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The Role of Asset Tangibility on Corporate Investment under Financial Constraints in Korea

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Abstract

The purpose of this paper is to investigate the possible role of asset tangibility (mainly collateral) on corporate's investment decision. To satisfy the purpose, we highlight the differences of corporate investment behaviors between the 1990s and the 2000s considering its financial phase. The empirical analysis is mainly based on the endogenous switching regression model using firm-level panel data from 1994 to 2009 in Korea.

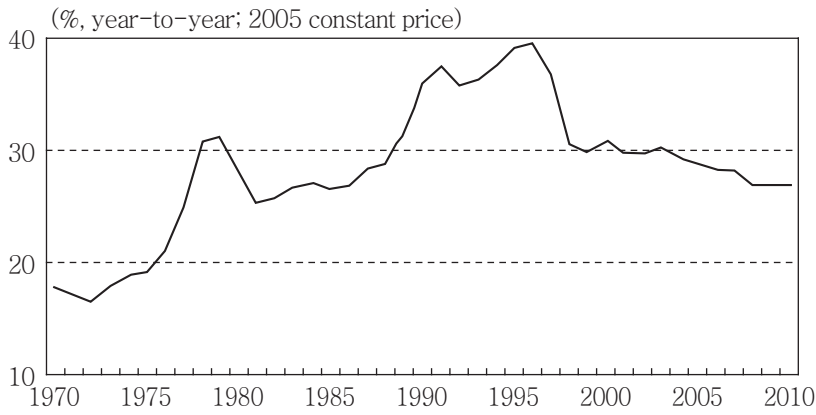
According to the empirical results, the corporate investment behavior in the 2000s became different from that in the 1990s, especially in terms of asset tangibility. In particular, asset tangibility played a more important role on the decision of a firm's investment after 2000.

In addition, the firm size effect on investment is significant only through the interaction variable between cash flow and asset tangibility under financially constrained phase, of which a small to medium-sized firm under financially constrained phase has a lower interaction effect on investment. This implies that even if a small to medium-sized firm has the same conditions as a large firm, the investment effects of asset tangibility or cash flow in the small to medium-sized firm is lower. However, this gap does not diminished during the 2000's because there is no statistical evidence that the firm size effect changes between two periods - the 1990s and the 2000s.

I. Introduction

Following the Asian Financial Crisis breaking of 1997, the Korean economy experienced a sharp decline in investment as well as in its other key economic indicators. Since then, investment has staggered at a substantially low level, even after most other indicators have recovered their previous levels or shown signs of recovery. Figure 1 shows that investment-to-GDP ratio fell dramatically from 39.5% in 1996 to 29.8% in 1999. Since the immediate impact of crisis subsided, the average ratio during the post-crisis period of 2000-2010 has remained 28.7 which was much lower than the pre-crisis level of

Figure 1. Ratio of Investment-to-GDP



Source : Bank of Korea.
Note : Investment includes construction, equipment, and intangible fixed investment.

37.4 during the 1990-96 period.

There have been many studies to account for what caused the dramatic fall in and the stagnation of investment thereafter. The two causeswidely accepted so far are the rising uncertainty and conservative attitude toward firm management, most of all, in financial aspects (See, among others, Lee, 2005; Im, 2008; Hong, 2006). Not limited to academic interpretation, there also have been various policy attempts to revive investment in many ways (See Ro *et al.,* 2010).[1)]

Despite efforts to resuscitate investment, stagnation in investment continues, which suggest that there may be unexplored factors which suppress investment in a critical and structural fashion. Regarding to this conjecture, we notice that financial intermediaries have leaned toward extending their loans based on the collateral of firms and households, as shown in Figure 2. This seems to reflect a change in the financial market where financial intermediaries try to reduce

1) The previous studies related with the stagnation of investment due to economic (financial) instability or uncertainty starts from debate between Hartman(1972) - or Abel(1983) - and Pindyck(1991). After that, most research explained that financial uncertainty tends to decrease expected (future) profits, aggravate the profitability of investment, and debase present investment. Furceri and Mourougane(2009) also state that financial uncertainty can negatively effect on investment decisions as a result of a reduced demand and corresponding credit crunch. That is, when the event which amplifies a financial uncertainty is occurred, the basic factors to affect investor appear to be influenced via an increase of risk premium and uncertainty in compensation of investment. In this case, it is possible that the effect of some positive factor for investment might decrease. Also, more directly, the financial uncertainty makes a firm which has a willingness to invest difficult to raise an enough resources for investment. For the related literature survey and research regarding to Korean economy, refer Ro *et al.*(2009) in detail.

Figure 2. Ratio of Real Estate-backed Loans to Total Loans

Source : Financial Supervisory Service.

risks and maintain a sound asset base by keeping their lending as conservative as possible.

Here we investigate the possible role of asset tangibility (mainly collateral) on firm's investment decision. The asset tangibility of a firm is taken as a possible channel which can promote borrowing ability by enabling firms to offer additional collateral to financial intermediaries, which in turn puts other firms which are unable to offer collateral to face tighter financial borrowing restrictions (Almeida and Campello, 2006). We have already noted that financial intermediaries leaned toward safer lending to both firms and households based on asset tangibility after the crisis. It is therefore a candidate for the unexplored factor mentioned above, so we will check if asset tangibility indeed played this role. In the rest of this paper, we estimated the firm's demand equation for investment putting asset tangibility into the equation and testing it to see if and

how far it could explain investment.

In section II, we survey the previous literature for the investment function, especially with financial constraints. In section III, the theoretical background, provided by Almeida and Campello(2006) is introduced. In section IV, the data description, empirical model specifications, and empirical results are reported. Section V provides the conclusion and implications from the empirical results.

Ⅱ. Previous Literature

First we look into the literature on the investment function. While new classical investment theory mainly focuses on the role of the user's cost in the investment function, Jorgenson(1963) expanded the model emphasizing the role of Tobin's q on investment behavior, which represents the future profits or the investment opportunity of firms. Devereux and Schiantarelli(1989) developed the standard Tobin's q model by incorporating an additional variable, cash flow, which represents a firm's financial restrictions. Almeida and Campello (2006) suggested that asset tangibility could affect a firm's investment decision when a firm is restricted to financial constraints. By using both empirical and theoretical analysis, they showed that the sensitivity of investment to cash flow increases as the level of asset tangibility increases when it is under financial restrictions. On the other hand, for the firms that are not financially restricted, the relationship appears to be effective.[2)]

There are also two different approaches in the literature depending on how the sample of firms is divided as they face different degrees of financing constraints. As thefirst approach, firms are distinguished by time-invariant prior criterion such as firm size, age, average

2) Also the studies which raise the question of whether Tobin's q is significant regardless of a firm's financial constraints exist. Gomes(2003), Alti(2003) provide that Tobin's q is 'a poorer proxy' for investment opportunities for firms typically classified as financially constrained. We do not analyze this issue. See Almeida and Campello(2006, p15).

dividend payout, etc. Studies such as Fazzari et al.(1988), Gertler and Gilchrist(1994), Erickson and Whited(2000), Almedia(2004), Hennessy and Whited(2005) applied this approach, and divided the sample of firms exogenously based on firm characteristic indicator. However, this approach has several drawbacks as Hu and Schiantarelli (1998) pointed out. First, a single indicator may not be a good proxy for the imperfect substitutability of internal and external sources of funding. Secondly, it implicitly assumes that the exogenously firm classification is fixed over the entire sample period. Finally, if the variable used a criterion in the sample split is correlated with the other endogenous variables in the investment function, it may cause a selection problem. Along with this, studies such as Hu and Schiantarelli(1998), Hovakimian and Titman(2006), Almedia and Campello(2006) recognized that a firm's investment pattern is endogenously related to the financial constraint in each regime, and applied an endogenous switching regression model to estimate the investment function. In our analysis, we follow the second approach, and thus apply an endogenous switching regression model on our model.

Ⅲ. Theoretical Background

Following Almeida and Campello(2006), we assume that a firm maximizes its investment value under the budget constraints. More specially, after a firm invests, it is able to produce its product. Throughout this production process, a firm can maximize the value of its investment (I). However, a firm has to use either internal funds(W) or external funds(τI) to finance this investment. Here τ represents a portion of external funds in total investment. In mathematical form, this relationship can be expressed as follows:

$$max\ f(I)-I \tag{1}$$
$$s.t\ I \leq W+\tau I \tag{2}$$

This implies that a firm is under the financial constraint if $I^{FB}-W \geq 0$, and in this case, a firm's optimal investment level is restricted by its budget constraints. The firm's optimal investment level is expressed as follows:

$$\begin{aligned} I(W,\tau) &= \frac{W}{(1-\tau)},\ if\ \tau < \tau^*(W, I^{FB}) \ \text{ - with the financial constraint} \\ &= I^{FB},\ if\ \tau \geq \tau^*(W, I^{FB}) \ \text{ - without financial constraint} \end{aligned} \tag{3}$$

where I^{FB} is the first-best level of investment, $f'(I^{FB})=1$.[3)]

3) $0 \leq \tau^* \leq 1$

Therefore, if a firm has a high level of asset tangibility ($\tau \geq \tau^*(W, I^{FB})$), then it is defined as a financially unconstrained firm. In this case, investment is no longer affected by cash flow or asset tangibility. On the other hand, if a firm is subject to low asset tangibility ($\tau \leq \tau^*(W, I^{FB})$), then the firm is defined as financially constrained, and investment will be a function of cash flow and asset tangibility. Also, in this case, the sensitivity of investment on cash flow will increase as asset tangibility rises.[4)]

4) It can be shown from the equation, $\frac{\partial^2 I}{\partial W \partial \tau} = \frac{1}{(1-\tau)^2} > 0$ *if* $\tau < \tau^*(W, I^{FB})$

Ⅳ. Empirical Analysis

1. Data

In this paper, we use Korean firm-level data obtained in the KIS VALUE database.[5] Among all non-finance corporates, 1,786, we initially chose firms based on their closing date(December) of the fiscal year, and duration (at least 5 years since 1990). The classification by industry in our firm data are reported in Appendix 1. The sample period and frequency are 1994 to 2009, annual.[6]

We used the following variables in the empirical analysis. Total assets (K) is defined as the sum of liquid assets and non-liquid assets. Investment(I) is the increment of fixed tangible assets. Also, retained earnings is used as a proxy for cash flow(CF), following Almedia and Campello(2006). It is calculated by summing earned surplus reserves, reserves for finance structure improvements, reserves for business improvements, other legal reserves, stock dividends, voluntary reserves, and net earned surplus forwarded. This implies the amount of funds that a firm can raise for unexpected equipment expansion or unexpected financial instability. Also, Tobin's q(Q) is estimated as the ratio of the sum of market value and liability book value to total assets, which represents the firm's value

5) The database is provided by the KIS Credit Service Company.

6) The choice of sample period is based on the qualities of the database. Before 1994, the database did not accumulate enough information on firms.

or the investment opportunities in the future. In this study, we examine the effect of Tobin's q, cash flow and asset tangibility on the firm's investment behavior.

However, since it is an unbalanced firm panel data, we need to improve the consistency of the dataset as well as deal with outliers. To improve the consistency, we only use firms which have lasted at least five years, and have reported annually every December. Also, the outliers of each variable are excluded from the raw database. Following the previous literature[7], the range of the investment ratio from 0 to 0.2, the cash flow ratio to the previous year's assets from 0 to 0.8, Tobin's q value from 0.1 to 3, and the debt ratio of less than 0.75 are included in our analysis.

Even though there are many studies that have used asset tangibility or collateral in their analysis, there is no unified consensus for a suitable proxy variable. Following Berger, Ofek and Swary(1996), Almedia and Campello(2006) which used the exit value[8] and cash holdings as a proxy for asset tangibility. Their formula is as follows:

$$T=EV_{i,t}+CASH_{i,t}=(0.715REC_{i,t}+0.547INV_{i,t}+0.535TF_{i,t})+CASH_{i,t}$$

where *REC*, *INV* and *TF* are the ratio of receivables, inventory assets, tangible fixed assets to total assets in each.

Kim and Son(1999) estimated the exit value using firm's insolvency data in Korea from 1980 to 1998, there was no direct

7) Please refer to Ro, Kim and Kim(2009), Kim *et al.*(2009), Sung and Kang(2008), Kim(2005), Love(2003), Leaven(2002).

8) The exit value is expressed as a function of account receivables, inventories and tangible fixed assets.

relationship between firm's estimated exit values and financial variables. Park, Kim and Lee(2007) defined the exit value as total asset minus organizational expenses, development costs, other intangible asset, short-term loans, current liabilities and fixed liabilities. Also, Lee(2007) estimated a firm's exit value as its net assets, which is defined as the modified total assets minus total debt. He assumed that all account receivables are not collectable, and 30% of inventory assets, 70% of investment assets, and 50% of tangible assets are considered as components of total assets. Lastly, KIS VALUE reports estimated value of firms annually since 1998. In this study, we adopt a first methodology from Almedia and Campello.[9]

All variables are expressed in real terms after being divided by CPI and normalized by dividing this amount by its assets (K). The summary statistics for the variables are reported in Appendix 2.

2. Empirical Model

(1) Basic Model and Estimation Method

This empirical analysis is mainly based on the endogenous switching regression model[10] using firm-level panel data from 1994

9) The first approach is more appropriate than others because of the followings. Kim and Son(1999) only used the data but did not provide their own data. Park, Kim and Lee(2007) and Lee(2007) calculatedthis value based on the assumption of the research. The last application in the KIS VALUE does not contain enough sample periods.

10) Alternatively, a traditional(fixed or random) two-way panel estimation for

to 2009 in Korea, similarly with Almeida and Campello(2006). The empirical model includes the following three assumptions. At first, the investment of a firm depends on four basic explanatory variables – cash flow, Tobin's q, asset tangibility, and the interaction between a cash flow and asset tangibility. Secondly, the investment function of a firm's can be different along with its financial status – financially constrained or unconstrained. This indicates a group effect in investment, when the investment behaviors between two different financial regimes can be distinguished or segregated. Lastly, each investment function according to its subsample has its own time effect.

The basic representation for the empirical analysis is as follows:

$$\begin{aligned} IK_{i,t}^{u} &= Z_{i,t}A^{u} + TE_{t} + \varepsilon_{1i,t} \\ &= \alpha_{0}^{u} + \alpha_{1}^{u}CK_{i,t-1} + \alpha_{2}^{u}Q_{i,t-1} + \alpha_{3}^{u}TK_{i,t-1} + \alpha_{4}^{u}IA_{i,t-1} + TE_{t} + \varepsilon_{1i,t} \end{aligned} \quad (4)$$

---

each sample group – financially constrained and unconstrained – can be considered. However, the empirical results, using the estimation, are not robust enough for the following two reasons. Firstly, the empirical results, using a traditional panel model, do not follow the theoretical findings. That is, even if the coefficient of interaction between asset tangibility and cash flow for the financially constrained firm is supposed to be significant by theory, the coefficientfrom the panel estimation is insignificant. It occurs in both subsample periods,the 1990s and the 2000s. Secondly, when we check the change in investment behaviors across two different time periods – the 1990s and 2000s, discordance occurs between two different estimation factors, which are the estimations using each sample period and the estimations using a time dummy variable. Therefore, we would like to use the endogenous switching regression model which does not show both problems, instead of the traditional panel model. The empirical results using a traditional two-way panel model can be provided upon request at jwkim@kiet.re.kr.

$$IK_{i,t}^{c} = Z_{i,t}A^{c} + TE_t + \varepsilon_{2i,t}$$
$$= \alpha_0^{c} + \alpha_1^{c}CK_{i,t-1} + \alpha_2^{c}Q_{i,t-1} + \alpha_3^{c}TK_{i,t-1} + \alpha_4^{c}IA_{i,t-1} + TE_t + \varepsilon_{2i,t} \quad (5)$$

$$\tilde{Y}_{i,t} = W_{i,t}\gamma + TE_t + u_{i,t} \quad (6)$$

The first two equations are structural equations that show the investment behavior of firms under alternative regimes – financially unconstrained and financially constrained. where, $IK_{i,t}^{u}$ and $IK_{i,t}^{c}$ are the ratios of investment to total assets for firm i at time t under financially unconstrained(u) and constrained(c) conditions, respectively. The basic explanatory variable vector(Z) for the investment function contains a constant, a cash flow(CK), Tobin's q(Q), an asset tangibility(TK), and interaction term(IA) which is the product of cash flow and asset tangibility. This interaction variable is introduced to consider the first order condition of the theoretical model which shows the positive relationship between cash flow and asset tangibility under the financially constrained phase. TE and ε are time specific individual effects and residual. The coefficient vector(A) contains the corresponding coefficients($\alpha_1 \sim \alpha_4$). The superscripts – u and c – denote both regimes, financially unconstrained and constrained.

Equation (6) is the selection equation, which determines the propensity of being in either regime. The vector W contains variables for determining the regime of a firm. Similarly with the choice in Almeida and Campello(2006)[11], W includes the basic explanatory variables(Z) in the investment function, and firm characteristic

11) They follows Hovakimian and Titman(2004). Also Almeida and Campello (2006) explain that the empirical result using the choice of Hovakimian and Titman(2004) is similar with the empirical result using the choice of Hu and Schiantarelli(1997).

variables, which are a firm's size(a logarithm of total asset), a firm's age(a logarithm of years the firms has been in existence since 1990), financial slack(the ratio of liquid assets to total assets), and a dummy variable that equals 1 if the firm has made any cash dividend payments in the year. All these variables, except the dummy variable, are used in a lagged form.

The observed investment of firm i at time t, $IK_{i,t}$, is given by

$$IK_{i,t}=IK_{i,t}^{u}.\ \ If\ \ \tilde{y}_{i,t}\leq 0$$
$$IK_{i,t}=IK_{i,t}^{c},\ \ otherwise$$

where $\tilde{y}_{i,t}$ is a latent variable that measures the likelihood of the firm belonging to a particular regime. The regime of a firm is not fixed, but interchangeable, as seen in equation (6). This means that the financial status of a firm can vary over time.

The coefficient vectors $-A^{u}$, A^{c}, and $\gamma-$ are estimated using the maximum likelihood method. In the estimation, the residuals$-\ \varepsilon_{1i,t}$, $\varepsilon_{2i,t}$, and $u_{i,t}-$ are assumed to be jointly normally distributed with a zero mean vector and covariance matrix, which allows for a non-zero correlation between shocks to investment and shocks to firms' characteristics. The covariance matrix is as follows,

$$\Sigma=\begin{bmatrix}\sigma_1^2 & \sigma_{12} & \sigma_{1u}\\ \sigma_{21} & \sigma_2^2 & \sigma_{2u}\\ \sigma_{u1} & \sigma_{u2} & \sigma_u^2\end{bmatrix}$$

where, σ_u^2 is normalized to 1.[12)]

12) See Maddala(1986), Hu and Chiantarelli(1988), and Hovakimian and Titman (2004) for details.

If $\sigma_{1u}=\sigma_{2u}=0$ then this switching regression model becomes exogenous rather than endogenous. Otherwise, it becomes an endogenous switching regression and implies that the two investment equations– the equation (4) and (5) – for each regime and selection equation – the equation (6)– should be considered concurrently. Even if we cannot observe the financial status or regime of a firm, we can calculate the probability when one of them occurs,

$$\begin{aligned} Pr(IK_{i,t}=IK_{i,t}^{u}) &= Pr(Z_{i,t}\gamma+u_{i,t}\leq 0) \\ &= Pr(u_{i,t}\leq -Z_{i,t}\gamma) \\ &= F(-Z_{i,t}\gamma) \\ Pr(IK_{i,t}=IK_{i,t}^{c}) &= Pr(Z_{i,t}\gamma+u_{i,t}> 0) \\ &= Pr(u_{i,t}> -Z_{i,t}\gamma) \\ &= 1-F(-Z_{i,t}\gamma) \end{aligned}$$

The log likelihood function(L) using the likelihood density function($l_{i,t}$) which is a weighted conditional density function of $\varepsilon_{1i,t}$, $\varepsilon_{2i,t}$ with both probability weights is as follows:

$$\begin{aligned} L &= \sum_{i=1}^{N}\sum_{t=1}^{T}\log(l_{i,t}) \\ &= \sum_{i=1}^{N}\sum_{t=1}^{T}\log\{f(\varepsilon_{1i,t}|\, u\leq -Z_{i,t}\gamma)F(-Z_{i,t}\gamma)+f(\varepsilon_{2i,t}|\, u> -Z_{i,t}\gamma)F(1-Z_{i,t}\gamma)\} \\ &= \sum_{i=1}^{N}\sum_{t=1}^{T}\log\{f(\varepsilon_{1i,t},\, \sigma_1)F(\eta_{1i,t})+f(\varepsilon_{2i,t},\, \sigma_2)F(\eta_{2i,t})\} \end{aligned}$$

where, $\eta_{ji,t}=[Z_{i,t}\gamma+\sigma_{ju}\varepsilon_{ji,t}/\sigma_j^2]/\sqrt{1-\sigma_{ju}^2/\sigma_j^2}$. And $f(\cdot)$ and $\mathrm{F}(\cdot)$ are the normal density and cumulative distribution functions.

(2) Model Extension 1 for Consideration of Period Effect

The Financial Crisis in 1997 crisis is known to conclude when Korea repaid the relief loans to the IMF in 2000, but the Korean economy underwent substantial changes, in particular, in investment behavior. Hence, this has led us to extend the basic empirical model for testing the period effect of investment behavior.

The basic model – equations (4)~(6) – does not specify the possibility of change in investment behavior after 2000. It is assumed that the period effect can occur via the basic explanatory variables in Z. In order to estimate and test the period effect, the basic equations are extended as follows.

$$IK^u = ZA^u + Z^T\delta^u + TE + \varepsilon_1 \tag{7}$$

$$IK^c = ZA^c + Z^T\delta^c + TE + \varepsilon_2 \tag{8}$$

$$\tilde{y} = W\gamma + W^T\xi + TE + u \tag{9}$$

where $Z^T = Z \cdot D^T = [CK^T, Q^T, TK^T, IA^T] = [(CK \cdot D^T), (Q \cdot D^T), (TK \cdot D^T), (IA \cdot D^T)]$ and $\delta^j = (\delta_1^j, \delta_2^j, \delta_3^j, \delta_4^j)'$, $(j=u,c)$. D^T is a dummy variable that equals 1 if a time (t) is after 2000. The subscripts i and t are not are not marked for convenience.

The differences in investment behavior between the two periods can be identified from the significance test for each δ^j. As an example, the significantly positive δ_1^j implies that the investment of a firm against cash flow becomes more sensitive during the 2000s, compared with the 1990's.

(3) Model Extension 2 for Consideration of the Period and Firm Size Effect

Now, we focus on whether firm size plays a meaningful role in investment behavior. The firm size effect is also assumed to occur via each of the basic explanatory variables. In order to test this, a sample is divided into two subsamples based on a firm size– large and small–medium sized firms. For efficiency's sake, the size and period effects need to be jointly considered in the model. Ideally, there are three possibilities – a firm size effect, a period effect, and a period & firm size(OR firm size & period) effect. These three possibilities are included in one model and tested. However, the convergence problem occurs in the empirical model for the joint null hypothesis testing. Hence, we employ the following testing procedure which considers the effects separately.

The test procedure starts from the model specification using equations (7)~(9) and their results,which investigate the period effect in investment behavior. The followings are the two null hypotheses tested here.

<Hypothesis 1> (time or period invariant firm size effect)

Investment behavior can be different across firm sizes, inherently. However, the period effects of investment is supposed to not to depend on firm size.

<Hypothesis 2> (time or period varying firm size effect)

Assuming a significant time invariant firm size effect estimated in Hypothesis 1, the period effects of investment behaviors between two firm sizes will be different.

The first null hypothesis tests whether investment behavior is same across firms of different size. For this test, the firm size effect on investment is assumed as a time invariant. The purpose of the test is to consider the possible presence of different investment behaviors due to the intrinsic characteristics of a firm, its size. The second null hypothesis includes the size effect in the period effects, via a significant path of a firm size effect found in the result of hypothesis 1. In reality, the period effect of investment can be different along with firm sizes. Different from null hypothesis 1, null hypothesis 2 considers changeability in the effect of firm size on investment.

Empirical models used to test hypotheses 1 and 2 are expressed by equations (7)'~(9)' and (7)"~(9)", respectively.

$$IK^u = ZA^u + Z^{T*}\delta^u + Z^M\omega^u + TE + \varepsilon_1 \quad (7)'$$
$$IK^c = ZA^c + Z^{T*}\delta^c + Z^M\omega^c + TE + \varepsilon_2 \quad (8)'$$
$$\tilde{y} = W\gamma + W^{T*}\xi + Z^M\psi + TE + u \quad (9)'$$

$$IK^u = ZA^u + Z^{T*}\delta^u + Z^{M*}\omega^u + (Z^{T*})^M\theta^u + TE + \varepsilon_1 \quad (7)''$$
$$IK^c = ZA^c + Z^{T*}\delta^c + Z^{M*}\omega^c + (Z^{T*})^M\theta^c + TE + \varepsilon_2 \quad (8)''$$
$$\tilde{y} = W\gamma + W^{T*}\xi + Z^{M*}\psi + (Z^{T*})^M\zeta + TE + u \quad (9)''$$

where Z^T and Z^M are calculated from multiplying the basic explanatory variables in the investment function (Z) by a time dummyvariable (D^T) and by a firm size dummy variable (D^M), respectively. D^M is a dummy variable that equals 1 if a firm is classified as a mid-sized firm. Similarly $(Z^T)^M$ can be obtained by multiplying Z^T and Z^M. The superscript $*$ is related to the inclusion of certain variables. Z^{T*} includes variables which show significance out of Z^T from the estimation of

equations (7)~(9). Z^{M*} includes variables which show significance in terms of Z^{M} from the estimation of equations (7)'~(9)'. This testing procedure is designed in order to prevent instability in the estimation results. A^j, δ^j, ω^j, and θ^j (for $j=u,c$) are estimated coefficients in each investment function. Also, γ, ξ, ψ, and ζ are coefficients in the selection equation. The subscripts i and t are not marked for convenience.

3. Results[13]

(1) Period Effect[14]

The basic empirical results are based on an endogenous switching regression using equations (4)'~(6)', and are reported in Table 1. From the estimation, we find the following significant differences across different firm groups which may or may not be financially constrained. The following findings regarding the empirical results are summarized by the financial status.

Firstly, all coefficients which show a period change among financially constrained firms are significant ; i.e the period effects via all

13) Endogenous switching models can be estimated one equation at a time either by a two-step least squares or maximum likelihood estimation. The procedure is inefficient and requires cumbersome adjustments. Hence, an efficient alternative using the full information maximum likelihood(FIML) method is applied here.

14) The empirical results using dummy variables are consistent with the results using estimation by period. The estimations are reported in Appendix 3.

explanatory variablesare significant. In particular, the coefficients δ_1^c and δ_3^c which are response increments against cash flow and asset tangibility during the 2000s are significantly positive, 0.115 and 0.046. This implies that cash flow and asset tangibility took on a more important role in investment for financially constrained firms during the 2000s. On the other hand, the coefficient δ_4^c which indicates a period effect via the interaction between cash flow and asset tangibility on investment is significantly negative at −0.302. This implies that the indirect synergy effect between cash flow and asset tangibility on investment weakens. The possible reason for this might be due to modifications and consolidations in lending rules after the financial crisis. The above results show that the direct and indirect effects of the two explanatory variables, cash flow and asset tangibility, on investments moved in opposite directions. Hence, in order to determine the changing direction of period effects in each cash flow or asset tangibility, adjusted coefficients $(\delta_1^c+\delta_4^c \cdot TK)$ or $(\delta_3^c+\delta_4^c \cdot CK)$ need to be estimated using coefficient values and average values for TK, and then evaluated. The former and latter adjusted coefficients are all positive, 0.020 and 0.003.[15] However, the coefficient δ_2^c, which indicates the change in the investment response against Q, is significantly negative, at −0.012.

Therefore, investment in financially constrained firms became more sensitive to asset tangibility and cash flow during the 2000s. However, the decrease in the coefficient of Q implies that the

15) The numbers calculated are based on the mean value of asset tangibility in financially constrained firms(0.3141), and the mean value of cash flow in financially constrained firms(0.1428). Hence, the period effect of cash flow on investment will be positive if $TK<0.38$. Similarly, the period effect of asset tangibility on investment will be positive if $CK<0.15$.

willingness to risk money has decrease even if the value of firm or investment opportunity has been recovered. In addition, the effect of interaction between cash flow and asset tangibility on investment decreases between the two periods. This is probably due to preparations for an undesirable economic event and consolidation of lending rules.

Table 1. Estimation Results of the Investment Function Considering a Firm's Financial Constraint

	Unconstrained Firm	Constrained Firm	Section eq.
CK	−0.057 (-1.10)	−0.062 (−1.19)	0.027 (0.02)
Q	0.009 (2.30)**	0.010 (1.51)	−0.093 (0.02)
TK	−0.058 (-2.64)**	−0.030 (−1.30)	−0.590 (−0.81)
IA	0.092 (0.56)	0.363 (2.23)**	−2.379 (−0.47)
$CK \cdot D^T$	0.068 (1.23)	0.115 (2.07)**	−0.391 (−0.23)
$Q \cdot D^T$	0.004 (0.98)	−0.012 (−1.74)*	−0.186 (−1.16)
$TK \cdot D^T$	0.056 (2.17)**	0.046 (1.78)*	0.553 (0.68)
$IA \cdot D^T$	−0.062 (.175)	−0.302 (−1.76)*	0.282 (0.05)
$\ln(age)$			0.027 (0.70)
D_{DIV}			−4.067 (−55.93)***
$\ln(K)$			−0.091 (−4.68)***
$LuquidK$			−0.470 (−3.23)***
$constant$	0.068 (8.74)***	0.035 (3.41)***	4.362 (7.69)***
$\#obs$	11,123		
σ_1	0.068 [0.000]		
σ_2	0.060 [0.000]		
ρ_1	-0.077 [0.029]		
ρ_2	-0.031 [0.086]		

Note : 1) The parenthesis ( ) is the t statistic, and *, **, and *** are significance levels of 10%, 5%, and 1%.

2) The parenthesis [ ] is the standard error, $\sigma_j^2 = \sqrt{var(\varepsilon_j)}$, and $\rho_j = corr(\varepsilon_j, u)$, where $\varepsilon_j \sim (0, \sigma_j^2)$ and j=1, 2.

Secondly, investment in financially unconstrained firms becomes more sensitive to its asset tangibility, as it does with financially constrained firms. This is somewhat different from the findings in theoretical model, which states that investment only in financially constrained firms varies with their asset tangibility. We introduce possible reason to support the empirical results. A firm tends to wait for collecting a present investment for a long time. Also, to achieve certain investment goals, firms need to invest continuously for a given period. Hence, when a firm invests today, it should consider future cash flows and alternatively external finance which needs asset tangibility as collateral. Changes in economic circumstances cause firms, including financially unconstrained firms, to consider and prepare for uncertainty in the future, more than the past. The rapid changes in the economic conditions after the crisis caused firms, including financially unconstrained, to prepare more for future uncertainty.[16)]

(2) Firm Size Effect[17)]

The empirical results for Hypotheses 1 and 2 are reported in

16) As seen in chapter Ⅲ, a corporate investment is assumed to be affected by its financial status, which in turn depends on the threshold ratio of external financing, τ^*. τ^* is expressed as a function of internal funds and optimal investment level. If a firm considers future internal funding as well as present internal funding in constructing an investment plan, it is possible that a financially unconstrained firm be affected by its asset tangibility.

17) As we described above, separate estimations by period and firm size are not available because of the convergence that problem occurs in the estimations using some of the subsamples.

Table 2. In particular, the results of hypothesis 1 and 2 are set out in <1> and <2>~<5> in Table 2, respectively.[18)]

Firstly, according to the empirical test results for Hypothesis 1, firm size effect on investment behavior is significant via the interaction factor in the financially constrained phase. The coefficient of interaction(IA^M) showing the additional response in small-medium firms is -0.365 with a significance level of 5%. This indicates that the effect of the interaction term in a small-medium size firm is significantly lower than that in a large sized firm. This indicates that even if a small-medium sized firm has the same conditions as a large firm, the investment effect of asset tangibility in small to medium-sized firms is lower than that in large firms. It implies that a small to medium-sized firm tends to have difficulties in raising investment compared to a large firm, under the same cash holding conditions. However, the otherfirm size effects of financially constrained firms via other explanatory variables in are not significant. Also, there is no significant firm size effect in the financially unconstrained firm group.

Secondly, the empirical results do not accept hypothesis 2, which tests whether the period effect is different along with firm sizes. All coefficients of $((Z^{T*})^M)$ which show the period and firm size effects are not significant. This indicates that the period effect in investment behavior has nothing to do with firm size.

Consequently, from both null hypothesis tests, we can say that a small to medium-sized firm has a significantly different investment effect via the interaction between cash flow and asset tangibility, compared with that in a large firm. This gap was not reduced in the

18) The statistics for the selection equation are not reported for the sake of convenience.

Table 2. Estimation Results of the Investment Function Considering Financial Constraint & Firm Size

	⟨1⟩		⟨2⟩		⟨3⟩		⟨4⟩		⟨5⟩	
	U	*C*	*U*	*C*	*U*	*C*	*U*	*C*	*U*	*C*
Basic variables (Z)										
CK	−0.017 (−0.57)	−0.110 (−1.60)	0.002 (0.13)	−0.070 (−1.35)	0.002 (0.13)	−0.068 (−1.30)	0.002 (0.15)	−0.068 (−1.31)	0.002 (0.13)	−0.070 (−1.34)
Q	0.015 (5.87)***	0.010 (1.24)	0.013 (7.85)***	0.010 (1.43)	0.013 (7.84)***	0.010 (1.46)	0.013 (7.85)***	0.010 (1.45)	0.013 (7.84)**	0.010 (1.43)
TK	−0.050 (−2.71)***	−0.037 (−1.37)	−0.057 (−3.26)***	−0.034 (−1.47)	−0.057 (−3.26)***	−0.032 (−1.42)	−0.057 (−3.27)***	−0.033 (−1.43)	−0.057 (−3.26)***	−0.034 (−1.46)
IA	0.074 (0.78)	0.729 (3.24)***	0.038 (0.66)	0.724 (3.59)***	0.038 (0.66)	0.619 (3.51)***	0.039 (0.68)	0.639 (3.58)***	0.038 (0.66)	0.725 (2.88)***
Periodical change (Z^T)										
CK^T		0.118 (2.13)**		0.070 (1.10)		0.115 (2.08)**		0.116 (2.10)**		0.121 (2.19)**
Q^T		−0.012 (−1.76)*		−0.012 (−1.68)*		−0.016 (−2.06)**		−0.012 (−1.74)*		−0.012 (1.68)*
TK^T	0.054 (2.73)***	0.046 (1.76)*	0.053 (2.72)***	0.047 (1.83)*	0.053 (2.72)***	0.045 (1.74)*	0.055 (2.72)***	0.033 (1.18)	0.053 (2.72)***	0.049 (1.89)*
IA^T		−0.313 (−1.83)*		−0.326 (−1.90)*		−0.310 (−1.81)*		−0.317 (−1.85)*		−0.477 (−1.80)*
Firm size effect (Z^M)			*Firm size effect* (Z^{M*})							
CK^M	0.031 (0.98)	0.044 (0.93)								
Q^M	−0.002 (−0.77)	0.000 (0.13)								
TK^M	−0.009 (−0.87)	0.004 (0.28)								
IA^M	−0.043 (0.42)	−0.365 (−2.25)**		−0.326 (−1.90)*		−0.247 (−3.78)***		−0.266 (−3.75)***		−0.349 (−1.88)*

⟨continue⟩

	〈1〉		〈2〉		〈3〉		〈4〉		〈5〉	
	U	*C*	*U*	*C*	*U*	*C*	*U*	*C*	*U*	*C*
Firm size effect in the periodical effect$((Z^{T*})^M)$										
$(CK^T)^M$				0.054 (1.43)						
$(Q^T)^M$						0.003 (1.28)				
$(TK^T)^M$							-0.001 (-0.28)	0.015 (1.43)		
$(IA^T)^M$										0.160 (0.82)
constant	0.061 (9.47)***	0.036 (3.49)***	0.062 (9.71)	0.036 (3.49)***	0.062 (9.71)***	0.036 (3.47)***	0.062 (9.70)***	0.036 (3.47)***	0.062 (9.72)***	0.036 (3.48)***
#obs	11,123									

Note : 1) The parenthesis ( ) is the t statistic, and *, **, and *** are significance levels of 10%, 5%, and 1%.
2) 『U』 and 『C』 are equations for unconstrained and constrained firm, respectively.

2000's, at least. In other words, the change in investment behaviors in the 2000's is mainly due to an increase in risk aversion and a consolidation of asset management rules, but discrimination in terms of firm size.

Ⅴ. Conclusion

This paper investigates the role of asset tangibility as well as other basic explanatory variables on investment decision of a firm's. The concatenate empirical works provide the following important findings and implications.

Firstly, the effect of asset tangibility on investment during the 2000s has increased since the 1990s, regardless financial status. This implies that the effect in the 2000s was subtler than in the past. Changes in economic circumstances cause firms, including financially unconstrained firms, to consider and prepare for uncertainty in the future, more than in the previous period. That is, a firm usually tends to wait to collect on an investment for a long period of time. Also, in some situations, firms require continuous investment for a substantial period of time. Hence, when a firm invests today, the firm should consider its future cash flows and later on, its asset tangibility. A rapid change in the economic condition after a financial crisis urges firms, including even financially unconstrained, to consider their future more carefully.

Secondly, the effect of Tobin's q on investment in financially constrained firms during the 2000s is significantly lower than in the 1990s. It implies the risk taking approach to investment works unsatisfactorily. However, this effect is not significant in financially unconstrained firms.

Thirdly, the interaction effect between cash flow and asset tangibility on investment has also decreased, significantly. A possible reason is

the preparation for undesirable economic events and the imposition of consolidation rules in lending by firms. This effect is significant only in financially constrained firms.

Fourthly, the direct effect of cash flow on investment has increased, significantly only in financially constrained firms.

In addition to above results, the firm size effect on investment is significant only through the interaction variable under financially constrained phase, of which a small to medium-sized firm under financially constrained phase has a lower interaction effect on investment. This implies that even if a small to medium-sized firm has the same conditionsas a large firm, the investment effects of asset tangibility or cash flow in the small to medium-sized firm is lower. However, this gap does not diminish during the 2000's because there is no statistical evidence that the firm size effect changes between two periods – the 1990s and the 2000s.

In summary, we found that the corporate investment behavior in the 2000s became different from that in the 1990s, especially in terms of asset tangibility. Asset tangibility has played a more important role on the decision of a firm's investment after 2000. It does not directly imply that a constant effort to increase asset tangibility must be the main purpose or the end goal for a firm. It would be desirable for a firm to hold the appropriate level of asset tangibility compared with its (potential) production capacity. If some asset – i.e. intangible asset – which is sufficiently valuable in firm but is not included as collateral in the present prequalification system for loan can be recognized efficiently as collateral, it will be one of the most useful alternatives to raise money for essential investment.

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Appendix 1. Industry Classification of Korean Non-financial Firms

CODE	Industry	# Firms
1	Agriculture, forestry and fishing	6
2	Mining and quarrying	2
3	Manufacturing	1,202
4	Electricity, gas, steam and water supply	11
5	Sewage, waste management, materials recovery and remediation activities	4
6	Construction	70
7	Wholesale and retail trade	124
8	Transportation	30
9	Accommodation and food service activities	2
10	Information and communication	183
11	Financial and insurance activities	3
12	Real estate activities and renting and leasing	7
13	Professional, scientific and technical activities	98
14	Business facilities management and business	18
15	Education	13
16	Arts, sports and recreation related services	8
Total		1,786

Source : KIS VALUE Database

Appendix 2. Summary Statistic of Basic Variables in Investment Function(mean, standard deviation)

		IK_t	CK_{t-1}	Q_{t-1}	TK_{t-1}	IA_{t-1}	# obs
All size of firms							
All period	All	0.055(0.066)	0.135(0.142)	0.909(0.471)	0.312(0.107)	0.043(0.049)	14,938
	C	0.052(0.070)	0.132(0.144)	0.907(0.513)	0.311(0.118)	0.042(0.050)	5,328
	U	0.054(0.061)	0.132(0.136)	0.928(0.459)	0.307(0.098)	0.041(0.045)	5,814
1990s	All	0.060(0.066)	0.083(0.099)	0.866(0.355)	0.307(0.106)	0.026(0.033)	3,129
	C	0.047(0.065)	0.089(0.109)	0.772(0.324)	0.301(0.123)	0.028(0.038)	1,025
	U	0.065(0.065)	0.080(0.091)	0.931(0.381)	0.304(0.096)	0.024(0.030)	1,467
2000s	All	0.053(0.066)	0.149(0.149)	0.920(0.497)	0.313(0.107)	0.048(0.052)	11,809
	C	0.053(0.071)	0.142(0.150)	0.939(0.543)	0.314(0.117)	0.046(0.052)	4,303
	U	0.051(0.060)	0.149(0.145)	0.927(0.482)	0.308(0.098)	0.046(0.048)	4,347
Firm size 1 (large firm sized firm group)							
All period	All	0.054(0.060)	0.088(0.108)	0.899(0.427)	0.295(0.101)	0.027(0.036)	5,913
	C	0.048(0.060)	0.071(0.100)	0.885(0.432)	0.276(0.114)	0.020(0.031)	1,136
	U	0.056(0.059)	0.089(0.109)	0.915(0.436)	0.296(0.095)	0.027(0.036)	2,744
1990s	All	0.070(0.067)	0.058(0.079)	0.907(0.325)	0.299(0.101)	0.017(0.025)	1,318
	C	0.056(0.068)	0.050(0.073)	0.836(0.322)	0.295(0.118)	0.016(0.022)	199
	U	0.072(0.065)	0.056(0.074)	0.934(0.346)	0.294(0.094)	0.017(0.024)	738
2000s	All	0.049(0.056)	0.097(0.114)	0.897(0.452)	0.294(0.101)	0.030(0.038)	4,595
	C	0.046(0.058)	0.075(0.105)	0.895(0.452)	0.272(0.112)	0.022(0.033)	937
	U	0.050(0.055)	0.102(0.117)	0.908(0.464)	0.296(0.095)	0.031(0.039)	2,006
Firm size 2 (small-medium sized firm group)							
All period	All	0.055(0.069)	0.166(0.153)	0.915(0.498)	0.324(0.109)	0.054(0.053)	9.025
	C	0.053(0.072)	0.149(0.150)	0.913(0.532)	0.321(0.118)	0.048(0.053)	4,192
	U	0.053(0.064)	0.169(0.147)	0.940(0.478)	0.318(0.099)	0.053(0.049)	3,070
1990s	All	0.052(0.064)	0.101(0.107)	0.836(0.373)	0.313(0.110)	0.032(0.036)	1,811
	C	0.045(0.064)	0.098(0.114)	0.757(0.323)	0.303(0.124)	0.031(0.040)	826
	U	0.058(0.064)	0.104(0.101)	0.929(0.414)	0.315(0.097)	0.032(0.033)	729
2000s	All	0.056(0.071)	0.182(0.158)	0.935(0.523)	0.326(0.108)	0.059(0.056)	7,214
	C	0.055(0.074)	0.161(0.155)	0.951(0.566)	0.325(0.116)	0.052(0.055)	3,366
	U	0.051(0.063)	0.189(0.153)	0.944(0.497)	0.319(0.100)	0.059(0.052)	2.341

Note : 1) The statistics uses observations after removing outliers by each variable as described in section 1 at Chapter IV.

2) Each number is a mean value. And the parenthesis indicates a standard deviation.

3) 『U』 and 『C』 are equations for unconstrained and constrained firm, respectively.

Appendix 3. Estimation Results of Investment Function by Period

	All period			The 2000s			The 1990s		
	U	*C*	*S*	*U*	*C*	*S*	*U*	*C*	*S*
CK	−0.007 (−0.42)	0.038 (2.32)***	−0.390 (−0.75)	0.022 (1.14)	0.052 (2.92)***	−0.292 (−0.63)	−0.056 (−1.04)	−0.631 (−1.29)	−0.276 (−0.18)
Q	0.013 (7.72)***	−0.001 (−0.56)	−0.254 (−4.56)***	0.015 (8.14)***	−0.002 (−0.99)	−0.342 (−6.69)***	0.010 (2.23)**	0.008 (1.20)	−0.098 (−0.71)
TK	−0.021 (−1.84)*	0.007 (0.71)	−1.153 (−0.46)	0.001 (0.12)	0.016 (1.33)	0.040 (0.13)	−0.058 (−2.49)**	−0.304 (−1.41)	−0.376 (−0.52)
IA	0.072 (1.28)	0.098 (1.92)*	−1.899 (−1.18)	0.020 (0.34)	0.061 (1.11)	−1.799 (5.85)***	0.088 (0.51)	0.369 (2.43)**	−1.661 (−0.36)
ln(*age*)			0.032 (0.83)			−0.043 (−1.44)			0.035 (0.38)
D_{DIV}			−4.062 (−56.13)***			−3.562 (−44.96)***			−3.679 (−31.61)***
ln(*K*)			−0.090 (−4.66)***			−0.365 (−2.16)**			−0.155 (−3.48)***
LiquidK			−0.473 (−3.27)***			−0.229 (−2.10)**			−0.723 (−1.95)*
constant	0.052 (9.78)***	0.037 (3.88)***	4.369 (8.24)***	0.043 (8.50)***	0.061 (11.12)***	3.463 (7.68)***	0.069 (8.29)***	0.036 (3.70)***	5.835 (5.38)***
#*obs*	11,123			8,645			2,478		
σ_1	0.068 [0.000]			0.069 [0.000]			0.063 [0.001]		
σ_2	0.060 [0.000]			0.061 [0.000]			0.063 [0.001]		
ρ_1	−0.071 [0.029]			−0.107 [0.034]			0.024 [0.695]		
ρ_2	−0.017 [0.078]			−0.853 [0.012]			0.068 [0.813]		

Note : 1) The parenthesis ( ) is the t statistic, and *, **, and *** are significance levels of 10%, 5%, and 1%.

2) The parenthesis [ ] is the standard error, $\sigma_j^2=\sqrt{var(\varepsilon_j)}$, and $\rho_j=corr(\varepsilon_j,u)$, where $\varepsilon_j \sim (0, \sigma_j^2)$ and j=1, 2.

3) 『U』 and 『C』 are equations for unconstrained and constrained firm, respectively. And , 『S』 is selection equation.