

# The Impact of Government Involvement on IPO Underpricing in Korea

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**Abstract** IPO underpricing is a subject of great interest for researchers. Previous studies have focused on the underpricing of private venture capital-backed IPOs, but mainstream academic researchers have left underpricing in government-backed IPOs largely uninvestigated. In this study, we fill this gap by analyzing the behavior of IPO underpricing for government-backed IPOs in Korea. For the purpose of this study, we examine 468 IPO cases on the KOSDAQ market during the period between 2009 and 2019. Empirical evidence shows that a unique structure of government sponsorship effectively reduces the level of underpricing in the IPO market. In particular, the dual sponsorship of government hybrid funding and private venture capital contributes most significantly to reducing the underpricing in the IPO market.

**Keywords** Hybrid Fund, Dual Sponsorship, Government Involvement, IPO Underpricing, Korean Stock Market

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## I. Introduction

The underpricing of initial public offerings (IPOs) is a well-documented fact (e.g., Ritter, 2003). Several studies provide evidence that the level of IPO underpricing is directly related to the degree of information asymmetry between informed and uninformed investors (e.g., Rock, 1986; Booth and Smith, 1986; Megginson and Weiss, 1991). Previous empirical research on IPO underpricing has shown that a reputable venture capitalist can mitigate the degree of the information asymmetry by certifying the quality of the IPO and thereby reduce the level of IPO underpricing. While previous studies have mainly focused on the underpricing of private venture capital-backed IPOs, mainstream academic researchers have ignored the underpricing of government-backed IPOs. In this paper, we investigate whether government involvement contributes to better outcomes in an IPO market. In particular, we explore the most effective type of government participation for reducing the information asymmetry in IPO markets.

When markets operate in accordance with standard perfect information, government involvement in such a world is strictly constrained. However, when markets operate on imperfect information, government involvement may help to reduce the level of imperfect information. IPO markets, characterized as they are by high levels of information asymmetry, provide an interesting research case for this relationship. With rising concerns about insufficient private investments in venture economies, governments have come to recognize the importance of their role in the successful establishment of new and early-stage entrepreneurial ventures. For instance, in the United States, the Small Business Administration (SBA) initiated the Small Business Investment Companies program in 1958. The SBA involves itself significantly in venture capital industry as a special limited partner (LP) or a public guarantor for a substantial amount of the funds raised and invested in venture firms. Similar programs have been adopted in many other countries including Korea.

The Korean government acknowledges that private venture capitals (PVC) is mostly

directed toward businesses without extreme risks and uncertainties, but this has led to less funding of young companies with high growth potential. It is generally accepted that the Korean government plays an important role in supporting private fund-raising and investment in the market; in particular, the government has supported the growth of the venture capital industry by providing direct capital investment as a limited partner. One of the Korean government's most important involvements in the country's IPO market in Korea is the Korea Fund of Funds (KFoF) to foster entrepreneurial growth firms. The government established the KFoF in 2005 based on the Special Measures for the Promotion of Venture Businesses Act, which was introduced to provide capital to firms that have high potential risks but with higher growth opportunities. As of August 2020, KFoF's total fund size was 5.6 trillion Korean won (about 4.7 billion US dollars). Eight different Korean ministries and agencies were set up and provided the capital to a designated government agency, called Korea Venture Investment Corp (KVIC).

Prior research argues that PVC has demonstrable advantages over government venture capital (GVC) because GVC has a number of operational limitations.<sup>1)</sup> First, GVC derives not from negotiations among partners but from political agenda or regulations, while PVC is usually established with extensive negotiations among investors and detailed covenants. In addition, GVC and PVC also operate under different restrictions and promises of covenants. Second, GVC can make less competitive compensation available to fund managers. The compensation structure of GVC usually comprises fixed management fees, whereas that of PVC consists of a 2% fixed fee and a 20% performance fee on investment profits.<sup>2)</sup> Third, GVC operators lack independence in making investment decisions because the government's aims tend to target less profitable industries.

Because of these limitations on GVC, Cumming et al. (2017) suggest that syndicated funds of government and private venture capital may enhance the performance of IPO

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<sup>1)</sup> Cumming (2007), Jaaskelainen et al. (2012), Murray et al. (2012), Brander et al. (2015), and etc.

<sup>2)</sup> However, the compensation structure of KFoF is different from the typical GVC. KFoF has a compensation structure of a 2.5% fixed management fee and a 20% performance fee.

firms, which might in turn reduce underpricing. Gompers and Lerner (2004) also argue that syndicated fund managers make better investment decisions because they receive input from the private and public sectors. It is possible that syndicated funds send a unique signal to the investors regarding the quality of IPO firms.<sup>3)</sup> Unlike the typical GVCs, KFoF is strictly managed by the government during the investment and operating process. In this regard, Cumming (2007) and Colombo et al. (2016) point out that GVC with proper design of investment process may have better performance than the other types of VC in the overall investment process. Another feature of KFoF is that it is a pooled investment fund that invests in other types of funds. In other words, KFoF contains different underlying portfolios of other funds and these holdings replace any investing directly in stocks of IPO firms. In that sense, KFoF can be regarded as a hybrid fund rather than a pure GVCs. The literature has often overlooked the performance of hybrid fund while some attention was given to the performance of GVC. Thus, understanding the role of hybrid fund for supporting venture firms is a crucial requirement for examining the effects of VC investment on IPO performance. Our main contribution in this paper is to investigate the performance of government-backed hybrid fund and find the unique form of government involvement to obtain the best results of IPO investment.

In this paper, we find that dual sponsorship of PVC and KFoF effectively reduces the level of underpricing in the IPO market. The results suggest that the involvement of diverse venture capitalists (VCs) with government participation improves the decision-making related to IPOs and effectively mitigates information asymmetry problems in an IPO market. Therefore, we conclude that government involvement can lead to an efficient outcome in IPO markets.

The remainder of this study is organized as follows. In section II, we discuss the existing literature and develop the hypotheses. Section III describes methodology, and Section IV presents the empirical evidence. Section V concludes.

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<sup>3)</sup> Megginson and Weiss (1991) suggest that incorporating reputable auditors and underwriters increases the certification role of VCs.

## II. Previous Studies and Hypothesis Development

### 1. Role of VCs in IPOs and underpricing

Rock (1986) and Welch (1989) develop a signaling model to explain the presence of IPO underpricing based on information asymmetry. In their models, rational investors expect that only worse-than-average-quality issuers intend to offer their equity at an average price in a world with information asymmetry where issuing firms have superior information to that of investors, leading to a market collapse. To prevent this lemon market issue, high-quality issuers attempt to distinguish themselves from low-quality issuers by lowering the offer price to an amount the low-quality issuers cannot match, signaling their quality at the market. If the market is efficient, lowering the offer price is not painful for those confident high-quality issuers because they will recoup the up-front sacrifice in the post-IPO market. These models imply that alleviating information asymmetry will lead to less IPO underpricing. That is, IPO sponsorship by informed investors such as VCs should reduce information asymmetry by signaling the quality of issuers to the market, leading to less IPO underpricing. Indeed, Megginson and Weiss (1991) provide evidence for a certification role for venture capitalists that entails incorporating reputable auditors and underwriters to reduce information asymmetry. They also argue that venture capitalists reduce underpricing by reducing the asymmetry of information among issuing firms, investors, and underwriters.

Dolvin and Pyles (2006) suggest that the opportunity cost of going public is directly related to the level of information asymmetry associated with the issuing firm; specifically, they find that higher-quality venture capitalists provide incremental certification value relative to those of lower quality. In line with these views, Field and Hanka (2001) and Brav and Gompers (2003) show that early-stage investor ownership sends a signal for the value of the firm to minority investors. Cho and Lee (2013) find that the participation

of VCs reduces the underpricing of technology-based IPOs because of reputable VCs' certification role amid the uncertainty of R&D activity. Likewise, Oh and Han (2014) finds significant certification roles of VCs in Korean IPO market. These studies suggest that a VC ownership of IPO firms is an important signal of firm quality to outside investors.

## 2. Role of hybrid funds in IPOs and underpricing

Carter and Manaster (1990) suggest that prestigious underwriters are associated with lower-risk offerings and lower underpricing by reducing information asymmetry in the IPO process. They argue that low-dispersion firms will attempt to reveal their low-risk characteristics to the market by selecting prestigious underwriters, and they provide empirical evidence of a significant negative relationship between underwriter prestige and the magnitude of the IPO price run-up. Meanwhile, Dharwadkar et al. (2000) find that coordination costs decrease in IPO firms with high ownership concentration; they argue that IPO ownership structure conveys information on firm value to external investors, leading to less IPO underpricing. Gompers and Lerner (2004) also propose that diverse VCs can reduce the overall investment risk by sharing risks associated with IPO firms. In general, empirical evidence shows that hybrid funds reduce information asymmetry more effectively than does single-source venture capital in IPO markets (Tian, 2012; Honorine & Emmanuelle, 2019).

Lee and Masulis (2011) emphasize the role of reputable VC in earning the trust of general investors in investigating whether financial intermediaries participating in the IPO process play a significant role in certifying the quality of issuers' financial reports. The authors find that reputable VCs are associated with significantly less earnings management. Brander et al. (2015) provide evidence that firms that receive both private and government VC raise more funds owing to complementarity between GVCs and private finance. They find that syndicated funding is the most common type of investment

funding, followed by pure private funding, and then pure GVC funding; they also find that a positive association between syndicated funding and successful exits of firms through IPOs. Cumming et al. (2017) report that syndicated funds in EU countries have better IPO exits than those of pure GVCs or pure PVCs because of their effective compensation structure. In addition, they report that syndicated funds have higher exit profits than those of PVCs because of PVCs' efficient management of funds and governments' superior information about industries.

The findings of these empirical studies suggest that government involvement could adequately reflect an issuer's true intrinsic value. This involvement process, in effect, limits any initial IPO underpricing and leads to a smaller problem of information asymmetry between the investor and the firm. Based on the above studies, we develop the following testable hypothesis:

Hypothesis 1. The KFoF's involvement in the IPO market will reduce underpricing.

As Cumming et al. (2017) suggest, the dual sponsorship of GVC and PVC may enhance the performance of IPO firms, which, in turn, reduces underpricing. Compared with pure GVCs, syndicated funds can better screen by obtaining various opinions from the private and the public sectors regarding prospects of IPO firms. Therefore, we expect that the certification role of syndicated funds is superior to that of non-syndicated funds. More specifically, we expect that IPO underpricing levels will vary with different types of VC such that underpricing will be greater with PVC than with government-involved funds.

Compared with the exclusive involvement of KFoF, we also expect that combining KFoF and private VC will reduce the degree of information asymmetry more. Cumming et al. (2017) explain how heterogeneity in venture capital might influence IPO performance. First, funding heterogeneity improves IPO decision-making because it is based on diverse perspectives and expertise from different venture capitalists whose backgrounds can

complement each other and facilitate effective due diligence. Second, competition among multiple venture funds could improve the quality of IPO firms and thereby increase their exit performance with profit maximization. Therefore, we postulate that combining KFoF and private funds will lead to more IPO underpricing than will single participation of KFoF or private funding, as follows:

Hypothesis 2. Combining KFoF and private funds will lead to more IPO underpricing than will single participation of KFoF or private funds.

### III. Empirical Methodology and Data

#### 1. Methodology

We apply the following regression model to test hypotheses 1 and 2:

$$UP = \beta_0 + \beta_1 VCOS + \beta_2 KFOS + \beta_3 VCKF(Dummy) + \beta_4 BIDRATE + \beta_5 SIZE + \beta_6 LEV + \beta_7 ROE + \beta_8 AGE + \beta_9 YEAR(Dummy) + \varepsilon \quad (1)$$

*UP* is the level of underpricing measured by the first day's opening price initial return over the IPO offer price as used by Ritter and Welch (2002). *VCOS* is the PVC ownership percentage, and *KFOS* is the KFoF's ownership percentage; we expect that the coefficient of *KFOS* is negative and lower than that of *VCOS*. *VCKF(Dummy)* is a dummy variable to test hypothesis 2 and represents the dual effect of KFoF and private VC combined; it takes the value of 1 if the IPO firm is backed by a dual fund and 0 otherwise. We expect that the coefficient of *VCKF(Dummy)* is negative and lower than those of *VCOS* and *KFOS*. We include several control variables suggested by previous studies. Ritter (2003) argues that abnormal return on the first day of trading can be due to the temporary

oversupply of investments. In order to control for this effect, we have included bid rates (*BIDRATE*) as a control variable and expect a positive relationship with the level of underpricing. *BIDRATE* is calculated by the amount of total application for IPOs divided by total equity amount. Offering size (*SIZE*) is included because a larger IPO attracts more attention and media coverage from investors and analysts, which results in less underpricing (Ritter, 2003). *SIZE* is measured by the offering size divided by total assets. We also include leverage (*LEV*) given that it can also reduce underpricing owing to the reduced information asymmetry (Schenone, 2004). *LEV* is measured by debt-to-asset ratio just prior to the listing. Firm's history (*Age*) is included because older companies are familiar to investors and may have reduced information asymmetry, which results in less underpricing (Muscarella and Vetsuypens, 1989). *AGE* is the difference between the founding and the IPO dates. We expect that established firms have less information asymmetry and therefore less underpricing. Return on equity (*ROE*) is employed in the model to control firm profitability. It is measured by ROE just prior to the listing.

In addition to the above OLS regression model, we employ Heckman's two-stage correction model to address possible sample selection bias and endogeneity issues in the model. In the first stage of the Heckman correction, the model is used to estimate the probability of being selected in the sample. The second stage, using the selected sample, employs a linear regression model including an additional explanatory variable, the inverse Mills ratio ( $Z\gamma$ ). This ratio is important because it is used as an independent variable in the second stage to control for the sample selection bias; if it is significant, then selection bias precludes using OLS and Heckman's two-stage correction model recovers the true effect by dealing with the selection. The model is presented in the following equations: <sup>4)</sup>

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<sup>4)</sup> See Heckman (1976) and Greene (2008) for more detailed model specifications and discussions.

$$\begin{aligned}
 y_i^* &= X_i' \beta + \varepsilon_i \\
 z_i^* &= W_i \gamma + u_i, \quad z_i^* = \begin{cases} 1 & \text{if } W_i \gamma + u_i > 0 \\ 0 & \text{if } W_i \gamma + u_i \leq 0 \end{cases}
 \end{aligned} \tag{2}$$

where  $y_i^*$  is the variable of interest and  $z_i^*$  is a binary variable in a selection equation, determining whether  $y_i^*$  is observed or not. In the second stage of the Heckman correction model, equation (3) is derived from equation (2) based on the selected observation:

$$\begin{aligned}
 E[y_i | z_i^* = 1] &= X_i' \beta + \alpha_\lambda \lambda_i(W_i \gamma) \\
 y_i &= X_i' \beta + \alpha_\lambda \lambda_i(W_i \gamma) + v_i
 \end{aligned} \tag{3.1}$$

$$y_i = X_i' \beta + \alpha_\lambda \lambda_i + v_i \tag{3.2}$$

$\lambda(X)$  is the inverse Mills ratio measured by  $\phi(X)/\Phi(x)$ , where  $\phi$  is the standard normal density and  $\Phi$  is the cumulative distribution function. Conceptually, the ratio indicates the probability of an observation's being ignored; adding it in the original OLS regression as an additive control factor allows for estimating unbiased coefficients.

For the use of Heckman's two-stage correction model in this paper, control variables (BIDRATE, SIZE, LEV, ROE, and AGE) in the first stage of the model are excluded in order to avoid multicollinearity problem in the second stage of the model. For model 3 where all control variables are included in the second stage of the model, only SIZE is used as a control variable in the first stage of the model since it is the most significant control variable in the OLS regression analysis.

## 2. Data

We initially identify 579 IPO cases in the KOSDAQ market during the period between 2009 and 2019 from the Data Analysis, Retrieval and Transfer System (DART) in Korea.

We collect bid rates, offer price range, and offer size for sample firms from “IPOStock (<http://www.ipostock.co.kr/main/main.asp>)” and manually collect IPO firm ownership structure from preliminary firm prospectus and registration statements in DART and KVIC. We exclude 111 firms from the initial sample that do not have sufficient information to run regression equation (1). The final sample consists of 468 IPO firms.

Table 1 shows the number of IPOs on the KOSDAQ market in Korea from 2009 to 2019 classified by sponsorship type. On average, 44 firms went public on KOSDAQ market per annum. For total of 487 IPO firms in the sample, 36.6% were sponsored by PVC, 7.4% were sponsored by KFoF feeder fund, 14.2% of IPOs were sponsored both by PVCs and KFoF feeder fund, and 41.9% are non-sponsored.<sup>5)</sup>

Table 2 presents descriptive statistics for the variables used in this study. Average return is 33.0%, showing that IPOs are deeply underpriced in Korea. The average proportions of PVC and KFoF ownership are 6.0 and 1.9%, respectively, and the average bid rate is 271.7:1, showing that IPOs are heavily oversubscribed. The average leverage ratio is 36.5%, and average *ROE* is 0.5%. It takes an average of 13.9 years for IPO firms to go public.

The average levels of IPO firm underpricing are 32.7% and 50.9% for, respectively, firms sponsored by PVC and KFoF, whereas dual-sponsored show underpricing of only 26.3%, the lowest of all firm sponsorship types. It is worth noting that VC-backed IPOs show more underpricing than that of non-VC backed IPOs (32.4%) with the exception of dual-sponsored IPOs. Non-VC backed IPOs are usually backed by individual angel investors,<sup>6)</sup> and the omission of individual angel investors in the study of IPO markets is particularly surprising when the finance literature has already recognized the deficiency of research in this area (Lerner, 1998). Angels are interested in the long-term profits of their initial investments, while venture capitalists are concerned about the future fund-raising for other investments as well. Previous studies show that VCs

<sup>5)</sup> It should be noted that KFoF is not allowed to directly invest in IPO firms. KFoF backed IPOs refers to the cases where VC funds invested by KFoF have invested in IPO firms.

<sup>6)</sup> An angel investor (also known as a private investor or angel funder) is an individual who provides financial backing for startups or entrepreneurs, typically in exchange for ownership equity in the company. Often, angel investors are found among an entrepreneur's family and friends.

〈Table 1〉 Number of IPOs on KOSDAQ, 2009–2019

	Total Number of IPOs	Number of PVC-backed IPOs	Number of KFoF-backed IPOs	Number of Dual-sponsored IPOs	Number of Non-sponsored IPOs
2009	52	15	2	9	25
2010	62	16	3	4	37
2011	59	10	9	9	28
2012	21	3	6	2	10
2013	36	6	3	5	35
2014	48	18	3	5	20
2015	61	33	7	1	20
2016	63	30	3	2	28
2017	53	11	7	10	25
2018	63	30	3	2	28
2019	61	33	7	1	20
Total	579	205	53	50	276

〈Table 2〉 Descriptive Statistics of IPO Activities by IPO Sponsorship Structure

The table reports descriptive statistics for IPO activities of 468 Korean firms in KOSDAQ market from 2009 to 2019.  $UP_{i,t}$  is the level of underpricing measured by the initial opening price of first trading day return over the IPO offer price.  $VCOF$  and  $KFOF$  are the ownership percentages of PVC and KFoF, respectively.  $BIDRATE$  is the pre-offering demand measured by the amount of total application for IPO divided by total amount of IPO offer.  $SIZE$  is measured by IPO offer size divided by total assets,  $LEV$  is debt-to-asset ratio, and  $ROE$  is return on equity ratio defined as net income over total equity.  $AGE$  is the period in years between IPO and the foundation. Data sources are 38.co.kr, ipostock.co.kr, DART, and KVIC.

Panel A. Key variables

N=468	Mean	Standard Deviation	Min.	Max.
$UP$ (%)	33.04	36.29	-10.70	100.00
$VCOF$ (%)	5.95	10.03	0.00	81.61
$KFOF$ (%)	1.92	4.79	0.00	35.00
$BIDRATE$	271.68	317.61	0.18	1290.00
$SIZE$ (%)	24.04	23.03	0.01	215.07
$LEV$ (%)	36.53	22.36	1.03	201.66
$ROE$ (%)	0.54	56.84	-133.12	771.93
$AGE$ (in years)	13.90	8.46	1.00	58.00

Panel B. Means of key variables by IPO sponsorship structure

N=468	PVC-backed IPOs	KFoF-backed IPOs	Dual-sponsored IPOs	Non-sponsored IPOs
$UP$ (%)	32.74	50.92	26.31	32.41
$BIDRATE$	344.80	253.09	215.74	227.57
$SIZE$ (%)	29.43	18.57	23.27	20.32
$LEV$ (%)	33.74	11.43	39.57	38.00
$ROE$ (%)	4.50	-7.86	-11.24	1.66
$AGE$ (in years)	13.16	11.43	11.36	15.71

usually sell the equities of firms at lower prices on IPOs to maximize the management fees (Gompers, 1995; Lee & Wahal, 2004). Unlike VCs, angel investors do not have such an incentive to sell their investment at lower prices on IPOs. Gompers (1995) and Lee and Wahal (2004) find that VC-backed IPOs experience larger initial returns (or higher underpricing) than do non-VC backed IPOs. The authors suggest that VCs tend to underprice their offerings to attract larger future capital flows into their funds, and indeed, bid rates confirm this line of reasoning in this study: The bid rate of non-sponsored IPOs is 227.6, far lower than those of PVC-backed IPOs (344.8) or those of KFoF-backed IPOs (253.1). For other control variables, *SIZE* and *LEV* do not show significant differences between IPO sponsorship types. For *ROE*, KFoF-backed IPOs show negative profitability, implying that government-backed funds work in the same way as an angel investor.

Table 3 reports the correlation coefficients among dependent and explanatory variables

〈Table 3〉 Correlations Coefficients

The table reports simple correlation relationships among variables applied in our analysis.  $UP_{i,t}$  is the level of underpricing measured by the initial opening price of first trading day return over the IPO offer price. *VCOS* and *KFOS* are the ownership percentages of PVC and KFoF, respectively. *BIDRATE* is the pre-offering demand measured by the amount of total application for IPO divided by total amount of IPO offer. *SIZE* is measured by IPO offer size divided by total assets, *LEV* is debt-to-asset ratio, and *ROE* is return on equity ratio defined as net income over total equity. *AGE* is the period in years between IPO and the foundation. Data sources are 38.co.kr, ipostock.co.kr, DART, and KVIC. P values are in brackets. \*\*\*, \*\*, and \* indicate significance at 1%, 5%, and 10%, respectively.

	<i>UP</i>	<i>VCOS</i>	<i>KFOS</i>	<i>BIDRATE</i>	<i>SIZE</i>	<i>LEV</i>	<i>ROE</i>	<i>AGE</i>
<i>UP</i>	1							
<i>VCOS</i>	-0.0335 (0.502)	1						
<i>KFOS</i>	0.1024** (0.040)	-0.0257 (0.607)	1					
<i>BIDRATE</i>	0.3318*** (0.000)	0.1366*** (0.006)	-0.0949* (0.056)	1				
<i>SIZE</i>	-0.131*** (0.008)	0.1224** (0.014)	-0.0697 (0.162)	0.1786*** (0.000)	1			
<i>LEV</i>	0.0442 (0.375)	-0.0802 (0.107)	0.0771 (0.121)	-0.1176** (0.018)	-0.2821*** (0.000)	1		
<i>ROE</i>	0.0039 (0.938)	-0.0186 (0.709)	-0.0932* (0.061)	-0.0032 (0.948)	-0.1180** (0.018)	0.0137 (0.784)	1	
<i>AGE</i>	-0.0105 (0.833)	-0.0828* (0.096)	-0.1141** (0.022)	0.0286 (0.566)	-0.163*** (0.001)	0.0381 (0.444)	0.0307 (0.538)	1

used in our regression analysis. KFOS, the ownership percentage of government-backed funds in an IPO firm, has a significant positive correlation with the level of IPO underpricing (0.1024), contradicting hypothesis 1. Gompers (1995) suggests that young venture capital firms take companies public earlier than older VC firms so that they establish their reputations and successfully raise capital for new funds. The KFoF is a relatively young VC and therefore it may face more pressure for a successful IPO; its certification role seems to be dominated by this “grandstanding” motivation, leading lead to more underpricing.

*BIDRATE* has a positive relationship with underpricing such that more underpriced IPOs attract more demand. *SIZE* is negatively related to underpricing, supporting Beatty and Ritter (1986) and Ritter (2003); these authors suggest that larger IPOs reduce information asymmetry by receiving more analysts’ coverage. Other control variables do not show significant relationships with IPO underpricing. Significant correlations among explanatory variables raise a concern of potential multicollinearity, and we check the variance inflation factor (VIF) to address this issue.<sup>7)</sup> We employ the Heckman model to address endogeneity.

#### IV. Empirical Results

Table 4 shows the results of OLS regression analysis with the VIFs. It is well-known that the standard errors of the estimated coefficients are inflated when multicollinearity exists; in these cases, the t tests for each of the individual coefficients can be non-significant even if the overall F for the model is significant. This can cause a serious misinterpretation problem caused by multicollinearity between independent variables. The VIF is a useful tool for detecting whether multicollinearity exists in

<sup>7)</sup> According to Hair et al. (2010), a VIF over 4 is a signal of multicollinearity with the maximum acceptable level of 10. Ideal condition is  $VIF < 3$ .

〈Table 4〉 OLS Regression Analysis on IPO Underpricing by Ownership Structure

The table reports the results of OLS regression models. *VCOS* and *KFOS* are ownership percentages of PVC and KFoF, respectively. *D\_VCKF* is a dummy variable representing the combination of KFoF and PVC. It takes the value of 1 if the IPO firm is backed by a dual-sponsored fund and 0 otherwise. *BIDRATE* is the pre-offering demand measured by the amount of total application for IPO divided by total amount of IPO offer. *SIZE* is measured by IPO offer size divided by total assets, *LEV* is debt-to-asset ratio, and *ROE* is return on equity ratio defined as net income over total equity. *AGE* is the period in years between IPO and the foundation. We include year dummy variable (*D\_YEAR*) to control year effect in the analysis. Data sources are 38.co.kr, ipostock.co.kr, DART, and KVIC. P values are in brackets. \*\*\*, \*\*, and \* indicate significance at 1%, 5%, and 10%, respectively.

Variables	Model 1	Model 2	Model 3	VIF
Intercept	0.3360*** ( $<.001$ )	0.3305*** ( $<.001$ )	0.4553*** ( $<.001$ )	
<i>VCOS</i> (%)	-0.0002 (0.999)	0.0331 (0.846)	-0.0886 (0.617)	1.1009
<i>KFOS</i> (%)	0.6632** (0.037)	0.8678** (0.045)	0.9402** (0.035)	1.5403
<i>D_VCKF</i>		-0.1515** (0.017)	-0.1593** (0.013)	1.5415
<i>BIDRATE</i>			0.0006*** ( $<.001$ )	1.4213
<i>SIZE</i> (%)			-0.2687*** (0.001)	1.3362
<i>LEV</i> (%)			0.0280 (0.723)	1.1456
<i>ROE</i> (%)			-0.0072 (0.804)	1.0217
<i>AGE</i> (in years)			-0.0019 (0.356)	1.0763
<i>D_YEAR</i>			-0.0283*** ( $<.001$ )	1.6046
Adj. R-Squared	0.0048	0.0071	0.2101	

a regression model; it measures how much the variance (or standard error) of the estimated regression coefficient is inflated due to collinearity. The ideal is  $VIF < 3$ , and Table 4 shows that the VIFs are less than 2, indicating no multicollinearity.

Model 3 contains all the variables, while the remaining models include only VC ownership variables. Results in Model 1 are consistent with the correlation analysis: *KFOS* (KFoF ownership) is positively related to the level of underpricing while *VCOS* (private VC ownership) is insignificantly negative. Therefore, hypothesis 1 is rejected. Separate participation of VC does not help to reduce the degree of underpricing; on the contrary,

the results suggest that the KFoF seems to be more concerned with IPO failures because it wants to establish its reputation in the market; as a consequence, it is more likely to underprice the issue for a successful exit. Unlike exclusive KFoF involvement, we believe that combining KFoF and private VCs decreases information asymmetry compared with single participation.

As noted earlier, Cumming et al. (2017) argue that heterogeneity of venture capital positively influences IPO performance, and Gompers and Lerner (2004) argue that diverse VC can reduce overall investment risk by sharing risks across funding sources. To check this possibility, we include the group dummy variable,  $D\_VCKF$ , in Model 2, and the model shows a significantly negative coefficient of  $D\_VCKF$ , suggesting that combining PVC and KFoF reduces IPO underpricing compared with levels for single-sponsor funds, which supports hypothesis 2. To ensure the robustness of the results, we re-estimate the model by including the other control variables in Model 3, and these results are consistent with the findings for Model 2.

Among the other control variables,  $BIDRATE$  has a significantly positive sign as expected, and  $SIZE$  has a significantly negative coefficient. Prior studies (Miller and Reilly, 1987; Clarkson and Simunic, 1994) suggest that the size of the IPO indicates uncertainty about IPO firms and tends to be negatively related to the underpricing level. Several studies report empirical evidence for a negative relationship between the amount of raised funds and the level of underpricing (Chalk and Peavy, 1990; Clarkson and Merkley, 1994; Carter et al., 1998; Jain and Kini, 2000). Other control variables have insignificant signs.

To address the issue of endogeneity among independent variables, we re-run equation (1) using the Heckman model. Table 5 shows the results. Inverse Mills ratios are statistically significant for all models, justifying the usage of the Heckman model.<sup>8)</sup> In general, the results remain the same as the OLS regression results. The coefficients of  $D\_VCKF$

<sup>8)</sup> If the IMR ratio is not significant, we are able to run just the OLS regression instead of Heckman's two-stage correction model. If it is significant, then we cannot just run OLS because selection is important and the two-step process would recover the true effect by dealing with the selection.

**〈Table 5〉 Heckman's Correction Model for IPO Underpricing by Ownership Structure**

The table reports the results of Heckman's two-stage correction regression models. *VCOS* and *KFOS* are ownership percentages of PVC and KFoF, respectively. *D\_VCKF* is a dummy variable representing the combination of KFoF and PVC. It takes the value of 1 if the IPO firm is backed by a syndicated fund and 0 otherwise. *BIDRATE* is the pre-offering demand measured by the amount of total application for IPO divided by total amount of IPO offer. *SIZE* is measured by IPO offer size divided by total assets, *LEV* is debt-to-asset ratio, and *ROE* is return on equity ratio defined as net income over total equity. *AGE* is the period in years between IPO and the foundation. We include a year dummy variable (*D\_YEAR*) to control year effect in the analysis. Data sources are 38.co.kr, ipostock.co.kr, DART, and KVIC. P values are in brackets. \*\*\*, \*\*, and \* indicate significance at 1%, 5%, and 10%, respectively.

Variables	Model 1	Model 2	Model 3
Intercept	0.5712*** ( $<.001$ )	0.5764*** ( $<.001$ )	-0.2900 (0.297)
<i>VCOS</i> (%)	-0.0220 (0.898)	0.0067 (0.969)	-0.0591 (0.737)
<i>KFOS</i> (%)	0.5908 (0.104)	0.8638* (0.052)	0.9001** (0.042)
<i>D_VCKF</i>	–	-0.1739*** (0.007)	-0.1643*** (0.009)
<i>BIDRATE</i>	–	–	0.0006*** ( $<.001$ )
<i>SIZE</i> (%)	–	–	-1.7919*** (0.002)
<i>LEV</i> (%)	–	–	-0.0142 (0.859)
<i>ROE</i> (%)	–	–	-0.0013 (0.966)
<i>AGE</i> (in years)	–	–	-0.0025 (0.215)
<i>D_YEAR</i>	–	–	-0.0240*** ( $<.001$ )
Inverse Mills Ratio	-0.5629*** ( $<.001$ )	-0.5450*** ( $<.001$ )	2.6221*** (0.006)
F-statistic	32.28*** ( $<.001$ )	24.56*** ( $<.001$ )	12.12*** ( $<.001$ )
Adj. R-Squared	0.1956	0.1963	0.2236

(group dummy variable) in Model 2 and 3 are significantly negative, indicating the synergistic effect of combining private VC and KFoF funding to reduce underpricing. This result is consistent with the view that syndicated funds reduce information asymmetry more effectively compared with single VC-backed IPOs.<sup>9)</sup> Furthermore, dual-sponsored

<sup>9)</sup> Tian (2012), Brander et al. (2015), Cumming et al. (2017), Honorine & Emmanuelle (2019), etc.

IPOs can send a signal to the market about VCs' ability to share risk because IPO underpricing is regarded as a risk premium for uncertainty. All control variables shows the same results as those in Table 4.

## V. Conclusion

IPO underpricing has been a subject of great interest to many researchers; many studies suggest that information asymmetry leads to IPO underpricing. Previous empirical research on IPO underpricing has shown that a reputable venture capitalist can mitigate the degree of the information asymmetry by providing a certification role regarding the quality of the IPO. Unlike most previous papers that focus on the PVC's certification role, we have analyzed the certification role of a government backed hybrid fund and investigated whether the involvement of the government in the IPO market can reduce the degree of underpricing in Korea. To conduct this analysis, we compared the performance of a Korean government-backed IPO sample with that of a sample of private-VC backed IPOs using Heckman's two-stage error correction model. The initial results regarding the underpricing are not consistent with previous studies: The government-backed IPOs were shown to be significantly underpriced. This finding indicates underpricing as a cost that issuers have to bear in order to enter the market whether they are government-backed or not.

However, in this paper, we show that government sponsorship can reduce the degree of underpricing in the IPO market under some conditions. In particular, the certification effect of VCs is maximized when government-backed funds and private funds participate together in the IPO market. This result is consistent with findings from previous research that the participation of heterogeneous investors may reduce the degree of information asymmetry in the IPO market (Cumming et al., 2017). The IPO literature argue that the presence of a third party with reputational capital at stake could reduce the risk

of the issue at flotation. This paper presents that combining KFoF and PVC can perform this role. Diversity of venture capitalists' experience and capability in monitoring investments seems to send a positive signal to investors at the time of an IPO.

The empirical findings of this paper have important policy implications. Our analysis identifies the roles and outcomes of the government as reliable information providers, an analysis that could offer some valuable information to policy makers. For investors, they can improve IPO performance by considering the ownership structure of VC in IPO markets. With regard to underwriters, the findings of this paper can assist them in organizing various types of partnership funds to convey firms' long-term prospects to market participants.

VC investment in unestablished companies is considered risky, an understanding that mainly derives from studies on the US market. However, a review of the Korean VC market indicates that this understanding may not be entirely applicable to the Korean VC industry. VC investments in Korea are more concentrated in late stages, among firms that were founded 13 years before their IPOs. This suggests to some extent that there is a difference between the two markets. Clearly, in-depth analysis of the involvement of venture capitalists in late-stage companies is necessary in order to cast some light on their relative impacts on levels of underpricing. Another extension of this research would be to examine the effect of government participation on IPO performance in the long term. Finally, as a limitation of our study, caution should be applied when generalizing the results of the study because these findings' applicability is restricted to the Korean IPO environment.

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