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The Case Studies on Performances of Start-up Companies over 40 Years since Reform and Opening-up in China —An Experimental Explanation to Economy Growth in China

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Abstract

The research examines the economy growth in China and the performances of 4 startup companies' representation in different ages from 1978 to 2021. The growth of GDP in China is back up by the growth of technology startup companies in different ages from the findings in the research. It is that the growth of startup technology companies of generation by generation put the GDP growth continuously in China. The growing speed is different among different ages' companies. The growing speed of startup recently seem is even faster than that of last generation with the development of economy and technology. The findings in this research tell us that the growth of technology companies is driven by innovation and the opposite is true also. There is mutual causality between performance and innovation whenever for technology companies or countries. There is positive feedback mechanism between the growth and innovation. It also gives the entanglement theory to explanate the interactive process between innovation and performance in country and company scale from the research.

1. Introduction

It has been more than 40 years since China's reform and opening up in 1978. China has been rapid growth since that time. China's sustained and rapid economic growth over the past four decades has reshaped the world economy. In 2021, China contributed 26.3 % of world economic growth. By the end of 2021, China's economic

aggregate will be USD 17.7 trillion at the exchange rate over the same period, 118 times that of 1978. The private economy is almost zero at first, and by 2021, it will create more than 60％ of the GDP of that year. The entrepreneurial activities of entrepreneurs in the private economy have become an important driving force for economic growth for more than 40 years. 40 years have experienced different stages of development. Entrepreneurs with different technology orientations are produced at different stages. In order to discuss the logic and drivers behind its growth, the research analyze the representative enterprise performance of entrepreneurial activities of science and technology enterprises at different stages and the relationship between innovation and performance.

China has been going though fast economic and social change since the implement of the "economic reform and opening" policy in 1978. This change is caught in the term "socialist market economy system", which shows China's ambition to change its old socialist economy to a new market economy with Chinese style features. This concept of "socialist market economy with Chinese features" means using market mechanics to improve the efficiency of China's economy while the State maintains control of main industrial, political activity and the economy development direction.

International societies are getting more and more attention on technology companies in China, like Huawei's sanction by US. This paper originates from a case study to document the phenomenon through the investigation of four companies that have been valued above a sill of USD 1 billion in their recent history. The research identifies some of their functions[1)] in sales growth with time series. The research was based on a review of these companies' annual report, and on the analysis of annual reports of publicly traded companies or some data from internet. The main data includes income and accumulated patents cases, and the founder of "Core entr epreneurs" who have created the companies and the initial generation product. Going beyond the observations gathered from the cases, the research found that the growth of the technology company ecosystem[2)] could provide an interpretative framework for the growth of these companies, furthermore also economy growth in China, especially with the development of the innovation. Indeed, such developments

1) Fit functions of sales or income in time series

2) Indicate the products of technologies from start-up, and the customers surround them, they depend on each other.

are predicated upon the emergence of fully fledged and fast-evolving environment of different period and technology, such as PC internet and mobile internet networks, supported by what can be described "economic reform and opening" policy, which is divided into four ages according to development period, such as shortage economy ages, market economy ages, internet ages and mobile internet ages. Each age has its own environment, especially technology, that is different time have different waves on technology.

With the country entering the fourth ages, sees increased device capabilities combined with faster, higher bandwidth and more intelligent networks, paving the way to a wide adoption of advanced multimedia applications. The phenomenon is gaining pace with cheaper handsets and more affordable data connections, allowing access to an array of new apps on a global basis. This paper is an attempt to account for the key factor to influence on the growth in company and country scale. Especially the different age enterprises' time characteristics are shown in their starting up times. The first part focuses on the performance of four cases of the technology companies after their starting up. It illustrates how these companies have been, one way or another, riding this new technology waves. In order to look for the kay factor for their growing, the second part describes briefly the enabling environment of the growth of these companies: the deployment of technology, measuring with accumulated patent application cases in their own fields. The last section suggests a theory to briefly explanate the mechanics of companies' growth to understand whether the company, which was leading in the earlier generations of product, has not only been losing ground but may also have missed the last technology wave. The paper concludes by valuing the role of "5 years Plan" recently policies, on both sides of the country and companies. Such policies may have pursued the technology with more positive consequences on the country and company side.

2. Literature Review

The technology companies in Chinas have mainly been thought as imitators or followers rather than innovators. Since about 2000, from the third decades after "Reform and opening" in 1978, the situation has been become different, with China showing stable and key innovations by domestic technology companies. China has opened the way in all domain innovations. Although Chinese technology companies

have long had a fame for imitation (Peng, Ahlstrom, Carraher, & Shi, 2017), some of leading companies are now beginning to innovate, not only in processes and products but also in technology (Fu, 2015; Huang, 2010; Yang, Liu, Gao& Li, 2012; Yip & McKern, 2016; Zeng & Williamson, 2007). Since about the 1990 s, such as Huawei, Giant, Alibaba and Bytedance,etc., a private sector has rapidly appeared with new business models, new organizational forms, and new products and technologies. The economic growth, market expansion, and increasing consumer income in China are important engine for innovation, and competition. It is the rapid developing in China economy to drive Chinese technology companies to accelerate their innovations in all aspects(Breznitz & Murphree, 2011; Williamson & Yin, 2014). The research suggests that this may be opposite or interactive. That is innovation being the driver to engine the growth of these technology companies and the economy growth in China. All innovations is an entrepreneurial seeking of creating economic value by reorganizing existing knowledge or finding new knowledge (Camisón & Monfort-Mir, 2012; Schumpeter, 1934). Allen and Potts (Allen&Potts, 2016) suggest that the innovation process does not only begin with the entrepreneur's new ideas but also have some relationship with macroeconomics environment, industrial environment and key resources. As a precondition to the innovation process, a joint base of knowledge is acceptable for the entrepreneurs in these technology companies to sketch data, information as well as inspirations (Potts,2019). One of the applications of knowledge rations is the creation of a shared pool of resources. For example, sharing the research on vaccines, ventilator design, and other vital scientific and engineering knowledge is very important to manage the pandemic. In response to the COVID 19 pandemic, social scientists working on the Population Council knowledge rations are hosting research on COVID 19 and how this virus is presently making an adverse impact on the world's health and economy (Acharya, Gundi, Ngo, Pandey, Patel, Pinchoff, Rampal, Saggurti, Santhya&White, 2020). It is just like what many technology companies open their operation syste m's source code. Innovation, no matter whether it is open or closed, is dependent on the taking use of knowledge in the organization or out of the organization. To ensure successful innovation, knowledge has to be identified and managed (Du Plessis, 2007) properly in organization. A study in 2011 explores the relationship between Knowledge Management (KM), innovation, and organizational performance and concludes that performance is directly influenced by KM and indirectly influenced by innovation (Hassan, Al-Hakim, L.A.Y., 2011). The research has a different

finding that the performance is influenced directly by innovation. While the association of innovation and KM to performance has been established in the extant research, but the mechanics that support innovation-centric knowledge is not well researched in this research. Although these are not the important point in this research, it may be provide a structure for us to explanate why these technology companies could develop so many innovations.

In less than 40 years, China has transformed from imitation to innovation development going step by step with the growing of China's entrepreneurial private sector（Nee & Opper, 2012; Wu, 2014）. While some researchers had the view that Chinese companies cannot innovate（Abrami, Kirby, & McFarlan, 2014）, recent observations and developments recommend that this is not a truth. How innovative do Chinese companies influence on their growth? Is the innovation key motivation to a company's growth? Making different companies' comparisons of their innovativeness is difficult, as the only hard data available are patent comparisons（Fu, 2015）, which have many limitations. One alternative indicator is the global rankings of leading innovation publications, such as MIT Technology Review. Listed in the MIT Technology Review world's B 50 Smartest Companies 2019 are more than 20 Chinese companies: Huawei（1#）, Alicould（4#）, Bytedace（21#）, Meituan（28#）and Tencent（8#）, etc. Moreover, Sensetime（29#）, a Chinese start-up valued at RMB 210 billion in the first day of IPO on December 30, 2021, is considered one of the top 30 Breakthrough Technologies 2019 in the world by the same magazine. Notably, two of these top twenty Chinese companies（MEGVII and Ant Financial）are recently established start-ups. Other researchers in global strategy are interested in different companies' relative competitive advantages. One reference is executive estimates. One research also references other researches regarding innovation in China（Booz, & Company, Benelux Chamber of Commerce, CEIBS Centre on China Innovation, & Wenzhou Chamber of Commerce, 2012; Veldhoen, Mansson, Peng, Yip, & Han, 2014; ）. The surveys were conducted online and sent to the contacts at Strategy, the Centre on China Innovation at China Europe International Business School（CEIBS）, and other survey partners. The surveys found that Chinese companies are rapidly matching the capabilities of Western companies in innovation for China, whether carried out there or elsewhere. An increasing percentage of executives observed their Chinese competitors as either equally or more innovative in China: 47％ in 2012, 64％ in 2013, and 65％ in 2014（Yip & McKern, 2016, p. 69）. Although we recognize that multinational corporation

(MNC) executives in China may be overdrawing the level of innovativeness of Chinese companies as these MNCs face the competitive threat every day, these indicators of the innovativeness of Chinese companies relative to Western MNCs are shocking. There is a research which carried out an annual report cross the time periods above (Yip & McKern, 2016, p. 69). Some research suggests that many Chinese companies are not only innovating in terms of cost and processes or continuously improving products, but also launching a variety of innovations under strategy or planning (Yip & McKern, 2016, p. 69). This supports our views in the research.

For this study, we contributed to their sales or income growth in time series on the relative innovation of four Chinese companies in China. For Huawei of 33 years (1988-2021), Giant internet of 29 years (1992-2021), Alibaba of 22 years (1999-2021) and Bytedance of 9 years (2012-2021),

In order to control other variables, the assumptions are suggested as follows. The first, Entrepreneurship requires environmental and resource conditions. Next, the macroeconomic environment is stable and predictable. The third, the industrial environment consists of key elements of industrial policy and market configuration, including manpower, capital, and technology. The fourth, the market provides a steady stream of entrepreneurs through education and training. The fifth, entrepreneurs have an inexhaustible supply of new concepts and ideas. The sixth, the market allocates and adjusts the resources required for entrepreneurship, such as human resources, capital, and technology. The seventh, the resources of the enterprise are also relatively limited, and the level of the limit is determined by the enterprise's own management capabilities. The eighth, the limitation of resources determines that the growth of an enterprise is limited, so the enterprise has a life cycle. The nineth, successful technology companies can push the limits of growth. Based on the assumptions above, the research first discusses the performance in company and country scale, then discusses the relationship between accumulated patent application cases and their performance in company and country scale. The interesting findings are shown in this paper.

3. Data and Methodology

3.1 The Data Types

The data this research used are a time series. A time series is a selection of observations sampled sequentially in time with the given observations taken at specific times which are normally equally spaced. A time series is normally represented as a collection of data y_t $(t=1, 2, \cdots\cdots.T)$, with the interval between x_t $(t=1, 2, \cdots\cdots.T)$, the interval being fixed and constant. The main advantage of a time series is the possibility for both explaining the past and predicting the future behavior of variables of GDP or companies' income. In practice time series arise in many fields like sociology, physiology, economics, meteorology. Many time series arise in finance as well, including such series as share prices on successive days, export totals on successive months, company profits in successive years and foreign exchange rates in successive days. This project is concerned with the time series of income in companies and GDP in China. It takes use of the trendline in Excel to get the Chinese GDP or companies' income growth curve in their performance research. The formula applicated here may be nonlinear function like this as follows.

$$y=f(x) \qquad (1)$$

Where x denotes the time or annual patent application, and y denotes GDP or companies' annual income. The table 1 below is an example of a time series showing observations of GDP over 40 years.

Table 1. GDP in China from 1978 to 2021 (Current US$, Billions)

GDP \ Years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
GDP	150	178	191	196	205	231	260	309	301	273	312
GDP \ Years	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
GDP	348	361	383	427	445	564	735	864	962	1029	1094
GDP \ Years	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GDP	1211	1339	1471	1660	1955	2286	2752	3550	4594	5102	6087
GDP \ Years	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
GDP	7552	8532	9570	10476	11062	11233	12310	13895	14280	14723	17700

Source: World Development Indicators in World Bank

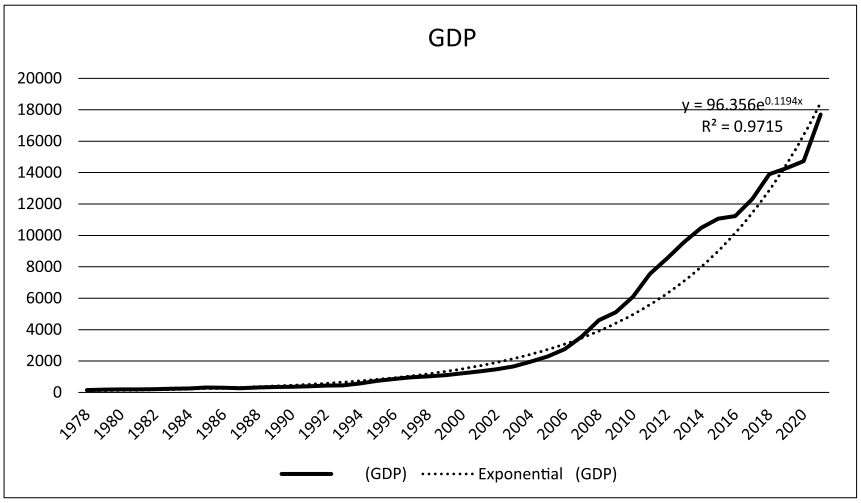

Figure 1. The GDP Growth Curve of China from 1978 to 2021　Current USD Billion

The GDP growth curve of China from 1978 to 2021 are drawn in figure 1. It takes use of Excel to get the Chinese annual GDP in the time series. The R square for the regression closes to 1, but to do the standard regression analysis is not necessary for time series. The formula for Chinese GDP growth in time series is shown as follows.

$$y = 96.356e^{0.1194x} \qquad (2)$$

Where variable x denotes the xth year, and variable y denotes the corresponding annual GDP in China. If someone want to forecast the Chinese future GDP in some year, the formula above would be used for forecasting the GDP in the future.

Annual time series data for sales or income from the companies' startup to 2021 were collected from annual report of the companies or some public report in compa nies' website. The GDP data were collected from the latest issue of World bank or the annual report from China Statistic Bureau. The patent application data for China is come from the database of World Intellectual Property Organization. Annual patent application for companies were collected from annual report of the companies or some public report in website. The econometric software used is the excel.

The study area covered the mainland China within the time limits of different period stratification since "Reform and opening" in 1978. The four Stratifications was produced by selecting one of the most popular characteristics available environmental variables based on experience from literature research. Principal company startup in this period was used to explain the main problem resolved in this

Stratification. The different principal companies are Huawei, Giant internet, Alibaba and Bytedance.

3.2 Model Specification

The China's GDP and companies' equation in different ages constructed in this paper is based on the univariate regression. A linear regression model can be defined as the function approximation that represents a continuous response variable as a function of one or more predictor variables. While building a linear regression model, the goal is to identify a linear equation that best predicts or models the relationship between the response or dependent variable and one or more predictor or independent variables. This research uses simple or univariate linear regression models: These are linear regression models that are used to build a linear relationship between one response or dependent variable and one predictor or independent variable. The form of the equation that represents a simple linear regression model is expressed form as follows:

$$y = ax + b \qquad (3)$$

where "a" is the coefficients of the predictor variable and b is bias. When considering the linear regression line, "a" represents the slope and b represents the intercept.

This paper aims to explain what are the key force to put the company growth. We choose the patent application data from World Intellectual Property Organization（WIPO）statistics database as the explanation variable. We look GDP or income as independent variables

4. The Performance and Their Influence on Chinese Economy of Startup Companies since 1978

We divided the time line of Chinese "open and reform" into 4 periods from 1978. We choose one startup technology company as a represent in corresponding time interval. The Performance of different ages' Startup technology companies

4.1 The Case Studies in Different Periods

It is necessary to choose one startup technology company as a represent in each period due to the different time characteristics. The performance in the research is measured by chosen technology companies' annual income from its birth.

4.1.1 The Huawei Technology Founded in Shortage Economy Ages

Since reform and opening in 1978, China's economy has been growing at almost 10％. In the first 10 years during 1978-1988, China's GDP growth rate averaged about 8％. This period can be divided into the following stages: the conceptualization of China's reform and opening-up program, the period of bringing order to chaos and implementing rural land contract system in countryside during 1978-1984, the development of township and village enterprises, we also call township and village enterprise start-up, during 1985-1988, we call the two period together as shortage ages from 1978-1988, the characteristics in this period are that goods are short in market, the industrial products are distributed mostly by administration power or planning, such as TV set, steel, etc. A little bit part of goods was allocated by market, such as some of agriculture products. The very famous company setup in that period is Huawei. Mention "Huawei" and most people would immediately associate the brand with the latest, high-quality technological products. Indeed, the Huawei brand has come a long way since it was founded in 1987. Within a short 30-years history, Huawei is today a global behemoth competing against the likes of Apple and Samsung. This begs the question: what is the secret to Huawei's rapid brand success? This article seeks to unravel some of the key factors to Huawei's accomplishments.

4.1.1.1 The Story of Huawei and Its Founder

Ren Zhengfei was born on October 25, 1944 in Zhenning County, Guizhou, China. Ren Zhngfei's primary and middle school years was spent in a beautiful mountainous town he was born in Guizhou Province. His young ages were spent in the Chongqing Institute of Civil Engineering and Architecture (now Chongqing University) in 1963. He joined the People's Liberation Army (PLA) research institute to work as a military technologist reportedly in the PLA's Information Technology research, a unit in Mianyang, Sichuan, after he graduate from the institute (Li Hongwen,2019). He had been employed in the civil engineering industry until 1974 when he joined the military's Engineering Corps as a soldier tasked to establish the Liao Yang Chemical Fiber Factory(Li Hongwen,2019). Mr. Ren had taken positions as a Technician, an Engineer, and was lastly promoted as a Deputy Director, which was a professional role equivalent to a Deputy Regimental Chief, but without military rank (Li Hongwen,2019). During this time, Ren was responsible for a number of technology achievements that were recognized at various levels. Ren was selected as a delegate from PLA to attend the National Science Conference in 1978(Li Hongwen,2019) due to this reason. In 1983, Ren retired

from the army due to a large army workforce reduction which impacted more than half million military personnel in active duty. After retired from army, Ren moved to Shenzhen and worked in the electronics company in Shekou, Shenzhen, Guangdong, China（Li Hongwen,2019）.

Ren Zhengfei founded Huawei Technologies in 1987 in Shenzhen China with 21,000 yuan, around US$5,000 at the time, as a contractor for selling, installing and maintaining server switches and equipment for a Hong Kong dealer in China at that time. In 1992, Ren pushed Huawei transforming from agent to a manufacturer to develop the C&C 8 server switch, which sold at 1/3 of the market price at that time and made the first successful boost of Huawei in small sized switches market. From then on, Huawei eventually had become a communication equipment manufacturer, especially from 1996 to 1998, Huawei first have entered into bigger sized program-controlled switch supplied metropolitan areas of China with its competitive capability increasing, such as rapidly service to its customers. Today, Huawei's products and solutions are deployed in over 700 cities all over the word, and serving over half top 500 companies in the world and more than one thirds of the global population. Huawei is the biggest global manufacturer of routers, switches and other telecommunications equipment by market share.

4.1.1.2 The Performance of Huawei from 2002 to 2021

The income data for Huawei Groups is showed in table 2 as follows.

Table 2. The Income of Huawei from 2002 to 2021　100 million RMB

Year	Income
2002	175
2003	221
2004	313
2005	453
2006	656
2007	922
2008	1230
2009	1466
2010	1825
2011	2039
2012	2202
2013	2390
2014	2882
2015	3950
2016	5216
2017	6036
2018	7212
2019	8588
2020	8914
2021	6368

Source: Huawei's Annual Report

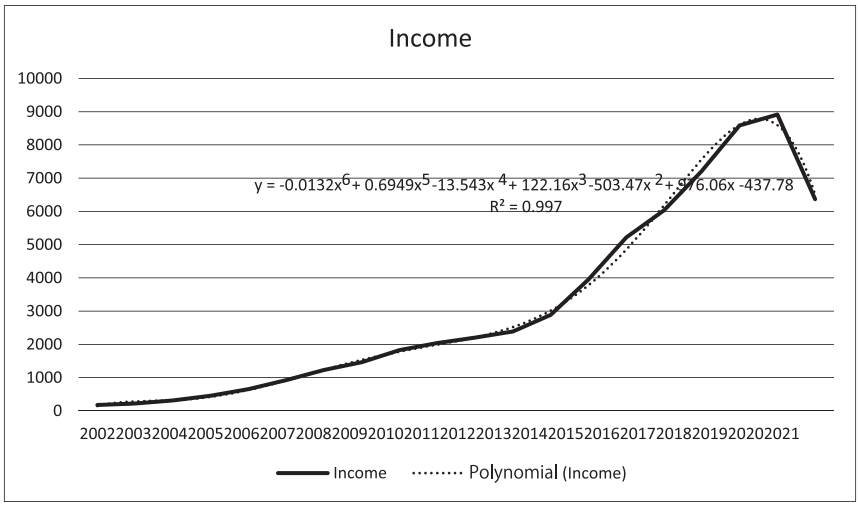

Figure 2. The Income Growth of Huawei from 2002 to 2021　100 million RMB

The income growth curve of Huawei groups from 2002 to 2021 are drawn in figure 2. It takes use of Excel to get the Huawei's annual income in the time series. The R square for the regression closes to 1, but to do the standard regression analysis is not necessary for time series.

$$y_H = -0.013x^6 + 0.695x^5 - 13.54x^4 + 122.16x^3 - 503.47^2 + 976.06x - 437.78 \quad (4)$$

Where variable x denotes the x^{th} year, and variable y_H denotes the corresponding annual income in Huawei. If someone want to forecast the Huawei's future income in some year, the formula above would be used for forecasting the income for Huawei in the future. The forecasting should pay attention that the sanction from United States recently should be considered.

For many customers, Huawei has seemingly come out of nowhere to become one of the world's most dominant technology brands. Primarily a business-to-business company (B2B), its biggest gains have been outside of the public eye. Major customers include telephone and internet operators, which use Huawei's expertise to provide services to customers under their brand name, not Huawei's brand. It has also lacked worldwide fame due to its Chinese origins till sanction by United States in May 2019. With up to one-fifth of the world's population within its own Chinese market, Huawei has been able to grow sustaining while Huawei not only satisfies the domestic, but also still focus on a more grandly market waiting it developing continuously.

4.1.1.3 The Performance of Different Business Groups from 2010 to 2021

Huawei divided its core businesses into three business groups in 2010 fiscal year's annual report. The Carrier Network Business Group was classified as the first group, it provides wireless networks, fixed networks, global services, carrier software, core networks and network energy solutions that are deployed by almost all major communications carriers all over the world. For over seven years leading up to 2012, the compound annual growth rate of Huawei's managed services division exceeded 70 percent annually, making Huawei the fastest-growing managed services provider globally.

The Enterprise Business Group was divided into the second business group, it is a division responsible for perfect complement. Once information is sent and received through "channels", these data have to be examined, analyzed, translated, stored and saved, by Huawei's data center and storage products.

The Consumer Business Group that is defined as the third group started in July 2003, which pushes the company into the personal handset and smartphone segments. Huawei calls this its "channel strategy", focusing on Information storage & processing, Information transportation & distribution and Information presentation & creation. In April 2017, the brand has announced its plans to create a separate cloud business unit as part of its plans to invest USD 1 billion to expand its cloud business. It has become the business group growing most rapidly among the Hua wei's three distinct business groups since 2010. The income data for the three distinct business groups from 2010 to 2021 is showed in table 3 as follows.

Table 3. The Income of Three Distinct Business Groups in Huawei 100 million RMB

Year \ Group	Enterprise Business Group	Carrier Network Business Group	Consumer Business Group
2010	58	1458	309
2011	92	1501	446
2012	115	1601	484
2013	153	1665	570
2014	194	1921	751
2015	276	2323	1291
2016	407	2906	1798
2017	549	2978	2372
2018	744	2940	3489
2019	897	2967	4673
2020	1003	3026	4892
2021	1024	2815	2434

Source: Huawei's Annual Report

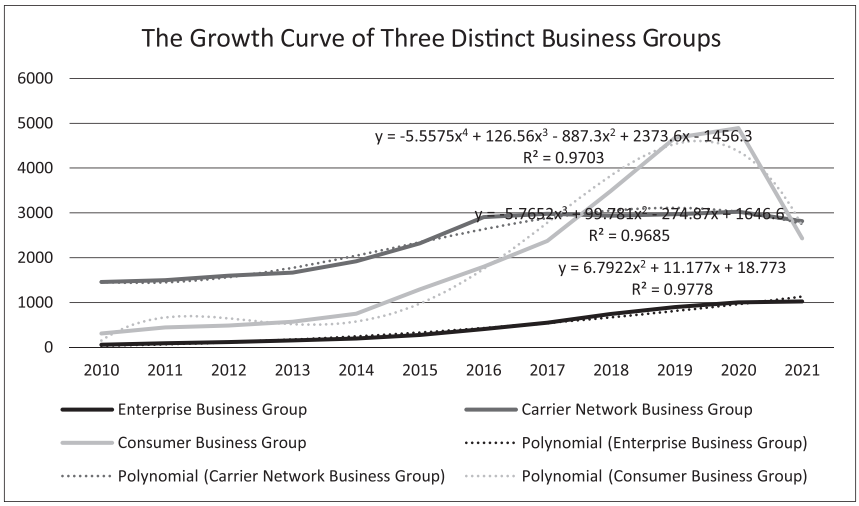

Figure 3. The Income Growth Curves of Three Distinct Business Groups in Huawei.

The income growth curves of three distinct business groups from 2010 to 2021 are drawn in figure 3. It takes use of Excel to get annual income for Huawei's three distinct business group in the time series. The R square for the regressions close to 1, but to do the standard regression analysis is not necessary for time series.

$$y_{HE}=6.7922x^2+11.177x+18.773 \qquad (5)$$

Where variable x denotes the x^{th} year, and variable y_{HE} denotes the corresponding annual income in Huawei's enterprise business group. If someone want to forecast the Huawei's future income of the group in some year, the formula above would be used for forecasting the income for Huawei enterprise business group in the future. The forecasting should pay attention that the sanction from United States recently should be considered. Although the influence of this group by sanction of United States is not too bigger compare with consumer business group, the growing for this group are more slowly.

$$y_{HC}=-5.7652x^3+99.781x^2-274.87x+1646.6 \qquad (6)$$

Where variable x denotes the x^{th} year, and variable y_{HC} denotes the corresponding annual income in Huawei's carrier network business group. If someone want to forecast the Huawei's future income of the group in some year, the formula above would be used for forecasting the income for Huawei carrier network business group in the future. The forecasting should pay attention that the sanction

from United States recently should be considered. Although the influence of this group by sanction of United States is not too bigger compare with consumer business group, the growing for this group are more slowly also.

$$y_{HCB} = -5.5575x^4 + 126.56x^3 - 887.3x^2 + 2373.6x - 1456.3 \qquad (7)$$

Where variable x denotes the x^{th} year, and variable y_{HCB} denotes the corresponding annual income in Huawei's consumer business group. If someone want to forecast the Huawei's future income of the group in some year, the formula above would be used for forecasting the income for Huawei consumer business group in the future. The forecasting should pay attention that the sanction from United States recently should be considered. The influence of this group by sanction of United States is the biggest among the three business groups, the growing for this group is significant slowly due to sanction.

The most rapidly growing business had been consumer business group among the three distinct business groups, far more than enterprise and carrier business groups till 2019, but its growth rate has decreased rapidly due to the United States sanction from May 2019. This research modifies the income of consumer business group from 2019 to 2021 according to its growth rate in 2018. Huawei Consumer Business Group became the second largest smartphone manufacturer by market share in 2019 commanding 17％ of the total global market. The modified data for consumer business group is shown in Table 4 as follows.

Table 4. The Modified Income of Three Distinct Business Groups in Huawei 100 million RMB

Year \ Group	Enterprise Business Group	Carrier Network Business Group	Consumer Business Group
2010	58	1458	309
2011	92	1501	446
2012	115	1601	484
2013	153	1665	570
2014	194	1921	751
2015	276	2323	1291
2016	407	2906	1798
2017	549	2978	2372
2018	744	2940	3489
2019	897	2967	(Modified) 4900
2020	1003	3026	(Modified) 7400
2021	1024	2815	(Modified) 8900

Source: Huawei's Annual Report

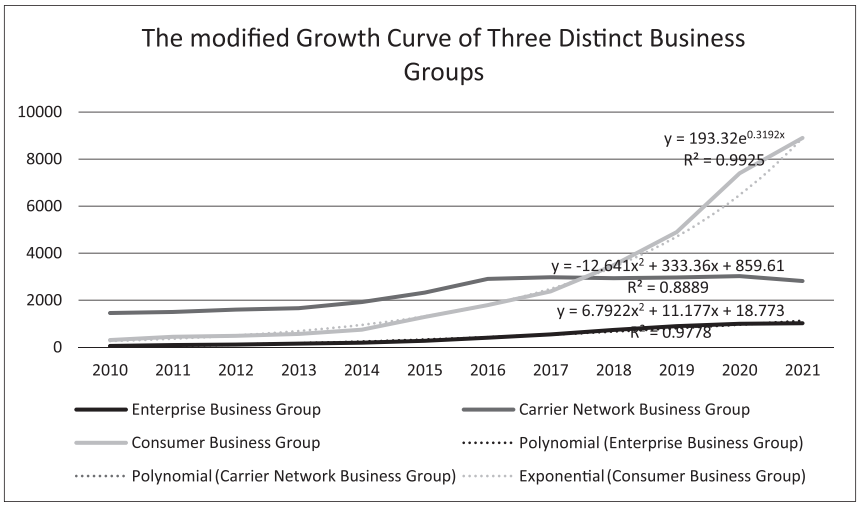

Figure 4. The Modified Income of Three Distinct Business Groups in Huawei
100 million RMB

The modified income growth curves of three business groups from 2010 to 2021 are drawn in figure 4. It takes use of Excel to get annual income for the Huawei's three business group in the time series. The R square for the regression closes to 1, but to do the standard regression analysis is not necessary for time series. The growth curve for consumer business group would be geometric progression if no sanction from United States

$$y_{HM} = 193.32e^{0.3192x} \qquad (8)$$

Where variable x denotes the x^{th} year, and variable y_{HM} denotes the corresponding annual income in Huawei's consumer business group. If someone want to forecast the Huawei's future income of the group in some year, the formula above would be used for forecasting the income for Huawei consumer business group in the future. The forecasting has considered the sanction from United States recently. If there were no the influence by sanction of United States, the income for the group would grow rapidly with geometric progression.

4.1.2 Giant Network founded in Market Economy Setting Ages

In the second 10 years, we call market economy setting period during 1989-1999. China's GDP growth rate averaged about 12％. The period of economic adjustment during 1989- 1991. Deng Xiaoping's travel and talks during his tour to Shenzhen in southern China unveiled a new chapter of China's opening-up in full

swing. The Third Plenum of the 14 th CPC Central Committee in 1994 published socialist market economic theory, the point of this theory is that all resources will be arranged by market, not by government. The internet was first introduced in China in 1995, only ones accessed to it worked in universities and research institutions, no one knew its influence on economy and peoples' daily life. In the first 20 years after 1978, China's reform and opening-up became more sophisticated. With great resolve and confidence, China created a kind of socialist market economy with its own characteristics. The achievements of reform and opening-up are incredible. After 1994, China's market economy system has become more completely in industrial and urban development, it gained momentum in Chinese history.

Before the last two year of the times, the eruption of the Asian financial crisis followed in 1997, an age ended and another ages, the internet ages, was coming soon.

4.1.2.1 The Story and Its Founder for Giant

Giant was found by Shi Yuzhu in 1991, it is an online game developer and operator that focuses on massively multiplayer online role-playing games in 2001.

The company, as a developer and platform of online gaming operator based in Shanghai, is expertized in the research and development of multiplayer online role-playing games, which are played through linked game servers on which players are able to connect and interact in same time.

Shi Yuzhu was born in a common family with common parents in Anhui, China. His father was a police officer in the Huaiyuan County Public Security Bureau. He was clever, fearless and passionate from his very childhood years. He spent his childhood in this 2300 sq km of area, as a child, he loved reading cartoon, and often sunk in thinking. He has absorbed the knowledge he could touch at that time. Reading comics, Shi got great understanding of China's culture and history. At the age of 10, he read something about the how to manufacture powder, and decided to make it himself. After several tests, he produced the works, the powder experience will have played a important role in his later in his business. He is famous for taking different risks at different points of his life and business. After receiving a bachelor degree in mathematics from the Zhejiang University, Shi Yuzhu finished post-graduation in software engineering from Shenzhen University. The first product "Hanka" for Shi yuzhu was developed in the dormitory before his graduate from Shenzhen University. Shi Yuzhu started his career in the software industry by establishing Zhuhai Giant Hi-Tech Group with this Giant Hanka in the year 1991.

But his eager quest for rapid growth and untouchable goals put the company in the disaster with heavy debts, and it finally bankrupted in 1997. In order to return the dabt, he reorganized his business, and engaged in online gaming and health sector. He founded Giant network in 2001, with which he focused on multiplayer online games. These games were played via linked servers, and enabled users in different locations to play while connecting and interacting with each other. The company was listed in the NYSE in the year 2007.

Shi Yuzhu currently serves as the president and founder of Giant Network, one of the biggest online game operators and developers in China. Although he was highly in debts and tasted the fails at the beginning of his early career in Giant in Zhuhai in 1992, and is listed among some of the most successful entrepreneurs now in China.

4.1.2.2 The Performance of Giant from 2016 to 2021

The income data for Giant Network from 2016 to 2021 is showed in table 5 as follows.

The income growth curve of Giant Network from 2016 to 2021 are drawn in figure 5. It takes use of Excel to get the Giant's annual income in the time series. The R square for the regression doesn't closes to 1, to do the standard regression analysis is not necessary for time series. The income for Giant networks has decreasing continuously since 2018, the income in 2021 even dropped to the half of 2018. The reason for this status is that there are no new products fever by customers these years.

Table 5. The Income of Giant Network from 2016 to 2021　100 million RMB

Year	Income
2016	23.2
2017	29.1
2018	37.8
2019	25.7
2020	22.2
2021	18.8

Source: Giant's Annual Report

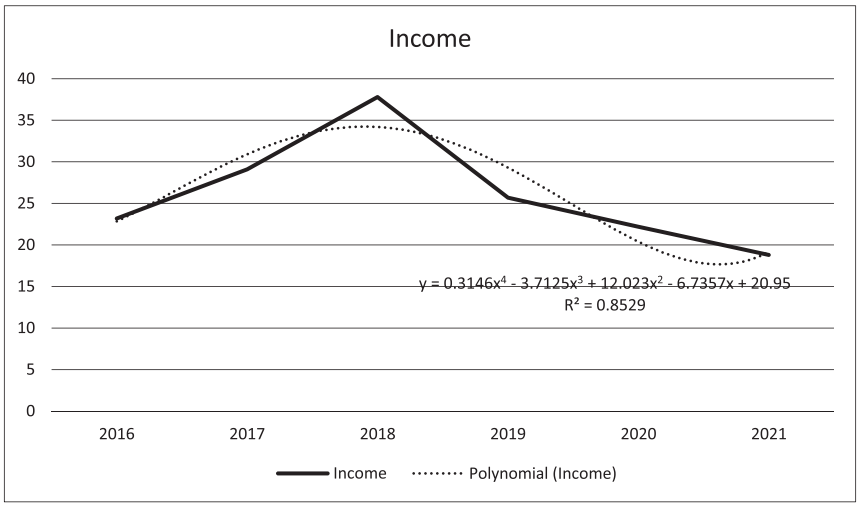

Figure 5. The Income of Giant Network　100 million RMB

$$y_G = 0.3146x^4 - 3.7125x^3 + 12.023x^2 - 6.7357x + 20.95 \qquad (9)$$

Where variable x denotes the x^{th} year, and variable y_G denotes the corresponding annual income in Giant Network. If someone want to forecast the Giant's future income in some year, the formula above would be used for forecasting the income for Giant in the future.

4.1.3 Alibaba Founded in Internet Ages

In the third decades, we call internet ages during 2000-2010. China's GDP growth rate averaged about 17％. With the internet technology development, e-commerce as the new growth strategy became a much more concentrated venture field. Electronic commerce is broadly defined as the production, marketing, sale, and/or delivery of goods and services via electronic means（Organization of Economic Cooperation and Development［OECD］, 1997 a; Laudon & Traver, 2012; Turban, King, Lee, Liang, & Turban, 2015 ）and it has affected the Chinese and global economy in many ways. It was possible to enter the global economy for Chinese people first time, several forecasts continue to predict huge potential in global e-commerce over the next several years led by corporate giants such as AliBaba.com despite the Burst of dotcom bubble in 2001 and China's accession into the WTO on December 11 in that year. Due to the big deal in Chinese economy history, although there has been much to boast about in advanced countries regarding e-commerce as a viable business strategy, many doubt its application to developing countries（Pearson A. Broome,2016）. Between 1990 and 2001, China's economy experienced

rapid growth (7-8％ on average) as performed its telecommunications, information technology (IT) and Internet infrastructures (50％ - 200％ on average). Its large population brings the penetration rates of these infrastructures way over below developed countries and a little bit higher than many developing countries.

China's infrastructure is characterized by "disparities" among geographic areas, demographics, and firm scale. Large cities and economically advanced coastal areas enjoy much better infrastructure and much more Internet users than remote and economically poorer provinces. Large companies have bigger IT budgets and better-trained staffs than small- and medium-sized companies. The younger population with higher level education is more easily to adopt Internet and e-commerce.

The infrastructure disparity leads to e-commerce diffusion disparity. The e-commerce activities at that time were concentrated in large cities, coastal provinces, large companies, and among well-educated young generation. The legal environment for e-commerce is better in large cities and coastal provinces because they publish local laws regarding e-commerce and IT infrastructure.

Barriers to e-commerce diffusion include low technical infrastructure in degree, lack of security, lack of a system to monitor and guarantee buyer and seller credibility and security, and an inefficient delivery system. The lack of a credibility monitoring system extends to both vendors and individual consumers.

Taxation and privacy, which are vital to e-commerce diffusion in many other countries, do not appear to be serious concerns yet in 2000 s. However, content censorship is among the top concerns.

The most significant driving forces are government promotion and private entrepreneurial desire to make profits. Government initiatives include general promotion of the IT industry, an industrial and regulatory policy to foster competition among service providers, encouragement of E-government, and sponsorship of projects to mobilize public awareness, such as the "Enterprise Online Project" and "Home Online Project".

The poor infrastructure for e-commerce in China pulled e-commerce back to a base building stage after an initial explosive stage. Significant diffusion can only occur after a solid infrastructure is built up, including the technical and legal infrastructure. Two examples, an E-store for residents in a local living complex and the E-system for college admissions, demonstrate e-commerce models unique in China (Zixiang Tan & Wu Ouyang, 2003).

4.1.3.1 The Story of Alibaba and Its Founder

The website Alibaba.com was found by Ma Yun, the company started in his

apartment in 1999.

It was initially created as a B 2 B platform with the objective of connecting Chinese manufacturers with overseas buyers. It has reached closed to a billion products with the company's platform C 2 C trading system, Taobao etc.. It helps small and medium enterprise find producers, exporters and wholesalers with their supplying demand by connecting millions of buyers and sellers all over the world. Alibaba's reached to 61％ of the online retail market in China in 2019, but from that time it's share has being decreased to 53％ till 2021.

Ma Yun had the idea to give the company's name "Alibaba" while sparing in a cafe in San Francisco. he did a market test by asking one of the waitresses in the cafe on whether she heard of the name and what it meant for her knowledge. she said sure and Alibaba meant "Open Sesame" from an Arab tale. Jack Ma decided on the Alibaba as the name for his new company on the timepoint she said like this.

As mentioned above, Jack Ma returned back to Hangzhou to startup the company in 1999 in his apartment close to Xihu in Hangzhou, leading 18 partners who were investors and also the company's first employees. But Ma always had entrepreneurial experiences to found different companies before, one of which was a translation institute and the other called China yellow Pages, which allowed Chinese companies to look for customers worldwide. Ma is a continuous entrepreneur who absorbing the experience from his early failure in China Pages. Ma's vision, distinct characteristics, management and operating style, excellent speaking style and ability to motivate employees is help for the success of the company and its meteoric rise as the world's biggest e-commerce marketplace. Because he exercised his English companying foreign traveler in his childhood times beside Xihu in Hangzhou and he was a English teacher in a university before he setup Alibaba, he can communicate clearly to the Western media, leaders and investors with his English fluently. In short, Ma Yun is Alibaba's signs, brand ambassador, director and communicator. In 2003, Taobao, the world's biggest consumer trading platform was founded and popular in the Non-classic Virus pandemic by defeating E-bay in China. The company has launched into the next generation of computing services with the launch of Alibaba Cloud Computing from 2013.

There are 1000 million active buyers using its websites and 1130 million active buyers, as the largest e-commerce company in the world, Alibaba has make revenues of RMB 717.3 billion in 2021.

In the first two years of its birth, it funded USD 25 million by SoftBank due to the company's attractiveness and potential in growing and business model. The co mpany's vision, " Let the business all over the world becomes easy" clearly centers

the power and potential of the Internet to reform the behavior for sellers and buyers. The translation institute of the very beginning to Alibaba, it has been providing the Internet platform for improving trade efficiency between small and medium sized enterprises worldwide.

Jack Ma has foreseen the technological changes and kept innovation in its products and services. Alibaba Not only have the trading platform, but also have its own online payment system called Alipay, which accounts for more than half of Chi na's online payments market now. Beside Alipay, the Alibaba group now has a series product portfolio including Taobao marketplace (B 2 C marketplace), Tmall.com (online retail platform), Xianyu , eTao (comparison shopping website), AliExpress (online retail service for small sellers), AliCloud (cloud computing service provider) and 1688.com (B 2 B trade in China).

Alibaba has been lunching 11/11 holiday for its four "1 s" as a online shopping festival, the number representing youngers' single status. In 2021, Alibaba's Singl e's Day transaction was RMB 540 billion, an increase of 8.4 % compared to 2020 (498 billion). The company can achieve the same amounts of transactions in an hour today, compared to what it achieved in a day back in 2013. The retail industry in China is completely reformed by e-commerce compared with 20 years ago.

4.1.3.2 The Performance of Alibaba from 2003 to 2021

Since its inception 23 years ago and its IPO 8 years ago, Alibaba has taken the world by storm. It will definitely be interesting to see how the company growth rapidly. The income data for Alibaba from 2023 to 2021 is showed in table 6 as follows.

Table 6. The Annual Income of Alibaba　100 million RMB

Year	Income	Year	Income
2003	2.2	2013	496
2004	3.6	2014	525
2005	7.4	2015	762
2006	13.6	2016	1011
2007	21.6	2017	1582.7
2008	30.1	2018	2502.7
2009	38.8	2019	3768.4
2010	55.6	2020	5097.1
2011	64.1	2021	7172.9
2012	254		

Source: Alibaba's Annual Report

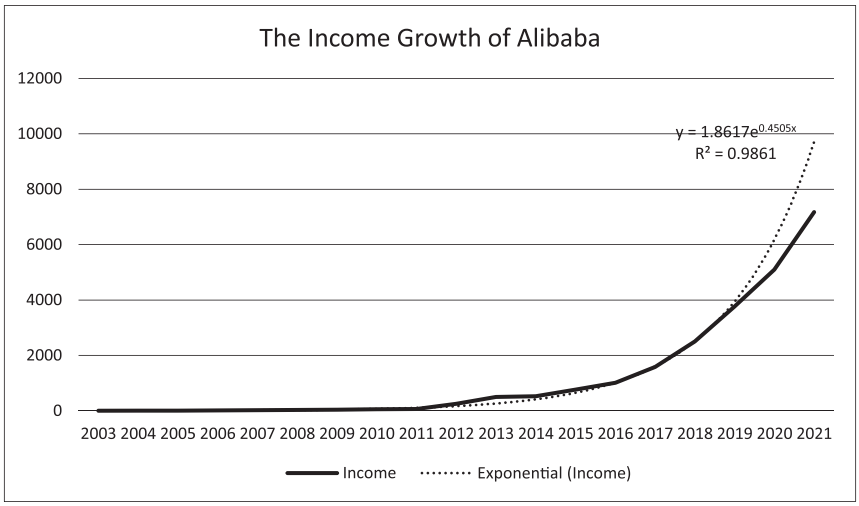

Figure 6. The Income Growth Curve of Alibaba 100 million RMB

The income growth curve of Alibaba from 2003 to 2021 are drawn in figure 6. It takes use of Excel to get the Alibaba's annual income in the time series. The R square for the regression closes to 1, but to do the standard regression analysis is not necessary for time series.

$$y_A = 1.8617e^{0.4505x} \qquad (10)$$

Where variable x denotes the x^{th} year, and variable y_A denotes the corresponding annual income in Alibaba. If someone want to forecast the Alibaba's future income in some year, the formula above would be used for forecasting the income for Alibaba in the future. The income for the group grows rapidly with geometric progression.

4.1.4 Bytedance in Mobile Internet ages

In the fourth decades, we call mobile ages during 2011-2021. China's GDP growth rate averaged about 8％. In 2004, Amazon set up a laboratory in Silicon Valley that would build its first piece of consumer hardware, a device for reading digital books. In 2007, Amazon launched its first mobile device, the Kindle eBook reader (Simon, 2011). Amazon created at the same time an entire and sophisticated ecosystem around the mobile device with Amazon Publishing (created in 2009) and 13 other imprints, tools for self-publishing and giving access to hundreds of thousands of books to borrow and read (for free for Amazon Prime subscribers) on a Kindle device. Amazon has since tried to duplicate this successful ecosystem with the introduction of another mobile device in 2014, the Kindle Fire TV, for TV, movies

and games, introducing tools for production, moving into content production under the flagship of Amazon Studios (created in 2011).

Regarding their Asian equivalent, BAT companies, Alibaba is leading in mobile commerce in China and its revenues are shifting more and more towards mobile: for the first time, the company announced, in August 2015, that its mobile revenues accounted for more than half of its total commerce revenues in China (Custer, 2015). In 2003, Tencent embraced mobile successfully with both the creation of WeChat/Weixin and the development of mobile games. In 2014, Tencent became the largest publisher of mobile games in China and one of the largest globally. Tencent pioneered the free-to-play[3] business model. This innovative business model now dominates the worldwide market for mobile games (Mobile Game Arch Roadmap, 2013)

4.1.4.1 The Story of Bytedance and Its Founder

The business model of Bytedance of is a form of top in the beginning. ByteDance was founded in March 2012 by Zhang Yiming, and it is best known for its smartphone apps with short video program. He was born in 1983 in Longyan, Fujian and entered Nankai University in January 2001. During this period, he switched from microelectronics to software engineering.

In 2011, Yiming observed the migration of netizens from traditional to smartphones, so he personally resigned as CEO of Jiujiufang and founded ByteDance in 2012.

Zhang Yiming believes that artificial intelligence can be used to recommend content of interest to users. Zhang Yiming said, "Just like Facebook connects people with people, Uber connects people with cars, and his products will connect people with information." However, at that time, the artificial intelligence industry was still in its infancy, Zhang Yiming and his colleagues Neither team knew how to build complex algorithms. Without book guidance, they start with the basics and teach themselves along the way. Zhang Yiming judged that Chinese netizens often cannot find the information they are interested in on the Internet. For example, Baidu, a search engine in the Chinese market, often confuses advertisements with search results, which led to the subsequent Baidu medical advertising scandal.

In August 2012, ByteDance launched the news recommendation application Today Toutiao (Jiri Toutiao). The platform studies what users read and search for,

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3) With free basic features (free trial period and full version for a fee), which is alternatively called also free-to-play (F2P: the content is made available for free online)

recommending information and articles based on those habits. The more people who use it, the better the user experience will be and the longer the stay will be with the accumulation of data and the progress of the algorithm. In the seed round in 2012, Zhang Yiming's early investor Haina Asia Ventures invested US$3 million, which provided the necessary funds for the company's breakthrough. By mid-2014, Toutiao's daily active users had climbed to over 13 million. Sequoia led a $100 million Series C round financing for it at this time.

Around September 2016, ByteDance launched Douyin. Douyin lets users shoot and edit short 15-second videos, add filters, and share them on platforms like Weibo or WeChat. This form attracted the attention of young people, and once it was launched, it became an instant hit, so much so that WeChat later blocked direct access to the app. In 2017, ByteDance acquired Musical.ly, a US-based mobile app founded by a Chinese founder for $800 million. ByteDance sees synergies between Musical.ly and Douyin (known as Tik Tok outside mainland China) and merges the two in one.

Rarely, Zhang Yiming and ByteDance are the first startups not to seek protection or funding from Alibaba, Tencent or Baidu. On the contrary, ByteDance is considered to have a strong competitive relationship with the two giants, because ByteDance is mainly funded by advertising revenue from Douyin and Toutiao.

In addition, ByteDance has been more successful in attracting younger audiences abroad than Alibaba, Baidu and Tencent. ByteDance is favored by users in the United States, Southeast Asia, Japan and other places, and is considered to be the most successful case of globalization among Chinese technology companies. Besides Apple, ByteDance is also the only technology company with more than 100 million users in both China and Western countries. The Economist magazine considers it to be the first international technology giant out of China. In the United States, TikTok is considered a competitor to companies such as YouTube and Instagram. ByteDance owns products such as Toutiao, Volcano Video and Douyin (and its overseas name Tik Tok).

It competes directly with other Chinese tech giants like Alibaba, Baidu and Tencent.

Its current apps include TikTok, Helo (an Indian social media app), Vigo Video (formerly Hypstar), Douyin (the Chinese version of TikTok), BaBe (an Indonesian news and content app) and Huoshan (a Chinese short-form video app.

The Jinri Toutiao is One of Bytedance's first products, which is one of the most popular AI-driven news distributors in China. According to reporting, the app of Jinri Toutiao was installed in more than 700 million smart devices by March 2022

worldwide. ByteDance is also supported by some of the famous hunters in venture capital funding, including SoftBank and Sequoia Capital.

4.1.4.2 The Performance of Bytedance

The income data for Bytedance from 2016 to 2021 is showed in table 7 as follows.

The income growth curve of Bytedance from 2016 to 2021 are drawn in figure 7. It takes use of Excel to get the Bytedance's annual income in the time series. The R square for the regression closes to 1, but to do the standard regression analysis is not necessary for time series.

$$y_D = 170.25x^2 - 460.95x + 364.2 \qquad (11)$$

Table 7. The Income of Bytedance from 2016 to 2021　100 million RMB

Year	Income
2016	60
2017	160
2018	500
2019	1200
2020	2366
2021	3712

Source: Bloomberg's report and Bytedance's Annual Report in 2021

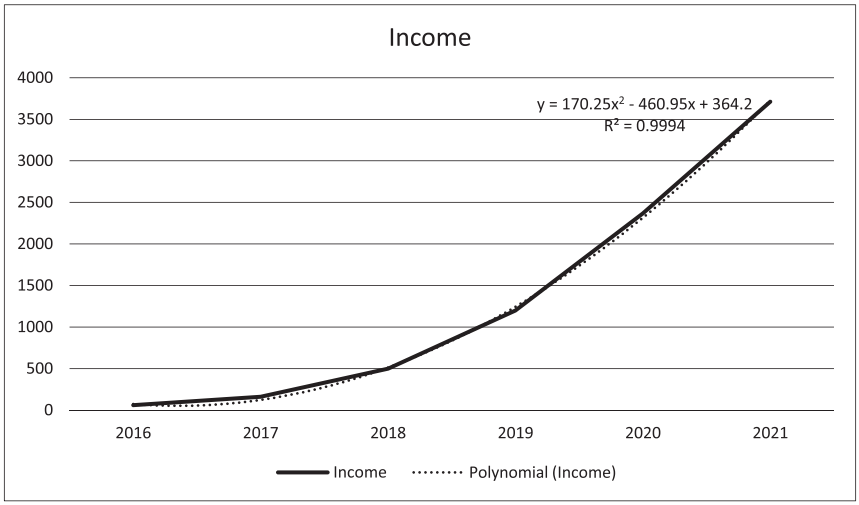

Figure 7. The Income Growth Curve of Bydance from 2016 to 2021　100 million RMB

Where variable x denotes the x^{th} year, and variable y_D denotes the corresponding annual income in Bytedance. If someone want to forecast the Bytedance's future income in some year, the formula above would be used for forecasting the income for Bytendance in the future

4.1.4.3 The Future for ByteDance

ByteDance is focused on global growth , particularly in the U.S. where the company has been on an actively recruiting talent from companies like Snapchat and Facebook, whenever IPO or not.

It's also facing with examination challenges from federal government as it has before in Trump times. With the conflicts increasing between China and US, the reviewing comes from U.S. lawmakers who have worries about TikTok's collection of user data, after all it is a compony from China.

Like Alibaba and Other platforms, ByteDance is also seeking ways to diversify its products and reach a series segment. Some news ported that it is intending extend into education-related hardware, and have hunted extensions into music streaming or even game market.

4.1.5 The Performance Comparing among Companies

The income data for the 4 companies above are showed in table 8 as follows.

The income growth curves of 4 companies above 2021 are drawn in figure 8. It takes use of Excel to get the four companies' annual income in the time series.

The growth of GDP in China is back up by the growth of technology companies startup in different ages from the figure 8. In another words, It is the growth of startup technology companies of Generation by generation put the GDP Growth continuously in China. The growing speed is different among different ages' companies. The Bytedance born in the fourth decades reached RMB 400 billion in only years, while Huawei reached same revenue in 37 years and Alibaba in 20 years. The growing speed that startup recently seem is more and more faster than that of last generation with the development of economy and technology.

Table 8. The Companies' Income in Different Period Startup 100 million RMB
GDP in Billion USD

Year	Huawei	Giant	Alibaba	Bytedance	GDP
2002	175				1471
2003	221		2.2		1660
2004	313		3.6		1955
2005	453		7.4		2286
2006	656		13.6		2752
2007	922		21.6		3550
2008	1230		30.1		4594
2009	1466		38.8		5102
2010	1825		55.6		6087
2011	2039		64.1		7552
2012	2202		254		8532
2013	2390		496		9570
2014	2882		525		10476
2015	3950		762		11062
2016	5216	23.2	1011	60	11233
2017	6036	29.1	1582.7	160	12310
2018	7212	37.8	2502.7	500	13895
2019	8588	25.7	3768.4	1200	14280
2020	8914	22.2	5097.1	2366	14723
2021	6368	18.8	7172.9	3712	17700

Source: Companies' report, Bloomberg report and World Bank Data Base

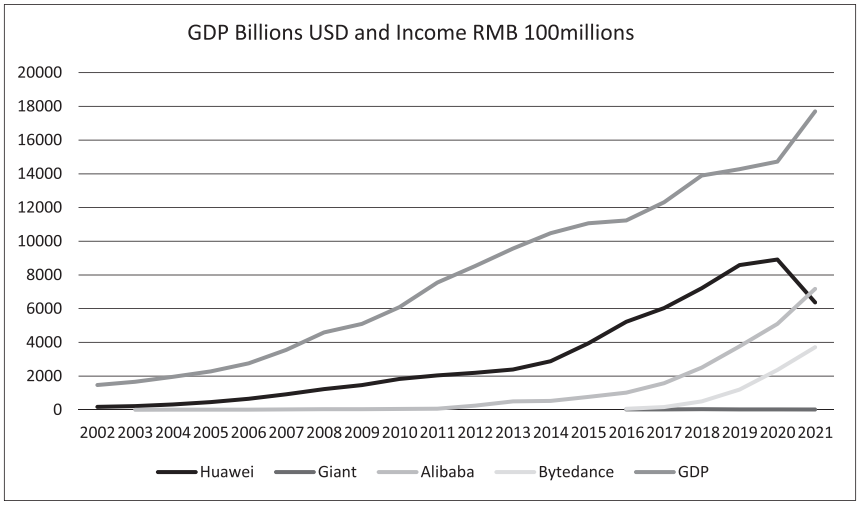

Figure 8. The Income comparing among different companies　100 million RMB

4.2 The Influence Factor on Startup Companies' Growth since 1978

The analysis above shows that the performance of almost all companies sustained have been growing except Giant Network. What is the key factor to drive the companies growing? The research will focus on annual patent application for each company to look for the relationship with its own annual performance. In another words, the research will look for the regression between each company's accumulate patent applications and annual income. The reason to use the accumulate patent application is that the performances may be have some relationships with the total intelligent properties till now, but not only themselves of the annual patent applications. Before it goes forward to next part, the Hypothesizes will be suggest as follows.

Hypothesis 1: Huawei's accumulate patent application cases have a strong relationship with its annual income for years.

Hypothesis 2: Giant's accumulate patent application cases have a strong relationship with its annual income for years.

Hypothesis 3: Alibaba's accumulate patent application cases have a strong relationship with its annual income for years.

Hypothesis 4: Bytedance's accumulate patent application cases have a strong relationship with its annual income for years.

Hypothesis 5: Chinese accumulate patent application cases have a strong relationship with its annual GDP for years.

Hypothesis 6: Chinese annual GDP have a strong relationship with its accumulated patent application cases for years.

4.2.1 The Regression between HUAWEI's Annual Patent Application and Income

The research will look for the simple regression between Huawei's Annual patent application and Income in first step.

4.2.1.1 The Simple Regression between Patent Applications and Income

The data about annual patent applications, accumulate applications and annual income in Huawei from 2002 to 2021 are listed in table 9 as follows.

This research takes use of the trendline in Excel to get the regression curve between Huawei's accumulate patent applications and annul income. The R square

for the regression closes to 1, to do the standard regression analysis is similar necessary.

$$y_H = y = -0.13x_p^6 + 6.95x_p^5 - 135.43x_p^4 + 1221.6x_p^3 - 5034.7x_p^2 + 9760.6x_p + 4377.8 \quad (12a)$$

Where variable x_p denotes the accumulated patent application in some year, and variable y_H denotes the corresponding annual income in Huawei. If someone want to forecast the Huawei's future income in some year with the patent data, the formula above would be used for forecasting the income for Huawei in the future.

Table 9. Annual Patent Application and Income in Huawei

Year \ Variable	Annual Patent Applications	Accumulate Patent Applications	Income
2002	2201	2201	1750
2003	1625	3826	2210
2004	2247	6073	3130
2005	3483	9556	4530
2006	5746	15302	6560
2007	4824	20126	9220
2008	5746	25872	12300
2009	4747	30619	14660
2010	3450	34069	18250
2011	4051	38120	20390
2012	5582	43702	22020
2013	7883	51585	23900
2014	6159	57744	28820
2015	3898	61642	39500
2016	4906	66548	52160
2017	4024	70572	60360
2018	5405	75977	72120
2019	4411	80388	85880
2020	5464	85852	89140
2021	6952	92804	63680

Source: Huawei's Annual Report and World Intellectual Property Organization

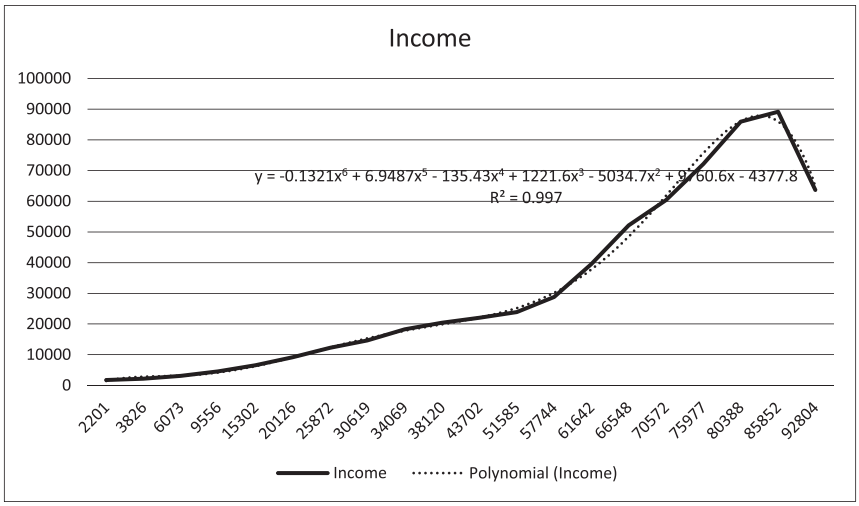

Figure 9. The Relationship between Annual Patent Application and Income in Huawei

4.2.1.2 The Linear Regression between HUAWEI's Annual Patent Application and Income under Natural Logarithmic Conditions

In order to do the standard linear regression analysis, the research takes the natural logarithm of the data of Huawei accumulate patent applications and annual income shown in Table 10 as follows.

It takes use of the trendline in Excel to get the linear regression between the natural Logarithms of Huawei's accumulate patent applications and annul income in Figure 10. The R square for the regression although doesn't close to 1, but also equals to more than 0.95. The research should do the work in which the linear regression hypothesis testing will be discussed in next part.

$$y_{HL} = 0.2024x_l + 7.6798 \qquad (12b)$$

Where variable x_l denotes the natural logarithm value of the accumulated patent application in some year, and variable y_{HL} denotes the corresponding the natural logarithm value of annual income in Huawei. The reason for using natural logarithm value is that it is easy to perform statistical tests for linear regression.

Table 10. The Natural Logarithm Value of Accumulate Patent Application and Income in Huawei

Year \ Variable	Annual Patent Applications	lnAPA	Income
2002	2201	7.6966671	7.467371
2003	1625	8.2495752	7.700748
2004	2247	8.711608	8.048788
2005	3483	9.1649245	8.418477
2006	5746	9.6357388	8.788746
2007	4824	9.9097678	9.12913
2008	5746	10.160917	9.417355
2009	4747	10.329376	9.592878
2010	3450	10.436143	9.81192
2011	4051	10.548494	9.9228
2012	5582	10.685149	9.999706
2013	7883	10.850986	10.08163
2014	6159	10.963775	10.26882
2015	3898	11.029099	10.58406
2016	4906	11.105679	10.86207
2017	4024	11.164389	11.00808
2018	5405	11.238186	11.18609
2019	4411	11.29462	11.36071
2020	5464	11.36038	11.39796
2021	6952	11.438245	11.06163

Source: The natural logarithm of the data in Table 9

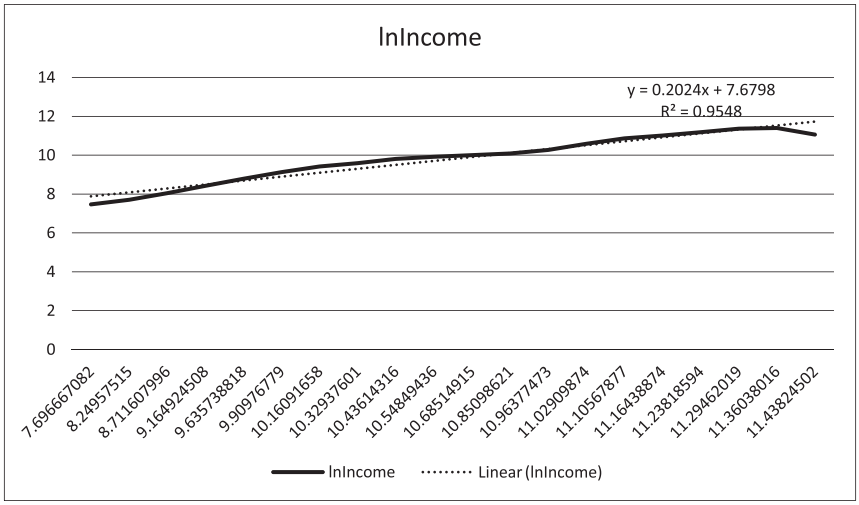

Figure 10. The Regression between the Natural Logarithm Value of Accumulate Patent Application and Income in Huawei

4.2.1.3 Linear Regression Hypothesis Testing

The research takes use of the data analysis of adds-in from Excel to get the statistic outcome shown from Table 11 to Table 13.

The coefficient is 0.97, very close to 1, and R square is 0.95, it represents that the regression line can explanation the 95% of income growth. Next, it will go forward to the significance testing of regression.

Based on the values of significance F in table 12, the decision regarding the linear regression model is taken. Evaluate significance F against the critical value/region: The value of Significance F above is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables does exist. The response variable is Huawei's income and the predictor variable is accumulated patent applications. The value of significance Fis less than the critical value at the level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists with at least one valid coefficient.

After the value of Significance F is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables does exist. It is necessary to evaluated the regression significance of intercept and X variable. The both values of P-value are all less than the critical value at the level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists at least one valid coefficient. It is now time to make a decision about to accept the hypothesis because the p-value comes out to be less than 0.05.

The final step of hypothesis testing is to draw a conclusion by interpreting the results in terms of the original claim or hypothesis. Because the significance F value lies in the critical region and the value of the p-value is less than the alpha value usually set as 0.05, we can say that there exists a linear regression model between the log value of Annual Patent Application and Income in Huawei. It is true for Hypothesis 1 by regression analysis estimation above.

The real regression line can be written by the data intercept and X variable in Table 13, it is be no meaning to show the formula in the research.

Table 11. SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.974055
R Square	0.948783
Adjusted R	0.945937
Standard E	0.284987
Observation	20

Table 12. ANOVA

	df	SS	MS	F	Significance F
Regression	1	27.08152	27.08152	333.4445	4.61E-13
Residual	8	1.461915	0.081217		
Total	19	28.54344			

Table 13. Regression Analysis Estimation

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-1.46899	0.620703	-2.36665	0.029366	-2.77303	-0.16494	-2.77303	-0.16494
X Variable	1.094745	0.059952	18.26046	4.61E-13	0.968791	1.220699	0.968791	1.220699

4.2.2 The Regression between Giant Network's Annual Patent Application and Income

Giant have 7 patents in 2021, three patents were granted, three were in process of application, the data was 1 patent in application and 1 patent had been granted. The other data in different years are intuited from website due to the intelligent property for Giant is difficult to look for. It's impossible with weak innovation to support the Growth of income. Although it is not necessary to do the statistics analysis, the outcome like other companies is shown in this part.

4.2.2.1 The simple regression between Patent Applications and Income

The data about annual patent applications, accumulate applications and annual income in Giant from 2016 to 2021 are listed in table 14 as follows. There are only

3 patents before 2016 and 4 patent application in 2021. The other patent application data are based on a reasonable estimate due to the company's closure data. This kind of estimation dose not change the analysis outcome for the relationship between patent application and its performance.

It takes use of the trendline in Excel to get the regression curve between Giant's accumulate patent applications and annul income. The R square for the regression closes to 0.85, to do the standard regression analysis is similar necessary.

$$y_G = 0.3146x_p^4 - 3.7125x_p^3 + 12.023x_p^2 - 6.7357x_p + 20.95 \qquad (13a)$$

Table 14. Annual Patent Application and Income in Giant RMB 100 million

Year	Annual Patent Application	Accumulated Patent Application	Income
2016	3	3	23.2
2017	2	5	29.1
2018	1	6	37.8
2019	1	7	25.7
2020	1	8	22.2
2021	3	11	18.8

Source: China Intellectual Property Bureau

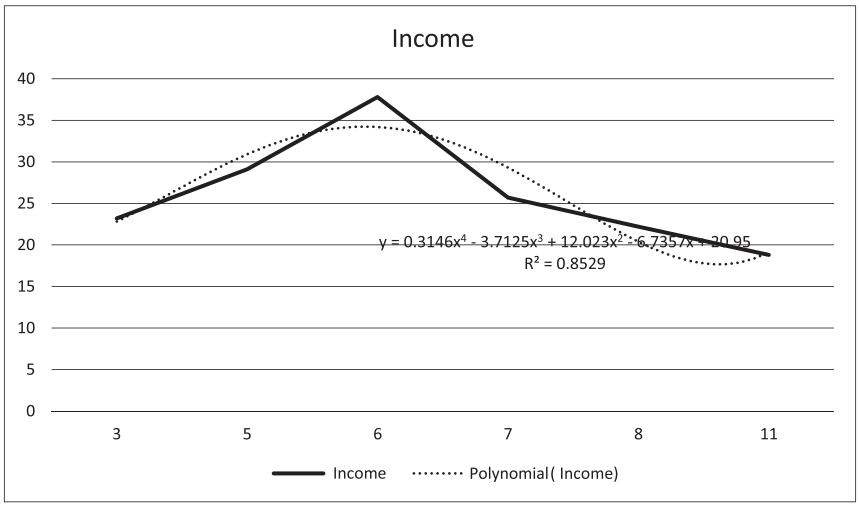

Figure 11. The regression between Accumulate Patent Application and Income in Giant

Where variable x_p denotes the accumulated patent application in some year, and variable y_G denotes the corresponding annual income in Giant. If someone want to forecast the Giant's future income in some year with the patent data, the formula above would be used for forecasting the income for Giant in the future.

4.2.2.2 The Linear Regression between Giant's Annual Patent Application and Income under Natural Logarithmic Conditions

In order to do the standard linear regression analysis, the research takes the natural logarithm of the data of Giant accumulate patent applications and annual income from 2016 to 2021 shown in Table 15 as follows.

Table 15. The natural logarithm value of Accumulate Patent Application and Income in Giant

Year	Annual Patent Application	LnAPA	lnIncome
2016	3	1.0986123	3.144152
2017	2	1.6094379	3.370738
2018	1	1.7917595	3.632309
2019	1	1.9459101	3.246491
2020	1	2.0794415	3.100092
2021	3	2.3978953	2.933857

Source: The natural logarithm of the data in Table 14

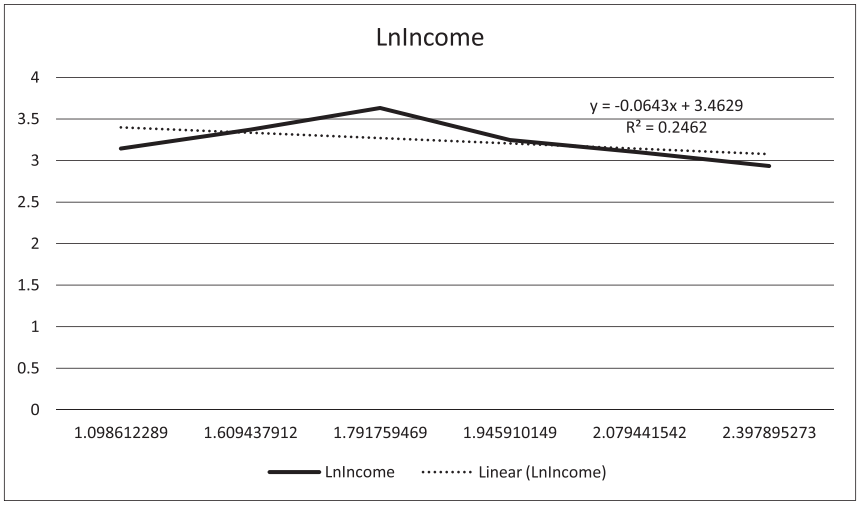

Figure 12. The regression between the natural logarithm value of Accumulate Patent Application and Income in Giant

It takes use of the trendline in Excel to get the linear regression between the natural Logarithms of Huawei's accumulate patent applications and annul income in Figure 12. The R square for the regression only equal close to 0.25, it is far smaller than satisfied value 0.75. Although it is no necessary to do the statistics analysis, the research should do the work in which the linear regression hypothesis testing will be discussed in next part.

$$y_{GL} = -0.0643x_l + 3.4629 \qquad (13b)$$

Where variable x_l denotes the natural logarithm value of the accumulated patent application in some year, and variable y_{GL} denotes the corresponding the natural logarithm value of annual income in Giant. The reason for using natural logarithm value is that it is easy to perform statistical tests for linear regression.

4.2.2.3 Linear Regression Hypothesis Testing

It takes use of the data analysis of adds-in from Excel to get the statistic outcome shown from Table 16 to Table 18.

The coefficient is 0.34 shown in Table 16, far smaller than 1, and R square is 0.11, it represents that the regression line can explanation only 11% of income changes. Next, it will go forward to the significance testing of regression.

Based on the values of significance F in Table 17, the decision regarding the linear regression model is taken. Evaluate significance F against the critical value/region: The value of Significance F above is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables does not exist. The response variable is Giant's income and the predictor variable is accumulated patent applications. The value of significance F is far more than the critical value at the level of significance as 0.05, the hypothesis is refused. This means that the linear model doesn't exist with at least one invalid coefficient.

After the value of Significance F is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables doesn't exist. It is necessary to evaluated the regression significance of intercept and X variable. The X variable values of P-value is less than the critical value at the level of significance as 0.05, but the intercept value of P-value is far more than the critical value at the level of significance as 0.06, so the hypothesis is rejected. This means that the linear model exists at least one invalid coefficient. Evaluate t-statistics against the critical value/region: After calculating the value of t-statistics for each

coefficient, it is now time to make a decision about whether to accept or reject the hypothesis. In order for this decision to be made, we need to set a significance level, which is also known as the alpha level. The significance level of 0.05 is usually set for rejecting the null hypothesis or otherwise. Not only the value of t-statistics do esn't fall in the critical region, but also the p-value comes out to be far more than 0.05, the null hypothesis is accepted.

The final step of hypothesis testing is to draw a conclusion by interpreting the results in terms of the original claim or hypothesis. Because the significance Fvalue doesn't lie in the critical region and the value of the p-value is far more than the alpha value usually set as 0.05, we can say that there doesn't exist a linear regression model between the log value of Accumulate Patent Application and Income in Giant. In other words, the weak innovation for Giant could not support the growth of it, this

Table 16. SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.338629
R Square	0.11467
Adjusted R	-0.10666
Standard E	0.254875
Observation	6

Table 17. ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.033656	0.03366	0.51809	0.511471
Residual	4	0.259845	0.06496		
Total	5	0.2935			

Table 18. Regression Analysis Estimation

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	3.574855	0.479504	7.45532	0.00173	2.243539	4.906171	2.243539	4.906171
X Variable	-0.18507	0.257114	-0.71978	0.51147	-0.89893	0.528796	-0.89893	0.528796

explanate partly the reason for giant's performance these years. It is false for Hypothesis 2 by regression analysis estimation above.

4.2.3 The Regression between Alibaba's Annual Patent Application and Income

It is the time to look for the simple regression between Alibaba's Accumulate patent application and Income in second step.

4.2.3.1 The Simple Regression between Alibaba's Annual Patent Application and Income

The data about annual patent applications, accumulate applications and annual income in Alibaba from 2002 to 2021 are listed in table 19 as follows.

It takes use of the trendline in Excel to get the regression curve shown in Figure 13 between Alibaba's accumulate patent applications and annul income in this part. The R square for the regression closes to 1, to do the standard regression analysis is similar necessary next.

Table 19. The Accumulate Patent Application and Annual Income in Alibaba 100 million RMB

year	Annual Patent Application	Accumulate Patent Application	Income
2009	208	208	38.8
2010	176	384	55.6
2011	479	863	64.1
2012	572	1435	254
2013	451	1886	496
2014	1575	3465	525
2015	3255	6720	762
2016	3025	9745	1011
2017	4628	14373	1582.7
2018	7081	21454	2502.7
2019	13336	34790	3768.4
2020	10834	45624	5097.1
2021	16576	62200	7172.9

Source: China Intellectual Property Bureau and World Intellectual Property Organization

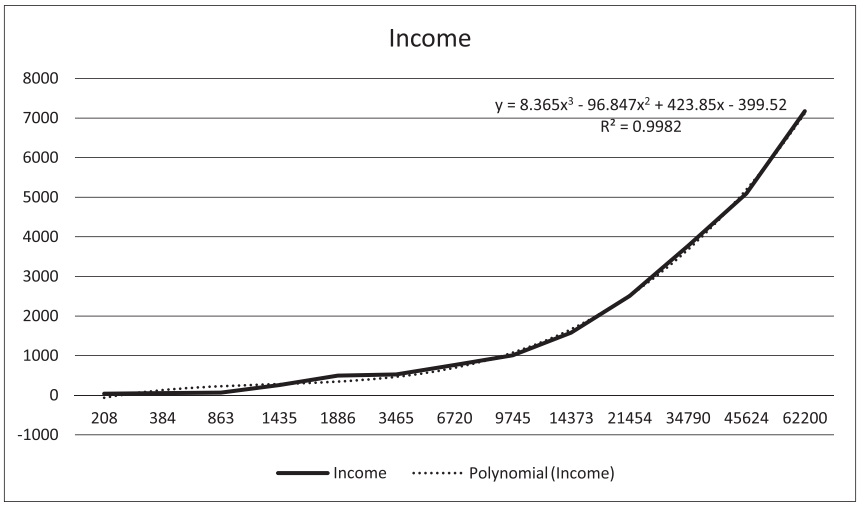

Figure 13. The Relationship between Accumulate Patent Application and Income in Alibaba

$$y_A = 8.365x_p^3 - 96.847x_p^2 + 423.85x_p - 399.52 \qquad (14a)$$

Where variable x_p denotes the accumulated patent application in some year, and variable y_A denotes the corresponding annual income in Alibaba. If someone want to forecast the Alibaba's future income in some year with the patent data, the formula above would be used for forecasting the income for Alibaba in the future.

4.2.3.2 The Linear Regression between Alibaba's Annual Patent Application and Income under Natural Logarithmic Conditions

In order to do the standard linear regression analysis, the research takes the natural logarithm of the data of Alibaba accumulate patent applications and annual income shown in Table 20 as follows.

It takes use of the trendline in Excel to get the linear regression between the natural Logarithms of Alibaba's accumulate patent applications and annul income in Figure 14. The R square for the regression although doesn't close to 1, but also equals to more than 0.97. The research should do the work in which the linear regression hypothesis testing will be discussed in next part.

$$y_{AL} = 0.4398x_l + 3.4014 \qquad (14b)$$

Where variable x_l denotes the natural logarithm value of the accumulated patent application in some year, and variable y_{AL} denotes the corresponding the natural

logarithm value of annual income in Alibaba. The reason for using natural logarithm value is that it is easy to perform statistical tests for linear regression.

Table 20. The Natural Logarithm Value of Annual Patent Application and Income in Alibaba

Year	Annual Patent Applications	lnAPA	Income
2009	208	5.3375381	3.65842
2010	176	5.9506426	4.018183
2011	479	6.7604147	4.160444
2012	572	7.2689201	5.537334
2013	451	7.5422135	6.206576
2014	1575	8.1504679	6.263398
2015	3255	8.8128434	6.635947
2016	3025	9.1845096	6.918695
2017	4628	9.5731067	7.366888
2018	7081	9.9736664	7.825125
2019	13336	10.457085	8.234406
2020	10834	10.728189	8.536427
2021	16576	11.03811	8.878065

Source: The natural logarithm of the data in Table 19

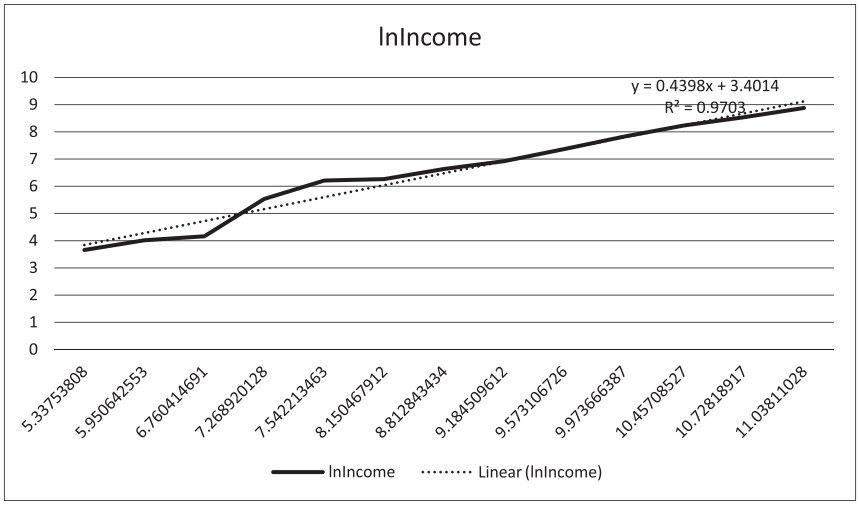

Figure 14. The Regression between the Natural Logarithm Value of Annual Patent Application and Income in Alibaba

4.2.3.3 Linear Regression Hypothesis Testing

It takes use of the data analysis of adds-in from Excel to get the statistic outcome shown from Table 17 to Table 21 in this part.

The coefficient is 0.99 shown in Table 21, very close to 1, and R square is 0.97, it represents that the regression line can explanation the 97％ of income growth in Alibaba. Next, it will go forward to the significance testing of regression.

Based on the values of significance Fin table 22, the decision regarding the linear regression model is taken. Evaluate significance F against the critical value/region: The value of Significance F above is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables does exist. The response variable is Alibaba's income and the predictor variable is accumulated patent applications. The value of significance F less than the critical value at the

Table 21. SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.985858
R Square	0.971916
Adjusted R	0.969362
Standard E	0.304359
Observation	13

Table 22. ANOVA

	df	SS	MS	F	Significance F
Regression	1	35.26376	35.26376	380.6768	6.97 E-10
Residual	11	1.018978	0.092634		
Total	12	36.28274			

Table 23. Regression Analysis Estimation

	Coefficients	Standard Error	t Stat	P-value	Lower 95％	Upper 95％	Lower 95.0％	Upper 95.0％
Intercept	-1.40338	0.412773	-3.39989	0.00593	-2.31189	-0.49488	-2.31189	-0.49488
X Variable	0.925131	0.047416	19.51094	6.97 E-10	0.820769	1.02949	0.820769	1.02949

level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists with at least one valid coefficient.

After the value of Significance F is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables does exist. It is necessary to evaluated the regression significance of intercept and X variable. The both values of P-value shown in Table 23 are all less than the critical value at the level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists at two coefficients. It is now time to make a decision to accept the hypothesis.

The final step of hypothesis testing is to draw a conclusion by interpreting the results in terms of the original claim or hypothesis. Because the significance F value lies in the critical region and the value of the p-value is less than the alpha value usually set as 0.05, we can say that there exists a linear regression model between the log value of Annual Patent Application and Income in Alibaba. It is true for Hypothesis 3 with the regression analysis estimation above.

4.2.4 The Regression between Bytedance's Annual Patent Application and Income

The research will look for the simple regression between Bydance's Annual patent application and Income in third step.

4.2.4.1 The Simple Regression between Bytedance's Accumulate Patent Application and Income

The data about annual patent applications, accumulate applications and annual income in Bytednce from 2016 to 2021 are listed in Table 24 as follows.

Table 24. The Accumulate Patent Application and Annual Income in Bytedance 100 million RMB

Year	Annual Patent Applications	Accumulate Patent Applications	Income
2016	5	5	60
2017	17	22	160
2018	280	297	500
2019	658	955	1200
2020	719	1674	2366
2021	14326	16000	3712

Source: China Intellectual Property Bureau

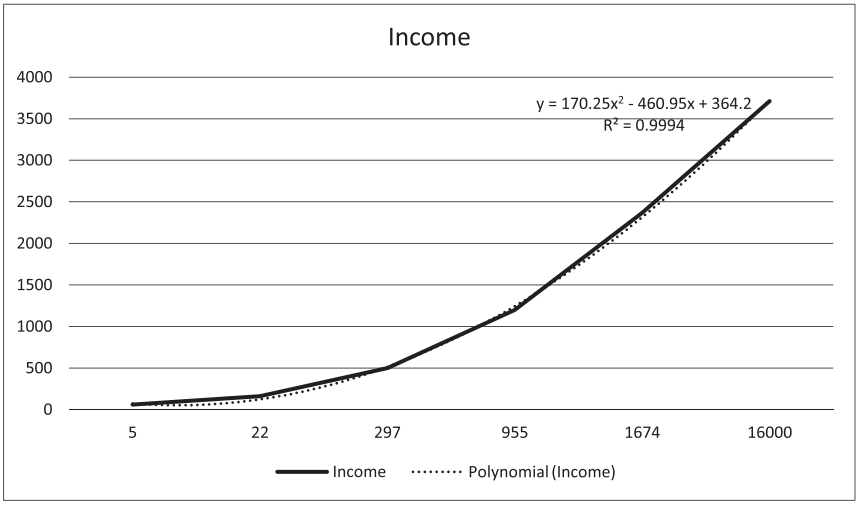

Figure 15. The Relationship between Accumulate Patent Application and Annual Income in Bydance

It takes use of the trendline in Excel to get the regression curve shown in figure 15 between Bydance's accumulate patent applications and annul income in this part. The R square for the regression closes to 1, to do the standard regression analysis is similar necessary next.

$$y_D = 170.25x_p^2 - 460.95x_p + 364.2 \qquad (15a)$$

Where variable x_p denotes the accumulated patent application in some year, and variable y_D denotes the corresponding annual income in Bytedance. If someone want to forecast the Bytedance's future income in some year with the patent data, the formula above would be used for forecasting the income for Bytedance in the future.

4.2.4.2 The Linear Regression between Bytedance's Annual Patent Application and Income under Natural Logarithmic Conditions

In order to do the standard linear regression analysis, the research takes the natural logarithm of the data of Bytedance accumulate patent applications and annual income shown in Table 25 as follows.

It takes use of the trendline in Excel to get the linear regression between the natural Logarithms of Bytedance's accumulate patent applications and annul income in Figure 16. The R square for the regression although doesn't close to 1, but also equals to more than 0.97. The research should do the work in which the linear regression hypothesis testing will be discussed in next part.

Table 25. The Natural Logarithm Value of Accumulate Patent Application and Annual Income in Bytedance

year	Accumulate Patent Applications	Income	lnAPA	lnIncome
2016	5	60	1.6094379	4.094345
2017	22	160	3.0910425	5.075174
2018	297	500	5.6937321	6.214608
2019	955	1200	6.8617113	7.090077
2020	1674	2366	7.4229713	7.768956
2021	16000	3712	9.680344	8.219326

Source: The natural logarithm of the data in Table 24

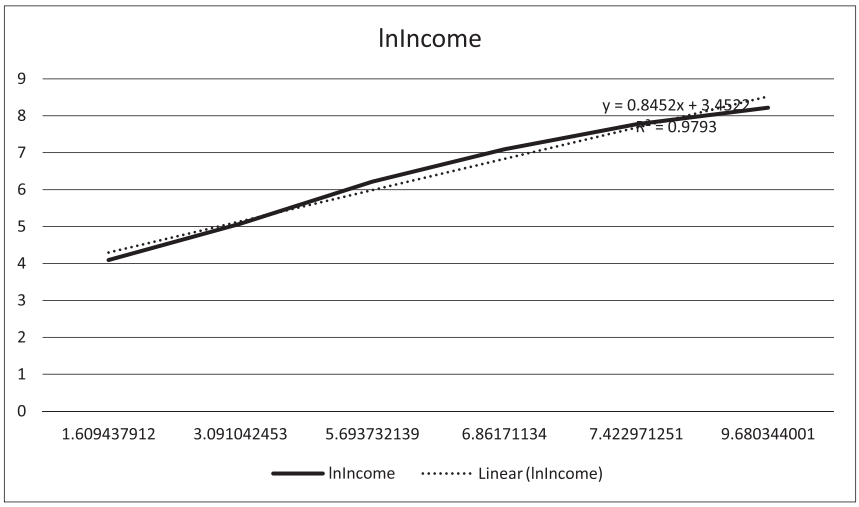

Figure 16. The Regression between the Natural Logarithm Value of Accumulate Patent Application and Annual Income in Bytedance

$$y_{dL} = 0.8452x_l + 3.4522 \qquad (15b)$$

Where variable x denotes the natural logarithm value of the accumulated patent application in some year, and variable y denotes the corresponding the natural logarithm value of annual income in Bytedance. The reason for using natural logarithm value is that it is easy to perform statistical tests for linear regression.

4.2.4.3 Linear Regression Hypothesis Testing

It takes use of the data analysis of adds-in from Excel to get the statistic outcome shown from Table 26 to Table 28 in this part.

Table 26. SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.986096
R Square	0.972385
Adjusted R	0.965482
Standard E	0.29686
Observation	6

Table 27. ANOVA

	df	SS	MS	F	Significance F
Regression	1	12.41262	12.41262	140.851	0.000289
Residual	4	0.352503	0.088126		
Total	5	12.76512			

Table 28. Regression Analysis Estimation

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	3.358301	0.284296	11.8127	0.000294	2.56897	4.147632	2.56897	4.147632
X Variable	0.532977	0.044908	11.8681	0.000289	0.408291	0.657663	0.408291	0.657663

The coefficient is 0.99 shown in Table 26, very close to 1, and R square is 0.97, it represents that the regression line can explanation the 97% of income growth in Bydance. Next, it will go forward to the significance testing of regression.

Based on the values of significance in table 27, the decision regarding the linear regression model is taken. Evaluate significance F against the critical value/region: The value of Significance F above is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables does exist. The response variable is Huawei's income and the predictor variable is accumulated patent applications. The value of significance Fis less than the critical value at the level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists with at least one valid coefficient.

After the value of Significance F is evaluated for testing the hypothesis that the

linear regression model representing response y and predictor variables x does exist. It is necessary to evaluated the regression significance of intercept and X variable. The both values of P-value shown in Table 24 are all less than the critical value at the level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists at two coefficients. It is now time to make a decision to accept the hypothesis. It is true for Hypothesis 4 with the regression analysis estimation above.

It can conclude that it is the innovation in which we measured above by accumulate patent application to drive the income growth in the three cases above, and it is the absent innovation in which the Giant Network can't sustain its growth in its over 20 years history.

4.3 The Influence Factor on Chinese Economy's Growth since 1978

After analysis the growth reason for technology companies, it is necessary to analysis what is the key factor to drive the Chinese Economy's Growth since 1978. The research will look for the simple regression between Chinese Annual patent application and GDP in this part.

4.3.1 The Simple Regression between Chinese Accumulate Patent Application and GDP

The data about annual patent applications, accumulate applications and annual GDP in China from 1985 to 2021 are listed in Table 29 as follows.

It takes use of the trendline in Excel to get the regression curve shown in Figure 17 between Chinese accumulate patent applications and annul GDP in this part. The R square for the regression closes to 1, to do the standard regression analysis is similar necessary next.

$$y_{GDP} = -0.0361x_p^4 + 2.9537x_p^3 - 58.791x_p^2 + 419.04x_p - 398 \qquad (16a)$$

Where variable x_p denotes the accumulated patent application in some year, and variable y_{GDP} denotes the corresponding annual GDP in China. If someone want to forecast the Chinese future GDP in some year with the patent data, the formula above would be used for forecasting the Chinese GDP In the future.

Table 29. The Accumulate Patent Application and Annual GDP in China Billion USD

Year	Annual Patent Applications	GDP Current USD in Billions
1985	8558	309
1986	16567	301
1987	24626	273
1988	34278	312
1989	43937	348
1990	54074	361
1991	65497	383
1992	79906	427
1993	99524	445
1994	118591	564
1995	137290	735
1996	159724	864
1997	184498	962
1998	220458	1029
1999	257152	1094
2000	293257	1211
2001	337476	1339
2002	395051	1471
2003	477014	1660
2004	574709	1955
2005	707903	2286
2006	870204	2752
2007	1064626	3550
2008	1296823	4594
2009	1557816	5102
2010	1886676	6087
2011	2348602	7552
2012	2931686	8532
2013	3683955	9570
2014	4532520	10476
2015	5552518	11062
2016	6809966	11233
2017	8111259	12310
2018	9568964	13895
2019	10880376	14280
2020	12289581	14723
2021	12362581	17700

Source: The Database of World Intellectual Property Organization

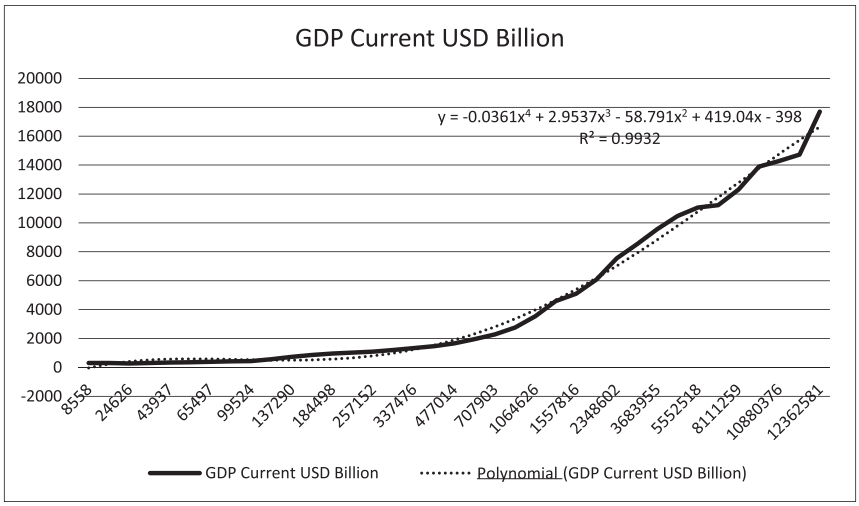

Figure 17. The Relationship between Accumulate Patent Application and GDP in China

4.3.2 The Linear Regression between Chinese Annual Patent Application and GDP under Natural Logarithmic Conditions

In order to do the standard linear regression analysis, the research takes the natural logarithm of the data of Chinese accumulate patent applications and annual GDP shown in Table 30 as follows.

It takes use of the trendline in Excel to get the linear regression between the natural Logarithms of Chinese accumulate patent applications and annul GDP in Figure 18. The R square for the regression equals to more than 0.98. The research should do the work in which the linear regression hypothesis testing will be discussed in next part.

$$y_{GDPL} = -0.1287x_l + 5.1811 \qquad (16b)$$

Where variable x_l denotes the natural logarithm value of the accumulated patent application in some year, and variable y_{GDPL} denotes the corresponding the natural logarithm value of annual GDP in China. The reason for using natural logarithm value is that it is easy to perform statistical tests for linear regression.

Table 30. The natural logarithm value of Accumulate Patent Application and Annual GDP in China

year	Accumulate Patent Application	lnAPA	lnGDP
1985	8558	9.0546218	5.733341
1986	16567	9.715168	5.70711
1987	24626	10.111558	5.609472
1988	34278	10.442259	5.743003
1989	43937	10.690512	5.852202
1990	54074	10.898109	5.888878
1991	65497	11.08976	5.948035
1992	79906	11.288606	6.056784
1993	99524	11.508154	6.098074
1994	118591	11.683436	6.335054
1995	137290	11.829851	6.59987
1996	159724	11.981203	6.761573
1997	184498	12.125394	6.869014
1998	220458	12.303462	6.936343
1999	257152	12.457423	6.997596
2000	293257	12.588805	7.099202
2001	337476	12.72925	7.199678
2002	395051	12.88677	7.293698
2003	477014	13.075301	7.414573
2004	574709	13.261619	7.578145
2005	707903	13.470062	7.734559
2006	870204	13.676483	7.920083
2007	1064626	13.878134	8.174703
2008	1296823	14.075428	8.432506
2009	1557816	14.258795	8.537388
2010	1886676	14.450327	8.713911
2011	2348602	14.669331	8.929568
2012	2931686	14.891088	9.051579
2013	3683955	15.119497	9.166388
2014	4532520	15.326789	9.256842
2015	5552518	15.529762	9.311271
2016	6809966	15.733898	9.326611
2017	8111259	15.908764	9.418167
2018	9568964	16.074036	9.539284
2019	10880376	16.202471	9.566615
2020	12289581	16.324262	9.597166
2021	12362581	16.330185	9.78132

Source: The natural logarithm of the data in Table 30

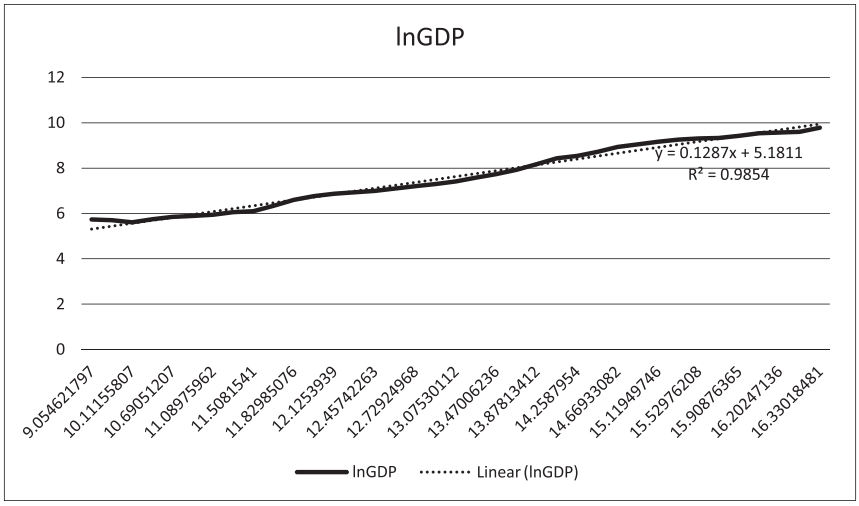

Figure 18. The Regression between the Natural Logarithm Value of Accumulate Patent Application and Annual GDP in China

4.3.3 Linear Regression Hypothesis Testing

It takes use of the data analysis of adds-in from Excel to get the statistic outcome shown from Table 31 to Table 33 in this part.

The coefficient is 0.99 shown in Table 31, very close to 1, and R square is 0.97, it represents that the regression line can explanation the 97% of income growth in Alibaba. Next, it will go forward to the significance testing of regression.

Based on the values of significance F in Table 32, the decision regarding the linear regression model is taken. Evaluate significance F against the critical value/region: The value of Significance F above is evaluated for testing the hypothesis that the linear regression model representing response and predictor variables does exist. The response variable is Huawei's income and the predictor variable is accumulated patent applications. The value of significance F less than the critical value at the level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists with at least one valid coefficient.

After the value of Significance F is evaluated for testing the hypothesis that the linear regression model representing response y and predictor variables x does exist. It is necessary to evaluated the regression significance of intercept and X variable. The both values of P-value shown in Table 33 are all less than the critical value at the level of significance as 0.05, the hypothesis is accepted. This means that the linear model exists at two coefficients. It is now time to make a decision to accept the hypothesis. 5

Table 31. SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.985899
R Square	0.971996
Adjusted R	0.971196
Standard E	0.238191
Observation	37

Table 32. ANOVA

	df	SS	MS	F	Significance F
Regression	1	68.92369	68.9237	1214.83	9.1 E-29
Residual	35	1.985728	0.05674		
Total	36	70.90942			

Table 33. Regression Analysis Estimation

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-1.267	0.258148	-4.90806	2.12 E-05	-1.79107	-0.74294	-1.79107	-0.74294
X Variable	0.674798	0.01936	34.8545	9.1 E-29	0.635494	0.714102	0.635494	0.714102

It can conclude that it is the innovation in which we measured above by accumulate patent application to drive the GDP growth in China over 40 years, and it is innovation in which the government wrote first time in the thirteenth 5 years Planning for technology from 2016 to 2020 give the direction in R&D for these companies.

5. The Explanation of Startup Companies' Sustained Growth and GDP growth in China

5.1 The Innovation Entanglement Theory to Startup Company Growth

Its dynamic mechanism can be solved by the growth entanglement theory. Entrepreneurs first launch the first products to solve market demand. The growth of the first generation of products has its limits due to the competition from competitors. The profitability of startups will attract competitors to join continuously, the competition faced by enterprises will intensify, sales growth will decline or even stagnate, and if there is no innovative product introduction, it will soon reach the growth limit. Like human growth, the growth of every adolescent child is entangled and can also be understood as entangled, and the performance of puberty will have a decisive impact on its future development potential. The same is true for startups, only those with a clear vision, mission, values, and clear strategic goals can develop the second generation of products that require market demand in this entanglement process. Although there will be entanglements or entanglements such as how the future market demand of the enterprise changes, whether the strategy needs to be adjusted, and how to choose the future direction of technological development, innovation has become an important code in the company's GENES. This continuous innovation due to growth entanglement will accompany the entire life cycle of the enterprise. For example, the possible technology path is for entrepreneurs to have a better strategic vision and use the rapid growth phase of the first growth curve to develop products or services that are in demand for the next generation. Providing services in the depth and breadth of products is the increasing dependence of consumers on the products or services of enterprises（Donald F Kuratko, 2016）. Gradually build an ecosystem of interdependence between consumers and enterprises.

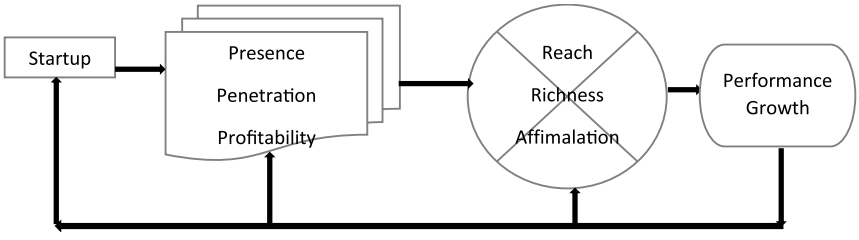

Figure 19. The Innovation Entanglement Model

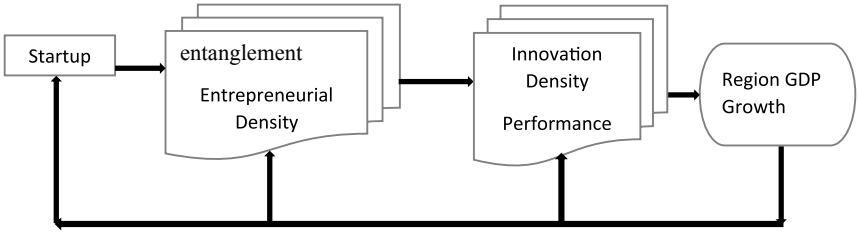

Figure 20. Economy Growth driven model

5.2 Innovation and Entrepreneurial Density Theory for Economic Growth

Entrepreneurship requires the necessary prerequisites, including the macro environment, the industrial environment, entrepreneurs, unique business concepts, and the necessary human capital technology and other key resources. In the case of these conditions, the entrepreneur evaluates the feasibility of starting a business by formulating the necessary entrepreneurial plan. Good resource support, such as venture capital, is also necessary. The entrepreneurial process after starting a business may produce more innovative events due to growth entanglement, and the exemplary effect of successful enterprises will also attract more imitators, competitors, and even more surpassers. The result is increased innovation density and entrepreneurial density within the enterprise and even in the region. Innovation density refers to the number of newly filed patents per 10,000 population per year. The entrepreneurial density here refers to the number of new start-up enterprises per 10,000 people per year. The level of entrepreneurial density determines the potential for regional economic growth.

5.3 The Entrepreneurial and Innovation Policy and the Government Effort

5.3.1 China's National and Local Innovation and Entrepreneurship Policies and Systems

China's 13 th "Five-Year Plan" in 2016 was the first to describe the Science and Technology Development Plan as a Science and Technology Innovation Plan (2016-2020). Each province has its own corresponding plan for decomposition. Each department also has a corresponding decomposition plan. Enterprises will also adjust their strategies according to science and technology plans, and invest resources in the

research and development of science and technology projects planned by the state or local government. Because this will be supported by policies or resources. Emerging technology startups will also focus on these key technologies. This entrepreneurial activity will also be supported by capital markets at all levels, in addition to China's huge early-stage venture capital market, there are also Shanghai main board market, Shenzhen small and medium-sized board market, ChiNext market, In 2019, the G market was opened in Shanghai financing in favor of technology enterprises.

5.3.2 The Government Effort in Entrepreneurial and Innovation

China will upgrade it's a series entrepreneurship and innovation activities to promote employment, technological innovation and industrial growth.

Innovation is the primary engine power of development and a strategic column of the modern economic system. Innovation and entrepreneurship have been placed an very important position since 2012.

Chinese Premier Minister, Li Keqiang, has addressed that the more entrepreneurship and innovation activities needs to be upgraded to improve services for business start-ups and innovation across the board, and create more opportunities for entrepreneurship-driven employment.

The central and local governments have introduced a series of incentives, including the business registration reforming, to make the more entrepreneurship and innovation initiative to a higher level and wider scope Since 2015.

These polices and steps have outcome obvious results. Different kinds of organization of innovation and entrepreneurship have been appearing with environment improving and a large number of remarkable entrepreneurial teams have stood out, and a crowd of innovation-driven companies as discussed above have achieved fast growth. The first half of 2018 has seen a daily average of 18,100 new businesses registered. This will have been improving the entrepreneurship density and innovation density countrywide.

The further measures have been taking to create a more friendly environment for entrepreneurship and innovation initiatives by different level governments. The measures include further simplifying administration process, decentralization, starting new businesses easily, simplifying enterprise deregistration, motivating scientific researchers to commercialize their ideas, and financing to support entrepreneurial activities of returning workers or ex-servicemen as possible as it can.

Financial support and tax incentives for entrepreneurship and innovation will be enhanced. Innovative enterprises with prominent potential but are not yet profitable will be also encouraged to be listed and apply for financing.

These measures increase the entrepreneurship and innovation density countrywide and drive the economy growth in China. It is to make the Chinese economy more innovation-driven and promote higher-quality development. The side effects of this measures have been improving employment, particularly employment for college graduates every year.

6. Conclusion

The growth of GDP in China is back up by the growth of technology startup companies in different ages from the figure 8. In another words, It is the growth of startup technology companies of Generation by generation put the GDP Growth continuously in China. The growing speed is different among different ages' companies. The Bytedance born in the fourth decades reached RMB 400 billion in only years, while Huawei reached same revenue in 37 years and Alibaba in 20 years. The growing speed that startup recently seem is faster than that of last generation with the development of economy and technology.

The six hypothesizes in the beginning of 4.3 are proven true. It tells us that the growth of technologies is driven by innovation and the opposite is true also. In other words, there are mutual causality between performance and innovation whenever for technology companies or countries. This is interesting that there is positive feedback mechanism between the growth and innovation. It is said that it is impossible for sustain growth if there are no innovation supporting and it is also impossible for more innovation if no growth supports in performance.

It is well known that innovation need direction in technology development. If the direction was wrong, the innovation in this direction could not support the growth of companies. The decision for innovation direction is a kind of entanglement process. It is said that the companies have to trial and error to explore the direction in strategy framework. The research will give the entanglement theory to explanate the process in next part.

Entrepreneurs need conditions to create a business for sustained growth. There is a limit to the growth of entrepreneurial products, and breaking through the growth curve is facing growth entanglement. Businesses that don't have a clear mission,

vision, values, and lack an executable strategy lose growth opportunities. Only those who rely on innovation to emerge from the entanglement of growth can push the limits of growth and start a sustainable growth of startups. The role model effect of successful companies will also attract more imitators, competitors, and even some surpassers in the future. These numerous entrepreneurs increase the entrepreneurial density within and in the region. The increase in entrepreneurial density promotes the economic growth potential of the region. In essence, the driving force for sustained regional economic growth can only come from continuous innovation that R&D activities, patent applications etc., contributed by technology companies or any others in any periods.

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Appendix

GDP and GDP Per Capita Growth Rate in China from 1978

Growth Rate/Ages	1978-1988	1989-1999	2000-2010	2011-2021
GDP Growth Rate	7.6	12.1	16.9	8.4
GDP per capita Growth Rate	6.1	11.	16.2	7.8

中国改革開放40年間の科学技術系新興企業の業績に関する個別案件の研究

―経済成長の経験を解説する―

馮　　建　　民

［摘要］

本研究では1978年から2021年までの期間の中国経済成長とこの期間の異なる時期に創業した新興企業の実績情況を考察した。研究の結果明らかになったのは、各時期に創業した科学技術系の新興企業の成長が確かに中国経済の絶え間ない成長を推進したということである。時期の違いにより新興企業の成長速度も異なるが、経済と技術の発展に伴い、創業時期が新しい程、企業の成長速度はそれ以前の時期の企業より更に速くなっている。研究の結果が示しているのは技術系企業の実績の成長はイノベーションにより促進され、逆もまた然りである。更に指摘したいのは、科学技術系企業或いは国家にとって、実績とイノベーションの間には何れも相互作用の因果関係が存在し、成長とイノベーションの間にはポジティブフィードバックのメカニズムが存在する。本研究では「反復の理論」が国家と企業レベルでの持続的イノベーションメカニズムについて一定の解釈を与えた事も提示した。