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# FINDING ALPHA

# TABLE OF CONTENTS




Winter 2022 Chief Editors: Vinyga Kumararajah and Matthew Unrau

FEBRUARY 2022

February 2022

# Xilinx is now a part of AMD

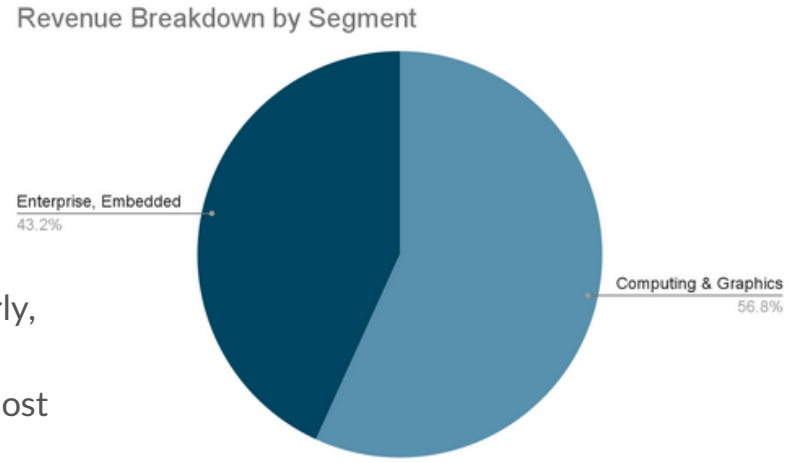
By Jarvis Zhang and Sharv Parikh, Market Research Analysts

## What Happened?

On February 14, 2022, AMD announced that it had finished the all-stock acquisition of Xilinx. An all-stock transaction is one where shareholders of the acquired company receive shares of the acquiring company as opposed to cash [1]. The deal was first announced in October 2020 and was originally valued at $35 billion. However, the recent rise in AMD's stock price pushed the value of this deal to $49 billion , a new record in the whole chip industry. This added momentum to the rise of the whole semiconductor industry that has already achieved substantial growth during the pandemic. The deal has helped to expand AMD's TAM (Total Addressable Market) to about $135 billion from $80 billion, an increase of about 70% [2].

## What is AMD?

Advanced Micro Devices (AMD) was incorporated on May 1, 1969 in Delaware and became public in 1972. AMD is a global semiconductor company that operates through two segments. The first segment is Computing & Graphics that includes desktop and notebook processors, discrete and integrated graphics processing units and professional GPUs and development services. The second segment is Enterprise, Embedded and Semi-Custom that includes server and embedded processors, semi-custom system-on-chip products and development services for game consoles [3]. The breakdown of revenue from the segments is provided. Clearly, Computing & Graphics accounts for most of the revenue within AMD and in turn also provides most of the operating income.



# AMD's Major Products

Through looking at the segments of AMD, we see that two of AMD's major products include CPUs and GPUs.
As the brain of a computer, the CPU (central processing unit) is the electronic circuitry that executes instructions comprising a computer program.
In contrast, GPU (graphics processing unit) is specially designed to handle intensive graphics rendering or deep learning tasks, which has made it a rockstar in fields like gaming and AI. It is surprising to see that for both of these products, AMD rivals two of the biggest companies in respect to each of these products.

In the **CPU** space, AMD's major rival for the past 50 years has been Intel. AMD has been the underdog to Intel since its inception. However, in the past 6 months due to the rapid growth in the use of AMD products, both companies have a market capitalization of about $180 billion as of March 15. The market share in the CPU market between Intel and AMD can be seen in Figure 1. From the graph we see how AMD's market share has been increasing over the years in this market, while Intel's has been falling. One of the major reasons for the increase in market share by AMD over the years is the introduction of its Ryzen microprocessors in 2017 and its increased usage through 2019.

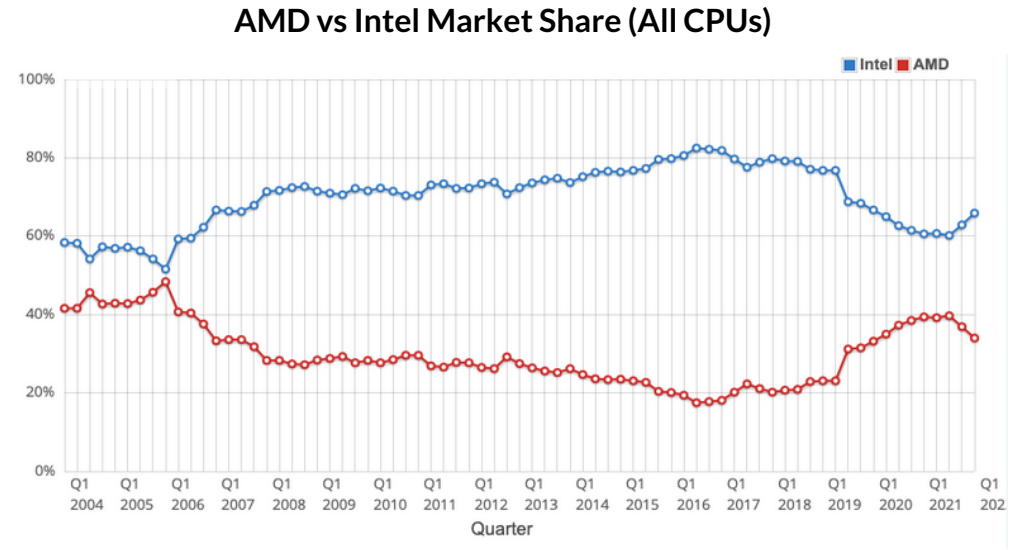



Figure 1 [4]

As for GPU, in 2006, AMD acquired ATI technologies for $5.4 billion in a stock and cash transaction - marking its first major play in the GPU market [5]. Today, AMD's major competitor in the space is Nvidia. The GPU market has two major categories: overall GPU shipments, which include PC graphics cards, and discrete GPUs [6]. Figure 2 shows the percentage of market share in the discrete GPU space between AMD and Nvidia over the past 2 years. Clearly, AMD still has a long way to go before it closes the gap on Nvidia but AMD is making strides through the production of its next generation products that could improve performance.

**AMD vs Nvidia Market share (Discrete GPU)**

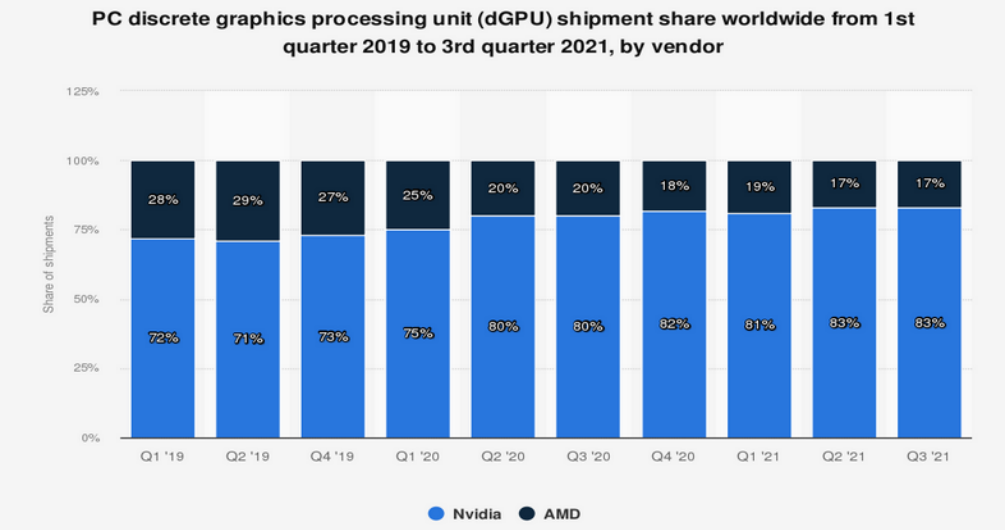



Figure 2 [7]

# Lisa Su's Extraordinary Management

AMD today seems to be a company that is too big to fail. This was however not the case 10 years ago. The company was bleeding money, was laden with debt and had sustained a net loss of $7 billion. There were talks of a potential bankruptcy at the time as well with the stock being downgraded by all financial analysts. The fortunes for the company changed when Lisa Su stepped in to become the chief executive of AMD in October of 2014 [8].

Lisa Su realized that several quick and long lasting decisions needed to be made at the time to save the company. The first move was to redefine the company's focus area and move into the computer gaming center. She also wanted to increase exposure into data and cloud solutions through the use of its high performing micro processors [8]. These moves in hindsight show the vision that Su had at the time. She was also concerned with the amount of debt and realized that the way to make the business sustainable was to reduce it. These measures coupled with her leadership have helped the company increase its value and stock price, which has risen at a CAGR of 23.85% over the past 5 years. Its total revenue has skyrocketed over the past 2 years from about $7 billion in 2019 to about $16.5 billion in 2021 [9]. The need for chips coupled with supply chain disruptions have assisted in this revenue rise. AMD is a classic example of how positive management from the top can really help revive a corporation.

# What is Xilinx?

Xilinx (former NASDAQ: XLNX) was incorporated in 1984 and is headquartered in San Jose, California. It was the inventor of FPGA (Field Programmable Gate Arrays), and now the leader in this field [10]. As for the general business coverage, Xilinx designs, develops, and markets programmable devices and associated technologies worldwide. In this newsletter, Xilinx's state-of-the-art FPGA business would be our major analysis focus. But in case you want to know more about its comprehensive business map, the paragraph below is the complete description [11]:

> Xilinx offers integrated circuits (ICs) in the form of programmable logic devices (PLDs); adaptive compute acceleration platform; software design tools to program the PLDs; software development environments and embedded platforms; targeted reference designs; printed circuit boards; and intellectual property (IP) core licenses covering Ethernet, memory controllers, Interlaken, and peripheral component interconnect express interfaces, as well as domain-specific IP in the areas of embedded, digital signal processing and connectivity, and market-specific IP cores. The company offers its products to electronic equipment manufacturers in sub-markets, such as data center, aerospace and defense, industrial, scientific and medical, automotive, media, and consumer. It sells its products through a network of independent distributors; and through direct sales to original equipment manufacturers and electronic manufacturing service providers, as well as independent sales representatives.

# What is the FPGA?

### Basic Definition

Field Programmable Gate Arrays (FPGAs) are semiconductor devices that are based around a matrix of configurable logic blocks (CLBs) connected via programmable interconnects. FPGAs can be reprogrammed to desired application or functionality requirements after manufacturing [12]. To make FPGAs less technical and more comprehensible, we will discuss its unique features and advantages by comparing it with the two other processor unit celebrities: CPU and GPU.

### FPGA vs CPU & GPU

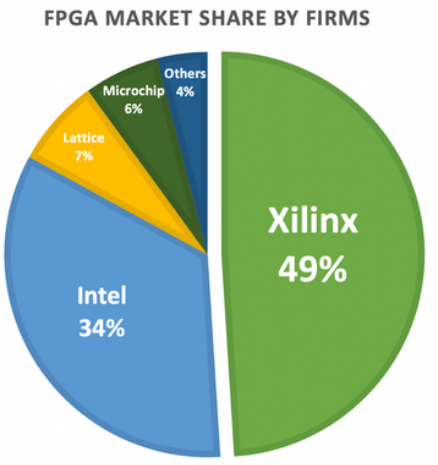
We introduced the latter two in our AMD's Major Products section. So how does FPGA differ? [13]

1. High Connectivity: On an FPGA, you can access any data source directly to the pins of the chip. This is sharply advantageous against GPU and CPU, where you have to connect your source via the standardized buses, such as a USB. This direct connection to the chip gives very high bandwidth (data volume transmitted per time period), as well as low latency.

2. Low Latency: With an FPGA, it is fully possible to get a latency below 1 microsecond, while a CPU with a latency of fewer than 50 microseconds is already very good. Thus, FPGA can be a killer when you need to program remotely controlled devices like autopilot jets, as well as when you require strict accuracy under fast and complicated tasks, such as high-frequency algorithmic trading engines.
3. Best Flexibility: Both CPUs and GPUs logic blocks are unconfigurable and limitedly customized. This means they cannot do any other job apart from what they were initially designed to do. They may be reprogrammed via software level, but in terms of hardware, their capabilities are completely fixed. On the other hand, an FPGA can be configured to process different tasks even after it has been taped out and released. This grants FPGA incredible competitiveness in fast-changing and growing fields whose related standards or algorithms have not been unified, such as the AI algorithm, which is evolving itself every few months.

**The Market of FPGA**

According to Yahoo Finance [14], in 2020, the global Field-Programmable Gate Array (FPGA) market size was $5.7 billion USD and it is expected to reach $11.4 billion USD by the end of 2027, with a CAGR of 10.4% during 2021-2027. We have the market share distribution by companies:




From this pie chart, it is quite easy to observe that Xilinx is the absolute leader given its ownership of nearly half of the market share.

But you may wonder, why AMD wants to acquire a firm that seems entirely irrelevant to its major business (CPU & GPU)?

# AMD + XilinX = ?

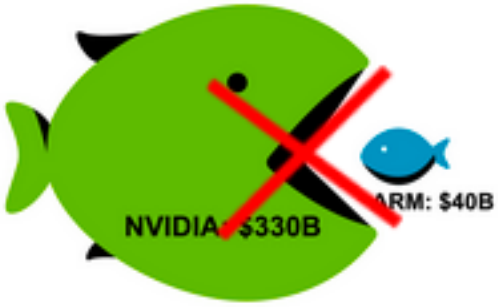
The Last Puzzle Piece AMD Needs in Datacenter Market

Combining all 3 advantageous features, it is not hard to find a perfect application scenario for FPGA: the Datacenter Processor (referred as datacenter later). It is exactly this market who demands high data volume, low latency and flexibility. This field requires three essential elements: CPU, GPU and DPU (Data Processing Unit) whose major representative is FPGA.

This 3-element argument can be further proven by the dominance of Intel in the datacenter area. After acquiring Altera [15], the second largest FPGA firm at the time, at the end of 2015, Intel owns leading products of CPU, GPU and FPGA. The influence of this “whole collection” is so strong that Intel almost monopolizes the entire datacenter processor industry with over 98% market share in 2017 [16].

Even though Intel's crown is not as shiny as before due to the rise of AMD (CPU+GPU), Nvidia (GPU+DPU) and ARM (CPU), it still occupied over a half (77%) market share of datacenter sales in 2021 [16].

The reason is that although these major opponents have their own fantastic products, they have not collected all the "infinity stones". This is also why Nvidia was trying so hard to acquire Israeli corporation Mellanox to develop its own bluefield DPU in 2020 [17] (for both datacenter and AI), as well as its desperate efforts to buy ARM to add CPU to its empire though this deal has been terminated this year by governments because of antitrust regulations [18].




On the contrary, AMD, who has already developed great CPU and GPU, successfully purchased the largest FPGA company Xilinx, finally collecting the last crucial puzzle piece in the datacenter business. In fact, even before this acquisition, through its powerful x86 CPU, AMD had already been powering 10% of the datacenter servers, and this number peaked at 18% in the third quarter last year, more than doubling that of the same period in the previous year [19]. Therefore, with the joining of FPGA giant Xilinx, AMD would be unprecedentedly competitive in terms of the datacenter market.

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February 2022

# War falls on Europe Once Again, Should Investors Worry?

By Tyler Lau and Rohan Kasoju; Market Research Analysts

## What is happening?

After accumulating over 190 thousand soldiers on the Russia-Ukraine border for "military exercises", President Putin did the unthinkable. On February 24, 2022, Russia began a full-scale invasion of Ukraine from its Northern, Eastern, and Southern border. Putin's grudge against Ukraine started back in 2014 when the country's pro-Russian president was ousted after months of protest. In retaliation, Russia annexed Ukraine's southern region of Crimea and supported armed rebellions in the country's east. Following this show of military aggression from Russia, Ukraine's government has clearly shown its intentions of joining the EU and NATO in order to align itself with the West.

As of March 14th, 2022, the Russian army has made relatively little progress into the country. Fierce Ukrainian resistance and logistical issues have slowed Russian progress. Most major cities in Ukraine are currently under siege with only the city Kherson being under firm Russian control.


*Figure 1*

The world has almost unilaterally condemned Russia's actions. Even China, a Russian ally, has called for de-escalation and for the two countries to find a diplomatic solution. The West has collectively shown their support for Ukraine and has sent billions of dollars worth of military equipment, mostly anti-tank and anti-air missiles, to the Ukrainian army.

# International Sanctions and Trade Restrictions

In response to the invasion, many countries have placed economic sanctions on Russia as a way to punish the country and starve its war machine. Here are some major ones:

**1. SWIFT and Foreign Payments**

Previously seen as the “nuclear option” for economic sanctions, the US has announced that it was working with its European partners to cut off Russian banks from the SWIFT financial system. SWIFT, the Society for Worldwide Interbank Financial Telecommunication, is a messaging system between thousands of financial institutions around the world. It allows financial institutions to quickly inform each other about incoming transactions and around 42 million messages are sent everyday [2].

Once cut off from the system, Russian banks will have a much harder time registering and receiving transactions from their domestic and international partners. This would also hurt Russian trade as exporters are heavily reliant on the SWIFT system to help receive payment from their international clients. It's difficult to gauge the current impact of this sanction but when Iran was cut off from SWIFT in 2012 because of their nuclear program, they lost half of their oil export revenues and 30% of their foreign trade [3].

**2. Sanctions on Russia’s Central Bank and collapse of the ruble**

After invading Crimea in 2014, Russia faced an economic crisis between 2014-2016 that saw the ruble lose over half its value. The Russian Central Bank has since built up its foreign exchange reserves in preparation for another economic crisis. The reserve is estimated to be currently worth around $630 billion, but most of it is held outside of the country [4]. So when Russia decided to invade Ukraine in February, many western countries retaliated by freezing Russian foreign accounts and essentially locking Russia away from most of its treasury. Now, the Russian central bank is only left with gold reserves worth $127 billion and Chinese Renminbi reserves worth $70 billion [5]. Without enough capital to artificially stabilize the ruble, the Russian Central Bank has taken drastic measures to hopelessly save the crashing ruble. Interest rates were increased to 20% and restrictions were placed to prevent Russians from having access to foreign currencies [6]. With a weaker ruble, imports can become more expensive and the Russian economy can be further isolated from the rest of the world.


*Figure 2 [7]*


*Figure 3 [9]*

### 3. Russian Debt Market

Another action taken to cut off Russian funding was a ban on the purchase or sale of Russian state securities. In light of this news, a mass sell-off of Russian securities occurred. One consequence of this mass sell-off was the crash of Russian bond prices and the rise of bond yields. As of March 15th, bond yields have exploded to 19.9% [8].

# Mass Corporate Exodus

### Auto Manufacturers

Volkswagen, Ford, and Toyota have all said that they would suspend Russian car production in wake of the invasion. For some context on the impact, Volkswagen alone accounts for 12% of the country's total vehicle manufacturing [10]. Russia's auto industry is very reliant on foreign brands with over half of its total production coming from Renault and Hyundai which account for 39.5% and 27.2% of domestic vehicle production respectively [11].

### Retailers

Global brands like Nike, McDonald's, Netflix, Apple, Ikea, and many more have announced that they would stop their operations in Russia. As a developed country deeply integrated within the global economy, many Russian consumers and businesses use/need foreign goods. This is especially true for technological goods that account for a quarter of total Russian imports. For example, 26% of the Russian smart-phone market is controlled by Apple, but on March 1st, the company decided that it would halt all Russian sales [12]. However, these companies may eventually return to Russia, as it is a large market.

*Figure 4 [13]*

**Shipping companies**

The world's two largest shipping lines, Maersk and MSC, have suspended all non-essential shipments to and from Russia. This is a major blow for the Russian economy as 28% of its total GDP comes from exports [14]. Without Maersk and MSC, which both account for 35% of global container shipping capacity, Russia's ability to deliver its exports is severely hampered [15].

**Financial Institutions**

Large payment processors, accounting firms, and investment banks have also pulled back their operations in Russia to varying degrees. Mastercard, Visa, and American Express have all suspended transaction services in Russia but it would only affect non-domestic transactions. After the 2014 annexation of Crimea, Russia has required that all domestic payments be processed through a nationally-run system, reducing the country's reliance on foreign systems. As for the accounting firms, all of the big 4 accounting firms have made moves to distance themselves from their Russian operations. For example PwC's Russian branch will now operate as an independent firm under a different name. Finally, investment banks like Goldman Sachs have said that they were "winding down" their Russian operations. In the last few years, most of the major investment banks like Goldman Sachs, JPMorgan, and Deutsche Bank have reduced their presence in the Russian market, so the invasion has only accelerated this process.

**Markets that investors should look out for**

In light of the recent geopolitical crisis, there are a wide range of industries which could expect to see immense change as investment choices – and in fact present buying opportunities. After Russian president Putin ordered a full-scale invasion of Ukraine, further escalating the conflict between both countries, the price of many raw materials rose to unprecedented multi-year (and even all-time) highs; oil rose to $100/barrel, aluminum hit $3,492/tonne, and wheat reached $0.19/bushel (or $926/5,000 bushels) [16].

Additionally, commodities such as palladium, nickel, and gold also saw sharp spikes. Palladium went up to $2,600/ounce (up 6.6%), nickel to $25,755/tonne (up 5.6%), and Gold to $1,945/ounce, its highest level in over a year (up 1.85%). The development in the price for nickel is especially noteworthy, as this gain places its current price at the highest it has traded at on the London Metal Exchange in the last 11 years [16].

As a dominant force in the precious metals trade, Russia exports 45.6% of the world's palladium, 15.1% of its platinum, and 9.2% of its gold. It is interesting to see growth at such a seismic scale for those commodities Russia is so heavily invested in, in the wake of recent news. However, this could have more to do with the commodities' reputation as 'safe havens' for investors looking to secure themselves against the wrath of raging world economies. As Neil Wilson, Markets.com's Chief Market Analyst puts it, "Gold spiked to $1,950, its highest since the end of 2020. Bitcoin plunged 5% to $35,000. [I] think we are finding out which of the two is the real haven" [16].

On the flipside, industries such as automobile, semiconductor, airfreight, and airline have seen an inverse set of changes. With over 90% of the US' semiconductors being sourced from Ukraine, the latter is a world leader in this space. However, with blockades and halted trades, it could drastically worsen the already-apparent worldwide shortage of semiconductors [17].

**Should Investors worry?**

Despite all the uncertainty and skepticism the recent crisis has sparked across every corner of the global market, many economists and leading financial authorities believe this is not a major cause for concern, especially because this is not the first time the world has experienced geopolitical conflicts and come out from the other side; perhaps not unscathed, but at least without major long term pitfalls.

As Michael Rosen, managing partner and chief investment officer at Angeles Investments and Angeles Wealth Management, says, "History tells us that major geopolitical events will have almost no impact on markets after six to 12 months" [18].

Investors may need not panic, and much less start reevaluating their holding strategies, as the common instinct to dump assets in downturn markets and "cut your losses" can actually do more harm than good. Reacting to the news and reflecting every new development in your investments may be an ineffective method of risk mitigation, as was suggested by the recent COVID-19 pandemic. At the beginning, in March 2020, the overall market saw a drop of over 30%, but has since more than doubled, which goes to show how volatile markets can be in the wake of global catastrophes [19].

While it is typical to see markets get shaken by wars and international conflicts in the short term, it very rarely seals any long-standing negative impacts. In fact, in the case of North America, much growth has been observed. After each of the last six US-involved wars, the overall stock market quickly rebounded and even rose to varying lengths. Let's take World War 2, for example. Within 10 years of its breakout in 1939, the market rose by 100%. In each of the other aforementioned conflicts, the gains were even greater (the largest being 500% post-Gulf War) [19].

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February 2022

# Microsoft's Biggest Deal in Gaming

By Kritnoor Singh and Matthew Truong: Market Research Analysts

## Blizzard

Activision Blizzard, Inc. (ATVI) is an American-based company competing in the electronic gaming industry, and subsequently delivers content and services on various gaming devices. The company primarily generates revenue through their subscription-based, full-game, and in-game sales; as well as by licensing software to third-party or related-party companies which distribute Activision and Blizzard products. [1]


Figure 1 [2]

However, it hasn't been all peachy at Blizzard. They have faced multiple lawsuits in the last few years which defamed the company and raised concerns about the leadership of the CEO, Bobby Kottick. Specifically, they faced a heafty lawsuit due to collecting "numerous complaints about unlawful harassment, discrimination, and retaliation." There were a lot of negative events like an employee walkout. These events led to the resignation of Kotick and ATVI's stock price took a beating. In the days following, stock prices dropped about 20% towards the $57 price point. [3]

# What Happened?

As you can imagine, Microsoft saw its opportunity and was able to capitalize on the fact that shareholders were deeply concerned because of these issues and hence welcomed the acquisition. Microsoft acquired Blizzard in a whopping $68.7 billion deal, set to be the largest all-cash acquisition on record in February 2022. Blizzard has been a leader in game development and interactive entertainment. The gaming industry has been booming for the last 5 years with over 3 billion people playing video games today. The acquisition of Blizzard definitely bolsters Microsoft's position in the video game industry and helps them diversify their business operations. They now have control over some major franchises like Call of Duty, Warcraft, Diablo and Overwatch.

Microsoft did have relationships with Blizzard prior to the acquisition. Microsoft had commercial licensing agreements with Blizzard for a while and hence speculators in the market weren't surprised by this acquisition.

# Financing

Microsoft paid $95 per share in an all-cash transaction to acquire Blizzard for $68.7 billion in total and now is a major player in the gaming industry. It is planning on publishing all Activision Blizzard games on the Xbox Game pass which allows the pass holders to have a selection of games for $9.99 a month. Microsoft had 25 million Xbox game pass holders prior to the acquisition, and now because of the acquisition they have a lot more games to offer for their passholders. Blizzard also had 400 million monthly active players who could be switching to the Game pass. Microsoft had already been a pioneer in the gaming industry with the Game pass, and now would reep a lot more benefits with the acquisition.

# Why did they do it?

As mentioned before, the gaming industry has been on the rise for a while now. Mobile gaming in particular has been developing rapidly and is now the biggest segment in gaming, Blizzard is known to have released many popular mobile games including Candy Crush, Pet Rescue, etc. Having performed really well in both console and mobile gaming Blizzard is a considerably attractive gaming company in the market, especially considering mobile gaming's extreme growth within the last few years.

# What's to be expected for Microsoft? / Outlooks [Electronic Gaming Industry]

“Microsoft will become the world’s third-largest gaming company by revenue once the transaction closes in fiscal 2023 and will have 30 internal game developing studios.” [5]

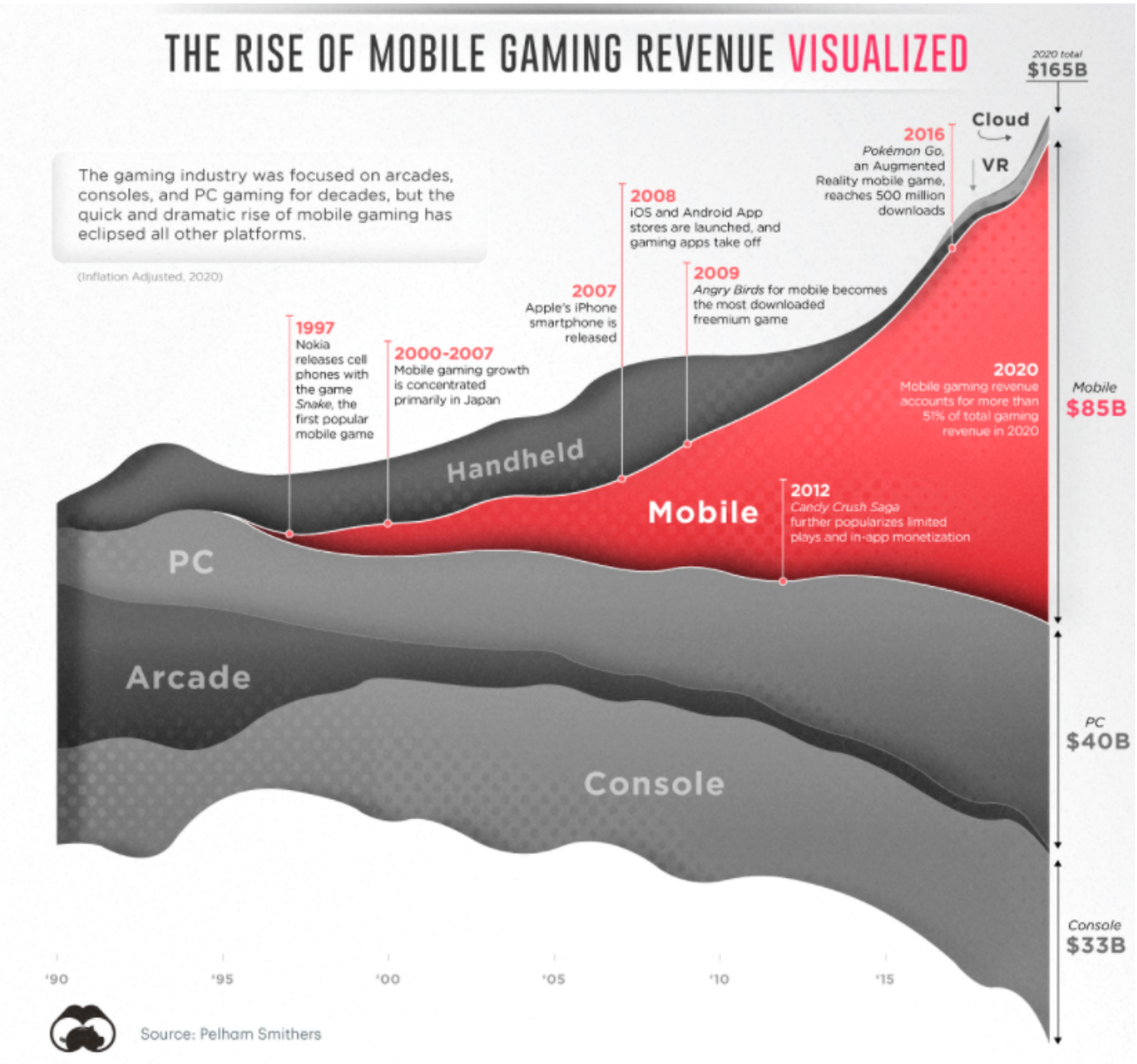


Figure 2 [4]

In a separate statement, CEO Satya Nadella, emphasized gaming as being one of the most dynamic and exciting entertainment categories across all platforms, and “will play a key role in the development of metaverse platforms." . With the metaverse being built right under our nose and tech giants like Meta (Facebook) in the competition, it can seem like a horse race to the market when it comes to these projects. As for their approaches, Meta is focusing on an all encompassing metaverse for people to work, rest and play. Whereas, Microsoft is likely more attuned with focusing on the enterprise aspect, expected to incorporate developments with its conferencing tools, such as with avatars and holographic technology. Nonetheless, for the time being, gaming is the most accessible to realize especially, with its integration of VR.

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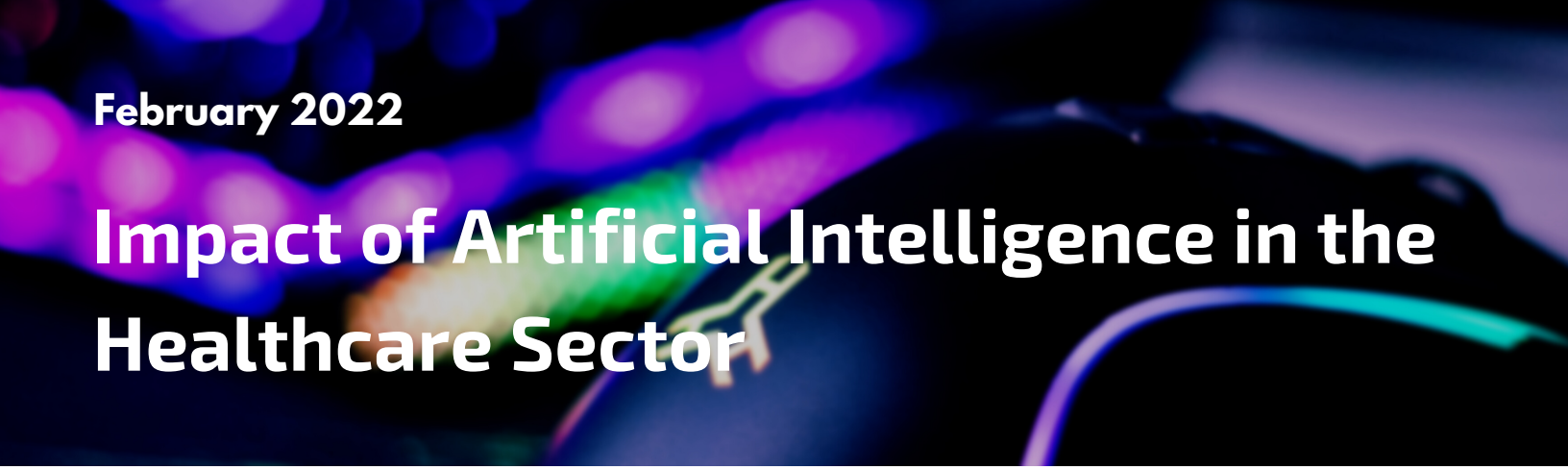

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# Impact of Artificial Intelligence in the Healthcare Sector

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## Introduction

Healthcare is one of the largest and most fundamental industries in the world, making up more than 10% of the GDP of the most developed countries. The global health industry was worth $8.45 trillion in 2018 and spending could reach over $10 trillion in 2022. [1] Since there is a lot of unpredictability with various topics in health research, biostatisticians who can leverage cutting edge technology to quantify risk are in high demand.

With the rapid advancement of technology, companies in the healthcare sector are constantly discovering more effective and efficient ways of completing tasks. Artificial Intelligence (AI) refers to software used by computers to mimic aspects of human intelligence. In many facilities, AI increases the ability of healthcare professionals to understand the day-to-day patterns and needs of the people they care for, so that they can provide better feedback, guidance, and support.

The healthcare sector is fast paced, dynamic and constantly changing. For instance, the COVID-19 virus changes through mutations that result in new variants. This motivates machine learning (ML) which is a subset of artificial intelligence. ML is an application of AI that provides systems with the ability to automatically learn and improve from experience without being explicitly programmed. As a result, ML can be used to make forecasts and predictions in order to mitigate the risk of any health hazards to various populations of people.

In addition to AI and ML, there is also deep learning which is a deep neural network made up of many layers. The neural networks imitates the inner workings of the human brain to process data, create patterns and inform decision-making. Algorithms are classified into supervised, unsupervised and reinforcement learning.

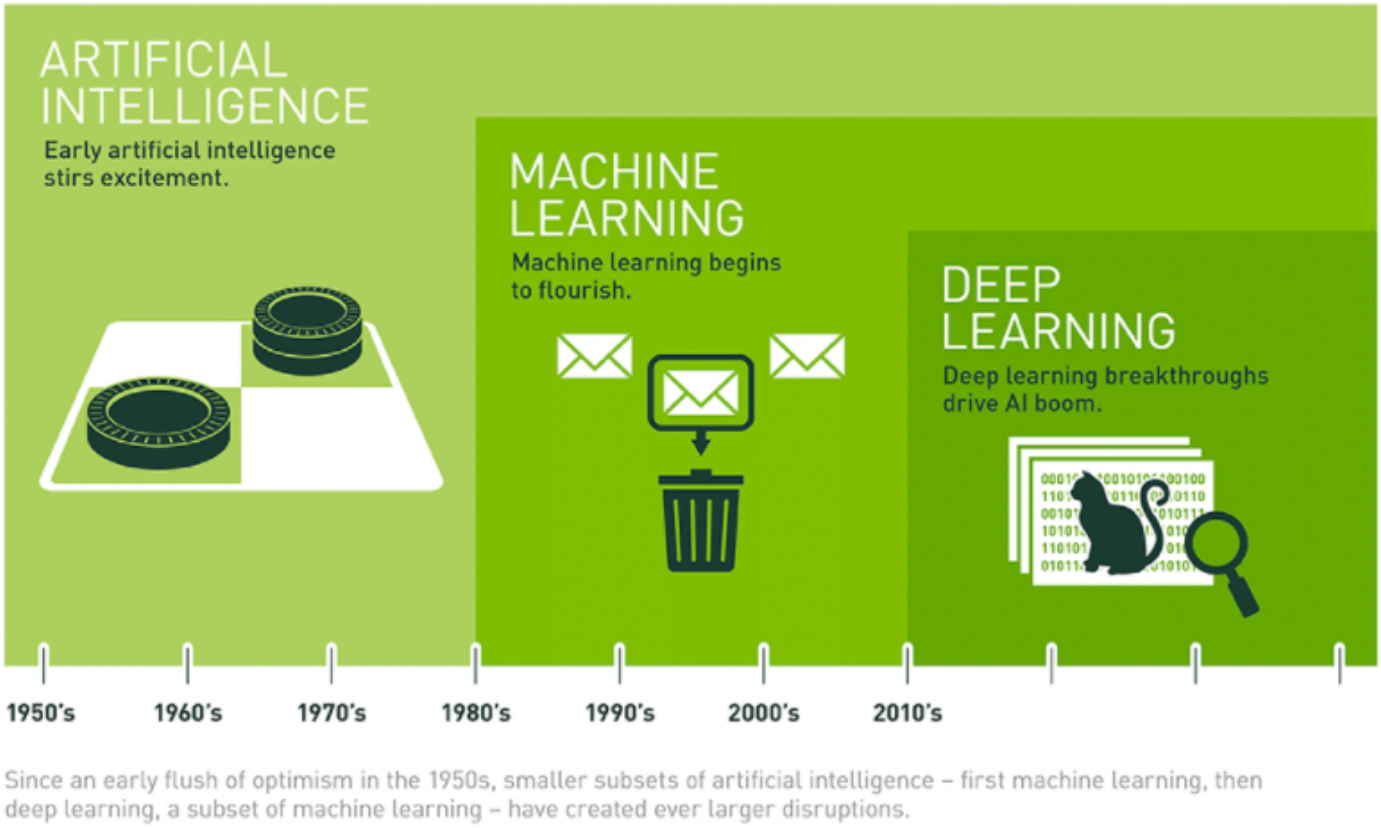



Figure 1: [2] Timeline of Artificial Intelligence, Machine Learning and Deep Learning

In the next section, the life cycle of artificial intelligence will be discussed. This is important when it comes to finding a solution to many of the underlying problems in the healthcare sector.

# Artificial Intelligence Life Cycle

There are five fundamental steps that are typically followed by practitioners when attempting to build out an AI driven solution.

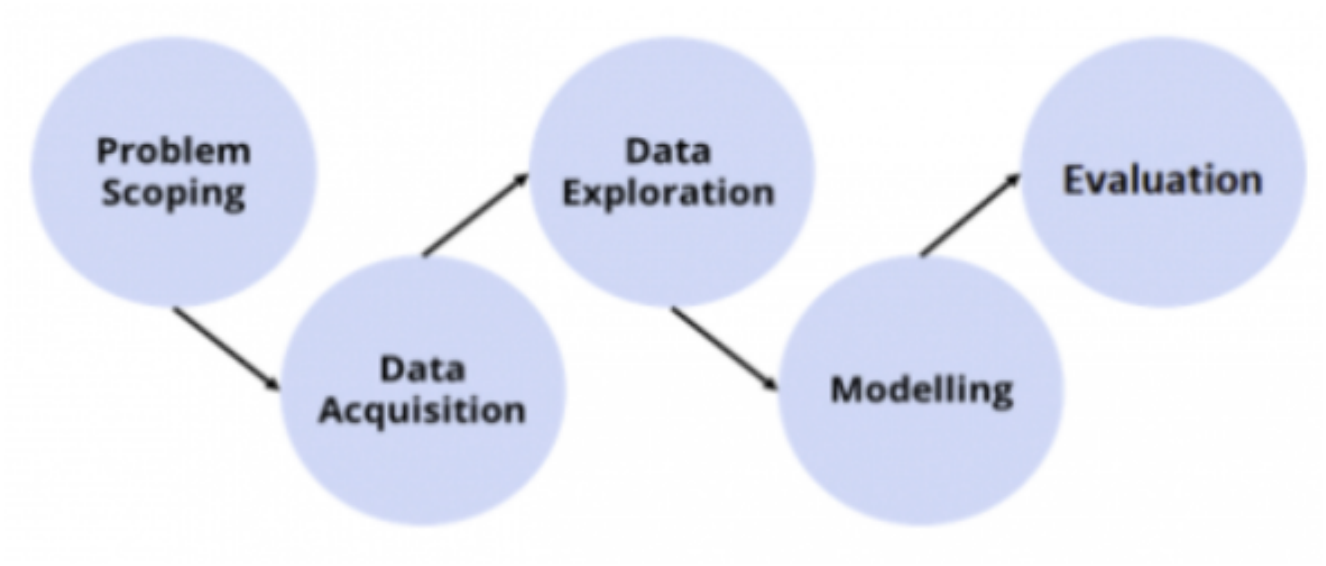



Figure 2: [3] Diagram of the Artificial Intelligence Life Cycle

Problem scoping is the first step in this process. This involves understanding the problem statement which is important when maximizing the added value of a project. Especially in health research, the solution must satisfy the changing needs of patients and clients. In addition, business and financial constraints are also very important before starting any model building. Overall, the project being undertaken must be worthwhile when comparing the benefits of undertaking the project against the financial costs and human labor.

Data acquisition is the second step and this consists of collecting data from reliable sources. This can come from various sources such as databases, public surveys or credible websites. Data serves as the backbone of artificial intelligence and is the main determinant to the success of the artificial intelligence model. The quality of the information gathered must be accurate and representative of the problem of interest.

After data is collected, the next step in the AI life cycle involves conducting exploratory data analysis (EDA). EDA helps to see which variables are important and identify the overall trend of the data that is available. In particular, preliminary statistical analysis is performed which involves looking at the distribution of the data and plotting various graphs.

The modeling stage is the main component of the AI life cycle, but it should only be done after having cleaned the data and having understood basic trends. A mathematical model is usually used to quantitatively approximate and describe the outcome of interest using several explanatory variables. Regression analysis is the most common approach used in the modeling stage.

Lastly, evaluation is done to test the trained AI model on new real life data to see how it is performing. Model evaluation is an integral part of the model development process and acts as a good indicator for choosing the best model and predicting whether or not it will work in the future. If analysts find that a model is inadequate, models must be retrained and the AI life cycle is restarted from the beginning. The implementation of machine learning algorithms allows for self-learning and improvement every time a model is retrained. This ultimately leads to more accurate and desirable results in the future.

# Applications of Artificial Intelligence in the Healthcare Industry

The step-by-step framework for artificial intelligence can be applied to solve problems within many existing and emerging fields in the healthcare industry. For instance, the presence of AI has dramatically increased in processes such as medical imaging, pharmacology and neuroscience.

Medical imaging is the technique and process of imaging the interior of the body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues. The most common forms of medical imaging are X-rays, CT, and MRI scans. This can be used for various purposes such as sports rehabilitation, intensive care units, dentistry and it is essential when tracking the progress of ongoing treatment of patients. AI has shown impressive accuracy and sensitivity in the identification of imaging abnormalities and promises to enhance tissue-based detection and characterization. [4] In addition, AI could produce visualizations that offer unique opportunities for learning about poorly understood disease processes. By harnessing the power of artificial intelligence in MRI scans, there could potentially be discoveries that lead to an earlier administration of therapy, ultimately leading to lower morbidity and mortality rates.

Next, AI can be applied to pharmacology which involves discovering, designing and synthesizing drugs that are used for medical or recreational purposes. This typically involves matching patients to their optimal drug or combination of drugs, predicting drug targets, and optimizing treatment protocols. A form of supervised learning using classification can be implemented to segregate the population by risk factors, determine likelihood of testing positive for a disease, and assigning appropriate drug treatments. In terms of synthesizing drugs, AI can assist in structure-based drug discovery by predicting the 3D protein structure [5] In particular, data-driven tools were used in the design and screening of the COVID-19 vaccine. [6]

# Neuroscience

Finally, artificial intelligence also has interesting applications in neuroscience which is the study of the nervous system including motor and cognitive tasks. Furthermore, deep learning models are simulated to learn more about how the brain works.

In particular, neural networks referring to systems of neurons are used to mimic the way the human brain operates.

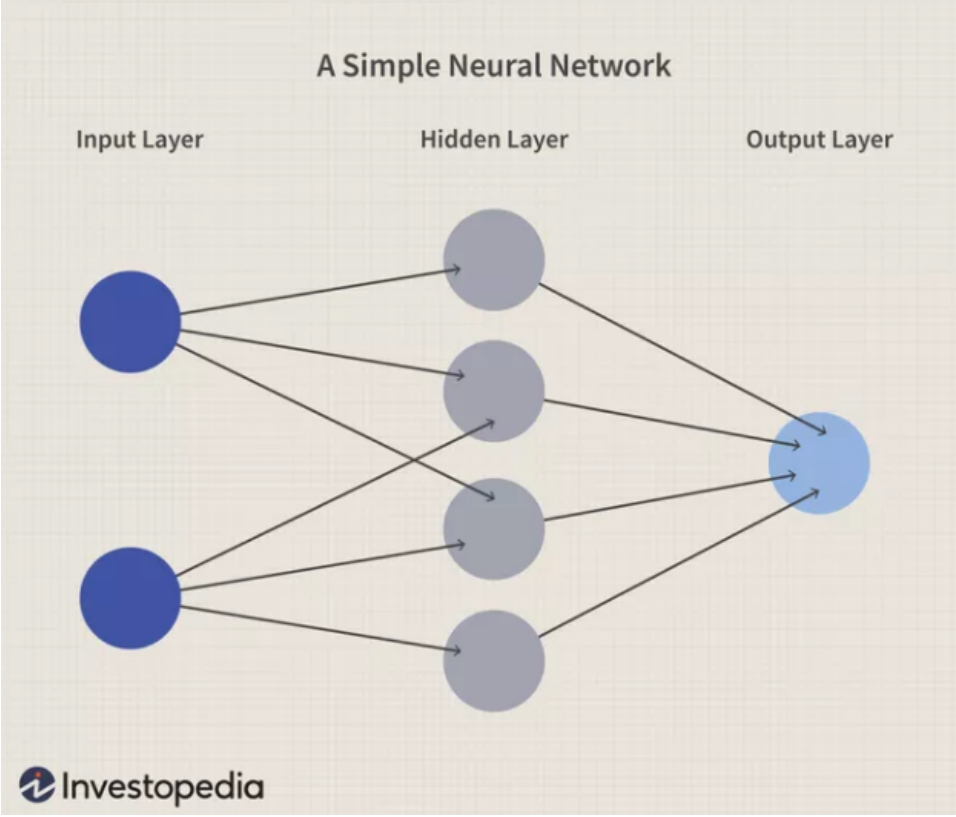



Figure 3: Diagram of a Neural Network [7]

The use of deep learning solutions in healthcare allows for the delivery of personalized patient care by analyzing historical data (i.e. patient's medical history), symptoms and tests.

## How Does This Impact Healthcare Stocks in the Financial Markets?

We have seen the wide range of applications of artificial intelligence in the healthcare industry. AI can improve outcomes and lower costs at each stage of the care cycle from prevention to treatment [8]. The discussion can be extended to consider whether the improved operational efficiency of healthcare corporations leads to superior financial performance and investment opportunities in the financial markets.

In the current inflationary and underperforming investment environment, healthcare stocks are classified as defensive stocks and can be used to diversify the portfolio. A defensive stock provides consistent dividends and stable earnings regardless of the state of the overall stock market. There is a constant demand for healthcare and its products, so returns tend to be more stable during the various phases of the business cycle. However, the medical field is complicated and can pose a lot of risks to prospective investors. In Canada, the federal government supports provincial health care systems through transfer payments and uses this money to influence policy-making in the area of health care. Shifting regulation can make or break pharmaceutical companies. For instance, Vaxart (VXRT); a company that produces oral COVID-19 vaccine tablets, saw a 16.1% stock price jump on August 2, 2021 in early-morning trading after the food and drug administration (FDA) approved their investigational new drug (IND) application.

Stocks in the healthcare sector can be growth or value stocks. Biotechnology, smaller drug development and research companies are typically classified as growth stocks. Growth companies have the capacity to alter the market through innovation. Artificial Intelligence will have a large impact on the product development of these companies. Meanwhile, many large brand name drug manufacturers and health insurance companies can be considered as value stocks in the healthcare industry. Value companies are more mature companies with predictable profits. As a result, they typically pay out stable dividends. For example, Johnson & Johnson (JNJ) and Pfizer are both dividend stocks that have yields of 2.5% and 3.18% respectively. With the U.S Healthcare Index trading at a 21% discount relative to the S&P 500 from a price-earnings perspective, compared to the 6% relative premium it has averaged over the past 30 years, it can be argued that healthcare stocks are a true value sector right now.

# Conclusion

Healthcare has become a booming industry in recent years especially with the integration of artificial technology to healthcare which allows for more seamless and streamlined completion of tasks. Additionally, the development of miniature technology and automated chatbots has made the healthcare sector an attractive sector to invest in. This has been made simpler with the increasing growth in M&As and market consolidation, and with the help of SPAC's has allowed for companies to be active on the stock market. With the new developments in the market, we as consumers are able to witness changes in the industry with further development in technology, to support daily healthcare tasks.

# Healthcare Stocks to Watch

**MEDICAL IMAGING STOCKS**

**Butterfly Network (BFLY) $73.80** At Close on Mar 16 / 52 Week Range: [3.66, 20.20] / Market Cap: **1.039B** / Beta (5 Yr. Monthly): **-0.69** / EPS: **-0.19** / Avg Volume: **3,214,711** / Earnings Date: **May 11, 2022 - May 16, 2022**

**BFLY 1y Target Estimate: 8.75**

**Medtronic (MDT) $105.40** At Close on Mar 16 / 52 Week Range: [98.38, 135.89] / Market Cap: **143.415B** / Beta (5 Yr. Monthly): **0.75** / PE Ratio: 29.29 / EPS: **3.63** / Avg Volume: **7,060,105** / Earnings Date: **May 26, 2022**

**MDT 1y Target Estimate: 124.93**

**Refer to Appendix A for Medical Imaging Stocks BFLY and MDT 1yr % change in share price**

**DRUG INVENTION AND VACCINE STOCKS**

**Moderna (MRNA) $148.12** At Close on Mar 16 / 52 Week Range: [117.34, 497.49] / Market Cap: **66.95B** / Beta (5 Yr. Monthly): **1.55** / PE Ratio: **5.87** / EPS: **28.29** / Avg Volume: **8,916,663** / Earnings Date: **May 04, 2022 - May 09, 2022**

**MRDA 1y Target Estimate: 238.66**

**Pfizer (PFE) $52.21** At Close on Mar 16 / 52 Week Range: [35.21, 61.71] / Market Cap: **294.607B** / Beta (5 Yr. Monthly): **0.71** / PE Ratio: **13.59** / EPS: **3.85** / Avg Volume: / Earnings Date:
**PFE 1y Target Estimate: N/A**

**Novavax (NVAX) $73.80** At Close on Mar 16 / 52 Week Range: [72.52, 78.55] / Market Cap: **5.769B** / Beta (5 Yr. Monthly): **1.40** / EPS: **-23.44** / Avg Volume: **6,017,315** / Earnings Date: **May 09, 2022 - May 13, 2022**

**NVAX 1y Target Estimate: 179.50**

**Johnson & Johnson (JNJ) $176.14** At Close on Mar 16 / 52 Week Range: [155.72, 179.92] / Market Cap: **456.192B** / Beta (5 Yr. Monthly): **0.71** / PE Ratio: **22.22** / EPS: **7.81** / Avg Volume: **7,807,941** / Earnings Date: **Apr 19, 2022**
**JNJ 1y Target Estimate: 186.37**

**Refer to Appendix B - Drug and Vaccine Invention Stocks PFE, JNJ, MRNA, and NVAX 1yr % change in share price**

**NEUROSCIENCE RESEARCH STOCKS**

**Sage Therapeutics (SAGE) $31.37 At Close on Mar 16 / 52 Week Range: [30.48, 81.00] / Market Cap: 1.945B / Beta (5 Yr. Monthly): 1.67 / EPS: -7.80 / Avg Volume: 595,236 / Earnings Date: May 02, 2022 - May 06, 2022**

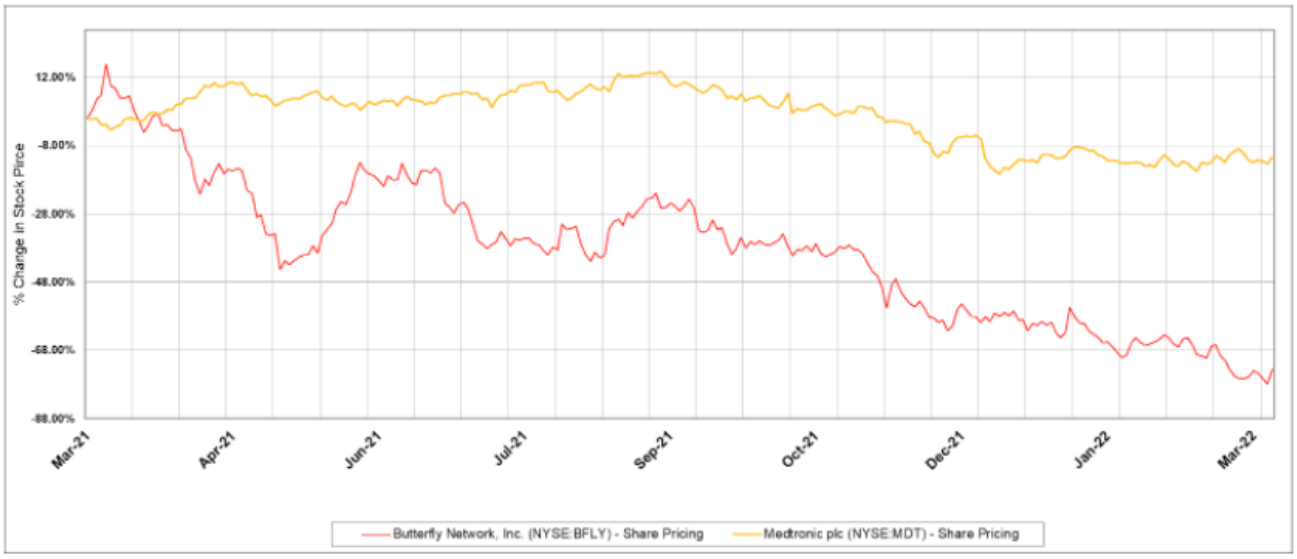
**SAGE 1y Target Estimate: 63.00**

**Acadia Pharmaceuticals (ACAD) $23.05 At Close on Mar 16 / 52 Week Range: [15.68, 28.31] / Market Cap: 3.803B / Beta (5 Yr. Monthly): 0.54 / EPS: -1.05 / Avg Volume: 1,666,238 / Earnings Date: May 03, 2022 - May 09, 2022**

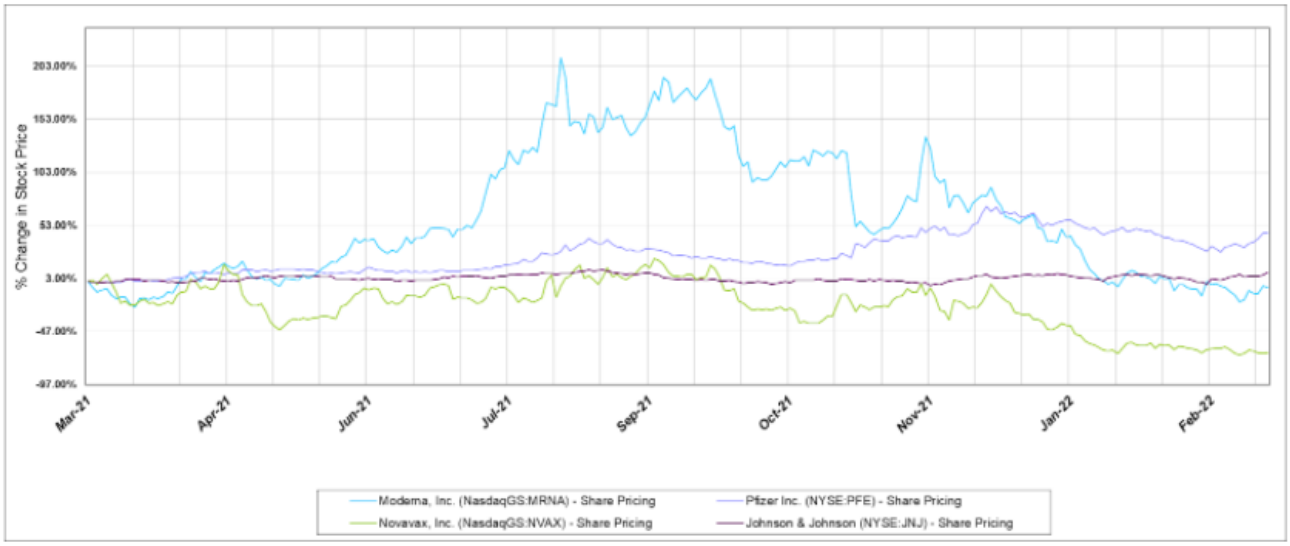
**ACAD 1y Target Estimate: 29.37**

**Refer to Appendix C - Neuroscience Research stocks ACHC and SAGE 1yr % change in share price**

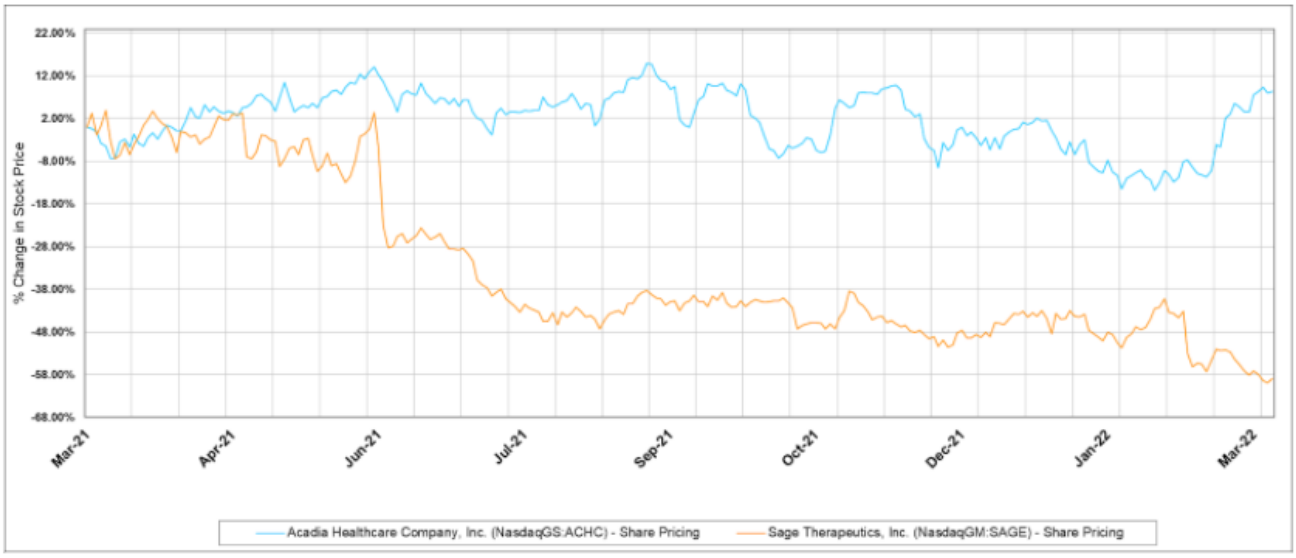
## Appendix A - Medical Imaging Stocks BFLY and MDT 1yr % change in share price




## Appendix B - Drug and Vaccine Invention Stocks PFE, JNJ, MRNA, and NVAX 1yr % change in share price



## Appendix C - Neuroscience Research stocks ACHC and SAGE 1yr % change in share price




## Appendix C - Trading Multiples of Healthcare stocks to Watch

| Company Name | TEV/Total Revenues LTM - Latest | TEV/EBIT LTM - Latest | P/Diluted EPS Before Extra LTM - Latest | NTM TEV/Forward Total Revenue (Capital IQ) | NTM Forward P/E (Capital IQ) |
|---|---|---|---|---|---|
| Medtronic plc (NYSE:MDT) | 4.9x | 22.5x | 29.0x | 4.72x | 18.19x |
| Johnson & Johnson (NYSE:JNJ) | 5.0x | 18.5x | 22.6x | 4.68x | 16.73x |
| Pfizer Inc. (NYSE:PFE) | 3.7x | 11.1x | 13.3x | 2.81x | 7.33x |
| Novavax, Inc. (NasdaqGS:NVAX) | 4.0x | NM | NM | 1.03x | 3.43x |
| ACADIA Pharmaceuticals Inc. (NasdaqGS:ACAD) | 6.7x | NM | NM | 6.03x | NM |
| Moderna, Inc. (NasdaqGS:MRNA) | 2.3x | 3.2x | 5.2x | 1.94x | 5.36x |
| Sage Therapeutics, Inc. (NasdaqGM:SAGE) | 20.4x | NM | NM | 6.48x | NM |
| Butterfly Network, Inc. (NYSE:BFLY) | 8.0x | NM | NM | 5.96x | NM |
| | | | | | |
| **Summary Statistics** | **TEV/Total Revenues LTM - Latest** | **TEV/EBIT LTM - Latest** | **P/Diluted EPS Before Extra LTM - Latest** | **NTM TEV/Forward Total Revenue (Capital IQ)** | **NTM Forward P/E (Capital IQ)** |
| High | 20.4x | 22.5x | 29.0x | 6.48x | 18.19x |
| Low | 2.3x | 3.2x | 5.2x | 1.03x | 3.43x |
| Mean | 6.9x | 13.8x | 17.5x | 4.21x | 10.21x |
| Median | 4.9x | 14.8x | 17.9x | 4.70x | 7.33x |

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