Research on the Development of NVIDIA

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Abstract. Established in 1993, the NVIDIA corporation has been committed to developing the most advanced GPU in the world in order to provide the best image processing technology to its clients. The GPUs designed by NVIDIA have been widely used in a many kinds of computer systems, such as laptops, military navigation system, digital media and so on. In response to the company being expected to be in the first place in the future artificial intelligence market, since May 2016, the share price of NVIDIA kept rising until September 2018, so did the EPS and revenue. However, after reaching the peak on October 1st 2018 at the price of 289.36, the share price of NVIDIA began to fall rapidly until the last month in 2018 and almost decreased about 60%, which caused big losses of a large number of investors. Fortunately, in the new year 2019, the situation has improved as the share price started to rise back and be more stable.This essay tries to analyze and explain the trend described above from the aspects of the development of NVIDIA's products, investors, consumers and the market competition in different time periods. In addition, the essay puts forward some predictions for the future development of NVIDIA.

1. Introduction

In 1999, NVIDIA corporation, an America technology company established in 1993, invented graphics processing units (GPUs), which greatly promoted the development of the PC game market and redefined the modern computer graphics technology. Its processors have been used in a great amount of OEM factories, graphics card producers and electronic commodity manufacturers all over the world to solve the imaging problems. NVIDIA concentrated on designing the innovative products for computer and mobile terminal which could change the whole industries such as the computer games, movies, industrial design, space exploration, medical imaging and so on. Their GPU product brands are aimed at specialized markets including GeForce for gamers; Quadro for designers; Tesla and DGX for AI data scientists and big data researchers; and GRID for cloud-based visual computing users.

NVIDIA listed on NASDAQ in 1999, and since then its share price kept staying in the range from $10 to $20, quite stable. Since 2016, however, the share price continued to rise until the second half of 2018 and almost 15 times the original price, letting some experts began to call this stock "monster". Interestingly, yet, not staying in the high level for a long time, the share price of NVIDIA suddenly began to fall about a half in six months.

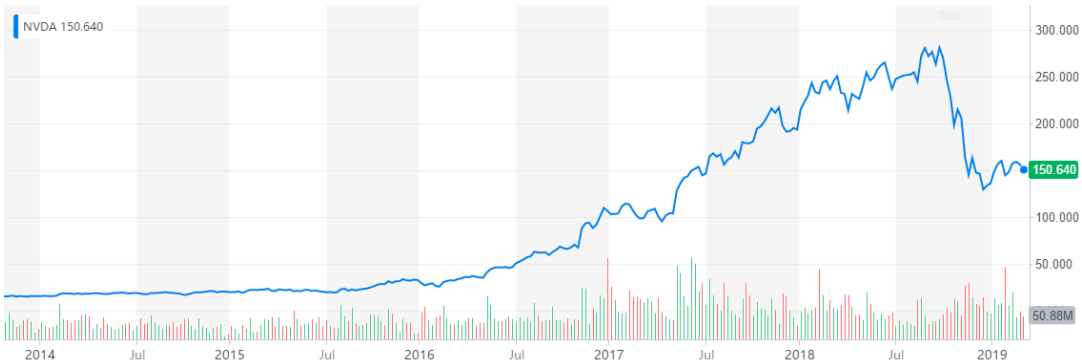

Figure 1. The share price of NVIDIA

It is widely acknowledged that there must be some factors about the company itself or about the market and the consumer will or some other things will affect the share price, which is one of the most obvious marks of a corporation's development in a mature market. Therefore, in the next part, we will discuss some possible reasons that could account for the phenomenon the NVIDIA appeared in the past years.

2. Trend Analysis: Period from May 2016 to October 2018

Since May 2016, the share price of NVIDIA kept rising until October 2018, from $45.90 to $289.36. According to the annual reports issued by NVIDIA for fiscal year 2017, 2018 and 2019, the revenue kept rising at high rates of 39% in fiscal year 2017, 41% in fiscal year 2018 and 21% in fiscal year 2019, which could account for the dramatic growth of the share price in recent years. The reports indicated that most of the increase in the total revenue comes from the development of the GPU business, including gaming, professional visualization, datacenter and automotive. Also the cryptocurrency mining may contributed to the fast-growing revenue to some extent when the price of the virtual currency such as Bitcoin haven't fall down. Therefore, in the next content, we will try to analyze the performance of NVIDIA from the development of these industries in recent years.

2.1 Gaming Market

Computer game industry is the largest entertainment industry all over the world and its market value is almost about 100 billion. What impressed us is that the GeForce, a gaming platform owned by NVIDIA, is one of the largest gaming platforms with 200 million game players who can bring vast traffic and new users to NVIDIA. In fact, majority of the loyal players are attracted by the superior GPUs products invented by NVIDIA, making the daily PCs able to bring perfect gaming experience to the consumers.

The development of excellent games is indispensable for the boom of gaming market. Thanks to the imaging technology provided by GPUs, Some games possesses exquisite pictures which can even compare with the movie scenes produced by Hollywood. The software named Gameworks of NVIDIA provided a lot of game companies with many advanced algorithms and tools, for instance, the technology of imaging realistic smoke effects, detailed hair and the water surface, to build vivid characters and make players more sense of substitution while GPUs provide the powerful processing functions for the software to achieve the tasks.

Thus, successful game graphics attract a number of loyal clients in the field of games for NVIDIA. In addition, the company always cooperates with some latest games such as Destiny 2 and Star Wars: Battle Front II. It is wroth mentioning that the game PLAYERUNKNOWN'S BATTLEGROUNDS coming out in March 2017 truly increased the sales of the whole PC game industry and inspired the demand of GPUs, contributing to the large growth rate of NVIDIA's revenue in fiscal year 2018.
It can be concluded that the boom of game markets brought NVIDIA a large quantity of profits through the GPU business.

2.2 Professional Visualization

According to the introduction made by NVIDIA itself, GPUs can serve the Professional Visualization market by working closely with independent software vendors to optimize their offerings for NVIDIA GPUs. Their computing solutions enhance productivity and introduce new capabilities for critical parts of the workflow for such major industries as automotive, media and entertainment, architectural engineering, oil and gas, and medical imaging.

Take medical imaging for an example. Medical imaging is a kind of study that try to acquire and process the image of internal organization of human body in a non-invasive way. What's more, the key factors in the stage of processing medical images include the imaging speed, image size and resolution. Traditionally, researchers used CPUs to finish imaging, however, those computing solutions couldn't satisfy the demand of real-time drawing and interaction. But, at present, experts can use GPUs, whose data processing capabilities far exceed CPUs, to improve the quality of medical imaging and save the time which used in processing images previously for the treatment.

Medical imaging is one of the earliest fields that used GPUs to speed up the computing process, thus so far many kinds of medical equipment have installed Tesla GPUs invented by NVIDIA, which greatly improved the efficiency of medical companies and the effect of medical imaging. It is obvious that as the medical technology developed rapidly, the demand of advanced medical equipment increased, and as a result, the demand of GPUs rose as well.

In the past years, some other industries used CPUs to processing pictures before such as architectural engineering or media began to try GPUs in their works, which also contributed to the high growth rate of the revenue of NVIDIA.

2.3 Artificial Intelligence

As the artificial intelligence, or AI, became more and more familiar with people, now deep learning of robots is not a new term to everyone. The definition of machine learning is a kind of science that research how can the computers simulate or achieve the studying behavior of human which means keep acquiring new skills and knowledge to reorganize and improve the knowledge structure. Deep learning is a branch of machine learning and requires high computing performance for computers. During these processes, the kinds of chips used include GPU, CPU, FPGA and ASIC, while among these four kinds GPU obviously takes the advantage of markets in the field of training machine and developing algorithms owing to its perfect computing functions. By the way, NVIDIA has almost monopolized the supplying of GPUs in the past three years. Its Volta processor architecture is known as the most advanced datacenter in the world which is used for deep learning. Therefore, it can be concluded that the datacenter section of NVIDIA is one of the fastest growing sections in its business. In fact, it is impressive that the datacenter revenue of NVIDIA truly increased 145% in fiscal year 2017 and 133% in fiscal year 2018, indicating the strong demand for deep learning training for AI. Because NVIDIA entered the market of deep learning very early, it occupied the main advantage in that field. Majority of the corporations and institutions, including some internet giants such as Google, Facebook and Alibaba, used GPUs designed by NVIDIA to accelerate the process of deep learning. For instance, the robot AlphaGo, which was popular in 2016 and 2017, has 170 GPUs connected to its body.

Another business section about AI that accounted for the fast-growing total revenue of NVIDIA is automotive. Self-driving cars can make the transportation industry become modern and efficient, but the technology requires powerful AI computing capacity. NVIDIA DRIVE PX2 is a prolongable AI car computer which can be used to control the system of self-driving technique. NVIDIA's CEO Jen-Hsun Huang announced that this AI could learn to drive on any complex roads by observing human driving behaviors. The corporation also announced several new partnerships aimed at getting AI-powered cars, trucks and commercial vehicles on the road, including partnerships with Aurora, Autoliv, Baidu, Bosch, Continental, Mercedes-Benz, Uber, Volkswagen, Volvo, Toyota, and ZF. As a result, in fiscal year 2019, NVIDIA's automotive revenue of $641 million was up 15% from a year earlier, driven by infotainment modules, production DRIVE platforms, and development agreements with automotive companies.

2.4 Cryptocurrency Mining

As we introduced in the parts above, GPUs have powerful computing capacity. Thus, except using them to develop AI or process imaging, computer engineers found GPUs could assist them to mine the digital coins such as Bitcoin.

In 2008, the concept of Bitcoins was first put forward by Nakamoto Satoshi and they are not issued by particular banks but produced by a quantity of calculation. On May 22th 2010, an American coders purchased an Italian pizza with 10 thousand Bitcoins, marking the first connection between the Bitcoin and the real world. Since then, more and more fields began to accept Bitcoin and the price of it continuing increased. In 2009, the first Bitcoin was valued that 1309.03 Bitcoins equal to one dollar. What shocked everyone was that on December 17th 2017 the price of Bitcoin rose to 19,860 dollars per one, almost 26 million times the price in 2009. Obviously, the dramatic growth rate of the price stimulated vast coders and investors to speculate in Bitcoins, which greatly increased the demand of GPUs in fiscal year 2018 as well.

3. Trend Analysis: Period from October 2018 to December 2018

After two years of rapid growth, the share price of NVIDIA suddenly began to fall since October 1st 2018 until the Christmas eve of 2018, from $289.36 to $127.08, decreasing more than a half in about three months. As for revenue, although we mentioned before that total revenue of NVIDIA in fiscal 2019 rose 21% year over year, its quarter revenue experienced a dramatic decline. In the last quarter in fiscal year 2019, its revenue decreased 24% compared to that in the third quarter and its EPS decreased 48% as well.

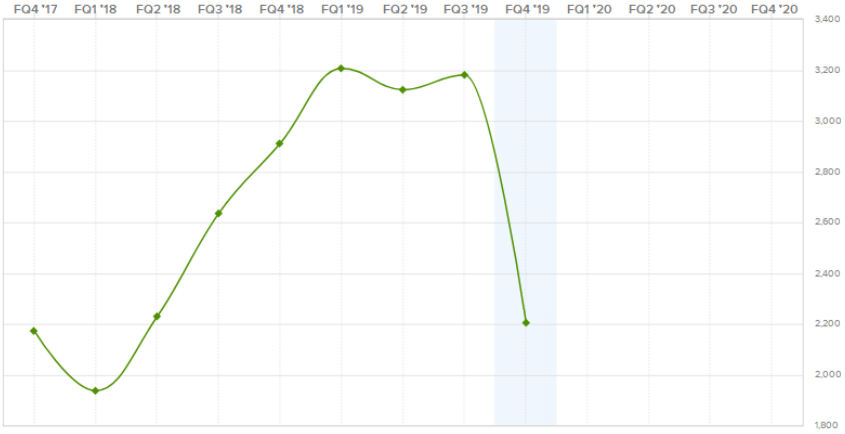

Figure 2. The trend of NVIDIA's revenue quarterly

It is said that the decline of the expected revenue in the last quarter of fiscal year 2019 announced by NVIDIA made investors decide to divestment from the corporation, which caused the slump of the share price to some extent. In the following parts, we will discuss some possible factors that influenced the revenue of NVIDIA significantly during that period.

3.1 Competition in the field of AI

NVIDIA has always been recognized as the representative of the global AI chips industry owing to the powerful computing capacity of its product GPU. As introduced before, GPUs are widely used in the datacenter which support the cloud computing of AI. To describe more specifically, cloud computing mainly includes cloud training and cloud reasoning. In the first part of cloud computing, GPU has natural advantages of computing capacity; however in the second part, the market seems to differ from the situation that NVIDIA occupies almost the whole markets in cloud training, as a large number of information technology, or IT companies participate in, including XILINX which produces the chips used the technique of FPGA(Field-Programmable Gate Array) and Intel. That is because the cloud reasoning focuses on the power efficiency more than the capacity of computing that GPU owns.

Therefore, we can summarize that, at the existing level of computing capacity GPU has, NVIDIA started to face the challenges from many other IT companies, including some clients of NVIDIA. For example, Google has invented its own AI chips series TPU. In addition, Microsoft, Amazon, HUAWEI and Alibaba all announced that they would involve in the AI chip industry. NVIDIA seemed to lose the first place in the AI field.

It can be concluded that the demand of GPUs declined with the appearance of vast substitutes for AI deep learning, which definitely had negative effects on the revenue of NVIDIA.

3.2 Fall of the cryptocurrency

In the fourth quarter of 2018, the board of cryptocurrency collapsed globally. The price of Bitcoin, which is known as the representative of the cryptocurrency, started to fell since January 2018 until March 2019, from $17,172.301 to about $3,915. Consequently, with the breakage of the Bitcoin bubble, a large number of "miners" undersold the GPUs which were used to mine the cryptocurrency previously, causing the decrease in the price of GPU and the demand of new model GPU.

According to the explanation of NVIDIA's CEO Jen-Hsun Huang, the reduction in demand of cryptocurrency led to the decrease in sale volume of Pascal GPU directly, which resulted in the increase of inventory as well, so that they decided to delay the production of new products, causing the decline in revenue of the last quarter.

Figure 3. Price of Bitcoin

4. Conclusion

With the rise of the game industry and AI in recently years, NVIDIA developed rapidly relying on its product GPU, which possesses high computing capacity. The corporation showed its advanced technology to the investors and once amazed the whole world with its fast-growing revenue and the share price. The bubble of cryptocurrency is also a significant factor.

However, as more and more IT companies began to involve in the AI chip industry, the position of NVIDIA in the field of AI was challenged and the slump of the Bitcoin price made the situation even worse, causing the share price of NVIDIA fell down dramatically. In addition, NVIDIA claimed that the slowdown in the world economic growth rate and the downturn of gaming market should also account for the horrible performance in the last quarter in fiscal year 2019.

The good news is that the share price appeared to rise back and gradually become stable at about $150 since 2019 as NVIDIA is still regarded as a valuable corporation with advanced technology and potential.

To deal with the situation, NVIDIA proposed some solutions. They plan to sell the RTX 2060, the latest GPU NVIDIA showed in CES, at the price $349, making more game players able to afford the cost for upgrading their computers and increasing the sales of GPU in turn. What's more, NVIDIA designed about 40 types of new model GeForce RTX gaming notebooks, which can satisfy the demand of light-weight gaming notebooks. They also announced that NVIDIA would try to exploit the new usage of GPU in deep learning and automotive.

In conclusion, NVIDIA needs to transfer the main revenue sector from traditional PC game industry and professional imaging to the application of GPU in AI, which is extremely hot and has vast market potential in 21st century.

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