

External Finance and Productivity Growth in Korea:
Firm Level Evidence Before and After the Financial Crisis

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외부금융과 기업생산성 간 관계에 대한 실증분석

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ABSTRACT

This paper empirically investigates the finance-growth linkage in Korea by utilizing firm-level data of manufacturing industries before and after the 1997 financial crisis. We find that, first, an increase in external finance is associated with a faster subsequent capital accumulation of firms. However, this capital accumulation channel became relatively attenuated after the crisis. Second, the total factor productivity growth effect of external finance has been considerably weak both before and after the crisis. Third, the information production and industry restructuring effects of external finance have also remained weak after the crisis. The limited role of external finance in post-crisis Korea partially reflects sluggish corporate investment and weakening dependence of good credit firms on external finance. The evidence suggests that, in order to effectively sustain economic growth, further reform efforts may be required to strengthen resource allocation and corporate restructuring roles of financial markets and institutions.

본 연구에서는 외부금융이 기업 성장에 영향을 미치는 다양한 경로에 대해 살펴보고, 1997년 외환위기를 전후하여 외부금융과 기업의 개별 성장요인 간 관계가 어떻게 변화하였는지를 우리나라 제조업 기업의 재무자료를 이용하여 실증분석하였다. 주요 분석결과는 다음과 같다. 첫째, 외부금융의 증가는 기업의 고정자본스톡 증가를 통해 기업 성장에 기여하는 것으로 분석되었다. 그러나 이러한 자본축적 촉진 효과는 위기 이전에 비해 97년 이후 상대적으로 약화된 것으로 나타난다. 둘째, 외부금융이 기업의 총요소생산성을 높이는 효과는 위기 이전과 이후에 모두 미약한 것으로 분석되었다.

셋째, 외부금융의 정보비대칭성 완화 효과 및 기업 구조조정 촉진 효과 또한 위기 이후에도 여전히 미약한 것으로 분석되었다. 이처럼 위기 이후 금융 구조조정의 진전에도 불구하고 외부금융이 기업 성장에 미치는 긍정적인 영향이 여전히 미진한 배경으로는, 기업투자의 전반적인 침체, 우량기업의 외부자금의존도 하락 등의 요인도 일부 작용하고 있는 것으로 보인다. 본 분석결과는 금융 부문이 우리 경제의 지속적인 성장을 보다 효율적으로 뒷받침하기 위해서는 자원배분, 모니터링, 구조조정 기능 등이 더욱 강화될 필요가 있음을 시사한다.

I. Introduction

The Asian financial crisis in 1997-98 has highlighted the importance of a robust and efficient financial system for sustainable growth of an economy. It has been argued that Korea's financial crisis has resulted from the weakening of investment discipline and distorted financial flows under the legacy of the state-led development policies. Accordingly, while it may be difficult to entirely refute the positive role of Korea's financial sector, numerous commentators have questioned the claim that Korea's financial sector had contributed to economic growth by accelerating productivity growth in the pre-crisis period.¹

Given the criticism, the post-crisis financial reform efforts have focused on rehabilitating and upgrading Korea's financial system in order to transplant a new paradigm more suitable for sustainable growth. Over the past ten years since 1997, a remarkable progress has been made in reforming Korea's financial system to make it healthier and more sophisticated. Indeed, as an outcome of rapid consolidation and conglomeration driven by the publicly funded restructuring program, the capital adequacy and profitability of banks and non-bank financial institutions have improved remarkably. Capital markets have also expanded both in size and deepness. The resolution of massive corporate failures also served as a credible signal that the traditional implicit guarantee and moral hazard-based paradigm would no longer persist.

While the post-crisis financial reform has led to noticeable changes in the behavior of fund users and financiers, little has been known yet on the extent of improvement in the role of financial markets and institutions in post-crisis Korea.² Despite the rapid expansion of financial assets in the post-crisis period, it is not clear yet whether such a tangible progress in financial sector development is effectively linked with the productivity growth of firms in the corporate sector. This is a particularly important concern when we observe the recent stagnation of corporate investment and excessive fund flows into the real estate sector.

In this paper, by utilizing firm level data before and after the 1997 financial crisis, we investigate the relationship between external finance and two sources of firm level growth - physical capital accumulation and TFP growth in Korea. To our knowledge, few attempts have been made to study the relationship between external

¹ For empirical studies on the investment behavior and efficiency of credit allocation in pre-crisis Korea, see Borensztein and Lee (1998), Cho and Kim (1997), Claessens et al. (1998), Hahn (1999) and Lee (2000) among others.

² For instance, Borensztein and Lee (1999) report that financial credits appear to have been reallocated in favor of more efficient firms after the 1997 crisis relative to the pre-crisis episode. Hahn (2007) investigates both macro flow of funds and micro firm level data and finds that, despite substantial improvement in risk management and credit allocation practices at individual financial institutions, savings have not been smoothly channeled to more productive investment opportunities at the macroeconomic level due to the phenomenon of flight to quality and excessive concentration of financial saving in the banking sector.

finance and TFP growth in Korea neither at the industry level nor at the firm level. More specifically, in an attempt to empirically assess the role of external finance in promoting economic growth in Korea, we address the following questions: Does an increased access to external finance enhance subsequent growth rates in firm level output, physical capital, R&D investment and total factor productivity? Does above relationship differ across alternative sources of external finance - banks, non-banks, and capital markets such as bond and equity? Is there a structural shift in the relationship between external finance and firm level growth factors across the 1997 financial crisis? Does the availability of industry-wide external finance exert positive externalities for firm level growth by ameliorating information asymmetry? Namely, do firms with higher information asymmetry tend to benefit more from the availability of external finance? Finally, does the availability of industry-wide external finance facilitate entry of new firms and restructuring at the industry level?

The present paper is organized as follows. Section II provides an overview of the literature on the relationship between financial development and economic growth. Section III describes and characterizes the pattern of corporate investment and its financing behavior before and after the 1997 financial crisis. Section IV discusses data and TFP measures, and provides diagnostic descriptions of the relationship among external credit allocation, capital accumulation, and TFP growth in Korean manufacturing industries. Section V describes regression models and discusses empirical findings. Finally section VI provides a summary and concluding remark.

II. Literature Review

While economic growth leads to financial development by expanding demands for financial services, a solid body of both theoretical and empirical research indicates that the causality may also run from financial development to economic growth. Traditionally, the contribution of financial development was understood as much limited since economic growth would be largely subject to diminishing returns to capital. Namely, under neo-classical growth models, the steady state per capita growth rate is determined by exogenous technology factors. Hence, financial development can influence growth only either by accelerating capital accumulation during the transition process to steady state or by affecting the rate of technological progress in the steady state.

However, with the emergence of endogenous growth theories, the role of financial development in supporting economic growth has been highlighted once again. The initial hypotheses of Goldsmith (1969), McKinnon (1973), and Shaw (1973) have been reinvestigated by numerous authors under this endogenous growth framework. On the theoretical front, for instance, Greenwood and Jovanovic (1990) investigate a general equilibrium model and show that financial intermediation promotes economic growth by allowing a higher rate of return earned on capital through better information processing and investment screening and by enabling pooling of risks. Bencivenga and Smith (1991) study an endogenous growth model in which the equilibrium behavior of competitive intermediaries affects the efficiency of

resource allocation. In their model, the development of intermediaries allows an economy to reduce the fraction of its savings held in the form of unproductive liquid assets and thus prevent misallocations of invested capital due to liquidity requirements.

The hypothesis that financial development exerts a positive influence on economic growth has also been empirically investigated by numerous authors. Cross-country regression analyses include King and Levine (1993), Levine and Zervos (1998), Levine (1998), Beck, Levine and Loayza (2000) among others. They find in general a robust and strong relationship between the measures of financial development and economic growth, capital accumulation, and productivity growth.³ This body of research also supports the causal relationship from financial development to growth by showing that the initial extent of financial development tends to be associated with subsequent economic growth. Beck, Levine and Loayza (2000) for instance find that financial development contributes more through total factor productivity growth rather than accumulation of capital or saving.

Some authors focused on the industry and firm level evidence. As widely noted, in a world with imperfect capital markets and information asymmetry, financial development can influence the growth performance of individual firms and industries by ameliorating unduly high cost of external financing. As noted by Stiglitz and Weiss (1981), the presence of agency cost makes investment of firms more dependent upon internal funds. Hence, the availability of and easier access to external finance render firms to resolve credit constraint and achieve optimal production scale, and this positive impact would be stronger for firms with higher uncertainties in technology and future profitability.

Using firm level data from 30 countries, Demircuc-Kunt and Maksimovic (1998) find that a wider access to external finance tends to encourage long-run growth performance of firms. At the industry level, Rajan and Zingales (1998) find that industries that are more dependent upon external finance grow faster in countries with more developed financial sector and argue that financial development enhances economic growth by reducing the cost of external financing. Not only physical capital but also R&D investments are significantly affected by asymmetric information problems, and thus are likely to be severely constrained by firm's financial situation. Himmelberg and Petersen (1994) find that R&D investment is indeed significantly related to cash flow position of firms in U.S. high-tech industries. Hence, financial development and increased access to external finance may lead to total factor productivity growth by facilitating R&D investment at firm level.

Another source of the linkage between finance and growth comes from the role of external fund providers as they exert ex-post monitoring and corporate controls that

³ There exists a large volume of related research that investigates the relationship between financial structure and economic growth. See Demircuc-Kunt and Levine (2001) for extant survey on the literature. Based upon a broad set of empirical evidence they conclude that, while overall financial development tends to accelerate economic growth, financial structure per se does not seem to matter much, and that legal systems that effectively protect property rights and contract enforceability tend to determine the extent of financial development. As for the seminal empirical work on this law and finance view, see La Porta, et al. (1997, 1998).

discipline managers to use funds more efficiently and as envisaged thereby increasing firm level productivity and outputs. This governance or delegated monitor function can be exercised by enforcing existing financial contracts as well as by not refinancing existing credits. For instance, Nickell, Nicolitsas and Dryden (1998), and Nickell and Nicolitsas (1999) show that financial pressures, as measured by the ratio of interest payments relative to cash flows, have a positive impact on subsequent productivity growth of firms in US and Europe.

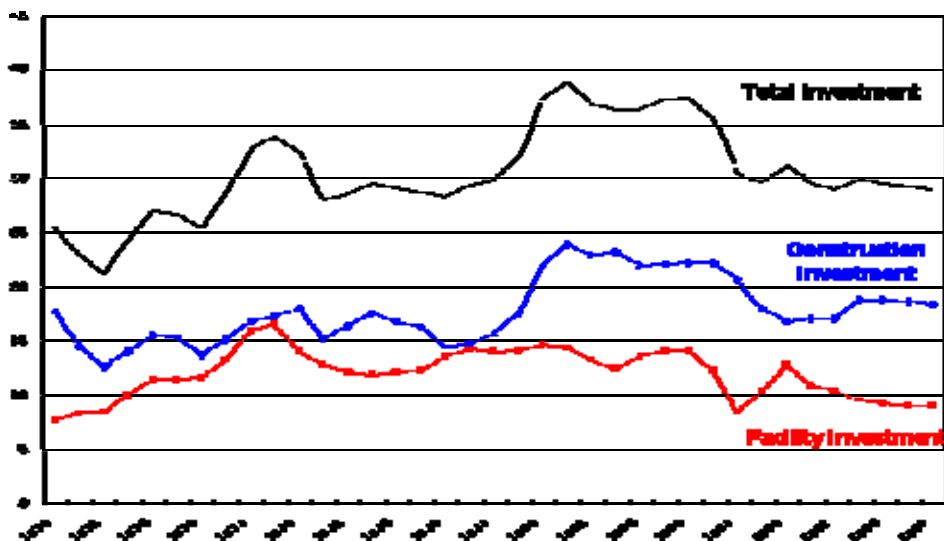
At the industry level, financial development may contribute to TFP growth by reallocating funds across firms and facilitating exits of unviable firms. Hence, redistribution of existing capital across firms can enhance average TFP growth at the industry level. For instance, Wurgler (2000) shows that the growth rate of industry fixed capital formation is more sensitive to the growth rate of industry value-added in financially developed countries. Furthermore, industry growth may be accelerated by encouraging entry of new promising firms into the industry. Beck, et al. (2001) and Beck and Levine (2002) find strong evidence that economies grow faster, new firms form more easily, firms' access to external financing is easier, and firms grow more rapidly in economies with a more developed financial system.

As for evidence in Korea, while there has been relatively little research on the relationship between financial development and growth, a couple of recent papers studied time-series evidence on the linkage. For instance, Hahm (2005) estimates a vector autoregression model and finds that a development in the banking sector has contributed to fixed capital accumulation, however, its impact on total factor productivity growth was much limited. Kim (2003) finds a positive relationship between economic growth and the index of financial liberalization constructed from various government financial deregulation measures. Lee (2004), Jin, Jinn and Hahm (2004) also report evidence supporting the positive role of banking sector in Korea's economic growth using various Granger causality regression models. At the industry level, Shyn and Oh (2005) investigates the hypothesis of Rajan and Zingales (1998) using Korean data and find a positive role of external finance in promoting industrial growth. However, to our knowledge, there has been little systematic research that investigates the relationship between TFP growth and external finance at firm level, which is the focus of the present paper.

III. Corporate Investment and Financing Patterns Before and After the 1997 Financial Crisis

Before we focus on the linkage between external finance and growth components of firms such as factor accumulation and total factor productivity, this section provides an overview of the aggregate corporate investment behavior and financing patterns before and after the 1997 financial crisis. Among many factors that have contributed to the slowdown of Korea's economic growth after the financial crisis, the single largest factor is the significant fall in facility investment. As shown in Figure 1, the facility investment to GDP ratio, after briefly recovering in 1999 and

[Figure 1] Corporate Investment to GDP Ratio (%)



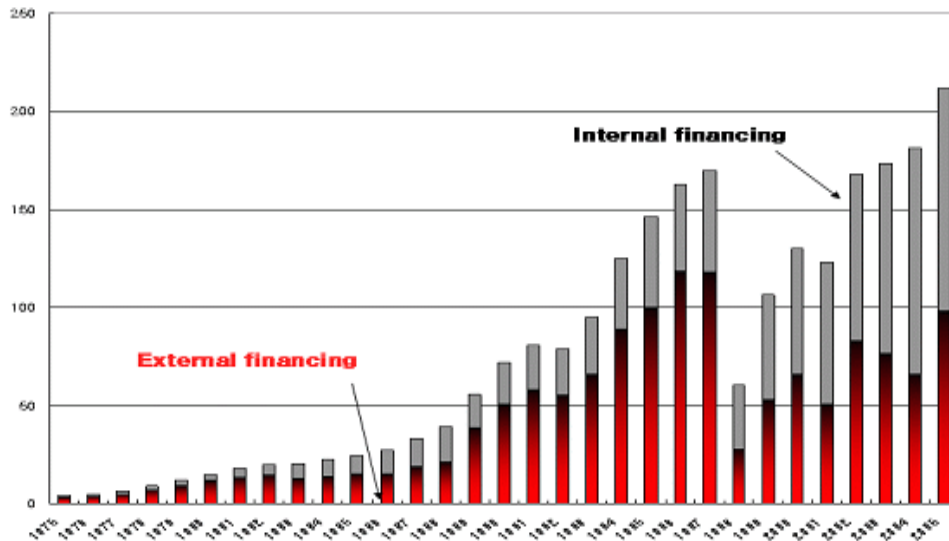
Source: Bank of Korea

2000, has been on a downward trend after the crisis. With the slowdown in corporate investment during the post-crisis period, the corporate financing pattern has also changed in a notable way, which we now describe from both macro flow of funds and micro firm level perspectives.

1. Macro Flow of Funds Analysis

Since the 1997 financial crisis, the way in which Korea's corporate sector finances its investment has changed remarkably. One distinctive feature is that firms have relied more upon internal financing. After suffering from the highly leveraged financial structure in reflection of the large investment and excessive borrowing, the corporate sector has become much more conservative in risk taking and investment after the crisis. Consequently, the demand for external finance has also substantially decreased. Along with this increased conservatism, Korea's corporate sector underwent a major restructuring process substantially downsizing its capital and labor. As a result of the restructuring effort, cash flows of major corporate firms have notably improved, which made them less reliant on external finance. As shown in Figure 2, the share of internal financing out of total annual financing flows increased from 29.5% during 1990-1997 to 54.6% during 1999-2005. Corporate sector's net saving, which is the major source of internal finance, has amounted to 30-50 trillion Korean won per year between 2002 and 2005.

With the decreasing reliance upon external finance, the composition of external [Figure 2] Internal and External Corporate Financing (trillion won)



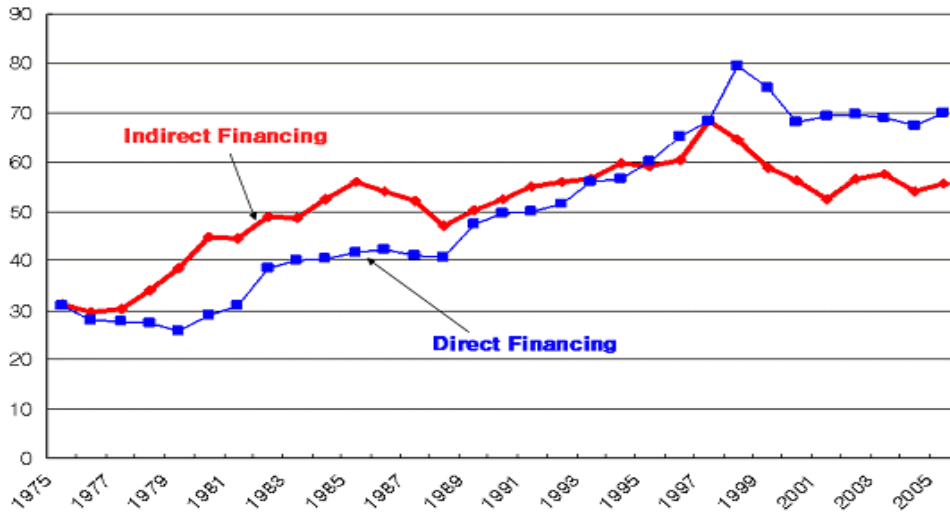
Source: Authors' computation from the Bank of Korea flow of funds data

financing has also changed. Figure 3 shows the outstanding volume of direct and indirect financing as a percentage of nominal GDP. Note that, before the crisis, indirect financing accounted for a larger share of total external financing. However, direct financing has exceeded indirect financing in the post-crisis period. As shown in Figure 4, the slowdown in indirect financing was partly due to the reduced volume of non-bank financial institutions' lending as many insolvent non-bank financial institutions were closed. In contrast, most of banks survived through the crisis with the help of the government aided restructuring program, and were able to expand their lending as households preferred safer assets such as bank deposits. Note that direct financing has also stagnated since 2000. As shown in Figure 5, direct financing through commercial papers and corporate bonds fell sharply following the massive failure of merchant banks and the collapse of Daewoo group. However, it is interesting to note that equity financing has continued to expand in the post-crisis period.

2. Micro Firm Level Analysis

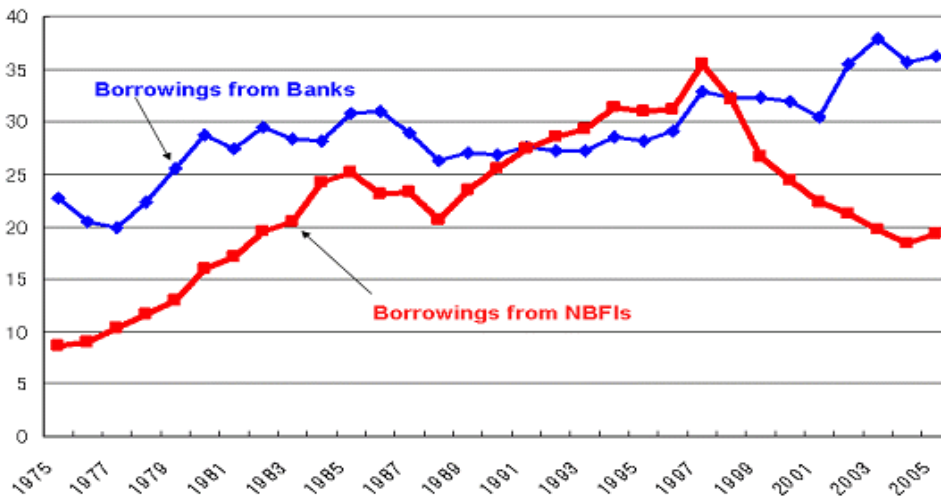
The sluggish corporate investment and decreasing demand for external finance in the post-crisis period yields an important implication for financial intermediaries as relatively good firms tend to rely more upon internal funds while relatively risky firms remain in the financial market and actively seek out loans. As Figure 6 shows, while the operating cash flows of firms listed in the Korea Stock Exchange improved

[Figure 3] Direct and Indirect Corporate External Financing (% of GDP)



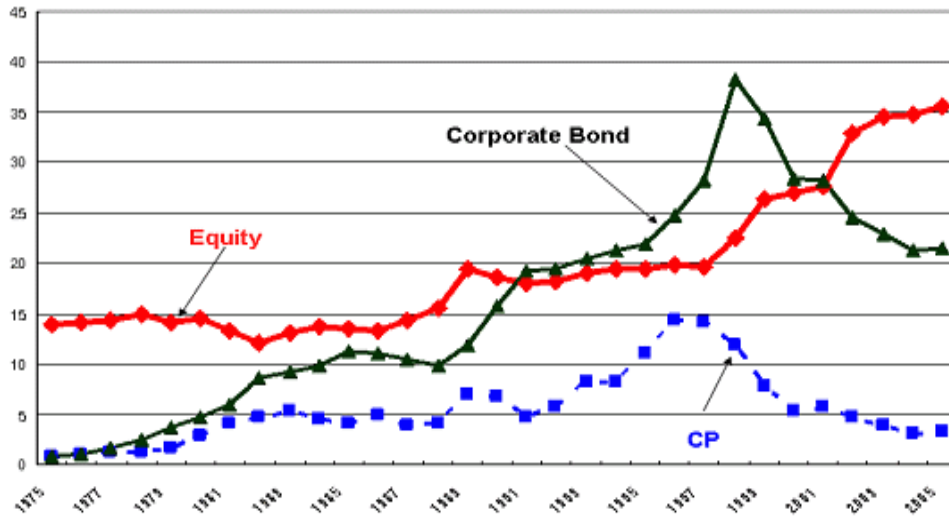
Source: Authors' computation from the Bank of Korea flow of funds data

[Figure 4] Indirect Financing through Banks and NBFIs (% of GDP)



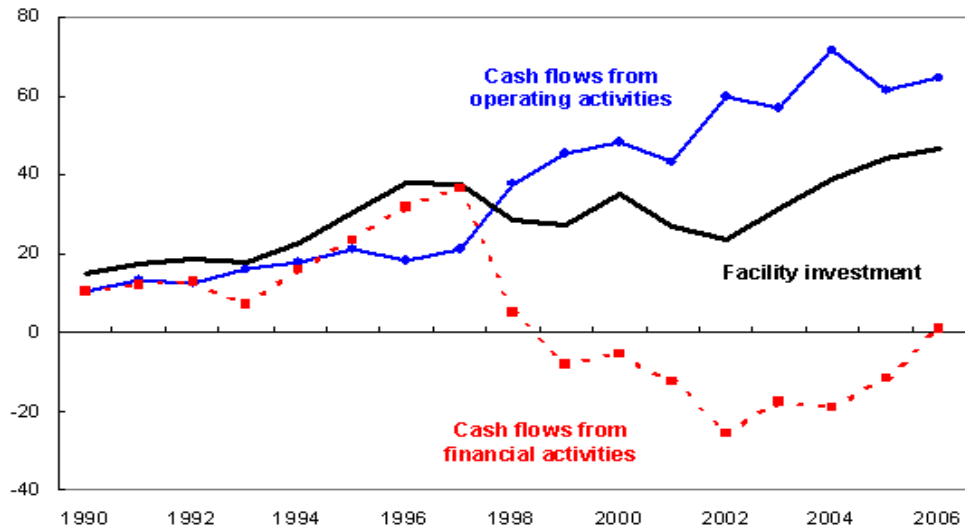
Source: Authors' computation from the Bank of Korea flow of funds data

[Figure 5] Direct Financing through Equity, Bonds and CPs (% of GDP)



Source: Authors' computation from the Bank of Korea flow of funds data

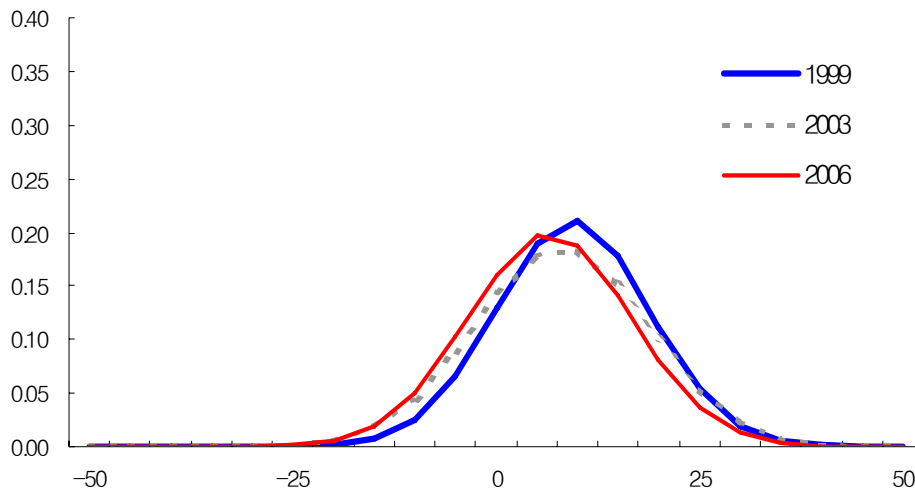
[Figure 6] Cash Flows and Facility Investment of Listed Firms (trillion won)



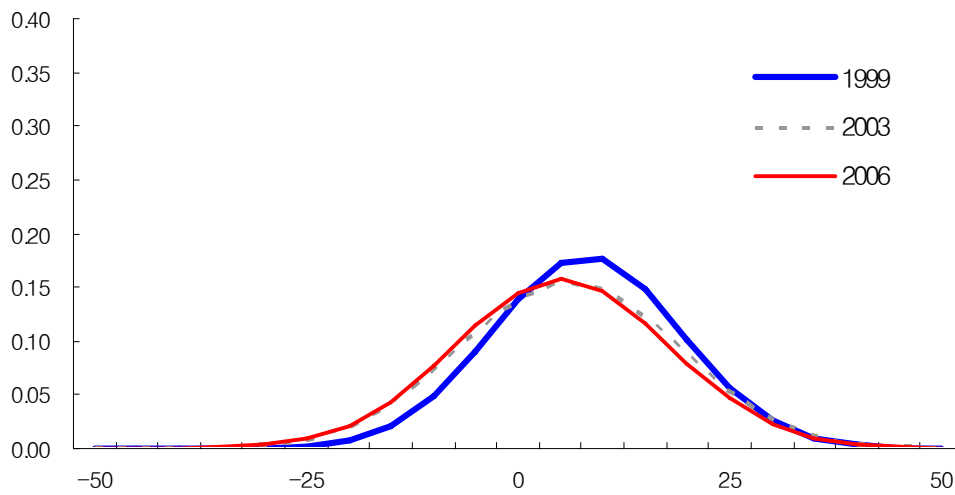
Source: Authors' update of Lim and Kim(2005)'s computation using WISEFN database

[Figure 7] Distribution of Operating Income as a Percentage of Total Asset

a. Large firms



b. SMEs



substantially after the crisis, those cash flows were used in financial activities rather

than in facility investment. The negative cash flows from financial activities after the crisis imply that firms actually repaid existing debts, paid out dividends, and bought back existing stocks.⁴

The cash flow evidence reconfirms our previous conjecture that Korea's corporate sector has taken a more 'conservative' approach in investment. The stagnation of corporate facility investment may partly reflect the adjustment of the over-investment in the pre-crisis. However, following the crisis, relatively large firms have become less willing to take risks as they realize that they could no longer benefit from the implicit government guarantee and the policy of 'too-big-to-fail.' Aggregate investment has remained stagnant as large firms have accumulated liquidities and improved their financial soundness by retiring debts. Furthermore, large firms have begun to embrace 'shareholder capitalism' by increasing dividend payouts after the crisis.

While relatively good firms that have improved their financial structure have become less dependent upon external finance, there still remains a fairly large group of financially vulnerable firms, particularly among the SMEs. Figure 7 shows the distributions of operating income as a percentage of total assets for externally audited large firms and SMEs respectively. Note that, for both large firms and SMEs, the entire distribution has shifted to the left and the mean operating income to asset ratio has fallen in 2006 compared to its value in 1999, indicating that the corporate profitability has deteriorated across the board. However, for SMEs, not only the leftward shift of the distribution is more pronounced, but has the left tail also become thicker and more dispersed implying that an increasing fraction of firms are earning negative operating income and thus become more vulnerable to bankruptcy risk.

The overall evidence in this section indicates that, while financially sound firms that have undergone corporate restructuring have reduced their demand for external finance, a significantly large number of firms remain financially vulnerable and still dependent upon external financing. This in turn implies that it has become more difficult for financial institutions to conduct their financial intermediation roles due to heightened uncertainty and worsening adverse selection problems after the crisis.

IV. TFP Growth and Credit Allocation in Korean Manufacturing Industries

1. Data and Measurement of TFPs

Following Good, Nadiri, and Sickles (1999) and its subsequent empirical studies including Ahn, Fukao, and Kwon (2004), firm-level total factor productivity (TFP) was estimated by the chained-multilateral index number approach. This approach uses a separate reference point for each cross-section of observations and then

⁴ During 1999-2005, listed firms repaid a total of 76 trillion Korean won of their debts and paid out 32 trillion won of dividends.

chain-links the reference points together over time, as in the Tornqvist-Theil index. The output, inputs, and productivity level of each firm in each year is measured relative to the hypothetical representative firm at the base-time period. This approach allows us to make transitive comparisons of productivity levels among observations in a panel dataset.

The Total Factor Productivity (TFP) level for firm i in year t in a certain industry is defined in comparison with the TFP level of a hypothetical representative firm in the base year (Year 1) in that industry⁵ as follows:

$$\begin{aligned} \ln TFP_{it} = & (\ln Y_{it} - \overline{\ln Y_t}) + \sum_{\tau=2}^t (\overline{\ln Y_\tau} - \overline{\ln Y_{\tau-1}}) \\ & - \left\{ \sum_{n=1}^N \frac{1}{2} (S_{nit} + \overline{S_{nt}}) (\ln X_{nit} - \overline{\ln X_{nt}}) \right. \\ & \left. + \sum_{\tau=2}^t \sum_{n=1}^N \frac{1}{2} (\overline{S_{n\tau}} + \overline{S_{n\tau-1}}) (\overline{\ln X_{n\tau}} - \overline{\ln X_{n\tau-1}}) \right\} \end{aligned} \quad (1)$$

Where, Y , X , S , and TFP denote output, inputs, the input shares (cost shares), and the TFP level, respectively, and symbols with an upper bar are the corresponding measures for the representative firms. We define the representative firm for each industry as a hypothetical firm whose output, inputs, and cost shares of all production factors are identical with the industry average. The subscripts τ and n are indexes for years and inputs, respectively.

The first and the third terms on the right hand side of equation (1) denote the gap between firm i 's TFP level in year t and the representative firm's TFP level in that year. The second and the fourth terms denote the gap between the representative firm's TFP level in year t and the representative firm's TFP level in the base year. Therefore, $\ln TFP_{it}$ in equation (1) denotes the gap firm i 's TFP level in year t and the representative firm's TFP level in the base year.

Deflators for converting book value for each firms' tangible fixed assets into real capital stock numbers were obtained by industry and by year from authors' calculation based on the 'Mining and Manufacturing Survey.' The 'Mining and Manufacturing Survey' is conducted annually by the Korea National Statistical Office. The survey covers all plants with five or more employees in the mining and manufacturing industries and contains plant-level information on output, input, and a variety of additional items, including the 5-digit Korean Standard Industry Classification (KSIC) code assigned to each plant based on its major product. For instance, the plant-level TFPs were calculated based on the 'Mining and Manufacturing Survey' and used in regression analyses in Ahn, Fukao, and Kwon (2004) and in Ahn, Fukao, and Ito (2007), among others.

2. TFP Growth, Capital Accumulation and Credit Allocation in Korean

⁵ In this study, the base year was 1990 and industries were 2-digit Korean Standard Industry Classification (KSIC) industries in manufacturing.

Manufacturing Industries

Before we statistically analyze the linkage between external finance and productivity growth at firm level, this section describes the relationship among indirect external finance, capital accumulation, and TFP growth at industry level for 20 manufacturing industrial sectors in Korea. Note that, in this section, the industry TFP and capital stocks are measured using the 'Mining and Manufacturing Survey' dataset of the Korea National Statistical Office. This survey data also includes relatively small firms with five employees or more. Since we don't have data for detailed sources of external finance for those small firms included in the 'Mining and Manufacturing Survey,' as a measure of the industry indirect external finance, we use the Bank of Korea's industry level external credit data measured by loans of commercial banks and non-bank financial institutions.

Figure 8 shows the relationship between the period average growth rates of indirect external credit and capital accumulation. Note that, while a positive correlation seems to exist before the crisis, this positive relationship tends to disappear after the crisis. As for the TFP growth, Figure 9 shows that no significant correlation seems to exist between indirect external credit and TFP growth rates in both pre- and post-crisis periods. Note however that, in this industry level diagnostic analysis, we are not controlling for other effects such as industry characteristics and business cycle effects. In the next section, using more reliable and detailed firm level data, we conduct regression analyses that take into account both firm and industry level characteristics.

Finally, Figure 10 shows the relationship between indirect external credit and industry turnover rate, which is computed as the sum of industry entry and exit rates. Note that the availability of indirect finance seems to have no significant relationship with industry turnover rate before the crisis. However, there exists a seemingly positive relationship after the crisis. This may suggest that external finance has begun facilitating industry restructuring in the post-crisis period.

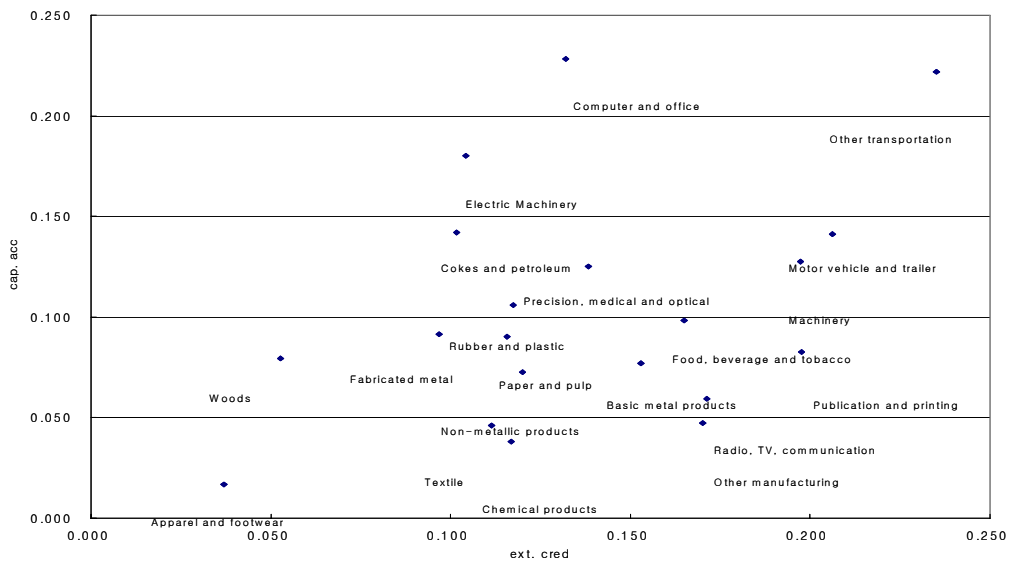
V. Regression Analyses and Empirical Results

1. External Finance and Value-added

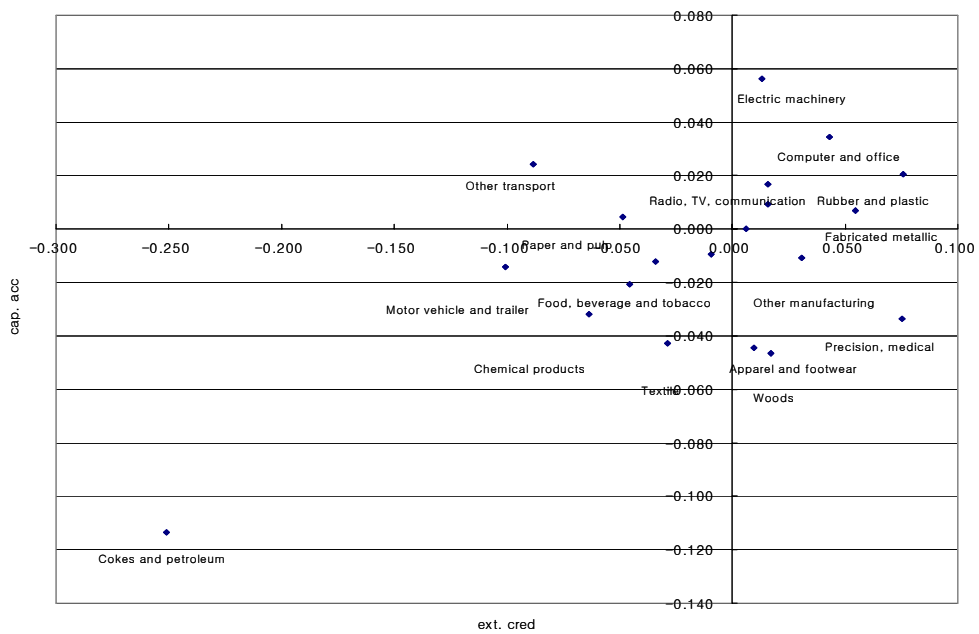
Before directly looking at the relationship between external finance and output growth factors such as capital accumulation and TFP growth at firm level, this section first estimates the relationship between external finance and firm's value-added. Note that for firm level regression analyses in this section, we employ a more exact and detailed dataset provided by Korea Information Service. The KIS database covers externally audited companies only, whose asset size is 7 billion Korean won or more. The KIS dataset also reports detailed sources of external finance raised by firms.

[Figure 8] Growth of Indirect External Credit and Capital Accumulation Rate

a. Pre-Crisis (1994-1996)

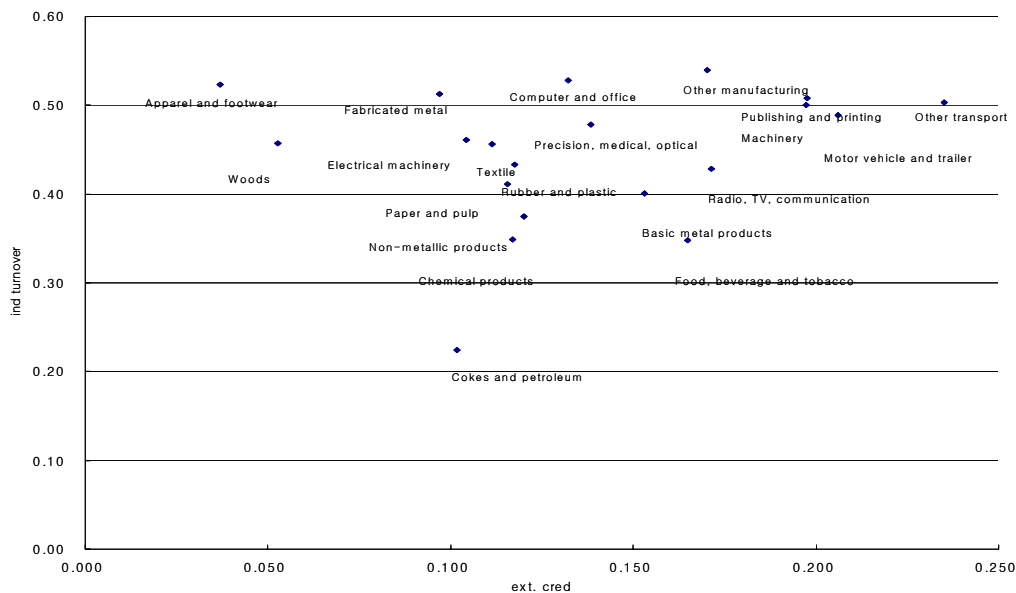


b. Post-Crisis (1999-2003)

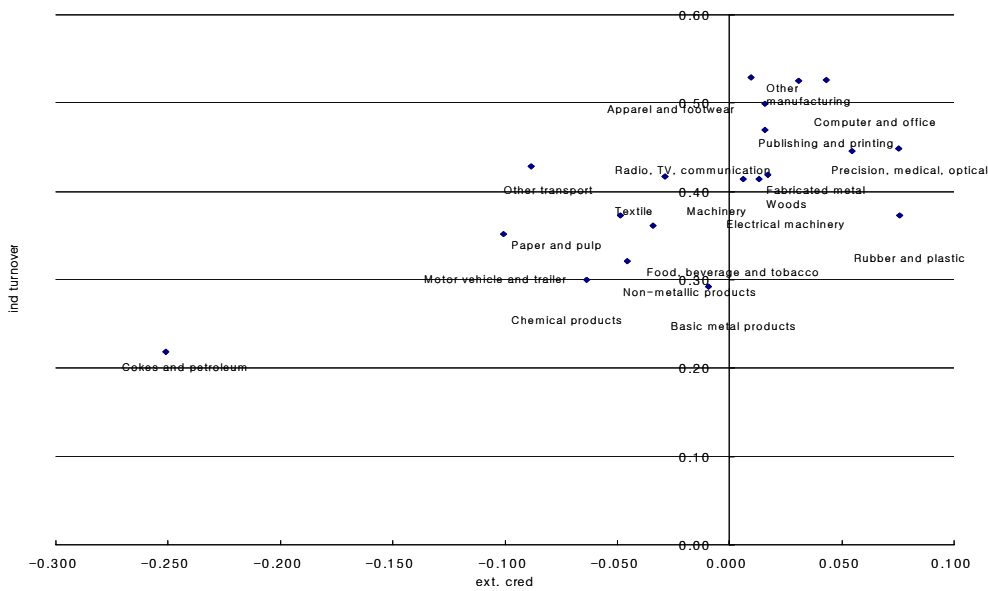


[Figure 9] Growth of Indirect External Credit and TFP Growth Rate

a. Pre-Crisis (1994-1996)



b. Post-Crisis (1999-2003)



In order to investigate the linkage between firm value-added and external finance

we explore two regression models:

$$d \ln V_{i,t} = \beta_0 + \beta_1 d \ln EXTF_{i,t-1} + \gamma' Z_{i,t-1} + \delta Year_t + \phi \mu_j + \varepsilon_{i,t} \quad (2-1)$$

$$d \ln V_{i,t} = \beta_0 + \beta_1 d \ln K_{i,t-1} + \beta_2 d \ln L_{i,t-1} + \beta_3 d \ln EXTF_{i,t-1} + \gamma' Z_{i,t-1} + \delta Year_t + \phi \mu_j + \varepsilon_{i,t} \quad (2-2)$$

Where, V denotes value-added of a firm and $EXTF$ is the volume of external finance extended to the firm. K is physical capital stock and L is labor input. $Year$ is year dummies and μ is industry dummies to control unobservable industry effect. Vector Z includes firm specific control variables. As for the external finance variable, we use four distinct types of external funding. $EXTF1$ is outstanding volume of borrowings from bank and non-bank financial intermediaries including both short-term and long-term borrowings. $EXTF2$ is outstanding volume of bond issuance. $EXTF3$ is outstanding volume of equity capital raised in stock market, which includes paid in capital and capital surpluses but excludes retained earnings. $EXTF4$ is total outstanding volume of external finance, which is the sum of $EXTF1$, $EXTF2$ and $EXTF3$. Note that we use the rate of change in outstanding volumes of external finance as independent variables in the regression, and thus, we estimate the flow effect of external finance.

In order to minimize potential endogeneity problems we use one-period lagged independent variables. Hence, above regression models estimate the impact of external finance on the next period value-added growth with and without considering the effect of factor inputs. Regression equation (2-2) can be interpreted as a diagnostic model which explores indirectly the impact of external finance on total factor productivity without imposing a functional form of production technology. Separate yearly regressions are estimated for the pre-crisis sample of 1991-1996 and the post-crisis sample of 1999-2003. We exclude 1997 and 1998 to avoid potential biases that may result from the unusual performance of firms during the crisis period.

Table 1 reports estimation results on equation (2-1) without including factor inputs and using log total asset size of firms as a control variable. Year and industry dummies were included in the regressions, but coefficient estimates are not reported to save space. It is interesting to note that all types of external finance variables are significantly positively associated with the next period value-added growth rate before the crisis, which suggests that financial sector played a positive role in output growth although we cannot clarify the exact channel at this stage. Note however that, only bond financing remains positively significant after the crisis, which may reflect that, as we discussed above, the connection between external finance and firm's production activities became weaker in the post-crisis period.

Table 2 reports estimation results when we explicitly include physical capital as well as labor input factors in the value-added growth regression. The coefficient of physical capital accumulation rate is almost always significantly positive while labor

<Table 1> External Finance and Value-added (without Input Factors)

- Dependent Variable: Value-added Growth Rate

	Before Crisis (1991-1996)				After Crisis (1999-2003)			
	I	II	III	IV	I	II	III	IV
dlnEXTF1(-1)	0.0476*** (3.60)				0.0107 (0.57)			
dlnEXTF2(-1)		0.0304*** (3.20)				0.0378** (2.35)		
dlnEXTF3(-1)			0.0400*** (3.49)				-0.0324*** (-2.80)	
dlnEXTF4(-1)				0.0150*** (3.06)				-0.0110 (-1.41)
lnAsset(-1)	0.0008 (0.26)	-0.0024 (-0.85)	0.0018 (0.75)	-0.0010 (-0.48)	-0.0092* (-1.87)	-0.0152*** (-2.68)	-0.0124*** (-4.26)	-0.0121*** (-4.40)
Constant	-0.0467 (-0.84)	0.0686 (1.34)	-0.0549 (-1.24)	0.0613 (1.53)	0.1480 (1.50)	0.3720*** (3.18)	0.2865*** (5.13)	0.2762*** (5.21)
No. Obs.	2,856	2,923	3,957	5,868	1,712	1,078	5,183	5,940
Adjusted R ²	0.0607	0.0492	0.0734	0.0545	0.0750	0.0452	0.0609	0.0643

Note: Numbers in the parenthesis denote t-values. ***, **, * indicate that the coefficient estimate is statistically significant at the 1%, 5%, and 10% respectively. Coefficient estimates for industry and year dummy variables are not reported to save space.

input growth rate has a negative sign in the post-crisis period.⁶ Note that external finance variables remain significantly positive before the crisis even if we include factor input variables. In the post-crisis sample, only bond financing remains significantly positive as in Table 1. Regression results in this section indicate that external finance may have played a significant role in firm growth especially in the pre-crisis period. Hence, more detailed analyses on the channels are warranted, which we focus in the next sections.

⁶ The negative association between labor growth and value added growth seems to be unusual. It may result from the shift in underlying production technologies after the crisis. It may also partially reflect the restructuring efforts of firms after the crisis. Note that various labor market reform measures such as layoffs have been introduced after the financial crisis in an attempt to make labor market more flexible and efficient. This observation was suggested by an anonymous referee, which we gratefully appreciate.

<Table 2> External Finance and Value-added (with Input Factors)

- Dependent Variable: Value-added Growth Rate

	Before Crisis (1991-1996)				After Crisis (1999-2003)			
	I	II	III	IV	I	II	III	IV
dlnK(-1)	0.0207 (1.62)	0.0525*** (5.14)	0.0350*** (3.95)	0.0336*** (4.40)	0.1066*** (4.09)	0.0569** (2.18)	0.0422*** (3.51)	0.0362*** (3.24)
dlnL(-1)	0.0289 (1.31)	0.0437** (2.01)	0.0422** (2.49)	0.0511*** (3.53)	-0.0311 (-0.96)	0.0196 (0.53)	-0.0948*** (-6.32)	-0.0906*** (-6.37)
dlnEXTF1(-1)	0.0379*** (2.67)				-0.0077 (-0.39)			
dlnEXTF2(-1)		0.0253*** (2.66)				0.0331** (2.04)		
dlnEXTF3(-1)			0.0321*** (2.78)				-0.0330*** (-2.72)	
dlnEXTF4(-1)				0.0113*** (2.28)				-0.0100 (-1.25)
lnAsset(-1)	0.0005 (0.19)	-0.0028 (-1.02)	0.0016 (0.65)	-0.0014 (-0.67)	-0.0112** (-2.27)	-0.0148*** (-2.60)	-0.0131*** (-4.54)	-0.0130*** (-4.71)
Constant	-0.0483 (-0.87)	0.0602 (1.17)	-0.0615 (-1.39)	0.0598 (1.49)	0.1866* (1.89)	0.3621*** (3.08)	0.3166*** (5.68)	0.3064*** (5.78)
No. Obs.	2,856	2,923	3,957	5,868	1,712	1,078	5,183	5,940
Adjusted R ²	0.0615	0.0592	0.0783	0.0596	0.0832	0.0483	0.0689	0.0711

Note: Numbers in the parenthesis denote t-values. ***, **, * indicate that the coefficient estimate is statistically significant at the 1%, 5%, and 10% respectively. Coefficient estimates for industry and year dummy variables are not reported to save space.

2. External Finance, Capital Accumulation and R&D Investment

This section directly estimates the linkage between various forms of external finance and physical capital accumulation as well as R&D investment of firms. As discussed above, firm's access to external finance may lead to faster accumulation of capital by ameliorating credit constraints thereby allowing firms to achieve optimal production scale. To some extent, the positive linkage between external finance and

capital accumulation seems to be obvious. However, firm's external funding does not always lead to investments in facility and formation of fixed capital. Firms often raise external funds in order to finance operating cash flows or service and repay financial obligations. Note also that, as emphasized in section II, not only physical capital but also R&D investments are significantly constrained by asymmetric information problems and thus firm's financial situation. Hence, increased access to external finance can lead to higher R&D investments and higher total factor productivity growth. More specifically, we estimate the following regression equations:

$$d \ln K_{i,t} = \beta_0 + \beta_1 d \ln EXTF_{i,t-1} + \gamma' Z_{i,t-1} + \delta Year_t + \phi \mu_j + \varepsilon_{i,t} \quad (3-1)$$

$$d \ln RD_{i,t} = \beta_0 + \beta_1 d \ln EXTF_{i,t-1} + \gamma' Z_{i,t-1} + \delta Year_t + \phi \mu_j + \varepsilon_{i,t} \quad (3-2)$$

Table 3 reports estimation results on the rate of physical capital accumulation. We include the one year lagged log capital stock to control the convergence effect across firms. Note that, the total volume of external financing (EXTF4) has a significantly positive relationship with subsequent accumulation rate in physical capital before the 1997 financial crisis. Note however that, this positive relationship became weaker in the post-crisis period. Findings in this table indicate that external finance has contributed to firm growth mainly through physical capital accumulation before the crisis. However, this channel has become relatively weaker after the crisis.

Table 4 reports the R&D investment regression estimation results. As the KIS database does not report R&D investment for most of firms after the crisis, we were able to estimate only for the pre-crisis sample. Note that for all types of external finance, R&D investment tends to accelerate with an increased access to external finance. This result implies that a potentially important channel through which financial development enhances firm level productivity growth is through encouraging R&D investment.

3. External Finance and Total Factor Productivity Growth

We now turn to empirical investigations of the relationship between external finance and total factor productivity growth:

$$d \ln TFP_{i,t} = \beta_0 + \beta_1 d \ln EXTF_{i,t-1} + \gamma' Z_{i,t-1} + \delta Year_t + \phi \mu_j + \varepsilon_{i,t} \quad (4)$$

Table 5 reports regression results on equation (4). Note that only the third lagged total external finance variable (EXTF4) is significantly positive at the 5% level before the crisis, while it becomes insignificant after the crisis. Namely, compared to physical capital accumulation, the linkage between external finance and TFP growth seems to be much weaker both in pre-crisis and post-crisis Korea. To summarize, our regression estimation results in this section imply that we have not yet witnessed a structural shift in this relatively weak TFP-external finance relationship despite the extensive financial restructuring and reform efforts after the crisis. As noted before,

<Table 3> External Finance and Capital Accumulation

- Dependent Variable: Capital Accumulation Rate

	Before Crisis (1991-1996)				After Crisis (1999-2003)			
	I	II	III	IV	I	II	III	IV
lnK(-1)	-0.1566*** (-8.64)	-0.1590*** (-9.61)	-0.1620*** (-12.28)	-0.1454*** (-13.61)	-0.1147*** (-6.50)	-0.1384*** (-7.16)	-0.1204*** (-12.29)	-0.1130*** (-12.69)
dlnEXTF1(-1)	0.1625*** (5.14)				0.0351 (1.52)			
dlnEXTF1(-2)	0.0734** (2.23)				0.0108 (0.42)			
dlnEXTF1(-3)	-0.0231 (-0.72)				0.0061 (0.21)			
dlnEXTF2(-1)		0.0541** (1.96)				0.0145 (0.76)		
dlnEXTF2(-2)		0.0188 (0.73)				0.0502** (2.28)		
dlnEXTF2(-3)		0.0412 (1.63)				0.0506** (2.05)		
dlnEXTF3(-1)			0.0125 (0.51)				-0.0129 (-0.83)	
dlnEXTF3(-2)			0.0029 (0.11)				0.0079 (0.52)	
dlnEXTF3(-3)			0.0232 (0.89)				0.0178 (1.23)	
dlnEXTF4(-1)				0.0433*** (3.55)				0.0209* (1.94)
dlnEXTF4(-2)				0.0259** (2.12)				0.0100 (0.97)
dlnEXTF4(-3)				0.0029 (0.25)				0.0038 (0.38)
lnAsset(-1)	0.1758*** (9.44)	0.1841*** (9.89)	0.1863*** (12.75)	0.1682*** (14.60)	0.1105*** (5.77)	0.1295*** (5.80)	0.1061*** (9.95)	0.0990*** (10.22)
Constant	-0.4930*** (-3.92)	-0.6264*** (-4.49)	-0.6639*** (-6.11)	-0.5498*** (-6.33)	-0.0773 (-0.62)	-0.0455 (-0.28)	0.0727 (0.95)	0.1427** (2.05)
No. Obs.	1,072	1,141	1,873	2,568	879	620	2,537	3,056
Adjusted R ²	0.1150	0.0973	0.0908	0.0907	0.0757	0.1490	0.0786	0.0725

Note: Numbers in the parenthesis denote t-values. ***, **, * indicate that the coefficient estimate is statistically significant at the 1%, 5%, and 10% respectively. Coefficient estimates for industry and year dummy variables are not reported to save space.

<Table 4> External Finance and R&D Investment

- Dependent Variable: R&D Investment Growth Rate

	Before Crisis (1991-1996)			
	I	II	III	IV
dlnEXTF1(-1)	0.2723*** (3.19)			
dlnEXTF2(-1)		0.1082* (1.91)		
dlnEXTF3(-1)			0.3270*** (4.24)	
dlnEXTF4(-1)				0.1015*** (3.10)
lnAsset(-1)	0.0337* (1.89)	0.0146 (0.91)	0.0432*** (2.76)	0.0336** (2.51)
Constant	-0.5518 (-1.56)	-0.2412 (-0.78)	-0.9539*** (-3.15)	-0.5858** (-2.31)
No. Obs.	1,215	1,379	1,593	2,262
Adjusted R ²	0.0156	0.0207	0.0342	0.0152

Note: Numbers in the parenthesis denote t-values. ***, **, * indicate that the coefficient estimate is statistically significant at the 1%, 5%, and 10% respectively. Coefficient estimates for industry and year dummy variables are not reported to save space.

one potential reason of the weak linkage is the sluggish investment and weakening dependence of the corporate sector on external finance in post-crisis Korea.

4. External Finance and Information Externality

Note that, in addition to firm's actual access to external finance, the positive impact of financial development on firm level output and TFP growth can be exerted indirectly through industry-wide availability of external finance. In this section, we estimate this externality effect of the industry-wide availability of indirect external credit on firm level value-added, capital accumulation and total factor productivity growth. Specifically, we focus on the channel that highlights the role of financial intermediaries such as banks and non-bank financial intermediaries in ameliorating

<Table 5> External Finance and Total Factor Productivity Growth

- Dependent Variable: TFP Growth Rate

	Before Crisis (1991-1996)				After Crisis (1999-2003)			
	I	II	III	IV	I	II	III	IV
dlnEXTF1(-1)	-0.0107 (-0.42)				-0.0260 (-0.93)			
dlnEXTF1(-2)	0.0293 (1.11)				-0.0116 (-0.37)			
dlnEXTF1(-3)	0.0382 (1.48)				0.0553 (1.56)			
dlnEXTF2(-1)		-0.0157 (-0.78)				0.0066 (0.28)		
dlnEXTF2(-2)		0.0347* (1.83)				-0.0101 (-0.36)		
dlnEXTF2(-3)		0.0012 (0.06)				-0.0165 (-0.53)		
dlnEXTF3(-1)			0.0007 (0.04)				0.0508*** (3.21)	
dlnEXTF3(-2)			0.0059 (0.30)				0.0265* (1.74)	
dlnEXTF3(-3)			-0.0070 (-0.37)				0.0067 (0.45)	
dlnEXTF4(-1)				-0.0036 (-0.38)				0.0141 (1.26)
dlnEXTF4(-2)				0.0068 (0.73)				0.0057 (0.53)
dlnEXTF4(-3)				0.0236*** (2.70)				0.0051 (0.50)
lnAsset(-1)	-0.0101* (-1.95)	0.0023 (0.43)	0.0006 (0.14)	-0.0041 (-1.15)	0.0000 (0.00)	0.0088 (0.95)	0.0000 (0.01)	0.0006 (0.16)
Constant	0.2196** (2.17)	0.0293 (0.29)	0.0286 (0.37)	0.0945 (1.44)	-0.0467 (-0.32)	-0.1031 (-0.55)	0.0942 (1.24)	0.0253 (0.36)
No. Obs.	1,072	1,141	1,873	2,568	879	620	2,537	3,056
Adjusted R ²	0.0237	0.0339	0.0316	0.0349	0.0569	0.0305	0.0480	0.0530

Note: Numbers in the parenthesis denote t-values. ***, **, * indicate that the coefficient estimate is statistically significant at the 1%, 5%, and 10% respectively. Coefficient estimates for industry and year dummy variables are not reported to save space.

asymmetric information problems. Diamond (1984) for instance, argues that banks have an advantage over outside investors because they know more about the borrowers' prospects as the insider position of banks allows them to overcome the information asymmetry. Namely, banks screen prospective borrowers and monitor debt service capacities of borrowers. By doing so, banks produce valuable private information that is not readily available in public capital markets, and borrowers' access to banks' informed fund yields a positive signal to other external financiers in the capital markets.

We test whether the increased availability of indirect external credit for an industry results in a non-linearly faster growth in value-added, accumulation of physical capital and TFP growth for firms with a relatively large information asymmetry. This non-linear externality effect can be estimated by using the intangible asset to total asset ratio as a proxy to the degree of information asymmetry inherent in the production technology of a specific firm. More specifically, we test the presence of the information externality by including an interaction term between this intangible asset ratio and industry-wide availability of indirect external credit in addition to the individual firm's external finance variable. Regression model is specified as in equation (5):

$$d \ln Y_{i,t} = \beta_0 + \beta_1 d \ln EXTF_{i,t-1} + \beta_2 d \ln INDEXTF_{j,t-1} + \beta_3 (Intg / Asset)_{i,t-1} + \beta_4 (d \ln INDEXTF)_{j,t-1} (Intg / Asset)_{i,t-1} + \gamma' Z_{i,t} + \delta Year_t + \phi \mu_j + \varepsilon_{i,t} \quad (5)$$

Where, for Y, we use firm level value-added(V), physical capital stock(K) and TFP growth rates. $INDEXTF_j$ denotes the volume of industry-wide indirect external credits from banks and non-bank financial intermediaries extended for industry j which firm i belongs to. As for the individual firm's external finance variable, we use total volume of external finance (EXTF4) including bond and equity financing in addition to bank and non-bank borrowings. The existence of direct industry externalities can be captured by β_2 and indirect information externality can be explored by investigating whether the coefficient of the interaction term β_4 is significantly positive. Total industry externality is $\beta_2 + \beta_4 (Intg/Asset)$.

Table 6 reports estimation results. As expected, intangible asset ratio in general has a significantly negative coefficient indicating that firms with higher information asymmetry tend to grow slowly in value-added, capital stock and total factor productivity. For value-added growth regressions, before the crisis, the industry-wide external finance variable is significantly positive in addition to the individual firm's external finance variable. However, the interaction term between the industry external finance and intangible asset ratio has an opposite sign. After the crisis, the interaction term has a significantly positive sign as conjectured, however, the industry and individual firm external finance variables have a negative sign.

For capital accumulation regressions, the individual external finance variable is significantly positive in both pre- and post-crisis periods, while the industry-wide external finance variable and its interaction term with intangible asset ratio are insignificant before and after the crisis. Hence, for capital accumulations, firms'

<Table 6> External Finance and Information Externality

	Before Crisis (1991-1996)			After Crisis (1999-2003)		
	Dependent Variable:			Dependent Variable:		
	dlnV	dlnK	dlnTFP	dlnV	dlnK	dlnTFP
lnK(-1)		-0.2968*** (-24.75)			-0.2273*** (-21.36)	
dlnINDEXTF(-1)	0.6925*** (2.20)	0.3680 (0.80)	0.2974 (0.82)	-0.2137* (-1.86)	-0.1522 (-1.13)	-0.1803 (-1.49)
dlnEXTF4(-1)	0.0120* (1.85)	0.0230** (2.43)	-0.0045 (-0.60)	-0.0106 (-1.35)	0.0185** (2.03)	-0.0280*** (-3.42)
Intang/Asset(-1)	0.0168 (0.27)	-0.8290*** (-8.34)	-0.0486 (-0.67)	-0.0587** (-2.10)	-0.4342*** (-9.38)	-0.1756*** (-6.00)
dlnINDEXTF(-1) * Intang/Asset(-1)	-0.9702** (-2.11)	-0.3337 (-0.50)	-0.4905 (-0.93)	0.4213** (2.49)	0.0076 (0.04)	0.4599*** (2.59)
lnAsset(-1)	0.0030 (1.08)	0.3058*** (25.18)	-0.0062* (-1.94)	-0.0124*** (-4.50)	0.2088*** (18.92)	-0.0075*** (-2.59)
Constant	-0.0350 (-0.50)	0.0317 (0.31)	0.1642** (2.04)	0.3171*** (5.73)	0.3013*** (4.65)	0.2831*** (4.87)
No. Obs.	3,531	3,531	3,531	5,940	5,940	5,940
Adjusted R ²	0.0545	0.1688	0.0377	0.0668	0.1109	0.0555

Note: Numbers in the parenthesis denote t-values. ***, **, * indicate that the coefficient estimate is statistically significant at the 1%, 5%, and 10% respectively. Coefficient estimates for industry and year dummy variables are not reported to save space.

actual access to external finance is more important and the industry-wide externality effect does not seem to be present. As for the TFP growth, it is interesting to note that the interaction term between industry-wide external finance and intangible asset ratio becomes significantly positive after the crisis.

The overall result indicates that the industry-wide availability of external finance does not have a significant externality for firms with higher information asymmetry in accumulating physical capital. However, at least in the post-crisis period, we can observe a positive externality effect of the industry-wide external finance upon the firm level TFP growth rate. This implies that, while firms with higher information

asymmetry tend to show slower growth, an industry-wide availability of external finance may ameliorate this negative effect and accelerate TFP growth of such firms.

5. External Finance and Industry Restructuring

Financial development may also lead to the enhancement of total factor productivity at industry level through better reallocation of resources across firms within the industry. Moreover, financiers can facilitate entry of young promising firms. In this section, we estimate the relationship between industry-wide availability of external finance and the industry entry and turnover rates in an attempt to explore the industry restructuring impact of external finance.

$$ENTRYR_{j,t} = \beta_0 + \beta_1 (INDEXTF / INDSIZE)_{j,t-1} + \gamma' Z_{j,t-1} + \delta Year_t + \varepsilon_{j,t} \quad (6-1)$$

$$TURNOVER_{j,t} = \beta_0 + \beta_1 (INDEXTF / INDSIZE)_{j,t-1} + \gamma' Z_{j,t-1} + \delta Year_t + \varepsilon_{j,t} \quad (6-2)$$

In the regression models above, $ENTRYR_j$ is the ratio of new firms entered into the industry j , and $TURNOVER$ is the ratio of firms entered into and exited from the industry during a given year. $INDSIZE$ is the industry size as measured by the industrial production. As distinctions between bank credits ($INDEXTF1$) and non-bank credits ($INDEXTF2$) are available at the industry level, we separately estimate the impact of bank versus non-bank credits on the industry entry and turnover rates. As control variables we use R&D investment as a percentage of sales volume and capital-labor ratio in an attempt to capture heterogeneous technologies and capital intensities of respective industry. Note that both entry and exit barriers can be relatively high for capital intensive industries. As additional controlling variables, we also include industry output growth rate and average number of employees per firm within the industry in order to avoid spurious correlations that may result from the relationship between these industry variables and entry and turnover rates.

Table 7 reports estimation results for the above industry level regression equations (6-1) and (6-2). As for the entry rate, both bank and non-bank credits are not significantly associated with the entry rate before the crisis. However, after the crisis, while bank credit remains insignificant and non-bank credit becomes significantly negatively associated with the entry rate, which suggests that non-bank credits may have actually raised entry barrier. As for the industry turnover rate, both bank and non-bank credits are not significantly associated with industry turnover rate in the pre-crisis. However, non-bank credit becomes significantly negatively associated with the turnover rate after the crisis.

The differential impacts of bank and non-bank credits in the post-crisis may reflect the phenomenon that relatively risky and low credit firms have become increasingly more dependent upon non-bank financial intermediaries as banks have become more risk averse and selective after the crisis. Consequently non-bank credits have effectively delayed corporate restructuring and exits of insolvent firms, which has in turn discouraged entry of new firms and lowered industry turnover rate.

<Table 7> External Finance and Industry Restructuring

A. Before Crisis (1991-1996)

	Dependent Variable:			
	Entry Rate		Turnover Rate	
	I	II	I	II
INDEXTF1/ INDSIZE(-1)	0.0120 (0.20)		0.1107 (1.03)	
INDEXTF2/ INDSIZE(-1)		0.0648 (0.85)		-0.0580 (-0.42)
R&D Ratio(-1)	0.5826 (1.08)	0.5949 (1.20)	0.7954 (0.83)	0.3416 (0.38)
K/L Ratio(-1)	-0.0003*** (-6.18)	-0.0003*** (-7.18)	-0.0006*** (-5.94)	-0.0006*** (-7.61)
IND Growth(-1)	0.0789** (2.33)	0.0874** (2.52)	0.0619 (1.03)	0.0382 (0.61)
INDL(-1)	-0.0001 (-0.07)	0.0001 (0.11)	-0.0001 (-0.41)	-0.0001 (-0.52)
No. Obs.	60	60	60	60
Adjusted R ²	0.6894	0.6935	0.6520	0.6461

B. After Crisis (1999-2003)

	Dependent Variable:			
	Entry Rate		Turnover Rate	
	I	II	I	II
INDEXTF1/ INDSIZE(-1)	0.0660 (1.62)		0.1086 (1.49)	
INDEXTF2/ INDSIZE(-1)		-0.3066*** (-4.31)		-0.5039*** (-3.92)
R&D Ratio(-1)	1.2408*** (4.61)	0.9225*** (4.00)	1.5085*** (3.14)	0.9854** (2.36)
K/L Ratio(-1)	-0.0002*** (-5.65)	-0.0002*** (-9.52)	-0.0004*** (-7.29)	-0.0004*** (-11.43)
IND Growth(-1)	-0.0315*** (-0.94)	-0.0617** (-1.99)	-0.0481 (-0.80)	-0.0978* (-1.75)
IND Avg Emp(-1)	-0.0001** (-2.09)	-0.0001*** (-3.16)	-0.0001** (-2.22)	-0.0001*** (-3.19)
No. Obs.	100	100	100	100
Adjusted R ²	0.7351	0.7740	0.6950	0.7330

Note: Numbers in the parenthesis denote t-values. ***, **, * indicate that the coefficient estimate is statistically significant at the 1%, 5%, and 10% respectively. Coefficient estimates for constant and year dummy variables are not reported to save space.

Overall evidence in this section suggests that the industry restructuring role of financial institutions remains largely weak even after the financial crisis.

VI. Summary and Concluding Remarks

In this paper, we empirically investigated the external finance-firm growth linkage in Korea by utilizing firm level data of manufacturing industries before and after 1997 financial crisis. Under asymmetric information and capital market imperfections, financial development and increased access to external finance can promote firm level factor accumulation and total factor productivity growth through various channels – by ameliorating credit constraints, facilitating risk sharing, lowering moral hazard and agency costs, and encouraging R&D investments, among others. Moreover, the positive impact of external finance can be reinforced at the industry level as external financiers encourage young promising firms to grow and facilitate corporate restructuring.

We constructed firm level physical capital stock and total factor productivity measures and evaluated their relationships with various forms of external finance such as bank and non-bank credits, bonds, and equity financing. Our main empirical results can be summarized as follows: First, we find that an increase in external finance tends to be associated with a faster subsequent capital accumulation rate. However, this positive capital accumulation effect became relatively attenuated after the 1997 crisis. Second, external finance encourages subsequent R&D investments. Third, compared to capital accumulation channel, the relationship between external finance and subsequent TFP growth is relatively weak in both the pre-crisis and the post-crisis periods.

We also examined the indirect impact of the industry-wide availability of external finance. We tested whether the increased availability of indirect external credits for an industry results in a non-linearly faster growth in value-added, accumulation of physical capital, and TFP growth for firms with a relatively large information asymmetry. We find that the industry-wide availability of external finance does not have a significant information externality for firms in accumulating physical capital, although, at least in the post-crisis period, we could observe a positive externality through the TFP channel. Finally, as for the industry restructuring effect, we find that the industry restructuring role of financial institutions is largely absent in both the pre-crisis and post-crisis periods. In the post-crisis period, non-bank credits have actually discouraged entry of new firms and reduced the industry turnover rate.

Our findings in this paper yield important implications in assessing the role of financial sector in promoting economic growth in Korea. In the pre-crisis period, the Korean financial sector contributed to economic growth relatively more through the factor accumulation channel rather than through the TFP channel. However, in the post-crisis period, even the factor accumulation channel has become relatively attenuated while the TFP channel still remains weak.

Considering Korea's extensive financial reform efforts since 1997, this finding seems to be somewhat surprising. The slowdown in aggregate corporate investment

and the phenomenon that firms have become more dependent upon internal funds have resulted in the separation of finance from real production activities in post-crisis Korea. As productive and profitable firms have become increasingly more dependent upon internal financing, the average quality of firms left in the external financial markets has deteriorated and the degree of asymmetric information has gotten worsen. However, the role of financial institutions in producing valuable information and exerting corporate restructuring remains far from fully functional. Overall evidence indicates that further efforts are required to strengthen resource allocation and corporate restructuring roles of financial markets and institutions in order to effectively sustain Korea's economic growth.

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