0.7% which is low, indicating that speculation phenomenon is not so obvious in this sample stock market; the rational investment greatly reduces the IPO

underpricing. The minimum IPO proceed is 78.3 million RMB, while the maximum proceed is 27120.41 million proceed; the difference is large given the number, which implies that the IPO scale is very different in China mainboard stock market. This fact might be explained as A-share market covers all the types of industries, and industry differences are usually huge. The same reason can also explain the difference between firm age, the industries and development stages of listed companies on the mainboard market are scattered and not concentrated.

**TABLE 1**  
**Descriptive Statistics for the Independent Variables Used in the Multiple Linear Regressions**

<u>Variable</u>	<u>Mean</u>	<u>Std.Dev.</u>	<u>Min</u>	<u>Max</u>
<i>MAR</i>	.439	.014	.136	.46
<i>MKT</i>	-.017	.058	-.202	.26
<i>TURV</i>	.007	.05	0.000048	.844
<i>PROCEED</i> (in mil RMB¥)	577.975	1095.704	78.3	27120.43
<i>UNDR</i>	.493	.5	0	1
<i>AGE</i> (in year)	14.226	5.459	3	55
<i>VC</i>	.573	.495	0	1
<i>TECH</i>	.22	.414	0	1
<i>RD</i>	1.609	.595	0.0003322	3.661
<i>N</i>	997	997	997	997

*MAR* = IPO underpricing; (first-day closing price-offer price)/offer price

*MKT* = Market returns prior to IPO; (filing day CSI 300 index-30 days prior to filing date index)/30 days prior to filing date index

*TURV* = Turnover ratio; The frequency at which shares change hands in the market in the first day; first-day trading volume/ No. of outstanding shares

*PROCEED* = IPO proceed; offer price x No. of shares issued

*UNDR* = Underwriter reputation; Dummy variable, UNDR=1 if ranking in TPO 10, otherwise UNDR=0

*AGE* = IPO age at issue date

*VC* = Venture capital; VC=1 if an IPO is VC-backing; otherwise VC=0

*TECH* = Demand on technology; TECH=1 if an IPO is in technology sector; otherwise TECH=0

*RD* = R&D intensity; The logarithm of (1+ R&D expense/Sales x 100)

Table 2 displays the correlation among the variables. Turnover rate has a significant negative relationship with underpricing, the IPOs with higher turnover rate are more underpriced (*TURV* = -0.049). Underwriter with good reputation brings more proceed for IPOs. Firm age can be treated as a factor that reflect the IPO underpricing; the older company usually has higher underpricing level (*AGE* = 0.067). In addition, VC-backing IPOs experiences lower underpricing (*VC* = -0.114), inferring that venture capital can contribute to reduce the underpricing phenomenon. Tech-IPOs have higher underpricing compared with non-tech IPOs (*TECH* = 0.083); technology industry often represents high-risk industry, that's why investors are more confident with non-tech IPOs and prefer to low-risk IPOs.

**TABLE 2**  
**Correlations for the Independent Variables Used in the Multiple Linear Regressions**

Variables	<i>MAR</i>	<i>MKT</i>	<i>TURV</i>	<i>PROCEED</i>
<i>MAR</i>	1.000			
<i>MKT</i>	-0.033	1.000		
<i>TURV</i>	-0.469***	0.110***	1.000	
<i>PROCEED</i>	-0.112***	0.028	0.042	1.000
<i>UNDR</i>	-0.005	-0.017	-0.033	0.129***
<i>AGE</i>	0.067**	0.039	-0.082***	-0.085***
<i>VC</i>	-0.114***	0.065**	0.018	0.016
<i>TECH</i>	0.083***	-0.017	-0.037	0.018
<i>RD</i>	0.042	0.000	-0.032	-0.108***

**TABLE 2 (continued)**  
**Correlations for the Independent Variables Used in the Multiple Linear Regressions**

Variables	<i>UNDR</i>	<i>AGE</i>	<i>VC</i>	<i>TECH</i>	<i>RD</i>
<i>MAR</i>					
<i>MKT</i>					
<i>TURV</i>					
<i>PROCEED</i>					
<i>UNDR</i>	1.000				
<i>AGE</i>	-0.075**	1.000			
<i>VC</i>	-0.023	-0.052*	1.000		
<i>TECH</i>	0.048	-0.082***	0.047	1.000	
<i>RD</i>	0.020	-0.026	0.055*	0.381***	1.000

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

*MAR* = IPO underpricing; (first-day closing price-offer price)/offer price

*MKT* = Market returns prior to IPO; (filing day CSI 300 index-30 days prior to filing date index)/30 days prior to filing date index

*TURV* = Turnover ratio; The frequency at which shares change hands in the market in the first day; first-day trading volume/ No. of outstanding shares

*PROCEED* = IPO proceed; offer price x No. of shares issued

*UNDR* = Underwriter reputation; Dummy variable, UNDR=1 if ranking in TPO 10, otherwise UNDR=0

*AGE* = IPO age at issue date

*VC* = Venture capital; VC=1 if an IPO is VC-backing; otherwise VC=0

*TECH* = Demand on technology; TECH=1 if an IPO is in technology sector; otherwise TECH=0

*RD* = R&D intensity; The logarithm of (1+ R&D expense/Sales x 100)

Table 2 also reflects that underwriter reputation is higher in younger firms than that in older firms ( $AGE/UNDR = -0.075$ ). Companies have venture capital background and belongs to high-tech industry are younger. Venture-backing IPOs provides higher R&D ( $RD/VC = 0.055$ ), verifying that venture capital prefer to invest in companies with high R&D. R&D also has

significant positive relationship with technology (RD/TECH = 0.381), which is common in technology industry that high-tech companies have to invest more money in R&D than non-tech companies do.

### Empirical Results

After conducting the moderating regression model, I get the following result. This table combines five regression models demonstrated before and investigates the effects of control variables, VC background, technology requirement, R&D expenditure and their interaction terms on IPO underpricing.

Variables	<i>MAR</i>				
	(1)	(2)	(3)	(4)	(5)
<i>MKT</i>	0.006 (0.937)	0.007 (1.050)	0.007 (0.976)	0.007 (0.971)	0.007 (0.970)
<i>TURV</i>	-0.126*** (-16.361)	-0.126*** (-16.192)	-0.126*** (-16.199)	-0.126*** (-16.205)	-0.126*** (-16.198)
<i>LAGE</i>	0.002 (1.407)	0.002 (1.376)	0.002 (1.414)	0.002 (1.371)	0.002 (1.377)
<i>PROC</i>	-0.002*** (-2.959)	-0.002*** (-2.849)	-0.002*** (-2.943)	-0.002*** (-2.931)	-0.002*** (-2.934)
<i>UNDR</i>	-0.000 (-0.076)	-0.000 (-0.098)	-0.000 (-0.083)	-0.000 (-0.045)	-0.000 (-0.059)
<i>VC</i>		-0.003*** (-3.960)	-0.002** (-2.454)	-0.004* (-1.657)	-0.004 (-1.634)
<i>TECH</i>		0.003** (2.527)	0.005*** (3.395)	0.006*** (3.474)	0.005 (1.385)
<i>RD</i>		-0.000 (-0.355)	-0.000 (-0.443)	-0.001 (-0.860)	-0.001 (-0.871)
<i>VC x TECH</i>			-0.004** (-2.298)	-0.005** (-2.416)	-0.005** (-2.408)
<i>VC x RD</i>				0.001 (0.764)	0.001 (0.746)
<i>TECH x RD</i>					0.000 (0.168)
<i>Prob&gt;F</i>	0.0000	0.0000	0.0000	0.0000	0.0000
<i>Obs.</i>	997	997	997	997	997
<i>Adj-R<sup>2</sup></i>	22.99%	23.99%	24.32%	24.28%	24.21%

T-values are in parenthesis

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

The above table investigates the effect of technology, R&D, VC dummy and the cross-product terms on IPO underpricing. The control variables include the market index, shares turnover ratio, firm age, IPO proceed and underwriter reputation. *MAR* is the IPO underpricing rate. *MKT* is the market condition prior issuing date measured by CSI 300 market index. *TURV* is used to examine the popularity of new shares on secondary market measured by first-day trading volume divided by the number of shares offered. *LAGE* is defined as the logarithm of the firm age from startup to going public plus one. IPO revenue is denoted as its logarithm *PROC*. *UNDR* represents the reputation of underwriter, measured by the Bloomberg ranking of underwriters, *UNDR*=1 if the underwriter company is one of the TOP 10, otherwise *UNDR*=0. If the company has VC background, *VC*=1, or

**TABLE 3 (continued)**

VC=0. TECH=1 if the company belongs to technology industry, otherwise TECH=0. RD is calculated as  $\log(1+RDES \times 100)$ , RDES = R&D expense/ sales one year before the IPO. The interaction terms are the products of two independent variables.

The first column of Table 3 reveals that the turnover ratio is negatively correlated with IPO underpricing ( $t=-16.361$ ), which means the higher the turnover ratio, the lower the underpricing rate. This fact was unexpected, which implied that when new shares are traded more frequently on the secondary market, the closer the first day's closing price is to the offer price, and the lower the underpricing rate. The IPO proceed also has negative relationship with underpricing ( $t=-2.959$ ), the offer size is bigger, the effect of information asymmetry is smaller and the lower the underpricing.

The Column 2 of Table 3 displays that venture capitalist can cut down the IPO underpricing ( $t=-3.960$ ). The technology company has a higher underpricing ( $t=2.527$ ) because such type firm had to take more risk that is common in technology industry. This result confirmed the hypothesis 1. However, the RD is not significant with IPO underpricing ( $t=-0.355$ ), which rejects the hypothesis 3. During the data collection process, I used the R&D and sales figure from one year before issuing date for 2013-2016 IPOs; the R&D and sales number one year before issuing date for 2017 and 2018 IPOs were not available, so I calculated the RD by using the two years before IPO date for R&D and sales of 2017 and 2018 IPOs.

An interaction term VC x TECH was added in the third model, whose result is in Column 3 of Table 3. The tech-IPO experiences greater underpricing ( $t=2.527$ ). The VC x TECH variable has a significant negative relationship ( $t=-2.298$ ) with dependent variables, which demonstrated that VC had a moderated effect on tech-IPO underpricing, reducing the uncertainty faced by technology companies. This fact verified the hypothesis 2.

The Column 4 of Table 3 indicates that the cross-term VC x RD ( $t=0.764$ ) is not significant, so venture capital did not have a direct moderating effect on the relationship of R&D expense and IPO underpricing. Hypothesis 4 regarding the VC and R&D appeared to be not well ground.

The Column 5 of Table 3 shows that the TECH x RD ( $t=0.618$ ) is not significant with underpricing, which indicated that RD did not have the moderating effect in dealing with the relationship of technology firms and IPO underpricing.

According to the above analysis, I found that R&D expenditure does not have significant influence on the underpricing of IPO in China A-share market. Thus, I then further develop the sub-group analysis examining the relationship of R&D and IPO underpricing in technology sector and non-technology sector.

**TABLE 4**  
**Sub-analysis On Examining The Effect of Technology On The Relationship Between R&D Spending And IPO Underpricing**

Variables	MAR	
	TECH	NON-TECH
MKT	-0.001 (-0.840)	0.006 (0.712)
TURV	0.087*** (20.652)	-0.128*** (-14.635)

TABLE 4 (continued)

<i>LAGE</i>	-0.000 (-0.702)	0.002* (1.679)
<i>PROC</i>	-0.000 (-1.163)	-0.002*** (-3.074)
<i>UNDR</i>	-0.000 (-0.089)	-0.000 (-0.180)
<i>VC</i>	-0.000** (-2.087)	-0.000 (-0.097)
<i>RD</i>	-0.000** (-2.313)	-0.001 (-0.671)
<i>Prob&gt;F</i>	0.0000	0.0000
<i>Obs.</i>	219	778
<i>Adj-R<sup>2</sup></i>	66.64	23.94

T-values are in parenthesis

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

The table explores the effect of technology on the relationship of R&D and IPO underpricing. The market condition, turnover rate, age of IPO firms, IPO proceeds, underwriter reputation, venture capital dummy and RD intensity are control variables. MAR is the IPO underpricing rate. MKT is the market condition prior issuing date measured by CSI 300 market index. TURV is used to examine the popularity of new shares on secondary market measured by first-day trading volume divided by the number of shares offered. LAGE is defined as the logarithm of the firm age from startup to going public plus one. IPO revenue is denoted as its logarithm PROC. UNDR represents the reputation of underwriter, measured by the Bloomberg ranking of underwriters, UNDR=1 if the underwriter company is one of the TOP 10, otherwise UNDR=0. If the company has VC background, VC=1, or VC=0. RD is calculated as  $\log(1 + RDES \times 100)$ ,  $RDES = R\&D \text{ expense} / \text{sales one year before the IPO}$ .

The column 1 of Table 4 for tech-IPOs, R&D has significant negative relationship with  $t = -2.313$ ; however, R&D did not bring any effect for non-technology IPOs considering the underpricing ( $t = -0.671$ ). Therefore, the greater the R&D expenditure, the smaller the degree of underpricing in technology industry. For high-tech companies, the disclosure of R&D expenditure will affect the judgement of investors.

Overall, after examining the five regression models, I can demonstrate that, according to Table 2, the turnover rate was very significant with underpricing ( $t = -16.361$ ); the popular new stock trading in secondary market could help reduce the information asymmetry and therefore significantly lessen the underpricing of IPO. Table 2 also shows that the proceed had a negative relationship with underpricing ( $t = -2.959$ ), implying that the large scale of IPO would reduce the underpricing degree. The column 2 of Table 2 represents that venture capitalist can help release the IPO underpricing and such finding confirmed the hypotheses 1. The second model as well as highlights that technology facilitated the IPO underpricing. The column 3 of Table 2 displays that venture capitalists can bring a moderated effect on IPOs in technology industry; the VC x TECH variable is negatively significant ( $t = -2.298$ ) given the TECH is positively significant ( $t = 3.395$ ). The column 4 and column 5 of Table 2 illustrates that R&D expense did not affect the IPO underpricing. The further analysis assesses the R&D effect on technology-underpricing relationship, and the result showing in Table 3 conveys that the greater R&D expenditure decreased the underpricing in technology sector ( $t = -2.313$ ).

## IV. DISCUSSION

My research objective is to investigate the moderating effect of VCs through interaction of technology and R&D on underpricing of IPO in China A-share market. The detail research questions are exploring whether technology firms experience higher IPO underpricing and whether venture capital can help reduce such underpricing effect on tech-IPOs, and test whether high R&D intensity IPO experience higher IPO underpricing and whether venture capital can help lessen such effect. My expected result is that tech-IPOs and high R&D IPOs would experience higher underpricing. Moreover, the paper is predicted to prove that the use of venture capital will alleviate IPO underpricing caused by technology, and that venture capital can reduce the uncertainty faced by high-R&D IPOs, thus reduce the underpricing. The actual result thoroughly confirmed this hypothesis 1, but the result I got was unexpected concerning the second hypothesis. R&D does not have any correlation with IPO underpricing based on the regression model result. However, the sub-analysis proposes that R&D had significant correlation with underpricing for technology companies. Griliches (1998) commented that company's R&D investment level is positively correlated with company's future value; for high-tech companies, such influence is more obvious. The evaluation of R&D investment efficiency needs to be analyzed in conjunction with the industry's competitive environment, operating conditions, and national industrial policies. However, most investors do not have the professional knowledge and the information research ability, so the increase in R&D expense will increase the level of information asymmetry between the issuer and the investors.

Although my result regarding to the R&D and IPO underpricing differ from Lu et al. (2012) and Han and Shen (2017), it could nevertheless be argued from several points. In Fu's study (2011), exploring the whether the R&D investment level affect the IPO underpricing, and in the research of Chen et.al (2017), both of the two studies selected GEM(growth enterprise market) IPOs as their samples, but I chose the companies listed in mainboard of China stock market. Fu claimed that (2011) mainboard listed companies generally include R&D investment in management expenses and rarely make separate disclosures or make incomplete disclosures. Secondly, industry and company size have a significant impact on the company's R&D expenditure; mainboard listed companies have a relatively fragmented industries while GEM listed companies have similar sizes and concentrated industries. Therefore, the A-share mainboard IPOs sample increases the error caused by the difference in industry and company size.

Comparing my research with other previous studies, I generated certain consistent as well as contradicted aspects. First, Lu et al. (2012) suggested that IPOs with technology have a greater degree of underpricing, and the emergence of venture capitalist can moderate the positive correlation between underpricing and high-tech in Taiwan stock market. This finding is consistent with my result. Second, Han and Shen (2017) commented that their empirical result did not support the expectation that venture capital has the adjustment relationship between R&D investment and IPO underpricing. Its reasonable explanation was that the level of venture capital involvement in GEM is not high enough. Third, Fu (2011) in the study investigating the R&D and underpricing of IPO in GEM stated that R&D investment level is positive related to IPO underpricing, which validated that as R&D expense increase, the

information asymmetry between issuers and investors significantly improve. My conclusion is not consistent with this result concerning the R&D.

It is plausible that a number of limitations might influence the result obtained. To begin with, I selected the China A-share mainboard IPOs as my sample; because most of the companies in mainboard are already mature enough, the influence of R&D and venture capital may not be huge. Second, I did not add the company's return on equity and capital structure as the control variables, which are considered have relationship with the valuation of the company from investors. Additionally, for VC variable, this study did not include VC-equity stakes, venture capitals' size and reputation index, only considered the presence of venture capital; further data collection is required to determine exactly the relationship between venture capital and underpricing of IPOs. Another possible source of error is, when I designed the model, I did not consider the market fluctuation on IPO underpricing, and did not use the adjusted underpricing rate.

### Reliability and Validity

Apart from the slight discrepancy, given the research method and sample collection technique my research is reliable and valid. First, the following evidence proves internal validity: Lu and Chen (2012) confirmed that there is a relationship among venture capital, technology and R&D expenditure with IPO underpricing in Taiwan stock market. I applied the similar model in my research and adjusted the model considering the special situations in China stock market; such adjustments were based on the Han and Shen's (2017) empirical study on the R&D, venture capital and IPO underpricing from growth enterprise market IPOs.

Second, external validity can be demonstrated as: the sample of my study is from 2013-2018 all China A-share IPOs, excluding the finance companies; the sample size consists 997 IPOs which is larger than the sample size of existed similar studies. All the data are mainly collected from Wind, which is the China leading financial terminal; this fact can guarantee the accuracy of the data collected. To sum up, my research model fits for the most types of capital market at some point and my study is reliable.

	VIF	1/VIF
<i>MKT</i>	1.019	.981
<i>TURV</i>	1.035	.966
<i>LAGE</i>	1.023	.978
<i>PROC</i>	1.082	.924
<i>UNDR</i>	1.066	.938
<i>Mean VIF</i>	1.045	.

	VIF	1/VIF
<i>MKT</i>	1.024	.977
<i>TURV</i>	1.037	.964
<i>LAGE</i>	1.036	.966
<i>PROC</i>	1.126	.888
<i>UNDR</i>	1.072	.932
<i>VC</i>	1.013	.987
<i>RD</i>	1.217	.822
<i>TECH</i>	1.184	.845
<i>Mean VIF</i>	1.089	.

Third, I conducted the variance inflation factor statistics to examine the multicollinearity among variables. Excluding the interaction terms, the mean VIF in Table 5 is 1.045 which is below 10; and after adding the VC, TECH and RD, the mean VIF in Table 6 is 1.089 still below

10. This result confirms that multicollinearity does not exist in my model and that my finding is substantial.

### **Theoretical Contribution**

A lot of studies have examined the roles of venture capital, technology or R&D on IPO underpricing, most of the samples are western stock market, such as Italy and German. Also, there are published Chinese papers explore the R&D and venture capital effects on IPO underpricing based on data from China Growth Enterprise Board. My research focus on IPOs from all China A-share market, expanding the sample size. More importantly, this study brings a new view, by illustrating the interaction effect between R&D and technology on IPO underpricing, and explaining the moderation influence of venture capitalists on IPO underpricing.

## **V. CONCLUSION**

The most popular theory explaining the IPO underpricing is the uncertain future value and information asymmetry. Technology companies have the characteristics of high risk and high return, which brings the uncertainty to the companies' future value. The intervention of venture capital is a good way to reduce the information asymmetry. The China IPO market grows rapidly, which provides a good data sample to explore the relationship among venture capital, R&D and technology on IPO underpricing. This paper uses the cross-product residual-centering approach to build the regression model, including market condition, offer size, firm age, underwriter reputation and IPO turnover rate as control variables, and adding the products of VC and TECH, VC and RD, and TECH and RD as interaction variables. The evidence from this study suggests that tech-IPOs experienced higher underpricing, while R&D expenditure does not put influence on the underpricing, the upshot of this is the possibility of the different R&D disclosure level in mainboard market; but R&D does increase the underpricing rate for technology IPOs. What's more, this study contributes a new view, illustrating the interaction effect between technology and venture capitalist, and explaining the moderation influence of venture capitalist on IPO underpricing. However, this study does not explore the same relationship in China stock Growth enterprise market and small and medium enterprise board; also, does not consider the influence of the capital market fluctuations on IPO underpricing when designs the model. Further research is needed to study the different stock market boards in China, apply the market adjusted IPO underpricing, and consider the venture capitals' share percentage of IPO companies and venture capital reputation in research model.

## REFERENCES

- Aboudy, D. and Lev, B., 2000. Information asymmetry, R&D, and insider gains. *The journal of Finance*, 55(6), pp.2747-2766.
- Barry, C.B., Muscarella, C.J., Peavy Iii, J.W. and Vetsuypens, M.R., 1990. The role of venture capital in the creation of public companies: Evidence from the going-public process. *Journal of Financial economics*, 27(2), pp.447-471.
- Beatty, R.P. and Ritter, J.R., 1986. Investment banking, reputation, and the underpricing of initial public offerings. *Journal of financial economics*, 15(1-2), pp.213-232.
- Chan, K., Wang, J. and Wei, K.J., 2004. Underpricing and long-term performance of IPOs in China. *Journal of Corporate Finance*, 10(3), pp.409-430.
- CHEN, C. and CHEN, W., 2003. Pricing Chinese IPOs. Are They Really Undervalued?. *China Accounting Review*, 2003(0), p.15.
- Chen, H.C., Jhou, C.J. and Yeh, H.C., 2007. Signalling by underwriter retention rate in the IPO market. *Applied Economics*, 39(15), pp.1973-1983.
- Chi, J. and Padgett, C., 2005. Short-run underpricing and its characteristics in Chinese initial public offering (IPO) markets. *Research in International Business and Finance*, 19(1), pp.71-93.
- Chin, C.L., Lee, P., Kleinman, G. and Chen, P.Y., 2006. IPO anomalies and innovation capital. *Review of Quantitative Finance and Accounting*, 27(1), pp.67-91.
- Fu, L.M., Wan, D.F. and Zhang, Y.H., 2011. Does R&D investment level affect the underpricing of IPOs? --- Research based on the companies listed on ChiNext. *Research on Economics And Management*, (11), pp.52-60.
- Gomez-Mejia, L.R., Larraza-Kintana, M. and Makri, M., 2003. The determinants of executive compensation in family-controlled public corporations. *Academy of management journal*, 46(2), pp.226-237.
- Gompers, P.A., 1996. Grandstanding in the venture capital industry. *Journal of Financial economics*, 42(1), pp.133-156.
- Griliches, Z., 1998. Patent statistics as economic indicators: a survey. In *R&D and productivity: the econometric evidence* (pp. 287-343). University of Chicago Press.
- Guo, R.J., Lev, B. and Shi, C., 2006. Explaining the Short-and Long-Term IPO Anomalies in the US by R&D. *Journal of Business Finance & Accounting*, 33(3-4), pp.550-579.
- Han, P. and Shen, C., 2017. R&D, venture capital and IPO underpricing —— an empirical study of IPO companies in GEM. *Management Review*, 29(4).
- Hausman, J.A., Hall, B.H. and Griliches, Z., 1984. Econometric models for count data with an application to the patents-R&D relationship.
- Heeley, M.B., Matusik, S.F. and Jain, N., 2007. Innovation, appropriability, and the underpricing of initial public offerings. *Academy of Management Journal*, 50(1), pp.209-225.
- Ibbotson, R.G., 1975. Price performance of common stock new issues. *Journal of financial economics*, 2(3), pp.235-272.
- Jensen, M.C. and Smith, C.W., 2000. Stockholder, manager, and creditor interests: Applications of agency theory. *Theory of the Firm*, 1(1).

- Jiang, P., Cai, C.X., Keasey, K., Wright, M. and Zhang, Q., 2014. The role of venture capitalists in small and medium-sized enterprise initial public offerings: Evidence from China. *International Small Business Journal*, 32(6), pp.619-643.
- Jiang, P., Cai, C.X., Keasey, K., Wright, M. and Zhang, Q., 2014. The role of venture capitalists in small and medium-sized enterprise initial public offerings: Evidence from China. *International Small Business Journal*, 32(6), pp.619-643.
- Jiang, S.C., Jiang, Y.M and Hu, Q., 2006. Research on the initial return of China's new shares under different issuance systems. *Management World*, (7), pp.132-138.
- Le, S.A., Walters, B. and Kroll, M., 2006. The moderating effects of external monitors on the relationship between R&D spending and firm performance. *Journal of Business Research*, 59(2), pp.278-287.
- Liu, X.H. and Xiong, P., 2005. Equity separation, government regulations, and Chinese IPO underpricing puzzle. *Economic Research Journal*, 5(2), p.4.
- Liu, X.M., Hu, W.W. and Li, Z., 2009. Empirical research on IPO underpricing in China Stock Market. *Journal of Management Science*, (4), pp.87-96.
- Ljungqvist, A., Nanda, V. and Singh, R., 2006. Hot markets, investor sentiment, and IPO pricing. *The Journal of Business*, 79(4), pp.1667-1702.
- Loughran, T. and Shive, S., 2011. The impact of venture capital investments on public firm stock performance. *Journal of Behavioral Finance*, 12(4), pp.233-246.
- Lowry, M. and Schwert, G.W., 2002. IPO market cycles: Bubbles or sequential learning?. *The Journal of Finance*, 57(3), pp.1171-1200.
- Lowry, M. and Shu, S., 2002. Litigation risk and IPO underpricing. *Journal of Financial Economics*, 65(3), pp.309-335.
- Lu, C.S., Kao, L. and Chen, A., 2012. The effects of R&D, venture capital, and technology on the underpricing of IPOs in Taiwan. *Review of Quantitative Finance and Accounting*, 39(4), pp.423-445.
- Meggison, W.L. and Weiss, K.A., 1991. Venture capitalist certification in initial public offerings. *The Journal of Finance*, 46(3), pp.879-903.
- Ritter, J.R., 1991. The long-run performance of initial public offerings. *The journal of finance*, 46(1), pp.3-27.
- Rock, K., 1986. Why new issues are underpriced. *Journal of financial economics*, 15(1-2), pp.187-212.
- Su, D., 2004. Adverse-selection versus signaling: evidence from the pricing of Chinese IPOs. *Journal of Economics and Business*, 56(1), pp.1-19.
- Wallin, C.C. and Gilman, J.J., 1986. Determining the optimum level for R&D spending. *Research management*, 29(5), pp.19-24.
- Yu, N. and Fei, Y., 2013. IPO underpricing analysis on companies with private equity investment. *South China Journal of Economics*, 31, pp.37-47.