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Risk and Reward in Venture Capital Funds*

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Abstract

Using detailed data from Korea, free from the selection bias problem and providing industry codes for companies a venture capital (VC) fund invests in, this study conducts comprehensive analyses of performance and performance persistence of VC funds. We find significant differences between the results using a non-risk-adjusted and those using a risk-adjusted performance measure. Another notable finding is that government participation affects the risk-adjusted performance and cash inflows of venture capital funds. Furthermore, the persistence of performance is much weaker when we control risk of VC funds. In addition, we provide the evidence that the performance in a public market has a positive influence on the probability of raising subsequent venture capital funds.

Keywords: venture capital funds performance, risk-adjusted measure, selection-bias, government participation

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1. INTRODUCTION

The venture capital (VC) industry has experienced tremendous growth internationally over the last two decades. In the U.S. alone, for instance, capital commitments to VC funds soared from $2 billion in 1980 to $36 billion in 2007.[1] This upward trend has been curved recently, however, because of the impact of the global financial crisis that started in 2008, recording reduced amount of committed capital to the VC markets around the globe.[2] As for the Korean market, ever since having experienced explosive growth between 1999 and 2001, which was during the Internet bubble period, the demand has been steadily growing even though the recent global crisis. In fact, the total amount of capital committed to VC funds has increased over the years.[3]

As such, venture capital markets in major economies have seen bursting expansion, yet having access to detailed data of such funds have been grossly limited. This has made it very challenging to conduct comprehensive studies on key characteristics of the VC market, especially regarding the risk and return of VC funds.

To meet the need for closer analysis of VC funds, this paper focuses on Korean cases to examine the overall performance of venture capital (VC) funds, whose detailed data set is readily available to the public, unlike in most other countries. Moreover, by choosing data of Korean VC funds, we can avoid selection bias that most of other VC data sets suffer from. Most data sets about the venture funds are arbitrarily provided by the venture companies themselves because as a subset of the private equity industry, information on VC funds is generally regarded as confidential and, therefore, scarcely disclosed. On the contrary, the Korean VC companies are required by law to submit monthly reports to the government-run Venture Capital Information Center. This eliminates

1) During the Internet bubble period, 1999 and 2000, the committed capital nearly doubled from $55 billion to $105 billion.

2) The committed capital to VC funds in the U.S. dropped from $28 billion in 2008 to $8 billion during the first three quarters of 2009.

3) The total amount of capital committed to VC funds increased by about 14 percentage points, from 960 billion Korean won (approximately USD 800 million) in 2007 to 1,090 billion Korean won (approximately USD 900 million) in 2008. The total size of the Korean venture capital market peaked at 1,400 billion Korean won (approximately USD 1.2 billion) in 2000.

the selection process of data, making our studies more reliable and objective. Another advantage of using the Korean VC data set is that it provides detailed information on which industry a VC fund invests in on any given day. Taking advantage of this uniquely available industry information in Korea, we can better control the risk of a VC fund.

In this study, we are to primarily estimate as accurately as we can the performance of Korean VC funds by adjusting for risks underlying each fund. This is a unique feature of our paper as most of previous studies obtain data from Venture Source or VentureXpert, which is shown as unreliable databases because of the selection and survivorship biases in Maats et al. (2011). This explains the scarcity of research focusing on the performance of VC funds at the individual fund level. More recent research has relied on fund valuation data and cash flow records provided by Thomson Financial Venture Economic Services. The net-asset-value data from Venture Economics database, however, has a significant selection bias since general partners (GPs) who manage VC funds are allowed to report the performance only on a voluntary basis. In sum, researchers face two major obstacles: one is lack of information, especially when calculating risk-adjusted returns by estimating appropriate risk measures of private equity funds and the other is the selection bias problem. Both of these issues originally arise from data limitations.

Recently, some researchers have tried to overcome these problems by using more comprehensive data including cash flow information and proprietary records while others have developed methodologies to produce more bias-free results. Among few studies exploring the private equity industry at the individual fund level, Ljungqvist and Richardson (2003) is the first that use detailed cash flow stream of each fund to investors in order to estimate risk-adjusted private equity fund performance[4] at a fund level. However, because their dataset was collected from a single limited partner (LP), the results are not comprehensive, and therefore, not reliable enough to apply to the whole VC industry. Consequently, we cannot rule out the possibility that data from other LPs may lead to different results.[5]

4) They assign industry betas, as estimated by Fama-French over a five-year period, to the portfolio companies held in a fund.

5) Lerner, Schoar, and Wongsunwai (2007) show the evidence that returns are dramatically different across different institutions.

In addition, their sample size of VC funds is rather small as the LP, who has provided the dataset, invests disproportionately in buyout funds. Kaplan and Schoar (2005) use actual cash flow records provided voluntarily by large private equity investors including both VC funds and buyout funds. Since their data are collected on a voluntary basis, they cannot avoid the inherent selection bias issue. Furthermore, the risk-adjusted returns are obtained under the assumption of beta=1. Phalippou and Gottschalg (2009) use a methodology similar to that of Ljungqvist and Richardson (2003) with a sample similar to that of Kaplan and Schoar (2005). In their study, Phalippou and Gottschalg (2009) estimate betas by assigning the industry/size-matched beta provided by Fama and French, which is estimated over a five-year period. However, their sample is collected from large investors also on a voluntary basis, which bears the selection bias. By choosing Korean data, therefore, we could extend the previous studies with access to reliable data on risk-adjusted performance.

In terms of performance, while Ljungqvist and Richardson (2003) report excess returns of 5 to 8 percent per annum on private equity funds compared to the public equity market, Kaplan and Schoar (2005) document the similar performance between public and private equity markets. Phalippou and Gottschalg (2009) report that the average net-of-fees performance is lower than the performance of S&P 500 by about 3 percent per annum. With risk-adjusted returns, Ljungqvist and Richardson (2003) document that the value of private equity funds exceeds the present value of invested capital by about 24 percent while Phalippou and Gottschalg (2009) report that the private equity funds underperform S&P 500 by nearly 6 percent per year. Among those studies which estimate beta of VC market, correcting for selection bias by introducing novel methodologies at the same time, Jones and Rhodes-Kropf (2003) report the beta of 1.8 for VC funds and of 0.66 for buyout funds. In this strand of the literature, Driessen, Lin, and Phalippou (2012) assign the beta of 3.21 for VC funds and 0.33 for buyout funds using GMM-style methodology, while Korteweg and Sorensen (2010) adopt similar beta for VC funds and different beta for buyout funds compared to those of Driessen, Lin, and Phalippou (2012) by developing a general model of dynamic sample selection. Overall, these studies show that different methodologies for correcting selection bias can lead to mixed conclusions in estimating betas, which are calculated at the

VC market level instead of at the individual fund level.

The mixed outcomes concerning private equity fund performance among the aforementioned studies may stem mainly from the lack of accessibility to a comprehensive and detailed data. The major contribution of this study is, therefore, to be made in improving our understanding of the key features of the VC funds by providing accurate analysis of risk-adjusted performance computed with the estimated time-varying betas of each VC fund. Again, we are able to do so without the common obstacle of selection bias problem thanks to the unique and comprehensive dataset available in the Korean VC industry. In addition, this study includes detailed information on the cash flow stream to portfolio companies invested by each fund, containing the exact dates of investments and the industrial codes of portfolio companies, which is similar to the SIC codes in the United States. Taking advantage of this detailed dataset, we can propose much more accurate risk-adjusted performance measures termed AR_IRR and AR_IRR_INDU, based on which we can conduct various comprehensive tests on VC funds. AR_IRR is the abnormal return obtained by subtracting the expected return, calculated by using the CAPM, from the internal rate of return (IRR), a traditional performance measure for a VC fund. Industry betas are used in the CAPM when calculating the expected return. AR_IRR_INDU is computed by subtracting the expected return, which is calculated using industry-sorted portfolio returns, from the IRR.

With these measures, this paper closely examines three issues in the VC asset class, with a particular focus on making the comparison of the outcomes from the traditional non-risk-adjusted to those from our risk-adjusted measures. First, after the examination of the performance of VC funds, we confirm that the conventional measure, the IRR, overstate VC fund performance, as claimed by Phalippou and Gottschalg (2009).[6] Moreover, we break down the sample into two sub-grouping criteria: first, government-backed funds versus non-government-backed funds, and long-term funds versus short-term funds. Based upon these sub-samples, we examine whether government-backed funds show different performance from that of non-government-backed funds.[7]

6) Phalippou and Gottschalg (2009) show that average IRRs are upward-biased.

7) Lerner, Schoar, and Wongsunwai (2007) show large heterogeneity in private equity fund performance across institutional investors.

One notable feature of the Korean VC industry is that a significant portion of VC funds receives a designated amount of committed capital from the Korean government. If the government participates for political reasons, for instance, we expect that those funds invested by government show inferior performance. By showing the actual results, our investigation can shed light on the fund performance differences according to the type of investors. In fact, Shleifer (1998) among others[8] has argued that the government's goal in investing VC funds is to either maximize social welfare or pursue political goals, instead of profit maximization. For these reasons, most researchers have insisted that privatized firms outperform both state-owned firms and mixed-ownership firms.[9] Our results show that government-backed VC funds indeed underperform compared to non-government-backed VC funds.

In addition, in order to investigate the impact of the funds' duration on performance, we divide our sample into two groups: short-term and long-term. Each fund's longevity can be influenced by the corresponding fund managers' investment strategy and ability to manage assets. In general, a VC fund has a life of more than ten years. Therefore, it is plausible that funds lasting for shorter periods show different figures compared to those of long-term funds. However, to the best of our knowledge, only few studies have investigated this time-related issue. Among them, Chevalier and Ellison (1997) investigate the relationship between fund performance and cash flow among younger funds and older funds. However, their studies primarily focus on incentives for risk taking by mutual funds, not VC funds. Unlike theirs, our paper addresses the issue directly on how the funds perform differently based on the time factor of whether they are long-term or short-term funds. We find that the group of long-term funds underperforms the group of short-term funds.

The second issue of this research is to explore the performance persistence of VC funds. While a rich body of literature has examined this issue in the mutual fund industry, again, very limited research has been conducted in this area for the VC industry. In this regard, our study distinguishes itself in that our results

8) See, Megginson and Netter (2001) for a survey of the effect of privatization on the performance of firms.
9) See, for example, Majumdar (1996), Frydman et al. (1999), Bortolotti et al. (2002), and Tian (2001).

underline the importance of measures- one with risk-adjustment and the other without it as the outcome can turn out to greatly differ accordingly. This outcome can be the basis of warning for researchers to take more heed in interpreting results regarding performance persistence of VC funds especially when using traditional performance measures. With our performance measure which controls risks in VC funds, we find that the performance of the second previous fund strongly affects the performance of the current fund. Interestingly, the influence of the performance of the first previous fund disappears when we add the performance of the second previous fund to the regression model. Furthermore, the relationship economically and significantly reduces by about half, when we control the risks in VC funds.

The third issue of the paper is to investigate relationships among the public market condition, new VC fund-raising, and the VC fund performance. This analysis reveals the significant impact of the public market condition on the competition in the VC industry and, furthermore, how increasing competition can influence the actual fund performance. In short, our results confirm the significance of the market condition on overall fund performance. To be more specific, we find that in the robust public market conditions, the number of new VC companies increases and the cash flow from newly established VC companies also increases. Yet, VC fund performance deteriorates as the number of entry funds increases, although this result is not strongly supported by statistical significance.

The remainder of the paper is organized as follows. Section 2 describes the dataset employed in the investigation and shows the descriptive statistics. Section 3 defines our performance measures. Section 4 analyzes the performance of VC funds while Section 5 reports the test results of the persistence of the fund performance. Section 6 examines the relationships among the public market condition, new VC fund-raising, and the VC fund performance. Section 7 contains the conclusion.

2. DATA AND SAMPLE DESCRIPTION

In this section, we explain the content and source of the data used in this paper and the screening filter applied to our base sample.

In addition, we also provide descriptive statistics about the fund size and the number of VC funds by the year when the funds were raised.

2.1. Data

We obtain the data for this study from the Venture Capital Information Center in the Korean Venture Capital Association. In many countries, general partners (GPs), who manage funds, and limited partners (LPs), who invest a certain amount of capital into funds, in the private equity industry report information on fund performance only on a voluntary basis. Therefore, poorly performing funds are not likely to report their performance, and this tendency could lead researchers using these data to biased results. However, in Korea, all of the VC companies listed on the Small and Medium Business Administration are required by law to submit monthly reports to the Venture Capital Information Center in the Korean Venture Capital Association. In addition, they must report the collected and distributed cash flow amounts of a fund when the VC fund is liquidated. This mandatory reporting system provides the results of VC fund performance tests using Korean data with reliability and accuracy, and makes the results free of selection bias issue.

Our original dataset covers 373 VC funds which were raised and liquidated between December of 1987 and September of 2008. Because we cannot obtain the precise IRRs for on-going funds, our sample consists of liquidated VC funds. Furthermore, it makes the results free of survivorship bias. To construct a base sample for the calculation of the fund performance and its persistence, we use 203 funds that contain detailed investment information. It is a salient feature of our data set that the sample of 203 VC funds starting in 1993 contains exact information about in what industry and on which date a fund had invested. The data set used here also contains information on the size of the VC funds, the IRRs, and the fund sequences, which mean the order of a fund set up by the same partnership.

One of the particular features of the Korean VC industry is that the Korean government is responsible for a substantial portion of the committed capital of VC funds. This is done for political purposes, for instance, fostering small businesses or innovative firms. This feature makes it possible to examine the role of the government participation on the VC fund performance by investigating the performance difference between funds with government involvement and funds without it. 68 funds among 203 VC funds, roughly 33% of our base sample funds, received an investment from the Korean government. The government investment amounts averaged 33% of the corresponding funds. Daily industry beta and daily industry returns are collected from the Data-Guide Pro database.

2.2. Sample description

Table 1 shows the sample descriptions of 203 VC funds raised and liquidated during the base sample period, from December of 1993 to July of 2008. This covers approximately 56% of all of the VC funds in the original sample period, which is from December of 1987 to September of 2008.

Panel A documents the average and standard deviation of the VC fund size during this base sample period. Our sample has 68 government-backed funds, meaning funds with the Korean government investment, and 135 non-government-backed funds, denoting the other cases. The average size of the government-backed funds is approximately 3.8 billion Korean Won larger than that of non-government-backed VC funds. The discrepancy is mostly from the investment amount from the government. Therefore, if we exclude the investment of the government, the average size of the VC funds for both groups is similar.

Panel B reports the number and ratio of funds by the sequence. VC funds generally have more than two rounds of financing. A first round fund refers a fund which is firstly set by a certain GP, a second round fund means a fund which is set right after the first one with the same GP, a third round fund means a fund which is raised right after the second one with the same GP, and so on. Columns (3) and (4) show a sample description of government-backed VC funds, and columns (5) and (6) report that of non-government-backed VC funds. This panel documents that government-backed VC funds are clustered in the first and second round funds. Among funds in which the government invested, 18% are first round funds and 13% are second round funds, while 4% are third-round funds. Among funds in which the government did not invest, 14% are first and second-round funds, and 13% are third

Table 1. Descriptive statistics

Panel A: Size (unit: million Korean Won)

	All funds	Government-backed funds	Non Government-backed funds
Average	8,971.54	11,493.38	7,701.28
Standard deviation	7,824.04	6,906.13	7,973.71

Panel B: Number of observation and ratio of each sequential funds

	All funds		Government-backed funds		Non Government-backed funds	
	Obs	%	Obs	%	Obs	%
1st raised funds	31	15.27	12	17.65	19	14.07
2nd raised funds	28	13.79	9	13.24	19	14.07
3rd raised funds	21	10.34	3	4.41	18	13.33
4th raised funds	20	9.85	7	10.29	13	9.63
5th raised funds	17	8.37	5	7.35	12	8.89
6th raised funds	12	5.91	6	8.82	6	4.44
7th raised funds	14	6.90	4	5.88	10	7.41
8th raised funds	10	4.93	4	5.88	6	4.44
9th raised funds	10	4.93	4	5.88	6	4.44
10th raised funds	9	4.43	3	4.41	6	4.44
11th raised funds	6	2.96	2	2.94	4	2.96
12th raised funds	4	1.97	2	2.94	2	1.48
13th raised funds	2	0.99	0	0.00	2	1.48
14th raised funds	3	1.48	1	1.47	2	1.48
15th raised funds	3	1.48	1	1.47	2	1.48
16th raised funds	2	0.99	1	1.47	1	0.74
17th raised funds	4	1.97	1	1.47	3	2.22
18th raised funds	2	0.99	2	2.94	0	0.00
19th raised funds	2	0.99	0	0.00	2	1.48
20th raised funds	3	1.48	1	1.47	2	1.48

round funds. This sheds some light on the interpretation of the purpose of the government participation in the VC industry, such as fostering start-up companies, which may be different from the investment purpose of private LPs.

Panel C reports the number of funds raised per vintage year, which means a year in which a VC fund was raised. This panel shows that many of the VC funds were raised between 1999 and 2001, which was the Internet-bubble period. During this period, about 76% of government-backed VC funds were raised and about

Table 1. (continued)

Panel C: Number of raised funds in each year

	All funds		Government-backed funds		Non Government-backed funds	
	Obs	%	Obs	%	Obs	%
1993	1	0.49	0	0.00	1	0.74
1994	2	0.99	1	1.47	1	0.74
1995	6	2.96	0	0.00	6	4.44
1996	4	1.97	1	1.47	3	2.22
1997	4	1.97	2	2.94	2	1.48
1998	3	1.48	1	1.47	2	1.48
1999	37	18.23	8	11.76	29	21.48
2000	84	41.38	27	39.71	57	42.22
2001	33	16.26	21	30.88	12	8.89
2002	18	8.87	7	10.29	11	8.15
2003	2	0.99	0	0.00	2	1.48
2004	3	1.48	0	0.00	3	2.22
2005	5	2.46	0	0.00	5	3.70
2006	1	0.49	0	0.00	1	0.74
Total Observation	203	100	68	100	135	100

73% of non-government-backed VC funds were raised. This panel also shows that there is only a small number of funds raised starting in 2003 in our sample. Considering that VC funds usually continue for more than 5 years, a small number of liquidated VC funds raised after 2003 is reasonable. Notably, none of the government-backed funds started after 2003 were liquidated. This suggests that government-backed funds generally exist for a long period of time and that few government-backed funds are liquidated before the official expiration date, as governments invest with long-term goals.

3. MEASURING THE PERFORMANCE OF VENTURE CAPITAL FUNDS

In this section, we introduce our methodology of estimating VC fund performance and compare it with a popular VC fund performance measure in literature. Before describing our measures, we briefly introduce performance measures that are commonly used in the VC industry.

3.1. Standard performance measures

The two typical measures for computing private equity fund performance are the internal rate of return (IRR) and the public market equivalent (PME). The IRR is the effective rate of return based on the cash flows and current valuations of the fund portfolio. As mentioned earlier, the interim valuations of on-going VC funds are voluntarily reported in most countries. Hence, this measure can bias the results toward good performance. Although the Korean data can allow us to avoid this selection bias problem with the help of the requirement of mandatory reports, there still exists the shortcoming that this typical measure does not consider the systematic risks in the VC funds. Particularly, because VC funds usually invest in small start-up companies, it is necessary to control the risk when we evaluate the performance of a VC fund.

The PME is also a widely used measure in assessing VC fund performance. The PME reflects the return on a private equity fund relative to the return on a public equity, for example, the S&P 500. In other words, this measure compares the terminal wealth obtained from investing in a private equity fund with the terminal wealth acquired from investing in a public market. Therefore, if we want to compare the private equity fund performance with the S&P 500, the following equation is used:

$$PME = \frac{(distributed\ amount\ of\ \ private\ \ fund\ /\ s\,\&\,p500\ \ index\ on\ \ fund\ distribution\ day)}{(raised\ amount\ of\ \ private\ \ fund\ /\ s\,\&\,p500\ \ index\ on\ \ fund\ \ formation\ day)}$$

If the PME measure is larger than 1, this indicates that the private equity performed better than the public equity benchmark. In contrast, if the PME measure is less than 1, this indicates that the private equity underperformed the compared public equity. The PME measure implicitly assumes that the beta of a VC fund return is 1 when estimating the performance. Considering the nature of bearing high risk in the VC industry, this assumption biases the results toward overstated performance.

In sum, the important disadvantage of using conventional measures such as the IRR or the PME is that these measures do not take into account different risks in VC funds when evaluating fund performance.

3.2. New performance measures

With the help of the unique Korean dataset, we construct two improved performance measures which consider risks in VC funds. We refer to them as AR_IRR and AR_IRR_INDU. The discrepancy between these two measures is that they use different benchmarks when calculating abnormal performance.

AR_IRR. To measure the performance considering the risks of the VC funds, we develop risk-adjusted measures by calculating the abnormal return of the IRR. Our first measure, the AR_IRR, is the abnormal return obtained by calculating the difference between the log of the IRR, which we term as log_IRR, and the log of the expected benchmark return computed by using industry betas. With investment information including the amount, invested industry, and accurate investment timing, we compute the expected return using the CAPM with the weighted daily beta of industries in which the raised capital was invested. This expected return is calculated as shown below.

$$E(r_{it}) = r_{ft} + \beta_{it}(E(r_{mt}) - r_{ft})$$

where, for VC fund i,

β_{it} = average of daily betas of invested industries weighted by investment size at time t

Below is an example of the weighted daily industry beta. This example assumes that the first investment day is March 1, the second investment day is March 3, the third investment day is March 5, and the liquidation day is March 8. Also assumed is that the first investment industry is the food industry, the second is the car industry, and the third is the steel industry. For the expected return from March 1 to March 2, we use the daily industry beta of the food industry; for the expected return from March 3 to March 4, we use the size-weighted daily industry beta of the food and car industries; and for the expected return from the last investment day to the liquidated date, i.e., from March 5 to March 8, we use the size-weighted daily industry beta of the food, car, and steel industries. To calculate the size-weighted daily industry beta, we use the daily betas of 57 industries.

With these size-weighted daily industry betas, the AR_IRR measure of fund i, which is the abnormal return compared to its log expected return, is calculated as shown below.

$$AR\_IRR(i) = \text{log\_}IRR - \log(1 + \text{Expected Return }(i))$$

where,

$$\text{log\_}IRR = \log(1 + IRR(i))$$

AR_IRR_INDU. Our second risk-adjusted performance measure, the AR_IRR_INDU, is the difference between the log_IRR and the log of the expected return on the benchmark portfolio using daily industry returns. First, using investment information including the amount, invested industry, and accurate investment timing, we construct a benchmark industry portfolio. Then, by assigning daily industry returns, we obtain the daily size-weighted return for this portfolio. Therefore, the expected return is as follows:

Expected return (portfolio) = daily size-weighted industry return

An example for the size-weighted daily industry return is given below. This example again assumes that the first investment day is March 1, the second investment day is March 3, the third investment day is March 5, and the liquidation day is March 8. It also assumes that the first investment industry is the food industry, the second is the car industry, and the third is the steel industry. From March 1 to March 2, the expected return of the benchmark portfolio is the daily return of the food industry, and from March 3 to March 4, the expected return of benchmark portfolio is the size-weighted daily industry return of the food and car industries. From the last investment day to the liquidated date, i.e., from March 5 to March 8, the expected return on this benchmark portfolio is the size-weighted daily industry return of the food, car, and steel industries.

With this size-weighted daily industry return, AR_IRR_INDU of fund i, which is the abnormal return compared to its log benchmark return, is computed as shown below.

$$AR\_IRR\_INDU(i) = log\_IRR - \log(1 + \text{Expected Return (benchmark portfolio)})$$

where,

$$\log\_\ IRR = \log(1 + IRR(i))$$

4. PERFORMANCE ESTIMATION OF VENTURE CAPITAL FUNDS AND RELATED CHARACTERISTICS

In this section, we analyze the performance of VC funds using our risk-adjusted performance measures and explore fund characteristics related to VC fund performance. While prior studies could not take into account risks in their investigations of VC fund performance due to a lack of available data, we conduct a more comprehensive investigation of VC fund performance adjusted for the risks in funds. This also produces more reliable results for the related characteristics affecting fund performance. As we described in the previous chapter, we use two different risk-adjusted performance measures: AR_IRR, which uses weighted daily industry betas when measuring the expected fund returns, and AR_IRR_INDU, which uses weighted daily industry returns in estimating the expected benchmark portfolio returns.

4.1. Performance of Venture Capital Funds

Panel A of table 2 shows the performance of VC funds using the log_IRR, which is the non-risk-adjusted performance measure. Panels B and C report the VC fund performance using the AR_IRR and the AR_IRR_INDU measures, which are both risk-adjusted performance measures. All of these measures are log-transformed to obtain compounded returns. From columns (1) through (4), we give equal weight in evaluating the performance of the VC funds. From columns (5) to (8), the performance is weighted in proportion to the fund size, the committed capital of a fund. Because VC funds have various investment strategies, different investment periods, and the large variation of returns across funds, the value weighted performance is preferred when estimating the performance.

We divide the sample into two groups – one group with government investment involvement and the other group with none. We refer to the former as "government-backed funds" and the latter as "non-government-backed funds." We also create two subgroups according to the existence period of the fund. If a fund has existed for 5 or more years, the fund is included in the "long-term" group. Otherwise, the fund is included in the "short-term" group. To explore the distinction between these subgroups, we use the Wilcoxon rank-sum test, as we cannot validate that the VC fund performance are nicely distributed.

The performance analysis documents different consequences according to whether a non-risk-adjusted or a risk-adjusted measure is used as a performance measure. Panel A, which represents the results using a non-risk-adjusted measure, illustrates that there are no performance discrepancies between government-backed and non-government-backed VC funds. In addition, there is no performance difference between long-term and short-term VC funds. However, panels B and C, showing the results of risk-adjusted performance measures, indicate different results. Outcomes with risk-adjusted measures, which are the AR_IRR and the AR_IRR_INDU, show clear differences in performance between government-backed and non-government-backed funds. According to panels B and C, the government-backed funds underperform relative to the non-government-backed funds. We interpret this finding as that the government may participate in the VC industry for political reasons, such as boosting start-up companies, in addition to seeking to maximize their return.[10] There also exist differences in performance between long-term funds and short-term funds. Panel B strongly illustrates that short-term funds perform better than long-term funds. The government-backed funds do not show a difference according to the duration of funds. However, it is important to note that there are only two VC funds that are included in the government-backed groups and that existed less than five years at the same time. Due to the small sample size, we cannot focus

10) Shleifer (1998) argues that the government's goal in investing VC funds is to either maximize social welfare or pursue political goals, instead of profit maximization. See, Megginson and Netter (2001) for a survey of the effect of privatization on the performance of firms.

Table 2. Venture capital fund performance

Panel A : log _IRR

		Equal weighted performance						Value weighted performance			
		(1)	(2)	(3)	(4)			(5)	(6)	(7)	(8)
		All funds	Non Government-backed funds	Government-backed funds	Diff test of (3)-(2) (t-value)			All funds	Non Government-backed funds	Government-backed funds	Diff test of (7)-(6) (t-value)
(a) All	med	0.0029	0.0009	0.0077		(a) All	med	0.0111	0.0119	0.0077	
	avg	-0.0449	-0.0661	-0.0027	0.3721		avg	-0.0090	-0.0146	-0.0016	0.4367
	stdv	0.4705	0.5687	0.1268			stdv	0.2380	0.2932	0.1325	
	minimum	-3.1412	-3.1412	-0.3909			minimum	-3.1412	-3.1412	-0.3909	
	qtile1	-0.1007	-0.1208	-0.0472			qtile1	-0.0718	-0.0828	-0.0435	
	qtile3	0.0857	0.0904	0.0712			qtile3	0.0900	0.1064	0.0802	
	percent1	-2.8346	-3.1394	-0.3909			percent1	-0.5017	-0.6259	-0.3909	
	percent5	-0.3909	-0.5391	-0.2588			percent5	-0.3140	-0.3792	-0.2588	
	percent95	0.2835	0.3176	0.1813			percent95	0.2668	0.2959	0.2668	
	percent99	0.9741	1.7198	0.3651			percent99	0.3623	0.3623	0.3651	
	maximum	1.9580	1.9580	0.3651			maximum	1.9580	1.9580	0.3651	
	ncount	203	135	68			ncount	203	135	68	
(b) < 5yrs	med	0.0180	0.0243	-0.0906		(b) < 5yrs	med	-0.0136	-0.0027	-0.1568	
	avg	0.0374	0.0443	-0.0906	-1.2416		avg	-0.0453	-0.0388	-0.1039	-1.6236
	stdv	0.4612	0.4723	0.0661			stdv	0.2938	0.3081	0.0648	
	minimum	-1.5533	-1.5533	-0.1568			minimum	-1.5533	-1.5533	-0.1568	
	qtile1	-0.0551	-0.0259	-0.1568			qtile1	-0.1568	-0.0551	-0.1568	
	qtile3	0.1889	0.1889	-0.0245			qtile3	0.0898	0.0898	-0.0245	
	percent1	-1.5533	-1.5533	-0.1568			percent1	-1.5533	-1.5533	-0.1568	
	percent5	-0.5017	-0.5017	-0.1568			percent5	-0.3792	-0.3792	-0.1568	
	percent95	0.7962	0.7962	-0.0245			percent95	0.2835	0.2962	-0.0245	
	percent99	1.9580	1.9580	-0.0245			percent99	0.3473	0.3473	-0.0245	
	maximum	1.9580	1.9580	-0.0245			maximum	1.9580	1.9580	-0.0245	
	ncount	39	37	2			ncount	39	37	2	

Table 2. (continued)

		Equal weighted performance						Value weighted performance			
		(1)	(2)	(3)	(4)			(5)	(6)	(7)	(8)
		All funds	Non Government-backed funds	Government-backed funds	Diff test of (3)-(2) (t-value)			All funds	Non Government-backed funds	Government-backed funds	Diff test of (7)-(6) (t-value)
(c) >= 5yrs	med	0.0017	-0.0224	0.0096		(c) >= 5yrs	med	0.0119	0.0180	0.0116	
	avg	-0.0644	-0.1078	0.0000	1.1854		avg	-0.0032	-0.0078	0.0018	0.9003
	stdv	0.4705	0.5958	0.1272			stdv	0.2272	0.2886	0.1328	
	minimum	-3.1412	-3.1412	-0.3909			minimum	-3.1412	-3.1412	-0.3909	
	qtile1	-0.1034	-0.1310	-0.0435			qtile1	-0.0632	-0.0828	-0.0368	
	qtile3	0.0843	0.0857	0.0802			qtile3	0.0983	0.1181	0.0802	
	percent1	-3.1394	-3.1412	-0.3909			percent1	-0.3909	-0.6259	-0.3909	
	percent5	-0.3727	-0.6259	-0.2588			percent5	-0.2751	-0.3135	-0.2588	
	percent95	0.2476	0.2710	0.1813			percent95	0.2668	0.2959	0.2668	
	percent99	0.9741	1.7198	0.3651			percent99	0.3623	0.3623	0.3651	
	maximum	1.7198	1.7198	0.3651			maximum	1.7198	1.7198	0.3651	
	ncount	164	98	66			ncount	164	98	66	
Diff test of (b) – (c) (t-value)		1.3617	1.7586	-1.3612		Diff test of (b) – (c) (t-value)		-0.4018	-0.9792	-1.3612	

Table 2. (continued)

Panel B: AR_IRR

		Equal weighted performance						Value weighted performance			
		(1)	(2)	(3)	(4)			(5)	(6)	(7)	(8)
		All funds	Non Government-backed funds	Government-backed funds	Dif f test of (3)-(2) (t-value)			All funds	Non Government-backed funds	Government-backed funds	Diff test of (7)-(6) (t-value)
(a) All	med	-0.4243	-0.2931	-0.7342		(a) All	med	-0.4605	-0.3210	-0.6776	
	avg	-0.4311	-0.2956	-0.7001	-6.1221		avg	-0.4209	-0.2280	-0.6774	-7.3827
	stdv	0.6745	0.7545	0.3453			stdv	0.5233	0.5533	0.3401	
	minimum	-3.6379	-3.6379	-1.3578			minimum	-3.6379	-3.6379	-1.3578	
	qtile1	-0.7762	-0.5970	-0.9515			qtile1	-0.7700	-0.5970	-0.9329	
	qtile3	-0.1018	0.0971	-0.4843			qtile3	-0.1804	0.1324	-0.4605	
	percent1	-3.4370	-3.6075	-1.3578			percent1	-1.3578	-1.3470	-1.3578	
	percent5	-1.1515	-1.3177	-1.1515			percent5	-1.1035	-0.8992	-1.1515	
	percent95	0.6055	0.7345	-0.0129			percent95	0.6089	0.7270	-0.0129	
	percent99	0.9507	1.7801	0.2173			percent99	0.7895	0.7895	0.2040	
	maximum	2.7169	2.7169	0.2173			maximum	2.7169	2.7169	0.2173	
	ncount	203	135	68			ncount	203	135	68	
(b) < 5yrs	med	-0.1018	-0.0883	-0.4991		(b) < 5yrs	med	0.0161	0.1324	-0.5377	
	avg	-0.0393	-0.0144	-0.4991	-1.4963		avg	-0.0488	0.0017	-0.5068	-2.1330
	stdv	0.6870	0.6967	0.0386			stdv	0.5295	0.5343	0.0378	
	minimum	-1.7156	-1.7156	-0.5377			minimum	-1.7156	-1.7156	-0.5377	
	qtile1	-0.4071	-0.3162	-0.5377			qtile1	-0.4605	-0.2836	-0.5377	
	qtile3	0.1956	0.1956	-0.4605			qtile3	0.3063	0.3063	-0.4605	
	percent1	-1.7156	-1.7156	-0.5377			percent1	-1.7156	-1.7156	-0.5377	
	percent5	-1.3177	-1.3177	-0.5377			percent5	-0.7202	-0.7202	-0.5377	
	percent95	0.9029	0.9029	-0.4605			percent95	0.6089	0.6089	-0.4605	
	percent99	2.7169	2.7169	-0.4605			percent99	0.9005	0.9005	-0.4605	
	maximum	2.7169	2.7169	-0.4605			maximum	2.7169	2.7169	-0.4605	
	ncount	39	37	2			ncount	39	37	2	

Table 2. (continued)

Panel B: AR_IRR

		Equal weighted performance						Value weighted performance			
		(1)	(2)	(3)	(4)			(5)	(6)	(7)	(8)
		All funds	Non Government-backed funds	Government-backed funds	Dif f test of (3)-(2) (t-value)			All funds	Non Government-backed funds	Government-backed funds	Diff test of (7)-(6) (t-value)
(c) >= 5yrs	med	-0.5349	-0.3963	-0.7614		(c) >= 5yrs	med	-0.5312	-0.3971	-0.6901	
	avg	-0.5243	-0.4018	-0.7062	-5.0449		avg	-0.4806	-0.2922	-0.6830	-6.0710
	stdv	0.6369	0.7482	0.3486			stdv	0.4970	0.5413	0.3442	
	minimum	-3.6379	-3.6379	-1.3578			minimum	-3.6379	-3.6379	-1.3578	
	qtile1	-0.8176	-0.6261	-0.9528			qtile1	-0.8104	-0.5986	-0.9408	
	qtile3	-0.2052	-0.0800	-0.4881			qtile3	-0.2564	-0.0800	-0.4192	
	percent1	-3.6075	-3.6379	-1.3578			percent1	-1.3578	-1.3470	-1.3578	
	percent5	-1.1515	-1.3470	-1.1515			percent5	-1.1155	-0.9728	-1.1515	
	percent95	0.3081	0.7232	-0.0129			percent95	0.6055	0.7895	-0.0129	
	percent99	0.9507	1.7801	0.2173			percent99	0.7895	0.7895	0.2040	
	maximum	1.7801	1.7801	0.2173			maximum	1.7801	1.7801	0.2173	
	ncount	164	98	66			ncount	164	98	66	
Diff test of (b) – (c) (t-value)		4.5656	3.1300	1.1797		Diff test of (b) – (c) (t-value)		5.1813	3.7071	0.3085	

Table 2. (continued)

Panel C: AR_IRR_INDU

		Equal weighted performance				Value weighted performance					
		(1)	(2)	(3)	(4)			(5)	(6)	(7)	(8)
		All funds	Non Government-backed funds	Government-backed funds	Diff test of (3)-(2) (t-value)			All funds	Non Government-backed funds	Government-backed funds	Diff test of (7)-(6) (t-value)
(a) All	med	0.1031	0.2803	-0.2541		(a) All	med	0.0782	0.2463	-0.2028	
	avg	0.1875	0.3551	-0.1454	-4.0793		avg	0.1260	0.3001	-0.1056	-3.7274
	stdv	0.9401	1.0363	0.5827			stdv	0.7955	0.8885	0.5748	
	minimum	-2.9406	-2.9406	-1.1310			minimum	-2.9406	-2.9406	-1.1310	
	qtile1	-0.3767	-0.2755	-0.6044			qtile1	-0.3547	-0.0986	-0.5415	
	qtile3	0.7208	0.9217	0.2076			qtile3	0.5706	0.7301	0.3171	
	percent1	-1.8469	-2.0967	-1.1310			percent1	-1.7600	-1.8469	-1.1310	
	percent5	-1.0756	-1.4742	-1.0159			percent5	-1.0450	-1.0805	-1.0450	
	percent95	2.0049	2.2163	0.9614			percent95	1.5487	2.0174	0.7904	
	percent99	2.8610	2.9824	1.3763			percent99	2.6619	2.8610	1.3763	
	maximum	3.3155	3.3155	1.3763			maximum	3.3155	3.3155	1.3763	
	ncount	203	135	68			ncount	203	135	68	
(b) < 5yrs	med	0.1464	0.1668	-0.1650		(b) < 5yrs	med	0.1668	0.4245	-0.0754	
	avg	0.4288	0.4609	-0.1650	-1.1143		avg	0.3190	0.3703	-0.1471	-1.8783
	stdv	0.9508	0.9656	0.0896			stdv	0.6219	0.6340	0.0877	
	minimum	-1.2488	-1.2488	-0.2545			minimum	-1.2488	-1.2488	-0.2545	
	qtile1	-0.2545	-0.2070	-0.2545			qtile1	-0.0217	0.0081	-0.2545	
	qtile3	0.8490	0.8490	-0.0754			qtile3	0.7301	0.7301	-0.0754	
	percent1	-1.2488	-1.2488	-0.2545			percent1	-0.9990	-0.9990	-0.2545	
	percent5	-0.9990	-0.9990	-0.2545			percent5	-0.3264	-0.3428	-0.2545	
	percent95	2.9824	2.9824	-0.0754			percent95	1.0067	1.2727	-0.0754	
	percent99	3.3155	3.3155	-0.0754			percent99	2.9824	2.9824	-0.0754	
	maximum	3.3155	3.3155	-0.0754			maximum	3.3155	3.3155	-0.0754	
	ncount	39	37	2			ncount	39	37	2	

Table 2. (continued)

Panel C: AR_IRR_INDU

		Equal weighted performance				Value weighted performance					
		(1)	(2)	(3)	(4)			(5)	(6)	(7)	(8)
		All funds	Non Government-backed funds	Government-backed funds	Diff test of (3)-(2) (t-value)			All funds	Non Government-backed funds	Government-backed funds	Diff test of (7)-(6) (t-value)
(c) >= 5yrs	med	0.0149	0.2824	-0.2653		(c) >= 5yrs	med	0.0055	0.2463	-0.2028	
	avg	0.1301	0.3152	-0.1448	-3.5259		avg	0.0950	0.2805	-0.1043	-3.1973
	stdv	0.9283	1.0590	0.5912			stdv	0.8157	0.9466	0.5839	
	minimum	-2.9406	-2.9406	-1.1310			minimum	-2.9406	-2.9406	-1.1310	
	qtile1	-0.4764	-0.3038	-0.6090			qtile1	-0.3982	-0.2221	-0.5981	
	qtile3	0.6500	1.0097	0.2199			qtile3	0.5354	0.7713	0.3171	
	percent1	-2.0967	-2.9406	-1.1310			percent1	-1.7600	-1.8469	-1.1310	
	percent5	-1.0805	-1.6539	-1.0159			percent5	-1.0450	-1.4742	-1.0450	
	percent95	1.8002	2.2163	0.9614			percent95	1.6256	2.1450	0.7904	
	percent99	2.6619	2.8610	1.3763			percent99	2.6619	2.8610	1.3763	
	maximum	2.8610	2.8610	1.3763			maximum	2.8610	2.8610	1.3763	
	ncount	164	98	66			ncount	164	98	66	
Diff test of (b) – (c) (t-value)		1.6361	0.3379	-0.1633		Diff test of (b) – (c) (t-value)		0.9932	0.2639	-0.0181	

on these funds. We should also note that the standard deviation of government-backed funds in the short-term group is very small compared to the other cases. Under the value-weighted AR_IRR, the average return on short-term and government-backed funds is -0.5, while the average return on short-term and non-government-backed funds is 0.002. The standard deviation of short-term government-backed funds is 0.04, while that of short-term non-government-backed funds is 0.53. These results support the assertion that the government participates in the VC industry for reasons not related to profit maximization. Funds existing for less than 5 years with government backing are usually established for special political purposes to be achieved quickly. Therefore, these funds are likely to be managed to boost the venture industry rather than extract large returns from an investment in VC funds. These types of special purposes may be behind the poor performance and small standard deviation of the short-term government-backed funds. When we test separately based on the longevity of funds, both the long-term group and the short-term group indicate the underperformance of government-backed funds.

As mentioned earlier, the performance of VC funds has strong fluctuations on a yearly basis. Table 3 presents the fund performance according to the vintage year, representing the year when the fund was started. Among funds established between 2003 and 2008, a few funds were liquidated but most are still running. Particularly, there are no liquidated government-backed VC funds among the funds raised since 2003. This suggests that, in general, the government invests in the VC funds for long-term purposes. In this table, the results with the risk-adjusted performance measures are different from those with the non-risk-adjusted performance measure. Panel A, which uses the log_IRR, reports that the VC funds performed fairly well, except when they were started during the Internet bubble period (1999 and 2000), and 2006. If we consider our sample period, funds raised in 2006 are funds that were liquidated in less than or approximately one year. This abrupt liquidation, when considering that the typical maturity of VC funds is long, may have been caused by the dismal performance of the fund. However, panel B, with the AR_IRR measure, reports generally worse performance of VC funds compared to the expected return. Only the funds that were started in 1995 and 1996 illustrate over-performance while the other cases show underperformance.

Table 3. Yearly performance of venture capital funds
Panel A : Performance without considering risk

	log_IRR					
	Mean			Obs		
vintage year	All funds	Non Government-backed funds	Government-backed funds	All funds	Non Government-backed funds	Government-backed funds
1993	0.0749	0.0749		1	1	
1994	0.0496	0.0447	0.0519	2	1	1
1995	0.0718	0.0718		6	6	
1996	0.0852	0.1125	0.0223	4	3	1
1997	0.1041	0.2798	0.0230	4	2	2
1998	0.2051	0.0274	0.3651	3	2	1
1999	-0.0412	0.0446	-0.1235	37	29	8
2000	-0.0884	-0.1205	-0.0304	84	57	27
2001	0.0262	0.0175	0.0285	33	12	21
2002	0.1431	0.1501	0.1329	18	11	7
2003	0.0597	0.0597		2	2	
2004	0.0603	0.0603		3	3	
2005	0.1862	0.1862		5	5	
2006	-1.5533	-1.5533		1	1	

Panel B: Performance with considering risk with a benchmark using industrial beta

	AR_IRR					
	Mean			Obs		
vintage year	All funds	Non Government-backed funds	Government-backed funds	All funds	Non Government-backed funds	Government-backed funds
1993	-0.1612	-0.1612		1	1	
1994	-0.0975	0.1312	-0.1991	2	1	1
1995	0.3258	0.3258		6	6	
1996	0.0983	0.5338	-0.9068	4	3	1
1997	-0.1911	-0.4044	-0.0927	4	2	2
1998	-0.2141	0.0903	-0.4881	3	2	1
1999	-0.1355	0.0215	-0.2861	37	29	8
2000	-0.4407	-0.2870	-0.7188	84	57	27
2001	-0.7881	-0.6002	-0.8387	33	12	21
2002	-0.6992	-0.5707	-0.8883	18	11	7
2003	-0.5608	-0.5608		2	2	
2004	-0.5774	-0.5774		3	3	
2005	-0.1613	-0.1613		5	5	
2006	-1.7156	-1.7156		1	1	

Table 3. (continued)

Panel C: Performance with considering risk with a benchmark using industrial return

	AR_IRR_INDU					
	Mean			Obs		
vintage year	All funds	Non Government-backed funds	Government-backed funds	All funds	Non Government-backed funds	Government-backed funds
1993	-1.8469	-1.8469		1	1	
1994	0.6127	-0.3165	1.0256	2	1	1
1995	-0.6526	-0.6526		6	6	
1996	-0.2184	-0.1676	-0.3356	4	3	1
1997	-0.3180	-0.6752	-0.1531	4	2	2
1998	-0.0112	0.6410	-0.5981	3	2	1
1999	0.2969	0.4146	0.1840	37	29	8
2000	0.4646	0.7970	-0.1369	84	57	27
2001	-0.0528	0.0401	-0.0778	33	12	21
2002	-0.3242	-0.1774	-0.5405	18	11	7
2003	-0.4467	-0.4467		2	2	
2004	0.0085	0.0085		3	3	
2005	-0.0602	-0.0602		5	5	
2006	-0.9990	-0.9990		1	1	

Notably, all of the government-backed VC funds demonstrate underperformance in this case. Panel C, with the AR_IRR_INDU measure, also shows general underperformance of VC funds.

4.2. Performance-Related Characteristics

Similar to the analysis of Kaplan and Schoar (2005), we also analyze the relationship among the fund size, fund sequence and fund performance. Kaplan and Schoar (2005) investigated private fund performance of VC funds and buyout funds, documenting positive relationships between fund size and fund performance and between fund sequence number and fund performance. In addition, their results show that a concave relationship exists between fund size and fund performance. However, the relation between fund sequence number and fund performance takes a convex function. In contrast to their results, our analysis displays a different outcome. For this analysis, we use the base model expressed below.

$$Performance_{it} = \alpha_{it} + \beta \times (FundSize_{it}) + \lambda \times (FundSequence_{it}) + \gamma \times (Gov_{it}) + \varepsilon_{it}$$

We used the log_IRR, the AR_IRR, and the AR_IRR_INDU measure as the dependent variable of Performance. All of these performance measures are log-transformed. We use logarithm of the fund size and the fund sequence number for the independent variables of FundSize and FundSequence. Gov variable was used as a dummy variable to test for the effect of a government investment on the performance of a fund. The indicator i refers to fund i and indicator t indicates the time t. Because the yearly performance variation is large for VC funds, we included a fixed year effect to control for this variation.

Table 4 displays the relationship between the VC fund performance and funds' observable characteristics. Panel A is the result using the log_IRR, and panels B and C are the results using the AR_IRR and the AR_IRR_INDU measures, respectively. The most notable outcome is that while the first panel, which uses the non-risk-adjusted IRR measure, shows that the government dummy variable is insignificant, the second and third panels using the risk-adjusted performance measures show that the government dummy variable has a statistically significant negative value. The values of R-squared increase when using risk-adjusted measures. The analyses with the AR_IRR measure show the highest R-square values. The fourth column in panel A, documents that the size, squared size, sequence and squared sequence have statistically significant influence on the VC fund performance. In the first column, the size variable has a positive relationship, as does the sequence variable, with performance. This result is identical to that of Kaplan and Schoar (2005).

However, panels B and C, which use risk-adjusted performance measures, document different results from panel A. With the AR_IRR and the AR_IRR_INDU measures, the influence of size and squared size disappears. The sequence and squared sequence variables both have a significant influence on performance. The sequence variable shows a significant positive effect, while the squared sequence variable has a negatively significant effect. From these outcomes we can infer that funds with more experience generate better returns. The reason of adding the squared terms of the size and sequence variable in the third and forth columns is to investigate the form of a functional relationship. In panels B and C, when we compare the

Table 4. Venture capital fund performance and related characteristics
Panel A: Performance without considering risk

	log_IRR			
	(1)	(2)	(3)	(4)
log(size)	0.0740	0.0679	1.1154	1.0980
(t-value)	(1.9596)	(1.6693)	(1.9068)	(1.8678)
log(size)^2			-0.0603	-0.0596
(t-value)			(-1.7779)	(-1.7524)
log(sequence)	0.0686	0.0701	0.2985	0.3019
(t-value)	(1.7165	(1.7422)	(2.4420)	(2.4586)
log(sequence)^2			-0.0846	-0.0853
(t-value)			(-1.9517)	(-1.9626)
Government dummy		0.0316		0.0313
(t-value)		(0.4101)		(0.4119)
Year fixed effect	Yes	Yes	Yes	Yes
R-square	0.1649	0.1657	0.1961	0.1968

Panel B: Performance with considering risk with a benchmark using industrial beta

	AR_IRR			
	(1)	(2)	(3)	(4)
log(size)	0.0168	0.0845	0.0711	0.2622
(t-value)	(0.3260)	(1.5688)	(0.0885)	(0.3346)
log(size)^2			-0.0029	-0.0101
(t-value)			(-0.0612)	(-0.2231)
log(sequence)	0.0665	0.0503	0.4140	0.3772
(t-value)	(1.2192)	(0.9456)	(2.4664)	(2.3042)
log(sequence)^2			-0.1300	-0.1220
(t-value)			(-2.1852)	(-2.1050)
Government dummy		-0.3497		-0.3423
(t-value)		(-3.4325)		(-3.3756)
Year fixed effect	Yes	Yes	Yes	Yes
R-square	0.2435	0.2885	0.2626	0.3056

second column, which does not have squared terms, to the fourth column, where we include the squared terms in the model, the significance of the sequence variable changes from non-significant to significant. That is, the sequence variable becomes significantly

Table 4. (continued)
Panel C: Performance with considering risk with a benchmark using industrial return

	AR_IRR_INDU			
	(1)	(2)	(3)	(4)
log(size) (t-value)	-0.0510 (-0.6846)	0.0636 (0.8257)	-0.0164 (-0.0141)	0.3079 (0.2752)
$\log(size)^2$ (t-value)			-0.0016 (-0.0232)	-0.0139 (-0.2146)
log(sequence) (t-value)	0.0459 (0.5823)	0.0186 (0.2443)	0.5618 (2.3168)	0.4994 (2.1369)
$\log(sequence)^2$ (t-value)			-0.1931 (-2.2464)	-0.1795 (-2.1692)
Government dummy (t-value)		-0.5919 (-4.0661)		-0.5808 (-4.0122)
Year fixed effect R-square	Yes 0.1860	Yes 0.2524	Yes 0.2076	Yes 0.2714

positive and the squared sequence variable is significantly negative. These results differ from those of Kaplan and Schoar (2005), in which a positive sequence variable and a positive squared sequence variable are found. We cannot assert that this result derives from the different measures since the sign of squared sequence is also negative when we apply the non-risk-adjusted measure. However, this table gives clear evidence that the influence of size, significant under the non-risk-adjusted measure, is diminished when the risk-adjusted measure is applied in the model.

We should also pay attention to the Government dummy variable in the results. Government dummy variable takes the value of one when the government participate in the investment while takes zero in the other case. This variable changes from statistically non-significant value to significant value when we use performance measure of the AR_IRR or the AR_IRR_INDU instead of the non-risk-adjusted measure, the log_IRR.

5. PERFORMANCE PERSISTENCE AND CASH FLOW

5.1. Performance Persistence of Venture Capital Funds

In this section, we focus on the persistence of VC fund performance. For this analysis, as in the work of Kaplan and Schoar (2005), we include a persistence variable in the base model of the previous section:

$$Performance_{it} = \alpha_{it} + \delta \times (Performance_{it-1}) + \beta \times (FundSize_{it}) + \lambda \times (FundSequence_{it}) + \gamma \times (Gov_{it}) + \varepsilon_{it}$$

The main difference between the work of Kaplan and Schoar (2005) and ours is that we apply risk-adjusted performance measures while Kaplan and Schoar (2005) assume that the beta of private equity funds including VC funds and buyout funds is equal to one. We include not only $\text{Performance}_{\text{it-1}}$ but also $\text{Performance}_{\text{it-2}}$ and $\text{Performance}_{\text{it-3}}$ in the above base model. $\text{Performance}_{\text{it-1,}}$ $\text{Performance}_{\text{it-2,}}$ $\text{Performance}_{\text{it-3}}$ are lagged performances of the first, second, and third previous funds which are set by the same GP with fund i, respectively. We include a fixed year effect to control for yearly variation.

Panel A of table 5 shows the performance of VC funds using the log_IRR, which is the non-risk-adjusted performance measure. Panels B and C report the performance of VC funds using the AR_IRR and the AR_IRR_INDU measures, which are both risk-adjusted measures. It is worth noting that the government dummy variable shows statistically significant negative values in panels B and C, with the risk-adjusted measures, while it is insignificant in panel A, with the non-risk-adjusted performance measure. With the AR_IRR measure, when we include only the performance of the first previous fund, the previous performance variable achieves statistical significance. The coefficient of the previous AR_IRR measure is 0.14 with a significant t-value of 2.28. Even after we add the government dummy variable into the model in column (1), the coefficient of the previous AR_IRR measure is positive and significant; the coefficient is 0.12 with a t-statistic of 2.06. This magnitude of influence is decreased compared to the results with the log_IRR. As panel A illustrates, the coefficient of the previous log_IRR is 0.18 with a

Table 5. Persistence of venture capital fund performance
Panel A: Performance without considering risk

	Dependent varible : log_IRR						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log_IRR_{t-1} (t-value)	0.1781 (3.2243)	0.1780 (3.2134)	0.0626 (0.7229)			0.0406 (0.4637)	0.0413 (0.4690)
log_IRR_{t-2} (t-value)			0.4487 (6.3731)	0.4695 (7.3229)		0.4539 (6.4416)	0.4545 (6.4219)
log_IRR_{t-3} (t-value)					-0.0598 (-1.0241)		
log(size) (t-value)						0.0495 (1.5559)	0.0526 (1.5605)
log(sequence) (t-value)						0.0079 (0.1465)	0.0080 (0.1472)
Government dummy (t-value)		0.0256 (0.4358)					-0.0180 (-0.2902)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.1547	0.1557	0.3812	0.3784	0.1750	0.3945	0.3949

Panel B: Performance with considering risk with a benchmark using industrial beta

	Dependent varible : AR_IRR						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
AR_IRR_{t-1} (t-value)	0.1387 (2.2807)	0.1207 (2.0623)	0.0647 (0.6969)			0.0599 (0.6340)	0.0514 (0.5706)
AR_IRR_{t-2} (t-value)			0.2249 (2.9133)	0.2370 (3.1564)		0.2224 (2.8455)	0.2507 (3.3487)
AR_IRR_{t-3} (t-value)					-0.0891 (-1.2608)		
log(size) (t-value)						0.0012 (0.0231)	0.0654 (1.2236)
log(sequence) (t-value)						-0.0354 (-0.3840)	-0.0313 (-0.3564)
Government dummy (t-value)		-0.3126 (-3.7744)					-0.3581 (-3.5883)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.2750	0.3379	0.2845	0.2816	0.2587	0.2854	0.3574

Table 5. (continued)

Panel C: Performance with considering risk with a benchmark using industrial return

	Dependent varible : AR_IRR_INDU						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
AR_IRR_indu$_{t-1}$ (t-value)	0.0641 (0.8569)	0.0245 (0.3424)	0.0862 (0.9361)			0.0738 (0.7967)	0.0246 (0.2720)
AR_IRR_indu$_{t-2}$ (t-value)			0.1238 (1.5153)	0.1322 (1.6297)		0.1280 (1.5638)	0.1075 (1.3585)
AR_IRR_indu$_{t-3}$ (t-value)					0.0497 (0.6414)		
log(size) (t-value)						-0.1145 (-1.2846)	-0.0171 (-0.1880)
log(sequence) (t-value)						-0.1050 (-0.6814)	-0.1152 (-0.7758)
Government dummy (t-value)		-0.5728 (-4.1857)					-0.5452 (-3.1637)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.2238	0.3050	0.2163	0.2105	0.2057	0.2320	0.2935

t-statistic of 3.22 without the government dummy variable; it is 0.18 with a t-statistic of 3.21 with the government dummy variable.

This table exhibits that the performance of the second previous fund is related to the performance of the current fund. Notably, when we add the second previous fund performance variable into the model in column (1), the first previous fund performance variable loses its significant influence. Using the AR_IRR measure, column (3) shows that the coefficient of the second previous AR_IRR measure is 0.22 with a t-statistic of 2.91, while the coefficient of the first previous AR_IRR measure is 0.06 with a t-statistic of 0.70. Using the log_IRR, column (3) shows that the coefficient of the second previous log_IRR is 0.45 with a t-statistic of 6.37, while the coefficient of the first previous log_IRR becomes 0.06 with a t-statistic of 0.72. We also find that the coefficient of the second previous performance in column (3) decreases from 0.45 to 0.22 when we change our performance measure from the log_IRR to the AR_IRR. This implies that the influence of the previous fund performance is overstated with the non-risk-adjusted performance measure. When we test for the performance persistence of the third previous funds, we find that it does not show a relationship with the performance of the current funds. Overall, the results show that performance of the first previous fund unrelated to the performance of the current fund, while the performance of the second previous fund has a positive relationship with the performance of the current fund. In columns (6) and (7), we control for the size and the sequence of funds, and this inclusion increases the R-square values. When we add control variables, the results still hold. The performance of the first previous fund loses its significance while the second previous performance retains its significant influence on the performance of the current fund. With the AR_IRR measure, the government dummy variable in column (7) is -0.36 with a t-statistic of -3.59. This reflects that a fund with government involvement has lower performance than a fund which raised no committed capital from the government. Using the AR_IRR_INDU measure, the significance of the performance of the second previous fund is even lower than when using the AR_IRR measure. The coefficient of the performance of the second previous fund in column (7) using the AR_IRR_INDU measure is smaller than that using the AR_IRR measure at 0.11 versus 0.25. The government dummy variable also has negative significance in column (7) when using the AR_IRR_INDU measure.

5.2. VC Fund Performance and Cash Flow

In this section, we investigate how the previous fund performance affects the cash flow into the subsequent fund. To examine this relationship, we employ Tobit regression analysis with the logarithm of the fund size as the dependent variable. The performance of the first previous fund and the second previous fund, the squared terms of both, the logarithm of the previous fund size, and the logarithm of sequence number serve as independent variables. Whether the fund received government investment or not is used as a dummy variable.

Table 6 presents the results. Panels A, B, and C show the results of the Tobit regressions using the log_IRR, the AR_IRR, and the AR_IRR_INDU, respectively. According to these results, the most influential factor is the size of the previous fund. That is, the size of the prior fund has a significant positive influence on the size of the current fund. In general, the previous performance and its squared terms do not appear to have a significant influence on the size of

Table 6. Performance and fund size

Panel A: Performance without considering risk

	Dependent varible : log(size)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log_IRR_{t-1}	0.0533	0.0193	0.0294	0.0667	0.0858	0.5722	0.5596	0.3071
(t-value)	(0.3525)	(0.1303)	(0.2114)	(0.3797)	(0.5200)	(1.8713)	(1.3813)	(0.7846)
log_IRR_{t-2}						-0.2469	-0.4416	-0.3571
(t-value)						(-1.2732)	(-2.1495)	(-1.8157)
$log\_IRR_{t-1}^{2}$				0.0383	0.0455		-0.2954	-0.0838
(t-value)				(0.5024)	(0.6358)		(-0.8799)	(-0.2584)
$log\_IRR_{t-2}^{2}$							-0.1927	-0.2019
(t-value)							(-1.9889)	(-2.1909)
log(lagsize)		0.2042	0.1923	0.2143	0.2042	0.2673	0.2458	0.2257
(t-value)		(2.7321)	(2.7390)	(2.7710)	(2.8137)	(3.1088)	(2.9413)	(2.8338)
log(sequence)	0.1263	0.1104	0.0921	0.1183	0.1014	0.2944	0.2213	0.1855
(t-value)	(1.2113)	(1.0827)	(0.9612)	(1.1471)	(1.0472)	(2.1153)	(1.6191)	(1.4239)
Government dummy			0.5924		0.5942			0.5287
(t-value)			(4.5896)		(4.6083)			(3.6458)

Table 6. (continued)

Panel B: Performance with considering risk with a benchmark using industrial beta

	Dependent varible : log(size)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AR_IRR_{t-1}	-0.1486	-0.1430	-0.0699	-0.1395	-0.0550	-0.0694	-0.1123	-0.0420
(t-value)	(-1.4856)	(-1.4639)	(-0.7456)	(-1.2668)	(-0.5206)	(-0.4105)	(-0.6734)	(-0.2647)
AR_IRR_{t-2}						-0.0846	-0.1740	-0.1894
(t-value)						(-0.6758)	(-1.3705)	(-1.5768)
$AR\_IRR_{t-1}^2$				0.0035	0.0143		0.0028	0.0136
(t-value)				(0.0698)	(0.3043)		(0.0170)	(0.0860)
$AR\_IRR_{t-2}^2$							-0.1610	-0.1404
(t-value)							(-2.9358)	(-2.6925)
log(lagsize)		0.2028	0.1928	0.2043	0.1989	0.2441	0.2266	0.2079
(t-value)		(2.7405)	(2.7601)	(2.6508)	(2.7366)	(2.7744)	(2.6540)	(2.5704)
log(sequence)	0.1186	0.1007	0.0894	0.1022	0.0957	0.2380	0.1625	0.1401
(t-value)	(1.1497)	(0.9966)	(0.9377)	(0.9885)	(0.9812)	(1.5899)	(1.1055)	(1.0064)
Government dummy			0.5746		0.5767			0.5549
(t-value)			(4.3882)		(4.3994)			(3.8467)

Table 6. (continued)

Panel C: Performance with considering risk with a benchmark using industrial return

	Dependent varible : log(size)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$AR\_IRR\_INDU_{t-1}$	-0.0751	-0.0511	0.0003	-0.0318	0.0023	-0.0381	0.0359	0.0870
(t-value)	(-1.0594)	(-0.7310)	(0.0050)	(-0.4145)	(0.0316)	(-0.4424)	(0.3250)	(0.8303)
$AR\_IRR\_INDU_{t-2}$						0.0712	0.1132	0.1148
(t-value)						(0.9098)	(1.3663)	(1.4733)
$AR\_IRR\_INDU_{-1}^{2}$				-0.0274	-0.0029		-0.0566	-0.0477
(t-value)				(-0.6122)	(-0.0687)		(-0.8907)	(-0.7989)
$AR\_IRR\_INDU_{t-2}^{2}$							-0.0518	-0.0461
(t-value)							(-1.0709)	(-1.0138)
log(lagsize)		0.1979	0.1936	0.1904	0.1928	0.2498	0.2414	0.2268
(t-value)		(2.6390)	(2.7451)	(2.5095)	(2.6986)	(2.8337)	(2.7551)	(2.7497)
log(sequence)	0.1330	0.1142	0.0943	0.1083	0.0937	0.2816	0.2570	0.2281
(t-value)	(1.2876)	(1.1277)	(0.9896)	(1.0656)	(0.9794)	(1.9854)	(1.8167)	(1.7118)
Government dummy			0.5921		0.5909			0.5999
t-value			(4.5198)		(4.4734)			(4.0403)

the current fund. The performance of the second previous fund has a negatively significant influence with a coefficient of -0.36 when we use the log_IRR, the non-risk-adjusted performance measure, while it shows a marginally significant influence with a decreased coefficient of -0.19 and a t-statistic of -1.58 when using the AR_IRR and with a coefficient of 0.11 and a t-statistic of 1.47 when using the AR_IRR_INDU measure. The squared term of the performance of the second previous fund reduces its negatively significant influence from -0.20 to -0.14 when we apply the AR_IRR measure instead of the log_IRR measure. The negative influence of this variable makes us infer that these results ensued because in Korea, GPs raise subsequent VC funds relatively frequently. Therefore, it takes some time for investors to learn about the performance of the preceding funds. In other words, when LPs invest in the first subsequent fund, they do not have precise information on the performance of the previous fund. This may have led to a lack of a significant relation between the current fund size and the previous fund performance. Using the AR_IRR measure, the relationship between the current fund size and the performance of the second previous fund is negative and convex, which, however, indicates marginal significance. This suggests that a fund with a high volatility of performance is not so preferred by investors that the cash flow towards the subsequent fund decreases. These results are different from those of the Kaplan and Schoar (2005) in that they report a positive and concave relationship between previous performance and the size of the subsequent fund. It is also different from the general outcome with mutual funds, which displays a positive and convex relationship between previous performance and the size of the subsequent fund. Regarding the relationship between government investment and fund size, the government dummy variable has a significant positive value. This outcome suggests that the size of government-backed VC funds is larger than that of non-government-backed VC funds.

6. THE ENTRANCE OF NEW VENTURE CAPITAL COMPANIES

In this section, we investigate the relationship between the public market situation and the competition in the VC industry and the relationship between the competition in the VC industry and the performance of VC funds.

For these analyses, we use data pertaining the amount of investments from newly raised VC companies from 1998 to 2007 and the number of new VC companies established from 1987 to 2007. We also use information on the yearly returns of the KOSPI index from 1987 to 2007 and the KOSDAQ index from 1997 to 2007.[11] VC returns on liquidated funds from 1999 to 2007 is collected from the Yearbook provided by the Korean Venture Capital Association. We obtained these data from the Korean Venture Capital Association and the Small and Medium Business Administration.

6.1. The Entrance of New Venture Capital Companies and the Market Situation

Table 7 exhibits the market environment when a new VC company enters the venture capital market. The left part of the table represents the relationship between the market situation and the number of newly established VC companies. The right part of the table shows the relationship between the market situation and the increased size of VC funds having come from the newly entered VC companies, which indicates the relationship between the market situation and cash inflows into VC funds. The dependent variable for the left side is the logarithm of the number of new VC companies while the dependent variable for the right side is the logarithm of the cash inflows from new VC companies. The first and second columns show that the previous market returns on the KOSPI market and the KOSDAQ market strongly affect the number of newly established VC companies. When a bull market existed in previous year, the number of new VC companies increases. Furthermore, the influence of the KOSDAQ market is stronger than that of the KOSPI market, with a coefficient of 22.11 versus 15.62. We can infer that this result comes from that VC companies usually invest in small businesses, and small businesses are usually listed on the KOSDAQ market. In addition, if we consider the fact that the VC companies in Korea

11) The KOSPI, the Korea Composite Stock Price Index, is the index of all common stocks of the Korea Stock Exchange market. The KOSDAQ index, the Korean Securities Dealers Automated Quotation index, is the index of all common stocks of the KOSDAQ market, which is the secondary stock market of Korea. Therefore, the KOSPI market is the Korean version of the NYSE market and the KOSDAQ market is the Korean version of the NASDAQ market.

Table 7. Timing of the entrance of new VC companies

	Number of new VC companies			Fundsize from new VC companies		
	(1)	(2)	(3)	(4)	(5)	(6)
$KOSPI_t$ (t-value)	-13.2965 (-1.7334)			0.2157 (0.1499)		
$KOSPI_{t-1}$ (t-value)	15.6160 (2.1077)			2.4718 (2.0610)		
$KOSDAQ_t$ (t-value)		7.7209 (1.7121)			1.1338 (3.4525)	
$KOSDAQ_{t-1}$ (t-value)		22.1092 (4.9532)			1.5798 (4.9686)	
$VCreturn_t$ (t-value)			152.6397 (0.7075)			-14.0212 (-0.3034)
$VCreturn_{t-1}$ (t-value)			24.9253 (0.1188)			29.0907 (0.4901)
R-square	0.2624	0.7825	0.1221	0.5720	0.8661	0.1399

mainly retrieve their investments through IPOs rather than M&As, this result in which the circumstances of the KOSDAQ market strongly affect the venture capital market appears feasible. The third column shows that the situation of the VC industry of the current and previous years does not have a significant influence on the number of new VC companies. Ku (2009) argues that one of the reasons for this result is that the sample period is not sufficiently long. Moreover, he argues that because the VC return variable, indicating the situation of the VC industry, is the averaged value for five years, it may not be directly related to the number of companies on a yearly basis. Columns (4)-(6) show that returns on the KOSPI and KOSDAQ markets have a positive influence on the cash inflows into the venture capital market from new VC companies. In short, when the previous year experienced a bull market, especially when the KOSDAQ market was a robust market, more VC companies are established and more cash flow come from new VC companies. These outcomes are consistent with those of Kaplan and Schoar (2005).

6.2. The Entrance of New Venture Capital Funds and the Fund Performance

In this subsection, we investigate whether the market situation of the year a fund was raised, was bear or bull, has a different effect on the fund performance. For this analysis, we employ logit regression, following the methodology of Kaplan and Schoar (2005). Kaplan and Schoar (2005) show that private funds raised during a brisk year have a high probability of not being able to raise the subsequent funds due to poor performance. The dependent variable is 1 if the subsequent fund exists and 0 if the subsequent fund does not exist. The market returns for the corresponding year and the year before the fund was raised and the market return for three years after the fund was raised are used as independent variables. The logarithm of the fund sequence and the logarithm of the fund size are used as control variables.

In table 8, we find out how the market situations affect the probability of raising the subsequent VC funding. The first column shows that if the public market, the KOSPI market, is a bull market, the probability of raising the subsequent fund increases. The second column shows that if the market situation after 3 years is a bull market, it is less likely that the subsequent funding will be raised. This pattern is consistent in columns (4) and (5), where the KOSDAQ market returns are used as independent variables. The third and the sixth columns are results with a sample using only the initially formed funds. They show the same pattern, although some variables take statistically insignificant values. The market return three years later is added for a comparison with the results of Kaplan and Schoar (2005). They add the t+3 market return because GPs generally raise subsequent funds three years later after the initial funding was raised. Our results are precisely opposite to those of Kaplan and Schoar (2005). Presenting a significant negative relationship between the market returns and the probability of raising subsequent funds, and a positive relationship between the market return three years later and the probability of raising subsequent funds, they argue that raising subsequent funds can be used as a proxy for fund performance. Unlike their outcomes, our results indicate that whether a fund can raise subsequent funds does not represent the performance of the fund.

Table 8. Probability of the formation of following funds

	Probability of making a following VC fund					
	(1)	(2)	(3)	(4)	(5)	(6)
$KOSPI_t$ (p-value)	0.8102 (0.0807)	0.5395 (0.3073)	0.5532 (0.5573)			
$KOSPI_{t-1}$ (p-value)	0.6091 (0.1204)	0.7068 (0.0892)	1.6546 (0.0268)			
$KOSPI_{t+3}$ (p-value)		-1.3402 (0.0410)	-3.3401 (0.0180)			
$KOSDAQ_t$ (p-value)				0.8573 (0.0248)	0.6423 (0.0894)	0.3810 (0.4126)
$KOSDAQ_{t-1}$ (p-value)				0.3516 (0.0771)	0.3116 (0.1155)	0.3697 (0.1849)
$KOSDAQ_{t+3}$ (p-value)					-0.7207 (0.1165)	-1.5964 (0.1566)
log(sequence) (p-value)	0.2190 (0.3905)	0.3584 (0.1800)		0.3408 (0.2030)	0.4317 (0.1173)	
log(size) (p-value)	0.4317 (0.0142)	0.4449 (0.0124)	0.4183 (0.2421)	0.4159 (0.0199)	0.4130 (0.0221)	0.2195 (0.5140)

In table 9, we illustrate the VC fund performance according to the number of VC companies or the number of VC funds. For this analysis, we use the IRRs of VC funds that existed for more than 5 years in the Yearbook provided by the Korean Venture Capital Association. We define the independent variables as the logarithm of the number of VC companies per year and the logarithm of the number of VC funds per year. We find that when there are numerous VC companies or large number of VC funds, the VC funds yield poor performance. The coefficient of the variable of the log of the number of VC companies is -0.05 with a t-statistic of -2.53. For the variable of the log of the number of VC funds, it is -0.04 with a t-statistic of -3.65. This suggests that the VC fund performance deteriorates when the VC market is competitive.

In table 10, following the method of Kaplan and Schoar (2005) and Ku (2009), we test whether the number of newly raised VC funds has an influence on the overall VC industry. For this analysis, we control for the fund size, fund sequence and public market situation, add a government dummy, and then regress the

Table 9. VC fund performance and VC industry circumstances

	Dependent variable: IRR of VC funds existing more than 5 years	
log(number of VC companies) (t-value)	-0.0501 (-2.5258)	
log(number of VC funds) (t-value)		-0.0416 (-3.6451)
R-square	0.5153	0.5962

performance measures of log_IRR, AR_IRR, and AR_IRR_INDU on the logarithm of the number of new VC funds on a yearly basis. In columns (3) through (6), we add an interaction term between the logarithm of the number of new VC funds and the logarithm of the sequence number of the corresponding fund. We add this term to examine the performance differences between younger funds and older funds. If the coefficient on this variable has a positive value, this suggests that the older funds are relatively less affected by the number of new raised VC funds. In columns (5) through (6), we include a government dummy variable to control for the influence of the participation of the government in VC funds as an LP (Limited Partner). The log_IRR, AR_IRR, and AR_IRR_INDU measures are used as dependent variables in panels A, B, and C, respectively. We show results for all VC funds on the left side of each panel and for long-term funds on the right side of each panel. We obtain the results in which the statistical significance of each variable increases in the analysis using long-term funds which existed more than 5 years. Kaplan and Schoar (2005) show that the number of new private equity funds makes the private equity industry deteriorate and that the interaction term has a significant positive coefficient. In contrast, Ku (2009) reports that the interaction term has a statistically insignificant value while the point estimate of the logarithm of the number of new VC funds takes a statistically significant negative value. Given that both of these prior studies use a traditional fund performance measure which does not take into account the risks in private equity funds, the differences in both studies may be driven by their use of a less accurate measure or by the use of data suffering from selection bias due to voluntary report systems. Therefore, we conduct the same analyses using our risk-adjusted performance measures with our unique reliable data.

Table 10. Fund performance and the timing of entrance

Panel A: log IRR

	Dependent variable: log_ IRR											
	All funds						equal or more than 5 years					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Entry	-0.0430	-0.0457	-0.0533	-0.0487	-0.0545	-0.0486	-0.0749	-0.0960	-0.1357	-0.2565	-0.1375	-0.2525
(t-value)	(-1.3815)	(-1.1383)	(-1.0667)	(-0.7378)	(-1.0867)	(-0.7353)	(-2.0573)	(-1.5269)	(-2.1883)	(-2.1895)	(-2.2060)	(-2.1382)
Entry*log (sequence)			0.0086	0.0022	0.0085	0.0015			0.0543	0.1052	0.0546	0.1036
(t-value)			(0.2632)	(0.0585)	(0.2608)	(0.0390)			(1.2101)	(1.6200)	(1.2120)	(1.5863)
log (sequence)	0.0763	0.0859	0.0465	0.0779	0.0473	0.0824	0.0826	0.0809	-0.1174	-0.3266	-0.1178	-0.3191
(t-value)	(2.0714)	(2.1411)	(0.3909)	(0.5468)	(0.3961)	(0.5767)	(2.0460)	(1.8019)	(-0.6900)	(-1.2786)	(-0.6905)	(-1.2408)
log(size)	0.0732	0.0765	0.0727	0.0765	0.0675	0.0655	0.1515	0.1690	0.1467	0.1607	0.1402	0.1543
(t-value)	(2.0352)	(1.9416)	(2.0163)	(1.9365)	(1.7358)	(1.5167)	(3.5262)	(3.5213)	(3.4026)	(3.3479)	(3.0586)	(2.9886)
$KOSPI_t$	0.1826		0.1831		0.1816		0.1184		0.1239		0.1220	
(t-value)	(2.7687)		(2.7688)		(2.7354)		(1.6787)		(1.7546)		(1.7207)	
$KOSDAQ_t$		0.0818		0.0818		0.0823		0.0474		0.0411		0.0420
(t-value)		(2.7246)		(2.7116)		(2.7225)		(1.3918)		(1.2058)		(1.2242)
government dummy					0.0264	0.0510					0.0315	0.0290
(t-value)					(0.3622)	(0.6370)					(0.4249)	(0.3481)
R-square	0.0999	0.0970	0.1002	0.0970	0.1008	0.0991	0.1610	0.1591	0.1687	0.1745	0.1696	0.1752

Table 10. (continued)

Panel B: AR_IRR

	Dependent variable: AR_IRR											
	All funds						equal or more than 5 years					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Entry	-0.0375	0.0489	-0.1172	0.0146	-0.0955	0.0140	-0.1165	0.0651	-0.3053	-0.1656	-0.2834	-0.2131
(t-value)	(-0.8296)	(0.9105)	(-1.6225)	(0.1650)	(-1.3842)	(0.1641)	(-2.2948)	(0.8150)	(-3.5967)	(-1.1149)	(-3.4922)	(-1.4801)
Entry*log (sequence)			0.0665	0.0248	0.0676	0.0306			0.1687	0.1512	0.1658	0.1702
(t-value)			(1.4125)	(0.4897)	(1.5058)	(0.6289)			(2.7451)	(1.8370)	(2.8275)	(2.1376)
log(sequence)	-0.0063	0.0547	-0.2376	-0.0349	-0.2503	-0.0707	-0.0048	0.0573	-0.6258	-0.5285	-0.6209	-0.6175
(t-value)	(-0.1173)	(1.0179)	(-1.3793)	(-0.1830)	(-1.5253)	(-0.3851)	(-0.0858)	(1.0039)	(-2.6877)	(-1.6319)	(-2.7949)	(-1.9688)
log(size)	0.0019	-0.0331	-0.0015	-0.0330	0.0891	0.0547	0.0897	0.0795	0.0746	0.0675	0.1555	0.1441
(t-value)	(0.0361)	(-0.6272)	(-0.0282)	(-0.6244)	(1.6658)	(0.9861)	(1.4976)	(1.3026)	(1.2644)	(1.1096)	(2.6053)	(2.2884)
$KOSPI_t$	0.3206		0.3246		0.3502		0.2327		0.2496		0.2726	
(t-value)	(3.3442)		(3.3934)		(3.8350)		(2.3651)		(2.5827)		(2.9516)	
$KOSDAQ_t$		0.2185		0.2176		0.2137		0.2008		0.1917		0.1814
(t-value)		(5.4323)		(5.3928)		(5.5046)		(4.6367)		(4.4351)		(4.3369)
government dummy					-0.4602	-0.4065					-0.3931	-0.3430
(t-value)					(-4.5849)	(-3.9506)					(-4.0710)	(-3.3779)
R-square	0.0746	0.1479	0.0838	0.1491	0.1726	0.2173	0.1097	0.1485	0.1502	0.1684	0.2313	0.2310

Table 10. (continued)
Panel C: AR_IRR_INDU

	Dependent variable: AR_IRR_INDU											
	All funds						equal or more than 5 years					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Entry	0.2371	0.1959	0.1959	0.1619	0.2220	0.1608	0.2872	0.3065	0.1845	0.2160	0.2144	0.1140
(t-value)	(3.7725)	(2.5212)	(1.9439)	(1.2660)	(2.2757)	(1.3370)	(3.8332)	(2.4925)	(1.4435)	(0.9351)	(1.7391)	(0.5285)
Entry*log (sequence)			0.0344	0.0246	0.0357	0.0349			0.0918	0.0593	0.0879	0.1001
(t-value)			(0.5239)	(0.3352)	(0.5622)	(0.5068)			(0.9928)	(0.4628)	(0.9865)	(0.8394)
log(sequence)	0.0216	0.0222	-0.0981	-0.0665	-0.1135	-0.1301	0.0026	0.0207	-0.3355	-0.2089	-0.3288	-0.3998
(t-value)	(0.2899)	(0.2860)	(-0.4082)	(-0.2410)	(-0.4888)	(-0.5007)	(0.0315)	(0.2364)	(-0.9570)	(-0.4146)	(-0.9742)	(-0.8514)
log(size)	-0.1108	-0.1016	-0.1125	-0.1015	-0.0035	0.0541	-0.0128	0.0017	-0.0211	-0.0030	0.0898	0.1613
(t-value)	(-1.5258)	(-1.3321)	(-1.5453)	(-1.3278)	(-0.0466)	(0.6900)	(-0.1452)	(0.0181)	(-0.2375)	(-0.0316)	(0.9904)	(1.7110)
$KOSPI_t$	0.1021		0.1042		0.1349		0.1885		0.1977		0.2293	
(t-value)	(0.7665)		(0.7804)		(1.0447)		(1.2984)		(1.3588)		(1.6341)	
$KOSDAQ_t$		0.0507		0.0498		0.0429		0.1065		0.1030		0.0808
(t-value)		(0.8718)		(0.8534)		(0.7806)		(1.5988)		(1.5311)		(1.2904)
government dummy					-0.5536	-0.7217					-0.5387	-0.7363
(t-value)					(-3.8999)	(-4.9578)					(-3.6725)	(-4.8426)
R-square	0.0808	0.0416	0.0821	0.0422	0.1482	0.1578	0.0874	0.0455	0.0931	0.0470	0.1648	0.1837

While panel A in table 10 exhibits the outcomes of adopting the non-risk-adjusted log_IRR as the performance measure, panels B and C show the results when applying the AR_IRR and the AR_IRR_INDU, our risk-adjusted performance measures. When we include all VC funds for our test, the left side of panel B shows that the estimates of the Entry variable, the logarithm of the number of new VC funds, and the interaction term between the Entry variable and the logarithm of the sequence number of a fund have statistically insignificant values. However, when we exclude funds that existed for less than five years in our sample, most of the variables obtain the statistical significance except when the AR_IRR_INDU measure is used. Comparing the outcomes of panel A and panel B, which use the log_IRR and the AR_IRR, respectively, the Entry variable takes more statistically significant values than the interaction term of the Entry variable and logarithm of the sequence number of a fund in panel A, which is opposite in panel B. More specifically, columns (5) and (6) demonstrate that the number of newly raised VC funds decreases the performance of the VC industry; in panel A, the Entry variable is -0.25 with t-value of -2.14, and in panel B, this negative influence decreases to -0.21 with t-value of -1.48. The coefficient of the interaction term between the Entry variable and the logarithm of the sequence number of a fund is positive and significant; the coefficient of this term is 0.10 with t-value of 1.58 in panel A, and it increases to 0.17 with t-value of 2.14. This suggests that older funds are less affected by the competition driven by the increase in new funds compared to younger funds in the venture capital market.

7. CONCLUSION

In this paper, we conduct comprehensive investigation on the performance of VC funds by comparing the results using a traditional measure to those using our new measures. Given the nature of the asset class of private equity, the lack of available data serves as a hurdle for detailed analyses. One of the challenges is to consider risk when calculating the performance of private equity funds. In the present paper, using a detailed dataset reported by the companies on the mandatory basis, we construct new measures taking risk into account.

We show that there exist discrepancies in results using risk-adjusted and non-risk-adjusted measures. Using the new measures, we also find that VC funds which receive an investment by the government perform worse than those that do not. We also observe that short-term VC funds outperform long-term VC funds, which does not appear in the test using the non-risk-adjusted measure. To investigate key factors that affect fund performance, we test the effect of the fund size and the fund sequence. Regarding the size, when we do not consider risk, size affects the performance significantly. However, when reflecting risk, the size does not affect performance. As for the fund sequence, it clearly affects the performance. Regarding the persistence of fund performance, the performance of the second previous fund has a significantly positive influence on the performance of the current fund. After examining the results of new VC fund raisings and the relevant factors, evidence tells us that if the previous public market has experienced a bull market, the number of new VC companies and cash inflow from these companies increase while the number of newly raised VC funds has a negative impact on the VC industry.

Overall, we find that there are significant differences in performance results depending on whether we use a risk-adjusted or a non-risk-adjusted performance measure. This finding requires further research into the question of risk adjustment when studying the performance of venture capital funds.

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