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Contents

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We study firm dynamics in Korea before and after the 1997-98 Asian crisis and pro-competitive reforms that reduced the dominance of chaebols. We find that in industries that were dominated by chaebols before the crisis, labour productivity and TFP of non-chaebol firms increased markedly after the reforms (relative to other industries). Furthermore, entry of non-chaebol firms increased significantly in all industries after the reform. After the crisis, the non-chaebol firms also dramatically increased their patenting activity. Finally, markups of chaebol firms declined substantially, especially with industries dominated by chaebols before the crisis. These results are in line with a neo-Schumpeterian view of transition from a growth model based on investment in existing technologies to an innovation-based model.

Keywords: innovation-based growth, chaebols, Asian crisis

JEL Classification: O43, L25

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Ⅰ. Introduction

In order to catch up with advanced economies, developing countries may use different growth models depending on their level of development. Thus Acemoglu, Aghion and Zilibotti (2006) distinguish between "investment-based" and "innovation-based" growth.[1] Economies that are far from the productivity frontier grow mainly by catching up with advanced economies, i.e. by adopting technologies first developed elsewhere. Such growth requires substantial capital investments and often involves centralized coordination of investments – by the state or by large business groups. As the economy gets closer to the frontier, however, it needs to switch to "innovation-based" growth, i.e. to growth from inventing new technologies rather than from importing those invented in other countries. Innovation-based growth requires skilled workforce, investment in advanced research and development as well as a dynamic competitive environment: competition between decentralized firms, their entry and exit.

Switching from investment-based growth to innovation-based growth may be delayed because of the political economy of institutional change. Investment-based model creates powerful interest groups that are keen to preserve status quo and may resist adopting the innovation-based model. In this case, the investment-based model may overstay its welcome – with adverse implications for the productivity growth and economic development. In this case, the economy may end up in a "middle-income trap" (Gill and Kharas 2007).

One country that has successfully managed the transition from investment-based to innovation-based model is South Korea. In this paper, we study disaggregated data on the universe of Korean manufacturing firms to develop a granular understanding of this transition which took place after the 1997-98 crisis.

Korea is a quintessential testing ground for the Schumpeterian growth theory. The conventional description of Korea's economic transformation in

1) See also Aghion, Akcigit, and Howitt (2014).

recent decades includes three key elements (Chang 2003). First, before the 1997-98 Asian crisis Korea's economic growth was driven by large business groups (chaebols). Chaebols' member firms and banks supported each other (through access to subsidized finance, providing explicit and implicit bailout guarantees) and effectively restricted entry of independent Korean firms and of foreign direct investors. The chaebol model did manage to deliver in terms of industrialization, investment and export growth – exactly in line with the Schumpeterian growth framework.[2)]

Second, the Asian crisis undermined the political legitimacy of the chaebol model and provided a window of opportunity for reform. At this point, the blueprints for pro-competitive reforms have already been discussed in Korea but it was the crisis that provided a critical impetus for reforms due to the pressure of the IMF.

Third, the restructuring of under-performing chaebols and removal of entry barriers and implicit financial support for chaebol members opened up the Korean economy for competition. This in turn promoted innovation and helped creating a knowledge-based economy.[3)]

While the narrative above seems to fit macroeconomic trends, it has never been tested with the disaggregated data. In this paper, we use the census of Korean manufacturing firms to understand whether the 1998 reforms did indeed result in greater entry of non-chaebol firms and their productivity growth in industries that used to be dominated by chaebols.

We find that after the crisis the industries previously dominated by chaebols have seen relatively faster productivity growth of non-chaebol firms. Furthermore, entry of non-chaebol firms increased significantly in all industries after the reform. Exit has also increased across all industries but exit of non-chaebol firms was lower in the industries that used to be

2) In 1963-97, Korean GDP per capita has been growing at an average rate of 7 per cent per year.

3) According to the US Patents and Trademarks Office (USPTO), in 1992, Korea filed 8 times fewer patents applications to the USPTO than Germany; in 2003, the respective ratio was only 1.8 times. Since 2012, Korea has overtaken Germany in terms of US patents applications; in 2015, it filed 30% more patent applications to the USPTO than Germany (despite having roughly half the population of Germany and less than half of German GDP, either in nominal or PPP terms).

dominated by chaebols.

We also study the firm-level data on patenting activity. After the crisis, the growth of annual number of patents by chaebol firms slowed down in industries with high pre-crisis chaebol shares – while patenting by non-chaebol firms accelerated (uniformly across all industries).

The reforms have also reduced the markups of chaebol firms in the industries with greater pre-crisis presence of chaebols. The markups of non-chaebol firms slightly increased after the crisis in all industries.

Taken together, these results are consistent with the conventional view that the 1998 reforms helped reducing dominance of chaebols, raised the competitiveness of the Korean economy, and promoted productivity growth and innovation.

The rest of the paper is structured as follows. In Section 2 we discuss related literature. In Section 3 we provide a background discussion of pre-crisis economic institutions in Korea, the role of chaebols and the 1998 reforms. In Section 4 we discuss the empirical methodology and the data sources; we also provide summary statistics and compare them to other countries. In Section 5 we present the main results. Section 6 includes additional results and robustness checks. Section 7 concludes.

Ⅱ. Literature review

The fact that the 1997-98 crisis and the subsequent IMF-backed reform reduced the chaebols' grip on the Korean economy and thus promoted access to finance, entry, exit and productivity growth has already been documented in the literature – albeit using much smaller datasets. Borensztein and Lee (2002) have shown that before the crisis the chaebol firms had preferential access to credit. After the crisis there was no significant difference between chaebol and non-chaebol firms. This has helped to increase efficiency: while before the crisis credit was not directed to more efficient firms, after the crisis it was. Hong, Lee and Lee (2007) studied the level of investment controlling for cash flows and investment profitability and showed that before

the crisis chaebol firms invested more than non-chaebol firms. This difference disappeared after the crisis. Both papers' datasets are limited to listed firms.

Borensztein and Lee (2005) have analysed both listed and non-listed firms but used aggregated industry-level data for 32 sectors. They also showed that before the reform credit was not likely to be directed towards more efficient sectors – nor that sectors receiving more credit demonstrated higher growth.

Minetti and Yun (2015) use data from KISLINE on 242 firms (including 37 chaebol firms) and 1608 syndicated loans to these firms. They show that before the reforms banks had weaker incentives to monitor their chaebol borrowers (relative to non-chaebol borrowers) than after the reform. They argue that the reform removed the implicit bailout guarantee to chaebols.

Asturias et al. (2017) uses the same Mining and Manufacturing survey that we use – who also utilize similar data for Chile and for the US. They show, both theoretically and empirically, that during the period of fast growth, net entry explains a higher share of growth (thus focusing on the change of aggregate performance change over time). Lee (2020) also exploits the same dataset to present the evolution of entry, exit, job reallocations, and growth of plants and perform decomposition exercises to find out the main driver of the aggregate productivity growth in the manufacturing sector. We use the same dataset for Korea but our focus is on the industry-level outcomes, the role of chaebols and the change in competitive environment due to the 1998 reforms.

Another relevant paper is Hemous and Olsen (2017) that shows that domination of business groups reduces market size for potential innovators resulting in fewer patents. They use data from the US and Japan where *keiretsus* were similar to Korean chaebols.

Ⅲ. Chaebols and the 1998 reforms

Chaebol is a Korean term that refers to a large business group in Korea.[4] Chaebols have played a critical role in the rapid growth of Korean economy, and some of its member firms such as Samsung Electronics and Hyundai Motors have become major global players. Chaebols emerged as Korean businessmen and government developed close ties after World War II. Chaebol founders benefited from the sales of assets previously held by Japanese owners and from the allocation of foreign currency due to their connections with high-ranking government officials. During 1960s, the government carried out a series of five-year plans to accelerate economic growth. The government examined the validity of large investment projects and effectively directed loans to projects that could foster export-oriented industries. Many chaebols grew rapidly since they were selected by the government to take on these projects and therefore benefited from various forms of government support. As real wages increased in 1970s, the government modified the target of its plans to promote the heavy machinery and chemical industries. It continued providing subsidies to chaebol firms in these industries and bailed out failed companies in the aftermath of the oil price shocks. Following the end of 18-year Chung-Hee Park's regime in 1979, the government's support of chaebols became less prominent. But deregulation of financial sector–including privatization of banks and elimination of the limits on ownership of non-bank financial institutions–provided chaebols with opportunities for funding their investments through internal capital markets and cross-subsidization within the groups.

Most of the chaebols diversified their business to unrelated areas, and each of the affiliate firms acted as if it was a subsidiary of the business group, sharing technology, brand, human resources, and capital within the group. Chaebols have formed their internal capital markets and utilized the

4) Its definition by the Korean Standard Dictionary is 'a group of capitalists and businessmen who manage several firms and own huge wealth'. The word chaebol consists of chae ("wealth or finance") and bol ("lineage or clique, with a strong connotation of exclusivity", Haggard et al. 2003, p. 25).

practices including loans, debt guarantees, and cross-shareholding to facilitate the expansion of their business. At their peak in mid- to late 1990s, the top 30 chaebols accounted for 16 percent of Korean GDP – with top 5 chaebols alone (Hyundai, Samsung, LG, Daewoo and SK) accounting for 10 percent of GDP (Chang, 2003, p. 11).

The mutual debt guarantees and cross-subsidization effectively limited access to finance for non-chaebol members.[5] Chaebols also benefited from restrictions on foreign ownership which before 1997 was limited to 26% of capital of Korean firms.[6]

The implicit bailout protection provided by the government (Minetti and Yun, 2015), mutual debt guarantees, cross-subsidization and non-transparent corporate governance[7] have however resulted in funding of inefficient activities. Within-group moral hazard has resulted in overinvestment: while chaebols' capital intensity has grown, the productivity of capital has declined in 1990s by a factor of two (Chang 2003, p. 18).

Eventually, the accumulation of inefficiencies and mutual debt guarantees triggered the 1998 crisis and the chain reaction of insolvencies and bankruptcies of chaebol affiliates. The number of bankruptcies in Korean economies in 1998 was twice as high as in the previous years (Chang, 2003, p. 5); a top-5 chaebol Daewoo went bankrupt in 1999 (OECD, 2000).

In late 1997, the Korean government applied for IMF funding and agreed to implement several important pro-competitive reforms and restructuring of chaebols (IMF, 1997a,b). First, the government forced them to cut their debt-equity ratios to less than 200%, and to eradicate the mutual debt

5) The Federal Trade Commission effectively started to police chaebols' anti-competitive practices involving debt guarantees and cross-subsidization only in 1998 (Chang, pp. 127, 222, 237, World Bank, 1999, p. 76). World Bank (1999, pp. 83-84) discusses the role of chaebols in limiting independent firms' access to finance before the reform.

6) Haggard et al. (2003, p. 319) refer to the FDI regime in pre-crisis Korea as "one of the most restrictive in Asia" providing firms with substantial protection in the domestic market.

7) Through cross-shareholding among affiliated firms, families of chaebol founders have practically dominated the entire group although they owned a small portion of shares. This has brought about several problems such as lack of accountability by chaebol chairmen, expropriation through inside trading or internal transfer pricing schemes (World Bank, 1999, ch.6).

guarantees (Chang, 2003, pp. 190, 195, 213). It also required to improve corporate governance and to consolidate accounts. It has also introduced transparent regulation of financial institutions.

Furthermore, the reform liberalized entry of foreign investors (lifting the foreign ceiling ownership to 50% by the end of 1997 and to 55% by the end of 1998).

The government also radically strengthened antitrust enforcement, both chaebol regulation and traditional competition policy (Haggard et al. 2003, p. 320). The number of corrective orders issued and amounts of surcharges imposed increased threefold and 25-fold, respectively, in 1998-2000 relative to pre-crisis levels (Shin 2003, p. 277).

All these measures drastically lowered barriers to entry for non-chaebol firms (including foreign-owned[8]) and reduced chaebol firms' preferential access to finance – thus further levelling the playing field for non-chaebol firms.

Ⅳ. Empirical methodology and data

1. Methodology

We employ differences-in-differences as our main methodology. The key regressor in our specification is the interaction term between the share of chaebol firms in industry sales and the post-crisis time dummy. The main specification is the following:

$$Y_{it} = \alpha_i + \beta_1 Post\,crisis_t + \beta_2 (Chaebol\,share_i \times Post\,crisis_t) + u_{it} \qquad (1)$$

The subscripts i and t denote each industry and year, respectively. We

8) As shown in Yun (2003), the reforms resulted in dramatic increase in FDI flows – from 0.5% of GDP before the crisis to 2% of GDP already in 1998-2000.

include industry fixed effects α_i and cluster standard errors at the industry level. Y_{it} is the dependent variable (productivity, entry, exit, patenting, markups). We define the *Post crisis* variable as a dummy variable that is 0 for years before 1998, 1 after 1998, and has no value for year 1998. We tried other variations such as including 1998 to either pre or post crisis period; the results did not change. (The results are also robust to replacing the *Post crisis* dummy with individual year fixed effects).

The *Chaebol share* is the average pre-crisis chaebol share in industry sales. This variable is a proxy for the degree of domination of chaebols in a given industry before the crisis – and therefore of the exposure of the industry to the 1998 pro-competitive reforms. As the *Chaebol share* variable is absorbed by the industry fixed effects, we only use *Post crisis* dummy and the interaction term $Chaebol\,share_i \times Post\,crisis_t$ as regressors. We expect that in regressions for productivity, the coefficient β_2 on this interaction term would be positive and significant – as the impact of reforms would be stronger for the industries with the higher pre-crisis presence of chaebols $Chaebol\,share_i$.

We run main regressions using each dependent variable for all firms, and for chaebol and non-chaebol firms separately.

In all regressions we winsorise top and bottom 1% firm-level observations in order to make sure that our results are not influenced by outliers.

2. Data

We start with a formal definition of chaebols. In this paper, we follow the criterion set by the Korean Fair Trade Commission (FTC) and consider the 30 largest private business groups of each year based on the total asset values of affiliated firms as 'chaebols.' FTC consistently collected and published the information on the names and the list of affiliated firms of these groups throughout our sample period. This definition has been extensively used in the literature. Table 1 shows the list of 30 largest business groups for each year.

Table 1. List of 30 largest business groups (chaebol groups) from 1992 to 2003.

Rank	1992	1993	1994	1995	1996	1997
1	Hyundai	Hyundai	Hyundai	Hyundai	Hyundai	Hyundai
2	Daewoo	Samsung	Daewoo	Samsung	Samsung	Samsung
3	Samsung	Daewoo	Samsung	Daewoo	LG	LG
4	LG	LG	LG	LG	Daewoo	Daewoo
5	Ssangyong	SK	SK	SK	SK	SK
6	Hanjin	Hanjin	Hanjin	Ssangyong	Ssangyong	Ssangyong
7	SK	Ssangyong	Ssangyong	Hanjin	Hanjin	Hanjin
8	Hanwha	Kia	Kia	Kia	Kia	Kia
9	Daelim	Hanwha	Hanwha	Hanwha	Hanwha	Hanwha
10	Lotte	Lotte	Lotte	Lotte	Lotte	Lotte
11	Donga	Kumho	Kumho	Kumho	Kumho	Kumho
12	Hanil	Daelim	Daelim	Doosan	Doosan	Halla
13	Kia	Doosan	Doosan	Daelim	Daelim	Donga
14	Doosan	Donga	Donga	Donga	Hanbo	Doosan
15	Pan Ocean	Hanil	Hyosung	Halla	Donga	Daelim
16	Hyosung	Hyosung	Hanil	Dongkuk Steel	Halla	Hansol
17	Dongkuk Steel	Dongkuk Steel	Halla	Hyosung	Hyosung	Hyosung
18	Sammi	Sammi	Dongkuk Steel	Hanbo	Dongkuk Steel	Dongkuk Steel
19	Hanyang	Halla	Sammi	Tongyang	Jinro	Jinro
20	Kukdong Engineering & Construction	Hanyang	Tongyang	Hanil	Kolon	Kolon
21	Kolon	Tongyang	Kolon	Kolon	Tongyang	Kohap
22	Kumho	Kolon	Jinro	Kohap	Hansol	Dongbu
23	Dongbu	Jinro	Kohap	Jinro	Dongbu	Tongyang
24	Kohap	Dongbu	Woosung Construction	Haitai	Kohap	Haitai
25	Hanbo	Kohap	Dongbu	Sammi	Haitai	Newcore
26	Haitai	Kukdong Engineering & Construction	Haitai	Dongbu	Sammi	Anam
27	Daesang	Woosung Construction	Kukdong Engineering & Construction	Woosung Construction	Hanil	Hanil
28	Samwhan Corporation	Haitai	Hanbo	Kukdong Engineering & Construction	Kukdong Engineering & Construction	Keopyung
29	Halla	Byuksan	Daesang	Byuksan	Newcore	Daesang
30	Woosung Construction	Daesang	Byuksan	Daesang	Byuksan	Shinho

(continued)

Rank	1998	1999	2000	2001	2002	2003
1	Hyundai	Hyundai	Hyundai	Samsung	Samsung	Samsung
2	Samsung	Daewoo	Samsung	Hyundai	LG	LG
3	Daewoo	Samsung	LG	LG	SK	SK
4	LG	LG	SK	SK	Hyundai Motors	Hyundai Motors
5	SK	SK	Hanjin	Hyundai Motors	Hanjin	KT
6	Hanjin	Hanjin	Lotte	Hanjin	POSCO	Hanjin
7	Ssangyong	Ssangyong	Daewoo	POSCO	Lotte	Lotte
8	Hanwha	Hanwha	Kumho	Lotte	Hyundai	POSCO
9	Kumho	Kumho	Hanwha	Kumho	Kumho	Hanwha
10	Donga	Lotte	Ssangyong	Hanwha	Hyundai Heavy Industries	Hyundai Heavy Industries
11	Lotte	Donga	Hansol	Doosan	Hanwha	Hyundai
12	Halla	Hansol	Doosan	Ssangyong	Doosan	Kumho
13	Daelim	Doosan	Hyundai Oilbank	Hyundai Oilbank	Dongbu	Doosan
14	Doosan	Daelim	Donga	Hansol	Hyundai Oilbank	Dongbu
15	Hansol	Dongkuk Steel	Dongkuk Steel	Dongbu	Hyosung	Hyosung
16	Hyosung	Dongbu	Hyosung	Daelim	Daelim	Shinsegae
17	Kohap	Halla	Daelim	Tongyang	Kolon	Daelim
18	Kolon	Kohap	S-Oil	Hyosung	CJ	CJ
19	Dongkuk Steel	Hyosung	Dongbu	CJ	Dongkuk Steel	Tongyang
20	Dongbu	Kolon	Kolon	Kolon	Hanaro Telecom	Kolon
21	Anam	Tongyang	Tongyang	Dongkuk Steel	Hansol	KT&G
22	Jinro	Jinro	Kohap	Hyundai Development Company	Shinsegae	Hanaro Telecom
23	Tongyang	Anam	CJ	Hanaro Telecom	Tongyang	Dongkuk Steel
24	Haitai	Haitai	Daewoo Electronics	Shinsegae	Hyundai Department Store	Hyundai Department Store
25	Shinho	Saehan	Hyundai Development Company	Youngpoong	Hyundai Development Company	Hansol
26	Daesang	Kangwon Industries	Anam	Hyundai Department Store	Youngpoong	Daewoo Shipbuilding & Marine Engineering
27	Newcore	Daesang	Saehan	Oriental Chemical Industries	Daesang	Daewoo Motors
28	Keopyung	CJ	Jinro	Daewoo Electronics	Dongwon	Hyundai Development Company
29	Kangwon Industries	Shinho	Shinsegae	Taekwang Industry	Taekwang Industry	Youngpoong
30	Saehan	Samyang	Youngpoong	Kohap	KCC	KCC

Notes: Rankings are based on the total asset values of affiliated firms. The list is based on the current names of chaebols. For example, LG has been known as Lucky Goldstar before 1994, and SK was known as Sunkyung before 1997. From 2002, public enterprises were included in the designation of large business groups by Fair Trade Commission. This list excludes public enterprises. Some chaebols were divided into several groups sharing the common name primarily due to the inheritance to the founder's offspring. For example, Hyundai Motors, Hyundai Oilbank, Hyundai Development Company, and Hyundai Department Store were separated from Hyundai after the death of its founder, Ju-Young Chung in 2001.

Source: Korea Federal Trade Commission

According to this definition, the same firm could be a chaebol member in a year and a non-chaebol firm in a different year depending on the chaebol status of the business group that it belonged to. In other words, the chaebol status is not a firm-specific characteristic, but it differs by each year and firm level. The chaebol status of a firm/plant can change over time in three cases. The first case is a firm that was a member of a continuing business group, which appeared in the list of top 30 only for some years due to fluctuations in the total asset value of the group. This case has been mainly prevalent among groups below the rank of 20 on the list. The second case is a firm that was separated from a chaebol group and joined a smaller business group (outside of top 30) or became/stayed an independent firm. The third case, which was more relevant for larger business groups after the crisis, is a business group whose key members went bankrupt in the aftermath of the crisis. For example, the affiliates of Daewoo and Kia lost its chaebol status after these groups collapsed. Interestingly, some of the previous members of these business groups which survived through the dissolution formed an independent business group or were acquired by other large business groups, becoming chaebol affiliates again later. For instance, Daewoo Electronics regained its chaebol status in 2001 and 2002 after becoming independent from Daewoo group in 1999 and Hyundai group purchased Kia Motors in 1999 that previously went bankrupt in 1997, making Kia Motors a chaebol member from 1999.

The FTC's annual press releases contain detailed information from which we can identify each firm's chaebol status in each year. FTC is a government agency that regulates chaebols based on the "Monopoly Regulation and Fair Trade Act." It has annually published the list of top 30 chaebol groups based on the total asset values of the member firms, which were under differential regulations of the government, since 1991.[9] The press releases contain

9) There have been several changes in the criteria for designating chaebols that are subject to regulations, but the criteria remained mostly consistent throughout our sample period (1992-2003) except for the inclusion of public enterprises from 2002. Taking these changes into account, we focus on 30 largest private business groups (excluding public enterprises in 2002 and 2003) based on the total asset value of affiliated firms.

either the whole list of firms that are members of top 30 chaebol groups or changes in affiliated firms within each top 30 chaebol group compared to the previous year. By following the lists of chaebol firms based on the information provided by FTC, we can determine precisely firms that were chaebol members in a given year.

The changes in a firm's chaebol membership status could potentially affect the *Chaebol share* variable. However, the impact of these changes on *Chaebol share* variable is minor: most of the changes in chaebol status before the crisis were either the first or second case, which primarily happened among lower ranking business groups. The dominance of top 5 chaebols among the top 30 was prominent as discussed earlier, which implies that changes in chaebol status of affiliates of smaller chaebols had very small effects on the *Chaebol share*.

Our main source of plant-level data is annual Mining and Manufacturing Survey implemented by Statistics Korea.[10] In our sample period, this survey covered all plants located in Korea with at least 5 employees in mining and manufacturing industries according to the KSIC (Korean Standard Industrial Classification). As 99.9% of the plants in this population have complied with the survey in 1992-2003, we can assume that the observations in the survey are effectively the universe of Korean mining and manufacturing plants. Each observation in the micro data is a plant, which is distinct from a firm in the sense that a firm can have multiple plants. We will keep this distinction until we explain our data collection method and follow the convention of calling the entities in the data 'firms' in later sections. The survey provides a wide range of information on plants' business activities such as number of employees, sales, manufacturing costs, selling and management expenses, and value of tangible assets.

We fix the sample period from 1992 to 2003, as the survey data are available from 1992 and we want to consider periods of the same span before and after the 1997-1998 crisis.[11] To take full advantage of the rich micro

10) The micro data were accessed using remote access service from the MDIS (Microdata Integrated Service), which is operated by Statistics Korea.

data, we choose to use the industry classification up to 5-digit level (the finest level in KSIC). The industry classifications are converted to the 8th KSIC for all years following the concordance by Statistics Korea.[12] We focus on manufacturing plants and ignore mining plants.

In the micro data each plant is identified with its unique plant ID, but the plants are anonymous. This is a major challenge as we need to be able to distinguish plants that are owned by chaebol-affiliated firms in the micro data. Most of the previous research that has analysed chaebol's behaviour circumvents this obstacle by using other non-anonymous but less comprehensive data sets such as KIS VALUE.[13] We try to identify plants operated by chaebol members in our micro data by matching the basic information in the micro data with the information from various other sources. To the best of our knowledge, this has never been done; we consider the identification of chaebol plants in the anonymous micro data as one of the most novel aspects of our research.

In order to identify chaebol-affiliated manufacturing plants we use year and month of establishment, 5-digit KSIC industry codes, locations, and sales of firms. We collect these data for every chaebol-affiliated manufacturing plant from external data sources. First, we construct the list of chaebol manufacturing firms in each year during the sample period. We retrieve the names of chaebol-affiliated firms in every industry from the data by FTC.[14] From 2001 to 2003, the year and month of establishment and 2-digit KSIC

11) One concern with the sample period is that restricting the post-crisis period to 2003 might not unveil the long-run effects of the reform. Although this is a valid concern, we stick to our original sample period. If we extend the post-crisis period, it is more likely that the regressions capture the effects of the events other than the reform, making it hard to identify the pure effects of the reform.

12) The industry classifications from 1998 to 2003 and from 1992 to 1997 are based on the 8th KSIC and the 6th KSIC code, respectively.

13) KIS VALUE is the Korean data set provided by NICE, which is a firm that specializes in credit ratings for Korean firms. It offers information on private firms that must be audited by external examiners. By the current Korean law, firms whose assets are above 12 billion wons (around 10 million dollars) need to submit audit reports by external examiners. Thus, the coverage of KIS VALUE is much narrower than 'Mining and Manufacturing Survey'.

14) The press releases since 2001 can be found from the webpage of FTC (http://www.ftc.go.kr) and the press releases before 2001 can be found in KDI (Korea Development Institute) Economic Information Center (http://eiec.kdi.re.kr).

codes can be obtained from OPNI.[15] In order to get the 5-digit KSIC industry codes for each chaebol manufacturing firm, we use information provided by DART.[16] Based on OPNI and DART, we can acquire the year and month of establishment and the 5-digit KSIC code of a firm that was a chaebol member between 2001 and 2003. Moreover, we can extend this information to firm-year pairs that correspond to firms that were affiliated with chaebols from 2001 to 2003, since the date of establishment and industry code of a firm are time-invariant characteristics.[17] Locations and sales of firms can be found in annual business reports of each firm from DART.

For firms which were chaebol affiliates before 2000 but not after 2001, we can only recover the names of firms and the affiliated chaebol groups from FTC. Various sources of data have been utilized to gather the dates of establishment and the industry classifications of these firms. Our search started from DART and history section of the firm's website. If both of these sources had no relevant data, we attempted to collect the information from search engines. The most useful sources include past news articles from newspaper websites and basic firm information from online hiring websites. In this process, we could not find any information for less than 5% of all chaebol members.

Next, we set up firm-plant links for chaebol firms. The survey offers firm IDs for every plant only from 2002. Hence, spotting chaebol plants in 2002 and 2003 is straightforward if we match the plant ID and firm ID of each plant. For links before 2001, we check changes in each chaebol firm's plants using annual business reports from DART, history section of each firm's website and news articles to modify the links in 2002 and 2003.[18]

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15) OPNI (http://groupopni.ftc.go.kr) is the Korean website that provides detailed information on chaebol affiliated firms, including the name of each firm, the date of establishment, and its 2-digit KSIC (Korean Standard Industrial Classification) code. It is run by Fair Trade Commission.

16) DART (http://dart.fss.or.kr/) is the website operated by the Financial Supervisory Service that offers information on every listed and statutory audited firms in Korea. It shows the date of foundation, detailed industry codes of the goods and services that the firm produces.

17) In some cases, the same firm changed its KSIC code possibly due to the change of products. But the changes can be accommodated by considering the basic information of the firm for all years during the sample period, as described in the procedure for the identification exercises.

Whenever available, we compared sales of a firm from financial statements in DART with total sales of the firm in the micro data to ensure that they are the same. Exploiting these links allows accommodating both multiple plants and industry classifications that one firm can have, because the survey treats the plants separately if either a location of plants or an industry classification of product is different.

Along with identifying the firm-plant links, we apply the basic information to the micro data to discern chaebol-affiliated plants at the same time.[19] In practice, the most crucial variables for the identification were the year of establishment, 3-digit KSIC code, and location of the plant. The months of establishment and 5-digit KSIC codes that we obtained from other sources showed a lot of discrepancies with those in the micro data. To deal with these discrepancies and potential measurement errors more generally, we performed the identification exercise based on the basic information of the firm for all years during the sample period, not just for the year when the firm was a chaebol member. In this way, we can prevent the risk of failing to identify a chaebol member due to a measurement error in that specific year. In addition to checking the year of establishment, 3-digit KSIC code, and location of the plant, we matched the sales of a firm that the plant belonged to based on our firm-plant links to the sales of the firm from DART. We confirmed that we identified a chaebol-affiliated plant when its basic information fit these four variables. Having pinpointed the chaebol plants in the micro data, we calculate sales shares of chaebols in each industry for each year, by dividing the total sales of chaebol plants by the total sales of all plants.

The main dependent variables in our regressions are productivity (logarithms of industry-level average labour productivity and TFP), entry,

18) We cannot produce such links for chaebol firms that did not exist in 2002 or 2003 because their firm IDs are unknown. These are mainly firms that went out of business, were acquired or merged by other firms before 2001. For these firms, we can identify at most one plant per firm based on the basic information although it is possible that they owned multiple plants.

19) We cannot provide examples of our identification exercises in this part because it is forbidden by Korean law to reveal any information that could potentially infringe the confidentiality of the survey respondents.

exit, employment, capital stock, and markups. They are computed for each industry and year. The average labour productivity is defined by total real value added over total number of workers. Since the value added is in nominal terms, we divide it by the Producer Price Index for each 2-digit KSIC industry and year. We derive the TFP and markups based on the methodology of De Loecker and Warzynski (2012); see Appendix B for the detailed description.[20] We proxy entry and exit by the market share of entering and exiting plants. They are calculated by dividing the total sales of entering and exiting plants by total sales of all plants in the industry. The capital stock of a plant is the average of capital stock at the beginning and the end of each year.

The other important variable in our regressions is the number of patents. We use the Orbis Historical data set provided by Bureau van Dijk. We classify each Korean firm as chaebol affiliates and non-chaebol firms based on our previous list of chaebol firms and count the number of patents for chaebol and non-chaebol firms by the publication dates. We then aggregate the number of patents for all, chaebol, and non-chaebol firms by each year and industry. Since majority of the patents are owned by Korean firms that represent their industry classification by the US SIC (Standard Industrial Classification), we define industries by the ISIC Rev. 4.[21] We assume that the current owner of each patent was the one that was engaged in research for the patent at the time of publication. In the regressions we use the year-on-year change in the logarithm of the number of new patents that were published each year for all, chaebol, and non-chaebol firms.

20) We note that the TFP measure derived from their method is the TFPR, rather than the TFPQ, and the TFPR might contain some elements of markups. However, the dataset does not provide information on individual plant level data on quantity, so this TFPR measure is the best we can get from the available data.

21) 73.6% of the patents are owned by firms that represent their industry classification by the US SIC during our sample period. The rest are owned by firms whose main industry classification is the 9th KSIC.

3. Summary statistics

Table 2 shows the summary statistics of chaebol plants and industries with chaebol plants. Through the process described above, we eventually identified 2,058 chaebol manufacturing firm-year pairs in the micro data out of 2,620 firm-year pairs in the list that we constructed. The success rate of the identification for the entire sample period was 78.5%; this ratio is above 70% in every year. Chaebol plants have taken up around 0.4% of total number of plants, but their sales shares have amounted to 33.9% in the data, reflecting the strong influence of chaebols in Korean economy. 29% of the KSIC 5-digit industries have had chaebol plants for at least one year during the sample period, and the unweighted mean of chaebol sales share in these industries was 31.2%. Comparison with the chaebol sales share in all industries (33.9%) implies that chaebol plants have primarily operated in industries with larger plants. We should also note that the share of chaebols in industry sales increased before the crisis and declined only slightly after the crisis. Therefore, our results are not driven by major changes in market structure but by the change in conduct.

The summary statistics for the key variables are provided in Table 3. For each industry, we calculate these variables for all, chaebol, and non-chaebol plants within the industry. The table shows means and standard deviations of these industry level variables for all, chaebol, and non-chaebol plants before and after the crisis. Most of the variables have increased after the crisis except for the employment.

In the Appendix Table A1 and Figures A1-A2 we also present the evolution of labour productivity and total factor productivity before and after the crisis. We compare productivity data from the Mining and Manufacturing Survey that we use with the macroeconomic data from OECD. The latter cover the whole economy (unfortunately, OECD does not provide sectoral data) while our data only refer to the manufacturing firms; so the numbers differ. However, the general trends are qualitatively the same. In both datasets, labour productivity is 36-39% higher after the crisis than before the crisis, the change of total factor productivity is 16-21%, respectively. In both datasets TFP stagnates before the crisis; its growth accelerates after the crisis.

Table 2. Summary statistics of chaebol plants and industries with chaebol plants.

	1992–2003	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Chaebol firms and plants													
– Number of chaebol firms	2,620	229	238	233	232	236	279	269	239	163	178	162	162
– Number of chaebol firms identified in the micro data (% of total number of chaebol firms)	2,058 (78.5)	179 (78.2)	189 (79.4)	185 (79.4)	185 (79.7)	184 (78.0)	212 (76.0)	200 (74.3)	186 (77.8)	136 (83.4)	142 (79.8)	131 (80.9)	129 (79.6)
– Number of chaebol plants identified in the micro data (% of total number of plants in the micro data)	4,455 (0.39)	269 (0.35)	309 (0.34)	315 (0.34)	342 (0.35)	375 (0.38)	427 (0.46)	424 (0.53)	459 (0.50)	346 (0.35)	391 (0.37)	408 (0.37)	390 (0.34)
– Sales share of chaebol plants in all industries (%)	33.9	27.5	28.8	29.7	31.8	32.3	35.4	35.9	37.6	34.8	35.5	34.2	34.6
Industries with chaebol plants													
– Share of industries with chaebol plants(%)	29.0	22.9	24.8	26.5	26.7	29.4	30.7	29.6	31.4	28.2	30.9	34.2	32.6
– Mean of chaebol sales share in industries with chaebol plants (%)	31.2	32.1	32.2	33.8	34.4	31.5	32.7	31.6	30.9	29.8	29.7	28.5	28.9

Note: Industries are defined by the 8th KSIC, up to 5-digit.

Source: Authors' own calculation based on the data from OPNI, Fair Trade Commission, Mining and Manufacturing Survey, and various other data sources

Table 3. Summary statistics for selected variables in each industry level.

	Mean						Standard deviation					
	All plants		Chaebol plants		Non-chaebol plants		All plants		Chaebol plants		Non-chaebol plants	
	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
log (Labour productivity)	4.001	4.330	4.666	5.292	3.953	4.263	0.783	0.744	1.192	1.019	0.781	0.709
log (TFP)	0.949	1.027	0.983	1.040	0.948	1.026	0.237	0.219	0.304	0.286	0.236	0.217
Share of entering plants	0.121	0.196	0.005	0.014	0.120	0.190	0.118	0.173	0.031	0.058	0.115	0.164
Share of exiting plants	0.099	0.203	0.001	0.013	0.105	0.197	0.106	0.181	0.012	0.053	0.106	0.175
log (Employment)	7.899	7.795	6.600	6.042	7.795	7.700	1.372	1.419	1.650	1.770	1.362	1.421
log (Capital stock)	11.561	11.891	11.346	11.519	11.375	11.707	1.572	1.686	1.952	2.062	1.489	1.592
log (Number of new patents)	2.001	3.631	0.793	1.159	1.624	3.308	1.827	1.995	1.738	2.262	1.506	1.765
Markups	2.501	2.682	3.049	2.915	2.484	2.670	0.887	0.980	1.841	1.720	0.873	0.974

Notes: Mean and standard deviation were calculated after winsorising top and bottom 1% of each variable for the whole sample period, except for the log of total number of new patents. Industries are defined by the 8th KSIC, up to 5-digit, except for the log of total number of new patents where industries are defined by the ISIC Rev 4., up to 4-digit. Log of total number of new patents is calculated by log (1+Total number of new patents) to accommodate the 0's.

Source: Authors' own calculation based on the data from Mining and Manufacturing Survey and the Orbis Historical.

We also compare the evolution of our key variables of interest in Korean economy to those of selected comparator countries (Appendix Tables A2-1 to A2-5). OECD data on productivity imply that Korea has outperformed most comparators in terms of labour productivity growth and especially in terms of TFP growth (in particular, after the crisis). While before the crisis, entry and exit rates in Korean industry were higher but comparable to those in the US and UK (and higher than in other advanced economies), after the crisis, they have increased dramatically (from 12 to 20 per cent for entry rates, and from 10 to 20 per cent for exit rates, respectively) while in all comparator countries they remained stable or even declined. Korea has also outperformed comparators in terms of growth of patents: the average annual number of patents after the crisis more than quintupled (exp(1.73)=5.5) while in other countries the number of patents less than doubled.

Ⅴ. Main results

1. Entry, exit, productivity growth.

Tables 4-9 present our main results on firm dynamics and reallocation of production factors. In each table we consider the results for the whole sample (column 1), then for the subsample of chaebol firms (column 2), then for the subsample of non-chaebol firms in industries with non-trivial presence of chaebols (column 3), and the subsample for the non-chaebol firms in the industries with zero chaebol presence (column 4).[22)]

In Table 4 we consider the change in labour productivity. Labour productivity growth is substantial in all industries, and for both chaebol and non-chaebol

22) Industries with non-trivial presence of chaebols denote the industries that showed a positive sales share of chaebols for at least one year during the sample period (1992-2003). Industries with zero chaebol presence are the industries that had zero chaebol shares throughout the period. We compare the results for non-chaebol firms in industries with and without presence of chaebols to highlight the fact that they showed similar performance after the crisis when chaebol share is not accounted for, but that the difference mainly comes from the chaebol share in each industry.

Table 4. Firm dynamics: LP.

Dependent variable: log (Average Labour Productivity)				
	All firms	Chaebol firms	Non-chaebol firms in industries with non-trivial chaebol share	Non-chaebol firms in industries with zero chaebol share
Post Crisis	0.291*** (0.013)	0.471*** (0.085)	0.271*** (0.024)	0.269*** (0.015)
Post crisis × Average Chaebol share in the industry before the crisis	0.467*** (0.118)	0.509** (0.240)	0.489*** (0.115)	
# of Observations	5,181	1,493	2,492	2,688
# of Industries	473	226	227	246

Notes: The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for the second and third columns use industries that showed non-trivial Chaebol shares during the sample period (1992-2003), and the regression for the fourth column use industries that showed zero Chaebol shares during the sample period.

firms. As can be seen from the coefficients on the interaction terms, there is a stronger acceleration of labour productivity growth after the crisis in industries with higher pre-crisis chaebol shares, compared to those not dominated by chaebols before the crisis. This holds both for chaebol and non-chaebol firms; the post-crisis increase is large for chaebol firms.

In Table 5, we consider the total factor productivity. TFP increased after the crisis in all industries, both for chaebol and non-chaebol firms but the largest increase took place for non-chaebol firms in (previously) chaebol-dominated industries: the reforms of these industries did open up additional opportunities for non-chaebol firms. This was not the case for the chaebol firms whose total factor productivity increased after the crisis, but the increase was the same in the industries with higher and lower pre-crisis share of chaebols.

The magnitudes of the effects are substantial. The average Chaebol share before the crisis was 0.32; therefore, the post-crisis increase in TFP of non-chaebol firms would be 2 percentage points higher in industries that originally had chaebol presence (0.061*0.32=0.02).[23] This implies that the non-chaebol firms in industries with a greater exposure to the 1998 competitive

Table 5. Firm dynamics: TFP.

Dependent variable: log (Total Factor Productivity)				
	All firms	Chaebol firms	Non-chaebol firms in industries with non-trivial chaebol share	Non-chaebol firms in industries with zero chaebol share
Post Crisis	0.074*** (0.002)	0.066*** (0.007)	0.077*** (0.004)	0.070*** (0.003)
Post crisis × Average Chaebol share in the industry before the crisis	0.062*** (0.024)	−0.012 (0.018)	0.061** (0.029)	
# of Observations	4,705	1,316	2,260	2,439
# of Industries	473	218	227	246

Notes: The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for the second and third columns use industries that showed non-trivial Chaebol shares during the sample period (1992-2003), and the regression for the fourth column use industries that showed zero Chaebol shares during the sample period.

reforms had TFP growth about one and a quarter times as fast as those in the industries which initially had no chaebol presence (and therefore were not directly affected).[24]

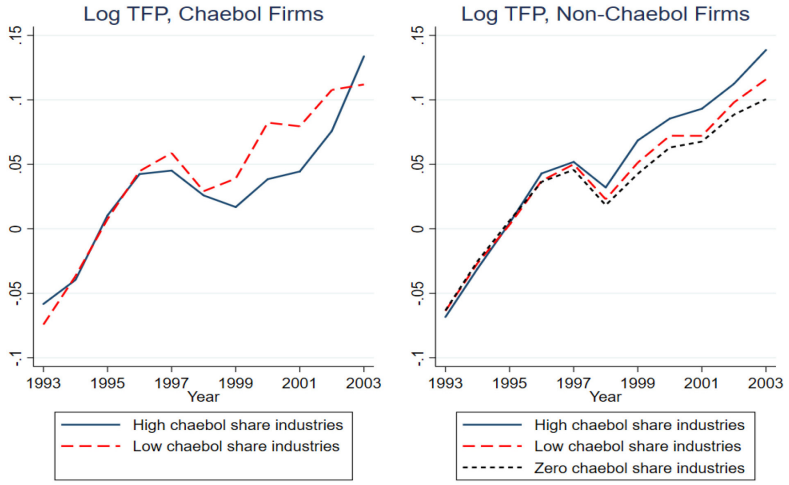
In Figure 1, we show that the results are not driven by pre-trends. Before the crisis, total factor productivity of non-chaebol firms in industries with zero, low or high chaebol share were growing in sync. After the crisis, these were the industries with high pre-crisis chaebol share that experienced much faster chaebol share.

In Table 6 we compare entry before versus after the crisis. We see a substantial increase in entry after the crisis across all industries, although this increase in entry was lower in chaebol-dominated industries. The magnitudes are again

23) The comparison is similar if we compare the industries with a one standard deviation difference in Chaebol share. The within-year standard deviation of Chaebol share in our dataset is very stable across the years ranging from 0.24 to 0.28; the average within-year standard deviation is 0.26 both before and after the crisis. The magnitude of the effect is therefore 0.061*0.26=0.016.

24) The average change in TFP for non-chaebol firms in the industries with the presence of chaebols are also faster than those of chaebol firms. For the chaebol firms the average effect is 0.066+0.32*(-0.012)=0.062 while for the non-chaebol firms in these industries the effect is 0.077+0.32*0.061=0.097.

Figure 1. Logarithm of total factor productivity (TFP) in chaebol and non-chaebol Firms in industries with high, low and zero chaebol share.



Notes: The figures are logarithms of averages of each industry's TFP for chaebol and non-chaebol firms, after winsorising top and bottom 1% for the whole sample period in each industry categories. Industries are classified by the average 1992-97 chaebol share: high (above median), low (below median), and zero. Industry-level log TFPs are normalized by 1992-97 average = 0. The median average chaebol share in 1992-97 is 0.20.

Table 6. Firm dynamics: Entry.

Dependent variable: Share of entering firms				
	All firms	Chaebol firms	Non-chaebol firms in industries with non-trivial chaebol share	Non-chaebol firms in industries with zero chaebol share
Post Crisis	0.081*** (0.005)	0.014*** (0.003)	0.061*** (0.007)	0.080*** (0.007)
Post crisis × Average Chaebol share in the industry before the crisis	−0.071** (0.028)	−0.025** (0.010)	−0.034 (0.021)	
# of Observations	4,713	2,268	2,268	2,352
# of Industries	473	227	227	245

Notes: This table uses the data for the entry of plants, not of firms. The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for the second and third columns use industries that showed non-trivial Chaebol shares during the sample period (1992-2003), and the regression for the fourth column use industries that showed zero Chaebol shares during the sample period.

substantial. Given that the average Chaebol share is around 0.32, the industries with chaebol presence have 2 percentage point less entry after the crisis (which amounts to about a quarter of all increase in entry). In this sense, the reforms did not completely remove barriers to entry in chaebol-dominated industries. However, we do find that after the crisis the increase in entry was much higher for non-chaebol firms than for chaebol firms (whether in chaebol-dominated industries or in other industries).[25] Virtually all increase in entry after the crisis is driven by increase in entry of non-chaebol firms.

In Table 7 we see that exit also increased after the crisis. The change in exit was different in industries previously dominated and not dominated by chaebols. The post-crisis increase in exit rates of non-chaebol firms from chaebol-dominated industries was significantly smaller than in other industries;

Table 7. Firm dynamics: Exit.

Dependent variable: Share of exiting firms				
	All firms	Chaebol firms	Non-chaebol firms in industries with non-trivial chaebol share	Non-chaebol firms in industries with zero chaebol share
Post Crisis	0.111*** (0.006)	0.011*** (0.003)	0.075*** (0.008)	0.108*** (0.008)
Post crisis × Average Chaebol share in the industry before the crisis	−0.086*** (0.025)	0.007 (0.008)	−0.055** (0.021)	
# of Observations	4,715	2,267	2,267	2,261
# of Industries	473	227	227	245

Notes: This table uses the data for the exit of plants, not of firms. The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for the second and third columns use industries that showed non-trivial Chaebol shares during the sample period (1992-2003), and the regression for the fourth column use industries that showed zero Chaebol shares during the sample period.

25) We previously noted that we are treating plants in the micro data as 'firms.' However, entry and exit of firms are different from entry and exit of plants. For example, if a non-chaebol, continuing firm opened 3 new plants, there is no entry of firm but there is entry of plants. Therefore, we note that Tables 6 and 7 technically show the entry and exit of 'plants.' We thank the anonymous referee for pointing this out.

this is natural as there were fewer non-chaebol firms in those industries to start with. As well as in the case of entry, the increase in exit rates after the crisis is fully explained by the increase in exit of non-chaebol firms.

Increase in both entry and exit after the crisis points to lower barriers to entry and exit; this was the main objective of the reforms. Have the increased exit rates helped removing least productive firms from the market? As we show in Appendix Tables A3-1 and A3-2, on average, less productive firms are more likely to exit; this relationship is much stronger after the crisis. This finding is consistent with the view that the reforms did succeed in promoting competition. We also find that this result is mostly explained by non-chaebol firms in industries that were formerly dominated by chaebols – again, in line with our main argument.

In Tables 8 and 9 we compare the evolution of employment and capital stock between before and after the crisis. Consistent with the secular trend of reallocation of labour from manufacturing to services, employment declined in all industries. However, in the industries previously dominated by chaebols, there is a much faster decline in chaebol firms and no decline in non-chaebol

Table 8. Firm dynamics: Employment.

Dependent variable: log (Employment)				
	All firms	Chaebol firms	Non-chaebol firms in industries with non-trivial chaebol share	Non-chaebol firms in industries with zero chaebol share
Post Crisis	−0.108*** (0.027)	−0.090 (0.123)	−0.137*** (0.039)	−0.155*** (0.038)
Post crisis × Average Chaebol share in the industry before the crisis	−0.042 (0.136)	−0.624** (0.293)	0.481** (0.238)	
# of Observations	5,184	1,501	2,492	2,690
# of Industries	473	226	227	246

Notes: The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for the second and third columns use industries that showed non-trivial Chaebol shares during the sample period (1992-2003), and the regression for the fourth column use industries that showed zero Chaebol shares during the sample period.

firms. We also find that the non-chaebol firms in industries previously dominated by chaebols enjoy much faster capital accumulation.[26] These results are consistent with the view that the reforms resulted in reallocation of capital and labour from chaebols to independent firms and complement our findings on TFP: the reforms resulted both in moving factors of production from chaebol to non-chaebol firms and in making the use of these factors more efficient.[27]

Table 9. Firm dynamics: Capital.

Dependent variable: log (Capital stock)				
	All firms	Chaebol firms	Non-chaebol firms in industries with non-trivial chaebol share	Non-chaebol firms in industries with zero chaebol share
Post Crisis	0.310*** (0.031)	0.584*** (0.144)	0.268*** (0.054)	0.195*** (0.043)
Post crisis × Average Chaebol share in the industry before the crisis	0.170 (0.188)	−0.568 (0.355)	1.089*** (0.396)	
# of Observations	5,184	1,499	2,491	2,690
# of Industries	473	226	227	246

Notes: The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for the second and third columns use industries that showed non-trivial Chaebol shares during the sample period (1992-2003), and the regression for the fourth column use industries that showed zero Chaebol shares during the sample period.

26) These results are not directly related to firm size as these are the total employment (or capital) by chaebol and non-chaebol firms in the industry, not the average size per chaebol firm or non-chaebol firm in the industry. In Tables A4-1 and A4-2 we report results of specifications with average employment per firm and average capital stock per firm in the industry as dependent variables. The results are consistent with our argument. Indeed, both chaebol and non-chaebol firms lose employment but the effect for the non-chaebol firms is less negative (or even positive) in firms with higher pre-crisis share of chaebol firms. Jointly Table 8, Tables A4-1 and A4-2 show that reallocation of labour from chaebol to non-chaebol firms takes place not only (and mostly not) through the growth of non-chaebol firms but through the increase in number of small non-chaebol firms. The results for capital are similar with the difference that capital per firm has increased for all categories of firms (but the increase was again much larger for non-chaebol firms in industries with higher pre-crisis chaebol share).

27) In order to check that our results are not driven by firm size, we run additional tests including the interaction of the average size of firms within the industry before the crisis with the post-crisis time dummy (the impact of industry-specific average size variable itself is absorbed by industry fixed effects). The results do not change (see the Appendix Tables A5-4 to A5-7 and A6-4 to A4-7).

2. Patents

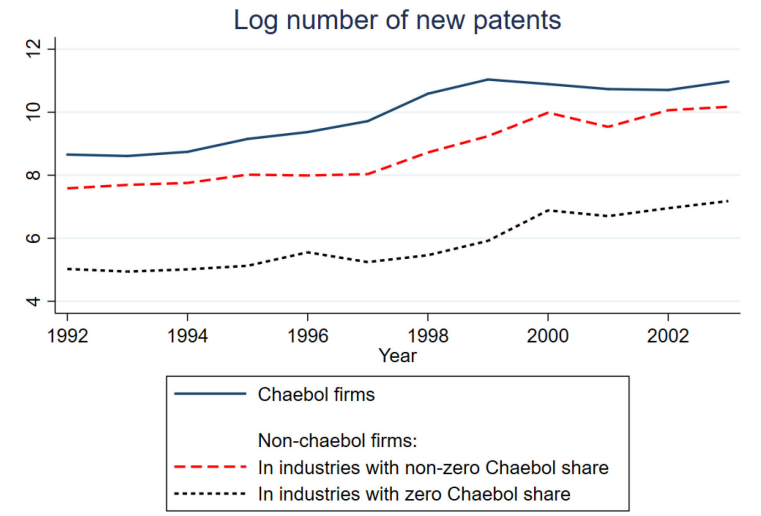
In addition to the analysis of productivity, we also study firms' patenting activity. The results are presented in Table 10. The sample is much smaller due to a different industry classification and to the fact that only 128 industries had non-trivial patenting activity (including only 97 industries with pre-crisis chaebol presence). In these industries, patenting activity has been growing steadily both before and after the crisis (Figure 2). In order to detrend the data, we use first differences in logarithms of the number of patents as a dependent variable. We find that for the full sample of firms, the growth in patents has accelerated after the crisis; however, this acceleration was much slower in chaebol firms. As the second, third and fourth columns show, the results for the whole sample mask an important heterogeneity between chaebol and non-chaebol firms. Among the non-chaebol firms, the post-crisis increase in annual patent growth rate was 22-26 percentage points per year, there was a major acceleration in patent growth after the crisis, both in industries without and with chaebol presence (the difference is not significant). As for the chaebol firms, there is no significant increase in patent growth after the crisis; in an

Table 10. Firm dynamics: Growth of patents.

Dependent variable: Growth of patents				
	All firms	Chaebol firms	Non-chaebol firms in industries with non-trivial chaebol share	Non-chaebol firms including industries with zero chaebol share
Post Crisis	0.242*** (0.038)	0.215 (0.167)	0.220*** (0.054)	0.260*** (0.044)
Post crisis × Average Chaebol share in the industry before the crisis	−0.498*** (0.133)	−0.743*** (0.223)	−0.086 (0.289)	−0.187 (0.259)
# of Observations	1,034	285	763	981
# of Industries	125	46	94	124

Notes: Industries are defined by the ISIC Rev. 4, up to 4-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for the second and third columns use industries that showed non-trivial Chaebol shares during the sample period (1992-2003).

Figure 2. Patenting activity in chaebol and non-chaebol firms.



Notes: The figures are logarithms of number of patents in each industry for chaebol and non-chaebol firms.

average industry (with chaebol share in sales at 0.32), the post-crisis change in patent growth rates in chaebol firms is actually negative ($0.215-0.743*0.32=-0.02$) but not statistically significant.

What is the mechanism of fast growth of patenting of non-chaebol firms? Did they substantially increase investment in research and development (R&D) or did they switch to a different kind of innovations (from incremental innovations that are usually not patented to breakthrough ones that need to be patented)? In order to answer this question, one needs firm-level data on R&D expenditures. Unfortunately, we have not been able to locate such data. However, in Figure A3 we present the evolution of aggregate R&D spending broken down into R&D by large firms and R&D by small and medium-sized firms. The large firms did outperform the smaller ones before the crisis but after the crisis the situation has completely changed – R&D spending was growing much faster among smaller firms. This suggestive evidence is consistent with our findings from disaggregated data.

3. Markups

In Figure 3 we show the evolution of markups for chaebol and non-chaebol firms in industries with pre-crisis chaebol share above and below its median. There are three major takeaways from these graphs. First, all Korean manufacturing industries had very high markups (ranging from 2.4 to 3.6). Second, the chaebol firms had much higher markups before the crisis than their non-chaebol counterparts. Finally – consistent with our story – the markups of chaebol firms were increasing before the crisis but dramatically decreased after the crisis. The decrease in markups was larger for chaebol firms in industries with higher pre-crisis chaebol presence.

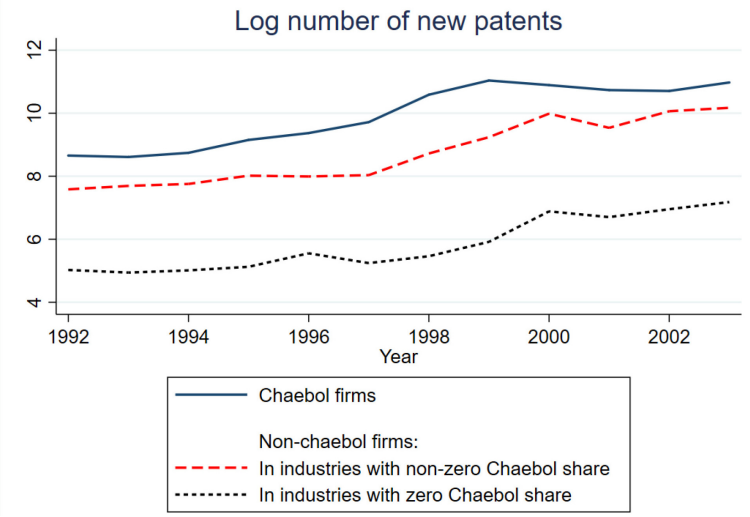
Table 11 presents the regression results for markups, separately for chaebol and non-chaebol firms. We find that markups of non-chaebol firms slightly increased after the crisis across all industries. There is no difference between the increase in markups between industries with high and low chaebol presence. Consistent with Figure 3, we find that markups of chaebol firms significantly decreased; this decrease was driven by the industries with higher pre-crisis

Table 11. Firm dynamics: Markups.

	All industries			
	Chaebol	Non-Chaebol	Chaebol	Non-Chaebol
Post Crisis	−0.236*** (0.064)	0.182*** (0.020)	−0.066 (0.111)	0.187*** (0.024)
Post crisis × Average Chaebol share in the industry before the crisis			−0.511** (0.219)	−0.029 (0.092)
# of Observations	1,316	2,260	1,316	2,260
# of Industries	218	227	218	227
	Industries above the median Chaebol share		Industries below the median Chaebol share	
Post Crisis	−0.343*** (0.076)	0.177*** (0.038)	−0.071 (0.110)	0.189*** (0.032)
# of Observations	677	774	499	770
# of Industries	78	78	77	77

Notes: The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. The regressions for all industries use industries that showed non-trivial Chaebol shares during the sample period (1992-2003). The industries above and below the median Chaebol share are based on the median of each industry's Chaebol sales share before the crisis (1992-1997). Markups are calculated using Cobb-Douglas production function and the endogenous productivity process.

Figure 3. Mean markups of chaebol and non-chaebol firms by industry categories.



Notes: The figures are means of each industry level average markup for chaebol and non-chaebol firms, after winsorising top and bottom 1% for the whole sample period in each industry categories. Industries are classified by the average 1992-97 chaebol share: high (above median), low (below median), and zero.

chaebol share (which were most affected by the reforms).

Why did markups increase after the crisis in the non-chaebol firms? The first potential explanation could be a survivor bias – the firms with high markups could be more likely to survive the crisis. In Table 12 we present results for the subsample of surviving firms. If the increase in markups were fully due to the survivor bias, we should have observed zero increase of markups for surviving firms. This is not what we find in Table 12. While coefficients are smaller (so there is certain survivor bias), they are still qualitatively similar to those in Table 11. The crisis has indeed resulted in higher markups for surviving non-chaebol firms.

The other explanation is the high innovation activity of these firms. As shown in the previous section, the non-chaebol firms did increase patenting after the crisis in all industries – which is consistent with the post-crisis increase in their markups.

Table 12. Firm dynamics: Markups (Surviving firms).

	All industries			
	Chaebol	Non-Chaebol	Chaebol	Non-Chaebol
Post Crisis	−0.258*** (0.069)	0.137*** (0.023)	−0.126 (0.117)	0.136*** (0.029)
Post crisis × Average Chaebol share in the industry before the crisis			−0.411* (0.240)	0.008 (0.116)
# of Observations	1,155	2,242	1,155	2,242
# of Industries	174	226	174	226
	Industries above the median Chaebol share		Industries below the median Chaebol share	
Post Crisis	−0.347*** (0.085)	0.141*** (0.044)	−0.127 (0.115)	0.144*** (0.030)
# of Observations	615	762	481	770
# of Industries	71	78	75	77

Notes: The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Industry fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each industry level and given in parentheses. Surviving firms denote firms that first appeared in the sample during 1992-1997, last appeared during 1999-2003, and appeared for at least 3 years. The regressions for all industries use industries that showed non-trivial Chaebol shares during the sample period (1992-2003). The industries above and below the median Chaebol share are based on the median of each industry's Chaebol sales share before the crisis (1992-1997). Markups are calculated using Cobb-Douglas production function and the endogenous productivity process.

Ⅵ. Additional results and robustness checks

In this section, we check the robustness of our results. In our baseline specifications we analyse the changes in productivity and other characteristics separately for subsamples of chaebol and non-chaebol firms. We have also run regressions with pooled data with two observations per industry-year: one for the aggregate characteristics for all chaebol firms in this industry and the other one for all non-chaebol firms in the industry. We have included industry fixed effects and clustered standard errors at the industry levels. The results are presented in Tables A7-1 and A7-2; they are very similar in terms of signs, magnitudes and statistical significance to respective results in Tables 4, 5, 8, 9, 11, and 12. The main variable of interest is the coefficient at the triple interaction term between $Post\ crisis_t$ time period dummy, the pre-crisis average share of chaebols in the industry $Chaebol\ share_i$,

and the *Chaebol* dummy (which takes the value of 1 for chaebol firms and 0 for non-chaebol firms). This coefficient is negative in most specifications: the non-chaebol firms have gained more from reforms in those industries with the larger impact of reforms. The coefficient is not significant for labour productivity and for markups of surviving firms (similar to the lack of significant difference between the effects on chaebols and non-chaebols in Tables 4 and 12). However, the coefficient is large in magnitude and significant in regressions for TFP, employment, capital, and markups for the full sample (again, in line with the results in Tables 5, 8, 9, 11).[28)]

In Table 13, we reproduce our results using firm-level rather than industry-level observations. We pool all firm-level observations and estimate the following relationship:

Table 13. Plant-level pooled regressions.

	Labour productivity	TFP	Entry	Exit	Employment	Capital	Markups
Post Crisis	0.198*** (0.002)	0.054*** (0.000)	−0.201*** (0.001)	0.245*** (0.001)	−0.107*** (0.003)	0.206*** (0.005)	0.208*** (0.005)
Chaebol dummy	−0.084* (0.049)	−0.010** (0.005)	−0.085*** (0.015)	0.067*** (0.014)	0.213*** (0.045)	0.163** (0.071)	0.071 (0.073)
Post crisis × Chaebol dummy	0.254*** (0.047)	0.014*** (0.004)	0.137*** (0.013)	−0.187*** (0.012)	−0.185*** (0.042)	−0.062 (0.066)	−0.318*** (0.069)
Post crisis × Average Chaebol share in the industry before the crisis	0.584*** (0.020)	0.117*** (0.004)	0.035*** (0.007)	−0.005 (0.010)	0.192*** (0.019)	0.310*** (0.035)	−0.203*** (0.030)
Chaebol dummy × Average Chaebol share in the industry before the crisis	0.305** (0.131)	0.086*** (0.015)	−0.048 (0.041)	0.121*** (0.032)	−0.152* (0.089)	0.306** (0.138)	0.642*** (0.191)
Post crisis × Chaebol dummy × Average Chaebol share in the industry before the crisis	−0.513*** (0.112)	−0.122*** (0.012)	−0.047 (0.031)	−0.018 (0.026)	0.201*** (0.077)	−0.342*** (0.121)	−0.139 (0.147)
# of Observations	1,054,728	669,626	984,219	946,452	1,056,957	1,054,990	669,491
# of Firms	378,938	222,969	364,438	354,146	379,509	378,336	222,931

Notes: Entry and exit are dummy variables. The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Plant fixed effects and the constant term are included in the regressions. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively. Standard errors are clustered in each plant level and given in parentheses.

28) We have also run the respective specifications with twice as many fixed effects including fixed industry times chaebol dummy. These results (available upon request) are very similar in sign, magnitude and statistical significance to those in Tables A7-1 and A7-2; all coefficients at the triple interaction term are negative; the coefficients for TFP, employment, capital, and markups in the full sample are negative and significant.

$$Y_{fit} = \alpha_i + \beta_1 Post\,crisis_t + \beta_2 Chaebol_{ft} + \beta_3 (Chaebol_{ft} \times Post\,crisis_t) + \beta_4 (Chaebol\_Share_i \times Post\,crisis_t) + \beta_5 (Chaebol_{ft} \times Chaebol\_Share_i) + \beta_6 (Chaebol\_Share_i \times Chaebol_{ft} \times Post\,crisis_t) + u_{it}$$

where f, i, t index firms, industries and years, respectively.[29] $Chaebol_{ft}$ is a dummy for firm f being a member of a chaebol at year t.

The results are similar to the ones at the industry level. For example, consider the second column where the dependent variable is total factor productivity. The TFP of non-chaebol firms increased after the crisis in all industries but especially so in industries that were previously dominated by chaebols. The increase in TFP in industries with zero pre-crisis chaebol share was only 5.4 percent; in industries with average chaebol presence (0.32) the increase was $5.4+11.7*0.32=9.1$ percent. This increase was significantly smaller in chaebol firms: in an industry with average chaebol presence the increase was only $5.4+1.4+(11.7-12.2)*0.32=6.6$ percent.

In addition to studying the pooled firm-level data, we also carry out a firm-level difference-in-differences analysis where for each firm we compare the average productivity before and after the crisis.[30] The results are reported in Tables 14 and 15 for labour productivity and TFP, respectively. The results are similar in terms of signs, magnitudes and statistical significance to those in Tables 4 and 5.

We have also checked alternative rankings of industries with respect to expected impact of reforms. In our main specification (1), we analyse the impact of reforms on industries depending on the pre-crisis share of chaebols in industry sales. In Tables A8-4 to A8-11, we use the interaction between the post-crisis dummy with the average pre-crisis relative productivity of chaebol firms (vs. non-chaebol firms) in the industry. One can assume that after the crisis, the non-chaebol firms would gain more in industries with less efficient chaebol firms; in these industries pro-competitive reforms would open up more

29) Again, we note that we are calling the entities in the micro data 'firms' but they are actually plants. Therefore, tables 13 to 15 show the regression results using plant-level data.

30) We cannot estimate a panel regression with firm-level fixed effects as the number of observations is too large.

Table 14. Plant-level difference-in-differences regressions: the difference of logarithm of average labour productivity between pre-crisis and post-crisis for each plant.

	All plants	Chaebol plants	Non-chaebol plants
Average Chaebol share in the industry before the crisis	0.605*** (0.141)	-0.007 (0.207)	0.644*** (0.166)
Constant	0.239*** (0.013)	0.535*** (0.067)	0.232*** (0.013)
# of Observations	8,455	285	8,170

Notes: These regressions use data of the plants that are present in all years during the sample period. The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Standard errors are clustered in each industry level and given in parentheses. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively.

Table 15. Plant-level difference-in-differences regressions: the difference of logarithm of average total factor productivity between pre-crisis and post-crisis for each plant

	All plants	Chaebol plants	Non-chaebol plants
Average Chaebol share in the industry before the crisis	0.070*** (0.025)	-0.011 (0.020)	0.093*** (0.030)
Constant	0.069*** (0.003)	0.079*** (0.007)	0.069*** (0.003)
# of Observations	7,293	260	7,033

Notes: These regressions use data of the plants that are present in all years during the sample period. The regressions were run after winsorising top and bottom 1% of each dependent variable for the whole sample period. Industries are defined by the 8th KSIC, up to 5-digit. Standard errors are clustered in each industry level and given in parentheses. ***, **, and * represent that coefficients are statistically significant at 1%, 5%, and 10 % level, respectively.

opportunities for non-chaebol firms. However, there may also be a countervailing effect: if the chaebols are more productive to start with, it is easier for non-chaebol firms to learn from chaebols hence accelerating their productivity. Results presented in Tables A8-4 to A8-11 show that the second effect dominates: in all specification, the higher pre-crisis relative TFP of chaebol firms (vs. TFP of non-chaebol firms) predicts a decline in TFP (and other outcomes) of chaebol firms and increase in TFP (and other outcomes) of non-chaebol firms. We interpret the negative impact for chaebol firms as a usual regression to the mean (which is essentially similar to the learning effect

– it is easier for the relatively lagging chaebol firms to catch up). The only exception is the impact of pre-crisis relative chaebol TFP on markups: here the more productive the chaebol firms were before the crisis, the slower was the growth in markups of non-chaebol firms. However, this effect is smaller in magnitude than the one on markups of chaebol firms. In the industries with more efficient chaebol firms to start with, the non-chaebol firms increase their markups after the reforms but at a slower pace than their chaebol counterparts.

Our results are also robust to controlling for the presence of chaebols not just in a given industry but also in specific regions or size categories. The former allows us to control for potential preferential treatment of chaebols in certain regions. The latter regards lower cost of capital of larger firms. As there are strong correlations between industry affiliation, size and geographical location of chaebols firms, we have run a "horse race" between the chaebol shares in the industry, in the region, and in the size category – by including (on top of the post-crisis dummy and the post-crisis × chaebol share in the industry interaction term) two additional interaction terms: post-crisis × chaebol share in the region and post-crisis × chaebol share in the size category. The results are reported in the Appendix Tables A9-4 to A9-12. The coefficients on the interaction terms for post-crisis × chaebol share in the industry for labour productivity and TFP of non-chaebol firms (as well as for all firms) remain positive and significant.

In addition to our main results on annual patent growth rates, we also estimate a specification for levels of logarithm of patents controlling for the linear time trend. The results (presented in Table A10-1) are similar. Before the crisis, chaebol firms had a slightly faster growth of patenting activity over time than their non-chaebol counterparts (9 percent vs. 8 percent per year, respectively). However, after the crisis the situation has changed. Chaebol firms' patenting growth after the crisis slowed down to zero. Also, for the chaebol firms there is no upward shift after the crisis (the coefficient at the Post Crisis dummy is very small and is not significantly different from zero). On the contrary, the results for the non-chaebol firms show both upward shift and a positive change in the slope of the time trend. The slope

of the time trend increases from 8 percent per year before the crisis to 19 percent per year after the crisis; the difference is statistically significant. There is also a 2.5-fold jump in the level of patenting activity of non-chaebol firms after the crisis (the coefficient at the Post Crisis dummy ranges from 0.85 to 0.95; exp(0.9)=2.5).

In Table A10-2, we examine the heterogeneity of these results with regard to the share of chaebol firms in the industry before the crisis. We add an interaction of the Chaebol share with the linear time trend, with the post crisis dummy, and the triple interaction of the Chaebol share with the dummy and the trend. For the non-chaebol firms, the coefficients at the interactions of Chaebol share with the post crisis dummy and the triple interaction are positive (thus in line with the conjecture that the results are stronger in industries previously dominated by chaebols); they are however not significant, likely due to a small sample size. There are however interesting findings for the chaebol firms (and therefore for the whole sample). Before the crisis was a faster growth of patenting activity by chaebol firms in industries dominated by chaebols (the coefficient at the interaction of Chaebol share with time trend is positive and statistically significant). However, after the crisis this effect was actually fully reversed: the coefficient at the triple interaction is negative, significant and larger in magnitude than the coefficient before the crisis. Therefore, after the crisis, chaebol firms in industries previously dominated by chaebols had slower growth in patenting activity than before the crisis.

In order to check that our results are robust to industry classification, we have re-run our main regressions using either 4-digit KSIC codes or 3-digit ISIC Rev.4 codes. The results–presented in the Appendix Tables A11-4 to A11-12–are qualitatively the same.

Our results are generally robust to alternative within-industry weighting of firms for calculating industry-specific dependent variables (Appendix Tables A12-4 to A12-12). For example, in our main specification (Table 4), labour productivity is defined as the total value added of all firms in the industry divided by total number of workers of all firms in the industry. The

Appendix Table A12-4 shows that the results remain the same if we use a simple unweighted average of firm-level labour productivities.

Ⅶ. Concluding remarks

In this paper we analysed firm dynamics in Korea before and after the 1997-98 Asian crisis and pro-competitive reforms that reduced the dominance of chaebols. We found that in industries that were dominated by chaebols before the crisis, labour productivity and TFP of non-chaebol firms increased markedly after the reforms (relative to other industries). The increase in TFP after the crisis was especially large for non-chaebol firms in (previously) chaebol-dominated industries.

Furthermore, we found that entry of non-chaebol firms increased significantly in all industries after the reform – while the markups of chaebol firms declined substantially (especially in the industries previously dominated by chaebols). Finally, after the crisis, the non-chaebol firms also significantly increased their patenting activity (unlike the chaebol firms where patenting stagnated). These results are in line with a neo-Schumpeterian view of a transition from investment-based growth to more innovation-based growth as the crisis weakened chaebols' power and opened a window of opportunity for pro-competitive reforms.

Online Appendix: Available at http://sites.google.com/view/kangchuljo.

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<Abstract in Korean>

대기업집단과 한국의 기업 동학

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본 논문은 사업장 단위 미시자료를 이용하여 외환위기 이후 우리 경제가 투자 주도 성장(investment-based growth)에서 혁신 주도 성장(innovation-based growth)으로 전환하였음을 엄밀하게 검증하였다. 분석 결과 외환위기 이전 재벌기업의 매출액 비중이 높았던 산업에서 외환위기 이후에 비재벌기업의 총요소생산성(total factor productivity)이 더욱 크게 상승한 반면 재벌기업의 총요소생산성에는 변화가 없었던 것으로 나타났다. 또한 모든 산업에서 비재벌기업의 진입과 신규 특허 건수가 증가하였다. 아울러 재벌기업의 이윤율이 외환위기 이후 하락했으며 특히 위기 이전 재벌 매출액 비중이 높았던 산업에서 그 추세가 더욱 뚜렷하였다. 이러한 분석 결과는 외환위기 이후 우리 경제에서 혁신의 역할이 중요해졌음을 실증적으로 뒷받침한다.

핵심 주제어: 혁신 주도 성장, 재벌, 외환위기

JEL Classification: O43, L25

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한국은행 경제연구원에서는 Working Paper인 『BOK 경제연구』를 수시로 발간하고 있습니다. 『BOK 경제연구』는 주요 경제 현상 및 정책 효과에 대한 직관적 설명 뿐 아니라 깊이 있는 이론 또는 실증 분석을 제공함으로써 엄밀한 논증에 초점을 두는 학술논문 형태의 연구이며 한국은행 직원 및 한국은행 연구용역사업의 연구 결과물이 수록되고 있습니다.
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