

Financial Liberalization and Corporate Investments: Evidence from Korea

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Abstract

We hypothesize that financial liberalization relaxes financing constraints on firms. Because of information asymmetry, managerial agency problem, and transaction costs, external financing is more costly than internal funds. Corporate investments depend on the availability of internal funds. As financial constraints faced by firms are weakened due to liberalization procedures, the sensitivity of investments to cash flow is expected to be reduced. Using panel data on Korean firms, we found that liberalization affects small and large, group and independent, and old and young firms differently. Small, independent and old firms which were severely financially constrained before financial liberalization gain most from liberalization.

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1. Introduction

The effects of financial liberalization on economic growth has received considerable attention in the literature. The traditional approach, due to McKinnon (1973) and Shaw (1973), argues that government intervention in financial markets inhibits financial development and thus economic growth. Financial liberalization steps include deregulation on interest rates and reduction in directed credit. Much existing literature investigates whether and to what extent liberalization results in an increase in financial deepening and economic growth. However, some researchers claim that financial regulation can play a positive role in the imperfect capital market.¹ In particular, Demetriades and Luintel (2001) provide empirical evidence that financial restraints have a positive impacts on Korean financial development. They claim that success of intervention policy of Korean government stems from ‘the strength of civil service and government institutions’. The empirical literature relating to the effects of financial liberalization on economic performance is largely based on the broad empirical correlations between macroeconomic aggregates. There is, however, a considerable scope for further theoretical and empirical research in identifying the microeconomic channels by which financial reform affect the economic performance.

Few studies has investigated whether financial liberalization in Korea affects the investment behavior of firms. Some research including Korea in their panel data set failed to consider the characteristics of Korean financial markets separately. The purpose of the paper is to analyze whether and to what extent Korean financial liberalization procedures during the 1990s have impacts on corporate investments by widening the accessibility to credit.

Asymmetric information, managerial agency problem, and transaction costs render firms difficult to finance without constraints. In this framework, firms' investment decision is affected by the availability of internal funds. We attempt to examine whether financial liberalization procedures actually relaxes financial constraints faced by firms.

Using panel data set on firms, we find that previously constrained firms, such as small, independent, and old firms have benefited more from financial liberalization. These firms get better access to outside financing after liberalization. It implies that financial liberalization promote economic

¹ Since many countries experienced financial crisis after financial reform, the positive role of financial repression deserves consideration. See Stiglitz (1994).

growth by helping constrained firms to get a wider access to finance.

Section 2 reviews the main literature investigating firms' investment under financial constraint. Several studies regarding the effect of financial liberalization on investments are also mentioned. In Section 3 we describe the data and the model, and present empirical results. The last section contains a brief conclusion.

2. Literature review

2.1. Financing constraint and Corporate Investment

Contrary to famous Modigliani-Miller theorem, many researchers claim imperfections in capital markets in that some firms are faced to financial constraints. Asymmetric information approach focus on the fact that not all market participants have the same access to information. Myers and Majluf (1982) argue that the cost of external financing is higher than that of internal funds. Such informational imperfections can result in credit rationing in competitive markets, and thus credit availability, not its cost determines the level of investment. Under these circumstances a firm with greater internal cash flow are likely to rely less on the more costly external financing.

Managerial agency problem arises when managers, who are not owners, pursue their own interests, as first noted by Jensen and Meckling (1976). The firm is required to pay some premium for external financing since outside investors may suspect that managers may not further the interests of shareholders. Therefore, the availability of internal funds can affect the investment decision. Finally, transaction costs associated with the issuance of debt and equity may be another reason why external financing is more costly than internal funds.

The combined effects of asymmetric information, managerial agency problem and transaction costs suggest that under financial constraint, firm's investment decision depends on the availability of internal funds. Furthermore, heterogenous firms' characteristics imply that investments of more financially constrained firms is more likely to be affected by the credit availability.

Much literature has examined the extent to which financial constraints have influenced corporate capital investments. Fazzari, Hubbard, and Petersen (1988) has shown that, utilizing the dividend payout ratio as a measure of financial constraints faced by firms, investments of more financially constrained firms respond more sensitively to changes in cash flow.² Ideally firms should be segmented on the basis

² Kaplan and Zingales (1997) argue that the sensitivity of investment to cash flow can not be interpreted

of exogenous firm characteristics. The existing empirical studies have used various segmenting variables to identify unobservable financial constraints, for example, group affiliation in Hoshi, Kashyap, and Scharfstein (1991) and Calem and Rizzo (1995); firm size in Samuel (1996), Athey and Laumas (1994), and Devereux and Schiantarelli (1990); maturity in Schaller (1993); issuing commercial paper and bond rating in Gilchrist and Himmelberg (1995) and Whited (1992); exchange listing in Oliner and Rudebusch (1993). Most studies report that the sensitivity of investments to cash flow is higher for more constrained firms.

Using Korean data set, Kong and Chin (1992) find little evidence that non-group, independent firms are more constrained in terms of accessibility to financial market while Shin (1992) report that the sensitivity of unlisted independent firms' investment with respect to cash flow is much higher than that of group firms. Recently Lee (2000) find that *chaebol* firms and large firms are severely constrained in financial markets. Sin and Park (1999), however, show that investment-cash flow sensitivity is lower and insignificant for *chaebol* firms because internal capital market reduces the financing constraints of the *chaebol*.

2.2. Financial liberalization and corporate investments

Much literature has investigated whether financial liberalization relaxes constraints on firms. In general liberalization contributes to reducing asymmetry information problems in financial markets, thus increasing accessibility of firms to external financing. Also, managerial agency problems can be reduced because financial institutions tend to monitor managers' behavior more carefully. Developments in security markets and financial opening render external financing less costly. Therefore, we expect that financial liberalization reduces the cash flow-investment sensitivity.

There have been several studies which investigated the association between financial liberalization and investment behavior. Using panel data on a large number of firms in 13 developing countries, Laeven (2000) found that financial liberalization relaxes financing constraints of firms, especially small ones. Some studies report that financial reform caused a reduction in financial constraints for several countries. (Harris, Schiantarelli, and Siregar (1994) for Indonesia, Gelos and Werner (2002) for Mexico, and Guncavdi, Bleaney and McKay (1998) for Turkey) Jaramillo, Schiantarelli, and Weiss (1996), however, fail to provide evidence that financial reform in Ecuador has served to ease financial constraints for

as a measure of financial constraint.

small firms. Hermes and Lensink (1998) also report that reforms did not improve access of small and young firms to outside finance using Chilean data.

It can be claimed that the effect of financial deregulation on firms' investment depends on the institution, and efficiency of policy authorities, and macroeconomic stability. It is, therefore, necessary to analyze the effect of liberalization on investment behavior country by country.

3. A measure of financial liberalization index

3.1. Overview of financial liberalization in Korea

Korea has observed a gradual financial liberalization implemented since the 1980s. A series of liberalization and opening-up measures were taken in the early 1990s. Among various steps for financial deregulation, decontrol on interest rates is of first concern. Government released the four-phase schedule for the full liberalization of interest rates in 1991. A series of interest deregulation culminated in liberalization of all bank and nonbank lending rates and long-term deposits over two-year maturity in 1993.

Entry barriers to banking sector was reduced in 1989 by approving the establishment of new financial institutions. Since then more managerial autonomy was given to financial institutions that rendered financial markets more competitively. Reserve requirements that can be regarded as a restriction on banks increased a few times during the 1980s and declined finally in 1996. Most policy-based lending phased out in 1996. In 1996, the Bank of Korea removed the restrictions on the premium a bank could charge over its prime lending rate, and revised its rules for credit control. Commercial banks were privatized during 1981-1983.³ General Banking Act of 1991 introduces new prudential measures and imposes supervisory regulations. In 1992, measures were introduced to increase transparency of regulations and procedures on bank supervision. The stock market opens for direct purchase by foreigners in 1992. Foreign investors are allowed to invest directly in Korean stock markets with ownership ceilings.

3.2. financial liberalization index

Following Laeven (2000), we construct the financial liberalization variable based on the data on the implementation of reform packages related to seven different measures.⁴ We define seven dummy

³ During financial reconstructing program, the government control on banks increased again.

variables taking value one in the years characterized by the liberalized regime. The financial liberalization variable, defined as the sum of seven dummy variables can take values between 0 and 7. The seven reform variables include interest rate deregulation, reduction of entry barriers, reduction of reserve requirements, reduction of credit controls, privatization of state banks, strengthening of prudential regulation, and liberalization on security markets.

Table 1 indicates the years in which significant progress has been made with respect to one of these seven measures. Our financial liberalization variable shows that Korea has liberalized financial systems gradually and in stages. We try to find the year when significant progress has been made with respect to seven measures of financial liberalization, that is when financial liberalization variable exceeds value 5. In fact, the year 1996 is chosen as a structural break point in financial liberalization process.⁵ Finally, we define a dummy variable, *FLI* which take value zero up to 1995, and one after 1996.

4. The Model and the Estimation

4.1. Data

We constructed firm-level panel data from KIS-FAS data base. The sample period is 1980-2000.⁶ Collecting the firms which were listed longer than 10 years during the whole sample period, we derived an unbalanced panel data set. We focus on listed firms only since we need the stock price data to calculate Tobin's q .⁷ We generate the necessary variables to estimate an investment equation. The detailed description of variables is presented in appendix. Summary statistics of variables are presented in Table 2. For the data for 1980-2000 on 348 firms, mean and standard deviations of each variable are presented.

⁴ We add development of security markets as seventh variable to six variables considered in Laeven (2000).

⁵ If we select the year 1993 when the *FLI* exceeds 3, we failed to find a significant difference in the sensitivity of investments between pre-liberalization and post-liberalization eras.

⁶ Since we lost the initial period to construct relevant series, all the regressions were applied on the period of 1981-2000.

⁷ Some researchers may criticize the appropriateness of the data set in that it is difficult to find differences in the asymmetry of information among listed firms.

To test for a difference in financing constraints between firms, we split our sample according to three exogenous characteristics of firms. As a measure of firm size, we use the number of employees. A small size dummy, *Small* takes value one if the number of employees exceeds 300, and zero otherwise.⁸ Similarly we construct a large size dummy, *Large* that indicates large firms. The group firms that belong to the 30 largest *chaebols* are represented as a dummy of *Group*, the other firms as *Indep*. The maturity of firms is captured by two dummies, *Young* and *Old*. Old firms are defined as being more than 29 years old.⁹

4.2. Model

Following Fazzari, Hubbard, and Peterson (1988), many studies has investigated whether the sensitivity of investment in response to internal funds differs across attributes of firms. We adopt a typical FHP-type investment function.¹⁰

$$(I/K)_{it} = c + \beta_1(I/K)_{it-1} + \beta_2Q_{it} + \beta_3(CF/K)_{it} + \beta_4(D/K)_{it} + \varepsilon_{it} \quad (1)$$

where I and K are investment and capital stock, respectively and CF is cash flow; D is leverage.

The OLS estimation results may suffer from an endogeneity problem. In a standard q model of investment the error term is a technology shock to the profit function and may be correlated with Q . The GMM (generalized methods of moments) estimators for dynamic panel data models are widely used as an alternative. We used the t-2, t-3, t-4 lagged endogenous variables as instruments.

4.3. Estimation results

Table 3 represents estimation results of various specification of investment function for whole sample period. We find that firms are financially constrained since the coefficient in (CF/K) is statistically

⁸ Some studies use asset vales as a measure of size. Frequent revaluation of assets, however, produce a lot of outliers.

⁹ According to this classification, the number of large (small) firms is 248 (100); group (independent) firms is 77 (271); old (young) firms 173 (175).

¹⁰ Theoretical derivation of equation (1) can be referred to in Gilchrist and Himmelberg (1989).

significant at the conventional level in all specifications. The magnitude of coefficients differs slightly across specifications. Also, we find a strong persistence in investment in that the lagged investment-to-capital ratio is significant. Marginal productivity of capital represented by Q plays a role of increasing investment ratio. The coefficient in the leverage ratio is, however, positive in contrast with the expectation of the theory.¹¹ It suggests that the accumulation of debt is not an obstacle to financing in Korea.

Besides the OLS estimation, we apply GMM techniques to equation (1) in levels. No strong unobserved firm effects are present because there are no serial correlations in residuals. Sargan test results for overidentifying restrictions also shows that the model is specified well. GMM-level estimation results are not much different from those by the OLS estimation.

We focus on the impact of financial liberalization on the sensitivity of investment to cash flow. Cross-sectional regressions of investment function in each year give us a time-series of estimates of cash flow coefficients. Figure 1 depicts the coefficient in cash flow over time. We can observe that after 1996, the coefficient severely declines. It implies that the association between investment ratio and internal funds was weakened after financial liberalization.

In Table 4, we analyze the effect of financial liberalization on investments by considering the *FLI* variable. A dummy, *FLI* that equals 1 after liberalization and 0 otherwise, is interacted with all explanatory variables. Before liberalization, the sensitivity of investments to cash flow is 0.442. It reduces dramatically into 0.034, implying that financial constraint was relaxed during liberalization era. We also find some evidence that investment has become less affected by the leverage of firms.

To test whether financial liberalization has had a different impact on investment according to firm size, we add the interaction terms between size and financial liberalization dummy variables into the specification. Both estimation results in Table 5 show that small firms were slightly more constrained in the pre-liberalization period. The coefficient in cash flow was 0.442 for large firms while that is 0.493 for small firms according to the GMM estimation results. Because lenders have more information on large firms, large firms are likely to be less financially constrained than small firms. After liberalization, financial constraints confronted by firms are reduced regardless of firm size. The initial difference

¹¹ Many studies including Harris, Schiantarelli, and Siregar (1994) report a negative association between investment and the debt-to-capital ratio. As the degree of leverage increases, the external financing costs are expected to be higher and the availability of external financing is deterred.

between large and small firms decreases over time.¹²

The second classification of firms, group or independent firms are applied in the estimation. Table 6 suggests that independent firms are severely constrained while group firms are less constrained before liberalization.¹³ Financial liberalization, however, relaxes financing constraints faced by independent firms. These firms had better access to external financing. The effects of liberalization on group firms' investment are, however, not statistically significant. We can not find evidence that group firms are benefited from liberalization.

In contrast with the expectation, old firms are more constrained than young firms before liberalization, as shown in Table 7.¹⁴ The reduction in coefficient in cash flow after liberalization, however, suggests that financial constraints are relaxed.

In all three cases we examined, previously constrained firms are faced with relaxed constraints after liberalization. They seem to be benefited from the reduction of directed credit system.

5. Concluding Remarks

The impacts of financial liberalization process gradually implemented in the 1990s in many developing countries have received much attention in the existing literature. The present paper tests for the hypothesis that financial liberalization improve access of financially constrained firms to external finance in Korea. We find some evidence that the cash flow variable became less important after liberalization, implying that financial liberalization have had a significant, positive impact on firms' investment decisions.

The overall conclusion drawn from our investigation should be, however, interpreted carefully. It may be difficult to interpret our findings as results of the impact of financial liberalization alone. Since all

¹² Laeven (2002) also shows that financing constraints faced by small and independent firms were eroded in the 1990s because of Korean government policy to favour SMEs (small and medium enterprises).

¹³ Some researchers such as Shin and Park (1999) claim that group-affiliated firms can use cash-flow of other firms with the group. The internal capital market may reduce the financing constraints of the chaebols.

¹⁴ Because established firms have less information problems, they are expected to be less financially constrained.

restructuring programs implemented during post-liberalization era are, to some extent, related to reforms in financial markets, we conclude that the reduction in the cash flow sensitivity of investments largely stems from financial liberalization.

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Table 1 Years of Financial liberalization with respect to seven variables

Financial variables	year
Decontrol on interest rates	1993
Reduction of entry barriers	1989
Reduction of reserve requirements	1996
Reduction of credit controls	1996
Privatization of banks	1983
Strengthening of prudential regulation	1992
Development of security market	1992

Table 2 Summary statistics

	<i>I/K</i>	<i>CF/K</i>	<i>Q</i>	<i>D/K</i>
Total	0.238 (0.357)	0.212 (0.121)	1.820 (2.439)	1.495 (0.822)
Large	0.227 (0.318)	0.112 (0.189)	1.829 (2.410)	1.493 (0.803)
Small	0.269 (0.451)	0.144 (0.265)	1.790 (2.523)	1.496 (0.877)
Group	0.248 (0.330)	0.080 (0.205)	1.790 (2.447)	1.442 (0.749)
Independent	0.235 (0.363)	0.130 (0.212)	1.826 (2.438)	1.507 (0.839)
Old	0.211 (0.325)	0.104 (0.187)	1.882 (2.213)	1.408 (0.740)
Young	0.271 (0.392)	0.141 (0.237)	1.742 (2.698)	1.602 (0.905)

Table 3 estimation results of investment model (whole sample)

Variables	OLS (levels)	GMM (levels)	GMM (DIF)	GMM (SYS)	
Constant	0.003 (0.10)	-0.061 (-1.67)	-0.101*** (-2.63)	0.130*** (3.19)	-0.150*** (-2.78)
$(I/K)_{it-1}$	0.020* (1.68)	0.020* (1.80)	0.168*** (2.65)	0.023** (1.69)	0.023** (1.99)
$(CF/K)_{it}$	0.119** (2.39)	0.152*** (3.25)	0.147*** (3.12)	0.175*** (2.77)	0.164*** (2.93)
Q_{it}	0.027*** (4.66)	0.013*** (3.08)	0.013*** (3.06)	0.026*** (3.06)	0.019*** (2.92)
$(D/K)_{it}$		0.063*** (5.37)	0.063*** (5.32)	0.149*** (2.70)	0.101*** (4.15)
Specification tests					
m1	0.401	0.659	0.041**	0.000***	0.000***
m2	0.131	0.341	0.469	0.829	0.865
Wald test	0.000***	0.000***	0.000	0.000***	0.000***
Sargan test	-	-	0.755	0.649	0.900
Adjusted R^2	0.104	0.149	-	-	-

Notes 1) t-values in parenthesis

- 2) ***(**,*) indicates significance at 1% (5%, 10%) level.
- 3) time dummies are included in equations.
- 4) m1 and m2 are p-values for the test of first- and second-order serial correlation, respectively.
- 5) Wald test is for joint significance of coefficients.
- 6) Sargan test is for overidentification.

Table 4 Estimation results of investment model (effects of financial Liberalization)

Variables	OLS-levels	GMM-levels
Constant	-0.105 ** (-2.46)	-0.129 *** (-3.30)
$(I/K)_{it-1}$	0.020 * (1.92)	0.147 ** (2.00)
$(CF/K)_{it}$	0.446 ** (2.48)	0.442 ** (2.40)
Q_{it}	0.024 *** (3.99)	0.023 *** (3.87)
$(D/K)_{it}$	0.046 *** (3.36)	0.045 *** (3.26)
$FLI_t*(CF/K)_{it}$	-0.409 ** (-2.24)	-0.408 ** (-2.21)
FLI_t*Q_{it}	-0.017 ** (-2.34)	-0.017 ** (-2.30)
$FLI_t*(D/K)_{it}$	-0.009 (-0.42)	-0.008 (-0.37)
Specification Tests (p-values)		
AR(1) test : m1	0.747	0.151
AR(2) test : m2	0.724	0.730
Wald test of joint significance	0.000 ***	0.000 ***
Sargan test	-	0.777
Adjusted R^2	0.179	-

Notes) same as in Table 3

Table 5 estimation results of investment model (large vs. small firms)

Variables	OLS-levels	GMM-levels
Constant	-0.102 ** (-2.44)	-0.127 *** (-3.23)
$(I/K)_{it-1}$	0.019 * (1.81)	0.137 * (1.88)
$Large_i*(CF/K)_{it}$	0.444 ** (2.22)	0.442 ** (2.17)
$Large_i*Q_{it}$	0.024 *** (3.71)	0.022 *** (3.59)
$Large_i*(D/K)_{it}$	0.042 *** (3.09)	0.043 *** (3.09)
$Small_i*(CF/K)_{it}$	0.480 *** (2.74)	0.493 *** (2.71)
$Small_i*Q_{it}$	0.026 ** (1.97)	0.023 * (1.78)
$Small_i*(D/K)_{it}$	0.071 *** (2.86)	0.069 *** (2.66)
$Large_i*FLI_i*(CF/K)_{it}$	-0.438 ** (-2.15)	-0.436 ** (-2.10)
$Large_i*FLI_i*Q_{it}$	-0.013 (-1.37)	-0.013 (-1.40)
$Large_i*FLI_i*(D/K)_{it}$	0.004 (0.22)	0.004 (0.203)
$Small_i*FLI_i*(CF/K)_{it}$	-0.406 ** (-2.26)	-0.429 ** (-2.31)
$Small_i*FLI_i*Q_{it}$	-0.022 * (-1.68)	-0.019 (-1.46)
$Small_i*FLI_i*(D/K)_{it}$	-0.042 (-1.50)	-0.041 (-1.43)
Specification Tests (p-values)		
m1	0.901	0.188
m2	0.674	0.682
Wald test of joint significance	0.000 ***	0.000 ***
Sargan test	-	0.820
Adjusted R^2	0.186	-

Notes) same as in Table 3

Table 6 estimation results of investment model (group vs. independent firms)

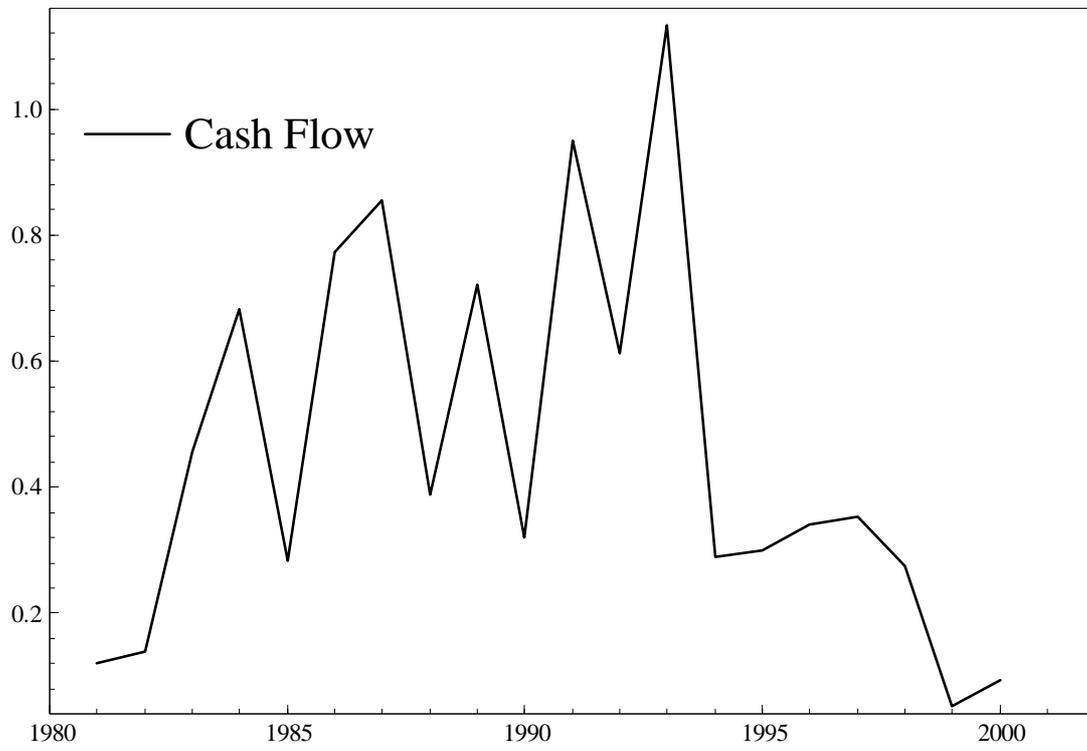
Variables	OLS-levels	GMM-levels
Constant	-0.103 ** (-2.44)	-0.129 *** (-3.16)
$(I/K)_{it-1}$	0.018 (1.63)	0.145 * (1.79)
$Group_i*(CF/K)_{it}$	0.231 (1.60)	0.280 * (1.83)
$Group_i*Q_{it}$	0.022 *** (2.64)	0.021 ** (2.50)
$Group_i*(D/K)_{it}$	0.062 *** (3.88)	0.059 *** (2.95)
$Indep_i*(CF/K)_{it}$	0.475 ** (2.35)	0.460 ** (2.23)
$Indep_i*Q_{it}$	0.025 *** (3.37)	0.023 *** (3.07)
$Indep_i*(D/K)_{it}$	0.041 *** (2.88)	0.042 *** (2.88)
$Group_i*FLI_i*(CF/K)_{it}$	-0.132 (-0.84)	-0.188 (-1.15)
$Group_i*FLI_i*Q_{it}$	-0.025 (-0.49)	-0.025 (-0.508)
$Group_i*FLI_i*(D/K)_{it}$	0.033 (0.48)	0.035 (0.514)
$Indep_i*FLI_i*(CF/K)_{it}$	-0.442 ** (-2.15)	-0.431 ** (-2.08)
$Indep_i*FLI_i*Q_{it}$	-0.017 ** (-1.96)	-0.015 * (-1.74)
$Indep_i*FLI_i*(D/K)_{it}$	-0.007 (-0.37)	-0.007 (-0.351)
Specification Tests (p-values)		
m1	0.829	0.189
m2	0.771	0.738
Wald test of joint significance	0.000 ***	0.000 ***
Sargan test	-	0.775
Adjusted R^2	0.184	-

Notes) same as in Table 3

Table 7 estimation results of investment model (established vs. young firms)

Variables	OLS-levels	GMM-levels
Constant	-0.128 *** (-2.59)	-0.168 *** (-3.41)
$(I/K)_{it-1}$	0.023 ** (2.25)	0.166 ** (2.39)
$Old_i*(CF/K)_{it}$	0.750 *** (3.13)	0.745 *** (3.20)
Old_i*Q_{it}	0.010 * (1.75)	0.008 (1.60)
$Old_i*(D/K)_{it}$	0.067 *** (3.29)	0.077 *** (4.11)
$Young_i*(CF/K)_{it}$	0.329 ** (2.10)	0.332 ** (2.08)
$Young_i*Q_{it}$	0.037 *** (3.27)	0.035 *** (3.16)
$Young_i*Q_{it}$	0.049 *** (3.25)	0.048 *** (3.11)
$Old_i*FLI_t*(CF/K)_{it}$	-0.689 *** (-2.84)	-0.689 *** (-2.93)
$Old_i*FLI_t*Q_{it}$	0.004 (0.19)	0.006 (0.27)
$Old_i*FLI_t*(D/K)_{it}$	-0.002 (-0.06)	-0.013 (-0.33)
$Young_i*FLI_t*(CF/K)_{it}$	-0.296 ** (-1.89)	-0.302 ** (-1.89)
$Young_i*FLI_t*Q_{it}$	-0.029 ** (-2.45)	-0.028 ** (-2.46)
$Young_i*FLI_t*(D/K)_{it}$	-0.017 (-0.80)	-0.013 (-0.67)
Specification Tests (p-values)		
m1	0.985	0.099
m2	0.309	0.301
Wald test of joint significance	0.000 ***	0.000 ***
Sargan test	-	0.811
Adjusted R^2	0.194	-

Notes) same as in Table 3

Figure1 cash flow coefficient

Appendix Variable Definition

K_t : Capital at the beginning of period t = tangible fixed assets at end of the period $t-1$ minus capital expenditure during period $t-1$ plus accumulated depreciation until the end of period $t-1$.

I_t : Investment during period $t = K_{t+1} + Depr_t - K_t(1 + \pi_t)$

$Depr_t$ = Depreciation during period t .

π_t = inflation over the period t

Q_t = Average q at the beginning of period $t = (D_t + MV_t) / K_t$.

D_t = Book value of debt at the beginning of the period t .

MV_t = market value of equity at the beginning of period t .

CF_t = cash flow during the period $t-1$ = net profit after-tax + depreciation during period $t-1$.