벤처창업연구 제17권 제1호 (통권79호)
Asia-Pacific Journal of Business Venturing and Entrepreneurship Vol.17 No.1 pp.29-43

ISSN 1975-7557
e-ISSN 2671-9509

Stock Price Return and Variance of Unlisted Start-ups*

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Abstract

This study measures the realized rate of return of venture capital(VC) fund at the level of investment agreement(as opposed to fund level returns reported by most of the relevant studies). It also measures the stock price return of the VC's portfolio firms (unlisted start-ups) at firm level(as opposed to fund returns) and its variance for the first time using unique data of the VC funds held by the Korean Venture Capital Association. Results of the analysis confirm that VC fund returns exceed individual stock price returns. Additionally, it is confirmed that VC portfolio firms exhibit a positive relationship between risk and return measured by total risk. Finally, we find that stock price returns at firm level are lower than that implied by the associated levels of risk. Consequently, this may make individual investors hesitate to directly buy unlisted startups' stocks even when investment in individual startup companies guarantees high risk-high returns relationship.

KeyWords: venture capital fund, unlisted stock price return, start-up, duration-adjusted return

Ⅰ. Introduction

Venture capital(hereafter VC) can be seen to perform the same role as existing financial institutions; that is, it facilitates access to finance for entrepreneurs, linking general investors to start-ups. VCs are distinguished from investment banks, security companies, or private equity funds in their targets. Those are mainly unlisted companies or start-ups with highly volatile future cash flows.

Investments in start-ups are more driven by expectation of new technologies or business models rather than accurate predictions of future cash flows. Thus, information asymmetry problems frequently occur between well-informed insiders and outside investors who lack relevant information. Constructing portfolios for start-ups is much more costly than for listed companies because of the information asymmetry problem. Therefore, for ordinary investors with handful of start-ups in portfolio, the risk of investing is measured by variance rather than the beta of each company(Ewens et al., 2013). For start-ups, predicting future cash flows is difficult, and the expected rate of return cannot be formed; hence, applying an investment decision-making method based on NPV is not available. In the end, the market capital seems almost impossible to match with new ideas of start-ups. This well explains the difficulty for start-ups to raise funds through banks. Nevertheless, the market has devised a way to connect the two parties, and the representative example is VC.

Compared to this reality, the Korean financial academia has not been active yet due to the lack of well-established databases in investigating how the theoretically impossible financing of start-ups can be made possible through VC and similar financial entities. In this study, we first measure the return on investment (multiple and internal rate of return(IRR)) and stock price return (average percent rate(APR) and effective annual rate(EAR)) or VC portfolio firms or unlisted start-up companies invested by the VC fund. We use undisclosed investment-related data on VC funds held by the Korea Venture Capital Association. Existing VC fund-related research is mainly limited to limited partner's(LP) realized return(IRR) because the accessible data are limited to the amount of formation and distribution of each VC fund.

* This research was supported by Korean Finance Association under Joint Research Grant of Korean Finance Association and Korean Venture Capital Association, 2019.
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· 투고일: 2022-01-12 · 1차 수정일: 2022-02-14 · 2차 수정일: 2022-02-21 · 게재확정일: 2022-02-23

Our data contain detailed investment information for each funding round, where we can find, among many, both the amount of investment and the associated amount of shares along with post-round total number of shares outstanding, types of investment(CB, EB, common or preferred stock, etc.), and the basic information on the portfolio companies as well. Furthermore the data informs us of the historical terms of interim and final exit deals for each investment agreement: stock sales, stock payments, bond sales, bond payments, M&A, IPO, etc., coupled with price and share information. Since most of the data is available at portfolio company level, using the data before the general partner(GP) deducts the management fee or performance fee, we can measure the return on investment (IRR) for each company pertaining to the VC portfolio.

Additionally, a good deal of the portfolio companies in our sample, have more than one funding round and one exit deal, and each time we have the detailed information mentioned above. This means that multiple market valuations of each company in question are presented to us at various points in time during its life span as unlisted firm. Therefore, by allowing for changes in number of shares and face values, we can determine how the portfolio company's stock price has developed during the investment period. From there, we can measure multiple EARs, stock returns, and its variance for an individual sample company that is unlisted company.

This point shows critical implications. For example, existing research on mutual fund focuses only on the fund's return rate with little regard to the risk of investors. We hardly had a chance to test the golden rule in finance, the high-risk and high-return relationship, for unlisted firms simply because the variance of stock return for unlisted company was not easily observable. A critical contribution of this paper, thus, lies in obtaining the stock return and variance of the unlisted firms by using the unique data that we have. Once we achieve stock price returns and measure the variance, we can judge whether a high-risk and high-return relationship exists in start-up investments at individual firm level. One shortcoming is though our data does not allow us to go to the extent of measuring beta of individual firm. However, the risk measured by beta has only meaningful usage when an investor does form a well diversified portfolio. Variance would tell a true risk born by the investor who holds a few companies in his basket, which is mostly the case when investment in start-ups by individual investor comes into play.

Next, by comparing the stock price returns in start-up companies and VC funds' realized returns, we examine whether the VC funds are generating excess returns in the start-up market. This will allow us to investigate empirically whether VCs outperform the start-up market or not. Simultaneously, we can determine whether the role of VC funds connecting start-ups and markets can be justified.

The remainder of this study is structured as follows. Section 2 theoretically reviews the literature on investment in VC funds. Section 3 calculates the realized return and stock price return for each investment agreement and compares these two returns. Section 4 presents an experimental study on the characteristics of the stock price return by analyzing whether stock price return is sensitive to total risk even in the investment of start-up companies and by performing large-scale verification of the high risk-high return relationship. Finally, Section 5 concludes.

Ⅱ. Literature Reviews and Theoretical Consideration

The existing VC fund-related research is mainly limited to the realized return(IRR) of GP or LP due to the limitations of accessible data. Among the companies that have received VC investment, not many investees have provided adequate returns to VC(Ruhnka et al., 1992; Dean & Giglierano, 1990). LPs that provide investment financing for VC funds also have low returns(Kaplan & Schoar 2005; Ewens et al., 2013). However, studies have shown that VC funds from individual investors have a high return(Cochrane 2005; Ljungqvist & Richardson, 2003). Harris et al.(2014) argued that VC funds have higher returns than publicly traded companies in 1990, but lower returns in 2000, simultaneously showing contradicting results of VC fund performance. Meanwhile, on the determinants of fund return rate, several studies have investigated execution time(Ljungqvist & Richardson, 2003) and determined the size of funds (Kaplan & Stromberg 2009; Robinson & Sensoy, 2011).

Research on the performance of VC funds has been conducted more actively on data obtained when a portfolio company makes an IPO because of the limitation in collecting price data on unlisted companies. They mainly compared and analyzed whether a company that received VC investment records a lower initial rate of return upon IPO than a company that does not. If VC investments act as a guarantee for IPO companies, their initial IPO returns will be lower. However, contradicting arguments have also emerged on this subject. Previous studies have reported low initial rate of return of companies receiving VC investment(Megginson & Weiss, 1991; Barry et al., 1990; Kim & Park 2006; Lee & Yoon 2018), but recent studies have reported the opposite(Lee & Wahal 2004; Barry & Mihov 2015; Kim 2021).

From traditional view point in finance, just deciding whether an

investment has yielded high or low return does not conclude one's judgement on its performance. As the sharpe ratio tells, we need to compare the return against the risk of investment project. The market participants always want to know the risk they are to bear. Without a proper knowledge on risk, they will hold their investment decision even when a high return is in prospect.

Thus, to be accepted as an alternative investment asset by market participants, VC must provide positive alpha and the information on variance as well. Of course, the market must be assured that the VC fund's GP can even remove uncertainties by monitoring and controlling the invested venture. In other words, even if an individual unlisted company may have started with high uncertainty, limited liability members can be assured that this uncertainty will be reduced to a measurable variance by VC fund's GP. They need also to be assured of a positive relationship between the risk and return. Only then will LPs participate in the fund. Moreover, an investment destination could also effectively constitute the economic justification.

Conversely, if the VC fund does not reduce uncertainty to a measurable variance or the risk premium is too low, not only creating a VC fund will be difficult, but also a forcibly created VC fund can be invested in trading outside the original purpose of investing in the start-up stage. If the time-series and cross-sectional stock price data of the unlisted companies invested by the VC fund can be constructed, the relationship between the rate of return and risk can be studied using existing financial theories. In response to this need, this study examines how to obtain the return on investments in VC funds with multiple investments and multiple payback points using unique data held by the VC Association.

Ⅲ. Empirical Analysis

3.1 Realized Rate of Return

3.1.1. Sample and Variable Definition

This study uses actual management data of venture capital funds formed and liquidated from 2000 to 2018 and secured through the Venture Capital Association. As highlighted in previous studies, a problem exists in the case of funds that have not yet been recovered because fund performance can vary greatly depending on the criteria for calculating the investment company's corporate value (Woodward & Hall, 2003; Phalippou & Gottschalg, 2009; Stucke, 2011). This study includes in the sample only the funds liquidated. This practice will establishe a research environment free from the problem of differences in performance of VC funds caused by differences in assumptions about the net asset value of investment.

When calculating the realized rate of return, investment agreements with a total investment of less than $1,000 are deleted. Finally, a total of 21,806 investment agreements are extracted as the final sample by removing the sample of the upper and lower 1% for each performance indicator(APR, EAR, and IRR). A total of four investment performance indicators(i.e., Multiple, APR, EAR, and IRR) are calculated based on the final sample judged to have no errors.

When measuring the realized return of a VC fund, the PME-IRR compared to the IRR or benchmarking index is mainly used. In this study, apart from IRR, the realized EAR and the realized APR are measured to obtain a more direct comparison with the stock price return. The APR and EAR are calculated by first measuring the HPR during the investment period and converting it to the annual rate of return, as in the conventional method. However, when applying this to VC funds, investments and returns occur multiple times, and the amount of each transaction and the period between the two transactions are not the same. In this case, finding the HPR reflecting both the period between each transaction and the amount of the transaction at each point in time is difficult.

To minimize this problem, we propose a novel method of 'duraion-adjusted return', where we first obtain the multiple by dividing the total recovery amount incurred during the investment period by the total investment incurred during the same period; this will be used as a substitute for HPR. After measuring the duration reflecting the amount and period of each transaction during the same period, we adjust HPR to the duration. Then, actual APR and the realized EAR return index are obtained. This can be expressed as follows:

$$M=\sum CF(t \mid t=\text{time of collection})/(-\sum CF(t \mid t=\text{time of investment})$$

$$D=\sum T_t \times CF(t \mid t=\text{collection}))/\sum CF(t \mid t=\text{collection}) - \sum T_t \times CF(t \mid t=\text{investment})/\sum CF(t \mid t=\text{investment})$$

$$APR=(M-1)/D$$

$$EAR=\ln(M^{1/D})$$

$$\text{IRR:}0=\sum[CF(t)\times\exp(-IRR\times T_t)]$$

where, CF=(-) if investment, (+) if collection,

T_t=(t^{th} time of cash flow - time of initial investment)/365,

M=multiple, D=duration.

With this calculation, the duration may have a negative value due to errors in the description or suspicious transactions. However, this study's sampling method did not yield an investment agreement with a negative duration value.

3.1.2. Descriptive Statistics

<Table 1> shows the descriptive statistics for each level of VC, VC fund, and portfolio company of the final sample used to analyze the realized return rate. The final sample consists of 230 VCs, with an average of 6 VC funds per VC, through which an average of 56.29 companies(or projects, etc.) invested per VC; moreover, the average deals per VC is 94.81. Meanwhile, looking at the final sample at the level of individual VC funds, we analyzed that 1,202 VC funds are invested in an average of 13.25 companies(or projects, etc.) per fund, and an average of 18.14 investment agreements are signed and liquidated per fund. Finally, looking at the final sample at the investee(or project, etc.) level, we found that 7,185 companies(or projects, etc.) received investment from VC, and an average of 3.05 investment agreements are signed and liquidated per company.

<Table 1> Sample size and average number of investment targets by an investment entity

	Total		Fund	Company	Deal
VC	230	Mean	6.00	56.29	94.81
		Median	3.00	23.50	37.00
Fund	1202	Mean		13.25	18.14
		Median		8.00	9.00
Company	7185	Mean			3.05
		Median			2.00

Note: The values are the mean and median of sample size and investment targets by investment entity.
The average number of investors per VC is 12,880 (230*56), which is greater than the number of investees (7,185). It is because several VCs invest in one investment, and multiple VC funds are in one investment investee.

Similarly, the number of VCs multiplied by the average number of investors per VC(230*56.29) is greater than the number of investees(7,185). This is because several VCs invest in and multiple VC funds invest in one investee. Meanwhile, 19 agreements included multiple investee companies in one investment agreement, and most of these are confirmed to be due to the involvement of investee company in mergers and acquisitions after the initial investment.

3.1.3. Realized Return on Investment Agreement

The statistics on the rate of return realized by VC funds per contract are presented in <Table 2>. On average, the EAR of 9.54% and IRR of 10.28% are recorded, and each profitability index is statistically significant. The IRR and EAR recorded around 10%, whereas the multiple measured is 1.3507. This indicates that the investment period and the size of the transaction amount at each point are important factors when calculating the rate of return.

<Table 2> Realized return on the investment agreement

Variable	N	Mean	Median	Std Dev	Minimum	Maximum	t-value
Multiple	21806	1.3507	1.0005	1.3879	0.0019	35.0000	**143.71*** **
APR	21806	0.1994	0.0003	0.5891	-0.7018	6.0220	**49.99*** **
EAR	21806	0.0954	0.0003	0.3282	-1.8318	2.5634	**42.94*** **
IRR	21806	0.1028	0.0003	0.3450	-1.2438	2.8808	**44.01*** **

Note: The realized return on investment agreement, four variables, and relevant descriptive statistics are presented in this table.
Multiple is obtained by dividing the total recovery amount incurred during the investment period by the total investment incurred during the same period. APR, average percentage rate; EAR, effective average rate; IRR, internal rate of return. *** represents a significant level of 1%.

<Table 3> reports the ANOVA results. It shows whether a difference exists in realized return between VCs(Panel A) and between VC funds(Panel B). The difference in the realized return rate between VCs and that between funds are both significant. This indicates that persistent good performers and bad performers exist across VCs and VC fund managers as well.

<Table 3> ANOVA between VCs and between funds

Panel A. Source: VC_code					
DV	DF	ANOVA SS	Mean Square	**F Value**	Pr > F
Multiple	244	1453.55	5.9572	**3.13*** **	<.0001
APR	244	347.25	1.4231	**4.20*** **	<.0001
EAR	244	548.92	2.2497	**4.73*** **	<.0001
Panel B. Source: Fund_code					
DV	DF	ANOVA SS	Mean Square	**F Value**	Pr > F
Multiple	1257	3485.42	2.7728	**1.46*** **	<.0001
APR	1257	912.96	0.7263	**2.21*** **	<.0001
EAR	1257	1216.10	0.9675	**2.07*** **	<.0001

Note: This table shows the difference in return between VCs (Panel A) and between VC funds (Panel B) based on ANOVA. *** represents the significant level of 1%.

The results of classifying the realized return by investment agreement according to the investment type are presented in <Table 4> Preferred stocks also include redeemable convertible preferred stocks frequently used by VC. Overseas investment is made in the past and classified either as foreignold or foreign.

<Table 4> Realized return on investment agreement by investment type

	Variable: Multiple			Variable: EAR		Variable: IRR	
inv_type	N	Mean	Median	Mean	Median	Mean	Median
BW	470	1.223	1.069	0.091	0.050	0.096	0.050
CB	2695	1.207	1.040	0.067	0.030	0.068	0.030
EB	4	1.225	1.127	0.138	0.070	0.139	0.070
common	8390	1.456	1.000	0.097	0.000	0.107	0.000
contract	358	1.020	1.000	0.030	0.000	0.031	0.000
foreign	523	1.242	1.000	0.017	0.000	0.019	0.000
foreignold	13	1.067	1.000	0.208	0.000	0.241	0.000
fund	3	1.437	1.583	0.221	0.257	0.223	0.260
loan	649	1.033	1.006	0.065	0.025	0.068	0.029
preferred	3636	1.618	1.020	0.095	0.008	0.099	0.008
project	5065	1.148	1.000	0.126	0.000	0.135	0.000

Note: BW, bonds with warrants; CB, convertible bonds; EB, exchangeable bond.

The number of contracts by investment type is in the order of common stock, project, preferred stock, and convertible bond(CB). Recently, the number of investments in common stock has increased, which can be attributed to the increased number of waiting funds in the market to invest in promising start-ups.

Among the four investment types, EAR and IRR are highest in the order of project, common stock, preferred stock, and convertible bond(CB), whereas the multiple is highest in the order of preferred stock, common stock, convertible bond(CB), and project. The low realized return on project investment in multiple but high in the EAR is believed to be mainly caused by shorter payback periods for project investments than other investment types.

<Table 5> presents the result of classifying the realized return of investment agreement by recovery or collection type. When a single investment agreement is recovered in multiple ways, the investment agreement is counted as many times as the number of collection methods concernred. Consequently, the number of observations for each of the nine recovery methods is greater than the number of investment commitments in the final sample. Stock-sell and stock-repayment is a sale to the third-party and an investee, respectively, before IPO. The same is true of bonds. The number of contracts by collection type is in the order of stock-other, project, stock-sale, and IPO.

<Table 5> Realized return on investment agreements by collection type

	Variable: multiple			Variable: EAR		Variable: IRR	
pay_type	N	Mean	Median	Mean	Median	Mean	Median
IPO	2287	2.582	1.763	0.333	0.245	0.357	0.259
M&A	496	1.411	1.000	0.086	0.000	0.096	0.000
Stock-other	9076	1.505	1.000	0.071	0.000	0.079	0.000
Stock-sell	4872	1.693	1.091	0.120	0.038	0.132	0.040
Stock-payment	1083	1.366	1.041	0.048	0.019	0.057	0.020
Bond-sell	573	1.257	1.085	0.085	0.046	0.090	0.046
Bond-payment	1259	1.202	1.095	0.075	0.060	0.076	0.060
Project	5068	1.148	1.000	0.126	0.000	0.135	0.000
Others	1555	1.105	1.000	0.043	0.000	0.045	0.000

Note: In terms of mean and median, multiple shows the biggest numbers.

The case of IPO recovery accounted for 8.7% of the total sample, recording a high number. This is because, on one hand, the VC fund has nurtured the investee well and, on the other, because the VC fund had invested more in companies that had seemed more likely to go for IPOs in a near future or companies that had already been planning an IPO. In Korea, the company applying for IPO receives favor during the listing examination on the KOSDAQ market if it has a record of funding from VCs. Meanwhile, the fewest cases of recovering through M&A reflect the poor situation in the Korean M&A market. EAR and IRR are highest in the order of IPO, project, stock-sell, and M&A, whereas multiples are high in the order of IPO, stock-sell, stock-other, and M&A.

The results of classifying the realized rate of return by industry of the investee are presented in <Table 6> Industries with a observation number of 10 or less are excluded. Moreover, multiple is sorted in descending order of the number of investment contracts per industry, whereas EAR and IRR are sorted in descending order of EAR. The VC fund has invested heavily in new technology and content industries such as advertising film and video production(code: 59000), other electronic component manufacturing(26000), system software development and supply(58000), and medical and pharmaceutical R&D(70,000), veterinary drug manufacturing(21000), and film and video production(code: 59000); it showed high profitability. Industry names by industry code are reported in the appendix.

<Table 6> Realized return on investment agreements by industry

Multiple				EAR				IRR	
Ind	N	Mean	Median	Ind	N	Mean	Median	Mean	Median
59000	4240	1.203	1.002	11000	13	0.274	0.003	0.278	0.003
26000	3867	1.352	1.000	70000	455	0.212	0.069	0.230	0.072
58000	3652	1.391	1.000	21000	658	0.209	0.088	0.221	0.090
29000	1418	1.518	1.050	59000	4240	0.145	0.001	0.155	0.001
27000	748	1.561	1.112	27000	748	0.132	0.045	0.142	0.045
21000	658	2.041	1.200	10000	210	0.130	0.035	0.140	0.035
20000	610	1.479	1.035	31000	98	0.128	0.058	0.139	0.058
63000	607	1.435	1.000	29000	1418	0.126	0.027	0.132	0.028
90000	604	1.034	1.000	20000	610	0.124	0.019	0.133	0.019
28000	559	1.405	1.020	13000	36	0.121	0.040	0.122	0.040
70000	455	1.977	1.156	64000	62	0.120	0.000	0.135	0.000
46000	371	1.207	1.000	52000	32	0.103	0.049	0.106	0.052
47000	345	1.272	1.000	22000	137	0.097	0.009	0.099	0.009
75000	323	1.131	1.000	35000	12	0.092	0.054	0.093	0.054
71000	295	1.181	1.000	42000	32	0.090	0.043	0.091	0.043
30000	224	1.160	1.064	1000	66	0.089	0.007	0.091	0.007
10000	210	1.370	1.018	63000	607	0.080	0.000	0.083	0.000
62000	201	1.058	1.000	72000	127	0.078	0.025	0.080	0.025
73000	179	1.069	1.000	28000	559	0.078	0.008	0.082	0.008
24000	177	1.160	1.000	47000	345	0.077	0.000	0.079	0.000
25000	155	1.323	1.000	58000	3652	0.075	0.000	0.082	0.000
33000	143	1.126	1.000	6000	16	0.072	0.000	0.072	0.000
23000	140	1.337	1.000	14000	36	0.071	0.057	0.075	0.057
22000	137	1.317	1.013	90000	604	0.069	0.000	0.071	0.000
85000	132	1.103	1.015	26000	3867	0.059	0.000	0.067	0.000
72000	127	1.300	1.069	46000	371	0.059	0.000	0.061	0.000
61000	125	1.344	1.003	30000	224	0.059	0.036	0.060	0.036
31000	98	1.617	1.111	61000	125	0.058	0.001	0.063	0.001
99000	81	1.283	1.000	25000	155	0.051	0.000	0.062	0.000
60000	80	1.014	1.000	23000	140	0.050	0.000	0.056	0.000
1000	66	1.198	1.011	38000	59	0.050	0.007	0.050	0.008
66000	64	1.017	1.000	85000	132	0.048	0.012	0.055	0.013
64000	62	1.264	1.000	75000	323	0.046	0.000	0.053	0.000
38000	59	1.143	1.035	24000	177	0.041	0.000	0.041	0.000
76000	51	1.087	1.000	71000	295	0.039	0.000	0.043	0.000
91000	50	1.042	1.000	91000	50	0.035	0.000	0.036	0.000
41000	46	1.019	1.000	33000	143	0.034	0.000	0.035	0.000
18000	43	1.264	1.000	62000	201	0.031	0.000	0.035	0.000
13000	36	1.249	1.064	41000	46	0.029	0.000	0.030	0.000
14000	36	1.234	1.084	7000	13	0.026	0.007	0.028	0.015
42000	32	1.186	1.056	99000	81	0.025	0.000	0.027	0.000
52000	32	1.247	1.027	37000	19	0.018	0.001	0.020	0.001
17000	29	1.098	1.000	39000	15	0.018	0.001	0.017	0.001
15000	21	0.984	1.000	66000	64	0.018	0.000	0.018	0.000
37000	19	1.044	1.003	73000	179	0.008	0.000	0.010	0.000
86000	17	1.355	1.000	17000	29	0.005	0.000	0.081	0.000
6000	16	1.478	1.000	76000	51	-0.005	0.000	-0.004	0.000
39000	15	1.029	1.003	60000	80	-0.012	0.000	-0.009	0.000
95000	15	0.996	1.000	95000	15	-0.020	0.000	0.071	0.000
7000	13	1.190	1.038	18000	43	-0.032	0.000	-0.012	0.000
11000	13	1.339	1.007	15000	21	-0.040	0.000	-0.039	0.000
35000	12	1.191	1.143	86000	17	-0.084	0.000	-0.085	0.000

Note: As expected, VC funds have heavily invested in new technology industry. Industry code and matching industry names are reported in the Appendix.

3.1.4. Realized Return on Investment Agreements Eliminating Suspicious Transactions

Among the final sample used to analyze the realized return, 7,708 contracts have zero profit and loss, which accounted for about one-third of the total. This study judges these samples as suspicious transactions, removes them, and reanalyzes the realized rate of return.[1] The number of investment agreements in the sample from which suspicious transactions are removed decreased to 14,098. <Table 7> shows the descriptive statistics of the sample from which suspicious transactions are removed. Compared with the sample containing suspicious transaction agreements with zero profit or loss(see <Table 2>), all four realized returns are high.

<Table 7> Realized return on investment agreements eliminating suspicious transactions

Variable	N	Mean	Median	Std Dev	Minimum	Maximum	t-value
Multiple	14098	1.5424	1.117417	1.6957	0.0019	35.0000	**108.00*** **
APR	14098	0.3085	0.0795	0.7094	-0.7018	6.0220	**51.63*** **
EAR	14098	0.1476	0.0725	0.3986	-1.8318	2.5634	**43.97*** **
IRR	14098	0.1590	0.0753	0.4185	-1.2438	2.8808	**45.12*** **

Note: This table shows the realized return on investment agreements after eliminating the suspicious transactions. *** represents the significance level of 1%.

3.2. Stock Price Return

3.2.1. Sample and Variable Definition

This study is the first to find the stock price return of an unlisted portfolio firm invested by a VC fund. Most research on VC funds has measured the realized return on VC funds; thus, the stock price return of unlisted investees may sound unfamiliar. A significant difference exists between the realized EAR of the

1) The results of the interviews with the association's officials reveal that this suspicious transaction could be an error in the description that occurs if VC did not generate revenue. Therefore, when suspicious transactions are eliminated, the realized return may be overestimated.

VC funds obtained through the investment agreement and the stock price EAR of the investee company that is the contractor of the investment agreement. For example, this difference is the same as the difference between the stock price return recorded by IBM for a certain period and the realized rates of return for small investors who invested in IBM during the same period. Even if IBM's stock price return reaches 10% in terms of the closing price for two weeks, in the same period, a small investor would have recorded a negative realized return if he/she had repeatedly bought(sold) at the closing price when the stock price rises(falls). In this way, VC funds also invest and recover several times in one investment agreement. Suppose a VC invests a small amount when the investee's valuation is high, and collects a large amount when the valuation is low. If the transaction is repeated, the VC fund will record a lower realized return compared to the company's stock price return.

To calculate the stock price return of the investee, we adjust the number of traded shares considering the change in par value, calculate the implied total number of outstanding shares, keep only the contract whose implied total number of shares such obtained is the same as the recorded total number of shares in the data. Afterward, each time the investment contract has historical transaction, the transaction amount is divided by the number of shares to obtain the price per share. The period between the previous and current transaction is divided by 365 and converted into an annualized rate of return. Then, stock price multiple, stock price APR, and stock price EAR are calculated. This can be expressed as a following equation.

$$M = P(t)/P(t-1)$$

$$d = T_t - T_{t-1}$$

$$APR = (M-1)/d$$

$$EAR = \ln(M^{1/d})$$

where, P(t)=tth amount of cash flow / tth number of shares

$$T_t = (t^{th}\, time\, of\, cash\, flow - time\, of\, initial\, investment)/365$$

The problem that arises when calculating the stock price return using the method described above is that the stock price return may be over or underestimated when the period between the previous transaction and the current transaction is short.[2)]

To avoid such an over or undervaluation problem, we can use a method of removing the transactions with less than one-month period between two consecutive transactions. However, if the sample is large enough, we could anticipate that the undervalued stock price returns would be offset against overvalued ones, and conduct the study without deleting transactions with short periods between transactions.[3)]

In this process, investment types such as contracted investment, project, and founder loan without information on the number of shares traded are naturally eliminated. Lastly, to eliminate extreme values, upper and lower 1% for each stock price return are removed. As a result, a total of 5,567 company-commitments are selected as the final sample. For each contract, the company's stock price return is calculated. One company can have multiple contracts; therefore, the sample size is obtained based on the number of contracts, not the number of companies. When multiple transactions occurred on the same day, they are added together so that only one transaction per day may exists. As a result, the average number of historical observations per contract(number of trading days) is 4.82, the median value is 2.00 equal to the minimum value, and the maximum value is 96.00. The average and variance of the stock price return is used as a substitute for the annualized company's price return and variance measured by each agreement.

3.2.2. Stock Price Return Calculated from Investment Agreement

<Table 8> shows the empirical statistics of stock price return by investment agreement. As shown in <Table 8>, the number of observations of APR variance and EAR variance is significantly smaller than the number of observations of the average stock price return. This is because the number agreement with one investment and one return, where we cannot calculate the variance of the stock price return, amounts to 3,256, which is more than half of the sample. Again, the number of observations of APR variance and EAR variance is greatly reduced because of the agreement removal without variance information from the sample.

<Table 8> Stock price return of the investee

Variable	N	Mean	Median	Std Dev	Maximum	Minimum	t-value
price_Multiple	5567	10.964	1.000	193.813	10000.000	-321.071	**0.67**
price_APR	5567	3.524	0.000	71.095	2360.700	-1189.190	**3.28*** **
price_EAR	5567	0.305	0.000	3.077	31.110	-10.971	**3.25*** **
std_APR	2306	24.445	3.356	195.922	4144.090	0.000	**5.12*** **
std_EAR	2125	6.406	3.074	13.826	389.568	0.000	**23.26*** **

Note: This table shows the empirical test statistics of stock price return and variance. Price_Multiple, price_APR, and price_EAR denote stock price returns, and std_APR and std_EAR denote the standard deviation. *** denotes the significance level of 1%.

2) In fact, among the sample data, many cases show that the period between two consecutive transactions was one day.

3) In fact, when a transaction with a period of less than 30 days or 10 days between transactions was deleted, the price returns showed more extremes.

As shown in <Table 8>, the stock price returns for each investment contract measured through several investment performance indicators are all significant positive with high standard deviations. A number of investment agreements have not changed the price per share during the trading period(first investment date to last collection day); thus, the median value of the stock price multiple is 1, and the median values of the other two are close to 0.

<Table 9> Stock price return by investment type

	Var: price_multiple			Var: price_APR		Var: price_EAR	
inv_type	N	Mean	Median	Mean	Median	Mean	Median
BW	35	-5.156	1.004	-22.485	0.833	2.748	2.021
CB	74	-4.120	0.995	-5.755	-0.149	0.741	0.092
EB	1	1.012	1.012	-1.663	-1.663	-1.694	-1.694
Common stock	3104	13.148	1.010	4.831	0.014	0.546	0.007
Overseas investment	137	1.870	1.000	2.729	0.006	0.285	0.014
Overseas investment2	2	0.678	0.678	-1.874	-1.874	-2.310	-2.310
Fund investment	2	1.194	1.194	0.035	0.035	-1.017	-1.017
preferred stock	2212	9.243	1.000	2.473	0.000	-0.080	0.000

Note: BW, bonds with warrants; CB, convertible bonds; EB, exchangeable bond.

<Table 9> shows the results of classifying stock price returns by investment type. We read the results as follows. Among the samples in <Table 9>, 3,104 company-contracts are invested by VC funds as common stock. Moreover, the average stock price multiple measured by multiple or single agreements is 13.148, and the average stock price EAR is 54.5%. As specified above, the median values of stock price return are not significantly different across APR, EAR, and multiple - 1, for the two investment types: common stock and preferred stock which have both many observations. Alternatively, in the investment type with a small number of observations, the median value of each stock price return shows a significant difference compared to the investment type with a large number of observations.

3.3. Comparison between Average Realized Return and Stock Price Return

To determine whether the VC fund is following the start-up market's performance or outperforming/underperforming, we compare the realized rate of return of VC with the investee's stock price return. To this end, the sample for comparative analysis is reconstructed based on samples that satisfy the conditions required for calculating the realized return and stock price return. However, in comparing the two samples, the condition of removing 1% of the polarity value for IRR is excluded because IRR is not a target for comparison.[4] As a result, a total of 4,974 investment agreements are selected as the final sample.

<Table 10> Comparison between realized return and stock price return

Variable	N	Mean	Median	Std Dev	Maximum	Minimum
price_APR	4974	0.485	0.000	46.655	1690.290	-1189.190
price_EAR	4974	0.119	0.000	2.590	31.110	-10.971
realized_APR	4974	0.349	0.063	0.787	6.022	-0.702
realized_EAR	4974	0.149	0.057	0.424	2.563	-2.055
diff. test		*t*-value	*Z* value			
APR	9948	*-0.20*	*10.75*			
EAR	9948	*0.83*	*9.58*			

Note: This table shows statistics of the comparison between realized return and realized return by investment type. Price denotes the stock price return and realized denotes realized return.

<Table 10> shows the descriptive statistics and t-test results of the sample used to compare VC's realized return and stock price return. When comparing based on the average value, APR shows higher investee's stock price return and EAR has a higher realized return rate of VC, but neither investment performance indicators have statistical significance. Alternatively, when comparing based on the median value, VC realized a higher return than the stock price return, and both are statistically significant whether the return is measured by APR or EAR.

This suggests that VCs performed better than the market's stock price returns in many number of contracts. However, due to extreme values in some contracts, VC's average performance is brought down just to meet the market expectation. Note that the sample in <Table 10> has some valuation limitations in that project investment, founder loans, and investment agreements of VC funds are excluded.

4) The result of the sample analysis with the removal of the 1% polarization value of IRR confirmed no significant qualitative difference between this analysis result and that in Section 5.

Ⅳ. Experimental Study on the Characteristics of Stock Price Return

This chapter measures the sensitivity of the stock price return(stock price EAR, stock price APR) to the total individual risk(standard deviation) of the start-up companies invested by the VC fund. Our biggest contribution is that we can obtain variance of the stock price returns on unlisted companies. Equiped with this risk measure, we can now apply to unlisted companies the financial theory on the risk-return relationship. We consider this venture as being experimental, for we are using variance instead of beta as risk measure. We believe, however, this analysis may provide an useful insight to start-up investors since, as we mentioned earlier, the individual investors in this market hardly form well diversified portfolios.

<Table 11> shows the result of the regression analysis after excluding investment agreements(three out of the total sample) in which the value of Std(EAR) exceeds 100. The coefficient of Std(EAR) is positive and significant(0.204). The intercept is also significant and, however, negative(-0.295). Even when the analysis is conducted, including an investment agreement in which the value of Std(EAR) exceeded 100, the sensitivity of Std(EAR) is significant, but the intercept loses its significance.

<Table 11> OLS model of share price EAR and its variance

Analysis of variance					
Source	DF	SS	MS	**F Value**	Pr > F
Model	1	6578.56	6578.56	**498.74*** **	<.0001
Error	2132	28697	13.46		
Corrected total	2133	35276			
Root MSE	3.668	R-Square	0.18		
Dependent mean	0.944	Adj R-Sq	0.18		
Coeff var	388.39				
Parameter estimates					
Variable	DF	Parameter	SE	**t Value**	Pr > |t|
Intercept	1	-0.295	0.097	**-3.04*** **	0.002
Std_EAR	1	0.204	0.009	**22.11*** **	<.0001

Note: This shows the results of the OLS model of stock price return and its variance. The dependent variable is the return, and independent variable is the standard variation (rick). *** denotes significance level of 1%.

In <Table 12> we use APR and exclude the investment agreements(69 out of the total sample) in which the value of Std(APR) exceeds 100. The analysis result shows the same as the <Table 11>. The coefficient of Std(APR) is positive and significant(0.227), and the intercept exhibits negative and significant value(-0.461). Even when we include investment agreements with a value of Std(APR) exceeding 100, the sensitivity of the stock price APR is significant as in the case of Std(EAR), but the intercept loses significance.

<Table 12> OLS model of stock price APR and its variance

Analysis of variance					
Source	DF	SS	MS	***F* Value**	Pr > *F*
Model	1	14572	14572	***404.19****	<.0001
Error	2247	81007	36.05		
Corrected total	2248	95579			
Root MSE	6.00	R-Square	0.15		
Dependent mean	1.09	Adj R-Sq	0.15		
Coeff Var	549.88				
Parameter estimates					
Variable	DF	Parameter	SE	***t* Value**	Pr > |*t*|
Intercept	1	-0.461	0.148	***-3.11****	0.002
std_APR	1	0.227	0.011	***20.1****	<.0001

Note: This table shows the results of the OLS model of stock price return and its variance excluding investment agreements (69 out of the total sample) in which the value of Std(APR) exceeds 100. The dependent variable is the return, and the independent variable is the standard variation (rick). *** denotes 1% of significance level.

Taking the results of <Table 11> and <Table 12>, we can observe that a high-risk and high-return relationship exists between the risk measured by total risk(standard deviation) and the stock price return in unlisted start-up companies invested by VC. Alternatively, the market seems to require a premium of about 21%-23% per unit of total risk, but alpha shows a significant negative number, indicating that start-up companies invested by VC gives the level of stock price return that is lower than that implied by the level of risk.[5] This can be seen as one of the main reasons that individual investors are reluctant to invest in unlisted companies even if investment in unlisted companies guarantees high risk-high returns.

5) However, when the deal with Std(EAR) and Std(APR)> 100 was included, the absolute value of alpha decreased and insignificant results were obtained

Ⅴ. Conclusion

This study uses a unique dataset related to investment in VC funds held by the Korea Venture Capital Association. Moreover, this is the first attempt to calculate the stock price returns and variances of the unlisted start-up companies invested by VC funds. First, we compare the realized returns of VC funds against the stock price returns of portfolio firms. Results of the analysis confirmed that, when measured by median values, the VC record better performance than the market's stock price return in a large number of investment agreements.

Then, we measure the stock price returns' variance for unlisted portfolio companies, and test the sensitivity of stock price return to the total individual risk measured by variance. Through this, we experimentally verify whether the relationship between high risk and high return exists even in the investment of unlisted companies. The results confirm a positive relationship between the risk measured by total risk and the return. Our study is expected to provide implications for theoretical research related to financing of start-up companies through VC.

On the other hand, we witness a significant negative alpha, indicating that individual start-up companies pay off less than that implied by their level of risks. This may explain why individual investors hesitate to directly invest in unlisted companies, and allow us to imagine the difficulties of fund raising in early ecosystems where main investors are angels and acquaintances.

Lastly, we demonstrate the VCs help considerably reduce the uncertainly as to start-ups' cashflow to the extent that variance comes to exist and becomes measurable. This implies that investment in unlisted ventures may well enjoy rapid progress as VCs become more competent. According to our analysis VC's competence surely lies in reducing the variance through monitoring and mentoring the start-ups.

In early ecosystem where VC's role is not so expected to play, we come to see recently other forms of uncertainly fighting mechanisms settling in place. Among a few, the so called crowdfunding contributes considerably to the reduction of uncertainly related risks through relatively small amount of money and relatively great number of donors or backers.

Even though the data we used is hard to come by, it is not free from selection bias. The very fact that a start-up hosts VC investment means it is already a good company. A caution is thus in order when this paper's result is applied to any start-up without VC investment. Furthermore, in order to circumvent the complex deal structures between VCs and start-ups, we resort to duration-adjusted stock returns which is not conventional way of measuring stock price returns in case of listed companies. The validity of the method needs to be rigorously scrutinized in the following researches.

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Appendix 1: Industry Code

<Table 13> Industry Code

Code	Industry	Code	Industry
1000	Growing grain and other food crops	39000	Other environmental purification and restoration business
6000	Non-ferrous metal mining	41000	Bridge, tunnel and railway construction
7000	Construction stone mining and crushed stone production	42000	Building machinery and equipment installation work
10000	Poultry processing and storage processing business	46000	Primary metal products wholesale business
11000	Other fermented liquor manufacturing industry	47000	Furniture retail
13000	Other unclassified textile product manufacturing business	52000	Other unclassified transportation related service businesses
14000	Leather garment manufacturing industry	58000	System software development and supply business
15000	Manufacture of bags and other protective cases	59000	Production of commercial films and videos
17000	Corrugated cardboard manufacturing industry	60000	Satellite and other broadcasting industry
18000	Other printing related industries	61000	Other telecommunications business
20000	Processing and refined salt manufacturing industry	62000	Other information technology and computer operation related service businesses
21000	Veterinary medicine manufacturing industry	63000	Other information service business
22000	Other rubber product manufacturing business	64000	Financial business not classified elsewhere
23000	Primary glass products, fiberglass and optical glass manufacturing	66000	Other financial support service business
24000	Steel casting foundry	70000	Medicine and pharmaceutical research and development
25000	Structural metal plate products and workpiece manufacturing	71000	Management consulting business
26000	Other electronic parts manufacturing industry	72000	Building and civil engineering service industry
27000	Other medical device manufacturing business	73000	Other unclassified professional, scientific and technical service industries
28000	Home non-electric cooking and heating appliance manufacturing industry	75000	Security and security service business
29000	Construction and mining machinery and equipment manufacturing	76000	Construction and civil engineering machinery and equipment rental business
30000	Other automobile parts manufacturing business	85000	Education-related advisory and evaluation business
31000	Steel wire drying industry	86000	Public health care
33000	Manufacture of wigs and similar products	90000	Performance planning business
35000	Other power generation industry	91000	Golf course operation business
37000	Livestock manure processing business	95000	Automobile professional repair industry
38000	Construction waste treatment	99000	PEF

Appendix 2: Raw Data[6)]

<Table 14> Investment Agreements (Deal)-String Information

variables	no.	entry examples
VC type	219,338	VC, LLC, etc.
VC code	219,338	OP1997****, etc.
Fund type	166,648	Fund, KVF, etc.
Fund code	219,338	AS1999****, etc.
FoF investment	219,338	O, X
VC Registration	219,338	138811****, etc.
Nationality	219,338	Korea, etc.
Approval	219,338	approved, denied
Investment type	219,338	common share, preferred share
New/Old issue	174,183	new issue, old share
Deal date	219,338	2000-03-09, etc.
Deal type (cat. 1)	219,338	collection, investment, etc.
Deal type (cat. 2)	219,338	sales, payback, etc.
Collection type	219,338	IPO, M&A, etc.
Contractors type	17,817	issuing firm, majority shareholder, etc.
Contractor name	20,070	Withl****, etc.
Contractor registration	14,434	742860****, etc.
Industry (cat. 1)	219,314	electicity, etc.
Industry (cat. 2)	219,314	electricity device, etc.
Industry (cat. 3)	219,314	battery manufacturing, etc.
Industry code	219,314	28202, etc.
Age (cat. 1)	219,338	early, intermediate, late
Age (cat. 2)	219,338	first 3 years, 3~5 years, etc.
Age (cat. 3)	219,338	1.7
Founding date	219,338	1998-07-10, etc.
Region	219,338	Seoul, etc.
First investment date by investee	217,388	1999-11-26, etc.
First investment date by VC	215,303	1999-11-26, etc.
First investment date by Fund	214,410	1999-11-26b, etc.
Investee type	219,335	venture, n.a., etc.
Fiscal year	188,653	2002-08-07, etc
GP Buyout	219,338	O, X
Market	51,395	Kosdaq, kospi, etc.
Listing date	51,395	2002-08-07, etc
Deal registration	219,338	I00000****, etc.
First deal registration	219,192	I00000****, etc.

6) caution: The raw data contains not a few extreme values most of which are eliminated through the data collection process discussed in section 3.1.1.

<Table 15> Investment Agreements (Deal)-Numeric Information

variables	no.	average	median	max	min	std
Deal size	219,269	95,756,270	0	40,000,108,443	-29,690,245,900	1,036,830,122
Net profit	215,926	55,734,472	0	127,000,000,000	-15,000,000,000	1,128,868,700
n. shares in transaction	182,820	714,991	0	3,270,000,000	-12,020	31,584,313
n. shares owned after deal	204,035	1,973,136	9,524	9,603,000,000	-6,942,344	91,489,696
total n. of outstanding shares (common)	207,419	93,310,781	725,416	1,703,038,808,000	-44,570	9,750,522,379
total n. of outstanding shares (preferred)	207,402	3,874,671	0	7,722,732,769	0	136,637,595
total n. of outstanding shares	219,338	97,185,349	1,020,241	1,703,039,062,076	0	9,751,683,258
Face value (common)	203,778	2,266,499	500	17,971,904,500	0	189,547,313
Face value (preferred)	141,746	8,610	500	100,000,000	0	538,873
Sales	188,653	25,394,132,774	2,784,217,026	27,728,627,718,341	-4,234,210,588	323,637,667,457
Capital	188,653	6,677,985,234	1,257,954,000	35,397,963,655,455	-264,263,481,492	288,745,919,360
EBIT	188,653	668,991,828	-52,576,107	2,509,653,154,487	-11,362,442,947,693	107,710,433,765
Work force	188,653	78	32	9,999	0	240

<Table 16> Funds dissolution-String Information

variables	no.	entry examples
VC code	4,586	OP1990****, etc.
Fund code	4,586	AS1997****, etc.
Registration date	4,586	1997-11-21, etc.
Liquidation date (report)	4,586	2005-06-16, etc.
Liquidation date	4,586	1997-11-21, etc.

<Table 17> Funds dissolution-Numeric Information

	no.	average	median	max	min	std
Payment	4,586	-2,117,656,178	0	0	-67,600,000,000	4,939,861,643
Dividend	4,586	2,577,996,376	891,668,699	80,361,136,057	0	4,794,089,858

<Table 18> Partners-String Information

variables	no.	entry examples
VC type	14,422	LLC
VC code	14,422	OP2015****
Fund type	14,422	KVF
Fund code	14,422	AS2016****
Registration date	14,422	2016-09-28
Liquidation date	8,493	2017-04-16
Partners registration	14,418	128866****
Partners type (cat. 1)	14,422	bank, VC, etc.
Partners type (cat. 2)	14,422	financial Inst., non fin. Inst., etc.
Partners type (cat. 3)	14,422	private, public
GP or not	1,707	Y, blank
Nationality	14,422	Korea, etc.

<Table 19> Partners-Numeric Information

	no.	average	median	max	min	std
Payment by partner	14,264	2,461,382,694	450,000,000	277,000,000,000	0	6,516,684,579
Payment by fund	14,422	19,867,799,552	10,000,000,000	350,000,000,000	1,000,000	31,601,047,884

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신정순***

국문요약

본 연구에서는 벤처캐피탈협회가 보유하고 있는 VC 펀드 관련 자료를 가지고 VC의 실현된 수익률을 투자약정 수준에서 측정하였다. 또한, 동 자료가 제공하는 자세한 정보를 가지고 국내 최초로 비상장 피투자사의 주가수익률과 분산을 측정할 수 있었다. 분석결과, VC 펀드가 피투자사의 주가수익률보다 높은 실적을 보였다. 또한 VC 펀드가 투자한 스타트업의 경우 분산으로 측정된 총위험과 주가수익률 간에 양의 관계가 존재함을 확인하였다. 마지막으로 이들 기업의 총위험에 기초해 시장이 기대하는 수익률에 비해 측정된 주가수익률은 낮은 수준에 머무르고 있음도 발견하였다. 이는 비록 비상장사 스타트업이 고위험-고수익의 관계를 보장하더라도 개인투자자들이 비상장사에 직접 투자하기를 꺼리게 만드는 한 요인으로 작용할 수 있을 것이다.

핵심주제어: VC 펀드, 비상장사 주가수익률, 창업기업, duration-조정 주가수익률

* 본 연구는 한국재무학회가 주관한 '2019년도 한국재무학회-한국벤처캐피탈협회 학술연구지원사업' 의 지원을 받아 수행하였음
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