경제학 석사 학위논문

Growth Dynamics of Firms during Recessions

- Evidence from U.S. Listed Firms -

경기침체기 기업의 성장 양상

- 미국 상장 기업 데이터를 활용하여 -

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경제학부

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이 논문을 경제학 석사 학위논문으로 제출함

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국문 초록

본 논문에서는 사전적으로 식별된 특정 유망기업들이 다른 기업들에 비해 경기침체기에 성장의 정도가 크다는 결론을 도출한다. 한편, 매출 및 고용의 시장 점유율의 절대 변화분이라는 두 가지 성장척도 중 오직 매출에 대해서만 경기침체기에 고성장 기대 기업들의 성장이 다른 기업들에 비해 더 크게 나타났다. 또한, 추가적인 채널 분석을 통해서 이와 같은 유망기업들의 경기침체기의 월등한 성장 양상은 사실 유망기업 중에서도 경기침체기에 투자를 증가시킨 기업들에서 대부분 나타나는 사실을 확인하였다. 위 결과는 슘페터의 창조적 파괴 및 기회비용 가설을 지지하는 간접적인 증거가 될 수 있다.

주요어: 슘페터 이론, 창조적 파괴, 경기 침체, 기업 성장, 연구개발투자, 자본투자
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목차

표 목차

그림 목차

1. Introduction

Firms are the most imperative elements of the economy. They employ laborers and produce several value-added goods and services. Firm is an essential driving force of an economy and thus, it is a quintessential subject to analyze what kind of, when, and how firms grow. In this regard, firm growth has been such an important issue studied in economics and business researches. One of the most renowned theory related to this strand is from Schumpeter who asserted that the "creative destruction" is the core logic of economic evolution and fluctuations. According to this theory, firms grow through innovation mostly during economic distress time. Through innovative activities, replacing incumbent firms, promising stars grow and these rather young and fresh firms take more weights in whole economy. Opportunity cost hypothesis is one suggestive rationale to explain Schumpeterian theory. This hypothesis was suggested by Aghion and Saint-Paul(1998) to address the causality from short-run fluctuations to long-run economic growth. They argue that long-run evolution of economy is rooted mainly from the time of economic contractions in which the opportunity cost for investments is generally lower than routine periods. Previous papers, such as Davis and Haltiwanger(1990) and Hall(1991) are on the same line with this hypothesis.

Along with this context, in the midst of the pandemic, there are some firms that show good performances despite of the generally harsh conditions for business to succeed. For example,

IT and "Untact" related businesses, such as an online communication business, like Zoom and home healthcare business, like Peloton, surpass other business sectors during this pandemic in terms of stock prices and sales. This empirical phenomenon raised a motivation of this paper that whether these firms' superior performances show some relevant evidence for Schumpeterian theory and opportunity cost hypothesis. In other words, are these firms doing well and would they do well continuously in the future because they grasp propitious chances to invest and enhance their productivity in economic downturn?

Following this story line, the goal of this paper is to test whether those firms which are expected by investors to grow faster in the future indeed grow more when it comes to the real data. That is, promising and attractive firms authentically show better performances in the future. Especially, referring to Schumpeterian theory, whether those firms grow faster during recession periods is investigated. Attractiveness of firm is considered to capture which firms are expected to grow more in the future and thus, likely to be the new “star firms”. To do so, I employ an existing measure in finance literature to represent “attractiveness” of firm for future performance: a price-to-book ratio. Typically, in finance, book-to-market ratio is used in lieu of price-to-book ratio which is a reciprocal of book-to-market ratio. According to finance literature, book-to-market ratio is said to be a salient factor that negatively affects future expected stock returns(Fama and French(1992)). Firms with low book-to-market ratios(i.e. high price-to-book ratios) usually show negative abnormal returns compared to firms with high

book-to-market ratios(i.e. low price-to-book ratios). And these low book-to-market ratio firms are named as "growth stocks" while high book-to-market ratio firms are called as "value stocks". Unlike in finance literature, in this paper, price-to-book ratio is used to analyze the aspects of firm growth in some relevant accounting elements such as revenue and employment not to analyze firms' stock returns.

Price-to-book ratio can represent investors' expectations for firms' future growth because, according to Kogan and Papanikolaou(2014), firms' price-to-book ratios are positively related with firms' growth opportunities. Therefore, it can be said that firms with higher price-to-book ratios have larger growth opportunities compared to those with lower price-to-book ratios. And by intuition, it is natural to consider that the reason why firms which are evaluated much higher than the level of their book values is, compared to now, they are anticipated by investors to have higher level of sales and earnings which is reflected as discounted terms on stock prices regardless of their expectations would be proven to be right or wrong. If those firms actually do well in the future, then those expectations would be right ones.

Based on the quantile numbers of firms' price-to-book ratios, I generate "expected high-growth" firm indicator variable which has value 1 if the quantile number of firm's previous 2-year mean price-to-book ratio value is 9 or 10 and 0 otherwise. Using it as a main explanatory variable in the regression, I analyze the relationship between the expectation for future firm growth and actual firm growth. Here, firm growth is

measured by absolute change in terms of revenue and employment market share. Of course, literature in firm growth uses mainly relative growth rate to measure firm growth((Yang and Huang(2005), García-Manjón and Romero-Merino(2012)) or both of absolute and relative terms(Delmar et al.(2003), Daunfeldt et al.(2016)). In this paper, however, because the main question is whether those promising firms actually usurp the incumbent businesses from the process of "creative destruction", it is not appropriate or has less meaning to use relative term for growth. In other words, even if relative growth rate of a firm is significantly higher than others, the overall importance or weight of the firm in total economy could be minuscule. For example, suppose that the growth rate of firm A is 100% while that of firm B is only 1%. This phenomenal growth rate of the firm A, however, does not mean that it has a meaningful role in overall economy if its absolute magnitude of growth is diminutive.

I use Compustat data set from WRDS(Wharton Research Data Service) which covers all of the U.S. listed firms from 1970 to 2018. This data set includes salient accounting elements, such as asset, cash, leverage, revenue, employment, and various investment related expenditures. By using this data set, I first conduct a simple OLS regression for each recession year. It turns out that for most of the economic downturns, expected high-growth firms indeed grow more than non-expected high-growth firms when other variables which are relevant to firm growth, like firm size and firm age, are controlled. For the more thorough investigation to the properties of firm growth, I then implement Difference-in-Difference(DiD) regression. In this

regression, the main regressor is the interaction term between expected high-growth indicator and recession year dummy. That is, this regression is aimed to seek out whether those highly anticipated firms grow more than others uniquely or especially much more during recessions compared to ordinary times. The result confirms that for the case of growth in revenue market share, expected high-growth firms outperform others especially far more during recession periods while for employment, it does not hold. The result is robust even after the concern regarding survivorship bias is taken into account.

After all, these results show that as growth opportunities of firms are higher, those firms grow more in the future particularly during recession periods. Therefore, it is consistent with the argument of Schumpeterian theory except that whether increased investments in the midst of economic hard times generate these escalated growth performances of expected high-growth firms is not yet checked. To shed light on it, I further investigate the role of research and development investment and capital investment on the facet of firm growth amid recessions. To do this, DiDiD regression is done with the main independent variable being the interaction term of expected high-growth firm indicator, recession year dummy, and magnitude of growth in investment-related variables. There are largely 4 investment-related variables. These are 'property, plant and equipment', R&D capital, capital expenditures, and R&D expenditures. The first two are stock variables and last two are flow variables. Since there is no direct reported data for R&D capital, I generate a new variable based on R&D expenditures

and intangible others(i.e. intangible assets less goodwill) data referring to Chan et al.(2001). They create imaginary R&D capital by accumulating depreciated R&D expenditures over 5 years. The only difference with this R&D capital and R&D capital used in this paper is that I use the maximum value between intangible others and the generated R&D capital to take the information of intangible others into account. Generally, intangible others include values of patents, licences, and copyrights which are all related to firms' innovative activities. Therefore, it is appropriate to incorporate this information of intangible others if formulated R&D capital is lower than intangible others. From this procedure, I find that among expected high-growth firms during recession periods, firms which have larger increments in their investments expenditures or investment stocks grow more than firms with smaller increases or firms with negative growth in investment-related terms. Furthermore, after introducing investment-related terms into the regression, previous significance of the interaction term between recession dummy and expected high-growth indicator vanishes. This can be interpreted as the compelling evidence for the creative destruction argument in the sense that only EHG firms with increased efforts during recessions exhibit superior performance in the future.

The remaining part of the paper is organized as follows. First, related literature is reviewed briefly in section 2. In section 3, basic settings, together with brief descriptions of data and variables are presented. Then, the model and results regarding the main topic of firm growth analysis are shown in section 4.

And next, in section 5, I investigate the roles of research and development investments and capital investments on firm growth to address the channel for it. Finally, I conclude the overall results and their implications.

2. Literature Review

There are largely three strands of literature that are relevant to this paper. First, theory of Schumpeter is the most closely related one. The main question of this paper is to test whether the creative destruction argument is genuinely reasonable by looking at the case of U.S. listed firms. Along with this story, in Aghion and Saint-Paul(1998), it is said that the short-term business cycle affects the long-term economic growth through the productivity growth channel. Therefore, business cycle fluctuations and economic growth have a quite entangled relationship and thus, they should be seen as a unified phenomenon. In detail, during economically bad times, firms dedicate their resources to improving productivity which is called as countercyclical investments or more formally, opportunity cost hypothesis. By increasing the overall efforts in recessions, potential strength for growth is enhanced. Davis and Haltiwanger(1990) and Hall(1991) are also corresponding to this opportunity-cost argument. Davis and Haltiwanger(1990) report that more labor reallocation is implemented during economic downturns due to a lower opportunity cost. Similarly, Hall(1991) contends that economic downturns are proper times for reorganizations. However, this paper tries to figure out slightly different aspects of investment behaviors compared to those previous papers related to opportunity cost hypothesis. Among the entire firms in whole economy, I focus on the firm growth dynamics of a certain subgroup during recession periods. That

is, I analyze the growth and investments aspects of expected high-growth firms during recessions.

Related to opportunity cost hypothesis, some papers investigated cyclicality of R&D and capital investments to check that whether these types of investments actually display countercyclical movements. Although there have been controversial results, it is now well admitted that R&D shows procyclical pattern(Fatas(2000), Barlevy(2004), Comin and Gertler(2006)) in aggreate scale for the United States and for G7 countries. Also, Ouyang(2011) says that at the industry level, R&D expenditure again shows procyclical behavior by investigating data of twenty U.S. manufacturing industries from 1958 to 1998. The degree of procyclicality, however, is milder than the results of aggregate level. In addition, the cause of procyclicality of R&D seems from liquidity constraints which could disturb R&D investments of firms. Regarding the behavior of capital investments, Hershbein and Kahn(2018) report that the Great Recession of 2008 facilitated the process of restructuring firms' labor skill demands toward high-skilled workers replacing routine-manual jobs and of introducing more capital investments during the recession along with routine-biased technology change. These results are partially consistent with this paper in that 'expected high-growth' firms which increase their R&D or capital investments during recession periods indeed grow much better than other firms.

Second, this paper is linked with literature of firm growth determinants. Starting from Gibrat(1931), the associations between plenty of candidate factors and firm growth have been

investigated. Gibrat(1931) argues that firm size is independent of firm growth which is quoted as Gibrat's law. This argument, however, has been debunked by lots of subsequent researches. For example, Evnas(1987) refutes Gibrat's law by showing that firm size and firm age are negatively associated with firm growth using data of firms from U.S. 100 manufacturing industries covering 1976 to 1980 periods. It is additionally reported that the probability of firm's survival rises with firm age. Similarly, Navaretti et al.(2014) report that by using quantile regression, conditional on survival, young firms grow faster than their old counterparts especially in the highest growth quantile. They use the data of manufacturing firms with more than 10 employees from 2001 to 2008 in 7 European countries. In the regard of the effect of leverage on firm growth, Huynh and Petrunia(2010) show that leverage has a strong positive relationship with growth even after controlling size and age using Canadian manufacturing firms data. They use debt-to-asset ratio as a proxy for leverage. Additionally, they also report that firm size has a negative relationship with firm growth while unlike Evnas(1987), they find non-monotonic U-shaped relationship between firm growth and firm age where age is set to x-axis. Related to the role of cash, Quader(2017) tells that cash flow is a proxy for firm's liquidity constraints. And following Carpenter and Petersen(2002), it is argued that cash flow should be included in a growth regression to address the concern related to liquidity constraints of firms. Adding to those factors, Bottazzi and Secchi(2003) argue that firm's past growth performance affects firm's growth positively. That is, there is an autocorrelation in firm's growth. To this

extent, in order to take these factors into account in the analysis of firm growth and to examine the effect of main regressors more clearly, I include these variables as control variables in the following regressions later.

Researches about the role and property of R&D investments regarding firm growth are closely related to these articles. In García-Manjón and Romero-Merino(2012), it turns out that the positive role of R&D intensity on sales growth is only seen among high-tech firms which is defined as top 1,000 R&D spending firms in European 18 countries. On the other hand, among low-technology industry firms, there is no significantly positive impact of R&D on sales growth. They find even negative effect of R&D among certain industries. In another paper, Yang and Huang(2005), the positive effect of R&D is shown only for small firms. In contrast, Daunfelt et al.(2016) argue that R&D intensity has a negative or no impact on the share of high-growth firms in an industry which is inconsistent with the perspective that R&D benefits high-growth firms. This paper, however, figures out that for specially chosen firms, expected high-growth firms, R&D shows positive impact on sales market share growth during recession periods.

Lastly, finance literature is also associated with this paper. Particularly, referring to Daniel and Titman(2006). high price-to-book ratio firms exhibit higher future accounting growth rates and lower future returns relative to low price-to-book ratio firms. Also, they tell that firms have high price-to-book ratios because they are viewed to have high future growth opportunities and thus, have high market prices. Similarly, in Kogan and

Papanikolaou(2014), they report that price-to-book ratio and growth opportunities have a positive relationship. However, there has been no research which investigated growth dynamics of high price-to-book firms during recessions. This paper finds that those firms with high price-to-book ratio even more accelerate the speed of absolute growth of revenue during recession periods compared to routine times. This is a contribution of this paper for those researches regarding firms' growth dynamics on the criterion of price-to-book ratio.

3. Basic Settings and Data

3.1. Basic Settings

3.1.1. Identifying Recessions

In order to analyze the aspects of firm growth in recession periods, it is necessary to properly identify recession years. In this paper, I use NBER Official Business Cycle Dates in the identification process. Since the data set used in this paper covers years from 1970 to 2018, I only look into recessions after 1970. There are officially 6 downturns after 1970 according to NBER.

Because the data is in annual scale, recession periods should be also identified in year terms not in months or quarters. NBER, however, defines recession periods in month. Therefore, I include a certain year in recession period if downturn occurred equal to, or more than 3 months in that year. For example, for 1990 recession, the contraction started on July 1990 and ended on March 1991. Then, the length of downturn in 1990 is 6-month from July to December and that in 1991 is 3-month from January to March. Therefore, 1990 and 1991 are included in the 1990 recession period. From this criterion, 4 recessions have been identified, which are 1981(1981-1982), 1990(1990-1991), 2001(2001), and 2008(2008-2009) recessions, named from the starting year of each recession.

Parentheses indicate years included in each recession period.

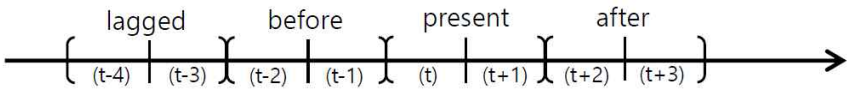
Of course, there are additionally 1973 and 1980 recessions apart from those 4 downturns in NBER. However, I exclude these two downturns from the analysis for two reasons. First, as it will be mentioned in the next subsection, I use past performance lag term in the regressions as a control variable which uses observations of 4- and 3-year before the target year in calculation. Because of this constraint, I can only use 1974 as the first target year since the whole data starts from 1970. Therefore, 1973 recession cannot be analyzed. And second, 1980 recession is removed since it lasted for a quite short term and in the next year, there is an another subsequent recession period.

3.1.2. Time Frame Setting

For each target year, there are 4 time intervals each composed of 2-year period: lagged 2-year, before 2-year, present 2-year, and after 2-year intervals when deriving the growth-related variables. For example, for the target year 2000, lagged 2-year interval is composed of 1996 and 1997, before 2-year interval is composed of 1998 and 1999, present 2-year interval is composed of 2000 and 2001, and lastly, after 2-year interval is composed of 2002 and 2003. This time interval setting is crucial when the firm growth is calculated from 2-year mean of market share in revenue and employment for each firm. This growth change is the main dependent variable in the analysis, which will be discussed in more detail later. The reasons why I use 2-year mean value, not the yearly value when I calculate the

firm growth are as follows. First, by using 2-year mean value, the problem of measurement error can be mitigated. Second, some concerns regarding the discrepancies in the timings of each firm experiencing contraction and recovery can be also resolved. For example, in Chang and Hwang(2015), they show that U.S. industries exhibit different timings of turning points regarding peaks and troughs for all previous 6 recessions from 1973 to 2015. Some industries' peaks or troughs precede NBER recession dates while others' peaks or troughs lag. Therefore, because some firms could experience downturn in the first year of recession while other firms could experience distress times in the second year of recession, by using 2-year mean growth, I can incorporate those two timings into the one integrated criterion to measure the impact of recession for each firm. That is, it is not necessary to account for the differences in the timing of downturns of firms. Actually, as seen in the previous subsection, every recession except 2001 consists of 2-year period.

[Figure 1] Illustration of Time Frame



3.2. Data and Variable Descriptions

3.2.1. Data Sources

Data set is composed of U.S. listed firms' financial statements and related financial ratios information which are both from Compustat of WRDS(Wharton Research Data Service). The time period is from 1970 to 2018. The data contains annual revenue, R&D expenditures, capital expenditures, asset, intangible asset, goodwill, intangible others, debt-to-asset ratio, cash, and the number of employees in financial statements of each firm. Among these variables, asset, cash, and employment are stock variables and others are flow variables except debt-to-asset ratio. Every dollar denoted variable is deflated using GDP deflator which has the value of 100 in 2015. Additionally, from financial ratios data, I use price-to-book ratio(ptb ratio, hereafter) which is a crucial variable in this research. Industry classification is based on SIC(Standard Industrial Classification) code and SIC 4-digit level is used in the analysis. Since age information is not directly available in Compustat data, I generate it by setting a firm's age to 1 for the first year that a firm appears in Compustat database following Quader(2017). Surely, it could not be an exact age of a firm because Compustat covers only publicly listed firms-therefore, the first year of coverage in Compustat is, probably, not the same year that a firm was established. Nonetheless, I think it is the second-best way to generate age data of firms through the uniformed criterion.

Additionally, I manipulate some observations to fill as many as missing values and eliminate erroneous data based on objective criteria. First, by using the relationship among intangible asset, goodwill, and intangible others, which is that intangible asset is the sum of goodwill and intangible others, I fill missing values of one of the variables if two other variables are not missing. Also, I replace negative values of intangible asset to 0 and equalize the values of intangible asset to either goodwill or intangible others if intangible asset is less than goodwill or intangible others. There is no case that intangible asset is less than both goodwill and intangible others removing the necessity to choose what variable value should be used as the replacing value for intangible asset between goodwill and intangible others. And if intangible asset is 0 and goodwill and intangible others are missing, I substitute those missing values to 0. Second, related to R&D expenditures data, by using R&D-to-sale ratio from Compustat, missing values of R&D expenditures are filled by multiplying R&D-to-sale ratio and sales data. Also, I set the missing values of R&D expenditures of a certain year to 0 if a firm's R&D expenditures values are all missing values or zero and intangible asset of that year is also zero. This is based on the logic that if all the R&D expenditures value is reported missing or zero and furthermore, intangible asset which is related to R&D expenditures is also zero, it is highly likely that missing value of R&D expenditures of a certain firm at a certain year is actually zero. From this procedure, 39,682 firm-year observations are changed among total 214,822 firm-year observations.

Finally, some observations are excluded from the final sample. First, financial firms which are coded as "FS" for the variable "indfmt" from Compustat are excluded following Quader(2017). Because financial firms are fundamentally different in their financial statements composition and their business performances, they are excluded and only non-financial firms are remained. Second, agriculture related firms which have SIC 2-digit code from 01 to 09 are also removed from the final sample because of the similar reason with financial firms. Those agricultural firms are essentially different with non-agricultural firms. Except these eliminated firms, the data set includes all industries such as manufacturing, mining, construction, services, retail and wholesale trade, and so on. Then, the number of remaining firm-year observations is 194,691 which covers years from 1974 to 2015. Lastly, in the regression, observations which have non-missing growth-related dependent variable values are included. Then, the final number of firm-year observations is 107,041 from 1974 to 2015.

3.2.2. Variable Descriptions

Expected high-growth firms The core variable is the indicator variable of 'expected high-growth' firms(hereafter, EHG firms) derived from the quantile number of ptb ratios. For the calculation procedure, first, for each year, derive mean value of ptb ratios of each firm for before 2-year interval. For example, for the case of target year 2000, calculate mean of ptb ratios from 1998 and 1999. Based on 2-year mean ptb values, set the

quantile of each firm of target year 2000. Finally, set the indicator variable of EHG firms to 1 if the quantile is 9 or 10 and 0 otherwise. This calculation, of course, requires each firm to be in the Compustat data from 1998 to 1999 for the target year 2000. The rationale for this procedure in which higher ptb ratio firms are set to be expected high-growth firms is based on the work of Kogan and Papanikolaou(2014). They argue that firms' market-to-book ratios, which are equivalent to price-to-book ratios in this paper, are positively correlated with firms' growth opportunities. Similarly, Daniel and Titman(2006) tell that firms have high ptb ratios because they are viewed to have high future growth opportunities and thus, have high market prices. Therefore, it can be said that higher ptb ratios represent higher growth opportunities. Besides, intuitively, because firms with high ptb ratios are valued higher relative to their book values, this implicitly indicates that those firms are more expected to grow in the future by investors. Apart from this, the reason that I use the term 'expected high-growth' rather than just 'high-growth' is, generally, high-growth firms represent firms which have grown rapidly in terms of employment or sales through the past few years. For example, in Schreyer(2000), high-growth firms are defined as those firms ranking top 10% in terms of combination of relative and absolute growth of employment which reflects the past performances of firms. Likely, in Daunfeldt et al.(2016), high-growth firms are defined as top 1% firms in terms of absolute or relative growth in employment or sales over a past 3-year period. This paper, however, aims to analyze the growth aspects of firms which are

anticipated to grow highly in the future. In this regard, to separate past high performers and expected future high performers, the term 'expected high-growth' is used.

Indicator of recession The value of indicator variable for recession is coded as 1 if a year equals either 1981, 1990, 2001, or 2008 which is the starting year of each recession, respectively. For the rest of years, this value is set to 0. This indicator variable is used as the main regressor as an interaction term with EHG indicator in DID regression.

Market share Market share of each firm is defined as follows. Here, f denotes firm, t denotes year, N_t denotes the total number of firms that remain after eliminating financial and agricultural firms and whose data of *var* exist in year t. *var* is either revenue or the number of employees. Therefore, *Market_share* means the share of revenue or employment of a firm relative to the total economy. A caveat is that total economy here is not composed of all existing firms in the economy but is composed of 'listed U.S. firms' which exist in Compustat and which are not financial nor agricultural firms. To use the term conveniently, henceforth, use the term MS instead of *Market_share*.

$$Market\,share_{f,t} = \frac{var_{f,t}}{\sum_{f=1}^{N_t} var_{f,t}}$$

Growth Measure Annual revenue and the number of employees are the two variables to measure the growth of firms. To be specific, I use the absolute change in the market share of

revenue and employment as the main measures of firm growth. Regarding the proper choice of the measure of firm growth, in the firm growth literature, sales and employment are usually used. In Delmar et al.(2003), Yang and Huang(2005), Anyadike-Danes et al.(2009), and Daunfeldt et al.(2016), they measure firm growth from employment and sales data. Regarding the choice between absolute and relative growth terms, many papers recommend to use both measurements. Delmar et al.(2003) argue because high-growth firm is a heterogeneous and multidimensional in nature, researchers should be careful when using only a single aspect of growth. They use both absolute and relative terms for employment and revenue for the measure of firm growth. Similarly, in Schreyer(2000) and Hölzl and Friesenbichler(2010), the combination of absolute and relative term is used as a measure of firm growth to avoid some related biases when using just one criterion. Unlike these papers, García-Manjón and Romero-Merino(2012) measure firm growth only by relative growth rate of sales. In this paper, however, only absolute term is used to measure firm growth because, as it is mentioned earlier, I aim to analyze the overall takeover of EHG firms against to non-EHG firms in total market economy.

There are largely three growth measure based on the starting point and the ending point when calculating growth in this paper. The first one is *Overall_growth* which is the growth from before 2-year to after 2-year interval. The second one is *Downturn_growth* which is the change from before 2-year to present 2-year interval. The last one is *Recovery_growth* which is the change between present 2-year and after 2-year interval.

These names of variables are set to reflect the timing of contraction and recovery during recessions. To be specific, for the target year 2008 which is the starting year of 2008 recession, the present 2-year which includes 2008 and 2009 is the very time when contraction of 2008 recession occurred. Then, after 2-year interval which incorporates 2010 and 2011 is the time of recovery after the recession. In this regard, *Downturn_growth* which measures the change from before 2-year(2006, 2007) period to present 2-year(2008, 2009) period indicates the growth of a firm during contraction occurs. Similarly, *Recovery_growth* shows the growth from present 2-year(2008, 2009) to after 2-year(2010, 2011) which coincides with a recovery period.

$$Overall\,growth_{f,t} = \frac{obj_{f,t+2} + obj_{f,t+3}}{2} - \frac{obj_{f,t-2} + obj_{f,t-1}}{2}$$

$$Downturn\,growth_{f,t} = \frac{obj_{f,t} + obj_{f,t+1}}{2} - \frac{obj_{f,t-2} + obj_{f,t-1}}{2}$$

$$Recovery\,growth_{f,t} = \frac{obj_{f,t+2} + obj_{f,t+3}}{2} - \frac{obj_{f,t} + obj_{f,t+1}}{2}$$

Other control variables There are additional variables which are used as control variables in the regression. *Lag_growth* term represents firm's past growth performance, *Lag_mean* is 2-year mean value of the market share of revenue or employment over before 2-year period, and *Mean* is 2-year mean value of the market share of revenue or employment over present 2-year period. *Lag_growth* term is used as a control variable to eliminate the effect of past performance of a firm on the present growth to show the effect of being EHG firms on firm

growth more clearly. Indeed, Bottazzi and Secchi(2003) assert that there is a positive association between the growth and past growth performance for U.S. manufacturing firms. *Lag_mean* or *Mean* variable is included to mitigate bias from the scale effect on growth. Specifically, because the main dependent variable is absolute term, the bigger the firm is, the larger the growth magnitude is likely. Therefore, to alleviate this problem, I include mean value terms. Considering the starting points of 3 growth measures, *Overall_growth*, *Downturn_growth*, and *Recovery_growth*, *Lag_mean* is used when the dependent variable is either *Overall_growth* or *Downturn_growth* and *Mean* is used when the dependent variable is *Recovery_growth*.

$$Lag\ growth_{f,t} = \frac{obj_{f,t-1} + obj_{f,t-2}}{2} - \frac{obj_{f,t-3} + obj_{f,t-4}}{2}$$

$$Lag\ mean_{f,t} = \frac{obj_{f,t-1} + obj_{f,t-2}}{2}$$

$$Mean_{f,t} = \frac{obj_{f,t} + obj_{f,t+1}}{2}$$

[Table 1] shows summary statistics of EHG and non-EHG firms for the main variables. Again, all dollar denoted variables are deflated using GDP deflator which has the value of 100 in 2015. These dollar denoted terms are scaled at one million dollars and employment is scaled at 1,000 employees.

[Table 1] Summary Statistics for Main Variables

Variable Name	Mean		Median	
	EHG	non-EHG	EHG	non-EHG
Assets ($ mil.)	3582	7534	233	501
Cash ($ mil.)	272	303	19	17
Revenues ($ mil.)	2858	2940	213	398
Employment (1,000 Employees)	11.5	9.5	0.9	1.7
Market Share of Rev. (1/mil. %p)	302	345	26	50
Market Share of Emp. (1/mil. %p)	377	330	29	59
Age	17	21	13	17
Debt-to-Asset Ratio	0.61	0.55	0.48	0.55
Before 2-year Average of ptb Ratio	7.63	1.55	5.71	1.33
R&D Expenditures ($ mil.)	106	39	1.6	0
Capital Expenditures ($ mil.)	167	206	11	14
Intangible Assets ($ mil.)	581	553	3.6	5.3
Property, Plant, and Equipment ($ mil.)	748	1272	40	76
Overall_growth of Emp. (1/mil. %p)	5.33	0.25	2.75	0.36
Downturn_growth of Emp. (1/mil. %p)	2.82	0.17	1.44	0.18
Recovery_growth of Emp. (1/mil. %p)	2.52	0.1	0.93	0.12
Overall_growth of Rev. (1/mil. %p)	4.37	0.51	2.12	0.22

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Downturn_growth of Rev. (1/mil. %p)	2.19	0.29	1.19	0.14
Recovery_growth of Rev. (1/mil. %p)	2.18	0.22	0.73	0.08
Number of firm-year Observations	19,845	87,196	19,845	87,196

The last 6 growth-related variables are all growth magnitude in market shares and scaled at one-millionth percentage points. The average and median values are reported using all of the firm-year observations from 1974 to 2015. As seen in [Table 1], on average, EHG firm has smaller firm size and capital expenditures while it is younger, have more employees and especially way larger R&D expenditures than non-EHG firm. Furthermore, in terms of growth in market share, EHG firm has much larger growth magnitude both for revenue and employment compared to non-EHG firm, on average. Now, I would move on to the main analysis procedure in the next section.

4. Firm Growth Analysis

4.1. Simple Regression for Each Recessions

As a preliminary analysis, I first conduct 4 elementary regressions for each recession year. The recession years are 1981, 1990, 2001, and 2008. [Table 2] shows the results of simple OLS regressions for 4 recessions. These regressions are based on the equation (1) and α_1 is the main coefficient of interest. Here, the dependent variable *outcome_growth* is either *Overall_growth*, *Downturn_growth*, or *Recovery_growth*. *I(EHG)* is an indicator variable which is 1 if the ptb quantile number of a firm is 9 or 10 and equal to 0 otherwise. *I(industry)* is an industry fixed effect term which is based on SIC 4-digit level. *Lag_growth* term controls the past performance of a firm. Another control variables include *Mean* or *Lag_mean*, age, asset, cash, and debt-to-asset ratio which represents leverage. Here, *Mean* is used for the dependent variable *Overall_growth* and *Downturn_growth* while *Lag_mean* is used for the dependent variable *Recovery_growth*. *Mean* or *Lag_mean* is included to control the effect of present magnitude on subsequent growth. For instance, it can be the case that the larger the present market share, the higher the future market share growth. Or, in contrast, the smaller the market share of a firm is today, the more the future market share grows. Therefore, present scale of market share should be controlled. Additionally, age, asset, leverage, and cash are controlled because these variables are reported to have

significant associations with firm growth.

$$Outcome\ growth_f = \alpha_0 + \alpha_1 I(EHG)_f + \alpha_2 Lag\ growth_f + Controls_f + I(industry)_f + \epsilon_f \qquad (1)$$

The results show the role of EHG indicator on growth of firms in terms of market share of revenue and employment in each recession. The regressions are conducted either by including both *Lag_mean* and EHG indicator variable or the indicator only to see the difference between two of them. As shown in [Table 2], EHG is significant in all of the recessions except 2001 for both revenue and employment market share growth without lag term. And these results also remain significant except few cases when lag term is included. Most importantly, EHG for *Overall_growth* in all recessions but 2001 remain significant even after lag term is contained. In 2008, *Overall_growth* and *Recovery_growth* of market share of employment are significant while all 3 dependent variables of market share of revenue are all significant. This means that in 2008, the average market shares of both employment and revenue of EHG firm increase more rapidly from before recession to after recession than that of non-EHG firm. And this higher growth is rooted from *Recovery_growth* for employment and *Downturn_growth* and *Recovery_growth* for revenue. The employment market share of EHG firm grows similarly with that of non-EHG firm in downturn period while goes higher than that of non-EHG firm in recovery period, on average. However, the revenue share of EHG firm increases more rapidly in both

downturn and recovery periods. These results of 2008 are analogous to the results of 1990 and 1981 recessions. Despite the significance of *Downturn_growth* and *Recovery_growth* is a little different, that of *Overall_growth* is significant in 1990 and 1981, also. The only different result appears in 2001 which is the year when no significant results emerge. For both employment and revenue, and for all dependent variables, significance of EHG is low or almost zero. The conjectured reason for this result is that, actually, although the 2001 recession is included as the recession in NBER, it is a somewhat ambiguous recession period. Specifically, in 2001 recession, the minimum value of the percent change from the quarter before one year in real GDP and seasonally adjusted is just 0.2% which is even positive. In contrast, those of other recessions (1981, 1990, and 2008) are -2.6%, -1%, and -3.9%, respectively. Therefore, it can be supposed that because the negative impact of 2001 recession is modest, there is no critical role of EHG in this recession period.

[Table 2] Results for Each Recession Year

		panel A : 1981 Recession[1]			
		Emp.		Sales	
		(1)	(2)	(1)	(2)
Overall_	I(EHG)	79.8***	72***	50.1**	42.6*
growth_MS	(1/mil. %p)	(4.22)	(3.91)	(2.23)	(1.95)
	Lag_growth		0.33***		-0.3***
			(9.85)		(-10.3)
Downturn_	I(EHG)	32.5***	27.6***	9.3	16.2
growth_MS	(1/mil. %p)	(3.23)	(2.81)	(0.77)	(1.45)
	Lag_growth		0.22***		0.28***
			(12.32)		(18.33)
Recovery_	I(EHG)	44.7***	41.1***	42.3**	27.3*
growth_MS	(1/mil. %p)	(3.23)	(2.97)	(2.44)	(1.91)
	Lag_growth		0.1***		-0.6***
			(3.89)		(-30.02)
Industry fixed effect		O	O	O	O
Number of Firm Obs.		2,104	2,075	2,208	2,203
		panel B : 1990 Recession			
		Emp.		Sales	
		(1)	(2)	(1)	(2)
Overall_	I(EHG)	79.3***	62.6***	77.9***	73.2***
growth_MS	(1/mil. %p)	(4.07)	(3.29)	(5.33)	(5.02)
	Lag_growth		0.7***		0.19***
			(16.13)		(6.66)
Downturn_	I(EHG)	41.6***	30.9***	36.8***	40.1***
growth_MS	(1/mil. %p)	(4.74)	(3.89)	(3.89)	(4.25)
	Lag_growth		0.47***		-0.1***
			(25.55)		(-6.96)
Recovery_	I(EHG)	45.5***	39.1***	42.4***	34.8***
growth_MS	(1/mil. %p)	(3.68)	(3.14)	(4.21)	(3.63)
	Lag_growth		0.36***		0.32***
			(12.14)		(16.88)
Industry fixed effect		O	O	O	O
Number of Firm Obs.		2,457	2,405	2,540	2,531

1) The numbers in parenthesis are t-values. ***, **, and * denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

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		panel C : 2001 Recession			
		Emp.		Sales	
		(1)	(2)	(1)	(2)
Overall_	I(EHG)	27.6	19.4	25.1	21.7
growth_MS	(1/mil. %p)	(1.56)	(1.09)	(1.25)	(1.1)
	Lag_growth		0.52***		0.39***
			(16.31)		(9.12)
Downturn_	I(EHG)	18.8	14.6	25.7**	23.5*
growth_MS	(1/mil. %p)	(1.41)	(1.06)	(2.1)	(1.95)
	Lag_growth		0.29***		0.26***
			(11.84)		(9.71)
Recovery_	I(EHG)	3.2	1.48	-5.7	-6.2
growth_MS	(1/mil. %p)	(0.41)	(0.18)	(-0.46)	(-0.49)
	Lag_growth		0.18***		0.07***
			(12.3)		(2.69)
Industry fixed effect		O	O	O	O
Number of Firm Obs.		2,959	2,720	3,111	3,108

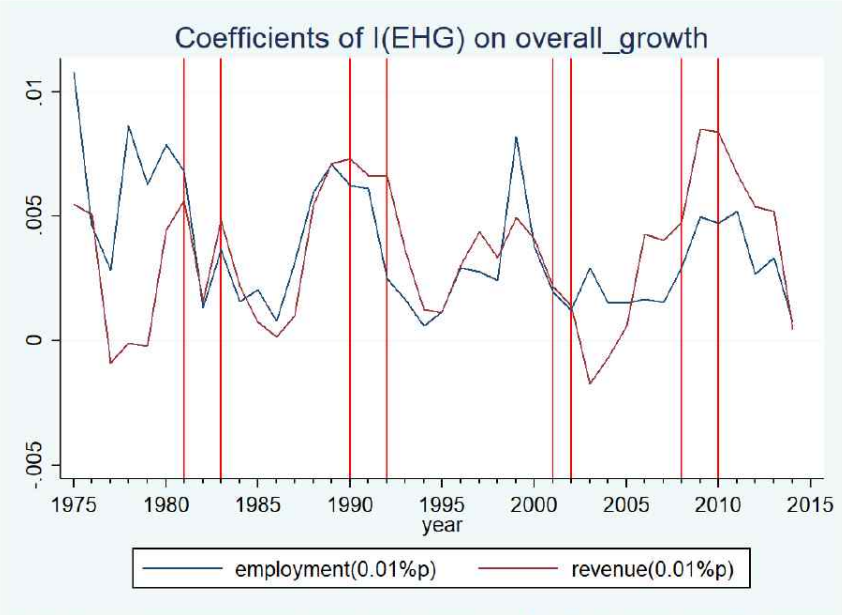
		panel D : 2008 Recession			
		Emp.		Sales	
		(1)	(2)	(1)	(2)
Overall_	I(EHG)	28.6*	29.2*	45.3***	47.6***
growth_MS	(1/mil. %p)	(1.81)	(1.89)	(2.83)	(3.21)
	Lag_growth		0.43***		0.65***
			(11.05)		(19.8)
Downturn_	I(EHG)	7.8	8.35	22.1*	24.2**
growth_MS	(1/mil. %p)	(0.7)	(0.78)	(1.87)	(2.33)
	Lag_growth		0.4***		0.61***
			(14.89)		(26.6)
Recovery_	I(EHG)	20.3***	20.1***	23.1***	23.4***
growth_MS	(1/mil. %p)	(2.67)	(2.62)	(2.56)	(2.59)
	Lag_growth		-0.014		0.04**
			(-0.73)		(2.01)
Industry fixed effect		O	O	O	O
Number of Firm Obs.		2,587	2,558	2,638	2,637

In conclusion, these results can be summarized as follows. First, significance of EHG for all recessions and for all dependent variables remain similar after controlling past performance. Second, for all recessions except 2001, EHG firms grow more than non-EHG firms between before recession period and after recession period, which is represented as *Overall_growth*, regardless of the existence of *Lag_growth*. And this is true for both revenue and employment. Third, for all recession periods rather than 2001, growth of EHG firms during recovery period, indicated as *Recovery_growth*, is higher than that of non-EHG firms for both revenue and employment. In contrast, significance of EHG during downturn period, indicated as *Downturn_growth*, is different across 4 recession times and between employment and revenue. For example, for *Downturn_growth* of employment, EHG plays a critical role in 1981 and 1990, while it is insignificant in 2001 and 2008. And for *Downturn_growth* of revenue, EHG through 1990 to 2008 is significant but that in 1981 is insignificant. This implies that regardless of *Downturn_growth*, EHG firms' higher growth in terms of employment and revenue market share are concentrated on the recovery periods.

4.2. DID Regression

Although EHG plays a powerful role in firm growth in terms of revenue and employment market share for recession periods, it is not clear that this result is unique for recessions. Particularly, EHG can be also significant when the same regression using equation (1) is done for other non-recession years. If so, the results in [Table 2] are not from the unique property of recession. In other words, EHG firms grow more than non-EHG firms occasionally regardless of recession periods and the significant results in [Table 2] for 1981, 1990, and 2008 recessions could be just a mere coincidence. Or, irrelevant to

[Figure 2] Coefficients of EHG for Overall_growth



Note: This figure represents estimated coefficients of $I(EHG)$ for $Overall\_growth$ dependent variable from the regression of equation (1) for all of the years from 1975 to 2015. The y-axis is the magnitude of coefficients which is scaled at 0.01%p and the x-axis is year. The red vertical lines show 4 recessions. The results of employment are shown in blue line and those of revenue are shown in brown line.

being recession periods, EHG firm always grows more than non-EHG firm on average.

[Figure 2] displays the coefficients of *I(EHG)* for *Overall_growth* dependent variable by conducting regression of equation (1) for each year from 1975 to 2014. The vertical red lines represent 4 recession periods. As can be seen in [Figure 2], there are suspicious patterns that around recession periods except 2001, coefficients of EHG for *Overall_growth* are larger than other routine periods.

For more thorough analysis, DID regression is implemented. In equation (2), the second term of right hand side represents the interaction term of EHG and recession period. *I(Rec)* is an indicator variable which has a value of 1 if the year equals either 1981, 1990, 2001, or 2008 and 0 for other years.

$$\begin{aligned} &Outcome\,growth_{f,t} \\ &= \alpha_0 + \alpha_1 [I(EHG)_{f,t} * I(Rec)_t] + \alpha_2 I(EHG)_{f,t} + \alpha_3 Lag\,growth_{f,t} \\ &\quad + Controls_{f,t} + I_t + I(industry)_f + \epsilon_{f,t} \end{aligned} \tag{2}$$

Here, the main interest is α_1. If α_1 turns out as being significant, it implies that in recession periods, EHG firms grow larger than non-EHG firms even compared to routine years. Therefore, it can be arguably concluded that there indeed exists the unique role of recessions. Again, in the regression, the dependent variable *outcome_growth* is either *Overall_growth*, *Downturn_growth*, or *Recovery_growth*. And control variables are the same with the regression of equation (1) except that year fixed effect term, I_t, is added since DID regression uses panel data. In this panel

regression, standard errors are clustered by year following Petersen(2009) and Thompson(2011). In these papers, it is said that when the number of time-cluster and that of firm-cluster are different substantially, then clustering standard error in the cluster with fewer number is better and the resulted standard error is almost similar with that of double clustering. In this regression, the number of year cluster is 7 and that of industry(SIC 4-digit level) is about 300 to 400 dependent on each recession. Therefore, using year clustering is better than using industry clustering.

DID regressions are conducted for separate time windows including 4 recession years. Each DID regression contains samples of a recession year, previous 4 years, and after 4 years excluding right before and after recession years. For example, in the case of 2008 recession, DID regression includes samples from 2004 to 2012 except 2007 and 2009. The resulting sample years are 2004-2006, 2008, and 2010-2012. The reason that I exclude right before and after years from DID regression sample is as follows. For each year, the dependent variables are calculated from 2-year average values of before 2-year, present 2-year, and after 2-year. In the case of 2007, *Overall_growth* is calculated as the average of 2009 and 2010 less the average of 2005 and 2006. Similarly, *Downturn_growth* is calculated as the average of 2007 and 2008 less the average of 2005 and 2006 and *Recovery_growth* is calculated as the average of 2009 and 2010 less the average of 2007 and 2008. Therefore, in those calculations, especially for *Downturn_growth* and *Recovery_growth*, the recession year 2008 is included. This can distort the overall regression result because

despite 2007 is not a recession year, its dependent variables include the negative shock information of 2008. Similarly, 2009 is excluded in this regard. And also, although 2009 is economic distress time with 2008, through dependent variables corresponding to 2008, the negative impact of recession period is already addressed.

[Table 3] Results of DID Regression for Each Recession Period

		Panel A : 1981 Recession[2]		Panel B : 1990 Recession	
		Emp.	Sales	Emp.	Sales
Overall_	I(EHG)*I(Rec)	0.124	16.1*	21.5*	44.7***
growth_MS	(1/mil. %p)	(0.01)	(2.43)	(2.38)	(4.2)
	I(EHG)	43.8***	19.3	24.4**	19.7*
	(1/mil. %p)	(4.28)	(1.58)	(2.64)	(1.99)
Downturn_	I(EHG)*I(Rec)	-3.92	4.58	3.64	14.9*
growth_MS	(1/mil. %p)	(-0.81)	(1)	(0.88)	(2.4)
	I(EHG)	17.8**	10.7	15.6**	11.1*
	(1/mil. %p)	(2.81)	(1.43)	(3.44)	(1.98)
Recovery_	I(EHG)*I(Rec)	3.8	14**	29.6***	30.6***
growth_MS	(1/mil. %p)	(0.73)	(2.81)	(6.13)	(6.39)
	I(EHG)	23***	7.52	9.15	8.83
	(1/mil. %p)	(6.5)	(0.84)	(1.7)	(1.67)
Industry&year fixed effect		O	O	O	O
Number of Firm Obs.		14,810	15,821	16,599	17,589
		Panel C : 2001 Recession		Panel D : 2008 Recession	
		Emp.	Sales	Emp.	Sales
Overall_	I(EHG)*I(Rec)	-17.5	13.1	4.64	30.6*
growth_MS	(1/mil. %p)	(-1.88)	(0.95)	(1.12)	(2.11)
	I(EHG)	31.8**	11.8	35.4***	35*
	(1/mil. %p)	(3.16)	(0.88)	(6.63)	(2.25)
Downturn_	I(EHG)*I(Rec)	-2.45	14.7*	-0.792	15.8
growth_MS	(1/mil. %p)	(-0.28)	(2.11)	(-0.25)	(1.49)
	I(EHG)	16.1	4.3	16.5***	13.9
	(1/mil. %p)	(1.8)	(0.69)	(5.08)	(1.44)
Recovery_	I(EHG)*I(Rec)	-18.6**	-2.92	5.38**	15.4*
growth_MS	(1/mil. %p)	(-3.61)	(-0.31)	(2.82)	(2.23)
	I(EHG)	14.6**	5.83	17.6***	20**
	(1/mil. %p)	(3.61)	(0.7)	(6.18)	(2.71)
Industry&year fixed effect		O	O	O	O
Number of Firm Obs.		19,270	21,260	18,998	19,600

2) The numbers in parenthesis are t-values. ***, **, and * denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

The results of DID regressions are presented in [Table 3]. As it shows, compared to the previous results of equation (1), the overall significance declines. This implies there are some similar results of equation (1) for non-recession years also. However, importantly, the results of *Overall_growth* survive especially for the revenue in 3 recession periods except 2001. Similar to equation (1), *Overall_growth* of the revenue market shares in 1981, 1990, and 2008 remains significant. For 1981 recession, *Overall_growth* and *Recovery_growth* of revenue are significant in 5% level and 1% level, respectively. However, significance of *Downturn_growth* is similarly low like the results of the regression using equation (1). According to the coefficient value of *I(EHG)* for *Overall_growth* which is 19.3 millionth percentage points, it cannot be said that EHG firms ordinarily grow more than non-EHG firms because it is not statistically significant although it is economically large. Contrarily, during recession period, EHG firms grow more than non-EHG firms in terms of market share of revenue. The coefficient of EHG firm is 16.1 millionth percentage points and it is statistically significant in 10% level. In other words, during ordinary times, EHG firm increases its revenue market share about 19.3 millionth percentage points more than non-EHG firm even though it is not significant. In contrast, during recession period, the difference between growth in revenue market share of EHG firm and non-EHG firm becomes much bigger than that of ordinary times about 16.1 millionth percentage points, all else equal. And from the results of *Downturn_growth* and *Recovery_growth*, most of this higher growth in revenue market share during recession

period comes from the growth during recovery times rather than downturn times. This is because, coefficient of the interaction term for *Downturn_growth* is 4.58 millionth percentage points which is statistically insignificant and economically marginal while that for *Recovery_growth* is 14 millionth percentage points which is statistically significant in 5% level and economically substantial. Therefore, almost all of increments in the difference between revenue market share growth of EHG firms and non-EHG firms during recession period compared to routine times are rooted from recovery time.

These interpretations for the results of 1981 recession can be also applied to 1990 and 2008 recessions. For 1990 recession case, EHG firm's market share of revenue increases about 19.7 millionth percentage points more than non-EHG firm's during ordinary years. And this significant difference between sales market share of EHG and non-EHG firm gets larger about 44.7 millionth percentage points for recession year. This is statistically significant and economically very large because, on average, during recession times, EHG firms grow about 3 times faster than routine times from 19.7 to 64.4(=19.7+44.7). And two-thirds of this overall higher growth in recession year comes from that of recovery period like 1981 case. One different result is that in 1990, there is also a significant contribution of the interaction term of recession and EHG for *Downturn_growth* to that for *Overall_growth*. Although *Downturn_growth* is significant in 10% level, its contribution to *Overall_growth* is about one-third of total *Overall_growth*. In 2008 recession, despite the significance of the interaction term for *Overall_growth* and *Recovery_growth* of

revenue are relatively weak compared to 1990 recession case, they are still significant in 10% level and their t-values are above 2. All else being constant, EHG firm's revenue market share growth in normal years is bigger than that of non-EHG firm about 35 millionth percentage points. And this growth gap becomes much larger in recession year about 30.6 percentage points. However, unlike 1981 and 1990 recessions, for the role of the interaction term, relative contributions of *Downturn_growth* and *Recovery_growth* to *Overall_growth* are similar with each other although the statistical significance of *Downturn_growth* is low. Also, in 1981 and 1990 recessions, indicator variables of EHG are insignificant or less significant compared to the regression of equation (1) for both *Overall_growth* and *Recovery_growth* of revenue. For 2008, however, those same coefficients are strongly survive. These results implicitly show that around 2008, although the role of recession exists, lower but similarly powerful role of EHG indicator exists during ordinary years.

In contrast to the results of revenue, market share of employment does not seem to show powerful role of recession in almost all recession cases. For *Overall_growth* only for 1990 recession, there is a significant result for the role of recession and EHG interaction term. Instead, EHG plays a critical role for the growth in market share of employment for all recession events and for 3 dependent variables. It can be supposed, therefore, that for the case of employment, EHG firms increase their market shares usually during general times and this pattern is not that different quantitatively in recession years. To

summarize, in the case of revenue market share, EHG firms indeed grow much larger than non-EHG firms during recession years compared to routine times. And it is noteworthy that the powerful role of recession is mostly based on recovery periods which can be checked by watching the results of *Recovery_growth.* Antithetical to revenue, for the case of employment market share, recession does not display uniquely strong role for all 1981, 1990, 2001, and 2008 recession events.

4.3. Robustness Tests

4.3.1. Survivorship Bias

From the DID regression, it can be decisively asserted that there genuinely exists the special role of recession for the growth of market share in revenue of EHG firms. Except only 1 recession, 2001, which is said to be an opaque downturn period, the coefficients of recession and EHG interaction term for *Overall_growth* are significant. There is, however, another concern to deal with: a survivorship bias. That is, the powerful role of EHG especially in recession times could be rooted from a bias not from a real phenomenon.

Generally, high ptb firms are said to have high growth opportunities(Kogan and Papanikolaou(2014)). And these firms usually invest in R&D more, are small or medium sized, and are young firms which can be seen in [Table 1]. Therefore, their investment projects could be riskier than low ptb firms' investment projects. This is because, R&D investments are generally referred to as uncertain and high risk projects. More risky investments generate more profitable projects if they succeed, but can lead firms to bankrupt or at least to get more loss if they fail. Moreover, recession times are good times for those vulnerable firms to crush. In this regard, it could be the case that existing samples which have *I(EHG)* value of 1 are those firms that their risky projects have succeeded and thus, grow more rapidly. Firms which have *I(EHG)* value of 1 but are

not included in the sample are those firms that their chancy investments have failed and disappeared. Then this can make the remaining EHG firms' growth look more attractive and robust especially in recession periods, which is not a real truth.

To alleviate this problem, I manipulate the original sample data to retain disappeared firms for four more years with having zero revenue and employment. Their another financial statement information such as asset, leverage, and cash are assumed to be identical with those of the last year they appear in the original WRDS sample data. Only age data are changed timely. Below, I provide the order of this procedure in detail.

1. First, for firms in the original data, generate *last_year* variable which indicates the year when the firm exists on the sample lastly.

2. Second, for each firm, append additional 4 fictional observations after the *last_year* of the firm.

- For example, if firm A exists from 1980 to 1990 in the original data, then 1990 is the *last_year* of firm A. And add new imaginary 4 observations of firm A from 1981 to 1984.

- These additional observations have the same variable values with those of the *last_year* except few variables. Age and year variables are changed along the time order, and ptb ratio values are set to missing values. Revenue and employment data are set to 0 to reflect the fact that these observations are from default firms which indeed have zero employments and revenues.

3. Third, from this new data set including additional 4-year default firm observations, calculate quantile of previous 2-year average of ptb ratios and the variable *I(EHG)*. Since default firms are included when deriving quantile of average ptb ratios among all firms for each year, the resulting quantile numbers could be different with those from the original data set.

- Suppose firm A's *last_year* is 1980. Then, originally, since the time window of each year t to calculate 3 dependent variables is from t-2 to t+3, in 1977(in which t+3 corresponds to 1980), all the necessary data to derive dependent variables of firm A exist. However, from 1978 to 1980, it is impossible to calculate those dependent variables because there is no observation of firm A after 1980. For example, *Overall_growth* of firm A in 1978 requires data from 1976 to 1981. Therefore, from 1978, there is no observation of dependent variables of firm A even though the firm exists until 1980. Therefore, by adding 3 additional fictional observations of firm A from 1981 to 1983, it is possible to derive dependent variables of firm A until 1980.

- The reason why I add 4, not 3, additional observations is as follows. In the case of the above firm A, it has ptb ratio values in 1979 and 1980. Therefore, we can derive the 2-year average ptb ratio in 1981, the time when firm A actually does not exist. If this average ptb ratio of firm A is included in quantile of 10 in 1981, then the firm A belongs to EHG but bankrupted unfortunately. Then, to address the concern of the possibility that high ptb firms exert more risky projects which are more likely to lead those firms to bankrupt, it is necessary to include firm A in year 1981 also. Therefore, to calculate

dependent variables of firm A in 1981, we need data until 1984 of firm A. This is the reason why I add 4 observations.

4. Lastly, follow the same procedure with the above DID regression using equation (2) for each recession event.

[Table 4] shows the results of DID regressions with default firms. This is the same analysis with [Table 3] except, in this case, default firms have been included. Overall, surprisingly, results of recession and EHG interaction term are almost analogous to [Table 3] qualitatively while quantitatively, those coefficients are smaller than those of [Table 3]. For example, for *Overall_growth* of revenue, coefficients of the interaction term decrease from 16.1, 44.7, and 30.6 to 15.9, 29.4, and 25.4 respectively for 1981, 1990, and 2008 recessions. This pattern is similar for *Recovery_growth* of revenue in that coefficients of the interaction term diminish from 30.6 and 15.4 to 20.5 and 10.8 respectively for 1990 and 2008 recessions. However, once again, the important point is that significance of the interaction term for both *Overall_growth* and *Recovery_growth* of revenue remain constantly after taking a survivorship bias into consideration for 1981, 1990, and 2008 recession cases. These results show that the powerful results of [Table 3] do not seem to be based on a survivorship bias. They are not the results which are contaminated by a bias but the results from some fundamental factors. Therefore, in the next section, I proceed to analyze channels of the results of [Table 3].

[Table 4] Results of DID Regression with Default Firms

		Panel A : 1981 Recession[3]		Panel B : 1990 Recession	
		Emp.	Sales	Emp.	Sales
Overall_	I(EHG)*I(Rec)	-2.99	15.9**	14.2**	29.4***
growth_MS	(1/mil. %p)	(-0.45)	(2.94)	(2.66)	(6.31)
	I(EHG)	45.8***	24.2**	33.4***	19.4***
	(1/mil. %p)	(5.32)	(2.46)	(4.79)	(3.75)
Downturn_	I(EHG)*I(Rec)	-2.43	3.58	1.71	9.42**
growth_MS	(1/mil. %p)	(-0.74)	(0.88)	(0.61)	(2.86)
	I(EHG)	20***	14*	19.7***	10.9**
	(1/mil. %p)	(3.99)	(2.26)	(6.28)	(3.25)
Recovery_	I(EHG)*I(Rec)	-2.05	14.7**	22.4***	20.5***
growth_MS	(1/mil. %p)	(-0.68)	(3.6)	(7.56)	(8.15)
	I(EHG)	24***	9.18	14.5**	8.54**
	(1/mil. %p)	(7.6)	(1.32)	(3.12)	(2.57)
Industry&year fixed effect		O	O	O	O
Number of Firm Obs.		19,286	20,662	21.483	22,901
		Panel C : 2001 Recession		Panel D : 2008 Recession	
		Emp.	Sales	Emp.	Sales
Overall_	I(EHG)*I(Rec)	-6.09	21.8	2.07	25.4**
growth_MS	(1/mil. %p)	(-1.11)	(1.8)	(0.73)	(2.65)
	I(EHG)	32.9***	16	37.2***	24.5*
	(1/mil. %p)	(4.85)	(1.31)	(9.84)	(2.19)
Downturn_	I(EHG)*I(Rec)	5.99	20.7**	-3.6	15.2*
growth_MS	(1/mil. %p)	(1.15)	(3.58)	(-1.84)	(2.14)
	I(EHG)	16.8**	9.17	17.8***	10.1
	(1/mil. %p)	(3.18)	(1.64)	(6.89)	(1.52)
Recovery_	I(EHG)*I(Rec)	-15***	-0.56	5.02**	10.8*
growth_MS	(1/mil. %p)	(-5.2)	(-0.07)	(2.87)	(2.05)
	I(EHG)	14.4***	4.64	18.1***	13.4**
	(1/mil. %p)	(5.56)	(0.65)	(8.97)	(2.53)
Industry&year fixed effect		O	O	O	O
Number of Firm Obs.		27,132	30,193	24,685	25,543

3) The numbers in parenthesis are t-values. ***, **, and * denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

4.3.2. Endogenous Threshold Model

In this subsection, I conduct other type of quantitative model by referring to Seo and Shin(2016). This model considers dynamic panels with threshold effect and endogeneity. The unique property of this model is the ability of it to estimate main regressors and endogenously determined threshold value simultaneously. In other words, previously, I analyzed the aspects of firm growth during predetermined recession periods from NBER. This new method, however, estimates the role of EHG indicator and optimized threshold value for annual GDP growth rate, which is used to determine economic bad years, at the same time. Because this model does not assume certain recession periods in advance, the analysis can be done in a more thorough and comprehensive manner.

Also, by utilizing this alternative model, I can provide additional supportive evidence for the argument of this paper. First of all, the possibility that there could be other economic harsh times other than official recession periods can be investigated. In this case, the threshold model can identify proper economic contraction years and firm growth aspects of EHG firms during these hard times. To be specific, if the resulting economic bad years are analogous to the official recession years, the reasonability of the unique role of recessions can be reinforced in the sense that even without the assumption for recession times, these years can be identified through endogenous threshold model. And if the results are consistent with the original analysis, those results can be said robust.

There are some constraints to implement this substitute model. First, the model can be used only for strongly balanced panel data. Unfortunately, since the dataset used in this paper is unbalanced, only firms which exist for the entire sample years are utilized. Therefore, the number of final remaining sample firms is lower than that of the previous analysis. Also, from this elimination, the proportion of EHG firms is about 10~15% while originally, that of EHG firms was 20% by setting. Second, for now, because the model does not incorporate error clustering method, standard errors can be underestimated to some extent. Third, the results could be susceptible to trim rate in this model. Particularly, trim rate specifies the range of usage of transition variable, *GDP rate*. For example, according to the 'help' of the function *xthenreg* in Stata, if the trim rate is 0.2, the start and end points of the grid are 0.1 quantile and 0.9 quantile of *GDP rate*. The default value of trim rate is 0.4 and I report the results of various values of trim rate from 0.4 to 0 in a 0.1 interval. Finally, in this case, there is no pre-existing recession periods. Consequently, it is more appropriate to use annual data not 2-year mean value for firm growth measure. This is because, in the previous analysis, 4 recessions except 2001 lasted for almost 2 years and to compare the before-recession states and after-recession states, I used 2-year mean value for the derivation of growth variables. Moreover, the threshold model uses annual GDP growth rate data to determine economic hard regimes and because of these, it can provide more clear results to utilize yearly growth measure not 2-year mean value.

$$\begin{aligned}\triangle growth_{f,t+1} &= I(GDPrate_t \leqq \gamma)[\alpha_1 I(EHG)_{f,t} + controls_{f,t}] \\ &+ I(GDPrate_t > \gamma)[\alpha_2 I(EHG)_{f,t} + controls_{f,t}] + \epsilon_{f,t} \\ where \quad & \epsilon_{f,t} = \alpha_f + \nu_{f,t} \\ & \triangle growth_{f,t+1} = MS_{f,t+1} - MS_{f,t}\end{aligned} \tag{3}$$

The model is conducted using the equation (3). This model can be implemented simply from Stata using *xthenreg* function. The main coefficients and parameter are α_1, α_2, and γ. γ is the threshold parameter and it will be estimated endogenously with *I(EHG)* variables' coefficients. After gamma is estimated, lower regime with respect to annual GDP growth rate and corresponding economic bad years can be determined. In the equation (3), *GDP rate* is annual GDP growth rate and *controls* include past performance, lagged market share, asset, leverage, age, and cash which are identical to those of the equation (2). As the error term incorporates α_f, this means that the model takes fixed effects into consideration. The dependent variable is one year change in revenue market share. In this case, I do not analyze the case of employment since the results of it are not that meaningful. Note that, there are two candidate dependent variables which are the growth from t-1 to t and the growth from t to t+1. However, between these two growth measures, I use the latter one to minimize contemporaneous bias. Specifically, because the transition variable, *GDP rate*, which is used to determine lower regime, is the change rate from t-1 to t, if the dependent variable is also the market share change from t-1 to t, there could be some contemporaneous correlation. To mitigate this problem, I use the growth measure which calculates the increment between t and t+1. This may correspond to *Recovery growth* in the previous analysis.

[Table 5] Results of Dynamic Panel Threshold Model

		Panel A : 1974 - 2014				
Trim rate		0.4	0.3	0.2	0.1	0
I(EHG) (1/mil. %p)						
	lower regime	181***[4]	181***	181***	181***	181***
		(230.1)	(230.1)	(230)	(230)	(230)
	upper regime	-280***	-280***	-280***	-280***	-280***
		(-455.7)	(-455.8)	(-455.8)	(-455.9)	(-455.8)
Gamma		1.6				
Corresponding bad years		74, 75, 80, 82, 91, 01, 08, 09, 11				
Number of different firms		236				
Number of sample years		41				
Proportion of EHG firms		15.64%				
		Panel B : 1984 - 2014				
Trim rate		0.4	0.3	0.2	0.1	0
I(EHG) (1/mil. %p)						
	lower regime	321***	387***	387***	387***	387***
		(438.01)	(358.93)	(358.93)	(358.93)	(358.93)
	upper regime	-421***	-468***	-468***	-468***	-468***
		(-655.69)	(-489.13)	(-489.13)	(-489.13)	(-489.13)
Gamma		1.8		1.6		
Corresponding bad years		91, 01, 02, 08, 09, 11, 13		91, 01, 08, 09, 11		
Number of different firms		447				
Number of sample years		31				
Proportion of EHG firms		12.87%				

4) The numbers in parenthesis are z-values. ***, **, and * denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

[Table 5] shows the results of dynamic panel threshold model for two sample year cases, 1974 to 2014 and 1984 to 2014. The table reports estimated values of coefficients of *I(EHG)* and gamma. The results turn out to be consistent with the original analysis. The coefficients of EHG indicator are positive for lower legimes(bad times) for both panel A and panel B while those are negative for upper regimes(good times) for both panel A and B. This implies that during economic bad times, EHG firm grow larger than non-EHG firm on average whereas during good times, the growth aspects of EHG firms are lower than those of non-EHG firms. Furthermore, surprisingly, years belong to lower regime corresponding to the estimated threshold value for annual GDP growth rate are almost identical to the official recession years. There are only few additional years which are identified as economic bad years such as 2011 in the panel A and 2002, 2011, and 2013 in the panel B. Therefore, from these results, the legitimacy of the previous results can be strengthened.

5. Growth Channel Analysis

In this section, I investigate a channel for the high growth of EHG during recession periods. This analysis is conducted through analyzing the roles of core inputs of firms' businesses: R&D and capital investments and stocks.

5.1. R&D and Capital Investments

Research and development expenditures(XRD) and capital expenditures(CAPX) are among the imperative sources of firms' growth. They are said to be the main drivers of firms' growth. These activities generate productive intangible assets or capital stocks which are used directly or indirectly in production. In this context, suppose that EHG firms increase their capital stocks and intangible assets, or XRD and CAPX relatively more than non-EHG firms usually and especially much more during recession periods. Then it could be the case that the results of [Table 3] are rooted from these increased amounts of investments which are related to enhanced production in the future. To explore this possibility, DIDID regression is implemented using the equation (4).

$$\begin{aligned} &Overall\,growth_{f,t} \\ &= \beta_1[I(EHG)_{f,t} * I(Rec)_t * XRD\,growth_{f,t}] \\ &+ \beta_2[I(EHG)_{f,t} * I(Rec)_t * I(zero\,XRD)_{f,t}] \\ &+ \beta_3[I(EHG)_{f,t} * I(Rec)_t * CAPX\,growth_{f,t}] \\ &+ \alpha_0 + \alpha_1[I(EHG)_{f,t} * I(Rec)_t] + \alpha_2 I(EHG)_{f,t} \\ &+ Controls_{f,t} + I_t + I(industry)_f + \epsilon_{f,t} \end{aligned} \tag{4}$$

Here, *XRD_growth* and *CAPX_growth* are the overall growth from before 2-year to after 2-year in R&D expenditures and capital expenditures. These are compatible with *Overall_growth* dependent variable above in the sense that they are all calculated from mean change between before 2-year and after 2-year intervals. One manipulation for *XRD_growth* and *CAPX_growth* is that, to make it easier to interpret the results, they are normalized so that one unit change in *XRD_growth* or *CAPX_growth* is equal to the difference between the 90th and 10th percentile values following Hershbein and Kahn(2018). Note, when normalizing *XRD_growth,* 90th and 10th percentile values are derived from samples excluding firms which have the below *I(zero_XRD)* value of 1 to capture the authentic gap between 90th and 10th percentile among effectively executing XRD. The new indicator variable *I(zero_XRD)* is added to the regression to address some concerns related to the discrepancy existing in zero *XRD_growth*. To be specific, unlike capital expenditures, more than half of firms do not spend their budget on R&D expenditures at all. These firms' R&D expenditures are always zero and thus, values of *XRD_growth* are also zero. However, zero value in *XRD_growth* of these zero-R&D expenditures firms and those of positive-R&D expenditures are qualitatively different. The former case is derived from 0 to 0 change, while the latter case is derived from a positive value to the same positive value. This leads to the conclusion that there should be a proper handling to separate those two cases. In this regard, *I(zero_XRD)* is included in the regression. This indicator variable has the value of 1 if a firm's R&D expenditures in before 2-year and

after 2-year periods are all zero and 0 otherwise. Therefore, it represents some kind of non-R&D investing firms or non-R&D intensive firms. The regression is implemented in 4 ways: (1) no betas, (2) only R&D expenditures related terms, β_1 and β_2, (3) only capital expenditures related term, β_3, (4) all betas included. The results of these four cases are reported through column (1) to (4) in [Table 6], respectively. Note that standard errors are clustered by year analogous to the previous regressions.

[Table 6] Results of Channel Analysis for Investment Flow Variables

		Panel A : 1981 Recession			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	16.1*	-53.1***	8.42*	-42.4***
growth_MS	(1/mil. %p)	(2.43)	(-10.1)	(2.24)	(-8.34)
	I(EHG)	19.3	19.6	14	14.4
	(1/mil. %p)	(1.58)	(1.62)	(1.05)	(1.08)
	I(EHG)I(Rec) XRD_growth (1/mil. %p)		84.8***		64.1***
			(17.96)		(24.33)
	I(EHG)I(Rec) I(Zero_XRD) (1/mil. %p)		56**		45.1***
			(3.44)		(3.96)
	I(EHG)I(Rec) CAPX_growth (1/mil. %p)			-69.1***	-22.1***
				(-12.16)	(-3.56)
Number of Firm Obs.		15,821	15,821	14,378	14,378
		Panel B : 1990 Recession			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	44.7***	-8.59	-4.54	-12.9
growth_MS	(1/mil. %p)	(4.2)	(-0.67)	(-0.39)	(-0.98)
	I(EHG)	19.7*	19.8*	20.6*	20.4*
	(1/mil. %p)	(1.99)	(1.99)	(2.02)	(2)
	I(EHG)I(Rec) XRD_growth (1/mil. %p)		23.3***		-4.38
			(8.3)		(-1.92)
	I(EHG)I(Rec) I(Zero_XRD) (1/mil. %p)		82.9***		23.1***
			(13.24)		(3.84)
	I(EHG)I(Rec) CAPX_growth (1/mil. %p)			94.3***	94.7***
				(24.45)	(26.1)
Number of Firm Obs.		17,589	17,589	16,142	16,142
Industry fixed effect		O	O	O	O
Year fixed effect		O	O	O	O

- *Contiuned*

		Panel C : 2001 Recession[5]			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	13.1	-16.1	36.4**	2.68
growth_MS	(1/mil. %p)	(0.95)	(-1.44)	(2.89)	(0.28)
	I(EHG)	11.8	12.2	11.4	11.5
	(1/mil. %p)	(0.88)	(0.91)	(0.99)	(1)
	I(EHG)I(Rec) XRD_growth (1/mil. %p)		15.6***		12.6***
			(35.44)		(31.26)
	I(EHG)I(Rec) I(Zero_XRD) (1/mil. %p)		61.2***		83.8***
			(5.4)		(6.99)
	I(EHG)I(Rec) CAPX_growth (1/mil. %p)			39.9***	37.8***
				(72.36)	(86.3)
Number of Firm Obs.		21,260	21,260	18,471	18,471

		Panel D : 2008 Recession			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	30.6*	7.62	12.9	-0.04
growth_MS	(1/mil. %p)	(2.11)	(0.48)	(1.01)	(0)
	I(EHG)	35*	35.1*	34.4	34.7*
	(1/mil. %p)	(2.25)	(2.26)	(2.2)	(2.23)
	I(EHG)I(Rec) XRD_growth (1/mil. %p)		35.4***		24.7***
			(34.04)		(30.02)
	I(EHG)I(Rec) I(Zero_XRD) (1/mil. %p)		7.54		6.7
			(1.57)		(1.31)
	I(EHG)I(Rec) CAPX_growth (1/mil. %p)			85.4***	63.1***
				(31.99)	(25.8)
Number of Firm Obs.		19,600	19,600	18,720	18,720
Industry fixed effect		O	O	O	O
Year fixed effect		O	O	O	O

5) The numbers in parenthesis are t-values. ***, **, and * denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

[Table 6] shows the results of DIDID regression of equation (4) only for revenue, not for employment. This is because, from [Table 3], the results for employment are insignificant compared to those for revenue which makes the channel analysis for employment to be irrelevant to some extent. Also, the results are reported only for the dependent variable, *overall_growth* apart from *Downturn_growth* and *Recovery_growth* because time coverage of the main regressors, *XRD_growth* and *CAPX_growth,* is corresponding to *Overall_growth.* As shown from column (2) in [Table 6], XRD alone plays a significantly positive role during recession periods for EHG firms. That is, EHG firms in recession periods with higher increments in R&D investments grow more than EHG firms in recession periods with lower increments or negative changes in R&D investments. Surely, the magnitude of significance for each recession period is quite divergent. Their coefficient values range from 15.6 to 84.8 millionth percentage points. In other words, on average, switch from 10th percentile to 90th percentile of the amount of increase in XRD raises revenue market share from 15.6 millionth percentage points to 84.8 millionth percentage points for EHG firm in recession period. Similarly, CAPX also plays a greatly positive role in growth of revenue market share except the case of 1981 recession. In 1981 recession, the increase in the amount of CAPX negatively affects firm growth which is, to some extent, counter-intuitive. In the case of column (4), overall results are similar to those of column (2) and (3) except for 1990 recession. Specifically, in 1990 recession, significance of XRD fades away when CAPX term is incorporated. In column (2) where only

XRD-related terms are included, XRD is significant while in column (4) where in addition to XRD-related terms, CAPX term is covered, significance of XRD term dies out. And rather, although it is statistically insignificant, the direction of coefficient is negative. Along with the negative result of CAPX in 1981 recession, one suggestive conjecture for these negative impacts of investments on firm growth is that they may have emerged from a kind of overinvestment problem. For example, firms with too much investment during recession periods can be led to financial distress and deterioration in firm performances. Consistently, in García-Manjón and Romero-Merino(2012), it is said that R&D intensity which is defined as the ratio of XRD to sales could negatively affects growth rates of firms' sales in certain industries. Apart from these exceptional cases, XRD and CAPX generally are conducive to firm growth of EHG firms during recession periods. Note that, for the role of *I(zero_XRD)* term, the results are qualitatively analogous between column (2) and (4) although quantitatively, they are disparate to some degrees. And except for 2008 recession case, *I(zero_XRD)* plays positive role on firm growth which means that all else equal, EHG firms with no R&D investments perform better than EHG firms with positive R&D investments during recession periods on average.

One other thing that should be pointed out is the dynamic of significance of the interaction term between recession and EHG. For all recessions, significance of this variable vanishes or switches into negative direction. Particularly, for 1981, 1990, and 2008 recessions, the interaction terms are originally all

statistically significant in positive direction. However, as seen in column (4), the result for the interaction term is negatively significant for 1981 recession, and those are insignificant for 1990 and 2008 cases. From these results, it can be concluded that the initially positive role of EHG during recession is mainly based on the growth performances of EHG firms which have increased their innovative or capital investments during recessions. That is, only those EHG firms which have done more efforts during recessions show superior performances over other firms. It is consistent with the argument of Schumpeter's creative destruction. According to his rationale, firms grow by innovative activities during economic hard time and this makes new firms to take the original stacks of incumbent firms in terms of economic weights. Similar to this story, the results of [Table 6] demonstrate that firms which are highly expected to grow in the future indeed grow faster than other firms if they conduct some more endeavors during recession periods.

5.2. R&D and Capital Stocks

[Table 7] shows the same DIDID analysis with [Table 6], except that in this case, the main regressors are not the changes in flow variables, R&D and capital expenditures, but the changes in stock variables, R&D stock and property, plant, and equipment net(hereafter, PPENT). PPENT data is available directly from Compustat database while R&D stock data is not. Therefore, based on Chan et al.(2001)(referred to CLS hereafter), I generate R&D stock data. The difference with CLS is that in this paper,

R&D stock is calculated as the maximum value between the original R&D capital which is derived by following the procedure of CLS and the value of intangible others(INTANO). Again, INTANO includes proprietary technology, copyrights, patents, licensing agreements, and website domain names. Therefore, INTANO represents some research or innovation related assets in a firm which is the reason why I use the maximum of original CLS-style R&D capital and INTANO as R&D stock. In other words, basically, I use CLS-style R&D capital but in the case that this value is less than INTANO, then to reflect some possibilities that a firm does not work on R&D activities directly, but buy some patents or get licenses from outside the company, the value of INTANO is used as R&D stock. In this case, the naive R&D capital could be very low or even zero while the actual budget assigned to innovation or technology of the firm are very large. From here, I would call this managed R&D stock as RDCAP.

$$R\&D\ capital_{f,t} = 0.2XRD_{f,t-4} + 0.4XRD_{f,t-3} + 0.6XRD_{f,t-2} + 0.8XRD_{f,t-1} + XRD_{f,t}$$

$$RDCAP_{f,t} = \max[R\&D\ capital_{f,t}, INTANO_{f,t}]$$

Analogous to the case of equation (4), I generate the indicator variable, *I(zero_RDCAP)*, which has the value of 1 if the values of RDCAP are zero for all before 2-year and after 2-year periods. Otherwise, the value is set to 0. The roles of *RDCAP_growth* and *PPENT_growth* correspond to those of *XRD_growth* and *CAPX_growth,* respectively. Also, *RDCAP_growth* and *PPENT_growth* are normalized just in the same way with *XRD_growth* and *CAPX_growth.*

[Table 7] Results of Channel Analysis for Investment Stock Variables

		Panel A : 1981 Recession			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	16.1*	-60.9***	23.3**	-57***
growth_MS	(1/mil. %p)	(2.43)	(-10.17)	(2.8)	(-9.68)
	I(EHG)	19.3	19.7	19.5	20
	(1/mil. %p)	(1.58)	(1.62)	(1.58)	(1.62)
	I(EHG)I(Rec) XRD_growth (1/mil. %p)		93.7***		93.4***
			(19.5)		(20.05)
	I(EHG)I(Rec) I(Zero_XRD) (1/mil. %p)		63.7***		67.6**
			(3.79)		(3.64)
	I(EHG)I(Rec) CAPX_growth (1/mil. %p)			-16.7**	-12.2*
				(-3.48)	(-2.33)
Number of Firm Obs.		15,821	15,821	15,749	15,749
		Panel B : 1990 Recession			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	44.7***	10.6	-15.4	-9.73
growth_MS	(1/mil. %p)	(4.2)	(0.88)	(-1.19)	(-0.76)
	I(EHG)	19.7*	19.5*	20.1*	19.9*
	(1/mil. %p)	(1.99)	(1.97)	(2.01)	(2)
	I(EHG)I(Rec) XRD_growth (1/mil. %p)		8.65***		-6.86***
			(5.57)		(-6.55)
	I(EHG)I(Rec) I(Zero_XRD) (1/mil. %p)		84.4***		-4.98
			(13.05)		(-0.8)
	I(EHG)I(Rec) CAPX_growth (1/mil. %p)			104***	106.2***
				(21.15)	(22.57)
Number of Firm Obs.		17,589	17,589	17,447	17,447
Industry fixed effect		O	O	O	O
Year fixed effect		O	O	O	O

- *Contiuned*

		Panel C : 2001 Recession[6]			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	13.1	-22.5*	-24.1*	-27.7**
growth_MS	(1/mil. %p)	(0.95)	(-2.05)	(-2.24)	(-2.69)
	I(EHG)	11.8	11.8	12.5	12.4
	(1/mil. %p)	(0.88)	(0.87)	(0.99)	(0.98)
	I(EHG)I(Rec) XRD_growth		16.4***		5.2***
	(1/mil. %p)		(13.14)		(6.87)
	I(EHG)I(Rec) I(Zero_XRD)		136.9***		-4.72
	(1/mil. %p)		(7.62)		(-0.88)
	I(EHG)I(Rec) CAPX_growth			55.5***	49.5***
	(1/mil. %p)			(11.35)	(10.18)
Number of Firm Obs.		21,260	21,260	20.994	20,994

		Panel D : 2008 Recession			
		(1)	(2)	(3)	(4)
Overall_	I(EHG)I(Rec)	30.6*	9.16	-2.19	-4.38
growth_MS	(1/mil. %p)	(2.11)	(0.57)	(-0.14)	(-0.27)
	I(EHG)	35*	35.2*	34.7*	35.1*
	(1/mil. %p)	(2.25)	(2.27)	(2.26)	(2.3)
	I(EHG)I(Rec) XRD_growth		20.5***		13***
	(1/mil. %p)		(14.12)		(8.79)
	I(EHG)I(Rec) I(Zero_XRD)		-25.6		-49.3**
	(1/mil. %p)		(-1.65)		(-3.31)
	I(EHG)I(Rec) CAPX_growth			73.4***	52.6***
	(1/mil. %p)			(17.7)	(12.82)
Number of Firm Obs.		19,600	19,600	19.394	19,394
Industry fixed effect		O	O	O	O
Year fixed effect		O	O	O	O

6) The numbers in parenthesis are t-values. ***, **, and * denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

As shown in [Table 7], the overall results are almost same with those of [Table 6]. In column (2) from panel A to D, RDCAP positively affects firm growth very significantly. For the case of PPENT, except 1981 recession, EHG firm with higher PPENT growth increases its revenue market share more than EHG firm with lower PPENT growth during recession years. From column (2), on average, switch from 10th percentile to 90th percentile of the amount of increase in RDCAP raises sales market share from 8.65 millionth percentage points to 93.7 millionth percentage points for EHG firm in recession period. Similarly, from column (3), all else being constant, switch from 10th percentile to 90th percentile of the amount of increase in PPENT raises sales market share from 55.5 millionth percentage points to 104 millionth percentage points for EHG firm in recession period except for 1981 recession. For column (4), the results of RDCAP and PPENT remain almost same with each of column (2) and (3) although the magnitude for RDCAP generally decreases compared to that of column (2). Like the results of [Table 6], the signs of PPENT in 1981 recession and RDCAP in 1990 recession are also negative. However, apart from these 2 disparate results, overall results of RDCAP and PPENT indicate that they affect revenue market share growth positively for EHG firms in recession times.

6. Conclusion

This paper looks into the dynamics of firm growth during recession periods focused on firms' growth aspects and the relationship between investment behaviors and growth. The aim of the analysis is to shed additional light on Schumpeter's creative destruction argument and related opportunity cost hypothesis from Aghion and Saint-Paul(1998). I use a panel of U.S. listed firms from almost all industries, except financial and agricultural firms, covering recessions in 1981, 1990, 2001, and 2008. I especially concentrate on the properties of predetermined expected high-growth firms which are viewed attractive and promising by investors. By utilizing a price-to-book ratio and the proposition that price-to-book ratios are positively correlated with firms' growth opportunities from finance literature like Kogan and Papanikolaou(2014), I generate the new indicator variable of expected high-growth(EHG) firms.

The results from DID regression confirm that those firms which are anticipated to grow more in the future indeed grow faster than other non-EHG firms in terms of absolute changes in revenue market shares especially during economically hard times. For all recession events except 2001 contraction case, EHG firms surpass non-EHG firms in terms of revenue market share growth even compared to the routine years. Therefore, it can be argued that recession plays a critical role on EHG firms' growth in revenue weights. Unlike the case of revenue, employment market share growth does not show any significant result during most of

recession periods. These results are robust to a survivorship bias which can arise from the fact that EHG firms generally spend more resources on R&D investments which is said to be uncertain and risky projects.

Moreover, from the channel analysis for revenue share growth by conducting DIDID regression, it is shown that EHG firms with bigger increases in investments of R&D or capital during recession periods grow much more than EHG firms with lower increments in those investments. Therefore, positive role of R&D or capital investments is verified for the case of EHG firms during recessions. However, what is the most important result is that after introducing those investment-related terms in regression, originally positive and strong role of recession on EHG firms' growth either vanishes or turns into negative direction. This indicates that the powerful result of the recession is solely rooted from the role of EHG firms which have higher growth in investments or investment-related stocks during recessions. Therefore, it can be a supportive evidence for Schumpeterian theory and opportunity cost hypothesis in the sense that there are firms that grow more during recessions than other firms if they have spent more resources on productivity enhancing activities during that tough times.

Surely, these results do not imply that R&D or capital investments are counter-cyclical which is the core argument of opportunity cost hypothesis. Rather, this paper shows that among specially chosen firms(here, EHG firms), the larger their increase in R&D or capital investments during recessions, the more they likely grow during that period compared to other firms and

routine times. Nevertheless, I think that this analysis can convey some partially relevant evidence for opportunity cost hypothesis in that there actually exist a group of firms that devote their resources to productivity improvement activities during their hard times and consequently, excel others in terms of absolute revenue market share. Also, in this paper, there is no direct explanation for what factors can facilitate firms' investments during economic hard times, which could be a limitation of this paper. These unanswered questions should be investigated by future researches.

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Abstract

Growth Dynamics of Firms during Recessions

- Evidence from U.S. Listed Firms -

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I report that certain predetermined promising firms grow larger than other firms especially during recession periods. Between two measurements of growth, absolute changes in market shares of revenue and employment, only for revenue, the unique positive role of recession on growth of expected high-growth firms over other firms is found. After further channel analysis is conducted, I also find that the aspects of superior performances of expected high-growth firms during recessions compared to other firms and routine times actually come from expected high-growth firms which have larger increments in their spending of valuable resources on investments during recession times. These results impart some supportive evidence for Schumpeter's creative destruction argument and opportunity cost hypothesis.

Keywords: Schumpeterian theory, creative destruction, price-to-book ratio, recession, firm growth, investment

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