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Long-term Growth Patterns and Determinants of High-growth Startups – Focusing on Korean Gazelle Companies during 2006-2020

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Abstracts To know the long-term growth patterns and determinants of successful startups, 15-year (2006-2020) panel data of 252 companies that had a growth rate of over 20% every year in the last three years were used. In the first analysis, statistics on the period required to designate a gazelle company or listed on the stock market were examined. In addition, five long-term growth patterns were presented. In the panel analysis, the R&D intensity, operating profit ratio, size, and age of the company were pointed out as determinants of growth. The operating profit margin and R&D intensity have a positive effect on growth. Gibrat's law was not supported, but an inverted U-shape was observed. Jovanovic's law was confirmed. Although many studies tend not to point to profitability as a determinant of long-term growth, this is an important long-term growth factor of a company. The operating profit ratio was used in this study.

Keywords High-growth, Gazelle company, Successful startups, Growth pattern, Long-term growth determinant

I. Introduction

The high growth of companies in any country or any society is greatly welcomed not only by entrepreneurs but also by the nation for economic growth

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or job creation. And the emergence of such enterprises is an important policy task (Schreyer, 2000; OECD, 2002, 2010). The UK Innovation Foundation reports that although high-growth companies are rare, high-growth companies, or about 6% of the total, account for 54% of employment growth. In addition, these companies have a positive impact not only on themselves but also on neighboring businesses and regions (NESTA, 2009).

Therefore, there are many studies related to corporate growth in any society. However, most of the research on corporate growth is a cross-section analysis of a reliable corporate DB at a specific point in time, a survey on a company based on a specific point in time, or an in-depth case study targeting a small number of companies.

There are some limitations in cross-sectional analysis or survey at a specific point in time. First, cross-sectional analysis can identify the attributes of high-growth companies at the time of measurement, but it is difficult to consider long-term how those companies have grown. There are too many companies to be surveyed in a cross-sectional analysis. Therefore, it is usually conducted in the form of case studies, limited to a small number of companies. Second, considering only high-growth companies at a certain point in time, it is not possible to identify cases that were high-growth companies just a while ago and then decline or go bankrupt. Third, the overall pattern of the rise and fall of a company is not grasped.

Because high growth at a specific point does not last for a long period, the measurement timing is important for the meaning of high growth. In addition, cases of stagnant or declining companies that were high-growth companies in the past are not considered. This phenomenon occurs because of the data collection of many companies over a long period. As a result, it is difficult to find studies on the long-term growth patterns of many companies, including those that have failed.

On the other hand, there is a high tendency that companies' interest in high growth and startups' interest in high growth are regarded differently. Startups grow and become a normal group of companies, but startups have a low survival rate, and fewer companies succeed on a unicorn[1] scale. In addition, since it is difficult for startups to collect corporate data, the growth of startups and the growth of high-growth companies tend to be perceived as different. Monitoring high-growth startups from the beginning and examining how they are growing over a long period will be of great help to corporate research.

Accordingly, this study aims to examine the long-term growth patterns of high-growth startups. The target companies are gazelle companies announced annually by the Ministry of SMEs and Startups in Korea. A gazelle company by

[1] Unicorn is defined in various forms, but is generally defined as having an enterprise value of more than USD 1 billion (about KRW 1.17 trillion) within 10 years of establishment.

the Ministry of SMEs and Startups in Korea refers to a company that has been designated as a venture company by the government with sales of 100 billion won or more and an average sales growth rate of 20% or more over three years. In other words, the purpose of this study is to look at the long-term growth patterns or growth determinants of successful startups that recorded more than 100 billion won in sales among startups.

II. Definition of Gazelle and High Growth

Birch and Medoff (1994) define a gazelle company as a company with an annual sales growth rate of 20% or more for 4 years among companies with annual sales of more than $100,000. Henrekson and Johansson (2009) analyze the gazelle firm with the same definition. Korea's Ministry of SMEs and Startups (each year) defines a gazelle company as a company that has grown by 20% or more in 3 years since 2004.

However, the definition of a high-growth company is being made from several angles. The first is the definition based on the sales growth rate. The OECD (2002, 2010) defines a high-growth company as a company that has grown more than 20% over 3 years. The Korean studies of Kim and Hong (2015) also use these definitions. On the other hand, Kang et al. (2018) define a company with 50 or more employees, which has recorded 15% or more of sales over the past 5 years.

The second is a definition centered on employment. NESTA (2009) defines a high-growth company as a company with 10 or more employees in the study of high-growth companies in the UK, and a company with an average annual employment growth rate exceeding 20% for 3 years or more. They reveal that 6% of high-growth firms account for 54% of total employment. In Korea, Kim and Seo (2009) study 4,683 Innobiz companies and define high-growth companies as those with an employment growth rate of 100% or more over 4 years.

The third is a definition that considers sales and employment at the same time. Lim (2009) defined a high-growth company as a company with a four-year sales growth rate of 100% or more or an employment growth rate of twice or more in a survey of 2,393 innovative SMEs. Kim and Jeong (2011) from Science and Technology Policy Institute (STEPI) define a high-growth company as a company with a compound annual growth rate (CAGR) of 20% or more or an employment growth rate of 15% or more over the past five years. Park and Shin (2013) define a company with a recent employment growth rate of 20% or more by year and a sales growth rate of more than three times that of the median in the last three years.

However, there is a subtle difference in the definition of growth rate other than the difference between whether these definitions are sales-oriented or employment-oriented. The average rate of increase of 3 years and the rate of increase of 20% or more every year is different. For example, a company with a 3-year CAGR of (5%, -5%, 100%) is different from a company with (25%, 30%, 40%).

III. Literature Survey

Research on the growth of companies has been around for a long time, but the research that continues with a lot of interest is the question of the growth rate with the size and age of the company. Gibrat's Law, proposed in 1931, states that the size and growth rate of a firm is not related and is distributed according to a logarithmic distribution rather than a real size. As a result, many studies have tried to verify this fact, some agree with this law, and some reject this law (Fiala and Hedija, 2019). On the other hand, Jovanovic's law (Jovanovic, 1982), which states that a company's age and growth rate have a negative relationship, was also tested, and results were derived from both positive and negative sides (Audrech, 2012). In Korea, Seong (2000) agrees with Gibrat's law, and another study conducted by the same researcher (Seong, 2002) also rejects this law. Daunfelt and Elert (2013), who analyzed small and medium-sized enterprises (SMEs), point out that this rule may or may not be applied depending on the characteristics of the industry. Industry-specific factors include minimum size, market concentration, and the number of small firms.

Studies on the relationship between firm size and innovation are also referred to as the determinant of firm growth. Schumpeter pointed out that the larger the firm, the greater the innovation of the firm. As a result, many studies have been conducted to confirm this hypothesis. However, Horowitz (1962) and Cohen, Levin, and Mowery (1987) deny this relationship. On the other hand, Shin (1999), Song and Oh (2010), and Oh (2020) support the relationship. Furthermore, Shin (1999) pointed out that there is an inverse U-shaped relationship in the Korean manufacturing industry, and Oh (2020) in the bio-health industry.

The second type of research on corporate growth is research on the determinants of high growth. Audrech (2012) points out additional factors that determine the growth of a company in addition to the age and size of the company mentioned above. The characteristics of entrepreneurs are also pointed out, and the location factor where the company is located is also pointed out. Furthermore, the proportion of high-growth companies varies depending on the

industrial organization of the industry or what industry it is. In Korea, Seong (2002) analyzes the growth factors of foreign direct-invested companies. Kim and Hong (2015) examine evaluation indicators used when receiving guarantees from the Korea Technology Credit Guarantee Fund. Lee (2020) also argues that GDP growth affects corporate growth.

Porter (1998), through his diamond model, typically views the growth of companies from the perspective of the industrial environment. On the other hand, Kim and Seo (2014) analyze the successful growth factors of Korean conglomerates, classify the corporate group level and the corporate level, and simultaneously review internal strategies from a case study, environmental factors, and path-dependent perspective. Yang and Jung (2010) discuss the intrinsic and extrinsic growth models. On the other hand, R&D is a representative factor among the internal growth factors of a company. This factor has been emphasized for a long time by the SPRU school (Freeman, 1982; Garcia-Manjon and Romero-Merino, 2012), and in STEPI studies since 2006, it is common that all high-growth companies have affiliated research institutes. Ahn and Kim (2016) also examine the role of R&D emphasized in the School of Innovation.

Birch and Medoff (1994), Henrekson and Johansson (2009), and Korea's Ministry of SMEs and Startups (2004~) have conducted studies on the high growth of specific-sized companies by defining high-growth companies as gazelle companies. Park and Shin (2013) also review gazelle companies among venture companies between 2000 and 2010. The gazelle company they named has a different definition from the gazelle company established in this study. These are defined as companies that have been designated as venture companies by the government, with a recent employment growth rate of 20% or more per year and a sales growth rate of more than three times the median of their industry for the past three years. As a result, 9.12% of the sampled venture companies met this definition. Meanwhile, Kim and Jin (2020) discuss the scale-up policy of venture companies.

The second type of research on the high growth of specific-sized companies is research on the growth of medium-sized companies, which can be said to be the next stage of the 100 billion venture companies that are the basis of the gazelle companies. Lee (2013) reveals several growth drivers such as age, R&D, and an increase in operating profit margin. Lee (2015) examines issues such as innovation capability, customer orientation, and market scalability through a survey.

The third type of research on the growth of a specific size company is a study on the size movement of a company. Lee and Kim (2019) analyze the mid-sized enterprises of research-based spin-off startups. This study deals with the company's internal capabilities and external environment at the same time. Oh, Park and Mo (2017) empirically show the case of SMEs becoming medium-

sized enterprises, medium-sized enterprises becoming large enterprises, and vice versa. They report that there were many of these shifts around 2000 and 2010 in Korea.

A monumental study of high-growth companies in Korea is being conducted by STEPI, which has been conducting Technical Innovation Performance Indicator and DB Construction Project since 2006 (Kim et al., 2006), and as a part of this study, it analyzes the attributes of high-growth companies. However, the analysis target is a high-growth company based on the year, not a long-term analysis of a specific company. In some of these years, a separate report analyzing high-growth companies (Kim et al., 2009; Kim et al., 2010; Kim and Jeong, 2011; Kim et al., 2013; Kim et al., 2014; Kang et al., 2018; Kim and Hwang, 2019) is there. In the most recent study, Hyuk Lee et al. (2020), 271 out of 25,411 externally audited companies were analyzed.

However, the researcher for each year is different, and there is a difference in the definition of subjects and high growth. The scope of the investigation is either for manufacturing companies with 50 or more people listed on the stock market or for companies to which the Act on External Audit is applied. On the other hand, the definition of high growth is different. In some years, companies with 15% or more sales and 10% or more of employment among listed companies are eligible. Or more than 20% of sales or more than 15% of employment over 5 years. The characteristics of high-growth companies pointed out in the STEPI study are slightly different every year, but the common point is that the ratio of R&D expenses to sales is larger than that of general companies.

Another landmark study on corporate growth in Korea is a 2008 study series by the Korea Credit Guarantee Fund. These studies are based on 544,433 SME data held by the Korea Credit Guarantee Fund for the period 1990-2006. First, Kim, Cho, and Park (2008) evaluate the entry into the growth stage based on the time when the break-even point is achieved and the time when the sales growth rate of 15% is achieved, respectively. As a result, it is revealed that it takes about 4 years for Korean SMEs to enter the growth stage, and the smaller the size, the faster the entry to the growth stage. Kim and Cho (2008a) report that they leave the startup stage 4 years after establishment, then reach the maturity stage for about 10 years, and reach the declining stage after 16 years. Similarly, smaller firms report that they enter the next stage faster. It also reveals that a company's profitability and financial stability are important factors necessary for the growth and long-term survival of SMEs. Kim and Cho (2008b) report the financial attributes of each stage.

Another study on the high growth is the study of the Korea Valuation Association which deals with the technology business (Seol, Oh, and Park, 2012; Park, Cho, and Seol, 2013; Seol, Park, and Hanlin, 2019; Seol et al., 2020). Since technology valuation is estimated based on the income of the entire survival period of a specific technology business, there is great interest in the long-term

growth of the technology business. Therefore, this group places importance on various factors including internal factors such as technological capabilities by R&D investment and internal capabilities represented by operating profit.

Although there are many studies on the relationship between high-growth companies and employment, employment is not the subject of this study, so the review is omitted.

IV. Methods and Data

1. Research Question

This study started with the simple question of what are the long-term growth patterns and determinants of successful startups. Simply put, it is how startups are differentiated when they succeed, and what kind of growth patterns they follow in the long term? It is a question about the rise and fall of startups.

1.1 Definition of a successful startup

The Korean government classifies and manages companies into small and medium-sized enterprises (SMEs) - medium enterprises - large enterprises. In other words, SMEs[2] are classified as medium-sized enterprises when they grow in size and then into large enterprises when they grow further. Corporate policy is characterized by support for SMEs and regulation for large enterprises.

SMEs are managed by the Ministry of SMEs and Startups, and only those that meet legal requirements among SMEs are designated as venture businesses[3]. Venture business designation requirements have changed little by little.[4] Startups, as well as small and medium-sized enterprises (SMEs) with a small size, are designated as venture companies when they meet the legal requirements. Medium-sized companies vary depending on the industry but generally refer to companies with sales of 400 to 150 billion won and assets of 500 billion won or

[2] The definition of small and medium-sized enterprises is defined in the Framework Act on Small and Medium-sized Enterprises. After 2016, it is defined as a company with assets less than KRW 500 billion, sales of KRW 40 billion to KRW 150 billion or less, depending on the industry, and does not belong to a specific business group.

[3] As of 2018, there are 36,503 venture companies designated by the government (Ministry of SMEs and Startups, 2020).

[4] Legal venture companies that receive tax and financial benefits from 2020 must meet the following requirements: 1) Startups that have received an investment of 10% or more of capital from a professional investment company/organization, 2) Technology-based start-ups recognized by evaluation agencies, 3) Start-ups whose R&D investment in the previous 4 quarters accounted for more than 5-10% of sales.

more but less than 10 trillion won.

The Ministry of SMEs and Startups annually discloses companies with sales of 100 billion won or more that are recognized as successful among companies that have been designated as venture companies in the past. Among them, there are not only small and medium-sized enterprises but also medium-sized enterprises and large enterprises. A gazelle company is designated when a startup designated as a venture company succeeds with sales of 100 billion won or more and meets the growth rate conditions.

1.2 Research questions specified

The following research questions are posed about growth startups.

- How long is the high growth recorded? Can it grow rapidly over a long period?
- What is the long-term growth pattern of companies that have recorded high growth? Do they keep growing?
- What are the determinants of high growth for high-growth companies?

The above questions are broadly divided into two types. One is about the growth patterns of successful startups, and the other is about the growth determinants of startups.

2. Data and Analytical Framework

2.1 Data

Our research target is a gazelle company. Gazelle companies have been designated every year since 2004 by the Ministry of SMEs and Startups, and the aggregate statistical properties of those companies were analyzed and reported. However, this announcement applies only to companies that have been designated as venture companies, have sales of 100 billion won or more, and have an average growth rate of 20% or more over the past three years. Gazelle companies are selected among successful venture companies. However, there are no statistics other than three years for the designated company every year, so we had to obtain long-term data for those companies.

In particular, it was at the end of 2007 that the International Accounting Standards adopted by Korea were announced. Therefore, we gathered company data whose financial statistics from 2006 were secured in the DART DB, which stores the financial reports of companies subject to external audit. The other reason for securing data from the DART DB rather than from the existing corporate DB is that we wanted to see the actual growth of the company connected to its subsidiaries, that is, the performance of the consolidated financial statements rather than the company's independent financial

performance. The year of the establishment was regarded as the year of actual establishment, not the year of filing. In summary, a list of gazelle companies up to 2019[5] was obtained from the government announcement, and 252 data for 2006-2020 for which the company DB was secured were analyzed.

The definition of high growth in this study is a gazelle company with an annual sales growth rate of 20% or more. In other words, it was limited to cases where the annual growth rate was 20% or more, not the CAGR. The CAGR can distort the trend by successful one or two years' earnings.

2.2 The framework and limitations of the analysis

The primary concern of this study is the rise and fall of successful startups. By the way, our data is from 252 companies over 15 years. Therefore, it was fundamentally impossible to deal with both the industrial environment analysis at the company level or the industry level and the capability analysis within the company, which can only be seen in case studies. In our primary analysis, the long-term growth pattern of high-growth startups is to be shown statistically and visually. Furthermore, in the secondary analysis, the determinants of high growth will be dealt with by focusing on relatively simple variables.

Analysis 1 – Statistics and Visual Patterns
1. Duration of high growth
2. Required period for listing
3. Growth pattern after recording high growth

By adding some information to the given data, we tried to look at the determinants of high growth secondarily. Two analyzes were added for this purpose.

Analysis 2 - Determinants
1. Long-term high-growth determinants
2. Validation of Gibrat's Law and Jovanovic's Law

2.3 High-growth determinants

Due to the limitations of panel data, we focused on factors that were important in previous studies and verifiable variables rather than testing all determinants. First, as a financial characteristic variable, R&D intensity (ratio of R&D expenditure to sales) continues to be emphasized in the SPRU school, and as confirmed by Garcia-Manjon and Romero-Merino (2012), it is an essential factor for high corporate growth. NESTA (2009), a study of high-growth

[5] Data for 2019 was released in early 2021.

companies in the U.K., has a similar position. Also, in Korean studies, R&D is an essential factor for high growth in STEPI studies since 2006. Kim et al. (2009) point out that high-growth companies generally have high R&D expenses as a percentage of sales. The statistical properties of gazelle companies announced annually by the Ministry of SMEs and Startups (each year) also support this. The importance of R&D for securing technological capability is also pointed out in the field of technology valuation in Korea (Seol et al., 2012; Seol et al., 2020).

In addition, the operating profit ratio was added as a variable in this study by reflecting the two research flows in the field of technology valuation and the research of credit guarantee institutions in Korea that the capability created inside a company is decisive for the growth of a company. This is a company's ability to generate profits, which is described by Yang and Jung (2010), Kim and Cho (2008), Seol, Oh and Park (2012), Seol et al. (2020) also pointed out. Meanwhile, Oh and Song (2020) use the operating profit rate as an independent variable in the analysis of determinants of technological innovation.

The firm characteristic variables are firm size and firm age. This is the process of confirming Gibrat's law and Jovanovic's law, which we looked at earlier. On the other hand, to see what effect the size of the firm has by size, we tried the same as in studies on firm size and technological innovation such as Horowitz (1962), Cohen, Levin, and Mowery (1987), Shin (1999), and Oh (2020).

V. Analysis and Results

1. Basic Stats

A total of 252 gazelle companies were analyzed, and only 130 companies had data over the 15 years of analysis. There are two main reasons why many companies do not have 15 years of data. First, there is no data for a very small company that was designated as a gazelle company in the middle of the analysis period but before the designation. The second is the case where the need to submit a financial report to the DB is no longer due to the decline of the company during the analysis period. In this analysis, data from 252 companies, that is, unbalanced data, were used.

Depending on the year of establishment, the number of years required to be listed as a gazelle company and the number of years required for stock market listing differed significantly. The more recent companies, the shorter the period required for gazelle or listing. Companies established before the 1970s required 47.4 years for Gazelle designation but recently designated companies 5.1 years. The time required for listing on the stock market has also been shortened, so it took 29.0 years for companies established before the 1970s and 7.0 years for

companies in the 2010s. These are statistics that indirectly show that recent companies are characterized as high-tech companies, and these are high-growth.

Table 1 Years for Gazelle designation and listing by establishing period

Establishing period	Gazelle designation		Listed in stock market	
	Years needed	No	Years needed	No
~1970	47.4	5	29.0	3
1971~1980	32.6	13	26.6	6
1981~1990	24.8	35	13.9	19
1991~2000	16.8	85	9.3	49
2001~2010	9.1	96	9.0	41
2011~2020	5.1	18	7.0	1
Total	14.8	252	11.4	119

Among the companies analyzed, the highest sales amounted to KRW 4.678 trillion (USD 4.1 billion). In some cases, the sales growth rate was 793% in positive cases. Out of a total of 3,528 cases (14 years * 252 cases), 30 cases recorded an increase in sales of 300% or more in one year. However, 21 of them were the year of the spark of corporate growth, and after that, the growth rate declined sharply. On the other hand, there were only 6 cases where sales recorded more than 100% annually for 3 consecutive years. These are the cases where the sales growth rate was extremely negative: sales of 283.5 billion won became 11.1 billion won, 30.8 billion won became 3.8 billion won, and 21.9 billion won became 200 million won. All of them were B2B companies and had only one customer.

In some cases, the operating profit margin on sales was -211%. Such cases appeared in industries that require a lot of initial investment, especially in the IT service industry, service, or distribution industry. Conversely, the companies with the highest operating profit margin are those that transfer games and generate only royalties, and recorded an average of 82.8% during the 15-year analysis period and a maximum of 93.1% in one year. The company's sales have grown by an average of 42.2% annually over the past 15 years.

Table 2 Key indicators of high-growth companies by industry

	No. of companies	Average operating margin	R&D Company	
			No.	Average R&D Ratio
IT Service	44	56.7	18	3.50
Machine & Metal	58	25.4	54	2.80
Others	17	30.0	10	0.69
Video & Communication	32	21.9	31	3.62
Pharmaceutical & Cosmetics	20	38.8	19	1.94
Manufacturing	22	30.6	20	1.22
Computer/semicondeuctor etc.	39	28.4	35	3.29
Chemistry/Energy	20	34.2	19	3.43
Total	**252**	34.2	216	3.34

Note: Other=Service/Distribution/Entertainment/Construction

Meanwhile, companies with R&D data accounted for 85.7% of the total. There are quite a few cases where the ratio of R&D investment to sales is over a hundred percent, but there are almost no sales due to a failure to deliver, but the R&D investment level from the past has been maintained to find technological alternatives and to recover sales. The company went bankrupt due to unsuccessful technological development.

Gazelle companies are widely distributed by industry, excluding other industries where service/distribution/entertainment/construction industries are combined. The operating profit margin is dispersed in the range of 25.4% to 56.7%. The R&D ratio of companies conducting R&D is 3.34%on average, and it is distributed between 0.69 and 3.62% of sales by industry.

Table 3 shows distribution statistics for 17 regions compressed into six. As of 2020, by region, the density of Seoul and Gyeonggi-do and Incheon, which surround Seoul, was high enough to account for 71.0%. In addition, the number of B2C (business to consumer) companies in these regions were 80.6%, higher than in other regions. The population of the Seoul-Gyeonggi region will account for 44.8% of the total population of 51.68 million in 2020.

Table 3 Distribution by region and business type (B2C, B2B, B2G)

	B2B/B2G	B2BC	B2C	Total
Gyeonggi/Incheon/Gangwon	79	1	24	104
Seoul	17	3	55	75
Chungnam/Chungbuk/Daejeon/Sejong	16	2	8	26
Busan/Ulsan/Gyeongnam	16	0	3	19
Daegu/Gyeongbuk	12	0	2	14
Gwangju/Jeonnam/Jeonbuk/Jeju	6	2	6	14
	146	8	98	**252**

2. Growth Patterns

According to the Ministry of SMEs and Startups, the period for which 100 billion venture companies continuously record sales of 100 billion won or more is up to 15 years, 30.7% for 6-10 years, and 13.9% for 11-15 years. Conversely, 55.4% of companies are unable to maintain 100 billion won venture companies for more than 5 years. Our data is more stringent, so 7 years is the best for consecutive sales of 20% or more each year. However, 1 out of 2 gazelle companies with 7 consecutive years of record sales was found to be fraudulent, and only 1 company achieved this record. Only 10.7% of companies recorded sales growth of 20% or more over five years.

As for the growth pattern, a trend line was derived for the sales of each of the 252 companies, and 5 patterns as shown in Table 5 were classified according to the shape of the trend line: Sustainable growth type. Growth-regression-growth type, growth-decline type, growth-decline-stasis type, growth-unstable type. Among these five patterns, the growth-decay type is the most common, accounting for 36.1% of the total, followed by the growth type at 23.4%, and the growth-regression-growth type and unstable type at 16.7% each. Growth-decline-stasis is 7.1% of the total.

On the other hand, these five patterns were again compressed into three growth, decline, and unstable patterns. Growth type is a combination of growth type and growth-decline-growth type, accounting for 40.1%. The decline type is a combined pattern of growth-decline and growth-decline-stagnation, accounting for 43.2% of the total.

Table 4 Duration year of high-growth

No of year	Over 100B (2018)[1]	This study
1	20.2	
2	12.5	
3	9.4	69.2
4	8.2	20.2
5	5.1	6.3
6	6.8	3.6
7	6.4	0.8
8~10	17.5	
11~15	13.9	
Total	100(966)	100(252)

Source 1. Ministry of SMEs and Startups (every year)
Note: KW=Korean Won (1USD = 1,187KW), B = billion

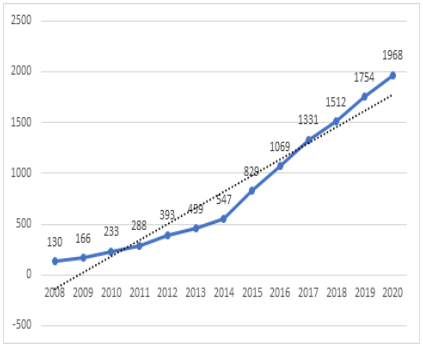
Table 5. Gazelle by sales growth pattern

Pattern 1	growth		decline		unstable (cyclical)	Total
Pattern 2	g	g-d-g	g-d	g-d-s	g-u	
No	59	42	91	18	42	252
%	23.4	16.7	36.1	7.1	16.7	100.0

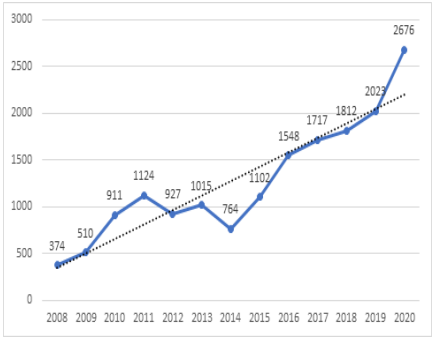
Note: g=growth, d= decline, u=unstable, s=stagnation

Figure 1 Growth Patterns

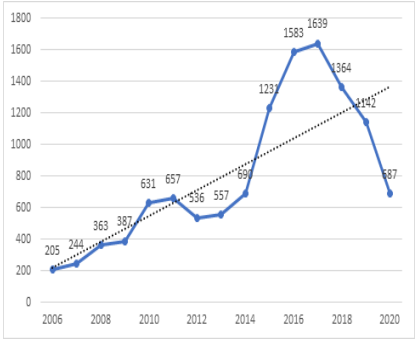
1. Growth



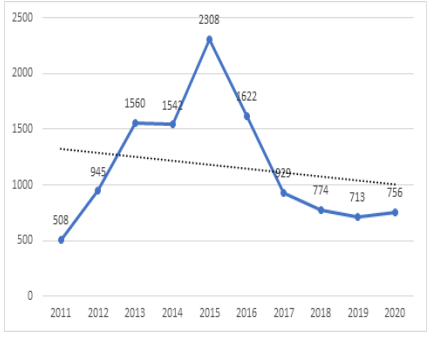
2. Growth – decline - growth



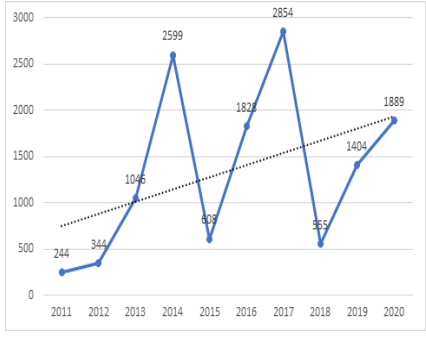
3. Growth - decline



4. Growth - decline - stagnation



5. Growth-unstable



Although it is not in the table, looking at the long-term growth patterns by industry, the IT industry shows the increasing patterns that the pattern 1 and 2 are 68.2%. Since the unstable cyclical type is also growing in the long term, if included in the growth type, only the video & communication industry shows the long-term decline pattern with 53.1%. The patterns of 3 and 4 of the computer, semiconductor & parts industry, and the machinery and metal industry are relatively strong with 48.7% and 44.8%. The details by industry will be introduced in the next study.

3. Determinants of High Growth

Our data is 15 years of 252 companies. There are two reasons for analyzing these panel data. The first is the limitation of cross-sectional data on corporate growth. The growth of a company has its factors by industry or company, and we wanted to know a common pattern ignoring these factors. The second is to overcome the problems of time series data and to see beyond the various environmental factors that determine the growth appearing over time.

Since the data of this study are long-term panel data for 15 years, a panel unit root test was adopted for the variables used using EVIEWS 10 to examine whether the series is stationary. As shown in the Appendix, all variables were stationary.

Model 1 sets the sales growth rate as a dependent variable and uses the operating profit rate, R&D intensity, company size, and company age as independent variables. Model 2 was established by adding size^2 as an independent variable to see the pattern of the size effect. If the coefficient of size is minus and that of size^2 is plus, then it is U-shaped. For R&D intensity, R&D as a percentage of sales, data from the previous year was used as a variable. This is because R&D affects sales with a time lag.

$$\text{Model 1: Growth} = \alpha + \beta_1 \text{ margin} + \beta_2 \text{ R\&D}_{(t-1)} + \beta_3 \text{age} + \beta_4 \log(\text{sales})$$

$$\text{Model 2: Growth} = \alpha + \beta_1 \text{ margin} + \beta_2 \text{ R\&D}_{(t-1)} + \beta_3 \text{age} + \beta_4 \log(\text{sales}) + \beta_5 \log(\text{sales}^2)$$

$$\text{Growth (\%)} = (\text{sales revenue} - \text{sales revenue}_{(t-1)}) / \text{sales revenue}_{(t-1)}$$

$$\text{Margin (\%)} = \text{operating margin} / \text{sales revenue}$$

$$\text{R\&D}_{(t-1)}\,(\%) = \text{R\&D intensity}_{(t-1)} = \text{R\&D}_{(t-1)} / \text{sales revenue}_{(t-1)}$$

EVIEWS 10 was used to estimate the panel data. Here, whether the error term of the model is fixed or random, that is according to the P-value of the Hausman Test proposed by Hausman (1978) and later studies, the Fixed Effects Model (FEM) and the Random Effect Model (REM) are selected (Baltagi, 2008). In our analysis, FEM was used as shown in Appendix 2. Technically, if the Hausmann test value is less than 0.05, the fixed-effects model is used; otherwise,

REM is used. Meanwhile, to overcome the problem of heteroscedasticity, the white-corrected panel method was applied through the test (White, 1980).

Table 6 Basic statistics

Variables	Mean	Median	Max	Min	S.D.	Skewness	Kurtosis
Growth%	28.06	14.48	793.51	-100.00	69.51	3.68	26.93
Margin %	5.53	4.90	176.50	-211.11	18.91	-1.97	32.31
R&D %	2.66	0.99	108.05	0.00	5.34	6.90	87.33
log(sales)	3.07	3.09	4.73	1.04	0.47	-0.16	3.78
Age	17.96	16.00	72.00	1.00	10.55	1.18	5.09

Table 7 Correlation between variables

Correlation	Growth	Margin	R&D	Log (sales)	Log ($sales^2$)	Age
Growth%	1.00					
Margin%	0.12***	1.00				
R&D %	-0.09***	-0.08***	1.00			
Log(sales)	0.02	0.20***	-0.06***	1.00		
Log($sales^2$)	-0.02	0.20***	-0.06***	0.99***	1.00	
Age	-0.20***	-0.01	-0.02	0.21***	0.21***	1.00

The analysis results are shown in Table 8. Both models have model fit, and all of the variables, operating margin, R&D intensity, scale, and age have high statistical significance. Looking at Model 1 alone, the operating margin coefficient of 0.68 means that the growth rate increases by 0.68% for every 1% change in the operating margin. Similarly, the R&D intensity coefficient of 2.40 shows that a 1% increase in R&D intensity in the previous year increases by 2.40%. In conclusion, our analysis shows that operating profit margin and R&D intensity are important growth factors, and that size and age also influence the growth rate. However, Gibrat's law says that size and age have no relationship, but in this study, there is a positive relationship, which is negated. Jovanovic's law states that the growth rate decreases with age, which is supported by this study.

Table 8 Results of determinants of high-growth

Variables	Model 1	Model 2
C	10.18 (0.59)	9.96 (0.60)
Margin (%)	0.68*** (0.00)	0.68*** (0.00)
$R\&D_{(t-1)}$ (%)	2.40*** (0.00)	2.40*** (0.00)
log(Sales)	35.39*** (0.00)	-152.70 (0.53)
log(Sales²)		376.32 (0.44)
Age	-5.61*** (0.00)	-5.61*** (0.00)
R-squared	0.24 [0.00]	0.24 [0.00]

Note 1: ***,**,* represent 1%, 5%, and 10% significance levels, respectively,
Note 2: Parentheses for variables indicate t-values, and R-squared brackets p-values.

In Model 2 to examine the scale effect a little more, the log(Sales) coefficient is a + sign, and the log(Sales^2) coefficient is –, so the effect of the scale on the growth rate will be inverse U-shaped. This is also consistent with Shin (1999)'s research on Korean manufacturing and Oh (2020) in the bio-health industry. As for the coefficient of the scale variable, only the direction of the sign is important because there is a unit difference in the data.

VI. Conclusions and Implications

1. Summary of Results

The purpose of this study was to know the patterns and determinants of the long-term growth of successful startups. For this purpose, data before and after the designation of these companies as gazelle companies were separately obtained using the list of gazelle companies announced annually by the Korean government. As a result, 15-year (2006-2020) panel data of 252 companies were used for analysis. Gazelle companies used in the analysis are companies that have been designated as venture companies with sales of 100 billion won or more and sales growth rate of 20% or more each over 3 years.

The first analysis was about the general properties and growth patterns of high-growth startups, and the following results were obtained.

- As for the growth period, the sales growth rate of 20% or more per year was up to 7 years, and it was only 10.7% for 5 consecutive years. A total of 30 cases showed a sales increase rate of 300% or more, of which 21 were at the time of sales ignition, and the growth rate decreased sharply thereafter. There was only one case of continuous growth that recorded 300% or more every year for 2 consecutive years, and there were only 6 cases of continuous growth of 100% or more for 3 years in a row.
- The period required for government designation as a gazelle company was 47.4 years for companies established before the 1970s, but 5.1 years for recently designated companies, which is rapidly shortening in recent years.
- The time required for listing on the stock market has been shortened, so it took 29.0 years for companies established before the 1970s and 7.0 years for companies in the 2010s. This, too, has been rapidly shortening in recent years.
- After recording high growth, there are five growth patterns: growth-decline, growth, growth-regression-growth, unstable, and growth-decline-stasis. They are again compressed into three patterns: growth type 40.1%, decline type 43.2%, and unstable type 16.7%.

The results of the long-term high-growth determinant analysis are as follows.

- The panel analysis showed that operating profit ratio, R&D intensity of the previous year, size, and age were all-important growth determinants.
- Gibrat's law that scale has no effect on growth rate was rejected, and the larger the scale, the greater the growth rate, but showed an inverted U-shape. It increases at a medium scale and decreases at a very large scale.
- Jovanovic's law, which states that the growth rate decreases with age, has been verified.

2. Theoretical Discussion

From a theoretical point of view, this study provides empirical data for the theory of corporate growth. In particular, it shows the characteristics of high-growth companies and supports the discussion of the successful long-term growth of startups. It has been shown that the high growth of a company is temporary within 7 years even in the case of success, and after a period of high growth, the growth rate is low, but it appears as a continuous growth type, a decline type, and a cyclical pattern at a certain level.

In the traditional discussion of determinants of corporate growth, Gibrat's law, which states that size and growth rate are irrelevant, is rejected, and Jovanovic's law, which says that the older a company gets, the slower the growth rate is

verified. However, the relationship between scale and growth rate showed an inverted U-shape as shown in Shin (1999) and Oh (2020). Looking at this relationship, it can be inferred that there is a positive (+) relationship between corporate innovation and growth rate, but this is a different research subject.

In this study, panel analysis was attempted in the determinant analysis. Corporate growth is affected by several factors (Audrech, 2012). The panel analysis, however, has limitations in that it cannot analyze specific factors of individual companies or the industrial environment. Conversely, this limitation has the advantage of being able to see universal determinants more clearly from a long-term perspective, which became clearer in this study.

Many studies tend not to point to the operating profit margin as a determinant of long-term growth. Even Audrech (2012), a review article on high-growth determinants, does. However, as emphasized by the Korea Credit Guarantee Fund's 2008 study and Korea's technology valuation study, internal financial capability is an important long-term growth factor of a company. In this study, the variable is the operating profit ratio.

This study showed that high-growth startups do not exist only in a specific industry, but appear in several industries at the same time. Also, in terms of the distribution of companies, there was not much difference in the industry. Of course, there were significant differences in operating profit margins by industry. Furthermore, although not specifically analyzed in this study, the attributes of the industry itself will need to be included in the determinants.

3. Managerial Implication

The results of this study can be used directly for sales forecasting. This study was conducted to provide data to support sales forecasting in technology valuation. First, no matter how successful a startup is, it is necessary to carefully predict the sales growth rate exceeding 100% for 3 years or more when the sales surge starts. Second, sales forecasting should be based on the absolute amount, not the growth rate. If the three-year sales are 20, 200, 400, the second year is 900% growth, and the third year is 100% growth. Even for the same amount of growth, there is a big difference in the rate of growth. Of course, the sales forecast based on absolute amount should be based on the production capacity of the company. Third, it should be borne in mind that even high-growth companies may decline sharply. The detailed growth patterns and their applications will be discussed further in the next study.

4. Conclusions and Future Tasks

Although this study dealt with the long-term growth patterns and determinants

of high-growth startups, there are still challenges to be solved. First, it is necessary to analyze what properties each growth pattern has. Here, it will be possible to review other factors such as the industrial environment. Second, similarly, it is necessary to study what determinants exist for each growth pattern. It is necessary to further study why companies continue to grow, or why such a phenomenon of growth-decline-grow occurs.

Furthermore, it will be necessary to illuminate the entire growth process of a startup by securing corporate data that can examine the entire process of startups from founding to high growth and even extinction.

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Appendix 1 Results of Panel Unit Root Tests

Variables	Type	Common root		Individual root		
		Levin et al. (t-stat)	Breitung (t-stat)	lm et al (W-stat)	ADF-Fisher (Chi-square)	PP-Fisher (Chi-square)
Sales-growth	Level	-21.10*** [0.00]	-7.53*** [0.00]	-6.03*** [0.00]	689.42*** [0.00]	1,587.79*** [0.00]
	1st Difference	-33.69*** [0.00]	-9.80*** [0.00]	-10.52*** [0.00]	894.92*** [0.00]	2,623.97*** [0.00]
Margin	Level	-11.31*** [0.00]	1.71 [0.96]	-2.94*** [0.00]	563.17*** [0.00]	1,183.24*** [0.00]
	1st Difference	-25.82*** [0.00]	-3.93*** [0.00]	-10.93*** [0.00]	902.76*** [0.00]	2,270.94*** [0.00]
R&D	Level	-2,438.5*** [0.00]	-0.75 [0.22]	-139.25*** [0.00]	588.06*** [0.00]	997.25*** [0.00]
	1st Difference	-2,183.6*** [0.00]	-6.34*** [0.00]	-128.27*** [0.00]	749.29*** [0.00]	2,016.48*** [0.00]
log(Sales)	Level	-18.72*** [0.00]	7.73 [1.00]	-0.37 [0.64]	486.70** [0.02]	753.79*** [0.00]
	1st Difference	-18.35*** [0.00]	-5.36*** [0.00]	-4.88*** [0.00]	644.29*** [0.00]	1,436.31*** [0.00]

Note 1. Brackets are p-values.

2. p: ***<0.01, **<0.05 and *<0.10.

Appendix 2 Results of Hausman Tests

Test statistic	Model 1	Model 2
χ^2	181.31 (0.00)	191.42 (0.00)

Note: Parentheses indicate p-values.