

The Development of Venture Capital Industry and the Role of
Government in Korea: Venture Boom vs. Post-boom

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벤처캐피탈 산업의 발전과 정부의 역할

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ABSTRACT

This paper evaluates the role of Korean government in the venture capital industry, in particular in the stages of fund-raising and venture investment. Utilizing data from Korean Venture Capital Association (KVCA), the analysis is conducted for the venture boom and post-boom periods separately. Empirical results show that the government played a significant role in the fund-raising stage in both venture boom and post-boom periods. When it comes to the investment stage, however, the empirical results indicate that the government did not accomplish expected roles. In particular, the government failed to induce investments in the outside funds of which the government had a larger stake toward early-staged firms and guide common stock investments during the venture boom period. The empirical outcomes also show that the government has not properly increased venture investments on high-tech industries during the post-boom period. This paper argues tentative reasons why the policy failures were observed in relation to the policy implications and provide several pieces of supporting evidence.

본 논문은 1990년대 후반 이후 벤처캐피탈 산업, 특히 자금조달과 벤처투자단계에서의 한국 정부의 역할을 평가한다. 실증분석은 한국벤처캐피탈협회에서 입수한 미시 자료를 활용하여 벤처붐 시기와 그 이후의 시기를 구분하여 이루어졌다. 실증분석 결과, 한국 정부는 벤처캐피탈의 자금조달과 관련하여 벤처붐 시기와 그 이후 모두에서 유의미한 역할을 수행하였던 것으로 나타났다. 이와 달리 투자단계에서 요구되는 정부의 역할은 제대로 수행하지 못했던 것으

로 나타났다. 특히, 분석 결과는 벤처붐 시기에 한국 정부가 자신이 참여한 투자조합의 벤처투자를 초기기업에 대한 투자, 보통주 투자로 유도하는 데 실패하였음을 보여준다. 벤처붐 이후에는 고기술산업군에 대한 투자 유도에 실패하였던 것으로 나타났다. 본 논문은 이와 같은 정책실패가 발생한 이유에 대해 가설을 제시하고 그 가설을 뒷받침하는 몇 가지 실증적인 근거를 제공한다.

1. Introduction

Korea's venture capital industry experienced a boom during the years of 1998-2000 and shrank rapidly thereafter with the abrupt ending of the boom. After the bubble burst, the industry has been in a steady recovery since 2003. The Korean government has made considerable efforts to develop venture capital industry as a critical route of innovative financing since the mid 1990s. The government has played an important role in the fund-raising process by directly making significant capital commitments. It also helped the exit process of venture capital investments by establishing KOSDAQ stock market in 1996, which provided venture-capital-backed companies with a window of IPO.¹ Compared with the U.S. that is a predominant country in venture capital investments, the venture capital industry in Korea is situated at an early stage and needs significant development and improvement. For instance, the venture capital investments in the U.S. amount to \$25.5 billion in 2006, which accounts for 0.19 % of the U.S. GDP. In contrast, the amount of venture capital investment in Korea is just \$0.75 billion in 2006, representing 0.095% of the GDP. The venture capital industry in Korea, vis-à-vis the U.S., also poses structural weak points. For example, the government remains as the largest investor of outside funds.² The stipulated life spans of outside funds are mostly five years.³ As for an exit, M&A takes up less than five percent of total venture capital investment recovery, unlike the U.S. where M&A is a dominant exit window. The organizational structure of venture capital firms has been a corporation; establishing a venture capital firm in the form of limited liability company (LLC) was not approved until 2005. These defects work as structural constraints on the development of the venture capital industry in Korea.

Among the above mentioned shortcomings of the venture capital industry, this study pays attention to the fact that the Korean government is the most influential playmaker, and analyzes the role that the government has played since the late 1990s in the stages of fund-raising and venture investment. Many papers in the past investigated venture capital industry in various aspects.⁴ Among those, Lee (2003)

¹ Rin *et al.* (2000) found that the opening of stock markets targeted at entrepreneurial companies positively affects the shares of early stage and high-tech venture capital investments.

² In Korea, a venture capital firm operates two different sources of funds. One is outside fund which is organized by external investors' capital commitments and the other is inside fund which is internally raised. I will explain the fund-raising and organizational structures of the venture capital industry in Korea more in detail in the next section.

³ When organizing an outside fund, a venture capitalist stipulates an expiration date of the fund.

⁴ For a comprehensive overview of previous literature on the venture capital industry, see Gompers and Lerner (2001); for an overview of previous literature on the role of contracting, screening, and monitoring in mitigating principal-agent conflicts, see Kaplan and Stromberg (2001); for the relationship between incentive contracts and market structure in an adverse selection setting or in a moral hazard setting, see Inderst (2001), and Inderst and Muller (2002); for the syndication and staged investment, see Admati and Pfleiderer (1994), Bergemann and Hege (1998), and Brander *et al.* (2002); for the structure and governance of venture capital organization and their performance, see Gompers and Lerner (1998b) and Sahlman (1990); and for the influence of a robust initial offering market on venture investment behaviors, see Black

and Rin et al. (2000) are closely related to this paper in that they deal with the role of government or public policy in the development of active venture capital markets. No previous research, however, has attempted to empirically evaluate the role that the government has actively taken in the stages of fund-raising and venture investment, which gives the uniqueness to this paper. For an analysis, data from Korean Venture Capital Association (KVCA) on fund-raising and venture investment were used. The evaluation on the role of the government is then conducted for the venture boom and post-boom periods separately, taking into account possible structural changes between these periods. More specifically, in order to evaluate the government's role in raising venture capital, this paper measures the size of the government capital commitments and uncovers how effectively the public capital commitments have attracted private capital in the venture boom and post-boom periods. Looking into the government's role in the investment stage, the following four criteria were chosen: (1) the average age of invested firms; (2) the ratio of venture investments in high-tech industries; (3) the ratio of investments in high- and medium-tech industries; and, (4) the ratio of common stock investments. The role of the government was evaluated by focusing on the changes of four variables as the share of government capital commitments in outside funds increases.

The empirical analyses show that the government played a significant role at the fund-raising stage in both venture boom and post-boom periods. The government has provided a considerable amount of capital to venture capital firms for their venture investments. This direct role of the government in the fund-raising stage seems to have been reinforced after the boom burst. It is also found that the government has played an effective role in attracting the private investors' capital in the post-boom period.

When it comes to the investment stage, the empirical results do not convey a clear answer to the question of whether the government accomplished expected roles during the venture boom and the post-boom periods. Regarding the age of invested firms and the common stock investment, the empirical outcomes show that the government failed to induce investments in the outside funds of which the government had a larger stake toward early-staged firms and guide common stock investments during the venture boom period. This type of apparent policy failure, however, disappeared after the boom and policy improvement seems to have been made on the two criteria. Regarding the investments in the high-tech industries, the story is completely opposite. A related empirical analysis tells us that the government has not properly increased venture investments on high-tech industries during the post-boom period, not the venture boom period. This paper argues

and Gilson (1998) and Jeng and Wells (2000). Kortum and Lerner (2000) evaluated the role of venture capital in an economy's overall process of innovation and Hellmann and Puri (2000) analyzed interrelations between investor types (venture capital *vs.* other financing) and product market strategies and outcomes of start-ups. Gompers and Lerner (2004) collected their papers examining U.S. venture capital industry in the fund-raising, investing, and exiting stages. Finally, Lee *et al.* (2003) investigated the difference in investment behavior according to the sources of funds (inside funds *vs.* outside funds) in Korean venture capital industry.

tentative reasons why the policy failures were observed in relation to the policy implications and provide several pieces of supporting evidence.

The remainder of this paper is organized as follows. Section 2 explains the current status of the venture capital industry in Korea and its characteristics. Section 3 provides data description. Section 4 evaluates the role of the Korean government in the fund-raising process by measuring the size of the government capital commitments and estimating the responsiveness of private sector to the government capital commitments in outside funds. Section 5 examines the role of the government in the investment stage. Analyses will be conducted focusing on the effects of the government participation on the investment behaviors of outside funds. To explain observed changing patterns in the investment behaviors, I suggest a hypothesis and also provide several pieces of indirect evidence relating to that. Finally, Section 6 concludes the analysis by summarizing the results and suggesting a direction for future research.

2. Venture Capital Industry in Korea

This section, first, explains the organizational structure of venture capital firm in Korea. Then the current status of venture capital industry in Korea is described and its characteristics are explained.

2.1 Venture Capital Firm as a Corporation

Different from the U.S., the organizational form of venture capital firms in Korea is corporation. Shareholders of venture capital firms pay capital and employ managers and venture capitalists who will invest the paid-in capital. Besides the paid-in capital, the venture capital firms also raise outside funds. Therefore, the venture capitalists in Korea have two different sources of capital pools to invest. One is own fund or inside fund composed of paid-in capital and debt, and the other is outside funds which are made by outside investors who are called limited partners.⁵ As shown in Lee et al. (2003), this organizational structure of co-management of inside fund and outside funds within a single entity contains the potential opportunistic behaviors of venture capitalists.

2.2 Current Status of Venture Capital Industry in Korea

Venture boom and its ending In Korea, the venture capital industry experienced a venture boom during 1998-2000. During the boom, 98 new venture capital firms

⁵ For clear contrast with 'outside' fund, I use a terminology of 'inside' fund instead of 'own' fund hereinafter.

were established and 281 outside funds were newly organized.⁶ Three factors contributed to the boom: ① IT boom started in 1997; ② the government's policy effort to develop the venture capital industry; ③ the establishment of KOSDAQ market as a window of new companies' IPOs. As the IT boom disappeared since 2000, the venture boom also ended. Many small-sized venture capital firms closed their businesses and new investment shrank abruptly in 2001 and remained at a low level since then.

Rapid growth of outside funds After the burst of boom, a main trend in the venture capital industry in Korea was the development of outside funds. The amount of outside funds per firm has increased almost four times in five years as shown in Table 1. Table 2 summarizes the changes in the proportion of inside and outside funds in the total venture capital raised. In 2000, the total size of inside funds amounted to \$4.2 billion and accounted for almost 70 percent of the total venture capital raised. The size of outside funds was just \$1.9 billion and represented only 31 percent of the total venture capital. Since then, however, the size of inside funds has shrunk and the size of outside funds increased rapidly. In 2005, the total size of outside funds amounts to \$4.6 billion and accounts for more than 70 percent of the total venture capital.

<Table 1> Summary Statistics for Venture Capital Fund-raising

| (Unit: \$ Million) | | | | | | |
|------------------------------|-------|-------|-------|-------|-------|-------|
| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
| No. of venture capital firms | 147 | 145 | 128 | 117 | 105 | 102 |
| Paid-in capital per firm | 11.51 | 11.66 | 12.94 | 13.37 | 15.21 | 14.90 |
| Asset per firm | 30.49 | 26.46 | 26.12 | 20.84 | 25.18 | 24.52 |
| Outside fund per firm | 12.95 | 16.02 | 22.20 | 27.91 | 39.59 | 45.34 |

Source: 2006 KVCA Yearbook.

<Table 2> Trend of Venture Capital Fund-raising

| (Unit: \$ Billion, %) | | | | | | |
|-----------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
| Inside fund | 4.18 (68.7) | 3.44 (59.7) | 2.85 (50.0) | 1.92 (37.0) | 2.02 (32.7) | 1.83 (28.4) |
| Outside fund | 1.90 (31.3) | 2.32 (40.3) | 2.85 (50.0) | 3.27 (63.0) | 4.16 (67.3) | 4.62 (71.6) |
| Total | 6.09 | 5.77 | 5.70 | 5.19 | 6.17 | 6.45 |

Source: 2006 KVCA Yearbook.

⁶ Before the venture boom, there were only 50 venture capital firms. Also, only 42 outside funds were organized during the period of 1989-1997.

<Table 3> Trend of Venture Capital Investment

(Unit: \$ Billion, %)

| Year | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|-----------------------------|--------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Balance of total investment | Inside fund | 1.48 (64.8) | 1.23 (53.0) | 1.19 (46.4) | 0.94 (40.5) | 0.87 (34.3) | 0.64 (28.7) |
| | Outside fund | 0.80 (35.2) | 1.09 (47.0) | 1.38 (53.6) | 1.38 (59.5) | 1.67 (65.7) | 1.60 (71.3) |
| | Total | 2.28 | 2.32 | 2.57 | 2.32 | 2.54 | 2.24 |
| New investment | Inside fund | 1.60 | 0.68 | 0.13 (25.4) | 0.11 (21.0) | 0.08 (13.8) | 0.12 (16.2) |
| | Outside fund | | | 0.39 (74.6) | 0.42 (79.0) | 0.50 (86.2) | 0.63 (83.8) |
| | Total | 1.60 | 0.68 | 0.52 | 0.53 | 0.58 | 0.75 |

Source: 2006 KVCA Yearbook.

This tendency of rapid development of outside funds in the fund-raising stage is also observed in the investment stage. Table 3 outlines the trend of venture capital investment since 2000. Whereas the amount of new investment from the inside funds rapidly decreased, new investment from the outside funds has steadily increased, thereby representing 83.8 percent of new investment made in 2005. Reflecting the trend in the new investment, the portion of balance of total investment accounted by the outside funds has also increased about two times in five years.

2.3 Characteristics of Venture Capital Industry in Korea

Significant role of government in the fund-raising Reflecting the fact that the venture capital industry in Korea is still at an early stage of development, the Korean government is taking on a significant role in the fund-raising of outside funds. Table 4 summarizes the capital commitments to the outside funds by partner type during the period of 2001-2005. The government is the largest investor by providing on average 27.1 percent of committed capital to each outside fund and corporations and venture capital firms follow next. This structure of fund-raising contrasts with the U.S. In the U.S., the major investors in the venture capital market are private and public pension funds, financial/insurance companies, endowments and foundations, and they represent at least 80 percent of the venture capital raised. The U.S. government only supports the fund-raising of public venture capital firms which is called SBICs (Small Business Investment Companies).

Short life span of outside funds Another characteristic of venture capital industry in Korea is that the life spans of outside funds are mainly five years. Table 5 shows a general outline of the life spans of outside funds organized during the period of 1989-2007. 480 (76.3 percent) out of 630 funds stipulate a five-year life span and only 102 funds have a life span equal to or more than seven years. This picture becomes

<Table 4> Capital Commitments to Outside Funds by Partner Type (2001-2005)

(Unit: %)

| Government | Corporation | VC Firms | Pension Funds | Institutional Investors | Individuals | Foreign Investors |
|------------|-------------|----------|---------------|-------------------------|-------------|-------------------|
| 27.1 | 19.0 | 16.0 | 15.1 | 13.6 | 5.6 | 3.6 |

Source: 2006 KVCA Yearbook.

<Table 5> Life Span of Outside Funds (1989-2007)

| Life Span | 5 years | 6 years | 7 years | 8 years or more | Total |
|-----------|-----------|----------|----------|-----------------|----------|
| 1989-1999 | 70(57.4)a | 20(16.4) | 20(16.4) | 12(9.8) | 122(100) |
| 2000-2003 | 327(88.9) | 13(3.5) | 26(7.1) | 2(0.5) | 368(100) |
| 2004-2007 | 84(60.0) | 14(10.0) | 38(27.1) | 4(2.9) | 140(100) |
| Total | 481(76.3) | 47(7.5) | 84(13.3) | 18(2.9) | 630(100) |

Note: a. Numbers in parenthesis are the proportions of each group.

clearer when focusing on the period of 2000-2003. Almost 90 percent of the funds organized during this period have a five-year life span. Even though this tendency has been alleviated since 2004, still 60 percent of the funds stipulate a five-year life span. A five-year life span is much shorter compared with the U.S. case in which the life spans of venture capital funds are mainly 10 years or more.

Dominant proportion of IPO as a device of exit The venture capital industry in Korea also contrasts with that of the U.S. in respect to the exit device. Figure 1 compares Korea with the U.S. by the exit type of venture investment. Whereas M&A is a dominant exit window in the U.S., it represents less than five percent of total exits in Korea, which reflects the Korea's underdeveloped M&A market. IPOs through the KOSDAQ market consist of dominant portion in the total exits of venture investment.

Increasing proportion of expansion-staged invested firms The above mentioned characteristics of the venture capital industry in Korea, *i.e.*, short life spans of outside funds and venture investment exiting mainly through the IPO, have a strong implication regarding the ages of invested firms. In Korea, it is expected to generally take more than seven years for a newly established venture firm to offer its stock to the public.⁷ Therefore, for Korean venture capital firms that have to exit from the investment within three or four years and depend only on the IPO as an exit device, it is natural to concentrate their venture investment on expansion-staged companies that have lasted more than three years. During the venture boom of 1998-2000, this structural constraint on venture investment was not as serious since an interval taken for a new venture company to go public in those days was much shorter than now.

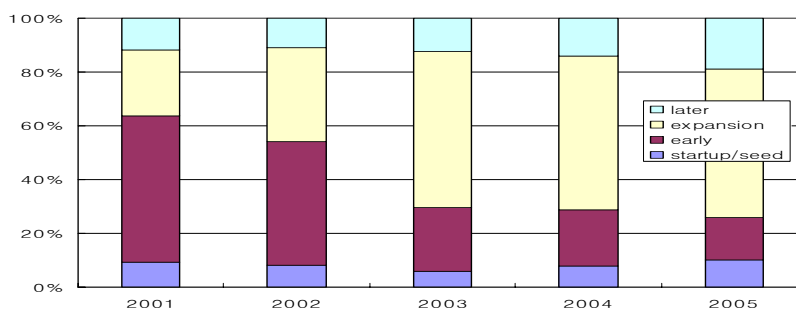
⁷ For venture invested companies that succeeded in going public, the average interval from the establishment to the IPO was 7.2 years in 2004 and 7.6 years in 2005 (2006 KVCA Yearbook).

[Figure 1] IPO and M&A as a Device of Exit: Comparison of Korea vs. U.S.



Source: NVCA homepage (<http://www.nvca.org>).

[Figure 2] New Investment by Invested Company Stage



Note: Startup/seed stage (less than 1 year); early stage (1 - 3 years); expansion stage (3 - 7 years); later stage (more than 7 years).

Source: 2006 KVCA Yearbook.

After 2000, the venture boom disappeared and the interval for an IPO has increased. The structural constraint of venture capital industry in Korea became apparent and the portion of venture investment toward expansion- or later-staged companies has increased rapidly. Figure 2 describes this trend in the venture investment. In 2001, expansion-staged firms account for only 24.6 percent of new venture investment, but in 2005, they represent 55 percent of new investment. During the same period, the proportion of new investment toward early-staged firms has promptly decreased from 54.4 percent to 15.8 percent.

3. Data

In Korea, each venture capital firm registered at SMBA (Small and Medium Business Administration) has an obligation to report full information on its

businesses to the KVCA. The information on the venture capital firms' businesses collected by the KVCA includes following categories: ① information on each venture capital firm's registration date, major stock holders, composition of inside fund, and the number of employees; ② information on each outside fund such as organization date, size, life span, the number of partners, each partner's capital commitment, managerial compensation rule, performance compensation rule, and the order of making up loss; ③ transaction data for each invested company such as transaction date, transaction amount, transaction type,⁸ and investment type;⁹ ④ information on each invested company such as registration date, region, type of business, the number of employees, and financial information including paid-in capital, sales, profit.

Among those categories, data in the second and third categories are mainly used for the analysis. Raw data from the KVCA include 164 venture capital firms, 636 outside funds, 9,947 invested firms, and 39,511 transactions. After excluding observations which have missing or miscoding values in the main variables, 109 venture capital firms and 601 outside funds are included in the dataset for the empirical analysis in Section 4 and 100 venture capital firms, 290 outside funds, 4,663 invested firms, and 12,530 investments are used for the analysis in Section 5.

In Section 4, for each of 601 outside funds, the amounts of capital committed by the Korean government, venture capital firms, and private investors are computed to evaluate the government's role in the fund-raising stage. In Section 5, where an examination on the role of the government in the investment stage is conducted, for each outside fund, the size, shares of capital committed by the government and a venture capital firm, concentration ratio of investment by industry and by region,¹⁰ average value of shares of a fund in invested firms, average age of invested firms, ratio of common stock investment, and ratio of money invested in high-tech industries, high- and medium-tech industries¹¹ are computed. In addition, the same variables at the venture capital firm level are also computed for the comparison of investment behaviors between inside fund and outside funds in Section 5.2. Along with those computed variables, several dummy variables representing the characteristics of venture capital firms and outside funds, and stipulated huddle rates¹² and life-spans of outside funds are used in the empirical analysis. Table 6 provides the definitions and summary statistics of main variables used in the analysis in Sections 4 and 5.

⁸ Transaction types include venture investment, retrieval of investment, and reduction of investment.

⁹ Venture investment is classified by its object: common stock; preferred stock; convertible bond; bond with warranty; and project financing.

¹⁰ For a detailed explanation on the computation of concentration ratio of investment by industry and by region, see Appendix.

¹¹ In the paper, any 'average' value of variable is a weighted average using the amount of investment in each invested firm as a weight.

¹² When organizing an outside fund, a venture capital firm defines a target rate of return which is called a 'huddle rate'. A typical outside fund is organized in such a way that a venture capital firm has no claim on earnings realized within a specified huddle rate in order to give the venture capital firm an incentive to make an effort to make considerable earnings.

<Table 6> Definition and Summary Statistics of Variables

| | Variables | Def. | # obs. | Mean | Std. | Max | Min |
|--|--------------------------|--|--------|-------|-------|-------|------|
| Section 4 Fund-raising | private _{ij} | Size of capital committed by private investors in outside fund j (\$ million) | 208 | 5.85 | 5.91 | 40.5 | 0 |
| | go _{ij} | Size of capital committed by the government in outside fund j (\$ million) | 208 | 4.08 | 4.48 | 40 | 0.3 |
| | vc _{ij} | Size of capital committed by venture capital firm i in outside fund j (\$ million) | 208 | 1.76 | 1.59 | 10 | 0 |
| | rep _{ij} | Registration date of outside fund j - registration date of venture capital firm i (year) | 208 | 5.82 | 5.63 | 19.8 | 0.3 |
| Section 5.1 Investment behaviors of outside funds | length _{ij} | Dummy, 1 if the stipulated life span of outside fund j is longer than 5 years | 288 | 0.13 | 0.34 | 1 | 0 |
| | rep _{ij} | Registration date of outside fund j - registration date of venture capital firm i (year) | 288 | 5.63 | 5.26 | 18.75 | 0.08 |
| | size(O) _{ij} | Size of outside fund j (\$ million) | 286 | 11.57 | 9.33 | 77.60 | 0.99 |
| | hrate _{ij} | Huddle rate of outside fund j (%) | 288 | 10.96 | 4.76 | 0 | 30 |
| | s_vc _{ij} | Share of venture capital firm i's commitment in the committed capital of outside fund j (%) | 286 | 18.16 | 12.34 | 70 | 0 |
| | s_go1 _{ij} | Share of commitment of SMBA (and Fund of funds) in the committed capital of outside fund j (%) | 286 | 15.77 | 17.94 | 94.66 | 0 |
| | hhi_inv(O) _{ij} | Concentration ratio of investment by industry (HHI) | 288 | 0.43 | 0.22 | 1 | 0.13 |
| | hhi_reg(O) _{ij} | Concentration ratio of investment by region (HHI) | 288 | 0.57 | 0.23 | 1 | 0.24 |
| | ave_age(O) _{ij} | Average age of invested firms (year) | 288 | 3.18 | 1.55 | 11.24 | 0.06 |
| | r_m1(O) _{ij} | Ratio of money invested in high-tech industries | 288 | 0.34 | 0.25 | 0.92 | 0 |
| | r_m12(O) _{ij} | Ratio of money invested in high- and medium-tech industries | 288 | 0.45 | 0.29 | 1 | 0 |
| | r_cs(O) _{ij} | Ratio of common stock investment | 288 | 0.55 | 0.33 | 1 | 0 |
| | share(O) _{ij} | Average value of shares of outside fund j in invested firms (%) | 260 | 11.89 | 10.48 | 83.33 | 1.24 |

<Table 6> Continued

| | Variables | Def. | # obs. | Mean | Std. | Max | Min |
|----------------|-------------------------|--|--------|-------|------|-------|-------|
| | ave_age(I) _i | Average age of invested firms in inside fund of venture capital firm i (year) | 76 | 2.95 | 0.97 | 5.63 | 0.93 |
| | ave_age(O) _i | Average age of invested firms in outside funds of venture capital firm i (year) | 76 | 3.11 | 0.97 | 6.09 | 1.34 |
| | d(ave_age) _i | ave_age(I) _i - ave_age(O) _i | 76 | -0.16 | 1.10 | 2.12 | -3.01 |
| | r_m1(I) _i | Ratio of money invested in high-tech industries in inside fund of venture capital firm i | 76 | 0.33 | 0.17 | 0.78 | 0 |
| | r_m1(O) _i | Ratio of money invested in high-tech industries in outside funds of venture capital firm i | 76 | 0.30 | 0.19 | 0.66 | 0 |
| Section 5.2 | r(r_m1) _i | r_m1(I) _i - r_m1(O) _i | 76 | 0.03 | 0.17 | 0.42 | -0.44 |
| Comparison | r_m12(I) _i | Ratio of money invested in high- and medium-tech industries in inside fund of venture capital firm i | 76 | 0.43 | 0.20 | 0.84 | 0.02 |
| between inside | r_m12(O) _i | Ratio of money invested in high- and medium-tech industries in outside funds of venture capital firm i | 76 | 0.41 | 0.22 | 0.84 | 0 |
| funds and | d(r_m12) _i | r_m12(I) _i - r_m12(O) _i | 76 | 0.02 | 0.20 | 0.54 | -0.32 |
| outside funds | r_cs(I) _i | Ratio of common stock investment in inside fund of venture capital firm i | 76 | 0.79 | 0.19 | 1 | 0.09 |
| | r_cs(O) _i | Ratio of common stock investment in outside fund of venture capital firm i | 76 | 0.52 | 0.24 | 1 | 0.02 |
| | d(r_cs) _i | r_cs(I) _i - r_cs(O) _i | 76 | 0.26 | 0.27 | 0.92 | -0.47 |
| | r_inv _i | Ratio of total size of outside funds to the size of inside fund of venture capital firm i | 76 | 3.47 | 4.79 | 28.25 | 0.12 |

In the paper, empirical analyses in Section 4 and Section 5.1 will be conducted separately for each period of venture boom and post-boom, and analyses in Section 5.2 and Appendix use the full sample without any distinction of periods

4. Fund-raising and the Role of the Government

This section investigates, the role of the Korean government in the fund-raising stage. In a situation where the venture capital industry is still underdeveloped and the amount of venture capital committed by the private sector is far below what is needed, the role of a government to increase the amount of venture capital by committing its capital or providing the private sector with incentives to invest in venture capital is considered very important. In Korea, the government has participated in various outside funds and committed a significant amount of public capital. In many cases, the Korean government also drew private investors to the fund-raising process by increasing the expected rate of return for the private investors by means of setting an upper limit on the rate of return for its share (and /or) allowing its share to be used foremost when covering potential losses. Considering those facts, the role of Korean government in the fund-raising process is evaluated in aspects of the size of government capital commitments, and the private sector's responsiveness to the government capital commitments to the outside funds.

4.1 Size of the Government Capital Commitments

The following table shows the size of government capital commitment and its share in outside funds made during the venture boom and after the boom. Variable *go* represents the amount of capital invested by the Korean government including the SMBA and the Fund of funds. During the venture boom the government invested about \$0.3 billion and represented 16.9 percent of the total outside funds. In the same period, general corporations accounted for 30.1 percent of the capital raised and individual investors provided 17.2 percent. After the boom, facing with an abrupt contraction of venture capital commitments from the private sector, the government expanded its role significantly. The government participated in 173 out of 309 outside funds made during the post-boom period and committed \$0.7 billion in total. This amount represented 24.4 percent of the capital raised during the same period and the government became the largest stakeholder in outside funds. In particular, for the outside funds with government participation, its share amounted to 38.0 percent followed by 16.5 percent of general corporations. With the end of the venture boom, the shares of general corporations and individual investors rapidly declined. Instead, pension funds have widened their presence in outside funds, providing 13.9 percent of the capital raised after the venture boom.

<Table 7> Size and Share of the Government Capital Commitment

(Unit: \$100 million, %)

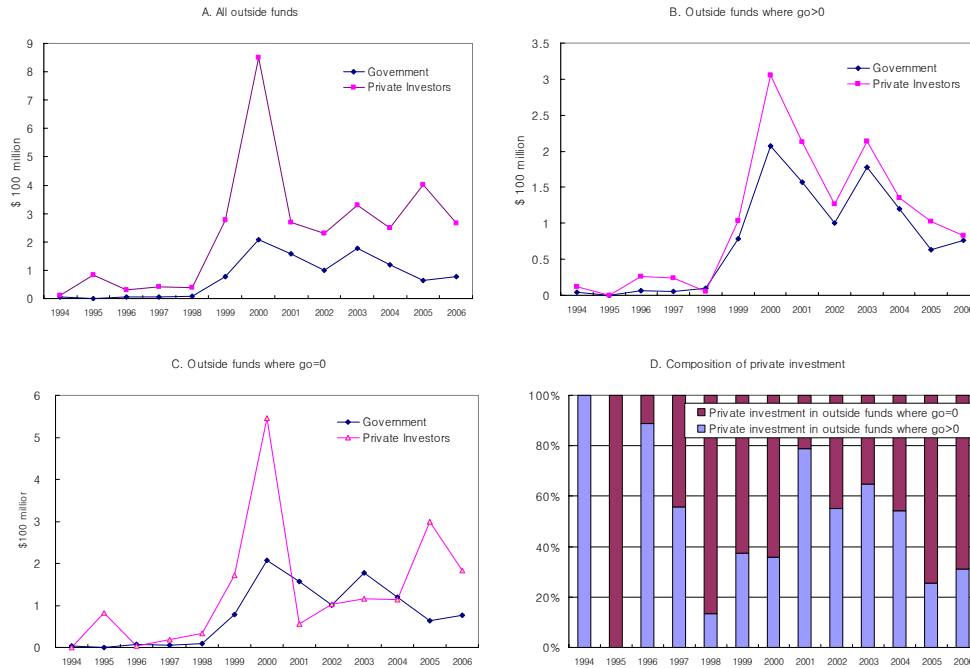
| Partner Type | Venture Boom | | | Post-boom | | |
|-------------------------|-------------------------|------------|------------|------------|------------|------------|
| | go>0[92] ^a | go=0[177] | Total[269] | go>0[173] | go=0[136] | Total[309] |
| Government | 2.95(34.3) ^b | 0(0.0) | 2.95(16.9) | 6.95(38.0) | 0(0.0) | 6.95(24.4) |
| VC firms | 1.52(17.7) | 1.38(15.5) | 2.90(16.6) | 2.63(14.4) | 1.48(14.5) | 4.12(14.4) |
| Institutional Investors | 0.52(6.0) | 1.79(20.1) | 2.31(13.2) | 2.03(11.1) | 1.76(17.3) | 3.79(13.3) |
| Corporations | 2.02(23.5) | 3.25(36.5) | 5.27(30.1) | 3.02(16.5) | 3.35(32.9) | 6.38(22.4) |
| Pension Funds | 0.14(1.6) | 0.10(1.1) | 0.24(1.4) | 2.09(11.4) | 1.88(18.5) | 3.97(13.9) |
| Individuals | 0.78(9.0) | 2.23(25.1) | 3.01(17.2) | 0.51(2.8) | 1.18(11.5) | 1.69(5.9) |
| Local Gov. | 0.03(0.3) | 0.02(0.2) | 0.05(0.3) | 0.25(1.4) | 0.22(2.1) | 0.47(1.6) |
| Foreigners | 0.65(7.5) | 0.14(1.5) | 0.78(4.5) | 0.82(4.5) | 0.33(3.2) | 1.15(4.0) |
| Total | 8.61(100) | 8.90(100) | 17.51(100) | 18.31(100) | 10.21(100) | 28.52(100) |

Note: a. Numbers in [] denote the number of outside funds in each group.

b. Numbers in () denote the shares of each partner type.

4.2 Private Sector's Responsiveness to the Government Capital Commitments

In addition to committing capital, the government also assists venture capital firms to organize outside funds by drawing private investors into the fund-raising process. One way of examining this aspect of the government's role is to see the responsiveness of private sector's venture capital commitments to the government capital commitments in outside funds. Figure 3 describes time-series movements of the size of capital commitments by the government and private investors, which are aggregated in outside funds. Figure 3-A is drawn with all outside funds made during a given year and Figure 3-B includes only outside funds with the government participation. Figure 3-A reveals that the capital commitments from the private sector moves together with the government capital commitments and this co-movement pattern becomes more apparent when considering only outside funds in which the government participated. In Korea, it was usually observed, in particular, after the ending of venture boom that a venture capital firm, when it planned to organize an outside fund, tried to obtain capital from the government first, and then went to the private sector to raise private capital with a leverage of capital committed by the government. Considering this common pattern of the fund-raising process, the co-movement between the sizes of capital coming from the government and the private investors during the post-boom period can be interpreted as a strong positive causality relationship from the government capital commitments to the private sector's capital commitments. That is, the capital

[Figure 3] Sizes of Capital Committed from Private Investors and the Government

committed by the government not only directly increased the size of outside funds, but also helped venture capital firms by attracting private investors to the fund-raising process in the post-boom period. Concerning the venture boom period, however, the co-movement between the two variables may not be interpreted strongly as a causality relationship. During the years of 1998-2000, the amount of private capital committed to the outside funds had drastically increased regardless of the government participation as shown in Figure 3-C, thereby creating a 'boom'.¹³ Taking the aspects of 'boom' into account, it may be misleading to interpret the co-movement between the capital commitments by the government and the private investors during the venture boom period totally as a causality relationship. Instead, a significant part of the co-movement observed during the venture period in Figure 3-A will represent a simple correlation between the two variables. This kind of reservation in interpretation may also be kept in regards to the co-movement between the relevant variables in Figure 3-B.

Since Figure 3 only describes time-series movements of the two aggregate variables without any conditioning, it may not be convincing enough to draw a

¹³ In fact, as Figure 3-D describes, in the venture boom period the amount of private capital committed to the outside funds with no government participation was much bigger than the amount of private capital in the outside funds where the government participated.

concrete relationship between the two variables. Now, a regression equation is constructed to explain the size of capital commitments by the private investors at the fund level for each period of the venture boom and post-boom. The regression equation for the venture boom period is as follows:

$$\begin{aligned} private_{ij} = & \alpha_0 + \alpha_1 go_{ij} + \alpha_2 vc_{ij} + \alpha_3 rep_{ij} + \sum_{k=0}^2 \alpha_{4+k} industry(k)_{ij} + \alpha_7 year99_{ij} \\ & + \alpha_8 year00_{ij} + u_{ij} \end{aligned} \quad (1)$$

where $private_{ij}$, go_{ij} , and vc_{ij} are the sizes of capital committed by the private investors, government, and venture capital firm i , respectively, in outside fund j organized by venture capital firm i . rep_{ij} is an interval between the registration date of fund j and the registration date of venture capital firm i and is assumed to represent the reputation of venture capital firm i when organizing outside fund j . $industry(0)_{ij}$, $industry(1)_{ij}$, and $industry(2)_{ij}$ are dummy variables indicating whether venture capital firm i stipulated culture and media-related industry, bio-related industry, and IT industry, respectively, as a main target for its investment when organizing outside fund j . $year99_{ij}$ and $year00_{ij}$ are year dummies indicating the registration date of fund j . Finally, u_{ij} is a mean-zero stochastic term representing either measurement error or a fund-specific shock unobservable to econometricians. A regression equation for the post-boom period is also constructed in the same way as Equation (1) substituting the year dummies of $year99$ and $year00$ with year dummies of $year02$, $year03$, $year04$, $year05$, and $year06$.

Those equations are estimated using the outside funds where the government participated.¹⁴ Table 8 summarizes the estimation results. For simplicity, coefficient estimates of industry dummies and year dummies are abbreviated from the table. Regression results show that the government participation in outside funds has been an effective device in attracting private investors into the fund-raising process of outside funds during the post-boom period.¹⁵ The coefficient estimate of

¹⁴ In general, this kind of regression analysis is likely to be plagued by a selection bias, *i.e.*, for a given outside fund, the size of capital committed by private investors and that by the government may depend on common unobservables. Considering the fund-raising process by a venture capital firm, however, it is very hard to control the selection bias problem considered here. A given venture capital firm submits a fund make-up proposal to the government and the government decides on its participation to the proposed fund. If the government decides not to participate, the proposed fund may have to raise its total amount of capital planned from the private sector, or the proposal may be given up totally. Furthermore, while raising private capitals, some funds are often combined with other funds to reach a certain level of size. Therefore, all *ex ante* proposed funds are not observed *ex post*. This means that we may not deal with the selection bias problem in a convincing way when measuring the impacts of the government capital commitments on the private investors' capital commitments. Because of this difficulty, simply OLS method was used to estimate Equation (1) despite the possible existence of selection bias problem.

¹⁵ A referee points out a possible existence of crowding-out effect, *i.e.*, the amount of private capital committed to a specific outside fund may increase with the government participation without any change in the total amount of private capital committed to the venture capital industry in a given year. Because of the characteristic of fund-raising process mentioned in the previous note, it is also very hard to detect the

<Table 8> Estimation Results of Responsiveness of Private Sector

| Variable ^a | <i>Private</i> | |
|-----------------------|-----------------------------|-----------------------------|
| | Venture Boom | Post Boom |
| | Coef. (t-value) | Coef. (t-value) |
| <i>go</i> | 1.663(5.11) ^{***b} | 0.926(6.83) ^{***} |
| <i>vc</i> | -0.043(-0.12) | -0.215(-0.75) |
| <i>rep</i> | -0.119(-1.28) | -0.126(-2.29) ^{**} |
| Adj. R-squared | 0.6553 | 0.7415 |
| # of obs. | 76 | 132 |

Note: a. Coefficient estimates of year dummies and industry dummies are abbreviated from the table.

b. ** and *** indicate that a coefficient estimate is statistically different from zero at the significance level of 5% and 1%, respectively.

go in the post-boom period amounts to 0.926, which means that each \$1 commitment from the government induced private sector's commitment of \$0.926 at maximum during this period.¹⁶ In the venture boom period, we also obtained a positive coefficient estimate of *go*. However, we need to be more cautious in interpreting this estimate result. As previously explained in this subsection, during the venture boom period a significant amount of the private capital invested in the outside funds where the government committed capital might move responding to the market condition, *i.e.*, a 'boom' rather than responding to the government participation. With currently available data, it is very difficult to distinguish precisely the effect of the government capital commitment on the private venture investment during the venture boom from the effect of the market condition. Another finding from the table is that the variable *rep*, which is assumed to represent the reputation of a venture capital firm organizing an outside fund, is negatively related to the size of private capital commitments into the outside fund. Considering the maturity or reputation of a venture capital firm has been identified as the most significant determinant of the size of funds in previous literature on the U.S. venture capital

existence of crowding-out effect from the fund-level data. Considering this difficulty, I just mention that the annual aggregate amount of private capital committed to the venture capital industry has co-moved very closely with the annual amount of the government capital commitments, as shown in Figure 3-A. Between 1994 and 2006, the correlation coefficient between the two aggregate variables amounts to 0.8283. For a reference, the correlation coefficients between the two aggregate variables in Figure 3-B and Figure 3-C are 0.9840 and 0.6174, respectively.

¹⁶ The terminology of 'at maximum' was used considering the coefficient estimate of *go* may not be interpreted as purely representing the 'responsiveness' of private sector to the government capital commitment because a selection bias may possibly exist. If a selection bias is present, only some portion of coefficient estimate would represent the 'responsiveness' and the remaining part should be interpreted as representing a 'correlation' between the government' and private sector's capital commitments.

industry,¹⁷ the negative coefficient of *rep* implies that the venture capital industry in Korea is not stabilized yet and still in an underdeveloped stage.¹⁸

In summary, the data tell us that the government has provided a significant amount of capital to venture capital firms for their venture investments since 1998 and this direct role of the government seems to have been expanded after the venture boom. The government also played an effective role in attracting private investors' capital in the post-boom period.

5. Venture Investment and the Role of Government

This section, which is a crucial part of this paper, evaluates the role of the Korean government in the investment stage. At first, Section 5.1 analyzes the investment behaviors of venture capital firms in Korea on outside funds at the fund level. Focus will be put on the effects of government capital commitment on the investment behaviors of outside funds and a hypothesis explaining empirical outcomes is suggested. The examination is conducted separately for each of venture boom and post-boom period. Section 5.2 compares the investment behaviors between inside funds and outside funds at the venture capital firm level and further attempts to find evidence on the hypothesis suggested in the previous subsection.

5.1 Government Participation and Changes in the Investment Behaviors of Outside Funds

As shown in Section 4, in a situation where the venture capital industry is still underdeveloped, the role of government in the fund-raising stage can be clearly stipulated as increasing fund capitalization by directly committing capital or attracting private sector's investment, and therefore it is somewhat straightforward to evaluate the role played by the government in the fund-raising stage. On the investment stage, however, it is not clear to outline the role of government since investment activities are done by venture capitalists, and not by the government. Nevertheless, we may stipulate several roles for the government with respect to the investment activities if we consider that the government has an objective to develop the venture capital industry itself rather than maximizing the rate of return from the venture investment like other limited partners. Following the definition of venture capital given in Gompers & Lerner (2001),¹⁹ the following activities are

¹⁷ Gompers & Lerner (1998).

¹⁸ The negative coefficient of *rep* should be interpreted with reservation since *rep* may not be an appropriate measure for the reputation of a venture capital firm. The reputation of a venture capital firm may be measured more properly by its history of track record. But, data on the track records are not available for an empirical analysis, even though private investors may have an access to that kind of information before committing capital to outside funds.

¹⁹ "Venture capital has developed as an important intermediary in financial markets, providing capital to

<Table 9> Investment Behaviors of Outside Funds: Comparison of Venture Boom vs. Post-boom

| Variable | Venture boom (1998-2000) | Post venture boom (2001-) | Diff. | p-value |
|-------------------|-----------------------------|------------------------------|--------|---------|
| <i>ave_age(O)</i> | 2.594 | 3.706 | 1.113 | 0.000 |
| <i>r_cs(O)</i> | 0.757 | 0.344 | -0.413 | 0.000 |
| <i>r_m1(O)</i> | 0.343 | 0.344 | 0.001 | 0.973 |
| <i>r_m12(O)</i> | 0.443 | 0.467 | 0.024 | 0.482 |

suggested as the role of a government that tries to develop the venture capital industry in the investment stage, though those are not undisputable: ① the government draws venture capitalists' investment toward earlier-staged firms which are plagued by high levels of informational asymmetry and uncertainty (*ave_age*); ② the government guides more venture investments toward industries of which markets change very rapidly such as high- and medium-tech industries (*r_m1*, *r_m12*)²⁰; and ③ the government induces a common stock investment of venture capitalists, thereby giving the venture capitalists incentives to engage actively in the management activities of invested firms (*r_cs*).²¹

Table 9 describes the trends of the above four variables since 1998. It also tabulates the results of t-test analysis for those variables. For the t-test analysis, outside funds organized during the venture boom were compared with those organized after the boom. If we assume that a major part of committed capital of an outside fund is invested within a year after the formation, the results of the t-test analysis tell us that the average age of invested firms (*ave_age(O)*) has significantly increased and the ratio of common stock investment (*r_cs(O)*) decreased very significantly after the boom burst. Larger values of *ave_age(O)* and smaller values of *r_cs(O)* in the post-boom period commonly reflect the fact that venture capital firms avoided risky projects after experiencing the venture boom and its abrupt ending, which is a generally accepted view on the venture capital industry in Korea.²² The

firms that might otherwise have difficulty attracting financing. These firms are typically small and young, plagued by high level of uncertainty... Moreover, these firms... operate in markets that change very rapidly. Venture capital organizations finance these high-risk, potentially high-reward projects, purchasing equity or equity-linked stakes..." (Gompers & Lerner, 2001)

²⁰ The classification of manufacturing industries by technology level follows OECD (2005)

²¹ Beside the variables *ave_age(O)*, *r_m1(O)*, *r_m12(O)*, *r_cs(O)*, there are other variables which are assumed to summarize the investment behaviors of venture capital firms, even though they may not be directly related to the government's objective of developing a venture capital industry. Those may include the concentration ratio of investment by industry (*lhi_inv(O)*), by region (*lhi_reg(O)*), and the average value of shares of an outside fund in invested firms (*share(O)*). The Appendix investigates outside funds in respect to those variables.

²² These changing patterns are exactly opposite from the government's objectives. However, it would be very difficult even for the government who came out to be the largest stakeholder of outside funds in the

ratios of investment in high-tech industries ($r_{m1}(O)$) and in high- and medium-tech industries ($r_{m12}(O)$) are not statistically different between the venture boom period and post-boom period.

Table 10 compares the investment behaviors between outside funds in which the government made capital commitment and outside funds with no government capital commitment for each period of venture boom and post-boom. Group 1 consists of outside funds whose value of s_{go1} is zero. Group 2 are composed of outside funds whose value of s_{go1} is positive.

If the government makes effort in the investment stage to accomplish its goal of developing the venture capital industry, we may expect to obtain a smaller value of $ave_age(O)$ and larger values of $r_{cs}(O)$, $r_{m1}(O)$, and $r_{m12}(O)$ in the second group for each period.²³ Contrary to the expectation, however, the table reports that the average age of invested firms in Group 2 is significantly higher than that in Group 1. The ratio of common stock investment also has lower values when the government has stakes in outside funds. These unexpected patterns, however, disappeared after the venture boom even though the average values of $ave_age(O)$ and $r_{cs}(O)$ in Group 2 are not still statistically different from those in Group 1. These results may indicate that the government did not play its expected role and rather played in the opposite direction with respect to the variables $ave_age(O)$ and $r_{cs}(O)$ during the venture boom period, and that there have been some policy improvements regarding those variables after the boom burst.

Concerning the ratios of investment in the high-tech and high- and medium-tech industries, the situation is opposite to what has been seen regarding the variables $ave_age(O)$ and $r_{cs}(O)$. During the venture boom period, the group with the government capital commitments had higher values of $r_{m1}(O)$ and $r_{m12}(O)$, though the value of each variable is not statistically different between the two groups. After the boom burst, however, the two variables have changed in the opposition direction from what was expected, resulting in significantly lower values in Group 2 in both variables. These results may also imply that the government is not working properly in leading the venture investment towards the high- and medium-tech industries.

Table 10 provides several indications of government policy failure in the investment stage, but it simply compared investment behaviors between two groups without controlling any other variables which may affect the compared variables.²⁴

post-boom period to go against that stream of changes in investment behaviors.

²³ The government may accomplish its goal by guiding venture capitalists' investment activities to the direction of its objective with implicit or explicit contracts with venture capital firms when committing capital.

²⁴ The comparison results in Table 10 may reflect other underlying effects rather than implying a policy failure. For example, the following chain of logics may work in deriving the observed patterns in the table: a higher level of s_{go1} → a larger size of outside fund → a bigger amount of investment per project → a higher value of $ave_age(O)$ and a lower value of $r_{cs}(O)$. The first two arrows are supported by the data. The last is generally accepted as true. A bigger amount of investment per project is usually related to relatively big-sized companies of which a venture capitalist may not have any strong incentives to engage in the management process, which directly results in a lower level of $r_{cs}(O)$. Also, a big-sized company is

<Table 10> Role of Government in the Investment Stage: Venture Boom vs. Post-boom

| Variable | Period | <i>s_go1 = 0 vs. s_go1 > 0</i> | | | |
|-------------------|--------------|-----------------------------------|-------------------------------|--------|---------|
| | | Group1 <i>s_go1 = 0</i> | Group2 <i>s_go1 > 0</i> | Diff. | p-value |
| <i>ave_age(O)</i> | Venture boom | 2.319 | 3.030 | 0.711 | 0.002 |
| | Post-boom | 3.730 | 3.687 | -0.043 | 0.869 |
| <i>r_cs(O)</i> | Venture boom | 0.863 | 0.587 | -0.276 | 0.000 |
| | Post-boom | 0.327 | 0.358 | 0.030 | 0.501 |
| <i>r_m1(O)</i> | Venture boom | 0.334 | 0.358 | 0.024 | 0.571 |
| | Post-boom | 0.402 | 0.295 | -0.107 | 0.015 |
| <i>r_m12(O)</i> | Venture boom | 0.426 | 0.468 | 0.042 | 0.372 |
| | Post-boom | 0.522 | 0.421 | 0.101 | 0.055 |

Now, in order to evaluate the role of government in the investment stage, for each of the above four variables, and for each period of venture boom and post-boom, a linear equation is constructed as follows:

$$\begin{aligned}
 dep_{ij} = & \beta_0 + \beta_1 industry(0)_{ij} + \beta_2 industry(1)_{ij} + \beta_3 scd(O)_{ij} + \beta_4 rep_{ij} \\
 & + \beta_5 size(O)_{ij} + \beta_6 hrate_{ij} + \beta_7 s_vc_{ij} + \beta_8 d(s_go1)_{ij} \\
 & + \beta_9 length_{ij} + \sum_i \beta_{9+i} D_i + e_{ij} \tag{2}
 \end{aligned}$$

where *industry(0)_{ij}* and *industry(1)_{ij}* are dummies indicating whether the stipulated main industries of investment outside fund j are culture- and media-related, or biotechnology-related, respectively; *scd(O)_{ij}* is a dummy indicating whether outside fund j is secondary²⁵; *size(O)_{ij}* is a total amount of capital committed into outside fund j; *hrate_{ij}* is a huddle rate of outside fund j; *s_vc_{ij}* is a share of venture capital firm i in the committed capital of outside fund j; and *d(s_go1)_{ij}* is a dummy indicating whether a share of the SMBA and the Fund of funds is positive. *length_{ij}* is a dummy indicating whether the stipulated life span of outside fund j is more than 5 years. *D_i*'s are dummies aimed at capturing firm-specific effect. Finally, *e_{ij}* is a mean-zero stochastic term representing either measurement error or a fund-specific shock unobservable to econometricians.

usually at the stage of expansion or later, which gives us a higher level of *ave_age(O)*. Therefore, a simple comparison such as in Table 10 does not give us a convincing answer to the main forces driving the higher value of *ave_age(O)* and the lower value of *r_cs(O)* in Group 2 during the venture boom period.

²⁵ A secondary fund purchases venture firms' stock owned by other venture funds rather than initially investing in venture firms, thereby it helps the exit process of other venture funds.

Table 11 reports the estimation results of those equations, in particular, the net effect of $d(s_go1)$ on the investment behaviors after controlling the effects of $industry(0)$, $industry(1)$, $scl(O)$, rep , $size(O)$, $hrate$, s_vc , and $length$ variables. The coefficient estimate of $d(s_go1)$ in the regression of $ave_age(O)$ during the venture boom, is positive and significant at 5% significance level. This confirms the implication from Table 10 that the government did not play an expected role regarding the ages of invested firms when it made capital commitments during the venture boom. On the contrary, after the boom, the opposite impacts of $d(s_go1)$ on the level of $ave_age(O)$ disappeared resulting in insignificant coefficient estimate of $d(s_go1)$.²⁶ Instead, the dummy variable indicating whether an outside fund is secondary, the maturity of a venture capital firm that organizes fund, and the size of fund are found to be the main determinants in the average age of invested firms. The same pattern follows for the variable $r_cs(O)$. The estimation result tells us that the capital commitment of the government in outside fund lowers the ratio of common stock investment rather than increasing it in the venture boom period. This opposite impacts of $d(s_go1)$ also disappeared during the post-boom period.

For the ratios of investment in the high-tech industries ($r_m1(O)$), the negative relationship between the variables $d(s_go1)$ and $r_m1(O)$ during the post-boom period found in the previous table still remains as true when controlling other variables. However, the negative relationship between the variables $d(s_go1)$ and $r_m12(O)$ during the post-boom period found in the previous table does not hold when other independent variables are controlled. The table reports that the ratios of investment of outside fund in the high-tech and high- and medium-tech industries are basically determined by the dummy variables indicating whether the stipulated main industries of investment of the fund are culture- and media-related, or biotechnology-related.²⁷

The finding that variable $industry(0)$, a dummy indicating whether the stipulated main industries of investment of the fund are culture- and media-related has

²⁶ A referee points out that the empirical strategy employed in the paper makes it impossible to test a structural break in the relationship between the government participation and the investment behaviors of outside funds because the regression analyses are conducted separately for each period of venture boom and post-boom. Although his opinion is right, the interest of this paper also lies in the possible breaks in the relationships between other independent variables and the investment behaviors of outside funds, as well, hence the empirical strategy presented here will be kept. In fact, the referee's suggestion was followed and each of the four equations was estimated using the full sample with an interaction term of time dummy (for post-boom period) and $d(s_go1)$. The estimation results reject the null hypothesis that there is no structural break in the relationship between the government participation and the investment behaviors of outside funds in the aspects of $ave_age(O)$ and $r_cs(O)$ at 5% significance level. Also the same results are found when using s_go1 instead of $d(s_go1)$ as an explanatory variable.

²⁷ In the sample, the proportions of outside funds of which stipulated main targets of investment are culture- and media-related industries, are 7.8 percent (10 out of 127) and 27.5 percent (41 out of 149), respectively, during the venture boom period and post-boom period. The weighted average values of r_m1 of those outside funds amount to 0.37 and 0.36 during the venture boom and post-boom period, respectively. Even though those values are lower than the average values of r_m1 of other outside funds (0.50 and 0.56, respectively), it may be difficult to say that the estimation results reported in Tables 11 and 12 are derived mainly by the inclusion of those outside funds in the sample.

<Table 11> Estimation Results of Investment Behaviors of Outside Funds (I)

| Variable | <i>ave_age(O)</i> | | <i>r_cs(O)</i> | | <i>r_m1(O)</i> | | <i>r_m12(O)</i> | |
|--------------------|-------------------|-----------------|------------------|------------------|------------------|-------------------|------------------|-------------------|
| | Venture Boom | Post Boom | Venture Boom | Post Boom | Venture Boom | Post Boom | Venture Boom | Post Boom |
| | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) |
| <i>industry(0)</i> | -0.430(-1.23) | -0.417(-1.39) | -0.353(-4.86)*** | -0.345(-7.48)*** | -0.223(-3.20)*** | -0.408(-11.37)*** | -0.325(-4.22)*** | -0.518(-12.41)*** |
| <i>industry(1)</i> | -0.760(-3.54)***a | 0.060(0.15) | 0.134(2.37)** | -0.080(-0.90) | 0.308(7.53)*** | -0.030(-0.27) | 0.259(4.90)*** | -0.138(-1.02) |
| <i>scd(O)</i> | | 3.017(4.77)*** | | 0.526(10.10)*** | | 0.124(0.64) | | 0.124(0.68) |
| <i>rep</i> | 0.032(1.63) | 0.052(2.07)** | -0.001(-0.30) | -0.002(-0.31) | 0.004(0.90) | -0.004(-1.02) | 0.007(1.39) | 0.006(1.30) |
| <i>size(O)</i> | 0.012(1.15) | 0.030(3.45)*** | 0.002(0.82) | -0.002(-0.98) | 0.003(1.47) | 0.003(1.79)* | 0.004(1.61) | 0.001(0.29) |
| <i>hrate</i> | 0.063(2.48)** | -0.051(-1.28) | -0.003(-0.63) | 0.004(0.54) | 0.004(0.77) | 0.005(0.68) | 0.006(0.93) | 0.004(0.31) |
| <i>s_vc</i> | -0.009(-1.15) | -0.008(-0.85) | 0.001(0.79) | 0.003(2.12)** | -0.000(-0.12) | 0.002(0.84) | -0.001(-0.64) | 0.001(0.50) |
| <i>d(s_go1)</i> | 0.586(2.59)** | -0.020(-0.11) | -0.241(-5.16)*** | 0.033(0.96) | 0.030(0.52) | -0.063(-2.01)** | 0.070(1.12) | -0.047(-1.22) |
| <i>length</i> | -0.429(-1.11) | -0.302(-1.07) | | | | | | |
| Adj. R-squared | 0.7824 | 0.6430 | 0.8749 | 0.8510 | 0.7589 | 0.8012 | 0.7558 | 0.8831 |
| # of obs. | 122 | 144 | 122 | 146 | 125 | 142 | 125 | 146 |

Note: a, *, **, and *** indicate that a coefficient estimate is statistically different from zero at the significance level of 10%, 5%, and 1%, respectively.

negative impacts on $r_{m1}(O)$ and $r_{m12}(O)$, is an expected one considering that the culture- and media-related industries are not high-tech or high- and medium-tech industries in general. Since an investment into the culture- and media-related industries usually takes the form of project financing rather than common stock investment, the variable $industry(0)$ also has a negative impact on $r_{cs}(O)$.

In regards of variable $industry(1)$, a dummy indicating whether the stipulated main industries of investment of the fund are bio-related, it is expected to have positive impacts on $r_{m1}(O)$ and $r_{m12}(O)$ because the bio-related industries are classified as high-tech industries. Estimation outcomes saying that the variable $industry(1)$ has no impact on $r_{m1}(O)$ and $r_{m12}(O)$ in the period of post-boom, seem to indicate that outside funds whose stipulated industries were bio-related were not invested as stipulated during the post-boom period.²⁸ A negative impact on $ave_age(O)$ of $industry(1)$ and a positive impact on $r_{cs}(O)$ in the venture boom period seem to tell us that outside funds stipulated to invest mainly to the bio-related industries took the risk more aggressively during the venture boom.²⁹

Positive coefficient estimates of $scd(O)$ in the regressions of $ave_age(O)$ and $r_{cs}(O)$ are expected from the definition of secondary fund. A positive impact of $size(O)$ on $ave_age(O)$ in the post-boom period may be explained by the logic provided in the previous note 24. On the contrary, it is not clear to interpret a positive impact of rep on $ave_age(O)$ in the post-boom period. It may reflect a changed recognition after the boom that only a small number of firms could be qualified for the investment from a conservatively changed view of venture capitalists. In this situation, well-qualified firms in the expansion or later stage might have a power to choose venture capital firms to invest to them and they chose experienced venture capital firms rather than newly-established ones.

Equation (2) is re-estimated with a substitution of $d(s_go1)$ with s_go1 in order to see how the investment behaviors of venture capitalists change according as the level of s_go1 increase.³⁰ The estimation results are summarized in Table 12 and they are very similar qualitatively to the results in the previous table. As shown in the table, the average age of invested firms was increasing and the ratio of common stock investment was decreasing as the share of the government in outside fund increased

²⁸ In the post-boom period, out of 149 outside funds, four funds were stipulated to mainly invest to the bio-related industries. Although their values of r_{m1} and r_{m12} are a little bit higher than those of other funds on average, their values of r_{m1} and r_{m12} are distributed broadly over the range of 0.07 and 0.83 and the range of 0.19 and 0.90, respectively. These distribution patterns are not significantly different from those for other outside funds.

²⁹ In the venture boom period, out of 127 outside funds, seven funds were stipulated to mainly invest to the bio-related industries. Their average values of $ave_age(O)$ and $r_{cs}(O)$ were 1.74 and 0.89, respectively, and those values for other outside funds were 2.64 and 0.75.

³⁰ To see how the investment behaviors change with an increase in s_go1 , it would be more appropriate to use only outside funds whose value of s_go1 is positive in the regression analysis rather than including all observations to the analysis. However, the number of outside funds whose value of s_go1 is positive in the venture boom period is just 56, which is relatively too small for a credible estimation result. Considering this difficulty, in the paper the analysis with all outside funds was conducted even though it may not be conceptually correct.

<Table 12> Estimation Results of Investment Behaviors of Outside Funds (II)

| Variable | <i>ave_age(O)</i> | | <i>r_cs(O)</i> | | <i>r_m1(O)</i> | | <i>r_m12(O)</i> | |
|--------------------|-------------------|-----------------|------------------|------------------|------------------|-------------------|------------------|-------------------|
| | Venture Boom | Post Boom | Venture Boom | Post Boom | Venture Boom | Post Boom | Venture Boom | Post Boom |
| | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) |
| <i>industry(0)</i> | -0.389(-1.12) | -0.421(-1.40) | -0.356(-4.73)*** | -0.342(-7.53)*** | -0.218(-3.05)*** | -0.411(-11.37)*** | -0.318(-3.98)*** | -0.520(-12.51)*** |
| <i>industry(1)</i> | -0.781(-3.73)***a | 0.072(0.18) | 0.145(2.67)** | -0.086(-0.96) | 0.308(7.67)*** | -0.025(-0.22) | 0.257(4.90)*** | -0.133(-0.97) |
| <i>scl(O)</i> | | 2.988(4.69)*** | | 0.540(10.57)*** | | 0.116(0.57) | | 0.113(0.61) |
| <i>rep</i> | 0.035(1.77) | 0.052(2.08)** | -0.002(-0.58) | -0.002(-0.38) | 0.004(0.92) | -0.004(-0.95) | 0.007(1.40) | 0.006(1.37) |
| <i>size(O)</i> | 0.014(1.33) | 0.030(3.55)*** | 0.001(0.65) | -0.002(-1.05) | 0.003(1.53) | 0.003(1.83)* | 0.004(1.68)* | 0.001(0.35) |
| <i>hrate</i> | 0.063(2.44)** | -0.049(-1.24) | -0.003(-0.70) | 0.004(0.48) | 0.004(0.76) | 0.005(0.62) | 0.006(0.94) | 0.004(0.31) |
| <i>s_vc</i> | -0.008(-1.03) | -0.008(-0.83) | 0.001(0.60) | 0.003(2.14)** | -0.000(-0.04) | 0.002(0.82) | -0.001(-0.49) | 0.001(0.49) |
| <i>s_go1</i> | 0.015(2.32)** | 0.001(0.20) | -0.007(-5.14)*** | 0.000(0.28) | 0.001(0.43) | -0.002(-1.88)* | 0.002(1.08) | -0.001(-0.87) |
| <i>length</i> | -0.388(-0.98) | -0.295(-1.04) | | | | | | |
| Adj. R-squared | 0.7799 | 0.6430 | 0.8710 | 0.8509 | 0.7586 | 0.7981 | 0.7554 | 0.8825 |
| # of obs. | 122 | 144 | 122 | 146 | 125 | 142 | 125 | 146 |

Note: a, *, **, and *** indicate that a coefficient estimate is statistically different from zero at the significance level of 10%, 5%, and 1%, respectively.

in the venture boom period. The ratio of investment in the high-tech industries decreased with an increase in the share of the government in the post-boom period. These estimation results can be interpreted as stronger evidences on a hypothesis that the government has failed in guiding the venture investments toward firms where the government targeted.

So far, the role of government in the investment stage was evaluated by comparing the investment behaviors of outside funds where the government committed capital and those of outside funds in which the government did not participate. The empirical outcomes indicate that the government failed in inducing the investment of outside funds toward earlier-staged companies that were suffering from a high level of informational asymmetry and uncertainty and also failed in guiding common stock investment, in particular, during the venture boom period. The empirical analysis also indicates that the government has not been working properly in increasing the venture investment toward the high-tech industries during the post-boom period.

It is not easy to figure out the reason why those undesirable investment behaviors from the government's perspective are observed, in particular, during the venture boom period. One plausible scenario is that, although the government wanted to develop the venture capital industry, at the same time it may not have the willingness to run the risk of losing money during the venture boom period and possibly thereafter. As stated in Section 4, the participation of government had been crucial in raising the capital of outside funds during the venture boom period. In this situation, a venture capital firm may have had an incentive to manage outside fund in which the government made a capital commitment relatively safely, thereby inviting the government to the fund-raising process successively. Then the undesirable investment behaviors are generated. If this has been a case, the fundamental reason for those undesirable investment behaviors is that the government is setting up two objectives incompatible to each other regarding the venture capital industry. By nature of the venture capital itself, running a risk of losing money is a basic role required in any participants. Therefore, from the perspective of the Korean government engaging in the fund-raising stage very actively, the government needs to be more flexible in losing its money in the investment process in order to maximize the original function of the venture capital investment. Instead, the government should put more resources in selecting qualified venture capital firms to invest its budget, monitoring the investment activities of selected venture capital firms, and evaluating their performance.

5-2 Finding Evidence on the Hypothesis: Comparison of Inside Funds and Outside Funds

In the previous subsection, a possible reason was suggested in why undesirable investment behaviors from the government's perspective are observed among outside funds where the government committed a significant amount of capital. In this subsection, the paper tries to find evidence on the above-mentioned hypothesis by comparing the investment behaviors between inside fund and outside funds at

the level of venture capital firm. As previously explained, inside funds and outside funds are different in respect to funding sources. Whereas inside funds are composed of paid-in capital and debt, outside funds are created mainly by external investors. In particular, the government has actively participated in outside funds as a major investor in Korea. Therefore, if the outside funds of a given venture capital firm were managed more conservatively relative to the inside fund as the venture capital firm's dependence on the government increases in the fund-raising process,³¹ then we may have an indirect evidence supporting the hypothesis that the venture capital firms managed outside funds conservatively in order to invite the government to the fund-raising process.

To proceed with an analysis following the logic suggested above, at first two weighted average values for each variable of *ave_age*, *r_cs*, *r_m1*, and *r_m12* were computed - one for inside fund and the other for outside funds for each of venture capital firms.³² Then the following four variables representing the differences in the investment behaviors between inside fund and outside funds for a given venture capital firm were created: $d(ave_age) = ave_age(I) - ave_age(O)$; $d(r_cs) = r_cs(I) - r_cs(O)$; $d(r_m1) = r_m1(I) - r_m1(O)$; $d(r_m12) = r_m12(I) - r_m12(O)$.³³ Finally, a regression equation to explain the variation of each difference variable at the firm level was constructed. a linear relationship is assumed as follows:

$$d(ave_age_i) = \gamma_0 + \gamma_1 ave_age(I)_i + \gamma_2 year(vc)_i + \gamma_3 s_vc_i + \gamma_4 s_go1_i + \gamma_5 r_inv_i + u_i \quad (3)$$

where $year(vc)_i$ is a dummy variable indicating whether venture capital firm i was established in or after 1999; s_vc_i and s_go1_i are the shares of venture capital firm i and the SMBA and the Fund of funds, respectively, in total amount of capital committed to outside funds organized by venture capital firm i ; and r_inv_i is the ratio of the total size of outside funds to the size of inside fund of venture capital firm i . u_i is a mean-zero stochastic term representing either measurement error or a fund-specific shock unobservable to econometricians. A variable s_go1 represents a venture capital firm's dependence on the government when organizing outside funds. r_inv is also expected to capture indirectly a venture capital firm's relative dependence on the government in the fund-raising process to some degree. A dummy variable $year(vc)$ is included in the explanatory variables reflecting a possibility that old venture capital firms and newly-established firms may have different attitude in managing their inside funds and outside funds.³⁴ For each of

³¹ A venture capital firm's relative dependence on the government with respect to the fund-raising is measured by the share of the government in the total amount of capital committed to the outside funds made by the venture capital firm.

³² Out of 100 venture capital firms in the sample, 24 venture capital firms, of which either an inside fund or outside funds in total made investments in less than 10 projects, are excluded from the analysis for a credible comparison.

³³ Table 6 provides several moments including average value and standard deviation for each difference variable.

³⁴ Among 76 venture capital firms used for the analysis, 44 firms were established in or after 1999. Venture

<Table 13> Estimation Results of Differences in the Investment Behaviors

| Variable | $d(ave_age)$ | $d(r_cs)$ | $d(r_m1)$ | $d(r_m12)$ |
|----------------|------------------|-----------------|-----------------|-----------------|
| | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) |
| $ave_age(I)$ | 0.655(7.03)***a | | | |
| $r_cs(I)$ | | 0.764(4.88)*** | | |
| $r_m1(I)$ | | | 0.323(3.34)*** | |
| $r_m12(I)$ | | | | 0.388(4.12)*** |
| $year(vc)$ | 0.476(2.43)** | 0.052(0.98) | -0.018(-0.45) | 0.047(1.03) |
| s_vc | 0.016(1.81)* | -0.000(-0.14) | -0.002(-1.21) | -0.001(-0.53) |
| s_go1 | -0.023(-2.51)** | 0.007(3.32)*** | 0.003(2.14)** | 0.001(0.82) |
| r_inv | -0.045(-1.43) | 0.019(2.65)** | 0.000(0.04) | 0.000(0.03) |
| Cons. | -2.106(-4.93)*** | -0.528(-3.55) | -0.082(-1.46) | -0.185(-2.65)** |
| Adj. R-squared | 0.4253 | 0.4368 | 0.2242 | 0.2198 |
| # of obs. | 74 | 74 | 71 | 71 |

Note: a, *, **, and *** indicate that a coefficient estimate is statistically different from zero at the significance level of 10%, 5%, and 1%, respectively.

other difference variables, we can construct a regression equation in the same way as Equation (3).³⁵

Table 13 tabulates the estimation results of Equation (3). In all regressions, except for the variable $d(r_m12)$, s_go1 has a statistically significant coefficient estimate. As the level of s_go1 increases, $d(ave_age)$ decreases. That is, for a given value of the average age of portfolio firms in an inside fund, the average age of portfolio firms in outside funds is increasing according as the portion of the government capital commitment in the total amount of capital of outside funds increases. Dependent variables $d(r_cs)$ and $d(r_m1)$ increase with the level of s_go1 , saying that the ratio of common stock investment and the ratio of money invested in high-tech industries in outside funds are decreasing with the share of the government in the outside funds for given values of those variables in an inside fund. These estimation results

capital firms established recently might not have enough time to build up networking with private investors yet and therefore depended more on the government participation in the fund-raising process. If the hypothesis made in the previous subsection is correct, this may lead to relatively more conservative management of outside funds among those new venture capital firms compared to old venture capital firms.

³⁵ In Equation (3), the variable $ave_age(I)$ comes in both sides since $d(ave_age)$ is just $ave_age(I)$ minus $ave_age(O)$. However, this does not create any problem in the estimation procedure. Equation (3) can be easily transformed to an equation explaining the variation of $ave_age(O)$ instead of $d(ave_age)$, and then we will have a usual regression equation.

commonly tell us that outside funds were managed more conservatively relative to inside fund as a venture capital firm's dependence on the government increases in the fund-raising process. Those results can be interpreted as a supporting evidence as well on the hypothesis that the venture capital firms managed outside funds conservatively in order to invite the government to the fund-raising process successively, although those are not directly confirming the hypothesis.

As a secondary matter, the variable $year(vc)$ does not have any explanatory power for the variations of $d(r_cs)$, $d(r_m1)$, and $d(r_m12)$ except for the variable $d(ave_age)$.³⁶ These regression outcomes contrast with the expectation and say that newly-established venture capital firms were not significantly different from old venture capital firms in managing their inside and outside funds. Both groups of venture capital firms managed outside funds more conservatively than their inside funds to a similar degree. On the contrary, the coefficient estimate of variable r_inv has an expected positive sign in explaining the variation of $d(r_cs)$. If r_inv can be regarded as measuring a venture capital firm's relative dependence on the government in fund-raising to some degree, the positive coefficient estimate of r_inv tells us that venture capital firms that relied more on the government, managed their outside funds more conservatively relative to their inside funds with respect to the common stock investment.

6. Conclusion

This paper, evaluated the policy effort of the Korean government in developing a venture capital industry. The evaluation is conducted in the fund-raising stage and investment stage, separately. Also the empirical analyses are conducted for the venture boom period and post-boom period separately, considering that there may be a structural change in the venture capital industry with the ending of the boom.

The empirical analyses show that the government played a significant role in the fund-raising stage in both periods. The government has provided a significant amount of capital to venture capital firms for their venture investments. This direct role of the government in the fund-raising stage has been expanded after the venture boom, making the government the largest shareholder in outside funds. The regression analyses reveal that the government capital commitment has also been an effective device to attract private investors' capital in both periods, even though the magnitude of responsiveness of the private sector to the government capital commitments declined significantly as the venture boom ended.

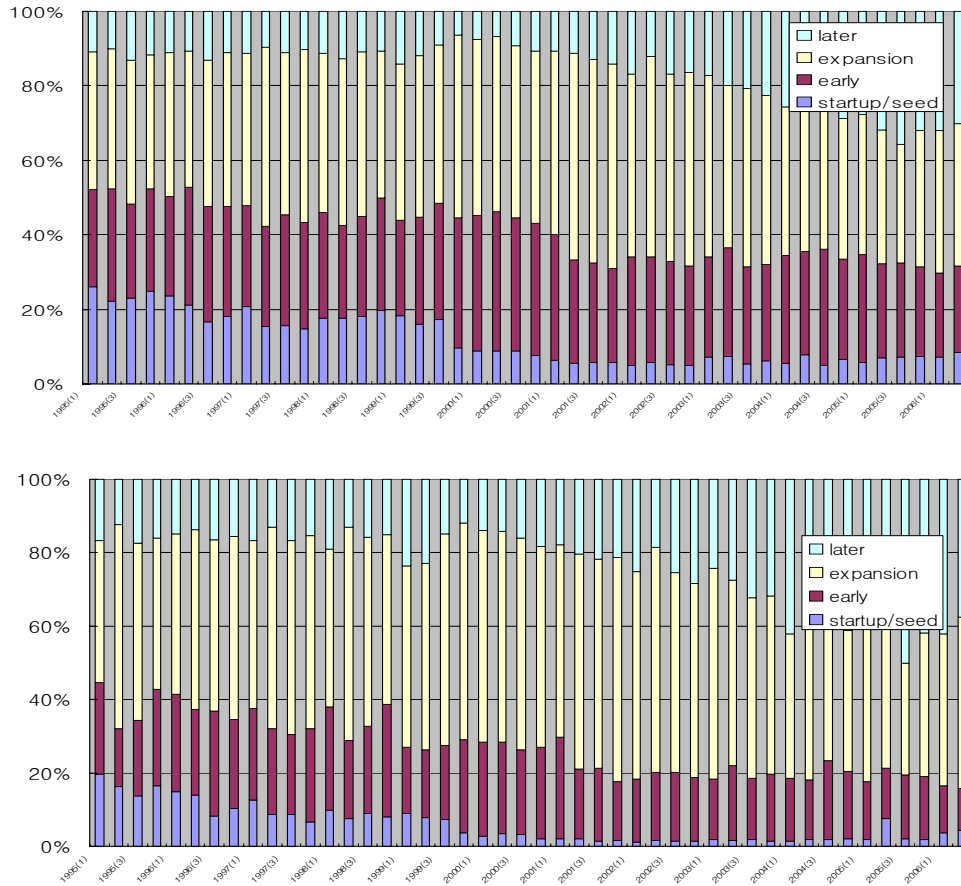
Regarding the role of the government in the investment stage, the empirical

³⁶ A positive coefficient estimate for the variable $year(vc)$ in explaining $d(ave_age)$, which is unexpected, seems to be caused by the fact that venture capital firms established before 1999, on average, have lower values of $ave_age(I)$ and higher values of $ave_age(O)$, compared to venture capital firms established in or after 1999. The average values of $ave_age(I)$ and $ave_age(O)$ are 2.90 years and 3.33 years, respectively, for the venture capital firms established before 1999, and 3.03 years and 3.25 years for the venture capital firms established in or after 1999.

results show that the government failed to induce investments of outside funds toward earlier-staged firms and to guide common stock investments during the venture boom period. Moreover, the investments of a venture capitalist were headed the opposite direction from the government's objective when the government had a larger stake in outside funds. This type of policy failure, however, disappeared after the boom and data indicate that there has been a policy improvement regarding those two criteria. Concerning investments in the high-tech industries, the situation is completely opposite. The empirical analysis tells us that the government has not worked properly to increase the venture investments toward the high-tech industries during the post-boom period, not in the venture boom period. In the previous section, a possible scenario which could generate those policy failures observed in the investment stage was suggested. According to the scenario, the fundamental reason for those policy failures is that the government has had two objectives incompatible to each other: developing a venture capital industry *vs.* avoiding the risk of losing money. By nature, when dealing with venture capital, taking the risk on losing money is regarded as a necessary premise for a government that is actively engaging in the fund-raising stage. Instead, if the government wants to continue to play the active role in organizing outside funds of the private venture capital firms, it should be more concerned with selecting qualified venture capital firms, monitoring the investment activities of those firms, and evaluating their performance.

Moreover, the fact that a government has an objective to develop a venture capital industry does not directly imply that the government should participate actively in the fund-raising process of private venture capital firms. A main reason why a government tries to develop a venture capital industry is that the industry has been assumed to be a pivotal channel in creating an innovative financing for earlier-staged firms and those industries that have rapidly changing markets. However, the reality shows that the venture capital industry has a tendency to evolve in the opposite direction while concentrating its investments on expansion- or later-staged companies. As shown in Figure 4, this tendency can be clearly observed in the U.S. which has the most developed venture capital industry. Considering this trend, the role of the Korean government of directly participating in the fund-raising process of private venture capital firms should be in question near in future. In Section 4, the data showed that, in Korea, venture capital firms have severely relied on the government in the fund-raising stage and this dependency seems to have held up to recent days. Furthermore, an empirical analysis in the same section tells us that the reputation or maturity of a venture capital firm is not working yet as a signaling device in attracting private investors. Considering these findings, it may not be appropriate to ask the government to stop its role of providing capital to the private venture capital firms immediately. However, the government needs to make a long-term plan for developing the venture capital industry and, based on the plan, the role of government should be reconsidered. For the Korean government, it would be a good alternative for the future to clearly distinguish public venture capital firms from private venture capital firms and provide only the public venture capital firms with subsidies accompanied by a clear stipulation on their investment activities, like the SBIC program in the U.S. This topic is beyond the research area of this paper, but important to explore in future researches.

**[Figure 4] Venture Capital Investment by Stage
(number of projects/dollar volume)**



Note: Startup/seed stage (less than 1 year); early stage (1 - 3 years); expansion stage (3 - 7 years); later stage (more than 7 years)

Source: NVCA homepage (<http://www.nvca.org>)

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Appendix

A. Investment Behaviors of Outside funds

Here I investigate the investment behaviors of outside funds in the aspects of the concentration ratio of investment by industry ($hhi_inv(O)$) and by region ($hhi_reg(O)$), and the average value of shares of an outside fund in invested firms ($share(O)$).

For a given outside fund, the concentration ratio of investment by industry was computed in the following way, which is similar to the computation of Herfindahl-Hirschman Index (HHI):

$$hhi_inv(O)_j = \sum_{s=1}^{14} p_{js}^2$$

where p_{js} is the proportion of money invested to s^{th} industry sub-sector in the total amount of investment of outside fund j . Whole industries are classified into 14 sub-sectors based on KSIC (Korean Standard Industrial Classification) as shown in Table A-1.³⁷ The concentration ratio of investment by region was computed in a similar way after dividing South Korea into eight regions:

$$hhi_reg(O)_j = \sum_{r=1}^8 v_{jr}^2$$

where v_{jr} is the proportion of money invested to r^{th} region in the total amount of investment of outside fund j .

For an overview of investment behaviors of outside funds in terms of the concentration ratio of investment by industry and by region, and the average value of shares of an outside fund in invested firms, Table A-2 tabulates the results of t-test analysis. For the t-test analysis, same as Section 5, outside funds organized during the venture boom were compared with those organized after the ending of the boom.

The results of the t-test analysis tell us that the concentration ratio of investment by industry and the average value of shares of an outside fund in invested firms have significantly increased after the boom burst. The concentration ratio of

³⁷ In the venture capital literature, the concentration ratio of investment by industry is generally accepted as a device measuring a venture capitalist's specialized knowledge on a specific industry. In regards to agriculture or service sectors, one-digit classification may be sufficient to represent a venture capitalist's specialty on those industries. On the contrary, in cases of manufacturing industries, one-digit classification is too broad and two-digit classification may be too narrow to be used for measuring the degree of a venture capitalist's specialty on a certain industry. Considering this discrepancy between the service and manufacturing sectors, I re-classified the manufacturing industries into eight subgroups (Ind.2 ~ Ind.9) by the similarity in technologies implied by the names of industries, instead of utilizing the two-digit classification. While I try to make the classification as objectively as possible, I admit that the classification result will be unavoidably arbitrary to some degree and, therefore, is not undisputable.

<Table A-1> Classification of Industries

| Classification | Covered Industries | KSIC Code |
|----------------|---|----------------|
| Ind. 1 | Agriculture | 01, 02 |
| Ind. 2 | Food & textile | 15, 17, 36 |
| Ind. 3 | Printing & publication | 22 |
| Ind. 4 | Chemicals | 24 |
| Ind. 5 | Plastic & non-metal & metal products, | 25, 26, 27, 28 |
| Ind. 6 | Machinery & equipment | 29, 34 |
| Ind. 7 | Computer and office instrument | 30 |
| Ind. 8 | Other electric machinery | 31 |
| Ind. 9 | Electronic components & medical & optical & precision machinery | 32, 33 |
| Ind. 10 | Wholesale & retail trade | 51, 52 |
| Ind. 11 | Information & communication | 64 |
| Ind. 12 | Financial & insurance services | 65, 66, 67 |
| Ind. 13 | Business services | 72, 73, 74, 75 |
| Ind. 14 | Recreational & culture & and sporting activities | 87, 88 |

<Table A-2> Investment Behaviors of Outside Funds: Comparison of Venture Boom vs. Post-boom

| Variable | Venture boom (1998-2000) | Post venture boom (2001-) | Diff. | p-value |
|-------------------------------|--------------------------|---------------------------|-------|---------|
| <i>Hhi_inv(O)</i> | 0.384 | 0.472 | 0.088 | 0.001 |
| <i>Hhi_reg(O)</i> | 0.555 | 0.585 | 0.030 | 0.280 |
| <i>Share(O)</i> ³⁸ | 10.695 | 13.348 | 2.652 | 0.048 |

investment by region also increased even though the change is not statistically different from zero. Similar to Section 5, I also construct a linear equation for each variable as follows, and estimate those for the venture boom period and the

³⁸ Table 9 reports that the average value of the ratio of common stock investment in outside funds decreased with the venture boom burst from 0.757 to 0.344 and Table A-2 reports that the average value of shares of outside funds in invested companies rather increased in the post-boom period from 10.7 percent to 13.3 percent. These seemingly contradicting changes over time can be explained by the fact that the average size of outside funds became bigger in the post-boom period from \$10.05 million to \$13.07 million and the average amount of capital of invested companies decreased with the boom burst from \$14.2 million to \$5.0 million.

post-boom period separately.³⁹

$$dep_{ij} = \delta_0 + \delta_1 industry(0)_{ij} + \delta_2 industry(1)_{ij} + \delta_3 scd(O)_{ij} + \delta_4 rep_{ij} + \delta_5 size(O)_{ij} + \delta_6 hrate_{ij} + \delta_7 s_vc_{ij} + \delta_8 s_go1_{ij} + \delta_9 length_{ij} + \sum_i \delta_{9+i} D_i + v_{ij} \quad (A-1)$$

Table A-3 summarizes the estimation results of Equation (A-1).⁴⁰ In the regression analysis regarding $hhi_inv(O)$, except a weak positive effect of the huddle rate, the only two independent variables affecting the concentration ratio of investment by industry are $industry(0)$ and rep . The coefficient estimates of $industry(0)$ and rep are both positive and statistically different from zero.⁴¹ Because the proportion of outside funds, of which stipulated main targets of investment are culture- and media-related industries, increased to 41 out of 149 funds in the post-boom period from 10 out of 127 funds in the venture boom period, a positive coefficient of $industry(0)$ will induce a higher value of concentration ratio of investment by industry in the post-boom period. Also, the average value of 6.93 years of rep among outside funds formed during the post-boom period is much higher than the average value of 3.99 years during the venture boom period. Combined with the positive coefficient of rep , this fact also implies a higher value of $hhi_inv(O)$ in the post-boom period. These two differences between the venture boom period and post-boom period may explain clearly why the concentration ratio of investment by industry has been significantly higher during the post-boom period.

The estimation results regarding the variable $share$ indicate that the maturity of a venture capital firm (rep), the size of a fund ($size(O)$), and the length of life span of a fund ($length$) commonly increase the average share of a fund in the total common stock issued by invested firms. But, as mentioned just before, the average value of the variable rep is much higher in the post-boom period. The average size of outside funds is also bigger in the post-boom period (\$10.05 million vs. \$13.07 million). The proportion of outside funds of which the life span is longer than five years is about 13% in both periods. From these facts, we can easily expect a higher value of $share$ in the post-boom period.

For the last, the table shows that $industry(0)$ and $hrate$ have positive effects on the concentration ratio of investment by region ($hhi_reg(O)$). As mentioned earlier, the higher average value of $industry(0)$ in the post-boom period will imply a higher value of concentration ratio in that period. The average value of huddle rates, however, is

³⁹ The only difference from Equation (2) is that s_go1 , a share of the SMBA and the Fund of funds, is included as an explanatory variable instead of dummy variable $d(s_go1)$.

⁴⁰ For each dependent variable, I estimate Equation (A-1) using the full sample and separating the sample into the venture boom and post-boom period. Since estimation results from the venture boom period and those from the post-boom period are very similar qualitatively and quantitatively, I simply report estimation results from the full sample in the table.

⁴¹ In fact, the average value of the concentration ratio of investment by industry among outside funds whose stipulated main industries of investment are culture and media related amounts to 0.724. The computed average value of $hhi_inv(O)$ among the other outside funds is just 0.352.

<Table A-3> Estimation Results of Investment Behaviors of Outside Funds (III)

| Variable | <i>hhi_inv(O)</i> | <i>share(O)</i> | <i>hhi_reg(O)</i> |
|--------------------|-----------------------------|---------------------------|----------------------------|
| | Coef. (t-value) | Coef. (t-value) | Coef. (t-value) |
| <i>industry(0)</i> | 0.361(5.89) ^{***a} | -0.531(-0.24) | 0.344(6.92) ^{***} |
| <i>industry(1)</i> | -0.057(-1.81) [*] | -3.872(-1.37) | -0.091(-1.08) |
| <i>scd(O)</i> | -0.131(-0.64) | 0.144(0.05) | 0.056(1.17) |
| <i>rep</i> | 0.015(2.10) ^{**} | 0.910(2.22) ^{**} | -0.002(-0.23) |
| <i>size(O)</i> | -0.001(01.25) | 0.108(2.11) ^{**} | -0.001(-0.52) |
| <i>hrate</i> | 0.004(1.27) | -0.053(-0.31) | 0.007(3.80) ^{***} |
| <i>s_vc</i> | 0.001(0.65) | 0.075(1.79) [*] | -0.000(-0.17) |
| <i>s_go1</i> | -0.000(-0.26) | 0.000(0.00) | -0.000(-0.67) |
| <i>length</i> | | 4.007(2.24) ^{**} | |
| Adj. R-squared | 0.6643 | 0.7929 | 0.7497 |
| # of obs. | 270 | 249 | 279 |

Note: a. *, **, and *** indicate a coefficient estimate is statistically different from zero at the significance level of 10%, 5%, and 1%, respectively.

higher in the venture boom period (12.6% vs. 9.4%), indicating a higher value of concentration ratio in the venture boom period. These two countervailing effects may be approximately cancelled out, thereby resulting the finding that the concentration ratio of investment by region is not statistically different between the two compared periods.