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Benchmarking Venture Investment and Korean Venture Capital Industry*

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— Abstract —

This paper studies the issues pertaining to the benchmarking and monitoring of the performance of private venture funds. In particular, this paper attempts to estimate expected return and associated risk involved in venture investment, along with the correlation with the comparable public market indices, which are key input in assessing the value of venture investment as an alternative asset class. In addition, relative benchmarks such as Quartile-*IRR* benchmark and public market equivalent *IRR* (*PME-IRR*) benchmark for different vintages are computed to examine the potential usefulness of such benchmarks in the Korean venture market. The data consist of 374 liquidated Korean venture funds collected for over the last two decades by the Korea Venture Investment Corporation. Despite the limited size of the data, the empirical results may shed some lights to sponsors like pension fund managers and fund of funds managers on how to interpret and monitor the performance of venture funds and the venture companies.

Keywords : Benchmark, Expected Return, Internal Rate of Return (*IRR*), *J*-Curve, Public Market Equivalent (*PME*), Venture Capita

JEL Classification Number : G24, G11

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Ⅰ. Introduction

Rises and falls of the venture capital markets during early 2000 worldwide have brought an opportunity and anxiety to investors who have regarded venture investment as an alternative asset class. The Korean venture capital market was no exception and the publicly traded market, called KOSDAQ which constitutes a counterpart to NASDAQ in the U.S., has risen by 240.7 per cent in 1999 and fell by 79.47 per cent in 2000. Considering the fact that the average return and risk in this market during the 1998～2007 period were, respectively, 21.0 per cent and 88.9 per cent, years 1999 and 2000 have marked indeed a remarkable boom and burst. Those who are not listed in the KOSDAQ market are expected to have experienced similar ups and downs.

Nevertheless, the size of the Korean venture capital industry has been growing steadily since 1999. In 2007, the total venture capital funds newly raised in the market has recorded almost one trillion Wons (approximately USD 1 billion) and 67 per cent of those are raised by KVIC-backed funds.[1] The KVIC's share of commitment into such funds is more than 25 per cent, which is large enough to make the company a leading partner. Using this market power, KVIC is in a position to collect the information on all liquidated private venture funds since 1987.

Surprisingly, however, little has been known in the literature about the nature of risk and return and the performance of private venture investment in the Korean market.[2] For instance, the National Pension Service (2008) simply sets the benchmark for the domestic private equity investment as the sum of the domestic benchmark stock return and the risk premium, the latter of which is derived from the assumption that the Sharpe ratios are equal across the asset classes. In their calculation, the volatility of the private equity is measured by that of the KOSDAQ index, but the appropriateness of this approximation does not appear to be formally tested based upon the actual VC investments.

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1) Korean Venture Investment Corporation (KVIC) is the government-sponsored fund of funds similar to the case of EU's EIF or Singapore's TIF.

2) Cochrane (2001) analyzes the VentureOne database and Chen et al. (2002) examines the Venture Economics database to study the characteristics of the venture investment in the U.S. Similarly, the Venture Capital Association in Europe publishes the database. In Korea, however, there has not been such database that can be accessed by the researchers.

The purpose of this paper is, therefore, to examine the unique dataset compiled by the KVIC. By doing so, it is expected to unveil the risk-return profile of the venture market, and possibly to propose relevant benchmarks that would help to assess the performance of venture capital investment in Korea. The main empirical methods include the internal rate of return (*IRR*), which has been a traditional measure of performance in the industry, and the single index model proposed by Chen et al. (2002).

This paper is organized as follows: Section 2 introduces benchmarking methods and a single index model that would allow measuring expected returns and risks of venture investment. Section 3 provides empirical results on the maximum likelihood estimation of the single index model, Quartile-*IRR* benchmark and *PME-IRR* benchmark. Section 4 discusses the quartile persistence of fund performance and section 5 illustrates how to apply benchmarks in monitoring the performance of on-going venture funds. Section 6 summarizes and concludes the paper.

Ⅱ. Methods

This section introduces the Chen et al. (2002) single index model and two relative private equity benchmarks studied in this paper, namely, one based upon the observed net cash flows and the other upon the scaled net cash flows, the scaling parameter of which is drawn from the public equity market.

1. Venture Capital as an Alternative Asset Class

Benchmarking the returns to venture investment is an important issue to both pension funds managers who seek for an opportunity to invest on the alternative asset class and fund of funds managers who seek for additional funding opportunity from them. The availability of the benchmark risk-return profile would help the sponsor to figure out the potential of the enhanced investment opportunity by drawing the efficient frontier inclusive of expected returns and risks from the venture investment.

Woodward and Hall (2003) proposed the method of constructing a value-weighted

total return index for all venture-backed companies. They use information such as valuations revealed in episodic transactions in the companies' shares and estimated value for un-reported-value rounds. Since the KVIC database does not include the information at the venture-backed company level, this paper adopts the method proposed by Chen et al. (2002). Their approach is to calculate the expected returns and risks based upon a single index model.[3] The Chen et al. model can be summarized as follows:

Let $C_{draw}(t_i, \tau_j)$ denote the observed drawdown (takedown or cash in) of the private equity investment i of market vintage t_i at time $t_i + \tau_j$. The subscript j $(0 \leq j \leq J_i - 1)$ represents the number of cash flow observation dates. Similarly, let $C_{dist}(t_i, \tau_j)$ denote the observed distribution (or cash out) of the private equity investment i of market vintage t_i at time $t_i + \tau_j$, $0 \leq j \leq J_i - 1$. Then the terminal internal rate of return for the private equity investment i of market vintage t_i, $irr(t_i)$, is defined as

$$\sum_{j=0}^{J_i-1} exp(-IRR(t_i) \times \tau_j)(C_{dist}(t_i, \tau_j) - C_{draw}(t_i, \tau_j)) = 0 \quad (1)$$

Or equivalently, one can interpret this equation as the initial investment on the private equity i, denoted by V_{t_i} and is normalized to be 1, would grow at a rate of IRR to yield the terminal value of $V_{t_i+m_i}$. Namely, denoting the maturity in years of venture investment i as m_i, the terminal value may be written

$$V_{t_i+m_i} = V_{t_i}(1 + IRR(t_i))^{m_i} \quad (2)$$

Thus, $V_{t_i+m_i}$ is interpreted as the cumulative return. Assume that the distribution of the cumulative return is lognormal. The single index model is then to relate logarithmic return of each venture investment i to logarithmic return of the stock market during the same time period as the private equity i, denoted $ln(M_i)$ $(\equiv ln(M_{t_i+m_i}/M_{t_i}))$.

$$ln(V_{t_i+m_i}) = \beta\, ln(M_i) + \epsilon_i \quad (3)$$

3) See, also, Cochrane (2001) for an alternate approach to estimating the risk and return of venture capital. He employs the parametric approach that explicitly corrects for the potential selection bias.

The residual return ϵ_i is assumed to yield the venture fund-specific annual expected return of α along with an idiosyncratic risk σ and is distributed as

$$\epsilon_i \sim N(\alpha m_i, \sigma^2 m_i) \tag{4}$$

The covariance structure between all distinct pairs of venture funds is specified by the annual correlation of the residual returns, ρ, and the coexistence time of the two funds i and j, m_{ij}.

$$Cov(\epsilon_i, \epsilon_j) = \sigma^2 \Omega$$
$$\Omega = \begin{cases} \rho m_{ij} \ if \ i \neq j \\ m_i \quad otherwise \end{cases}$$

Hence the log likelihood function can be formulated using Eq. (4) and is maximized with respect to unknown parameters $\theta = (\alpha, \beta, \sigma^2, \rho)$.

Using these estimates and the average and standard deviation of the logarithmic annual market return, the logarithmic annual expected return, ER_L, and standard deviation, SD_L, of venture investment can be calculated by setting the maturity m_i in Eq. (4) equal to 1 year.

$$ER_L = \alpha + \beta \times ER_{L,\,Market} \tag{5}$$
$$SD_L^2 = \beta^2 \times SD_{L,Market}^2 + \sigma^2 \tag{6}$$

$ER_{L,Market}$ and $SD_{L,Market}^2$ are, respectively, the annual expected return and the variance of the logarithmic market return. Normal scale average return (*ER*) and standard deviation (*SD*) of the venture investment can be computed using the property of lognormal distribution.

$$ER = e^{ER_L + \frac{1}{2} SD_L^2} - 1 \tag{7}$$
$$SD = (1 + ER) \sqrt{e^{SD_L^2} - 1} \tag{8}$$

It can be easily shown that the correlation (*CORR*) between venture investment and

public market is computed from

$$CORR = \frac{\beta \times SD_{Market}}{SD} \tag{9}$$

2. Quartile-IRR Benchmark

The internal rate of return for the private equity investment i, IRR_i, which is defined in Eq. (1) is grouped according to its risk categories such as the vintage year t_i and the industry in which it is held. To construct the quartile-IRR benchmark, the irr_i's of a particular risk category are sorted in their descending order. The irr_i's that belong to the 75% quartile and above will be assigned to rating 1, the ones that belong to the median and above of the empirical distribution will be assigned to rating 2 and so on.

The shortcomings of IRR as a benchmark have been emphasized by Woodward and Hall (2003) and Cheung et al. (2003) mainly because it often includes the net asset value in the computation that is earmarked by general partners and because cash flows are not adjusted for risks. Nevertheless, *IRR* is the most popular benchmark used in practice. The cumulative net cash distribution of the private equity market vintage t_i at time $t_i + \tau_j$, $0 \le j \le J_i - 1$, which is denoted by *Cumulative Net* $C_{dist}(t_i, \tau_j)$ and is often referred to as the "*J*-curve" in the literature, is simply given by

$$\textit{Cumulative Net}\ C_{dist}(t_i, \tau_j) = \sum_{k=0}^{j} (C_{dist}(t_i, \tau_k) - C_{draw}(t_i, \tau_k)) \tag{10}$$

3. Public Market Equivalent (*PME*) *IRR* Benchmark

The public market equivalent of private equity investments has been suggested to facilitate a comparison between public and private equity markets. It is because the nature of the private equity market is fundamentally different from that of the public market in that the cash flows in the former are generated intermittently. At the same time the estimate of liquidation value supplied by general partners may be too far off the true terminal value. In an effort to rate private equity CFOs (Collateralized Funds Obligations) that are backed

by a private equity, the researchers at S&P (Cheung et al. (2003a, b)) have proposed the method that can generate stochastic market cash flows. The idea is to interpret net cash flows from PE investments as long or short position in the public equity market. The steps for constructing the *PME IRR* (refer to Cheung et al. (2003a) for the practical example of *PME* scaling) are described as follows:

Step 1: To impose observed net cash flows from private equity investment on a public market index, for instance, KOSPI or KOSDAQ in Korea, by purchasing shares (long position) at the value of the market index to represent negative cash flows and selling shares (short position) to represent positive cash flows.

Step 2: To calculate the sequence of net asset values (*NAV*'s) of the public equity market equivalent portfolio over the life time of private equity investment as the sum of the previous *NAV* of a portfolio and the value of shares purchased/sold in this period. If the final *NAV* of the *PME* portfolio is negative, it would imply that the public market would have produced a smaller return than private equity.

Step 3: To reduce the cash distribution from private equity markets so that the *PME* portfolio has a final NAV of zero. This step is tantamount to obtaining the risk-adjusted distribution. The motivation for this adjustment is to impose a view that a risk-adjusted return to private equity should be no greater than that in a predetermined public market index. As is detailed in Cheung et al. (2003b), the scaling of the cash distribution can be achieved by applying the following *PME* scaling parameter $\theta(t_i)$.

$$\theta(t_i) = \sum_{j=0}^{J_i-1} \frac{C_{draw}(t_i, \tau_j)}{M(t_i+\tau_j)} / \sum_{j=0}^{J_i-1} \frac{C_{dist}(t_i, \tau_j)}{M(t_i+\tau_j)} \tag{11}$$

where $M(t)$ denotes the public market index share price at time t. The resulting scaled cash distribution, $\widetilde{C}_{dist}(t_i, \tau_j)$, is then computed as:

$$\widetilde{C}_{dist}(t_i, \tau_j) = \theta(t_i) \times C_{dist}(t_i, \tau_j) \tag{12}$$

Step 4: To compute net cash flows using the original drawdown and rescaled distribution and calculate the *PME-IRR*.

$$\sum_{j=0}^{J_i-1} exp(-PMEIRR(t_i)\times\tau_j)(\widetilde{C}_{dist}(t_i,\tau_j)-c_{draw}(t_i,\tau_j))=0 \qquad (13)$$

The *PME-IRR* for the private equity investment i, $PMEIRR_i$, is grouped according to its risk categories such as the vintage year t_i and the industry in which it is held. To construct the quartile *PME-IRR* benchmark, the $PMEIRR_i$'s of a particular risk category are sorted in their descending order. The $\mathrm{PMEIRR_i}$'s that belong to the 75% quartile and above will be assigned to rating 1, the ones that belong to the median and above of the empirical distribution will be assigned to rating 2 and so on.

The *PME* scaled cumulative net cash distribution of the private equity market vintage t_i at time $t_i+\tau_j$, $0\le j\le J_i-1$, which is denoted by $Cumulative\ Net\ \widetilde{C}_{dist}(t_i,\tau_j)$, is computed from

$$Cumulative\ Net\ \widetilde{C}_{dist}(t_i,\tau_j)=\sum_{k=0}^{j}(C_{dist}(t_i,\tau_k)-C_{draw}(t_i,\tau_k)) \qquad (14)$$

Next section applies the benchmarking methods to the Korean venture capital market.

Ⅲ. Empirical Analysis

1. Data

The data cover 374 liquidated venture funds held by 85 venture capital companies from 1987 to 2008. Database contains such information as the name of funds and venture capital companies, vintage year (date of inception), industry classification (general, IT, bio, and cultural contents), dates and the amounts of cash drawdown and distribution, and liquidation date. On-going venture funds are not included in the calculation of the IRR benchmarks.

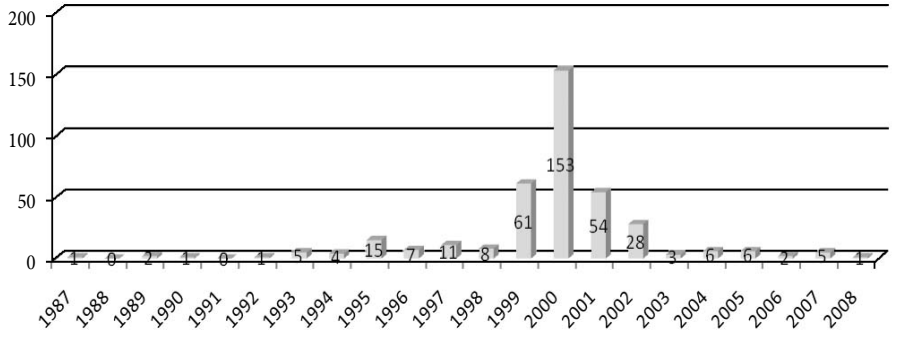
<Figure 1> depicts the number of venture funds over the 1987～2008 periods. The venture boom in Korea around year 2000 is evident as the vintages are concentrated during the 1999～2002 periods. The 313 funds out of the population did not specify the target industry that they are focusing on (classified as general), but are mostly IT venture-oriented.

The number of funds classified as IT, bio, and cultural contents sectors are 20, 13 and 28, respectively.

The median cash drawdown and distribution for the whole vintages are respectively 5 billion Wons and 5.621 billion Wons. The median IRR and the maturity are respectively 0.78% and 5.34 years. Before estimating the single index model, the quartile *IRR*'s and *PMEIRR*'s are examined in more detail in the following subsections to understand better the KVIC database.

<Figure 1> Venture funds reporting population: 1987～2008 vintages

The total number of venture funds over the 1987～2008 vintages is 374. Vertical axis represents the number of venture funds. The data are liquidated venture funds and are collected from the KVIC database.



2. Performance Measurement Based on Quartile-IRR Benchmark

<Table 1> reports the quartile-*IRR* benchmarks calculated for different vintages, i.e., 1987～1998, 1999, 2000, 2001, and 2002～2008. Thresholds for quartile 1 varies from as low as 1.70% in year 2000 to as high as 21.63% during the 2002～2008 periods. At a first glance, these figures appear to be too volatile. But it is understandable in that the performance of 2000 vintage bears the marks of the 1999～2000 IT bubble and burst experienced in Korea.[4] The median maturity of funds over the full sample is slightly above 5 years.

4) For comparison, the pooled *IIR* for all U.S. venture capital funds is estimated to be 14.9% over 1969～1998 ("1999 Investment Benchmarks", 1999), whereas the median IRR for 1987～1998 in <Table 1> is 9.4%. Pooled *IIR* for the latter is 10.0% as is shown later in <Table 3>.

<Table 1> Quartile-IRR benchmark for different vintages

The number in parentheses indicates liquidated venture funds with ages older than three years. IRR's are computed from Eq. (1).

Vintage	1987～1998	1999	2000	2001	2002～2008	1987～2008
Quartile 1	13.98%	14.78%	1.70%	6.12%	21.63%	9.45%
Median	9.41%	0.94%	-2.52%	0.08%	9.40%	0.78%
Quartile 3	2.49%	-11.49%	-12.28%	-5.78%	0.53%	-7.33%
Minimum	-24.21%	-73.07%	-95.68%	-54.82%	-78.84%	-95.68%
Maximum	659.45%	4347.36%	109-03%	37.39%	305.82%	4347.36%
Median Maturity (years)	6.05	5.24	5.41	5.28	3.47	5.34
Total Number of Funds	55 (51)	61 (54)	153 (141)	54 (48)	51 (28)	374 (322)

<Table 2> Pooled Quartile-IRR's for each rating and for different vintages

Rating 1, for instance, refers to funds that have yielded IRR greater than equal to quartile 1 threshold in <Table 1>. The cash flows of each rating are pooled and the pooled-IRR's are computed and are reported in each cell. Row with a label "Pooled" means IRR's computed from pooling funds for the subsample regardless of ratings.

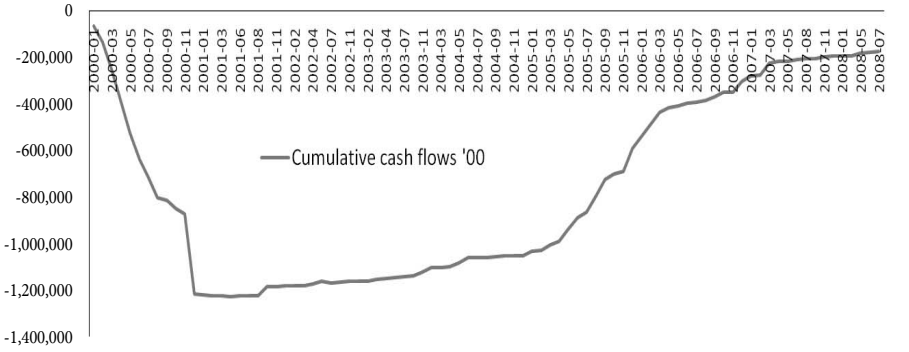
Vintage	1987～1998	1999	2000	2001	2002～2008	1987～2008
Rating 1	21.42%	79.24%	10.76%	12.51%	35.62%	19.39%
Rating 2	11.47%	3.87%	0.11%	3.45%	13.09%	4.62%
Rating 3	5.76%	-2.77%	-5.97%	-3.26%	4.98%	-2.56%
Rating 4	-0.61%	-19.52%	-21.05%	-12.25%	-20.15%	-18.51%
Pooled	9.98%	0.92%	-2.94%	3.01%	13.53%	3.39%

In order to learn more about the characteristics of venture funds that belong to rating 1 (for instance, funds that have yielded *IRR* greater than equal to quartile 1 threshold in <Table 1>) through 4 (funds that have yielded *IRR* less than quartile 3 threshold in <Table 1>), the cash flows of each rating are pooled and the pooled-*IRR*'s are computed. <Table 2> reports the pooled-*IRR*'s for different vintages. This information may be used to benchmark the performance of each fund within each rating. Pooled *IRR* in <Table 2> and the cumulative net cash distributions for 2000 and 2002～2008 vintages in <Figure 2a> and <Figure 2b> contrast the performance of two vintage groups (refer to <Appendix 1> for

other vintages). It clearly suggests that vintage is an important risk factor like in other countries and that the shape of benchmark would be drastically depending on the choice of vintage or vintage pool.

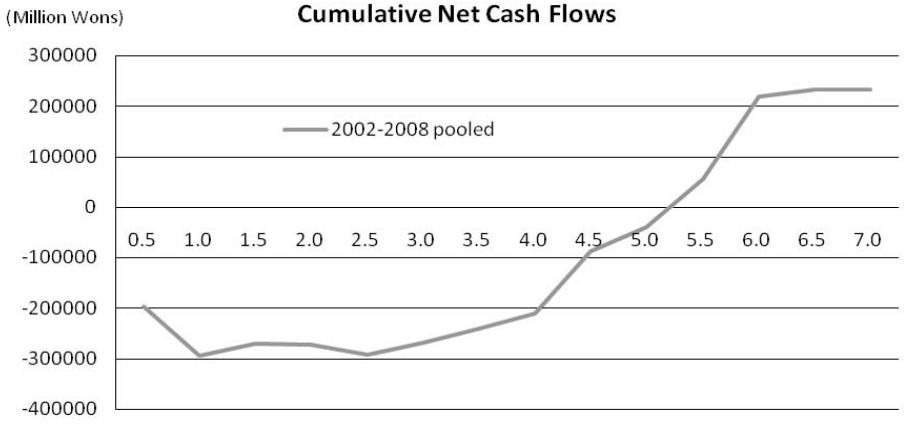
<Figure 2a> Cumulative net cash distribution for 2000 vintage

Figure depicts the cumulative net cash distribution for 2000 vintage, computed from using Eq. (10). Notice that time axis is marked uneven as cash flows are received each month. Unit is Wons in million.



<Figure 2b> Pooled cumulative net cash distribution for 2002~2008 vintage

Figure depicts the cumulative net cash distribution for several vintages altogether, computed from using Eq. (10). Since the inception year for each fund may be different, the time axis represents the semiannual period since the inception. Unit is Wons in million. The shape of the curve is often referred to as the "*J* curve" in the literature.



3. Performance Measurement Based on PME-IRR Benchmark

As explained before, the *PME-IRR* benchmark attempts to measure risk-adjusted performance of private equity investment. By applying PME scaling to private equity cash flows, it will explicitly ascribe non-diversifiable risk to private equity markets that is no more optimistic than a target public market index. <Table 3> provides *PME-IRR*'s for different vintages using both KOSPI and KOSDAQ indices as target public market indices.

The magnitude of PME scaling factors relative to KOSDAQ is in general less than one, indicating that the KOSDAQ market has performed poorer than private equity market over the life time of each vintage. Compared to pooled *IRR* benchmark cash flows, down-scaling of private equity cash flows has yielded *PME-IRR* relative to KOSDAQ market remarkably smaller, resulting in mostly negative *PME-IRR*'s. The commitment made when KOSDAQ zoomed, i.e., 1999 vintage, has performed the worst. Only 2002～2008 vintage has marked a positive *PME-IRR* of 4.87%, compared to the average KOSDAQ return of 5.74 per cent for the same period, as the KOSDAQ market slowly recovers from the collapse, which is illustrated in <Figure 3>.

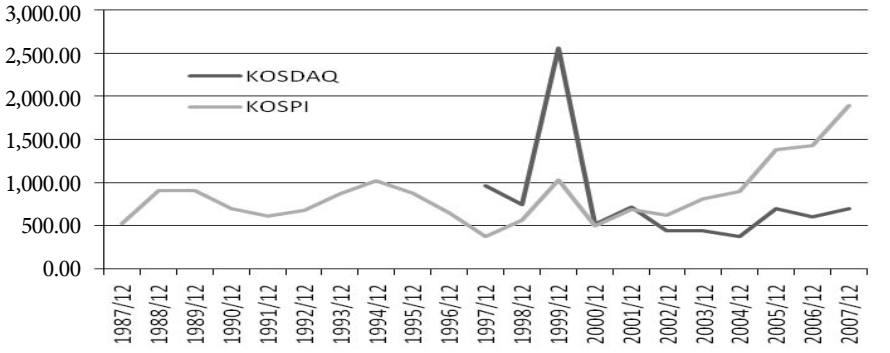
<Table 3> Pooled *IRR* vs. *PME-IRR*'s for different vintages

PME-IRR is computed from using Eq. (13) where the *PME* scaling factor is defined as Eq. (11) in the text. *IRR*'s and stock returns are expressed per annum.

Vintage	1987～1998*	1999	2000	2001	2002～2008	1987～2008**
Pooled IRR Benchmark	9.98%	0.92%	-2.94%	3.01%	13.53%	3.39%
PME Scale Factor : Relative ot KOSPI	0.5234	0.9400	1.9206	1.8602	1.1371	1.1636
Pooled PME-IRR : Relative to KOSPI	-2.61	-0.55%	10.71%	17.55%	18.03%	7.04%
PME Scale Factor : Relative to KOSDAQ	0.3869	0.2764	0.6911	0.7199	0.7684	0.6238
Pooled PME-IRR : Relative to KOSDAQ	-8.63%	-23.16%	-9.66%	-3.69%	4.87	-8.16%
KOSPI Return	12.85%	82.78%	-50.92%	37.47%	20.06%	16.38%
KOSDAQ Return	-22.69%[1)]	240.70%	-79.47%	37.33%	5.74%	21.0%[2)]

Note) * When KOSDAQ is assumed as a public equity market index, the vintage year covers 1997～1998 as the KOSDAQ index started from year 1997.
** The vintage year covers 1997～2008 period in case of the KOSDAQ benchmark.
[1)] Computed for 1998.
[2)] Computed for 1998～2007.

<Figure 3> Annual KOSPI and KOSDAQ indices



Note) Stock market Indices are December closings.

When KOSPI is used as a benchmark public market, <Table 3> reveals a different story. Over the life time of vintages 2000 and afterwards, the magnitude of *PME* scaling factors relative to KOSPI is greater than one, implying that the KOSPI market has produced greater return than the venture funds. Over the 1987～2007 period, KOSPI has earned the average annual return of 16.38%. Pooled *IRR* and *PME-IRR* for the similar period are, respectively, 3.39% and 7.04%, which is much smaller. Hence, the evidence from this particular *PME-IRR* benchmark suggests that private equity funds market has not been successful in generating excess residual returns over the KOSPI market. On the other hand, if 2002～2008 vintage has been chosen as a benchmark, *PME-IRR* and the average KOSPI return are similar (18.0 per cent and 20.1 per cent, respectively). The pooled IRR was 13.5 per cent for the same vintage, implying that the performance of venture funds since 2002 is catching it up with the public market.

4. Risk-Return Profile of Venture Capital Investment

The expected return and associated risk are estimated for different sample periods using the Chen et al. (2002) single index model introduced in section Ⅱ. When a venture capital company formed multiple funds in the same year, its cash flows are pooled when computing the terminal value $V_{t_i+m_i}$ in Eq. (2). In addition, the following cases are discarded in the sample: (1) defaulting venture capital or venture capital who has returned the VC license, (2) venture capital who has recorded only one investment, and thus, doubtful

to regarded as a pure venture capital firm, and (3) venture capital recorded too excess or low returns.[5)6)] <Table 4a> and <Table 4b> report parameter estimates and their imputed returns and risks measured against either KOSPI or KOSDAQ as a market index.

<Table 4a> ML estimates and risk-return profile of venture capital-Relative to KOSPI

α denotes the venture fund-specific annual expected return, σ denotes an idiosyncratic risk, and β is the sensitivity parameter of the single index model. ρ is the annual correlation of the residual returns between ϵ_i and ϵ_j. ER_L and SD_L are, respectively, the logarithmic annual expected return and standard deviation of venture investment. *ER* and *SD* are, respectively, the normal scale average return and the standard deviation of the venture investment. *CORR* refers to the correlation between venture investment and the public equity market (KOSPI). t-values are in parentheses.

ML Estimates					
Sample Period	1987～2007	1987～1999	2000～2007	2001～2007	2002～2007
ρ	0.2779	2.E-06	0.0000	3.E-08	9.E-08
	(1.111)	(0.003)	(0.007)	(0.002)	(0.001)
α	0.0576	0.0551	-0.0711	-0.0802	-0.0847
	(0.884)	(2.459)	(-1.386)	(-0.757)	(-0.623)
β	0.0266	-0.1558	0.4932	0.6926	0.8570
	(0.080)	(-0.495)	(1.423)	(1.099)	(1.086)
σ^2	0.2014	0.1122	0.1752	0.2254	0.3094
	(3.357)	(4.301)	(6.928)	(5.338)	(4.183)
Sample (total)	175	47	128	66	37
Sample (filtered)*	119	37	82	43	21
Expected Returns, risks and Correlations					
ER_L	0.0599	0.0379	-0.0439	0.0240	0.0192
SD_L^2	0.2017	0.1193	0.2358	0.3281	0.4523
*ER***	17.4%	10.2%	7.7%	20.7%	27.8%
*SD***	55.5%	39.2%	55.5%	75.2%	96.6%
CORR	0.016	-0.136	0.241	0.235	0.198

Note) * Refer to filtering rule explained in footnote 5 and the main text thereof.
** For comparison, KOSPI has earned the average annual return of 22.55% with the standard deviation of 21.86% over the 2001～2007 period.

5) This amounts to the filtering rule of deleting funds' cumulative return ($V_{t_i+m_i}$) exceeding 1,400 per cent. There are two cases in year 1999 and a single case in year 2000 that belong to this category.

6) As noted by Cochrane (2001), selection bias is a serious problem in analysis of the performance of individual venture capital investments, but the KVIC VC funds database contains full information on both successful and unsuccessful projects. Also it is worthwhile to note that funds included invest in multiple venture capital investment projects that would reduce the selection bias sufficiently. Nevertheless, this paper employs three filtering rules to focus on the performance of the meaningful venture investments. Hence, readers should exercise caution in interpreting the results in <Table 4>.

The estimated β's <Table 4a> are mostly positive, but not statistically significant at the usual significance level when KOSPI is considered as public equity market. Furthermore, the cases that are old less than three years (not reported here), the estimated β's are all negative and insignificant. Therefore, the KOSPI market seems to be less appropriate when the risk-return profile of venture investment needs to be derived.

<Table 4b> ML estimates and risk-return profile of venture capital-Relative to KOSDAQ

α denotes the venture fund-specific annual expected return, σ denotes an idiosyncratic risk, and β is the sensitivity parameter of the single index model. ρ is the annual correlation of the residual returns between ϵ_i and ϵ_j. ER_L and SD_L are, respectively, the logarithmic annual expected return and standard deviation of venture investment. *ER* and *SD* are, respectively, the normal scale average return and the standard deviation of the venture investment. *CORR* refers to the correlation between venture investment and the public equity market.

ML Estimates									
Sample period	1987~2007		1987~1999	2000~2007		2001~2007		2002~2007	
	All	3 years and older	3 years and older	All	3 years and older	All	3 years and older	All	3 years and older
ρ	1.73E-06	1.75E-06	1.09E-07	1.24E-06	0.3727	4.78E-07	6.35E-07	7.08E-07	1.77E-08
	(0.009)	(0.008)	(0.002)	(0.006)	(1.331)	(0.003)	(0.003)	(0.002)	(0.001)
α	0.0155	0.0217	0.0268	0.0130	-0.0070	0.0355	0.0570	0.0619	0.1092
	(0.790)	((1.316)	(0.482)	(0.614)	(-0.081)	(1.198)	(3.043)	(1.263)	(4.061)
β	0.1799	0.1735	0.0910	0.2826	0.0210	0.5106	0.5918	0.3728	-0.4295
	(1.299)	(1.443)	(0.328)	(1.569)	(0.093)	(1.421)	(1.588)	(0.750)	(-0.700)
σ^2	0.1679	0.1060	0.1394	0.1744	0.1345	0.2223	0.0806	0.3087	0.0640
	(7.778)	(7.280)	(3.464)	(6.928)	(2.457)	(5.338)	(4.637)	(4.183)	(3.240)
Sample (total)	161	161	33	128	128	66	66	37	
Sample (filtered)*	121	106	24	96	82	57	43	35	
Expected Returns, risks and Correlations									
ER_L	0.0154	0.0217	0.0510	-0.0331	-0.0106	0.0538	0.0782	0.0512	0.1215
SD_L^2	0.1813	0.1184	0.1421	0.2119	0.1347	0.3144	0.2044	0.3498	0.1185
*ER***	11.2%	8.4%	13.0%	7.6%	5.8%	23.5%	19.8%	25.4%	19.8%
*SD***	49.6%	38.4%	44.2%	52.3%	40.2%	75.1%	57.0%	81.1%	42.5%
CORR	0.163	0.202	0.095	0.241	0.025	0.265	0.405	0.138	-0.303

Note) * Refer to filtering rule explained in footnote 5 and the main text thereof.

** For comparison, KOSDAQ has earned the average annual return of 10.25% with the standard deviation of 40.76% over the 2001~2007 period.

<Table 4b> repeats the exercise above assuming the KOSDAQ index as a comparable market index. The cases of funds older than three years since the inception are additionally considered in the estimation. The goodness of fit is improved somewhat and the negative

beta is observed from only one case. The estimated beta of 0.5918 for 2001～2007 vintage, exclusive of funds younger than three years, is the largest with the smallest one-tailed *p*-value of 0.056.

Although the significance of the estimates is not in general strong, the expected returns and associated risks imputed from the Chen et al. (2002) single index model may still be informative. The lowest (highest) expected return and the lowest (highest) risk in <Table 5b> are, respectively, 5.8% (25.4%) and 38.4% (81.1%). Particularly for 2001～2007 vintage, inclusive of funds older than 3 years, the expected return and risk are, respectively 19.8% and 57%. For the same period, the annual average KOSDAQ return and its *SD* was 10.58% and 40.77%, respectively, implying that the venture investment would have offered a higher expected return-risk profile than that of KOSDAQ as is commonly conjectured.[7)]

Ⅳ. Quartile Persistence of Fund Performance

The performance of an individual venture fund (or general partner) or venture capital is often assessed by the ability of remaining in the same top rating or of improving its rating. This information is often summarized in the rating transition matrix. The dataset at hand includes venture funds managed by the relatively small number of venture capital firms. For instance, the number of venture capital firms that have the experience of liquidation for 1999, 2000, 2001, and 2002～2008 vintages are, respectively, 27, 62, 29, and 37. Therefore, the rating transition matrix constructed from these firms is expected to be quite noisy. Nevertheless, such information might provide the sponsors with some insight on the performance of the venture capital companies.

In order to compute the rating transition matrix for venture firms, cash flows at the firm level, as opposed to ones at the individual fund level, are generated for each vintage and Quartile-IRR ranking is assigned. Relatively meaningful transition matrix could be calibrated only for 1999, 2000, and 2001 vintages. <Table 5a>～<Table 5d> provide the rating

7) Chen et al. (2002) report that the average return and standard deviation for venture capital are, respectively, 45.0 per cent and 115.6 per cent. They use funds data followed by Venture Economics over January 1960 till June 1999 and considered S&P500 as the public market.

transition matrices for different vintages along with pooled 1999~2001 vintage, or long-run, rating transition matrix.[8)]

<Table 5a> Rating transition matrix based on a firm level Quartile-IRR rating : 1999 vintage

Quartile rating is defined in <Table 2>, along with quartile thresholds given in <Table 1>. Default indicates a defaulting firm or a firm that has returned its license. Since the actual date of default is not available, a defaulting firm as of 2008 that has record of the third funding, for instance, is not counted as a defaulting firm for the second funding. UR (unrated) means that no subsequent rating is available.

	start \ end	Q1	Q2	Q3	Q4	Default	UR	Total
1999	Q1	28.6%	14.3%	42.9%	14.3%	0.0%	0.0%	100.0%
	Q2	14.3%	57.1%	14.3%	0.0%	0.0%	14.3%	100.0%
	Q3	33.3%	33.3%	16.7%	16.7%	0.0%	0.0%	100.0%
	Q4	14.3%	42.9%	0.0%	42.9%	0.0%	0.0%	100.0%

<Table 5b> Rating transition matrix based on a firm level Quartile-IRR rating : 2000 vintage

	start \ end	Q1	Q2	Q3	Q4	Default	UR	Total
2000	Q1	12.5%	25.0%	25.0%	0.0%	18.8%	18.8%	100.0%
	Q2	0.0%	13.3%	13.3%	20.0%	13.3%	40.4%	100.0%
	Q3	33.3%	0.0%	13.3%	13.3%	13.3%	26.7%	100.0%
	Q4	18.8%	12.5	6.3%	25.0%	0.0%	37.5%	100.0%

<Table 5c> Rating transition matrix based on a firm level Quartile-IRR rating : 2001 vintage

	start \ end	Q1	Q2	Q3	Q4	Default	UR	Total
2001	Q1	14.3%	28.6%	0.0%	0.0%	0.0%	57.1%	100.0%
	Q2	14.3%	14.3%	0.0%	0.0%	28.6%	42.9%	100.0%
	Q3	14.3%	0.0%	0.0%	28.6%	0.0%	57.1%	100.0%
	Q4	0.0%	12.5%	12.5%	0.0%	25.0%	50.0%	100.0%

8) The average time of firms' investment until liquidation is, respectively, 5.8, 6.3, and 5.3 years for 1999, 2000, and 2001 vintages. For these vintages, the second funding took placed on average at 1.17 years.

<Table 5d> Rating transition matrix based on a firm level Quartile-IRR rating : pooled 1999～2001 vintages

Pooled rating transition matrix provided in this table is based upon pooling information in <Table 5a>～<Table 5c>.

	start \ end	Q1	Q2	Q3	Q4	Default	UR	Total
1999～2001	Q1	16.7%	23.3%	23.3%	3.3%	10.0%	23.3%	100.0%
	Q2	6.9%	24.1%	10.3%	10.3%	13.8%	34.5%	100.0%
	Q3	28.6%	7.1%	10.7%	17.9%	7.1%	28.6%	100.0%
	Q4	12.9%	19.4%	6.5%	22.6%	6.5%	32.3%	100.0%

The evidence from rating transition matrices indicates that the probability of remaining in the same rating is quite low regardless of vintage. The low level of the persistence of firms' performance is not surprising considering the fact that the inception period of such firms are mostly concentrated around the 1999～2000 venture bubble period. As far as the sponsors such as pension funds and managers of fund of funds are concerned, the possibility of the loss incurred by a defaulting firm is an important aspect from the risk management point of view. <Table 6> reports the long-run probability default of each rating, recalibrated from dropping unrated firms. The magnitude of default probability is mostly in double digits and it features the reversal of the PD level across ratings. In addition, downgrading occurs quite frequently at the high rating classes and even the top rating has not been successful in maintaining its original rating for three subsequent funding attempts, as is illustrated in <Table 7>.

<Table 6> Rating transition matrix based on a firm level Quartile-IRR rating (exclusive of unrated) : pooled 1999～2001 vintages

Pooled rating transition matrix provided in this table is based upon the same information in <Tables 5d>, except for excluding funds with no rating (UR rating).

	start \ end	Q1	Q2	Q3	Q4	Default	Total
1999～2001	Q1	21.7%	30.4%	30.4%	4.3%	13.0%	100.0%
	Q2	10.5%	36.8%	15.8%	15.8%	21.1%	100.0%
	Q3	40.0%	10.0%	15.0%	25.0%	10.0%	100.0%
	Q4	19.0%	28.6%	9.5%	33.3%	9.5%	100.0%

<Table 7> Persistence of Q1 Rating

Table considers a starting year of 1st funding as 1999 because the subsequent funding for later starting year is not frequently observed. The value of (Q3, 3rd funding) cell, 50%, means among Q1 rated firms in the first funding (7 firms to be exact), 28.6% of firms (namely, 2 firms) have maintained their ratings and among these two firms, one firm is downgraded to Q3.

	Rating	1st funding	1st funding	1st funding
1999	Q1	100%	28.6%	0.0%
	Q2		14.3%	0.0%
	Q3		42.9%	50.0%
	Q4		14.3%	0.0%
	UR		0.0%	50.0%

Ⅴ. Monitoring the Performance of On-Going Venture Funds

The valuation of on-going venture funds and/or venture capital companies is a demanding task. It is difficult because *NAV* earmarked by general partners may contain valuable information on funds at liquidation or it may just be a wishful thinking on the terminal value. The so-called "hedonic price" approach applied to the valuation of new companies funded by venture capital would be of help in this circumstance, provided that the sufficient observations of valuation events and company-specific characteristics are available in the data. When large numbers of observed valuations or estimated values are not readily available, fund of funds managers have to rely on their experience with respect to the quality of the GP reported *NAV*'s and to compare the trajectory of cumulative net cash flows with those of relative benchmarks. For instance, cumulative net cash flows based on quartile ratings selected from a relevant vintage and *PME* scaled cumulative net cash flows may be used to monitor the performance of the existing venture funds and/or companies. Recall that the latter focuses on risk-adjusted return whereas the former on nominal return.

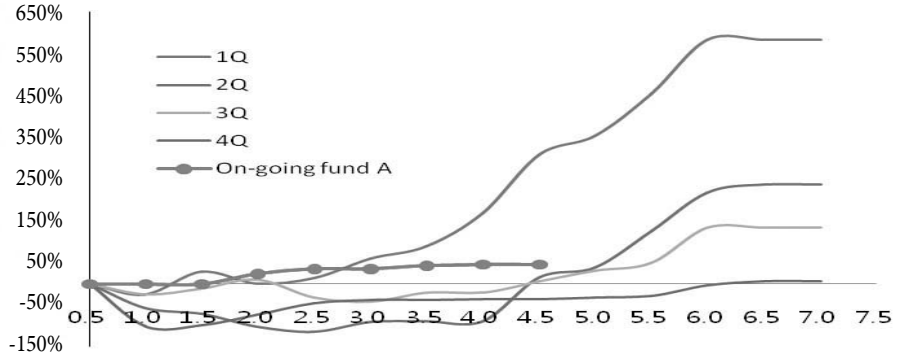
<Figure 4a> and <Figure 4b> illustrate cumulative net cash flows of each Quartile-*IRR* benchmark based on, say, 2002～2008 vintage, which are expressed as the percentage of initial takedown. Firms that belong to rating 1, denoted 1Q, tend to perform well on average until three to four years since the inception, whereas much clearer picture for the final rating emerges after four and a half years since the inception. Superimposed (line with

bullets) is cumulative net cash flow of a particular fund, say on-going fund *A*. The date of inception of fund *A* is June, 2004 and it has a single takedown at the inception. It also has the GP reported *NAV* at the end of fourth year. Estimated *IRR* of fund *A* is 8.29%.

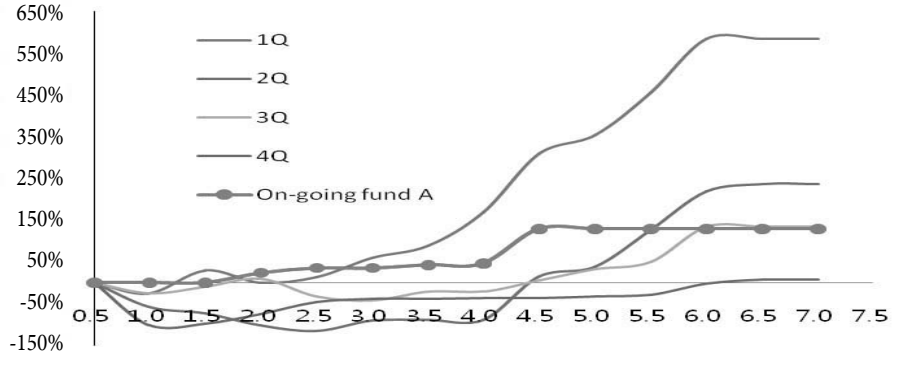
According to <Table 2>, fund *A* is earning *IRR* slightly below median, rendering itself to fall into rating 3. Cumulative net cash flows of fund *A* in <Figure 4a> and <Figure 4b> appear to confirm visually the performance of fund *A*. fund *A* does not seem to have generated enough cash flows to be rated higher than rating 3, even if the GP assessed *NAV* is accurate.

<Figure 4a> Cumulative net cash flows of quartile ratings 2002~2008 : Monitoring on-going fund A (exclusive of GP's NAV)

The y-axis is expressed as the percentage of total drawdown. The unit of x-axis is in years.



<Figure 4b> Cumulative net cash flows of quartile ratings 2002~2008 : Monitoring on-going fund A (inclusive of GP's NAV)

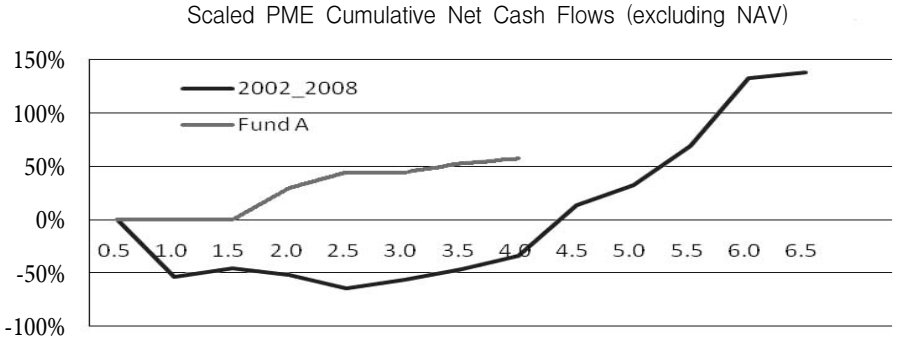


KOSDAQ market-adjusted *PME* cumulative net cash flows, and the corresponding *PME-IRR*, provide the additional information on the performance of fund *A*. <Figure 5a> depicts *PME* scaled cumulative net cash flows of fund *A* exclusive of GP assigned *NAV*. At the end of the fourth year since the inception, *PME-IRR* is computed as 35.31%, along with scaling factor of 3.74. Recall that pooled *PME-IRR* for 2002～2008 vintage was 4.87% along with scaling factor of 0.77. It implies that KOSDAQ market was outperforming this particular fund and that fund *A* bears a high opportunity cost compared to the investment to KOSDAQ market.[9)]

<Figure 5b> depicts *PME* scaled cumulative net cash flows of fund *A* inclusive of GP assigned *NAV*, which is provided as of the end of four and a half year. Because of the sharp decline of the market on June, 2008, scaling factor is now reduced to 1.24 and *PME-IRR* is lowered to 16.12%, implying that a foregone opportunity is now much smaller. Given the performance of KOSDAQ, fund *A* has to generate more cash flows that would equate the current *IRR* of 8.29% to *PME-IRR* of 16.12%. Under such circumstance, the investment made to KOSDAQ and to venture fund *A* would have been indifferent. Since the current *IRR* is about a half the size of that figure, it can be said that it is underperforming the comparable public market.

<Figure 5a> *PME* KOSDAQ market scaled cumulative net cash flow : Case of on-going fund *A* (exclusive of *NAV* assessed by GP)

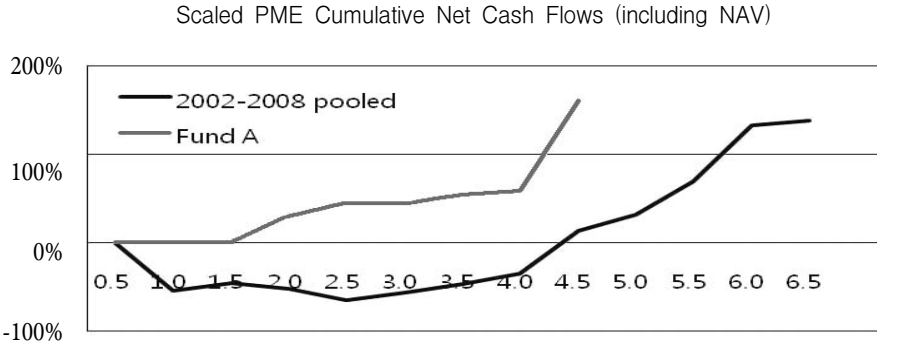
Scaling factor for pooled 2002～2008 vintage is 0.7684, whereas that of fund *A*, exclusive of GP's *NAV*, is 3.74.



9) As is depicted in <Figure 3>, KOSDAQ during years 2002～2003 was declining, followed by the steady increase in the market, particularly in the mid of 2007.

<Figure 5b> PME KOSDAQ market scaled cumulative net cash flow : Case of on-going fund *A* (inclusive of *NAV* assessed by GP)

Scaling factor for pooled 2002～2008 vintage is 0.7684, whereas that of fund *A*, inclusive of GP's *NAV*, is 1.24.



Ⅵ. A Summary and Conclusions

This paper studies empirically the performance of private venture funds in the Korean venture market. Particularly, this paper examines relative benchmarks such as Quartile-*IRR* benchmark and public market equivalent *IRR* (*PME-IRR*) benchmark for different vintages. Since private venture investments are intermittently valued in the market and the access to the data has been limited, the risk and return profile of such investment are hardly reported in the literature. Therefore, this paper attempts to assess the characteristics of the Korean venture capital market by estimating expected return and risk suing the Chen et al. (2002) single index model.

The data consist of 374 liquidated Korean venture funds collected for during the last two decades by the Korea Venture Investment Corporation, who is a leading fund of funds sponsored by the government. Despite the limited size of the data, the empirical results provide some insights to the understanding of the relevance and the performance of relative benchmarks in the Korean venture capital market. The empirical findings may be summarized as follows:

First, looking at funds older than three years for 2001～2007 vintages, the expected return and risk are, respectively, 19.8 per cent and 57.0 per cent, which is compared to

the annual average return of 10.3 percent and the standard deviation of 40.8 percent in the KOSDAQ market over the same period. The correlation between two markets was 40.5 per cent. Taking these estimates literally, the venture fund investment may be deemed attractive as an alternative asset class.

Second, traditional Quartile-*IRR* benchmark turned out to be sensitive to the choice of vintages. In case of the full sample, median Quartile-*IRR* was 0.78 per cent, whereas that of the 2002～2008 pooled vintage was 9.40 per cent. It may be tempting for the sponsors to choose a particular vintage when evaluating the on-going venture funds. However, the 2008 global liquidity crisis suggests that the nature of venture investment is indeed risky and that the exclusion of the crisis period of 2001 may result in much too high benchmark for the general partners to beat. Due to this sensitive nature of the IRR benchmark, it may be reasonable to set the Quartile-*IRR* benchmarks for each industry using the whole 1987-2008 vintage pool and for investments lasted longer than five years.

Third, *PME-IRR* benchmark revealed much greater sensitivity because KOSPI and KOSDAQ markets behaved differently over the sample period and because the volatility of the KOSDAQ was much greater. The current practice of the National Pension Service is to set the absolute benchmark that is computed as the KOSPI return plus risk premium that reflects the Sharpe ratio of the venture investment. Our results, however, suggest that this benchmark would be very difficult to outperform and in fact KOSDAQ is more relevant public market than KOSPI for the purpose of the performance measurement.

Lastly, the uncertainty in venture investment has resulted in a relatively short quartile persistence of fund performance and winners from subsequent funding are rarely observed.

As more funds incepted after 2000 are liquidated, estimates reported in the paper would gain more accuracy and serve a useful benchmark for the investors who try to figure out potential gains from participating in the Korean venture capital industry.

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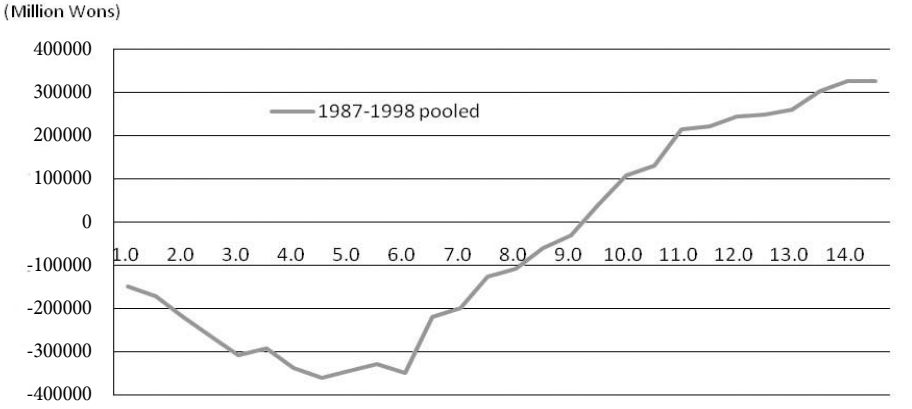
<Appendix 1> Cumulative net cash distributions for different vintages

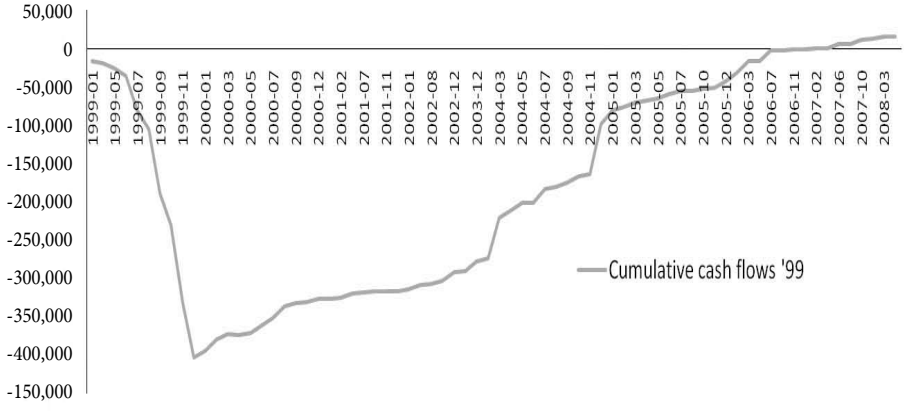
<Figure A.1a> 1987~1998 vintages pooled

Figure depicts the cumulative net cash distribution for several vintages altogether, computed from using Eq. (10). Since the inception year for each fund may be different, the time axis represents the semiannual period since the inception. Unit is Wons in million. The shape of the curve is often referred to as the "*J* curve" in the literature.



<Figure A.1b> 1999 vintage

Figure depicts the cumulative net cash distribution for 1999 vintage, computed from using Eq. (10). Notice that time axis is marked uneven as cash flows are received each month. Unit is Wons in million.



<Figure A.1c> 2001 vintage

Figure depicts the cumulative net cash distribution for 2001 vintage, computed from using Eq. (10). Notice that time axis is marked uneven as cash flows are received each month. Unit is Wons in million.