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ON THE CONVERGENCE OF PRODUCTIVITY BETWEEN LARGE ENTERPRISES AND SMEs*

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The Schumpeterian growth model by Aghion and Howitt is used to test convergence in productivity between small and large firms for Korea and EU countries. For Korea, convergence in productivity between Small and Medium‐sized Enterprises (SMEs) and Large Enterprises (LEs) exists in the sense that the productivity gap in the previous year between SMEs and LEs causes an increase in the productivity of SMEs this year. But there is no convergence in case of EU countries. Despite of convergence, the productivity gap between SMEs and LEs gets larger because the productivity improvement of LEs in the current period is bigger than that of SMEs. To make SMEs more productive, the Korean government needs to focus on the transfer of technology from LEs to SMEs.

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Keywords: Small and Medium-sized Enterprises, Large Enterprises, Labor Productivity, Convergence

I. INTRODUCTION

In Korea, polarizations in various sectors have proceeded. Recent globalization and technological development have aggravated polarization

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at least for short run since these changes benefit primarily those who are more competitive. A major instance of polarization is the widening labor productivity gap in manufacturing industries between small and medium-sized enterprises (SMEs) and large enterprises (LEs) since the early 1990s. The relative productivity of SMEs compared to LEs is falling continuously.

Considering the fact that the productivity difference between SMEs and LEs has been one of the main foci in the literature of small enterprises in Korea, it is surprising that there has not been much study on the convergence between SMEs and LEs.

Hence, we turn to the literature of convergence of per capita income among countries to understand the future of widening gap in the productivity between SMEs and LEs.

Convergences in per capita income among countries are demonstrated by Barro and Sala-i-Martin (1995). When the differences in the schooling level, savings rate, population growth and/ or human capital among countries are controlled, there is convergence in per capita income among countries. Poor countries tend to grow faster.

It will be also interesting to investigate the convergence between SMEs and LEs in countries other than Korea. For comparability and data availability, the European Union (EU) countries are chosen as cases of other countries.

LEs in Korea did not have high technologies in the beginning, but acquired those from abroad. As they obtained foreign technology, they also improved the imported technology to adjust to their circumstances. It is the process that SMEs could increase their productivities by learning from the entities with higher technologies. This implies that the government needs to focus more on the transfer of large firms' know-how to small firms.

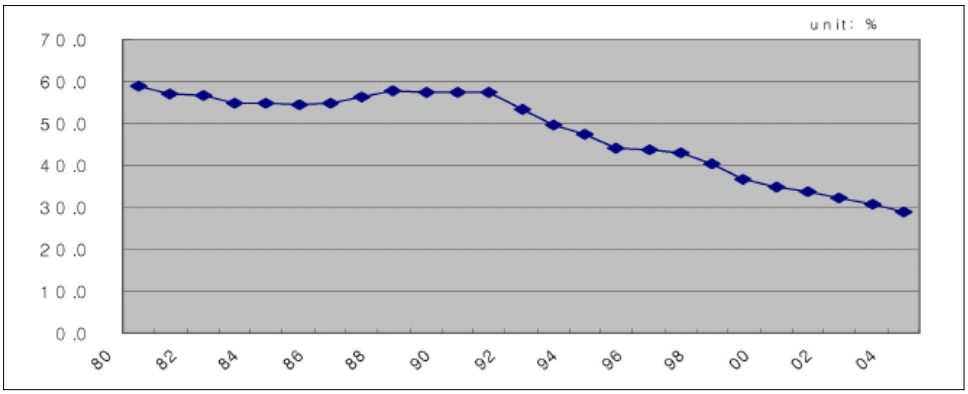
This study is directly related to the literature of convergence in per capita income among countries in bringing up the importance of the technology spill-over from the entities with more advanced technology to the entities with lower technology.

One of the reasons that there are not much research into the question of convergence between SMEs and LEs is lack of data on SMEs. In this

research, the Census Survey of the Mining and Manufacturing Industries of Korea will be used to derive labor productivities of SMEs and LEs.

The seriousness of the problem of widening productivity gap between LEs and SMEs in Korea is represented in Figure 1.

[Figure 1] Ratio of the Labor Productivities of SMEs over LEs in Korean Manufacturing Industries



Source: Korea Small Business Institute

The graph above is made out of the Census Survey of the Mining and Manufacturing Industries for establishments with 5 or more workers. LEs are defined as establishments with workers more than or equal to 300 and SMEs as establishments with less than 300 workers. Since the early 1990s, the relative labor productivity of SMEs against LEs has been deteriorating. This is the phenomenon we need to understand.

In the next chapter, we review the theoretical and empirical works on the productivity convergence between LEs and SMEs. Then, we offer possible explanations why Korea and EU countries have different results in convergence between LEs and SMEs. A chapter of data and another chapter of the empirical model follow. Regression results complete the analysis of this paper. At the end, we derive some policy implications.

II. LITERATURE SURVEY

Since there is not much research on the convergence of SMEs and LEs in productivity, we turn to the literature on the convergence in per capita

income among countries to get guidance.

2.1 Research on the convergence in per capita income among countries

Baumol (1986) is one of the first scholars to raise the question whether developing countries are catching up with developed countries. It is now generally agreed that conditional, not unconditional, convergence exists. Conditional convergence means that poor countries have a tendency to grow faster after controlling for human capital, while unconditional convergence means a strong negative relationship between growth rates of per capita income and the initial value of per capita income as predicted by the Solow model (Barro and Sala−i−Martin, 1995).

Developing countries can reduce income discrepancy with developed countries by trading (Grossman & Helpman, 1991) and by attracting direct investment from developed countries (Glass & Saggi, 1988 and 1999). Coe & Helpman (1995) even showed that the R&D stocks of developed countries trading with developing countries could be used to explain much of the technological upgrade of the developing countries.

The ways that developing countries improve their productivities have also been investigated. Developing countries improve their productivities by making goods vertically related to the newly invented goods by developed countries (Markusen & Verrables, 1999, Pack & Saggi, 2001), imitating goods made in developed countries (Huizinga, 1995), or employing people who have worked in firms in developed countries (Gerschenberg, 1987, Song, 2000).

The process of how new technology is spread in developing countries has also been studied. In many instances, technologies of developed countries are not directly applicable to developing countries. Then, some firms in developing countries find ways to modify foreign technologies to fit them. Many other firms follow the leaders. As time passes, many firms use the newly modified technologies (Aghion, 2001).

There does not seem to be much problem if we change developed countries with LEs and developing countries with SMEs in the above paragraphs. This is because developed countries and large firms both

represent entities with high technology and developing countries and SMEs with low technology. Actually, SMEs are in a better position to learn advanced technologies from LEs than developing countries from developed countries as LEs and SMEs in a country share common language and culture.

2.2 Research on the diffusion of technology from the technical leaders to laggards

Jovanovic and MacDonald (1994) built models to explain technology diffusion between technology leaders and laggards with time lag. They introduced the cost to innovate and imitate. A relevant result of their model to this study is that the technology laggards grow faster than the technology leaders do in average because the laggards make efforts to imitate the leaders and have more incentive to search new technology. The technological leaders belong to successful firms and, therefore, can be regarded as large firms and the technological laggards as SMEs because a firm becomes large only after it succeeds in market.

Since innovation makes other firms to imitate and imitation increases learning ability, both have externality. This implies that innovation and imitation is underachieved in the market. Their models are theoretical and not developed for empirical work.

2.3 Research on the importance of LEs for the productivity improvement of SMEs

In the research on high-growth SMEs in Korea, Ahn (2005) found out various factors contributing to high growth of these firms including industry wise R&D intensity, foreign direct investment, export, import and other things. Ahn's research indicates overall industry level performance is important to high-growth SMEs. Since large firms chiefly determine industry performance, their role in industries is important to high-growth SMEs.

III. CAUSES OF PRODUCTIVITY DIFFERENCE BETWEEN LEs AND SMEs IN KOREA

In 2001, the labor productivity of SMEs in manufacturing industries was approximately 34% of LEs in Korea while the labor productivity of SMEs in manufacturing industries was approximately 80% of LEs in EU countries in 2000. This may be explained by the difference in how both Korea and EU countries evolved economically over time.

A major development strategy of Korean government in the 1960s and 1970s was to select better firms available and support them to be competitive in the international market. This is one important reason Korea has larger firms relative to her market size in the early days of development.

Korea had to open its domestic market as Korean firms succeeded in international market. This means the Korean government opened its market when large firms became competitive internationally while many small firms were not ready to compete internationally. Korea opened its market completely after Korea solved chronic current deficit. This happened in the late 1980s. This is the reason we observe the labor productivity difference between LEs and SMEs deteriorates from the early 1990s. Large firms could take advantage of opening-up of the Korean economy, but SMEs had to compete with firms from other countries such as China. Of course, the existence of competitive large firms in Korea helped SMEs in Korea since SMEs could easily get into global value chains of the large firms in Korea.

EU countries have evolved to developed countries over a far longer period than Korea. There, SMEs have had ample chance to learn from large firms. It is likely that large firms and SMEs have improved their technologies side by side as new scientific discoveries and technologies are appearing in EU countries.

IV. DATA

Each year, the National Statistical Office of Korea surveys the establishment with more than 5 workers in mining and manufacturing industries. The survey collects information on number of workers, capital

stock, worker compensation, and other expenses. It is possible to estimate value-added and labour productivity of each establishment. Thirteen sub-sectors of the manufacturing industry are used as a unit of observation for the period of 1980-2004. The list of the manufactures is as follows: food, beverages, tobacco and feed, textile and apparel products, paper products and printing industries, chemical and allied products, petroleum and coal products, ceramic, stone and clay products, iron, steel and non-ferrous metals and products, fabricated metal products, general machinery, electrical machinery, equipment and supplies, transportation equipment, precision instruments and machinery, and miscellaneous manufacturing industries.

For the estimation of EU countries, the whole manufacturing industry is used as an observation for 15 countries for the period of 1991-2001.[1] The data were retrieved from the web of the Observatory of European SMEs, 2003.[2] There were no data of individual manufacturing industries. Unlike Korea, firms with workers less than 5 are included in the data of EU countries.

[Table 1] Descriptive statistics

		Change in Labor Productivity of LEs	Change in Labor Productivity of SMEs	Productivity Gap between LEs and SMEs	Non-Prod. & Prod. Worker Ratio	Capital Stock per Worker
Korea[3]	Mean	0.0392	0.0361	-0.3413	0.3628	29.1681
	Std. Dev	0.0514	0.0409	0.2144	0.1767	21.8868
Austria	Mean	0.0080	0.0094	-0.2711	-	-
	Std. Dev	0.0060	0.0057	0.0061	-	-
Belgium	Mean	0.0087	0.0062	-0.0733	-	-
	Std. Dev	0.0038	0.0052	0.0095	-	-
Denmark	Mean	0.0108	0.0108	-0.1934	-	-
	Std. Dev	0.0068	0.0082	0.0041	-	-
Finland	Mean	0.0101	0.0114	-0.2721	-	-
	Std. Dev	0.0171	0.0147	0.0151	-	-
France	Mean	0.0060	0.0028	-0.3692	-	-

[1] EU 15 countries are listed in Table 1.

[2] Firms with more than or equal to 250 workers are regarded large in EU countries.

[3] For comparability with EU countries, only statistics for the whole manufacturing industry is presented.

	Std. Dev	0.0041	0.0049	0.0109	-	-
Germany	Mean	0.0138	0.0078	0.0326	-	-
	Std. Dev	0.0056	0.0068	0.0205	-	-
Greece	Mean	-0.0032	-0.0007	-0.1540	-	-
	Std. Dev	0.0108	0.0133	0.0168	-	-
Italy	Mean	0.0076	0.0063	-0.2103	-	-
	Std. Dev	0.0104	0.0085	0.0066	-	-
Netherlands	Mean	0.0059	0.0025	-0.0984	-	-
	Std. Dev	0.0037	0.0047	0.0122	-	-
Norway	Mean	0.0095	0.0087	-0.3513	-	-
	Std. Dev	0.0076	0.0068	0.0044	-	-
Portugal	Mean	0.0106	0.0095	-0.2679	-	-
	Std. Dev	0.0073	0.0061	0.0065	-	-
Spain	Mean	0.0073	0.0067	-0.4994	-	-
	Std. Dev	0.0082	0.0037	0.0099	-	-
Sweden	Mean	0.0116	0.0140	-0.2030	-	-
	Std. Dev	0.0147	0.0125	0.0204	-	-
Swiss	Mean	0.0210	0.0082	-0.2568	-	-
	Std. Dev	0.0180	0.0064	0.0542	-	-
Britain	Mean	0.0136	0.0114	-0.2879	-	-
	Std. Dev	0.0050	0.0058	0.0056	-	-

Sources: Korea Small Business Institute, The Observatory of European SMEs

The average increase in labor productivities of SMEs and LEs is larger in Korea than that in EU countries. The growth is more variable in Korea than in other countries as revealed by the coefficient of variation, which is standard deviation divided by average. Only Greece, Finland, and Italy have larger coefficient of variation than Korea. The data of productivity gap between SMEs and LEs corresponds to the labor productivity gap between LEs and SMEs in the previous year. The productivity difference between LEs and SMEs in Korea is larger than that in the EU countries except Spain, Norway, and France. The ratio of non-production workers to production workers and capital stock per worker is available only for Korean manufacturing industries.

V. MODELS FOR ESTIMATION

According to the Schumpeterian growth model by Aghion and Howitt (2005), an economy or a firm grows by innovations, which improve the

product quality. For SMEs, these quality-improving innovations come from two sources: investing in new technology development and absorbing innovations already developed by other firms, mainly large firms. Since the data set we use is a panel data, two estimation models are available: fixed effects and random effects. We try both. In the fixed effects model, individual industries or country dummies are added to the estimation equations to capture industry or country effects. We use ordinary least squares estimation method for the fixed effects model. In the random effects model, individual effects of industries and countries are assumed to be not correlated with other explanatory variables. The variance-covariance matrix of the random effects model is heteroscedastic and generalized least squares estimation is used.

The fixed effects model can be written as follows:

$$\Delta \ln LP_{sjt} = \delta(\Delta \ln LP_{ljt}) + \sigma(progap_{jt-1}) + X'_{sjt}\beta + \sec t./timedummies + \varepsilon_{sjt}. \quad (1)$$

This equation is similar to the estimation equation used in Conway et al. (2006), Griffith et al. (2004), and Nicoletti & Scarpetta (2003).[4] The meanings of symbols in the equation are as follows: ln, logarithm; LP, labor productivity; progap, log of labor productivity of SMEs over labor productivity of LEs representing the labor productivity gap between LEs and SMEs; X', a vector representing other control variables; Sect. /Time Dummies, industry and year dummy variables; Lower script *s*, SMEs; *l*, Les; *j*, industry; *t*, year; and ε_{sjt}, a normally distributed random disturbance with the mean zero.

The change of labor productivity of SMEs in current period is influenced by the change of labor productivity of LEs and the difference of labor productivity between small and large enterprises in the previous year. Factors affecting the productivity of LEs can affect the productivity of SMEs. For instance, both large and small firms are affected by cyclical change of economy, new technologies applicable to various sectors, and

[4] They used Aghion and Howitt model to examine the regulation or other effect on the catching-up in the labor productivity among OECD countries. They examined cross-country convergence at various industries as a part of their analyses.

change in institutions.

The difference in productivities between small and large firms indicates that the technology gap is large between small and large firms in this model. The difference in productivities between SMEs and LEs in the previous period affects the productivity of SMEs because the spill-over effect of technology depends on how far SMEs are behind LEs in technology. It is important to use the productivity gap of in the previous period to avoid endogeneity problem. The current change in the productivity of SMEs does not affect the productivity gap last period. The gain of SMEs from absorbing a technology of LEs is bigger when the technology gap between SMEs and LEs is larger. As in the catching-up of developing countries with developed countries, the larger the difference in technology levels between small and large firms is, the faster the catching-up of small firms with large firms is, when other factors are controlled.

When the gap of technology level between small and large firms is large, there is also likely to be somewhat old technologies, which small and large firms both agree to trade. When the gap is small, large firms may try to protect new technology.

The variable indicating the productivity gap between small and large firms is the logarithm of the ratio of the productivity of small firms over the productivity of large firms. Hence, minus coefficient of this variable implies that an increase in the productivity of SMEs relative to LEs last year reduces the increase of current labor productivity of SMEs.

The differences in physical and human capital between small and large firms are reflected by the productivity difference between small and large firms. However, the physical and human capital stocks as such have direct effect to the productivity change of SMEs. For instance, SMEs with better educated labor force and more capital or deeper understanding of IT can more easily absorb new technology. Hence, we add per capita capital stock and ratio of non-production workers over production workers. Higher per capita capital stock and higher non-production worker ratio indicate the capacity of small firms to absorb new technology. Companies whose non-production worker ratio is large can be regarded as using workers with high human capital stock. Dummy variables for industry

and year are also added to capture unchanging and unobservable factors.

The estimation equation for the random effects model can be written as follows:

$$\Delta \ln LP_{sjt} = \delta(\Delta \ln LP_{ljt}) + \sigma(progap_{sljt-1}) + X'_{sjt}\beta + \eta_{sjt}$$
$$\eta_{sjt} = \varepsilon_{sjt} + u_{sj} + v_{st}, \quad (2)$$

where u_{sj} is the random heterogeneity error term specific to the *j*th industry and constant through time. v_{st} is the random heterogeneity error term specific to the time period t and constant through industries.

In estimation of Korea, we divide the whole period of 1981-2004 by three. The three periods are 1981-1987, 1988-1997, and 1998-2004. The first period is a time span from a trough to a peak of business cycle, the second period covers from a peak to a trough of business cycle, and the third period is from a trough to 2004. 1980 is the year when the second oil shock started. 1997 is the year when the Asian Financial crisis erupted. 1988 is the year when the boom caused by the Plaza Accord of 1985 reached the peak.

VI. REGRESSION RESULTS

As explained in the Chapter IV, data of the 13 sub-sectors of manufacturing industries during 1980-2004 are used for Korea and data of the whole manufacturing industry of the 15 countries during 1991-2001 are used for EU countries.

The Hausman test rejected the random effects model for the data of Korea and accepted the random effects model for the data of EU. We will report the result of the fixed effects model for Korea and that of the random effects model for EU countries.

There is convergence between small and large firms in Korea, but no convergence between small and large firms in EU. During 1981-2004, 1% increase in productivity gap between SMEs and LEs increased the productivity of SMEs by 0.1% next year in Korea, but no significant coefficient for the term of productivity gap between LEs and SMEs appeared for EU.

[Table 2] The Fixed Effects Regression Results of Change in the Labor Productivity of SMEs for Korea by Periods and the Random Effects Regression Results for EU

	Korea				EU
	Whole Period	1981-1987	1988-1997	1998-2004	1991-2001
Change in the Labor Productivity of LEs	0.22***	0.09**	0.39***	0.30***	0.57***
	(5.34)	(2.19)	(5.55)	(4.58)	(12.00)
Productivity Gap between LEs and SMEs	-0.10***	-0.31***	-0.29***	-0.31***	-0.01
	(-4.51)	(-3.60)	(-5. 34)	(-4.19)	(-0.99)
Non-Prod. & Prod. Worker Ratio	-0.00	0.02	0.07	-0.05	
	(-0.01)	(0.16)	(1.01)	(-0.46)	
Capital Stock per Worker	0.00	0.01**	0.00*	0.00	
	(1.76)	(2.38)	(1.71)	(0.28)	
Constant	-0.04	-0.08*	-0.07***	-0.05	0.00
	(-2.17)	(-1.95)	(-2.91)	(-1.39)	(0.53)
Industry Dummy	Included	Included	Included	Included	Not included
Year Dummy	Included	Included	Included	Included	Included
Country Dummy	Not included	Not included	Not included	Not included	Included
Probability of Accepting Hausman Test Statistic(%)	0.01	0.01	0.45	0.12	75.97
No. of Observation	312	91	130	91	165
Adjusted *R*-squared	0.15	0.08	0.23	0.31	0.64

Note 1: ***, **, and *: significant in the level of significance 1%, 5%, and 10% respectively.
2: The numbers in parentheses are *t*-values.

The empirical evidence that there is no convergence in EU implies that the levels of technology of LEs and SMEs in EU countries are about the same. The reason why there exists large difference in labor productivities between LEs and SMEs in EU countries is that LEs and SMEs have different comparative advantages in their industries. It is likely that the industries LEs have comparative advantage require larger amount of capital stock.

When the period is divided into 1981-1987, 1988-1997, and 1998-2004 for the case of Korea the fixed effects model is appropriate. Further mane, there are stronger convergence when the equation is estimated by the periods divided than it is done for the whole period.

When SMEs are further classified as small firms and medium-sized

firms for Korea, the fixed effects models appear to be appropriate. Firms with less than 50 workers are defined as small-sized firms and those with workers in between 50-299 are defined as medium-sized firms. For medium-sized firms, change in the productivity of small firms and the productivity gap between small- and medium-sized firms are added as explanatory variables. For small-sized firms, change in the productivity of medium-sized firms and the productivity gap between small- and medium-sized firms are added as explanatory variables.

The regression for medium-sized firms shows that there is convergence between LEs and medium-sized firms, but no convergence with small firms. Since medium-sized firms are technologically more advanced, it does not make sense to mention about convergence with small firms.

[Table 3] The Fixed Effects Regression Results of Change in the Labor Productivity of Small- and Medium-sized Firms of Korea during 1981-2004

Medium-sized Firms		Small-sized Firms	
Change in the Labor Productivity of LEs	0.12***	Change in the Labor Productivity of LEs	0.14***
	(2.69)		(3.06)
Change in the Labor Productivity of Small-sized Firms	0.40***	Change in the Labor Productivity of Medium-sized Firms	0.44***
	(7.60)		(7.60)
Productivity Gap between Medium-sized Firms and LEs	-0.06**	Productivity Gap between Small-sized Firms and LEs	-0.05**
	(-2.46)		(-2.04)
Productivity Gap between Small- and Medium-sized Firms	0.06**	Productivity Gap between Small- and Medium-sized Firms	-0.10***
	(2.02)		(-3.19)
Non-Prod. & Prod. Worker Ratio in Medium-sized Firms	-0.01	Non-Prod. & Prod. Worker Ratio in Small-sized Firms	-0.04
	(-0.56)		(-1.08)
Capital Stock per Worker in Medium-sized Firms	0.00*	Capital Stock per Worker in Small-sized Firms	0.00*
	(1.89)		(1.71)
Constant	0.01	Constant	-0.04*
	(0.58)		(-1.86)
Probability of Accepting Hausman Test Statistic(%)	0.07	Probability of Accepting Hausman Test Statistic(%)	0.10
No. of Observation	312	No. of Observation	312
Adjusted R-squared	0.37	Adjusted R-squared	0.37

Notes: ***, **, and *: significant in the level of significance 1%, 5%, and 10% respectively.

The regression for small-sized firms shows that there is convergence

between LEs and small-sized firms and between medium- and small-sized firms. In the regression of small firms, the coefficient of the productivity gap with medium-sized firms is larger than that with large firms. This implies that the technology of medium-sized firms is more useful than the technology of large firms to small firms.

Change in the productivity of medium-sized firms is more correlated with that of small-sized firms than LEs and change in the productivity of small-sized firms is more correlated with that of medium-sized firms than that of LEs.

Change in per capita capital stock and non-production and production worker ratio do not affect the productivities of medium- and small-sized firms.

VII. CONCLUDING REMARKS

There is convergence in the labor productivity between SMEs and LEs in Korean manufacturing industries in the sense that the larger the labor productivity gap between small and large firms is, the faster the increase of the labor productivity of SMEs is next year. While there is catching-up in technology of small firms with large firms, the increase of productivity in large firms is bigger than the increase of productivity in small firms as there are more investments in LEs than SMEs. Even though large firms have increased the productivity more than small firms have done for more than previous 10 years, it does not need to be an irreversible trend. For instance, large firms restructure earlier than small firms. The productivity gap between large and small firms will be reduced after all the major restructuring is completed. Or large Korean firms may reach the technological levels of globally competitive firms and then slow down in productivity improvement.

The regression result of EU countries suggests that the productivity of SMEs does not need be the same as the productivity of LEs in manufacturing industries even though the technology level between LEs and SMEs is about same. There is no technology spill-over estimated from LEs to SMEs in EU countries. The difference in the productivities between large and small firms may come from the difference in industries in which each kind of firm is heavily represented.

Since large firms have numerous and most up-to-dated information about markets, they seem to be the most important source to get new technology for small firms. It is also notable that for small firms, productivity gap with medium-sized firms matters more than productivity gap with large firms. Therefore, to improve productivity of small firms, the government needs to focus on the transfer of know‐how from large and medium-sized firms to small firms.

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