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An Analysis of Growth Engine Industries using the ORBIS DB

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Abstract Many countries set growth engine technologies and industries for economic growth and job creation. Each country always wants to know their technological or industrial position in the world in these industries. This study aims at identifying the worldwide position of 19 growth engine industries defined in Korean government. The methods are quantitative by counting the number of startup companies in the world. The ORBIS database was used to extract the number. Therefore, this article may be the first research for the world appearance of growth engine industries and its comparison between world and G7, and between G7 countries. Also, this may be the first study using the ORBIS database on the analysis of certain technology industries. Further, we showed a method to identify world features of technology industries.

Keywords Growth engine industry, startup company, global, G7, company analysis

I. Introduction

Many countries want to identify new technology industries for economic growth. Those industries can be cold growth engine technologies or industries. In particular, some developing countries eagerly want to catch up advanced countries both in technological and economic purpose.

Korean government led by the Ministry of Science, ICT and Future Planning selected 19 technologies for growth engine in April 2015 (Joint Ministries, 2015). These 19 technologies were recommended by each ministry and selected for consolidated efforts of all the ministries. In fact, this policy is

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supported by a Special Committee for Future Growth Engine under the National Science and Technology Council led by President of Korea. The 19 technologies will be shown in the results section.

The development of growth engine for sustainable growth and job creation, however, is not a proprietary policy for Korea or developing countries. Rather it is a global trend: Strategy for American Innovation (the US White House, 2011), Industrial Structure Vision (METI Japan, 2010) and Key Enabling Technology (EU, 2010).

In the discourse of growth engine industry, each country always wants to know their technological or industrial position in the world. The methods to supports this aim are the typical ones for technology and industry analysis such as technological literature analysis, patent analysis, expert discussion or surveys using the focus group method or the Delphi method.

Here, we want to add a new method for identifying the status of each country's growth engine industries compared to the global situation. The method is based on business activities, specifically the number of companies. Fortunately, there is a global database for global company information called Orbis, which is a product of an electronic publishing company, Bureau van Dijk (https://orbis.bvdinfo.com). The database has not well known to academic society. Therefore, this article may be the first trial for this topic using the database.

This study noticed that there is a difference among global startup companies by industry because it would be related to the characteristics of industrial life cycles. After establishing 2.81 million data records on the businesses which have been established for the past 3 years among a total of 154 million business data archived in ORBIS (Bureau van Dijk), this study analyzed changes in the number of startup companies in the world and G7 states by Korea's growth engine industry and stated their implications.

II. Literature Review

1. Growth Engine Industry

Growth engine industry is defined as "core technology, product or service which is expected to create a new market and make a big contribution to the development of new industry and job creation if discovered and nurtured by the government (Jang et al., 2014)." Methods selecting growth engine industry are the qualitative method by expert rating, basic data such as domestic and overseas technologies, and market outlook have been mostly used. In addition, there has been a demand for a quantitative methodology to improve subjectivity in the selection process (Bae et al., 2011).

In the Strategy for American Innovation, the US government chose and promoted clean energy, bio-technology, nano-technology, advanced manufacturing, aerospace, medical technology and educational technology as its key industries. Japan also selected top five strategic fields: emerging infrastructure market, next-generation energy solution, the solution to social problems, high-tech and cultural industry and high-tech industry. European Union (EU) named nano-technology, micro and nano-electronics, new materials, industrial bio-engineering, photonics and high-tech production system as its key enabling technologies and developed and promoted pan-European policies.

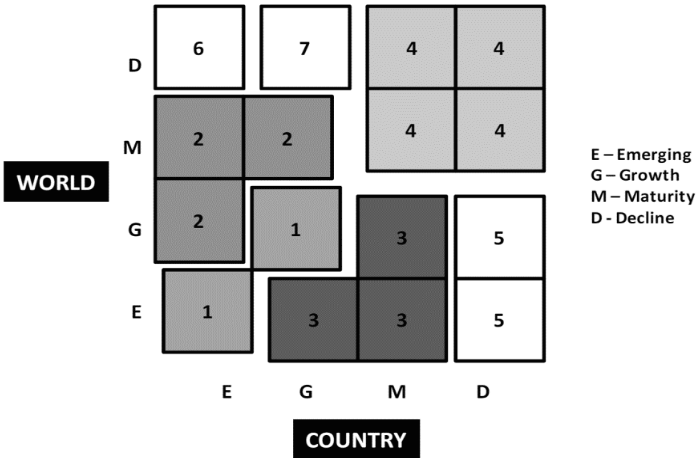
Growth engine technology industries selected in a country may not be the first runner in the world. The industries can be selected for technological catching up, for economic growth, or for world competitiveness. In another word, the life cycle of the industries should be considered in the globe perspective. A life cycle is a term used in classifying the entire processes of products or technologies from being introduced to the market disappearing by stage. In other words, it is a logic which mentions market characteristics by stage and suggests response strategies (Levitt, 1965). Regarding technology life cycle (TLC), Martino (2003), Jarvenpaa et al. (2011) and Järvenpää & Mäkinen (2008) tried to measure the cycle in an empirical manner. Watts and Porter (1997) suggested some indices to check the position in the life cycle.

As an empirical study to measure an industry life cycle (ILC), Klepper and Graddy (1990) insisted that in general industry, the number of businesses dramatically increases during a growth stage and starts to decline entering a maturity stage. The total number of businesses in the same industry is the most fundamental indicator which divides the market into the monopolistic, oligopolistic and competitive market because as the number of businesses increases, competition becomes more intense while the influence on market price diminishes. They wanted to tell that increase in the number of businesses would apply to the development of new industries under the same rules. We also use the number of business as an index of the position of certain industry in a life cycle.

2. Policies under Different Stage

If the growth engine industry is at the technology introduction or early market stage, intensive government policies such as infrastructure for the technology are expected. Livesy (2012) recommended different industrial policies based on the maturity of industry. He provides a theoretical framework for industrial policies from the perspective of developing countries.

In Figure 1, 'Area 1' refers to a new industry zone at an emerging stage in both Country and World. Many disputes and criticisms are found in this area; it is a sector which promotes strategic industrial policies to evolve into an advanced country. 'Area 2' represents an industry at a maturity stage in World. In Home, on the contrary, it is an industry at an emerging or growth stage. In this area, an attempt to enter into the conventional global industry and home industry protection policies are promoted together.



Source: Livesey (2012)

Figure 1 Types of maturity-based industrial policies

'Area 3' is an industry with a significant advantage in Country. In this area, protective trade is pursued by maintaining the comparative advantage or a shift toward 'Area 4' is supported by imposing tariff and improving productivity. R&D investments for science technology and key enabling technology mean a strategic entry into Areas 1 and 3.

III. Method and Data

Our main purpose is the finding of the world situation of Korean growth engine industry through the number of startup companies. The methods are summarized as follows:

- Extraction of startup companies in the growth engine industries from the ORBIS DB. For this purpose, we will convert Korean growth engine industries into the US Standards Industrial Code (SIC) since the database uses the US SIC.
- Comparison of the ratio of each industry with the world and G7 countries to see the world level of G7 and rest of the world.
- Comparison of the industry between key countries such as the US, Japan, England, and Italy. This limited comparison is due to the limits of the database.

1. The Orbis DB

The Orbis DB is a database service of the Bureau van Dijk founded in 1991. The Bureau van Dijk Electronic Publishing, simply Bureau van Dijk is owned by Swedish private equity group EQT. The database provides over 200 million private companies information across the globe: around 86 million European companies, around 53 million American companies, and around 55 million Asia-Pacific companies. The Orbis includes information on over 70,000 listed companies in a more detailed format.

The ORBIS gives the following consolidation codes to the information of companies publishing their financial statements officially.

C1: statement of a mother company integrating the statements of its controlled subsidiaries or branches with no unconsolidated companion.

C2: statement of a mother company integrating the statements of its controlled subsidiaries or branches with an unconsolidated companion.

U1: statement not integrating the statements of the possible controlled subsidiaries or branches of the concerned company with no consolidated companion.

U2: statement not integrating the statements of the possible controlled subsidiaries or branches of the concerned company with a consolidated companion.

The search criteria used in the ORBIS are shown in Table 1. In this research, the list of firms founded from 2013 to 2015 was extracted with limitation about accounting standards for financial statements of corporations. The limitation condition was the public announcement of their financial statements following the International Financial Reporting Standards (IFRS) and Local Generally Accepted Accounting Principles (GAAP). Also, the information about startup enterprises of all industries excluding branches was obtained.

Table 1 Criteria of ORBIS and search result

	Step result	Search result
All companies	188,476,493	188,476,493
Status: Active companies	154,113,173	154,113,173
Consolidation code: C1 (companies with consolidated accounts only), C2/U2 (companies with both types of accounts), U1 (companies with unconsolidated accounts only)	28,565,780	20,611,629
Accounting practice: IFRS (International Financial Reporting Standards), Local GAAP (Generally Accepted Accounting Principles)	28,565,782	20,611,629
Accounting template: Industrial companies, Banks, Insurance companies, Exclude branches	89,273,609	20,590,330
Year of incorporation: on and after 2013 up to and including 2015	22,994,878	2,814,620
TOTAL		2,814,620

Note: Export date 20/09/2016.

To analyze changes in the number of startup companies, a total of 2.81 million data records of the startup companies which were established during the past three years (2013-2015) were extracted from the data (154,113,173 records) archived in the ORBIS DB. Except for 269,880 U.S. SIC-less records, 2,544,717 data were developed as our analytical database.

2. Converting into the US SIC

Regarding the business classification provided by the ORBIS, the U.S. SIC is a 4-digit code which begins with the numbers from '0' to '9.' It's been used since 1930. Its final update was done in 1987, and since then, it has been used by the U.S. government, economists and financial and procurement departments to identify manufacturing, agricultural and service sectors.

In general, it has been replaced by the North American Industry Classification System (NAICS) developed in the United States, Canada and Mexico in 1997. However, based on the US SIC code, ORBIS DB classifies companies' industries.

In this research, we used the mapping table provided by ORBIS (KSIC code mapped to US SIC code). Utilizing this mapping table has the purpose of applying the KSIC code corresponding to South Korea's growth engine industries to the US SIC code.

Because the US SIC code bundle is mapped based on the Korean growth engine industries code bundle published by the Korean government, the industries here do not refer to the US growth engine industries.

Based on the target industry under the growth engine industry, 'intelligent robot' and 'tangible contents' were excluded from the analysis due to mapping absence or insufficiency (see Table 2).

Table 2 US SIC code and KSIC mapping

Growth Engine	U.S SIC Code	KSIC	Business Type
Smart car	3812	27211	Manufacture of wireless navigation devices and measuring instruments
	3663	26429	Other wireless communication equipment manufacturing
	3711	30121	Car and other passenger vehicle manufacturing
	No Mapping	30320	Automobile body parts manufacturing
	No Mapping	30392	Automobile electric system manufacturing
	3714	30399	Other auto parts manufacturing
5G mobile communication	3663	26429	Other wireless communication equipment manufacturing
	7372	58222	Development & supply of application software
	No Mapping	61220	Wireless communication
	4899	61299	Other electric communication
Deep-sea / extreme-environment offshore plant	3561	29131	Liquid pump manufacturing
	3731	31119	Other vessel manufacturing
	No Mapping	42136	Underwater construction
	8711	72129	Other engineering services
High-speed vertical take-off & landing unmanned aerial vehicle	3721	31310	Aircraft, spacecraft and auxiliary system manufacturing
Intelligent robot	No Mapping	29280	Industrial robot manufacturing
Wearable smart device	3661	26422	Mobile phone manufacturing
	3663	26429	Other wireless communication equipment manufacturing
	3845	27112	Electric diagnosis & treatment system manufacturing
	7372	58221	Development & supply of system software
Tangible contents	7372	58222	Development and supply of application software
	No Mapping	59114	Production of broadcasting programs
	No Mapping	70121	Electrical & electronic engineering R&D
	No Mapping	63991	Supply of database and online information

Smart bio-production system	3822	27215	Automatic measurement & control system manufacturing
	3823	27216	Manufacture of industrial process control equipment
	No Mapping	27112	Electric diagnosis & treatment system manufacturing
	No Mapping	27213	Manufacturing of inspection, measurement and analysis equipment
	3829	27219	Manufacture of other measuring, testing, navigation, control and precision equipment
	7372	58222	Development and supply of application software
Virtual training system	7371	62010	Computer programming service
	3721	31310	Aircraft, spacecraft and auxiliary system manufacturing
Customized wellness care	7372	58222	Development and supply of application software
	7371	62010	Computer programming service
	3845	27112	Electric diagnosis & treatment system manufacturing
	7379	62090	Other information technology & computer operation-related service
Smart public safety management system	3669	26410	Wire communication equipment manufacturing
	3663	26429	Other wireless communication equipment manufacturing
	No Mapping	61220	Wireless communication
	7371	62010	Computer programming service
	7373	62021	Computer system integration-targeted advisory & construction service
	No Mapping	63991	Provision of database and online information
Hybrid new & renewable energy system	3621	28111	Motor & power generator manufacturing
	3677	28112	Transformer manufacturing
	No Mapping	28202	Battery manufacturing
	4931	35119	Other power generation businesses
	7373	62021	Computer system integration-targeted advisory & construction service
Direct-current transmission & distribution system	3677	28112	Transformer manufacturing
	3613	28121	Electric circuit switch and protection & connection device manufacturing
	3625	28122	Switchboard and control panel manufacturing

Supercritical CO_2 power generation system	3511	29119	Other engine and turbine manufacturing
Supercritical CO_2 power generation system Intelligent semiconductor	3564	29176	Manufacture of distillation units, heat exchangers and gas generators
	4931	35119	Other power generation businesses
	3674	26110	Electronic integrated circuit manufacturing
Intelligent semiconductor Convergence materials	7372	58222	Development and supply of application software
	8731	70121	Electrical & electronic engineering R&D
	No Mapping	20111	Manufacture of basic petrochemicals
Convergence materials Intelligent Internet of Things (IoT)	2865	20119	Manufacture of other basic organic chemicals
	2819	20129	Manufacture of other basic inorganic chemicals
	2816	20131	Manufacture of inorganic pigment and other metal oxides
	2821	20302	Manufacture of synthetic resin and other plastic materials
	7372	58222	Development and supply of application software
Intelligent Internet of Things (IoT) Big data	No Mapping	61220	Wireless communication
	7379	62090	Other information technology & computer operation-related service
	7372	58222	Development and supply of application software
Big data Advanced material processing system	7371	62010	Computer programming service
	7379	62090	Other information technology & computer operation-related service
	No Mapping	63991	Supply of database and online information
	No Mapping	29176	Manufacture of distillation units, heat exchangers and gas generators
Advanced material processing system	No Mapping	29221	Manufacture of electronically applied machine tools
	No Mapping	29222	Metal cutting machine manufacturing
	3541	29223	Metal forming machine manufacturing
	3542	29229	Other processing machine manufacturing

3. Data Overview

The number of global startup companies in 2015 (250,000 records) is as low as one-fourth of 2013 and 2014. Since the data collection was deemed incomplete, the number of global startup companies in 2014 compared to the previous year was used in this study.

Table 3 Global startup companies by US SIC code

US SIC	Code	2013a	%	2014b	%	b-a %
Agriculture, forestry and fishery	0***	23,617	1.9	19,617	1.8	-16.9
Mining, construction	1***	123,067	10.1	121,558	11.3	-1.2
Manufacturing, publishing	2***	50,232	4.1	40,686	3.8	-19.0
Manufacturing	3***	43,019	3.5	34,319	3.2	-20.2
Transportation, utilities, sewage, environment	4***	77,795	6.3	70,596	6.5	-9.2
Wholesale & retail	5***	347,770	28.5	283,549	26.4	-18.4
Finance · insurance, real estate, service	6***	128,995	10.5	107,072	10.0	-16.9
Professional, business service	7***	253,900	20.8	235,794	22.0	-7.1
Health care, education, leisure, personal service	8***	167,972	13.7	156,018	14.5	-7.1
Public administration, international organization	9***	873	0.1	1,292	0.1	47.9
Total		1,217,240	100	1,070,501	100	-12.0

IV. Results

1. The World versus G7

Changes in the number of startup companies in the world and G7 coㄴuntries are stated in Table 4. Based on the 17 growth engine industries except for mapping-less ones, the world and G7 countries were compared. The data of 2014 decreased from that of 2013, and the reason is unknown like Appendix 1. Therefore, the analysis is quite limited.

The higher rate of change indicates that there are more start-up companies in the industrial areas of G7 countries and the ranking is as follows : (1) Unmanned aerial vehicle, (2) Intelligent Internet of Things (IoT), (3) Virtual training system, (4) Hybrid new & renewable energy system, (5) Big data, (6) Customized wellness care, (7) Smart car, and so on. From this result, it is possible to guess that those fields are hot industries in the period of inception and growth of the G7 countries. When this result is analyzed from the perspective of Livesey (2012) study as shown in Figure 1, the industry is in area 2 for the G7 countries, but it is still in area 1 for the world.

Table 4 Difference between world and G7

	World	G7
Wearable smart device	-69.3	-26
Smart bio-production system	-67.9	-26.9
Intelligent semiconductor	-40.2	-2.7
5G mobile communication	-36.6	0.2 (↑)
Advanced material processing system	-36.5	-25.6
Smart car	-27.6	8.3 (↑)
Direct-current transmission & distribution system	-19.5	0
Convergence materials	-18.9	-13.5
Hybrid new & renewable energy system	-14.1	15.6 (↑)
Supercritical CO_2 power generation system	-13	-5
Deep-sea / extreme-environment offshore plant	-12.2	-2.8
Smart public safety management system	-5.1	-0.1
Big data	0	14.4 (↑)
Customized wellness care	0.3 (↑)	14.4 (↑)
Intelligent Internet of Things (IoT)	3.1 (↑)	19.9 (↑)
Virtual training system	5.4 (↑)	14.9 (↑)
Unmanned aerial vehicle	9.1 (↑)	32.4 (↑)

	World -	No Change	World +
G7 -	Wearable smart device, Smart bio-production system, Intelligent semiconductor, Convergence materials, Supercritical CO_2power generation system, Deep-sea / extreme-environment offshore plant, Smart public safety management system		
No Change	5G mobile communication, Direct-current transmission & distribution system, Smart public safety management system		
G7 +	Hybrid new & renewable energy system, Smart car	Big data	Customized wellness care, Intelligent Internet of Things (IoT), Virtual training system, Unmanned aerial vehicle

Figure 2 Position of each industry

We classified the industries into 9 blocks following the growth of the number. As shown in Figure 2, eight industries have grown in G7 such as smart car, 5G mobile communication, high-speed vertical take-off and landing unmanned aerial vehicle, virtual training system, customized wellness care, hybrid new and renewable energy system, intelligent Internet of Things (IoT) and big data. However, four industries such as unmanned aerial vehicle, virtual training system, customized wellness care, and intelligent Internet of Things (IoT) has grown in both G7 and world.

Table 5 Order of difference between G7 and the world

Industry	Growth '13→'14	Gap G7-World
Unmanned aerial vehicle	1	7
Intelligent Internet of Things (IoT)	2	9
Virtual training system	3	13
Hybrid new & renewable energy system	4	6
Big data	5	10
Customized wellness care	5	11
Smart car	7	5
5G mobile communication	8	4
Direct-current transmission & distribution system	9	8
Smart public safety management system	10	17
Intelligent semiconductor	11	3
Deep-sea / extreme-environment offshore plant	12	14
Supercritical CO_2 power generation system	13	15
Convergence materials	14	16
Advanced material processing system	15	12
Wearable smart device	16	1
Smart bio-production system	17	2

Big gap of the number of startup companies between G7 and the world was observed in wearable smart device (43.3%), smart bio-production system (41%) and intelligent semiconductor (37.5%). Further, big industries such as semiconductor, mobile communication and smart car are the big gap industries since developing countries have no base infrastructure related to these industries. Another characteristic is found in the fact that there are big gaps in highly growing industries unmanned aerial devices, IoT, virtual training system and hybrid energy system.

2. Major Players in the G7

We wanted the data from all the G7 countries. The data are limited only to the US, Japan, England, and Italy. Also, the data from these countries are not perfect. For example, the data of Japan is not persuasive because only 18% (7,352 firms) of a total number of startup corporations (41,039 companies) published the financial statements officially based on IFRS and Local GAAP during 2 years. The result of comparison by main countries is indicated in Table 6.

Table 6 Comparison of changes in three countries (2013-2014)

Future Growth Engine	US	England	Italy
	(%)	(%)	(%)
Smart car	100	33.2	-5.2
Unmanned aerial vehicle	100	39.6	-7.6
5G mobile communication	50	11	-10.5
Intelligent Internet of Things (IoT)	43.7	26.9	9.4
Wearable smart device	31.8	0	0
Smart bio-production system	21	100	0
Customized wellness care	14.2	22.8	9.7
Intelligent semiconductor	8.1	20.8	3.5
Big data	3.4	22.8	9.7
Direct-current transmission & distribution system	0	0	0
Convergence materials	0	4.7	-16.6
Advanced material processing system	0	-10	-10
Hybrid new & renewable energy system	-25	60.4	-2.5
Virtual training system	-33.3	22.9	9.5
Smart public safety management system	-43.7	10	9.3
Deep-sea / extreme-environment offshore plant	-50	15.7	2.8
Supercritical CO_2 power generation system	-66.6	54	-30.6

Since the number of foundation in the United Kingdom was increased by 15.4% from 2013 to 2014 (273,148→323,160 firms), this means its positive increase. However, the number of startup companies in Italy fell by 5.5% (57,523→54,498 companies). In addition, merely 0.14% of all startup companies (543,244 firms) in the United States of America was extracted as its policy is that the public announcement of financial statements for the unlisted companies is not obligatory. Although the extracted data about the startup firms in the United States of America is small, it can be significant because the data is related to listed corporations mainly.

The industries showing the increased number of foundation in the United Kingdom, Italy, and the United States of America were Big data, Intelligent Internet of Things (IoT), Intelligent semiconductor, and Customized wellness care. Also, the industries of Deep-sea / extreme-environment offshore plant, Virtual training system, Smart public safety management system, and Intelligent semiconductor indicated the increase in the number of startup firms in the United Kingdom and Italy.

V. Conclusion

This study aims at identifying the worldwide position of 19 growth engine industries defined in Korean government. The methods are quantitative by counting the number of startup companies in the world. The ORBIS database was used to extract the number. Therefore, this article may be the first research for the world appearance of growth engine industries and its comparison between world and G7, and between G7 countries. Also this may be the first study using the ORBIS database on the analysis of certain technology industries. Further, we showed a method to identify world features of technology industries.

This study concluded that the differences in the number of startup companies between the world and G7 countries in several types: type 1 for growth in both areas, type 2 for G7 growth and world decrease, etc. Based on the results of this study, it is necessary for the developing countries to set up policies of (1) decreasing the gap of industrial fields with the G7 countries and (2) preparing the hot industries in the growth period of advanced countries for the future.

There are many limitations in this article because we used a definition of growth engine industry and a new worldwide database. First, the classification of the database is based on the US SIC, but our definition of growth engine industry is not just matched to them. Secondly, the change of the number of startups is not the only index for the comparative activities between countries. However, it might be available as an indicator to predict new industry at an emerging stage despite the industry in which the product from home country is not released yet. Third, the ORBIS database itself is not yet perfect. Some countries use different accounting system and the data gathering from many countries are not easy. In addition, we only used the data for two years (2013 and 2014) because of data limits. More evidence is required to show that increasing the number of startup company growth engine industries is related to the specific industrial position in that country.

We hope the database will be enhanced at least to cover full data of advanced countries to analysis the world phenomena.

References

Audretsch and Feldman (1996) Innovative clusters and the industry life cycle, Review of Industrial Organization 11, 253-273.

Bae, Y.H., Choe, J.S., Hwang, S.W., Lee, W.S. and Koh, M.J. (2011) A search for new methodology for nomination of future growth engine: focusing on the development of Korea Future Technology Index (KOFTI), Technology Innovation Research, 19(3).

Chun, S.P., Kim, Y.l. and Yu, H.S. (2013) 'A comparative study of consumers' Hype Cycle using web search traffic: focusing on NAVER and Google searches, Journal of Korea Technology Innovation Society, 16(4), 1109-1133.

European Commission (2010) An Integrated Industrial Policy for the Globalisation Era: Putting Competitiveness and Sustainability at Center Stage, Brussels 614.

European Commission (2011) High-Level Expert Group on Key Enabling Technologies: Final Report, Brussels.

Chang, S.I., Jung, E.M. and Park, S.R. (2014) Assessment of Korea's Growth Engine Policies and Future Challenges, KIET Research Report, 2014-723.

Jarvenpaa, H.M. and Makinen, S.J. (2008) An empirical study of the existence of the Hype Cycle: a case of DVD technology, Engineering Management Conference, June 2008.

Jarvenpaa, H.M., Makinen, S.J. and Seppanen, M. (2011) Patent and publishing activity sequence over a technology's life cycle, Technical Forecasting and Social Change, 78, 283-293.

Kyung, J.S. and Jeong, S.P. (2006) An approach to classification of industry life cycle using main statistics index in the mobile market, Survey, 7(1), 55-84.

Lee, T.G. (2015) Current growth engine policies and their policy implications, KERI Policy Research, 15-14.

Levitt. T. (1965) Exploit the product life cycle, Harvard Business Review 43, 81-94.

Livesey, F. (2012) Rationale for industrial policy based on industry maturity, Journal of Compet Trade, 12, 349-363.

Martino, J. (2003) A review of selected recent advances in technological forecasting, Technology Forecasting and Social Change (TFSC), 719-733.

Ministry of Economy, Trade and Industry, Japan (2010) Industrial Structure Vision 2010.

National Economic Council (2009) A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs.

National Science and Technology Council, Republic of Korea (April 2015) Comprehensive Action Plan for Future Growth Engine, Special Committee on Future Growth Engine.

Porter, M. (1980) Compatative Strategy, New York: Free Press.

Small and Medium Business Administration, Ministry of Trade, Industry and Energy, (2015) A Guide to Government's Small and Medium Business Support Policies 2016, 72-77.

Klepper, S. and Graddy, E. (1990) The evolution of new industries and the determinants of market structure, RAND Journal of Economics, 21(1)

The White House (2011) A Strategy for American Innovation: Securing Our Economic Growth and Prosperity.

Watts, R. and Porter, A. (1997) Innovation forecasting, Technical Forecasting and Social Change, 56, 25-47.

Joint Ministries, Consolidated Action Plan for Future Growth Engine, Korean Government, April 2015.

Appendix 1 Changes in the Number of Startup Companies

Future Growth Engine	US SIC Code	World 2013	World 2014	Change (%)	G7 2013	G7 2014	Change (%)
Smart car	3812	276	223	-27.6	114	110	8.3 (↑)
	3663	71	52		3	3	
	3711	441	353		204	211	
	3714	895	589		136	181	
5G mobile communication	3663	71	52	-36.6	3	3	0.2 (↑)
	7372	2517	730		185	135	
	4899	6458	4947		1756	1814	
Deep-sea / extreme-environment offshore plant	3561	313	239	-12.2	68	55	-2.8
	3731	376	412		54	67	
	8711	20226	17710		6814	6613	
Unmanned aerial vehicle	3721	131	143	9.1 (↑)	77	102	32.4 (↑)
Wearable smart device	3661	10	7	-69.3	2	1	-26.0
	3663	71	52		3	3	
	3845	9	10		6	6	
	7372	2517	730		185	135	
Smart bio-production system	3822	36	1	-67.9	0	0	-26.9
	3823	97	90		1	1	
	3826	26	21		1	0	
	3829	37	27		2	2	
	7372	2517	730		185	135	
Virtual training system	7371	14025	13411	5.4 (↑)	5594	5601	14.9 (↑)
	3721	131	143		77	102	
	7379	20758	23273		14475	17455	
Customized wellness care	7372	2517	730	0.3 (↑)	185	135	14.4 (↑)
	7371	14025	13411		5594	5601	
	3845	9	10		6	6	
	7379	20758	23273		14475	17455	
Smart public safety management system	3669	201	165	-5.1	69	54	-0.1
	3663	71	52		3	3	
	7371	14025	13411		5594	5601	
	7373	830	727		4	3	
Hybrid new & renewable energy system	3621	191	120	-14.1	1	0	15.6 (↑)
	3677	7	6		0	0	
	4931	372	349		78	93	
	7373	830	727		4	3	

Direct-current transmission & distribution system	3677	7	6	-19.5	0	0	0
	3613	93	31		3	3	
	3625	376	346		0	0	
Supercritical CO_2 power generation system	3511	123	114	-13.0	34	23	-5.0
	3564	718	588		68	55	
	4931	372	349		78	93	
Intelligent semiconductor	3674	100	53	-40.2	100	53	-2.7
	7372	2517	730		185	135	
	8731	3825	3069		1020	1081	
Convergence materials	2865	1	0	-18.9	1	0	-13.5
	2819	129	95		17	16	
	2816	23	24		7	7	
	2821	275	228		34	28	
Intelligent Internet of Things (IoT)	7372	2517	730	3.1 (↑)	185	135	19.9 (↑)
	7379	20758	23273		14475	17455	
Big data	7372	2517	730	0	185	135	14.4 (↑)
	7371	14025	13411		5594	5601	
	7373	830	727		4	3	
	7379	20758	23273		14475	17455	
Advanced material processing system	3541	169	86	-36.5	2	0	-25.6
	3542	94	81		37	29	

Note: The numbers of the World include the G7.