MÁSTER EN INGENIERÍA INDUSTRIAL (MII)

PROYECTO FIN DE MÁSTER

The NVIDIA-Arm Deal and its Impact on the Semiconductor Industry

Autor: José Cabrera Sánchez

Director: Luis García Jiménez

Madrid

Junio 2022

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The NVIDIA-Arm Deal and its Impact on the Semiconductor Industry

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Fdo.: José Cabrera Sánchez Fecha: 27/ 06/ 2022

Autorizada la entrega del proyecto

EL DIRECTOR DEL PROYECTO

Fdo.: Luis García Jiménez Fecha: 27/ 06/ 2022

EL ACUERDO NVIDIA-ARM Y SU IMPACTO EN LA INDUSTRIA DE SEMICONDUCTORES

Autor: Cabrera Sánchez, José.

Director: García Jiménez, Luis.

Entidad Colaboradora: ICAI – Universidad Pontificia Comillas.

RESUMEN DEL PROYECTO

Acontecimientos como el COVID-19 y el bloqueo del Canal de Suez ejercieron una enorme presión sobre las cadenas de suministro mundiales y, en particular, sobre la de semiconductores. Hoy en día, estos materiales son estratégicos y juegan un papel importante en la fabricación de los chips que se utilizan en casi todas las industrias a nivel global.

En mitad de estos difíciles momentos, el 13 de septiembre de 2020 la empresa estadounidense NVIDIA anunció un acuerdo con la empresa japonesa SoftBank Group para adquirir Arm por aproximadamente $40 billones americanos a pagar en efectivo y en acciones de la propia NVIDIA. NVIDIA es líder en la fabricación de procesadores gráficos tridimensionales y software relacionado, mientras que el negocio principal de Arm es el diseño de la arquitectura de semiconductores (CPUs y NPUs), motores de datos y software que monetiza a través de la venta de licencias a empresas fabricantes como NVIDIA y otros competidores.

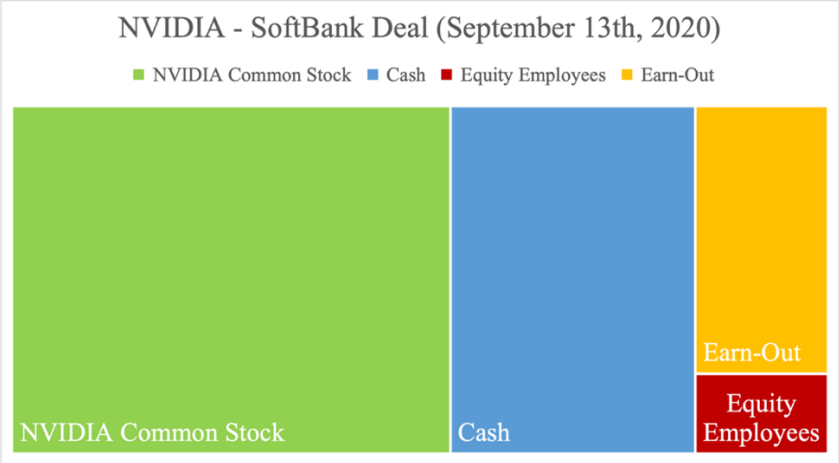

Figura 1: SoftBank Equity Stakes Value (¥T) Marzo 2022. Fuente: SoftBank IR [1]

El accionista mayoritario de Arm es el grupo SoftBank y su principal negocio solía ser los servicios de telecomunicaciones, aunque hoy SoftBank es conocido por sus grandes participaciones en empresas líderes como Alibaba y T-Mobile.

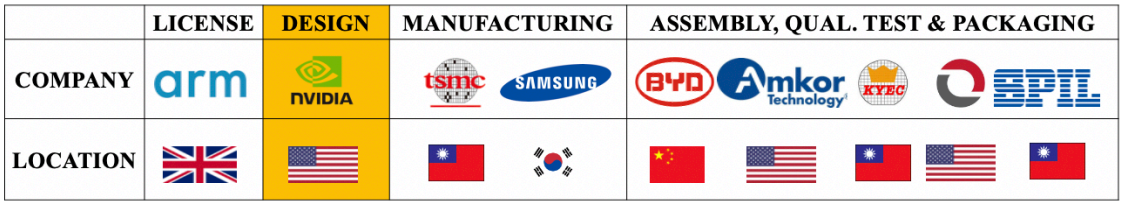

Figura 2: NVIDIA Partners. Fuente: [2]

En los últimos años, Arm ha ido ganando poco a poco cuota de mercado a Intel al centrarse mucho más en la eficiencia y la portabilidad que en la velocidad de los procesadores. El nicho en el que Arm ya es líder es el mercado de los procesadores móviles, chips para teléfonos móviles, tabletas, televisores, ordenadores portátiles o sistemas biométricos. La clave en el modelo de negocio de la compañía es que Arm no fabrica realmente esos procesadores. El negocio de Arm se centra en el diseño de arquitecturas de CPU y la concesión de licencias a los fabricantes (es decir, Apple, Samsung o Qualcomm). Esta es la razón por la que el acuerdo detrás de este proyecto tiene enormes críticas por parte de los reguladores y los competidores de NVIDIA, al sr un proveedor clave para todos ellos.

Todo chip informático requiere una arquitectura de conjunto de instrucciones (ISA) y eso es lo que Arm, al igual que otros competidores, proporciona. Una ISA describe las características de la instrucción que el chip puede procesar, el formato de entrada y salida y la interacción chip-RAM. Así, puede entenderse como el conjunto de reglas de funcionamiento de la CPU que descompone todos los procesos en varias operaciones más pequeñas de 32 o 64 bits de longitud.

La principal diferenciación entre las arquitecturas ISA es la computación de conjuntos de instrucciones reducidos (RISC) y la computación de conjuntos de instrucciones complejos (CISC). La ISA de ARM es RISC y esto es lo que hace que ARM sea tan atractiva para los grandes fabricantes de chips. Esta arquitectura RISC significa que cada orden especifica una acción que la CPU tiene que realizar, mientras que una arquitectura CISC da lugar a un mecanismo mucho más complejo.

La cuestión puede ser por qué elegir un ISA tipo RISC, si el rendimiento puede ser menor. La respuesta es que no sólo se tiene en cuenta el rendimiento. El ISA tipo RISC de Arm necesita menos energía, por lo que su punto diferenciador es la eficiencia, ya que cuando se habla de teléfonos móviles, las limitaciones clave son el calor y el consumo de energía. En el mercado es típico encontrar chips basados en ISA tipo CISC en los ordenadores y chips basados en RISC en los teléfonos móviles. Todo se basa en la eficiencia y Arm es el líder en este ámbito gracias a su ISA tipo RISC, ya que la arquitectura puede ser mucho más sencilla. Por tanto, los chips Arm no pueden ejecutar tantas operaciones a la vez como un chip x86 basado en CISC, pero ahorran más energía.

La segunda característica diferenciadora de los chips Arm es su pionera arquitectura de computación big-little en el mismo chip. Dos alternativas en el mismo chip: una potente que consume energía y otra menos potente que la ahorra. El propio chip analiza la utilización del sistema para determinar qué núcleo debe funcionar. Arm explica que esta innovación puede suponer un ahorro de energía de alrededor del 75 %. El chip de Arm no sólo reduce el consumo de energía como una CPU de sobremesa tradicional cuando la carga es menor (esto hace que algunas partes nunca se apaguen), sino que apaga completamente un núcleo. Este innovador proceso es clave para el ahorro de energía y considerando lo extendida que está la tecnología Arm, esta es una fantástica forma de reducir las emisiones globales al reducir el consumo de energía. Esto está relacionado con el Objetivo de Desarrollo Sostenible número 13 de las Naciones Unidas: Acción por el Clima, que se centra en tomar medidas urgentes para combatir el cambio climático y sus impactos.

Según el Foro Económico Mundial, las soluciones digitales podrían reducir las emisiones en un 15 % para 2030. En este sentido, el crecimiento de la tecnología digital y de los servicios en la nube debe equilibrarse con una mayor eficiencia en todos los terminales, maximizando el rendimiento en el procesamiento de bajo consumo. Para conseguirlo, Arm aumentará el rendimiento de los nuevos chips en torno a un 30 % sin que haya un uso extra de energía. Esto reduciría la contribución del sector energético a las emisiones globales de CO2, que representan alrededor del 76 % de las emisiones totales de CO2.

Como se puede extraer, el diseño de un procesador es un compromiso entre potencia y consumo. En 2010, Arm controlaba alrededor del 95 % del mercado de procesadores para teléfonos móviles gracias a su innovadora arquitectura RISC. Hoy en día, este porcentaje no es tan alto porque algunas empresas vieron la oportunidad y entraron en el mercado, pero el dominio sigue siendo claro.

La tercera gran ventaja de la arquitectura Arm está relacionada con lo que se denomina espacio "System on a Chip" (SoC), que suele denominarse el siguiente paso después de las CPU. La tendencia en el mercado de los móviles es hacia los diseños integrados, donde los requisitos de potencia y espacio son cada vez más estrictos. El objetivo de un SoC es mejorar la eficiencia combinando varios componentes en un chip (CPU, memoria, gráficos, gestión de la energía, etc.). Por tanto, esto es fantástico para los fabricantes de teléfonos móviles.

Los clientes eligen las características propias de los chips de Arm para implementarlas en sus chips. Algunos de estos clientes son Apple, Huawei, Samsung, NVIDIA, Broadcom, AMD o Qualcomm. No solo utilizan estos conocimientos en los teléfonos móviles, sino también en los ordenadores (por ejemplo, Apple y su macOS M1 o Windows y su Surface Pro X). Además, la arquitectura Arm ya está presente en gadgets IoT como Google Home Mini o Amazon Echo [3].

Una vez detallado el dominio de Arm, es obvio por qué los competidores de NVIDIA tienen que detener el acuerdo, para que la compañía americana por sí sola no pueda controlar a un actor tan poderoso en el mercado, y tan estratégico para NVIDIA y todos sus competidores.

Esta es la raíz del problema y el reto para el comprador: cómo convencer a los reguladores de que Arm seguirá operando de forma independiente. ¿Tendrán los competidores de NVIDIA acceso a las licencias actuales y futuras de Arm en las mismas condiciones y a precios razonables? ¿Seguirá siendo el mercado de semiconductores un mercado competitivo?

Desde el anuncio del acuerdo, el precio de las acciones de NVIDIA aumentó notablemente hasta finales de 2021. Esto supuso una oferta mucho más atractiva para SoftBank, ya que el acuerdo total incrementó su valor debido al aumento del valor de la parte del pago consistente en acciones de NVIDIA. Esta situación cambió en 2022, cuando el aumento de la inflación, el inicio de la guerra entre Ucrania y Rusia y el anuncio por parte de los bancos centrales de la subida de los tipos de interés provocaron un mercado bajista, especialmente en el Nasdaq, donde las acciones de las empresas tecnológicas empezaron a bajar.

Figura 3: Precio de la Acción de NVIDIA (Fecha del Acuerdo). Fuente: [4]

La evolución del valor del acuerdo se muestra a continuación:

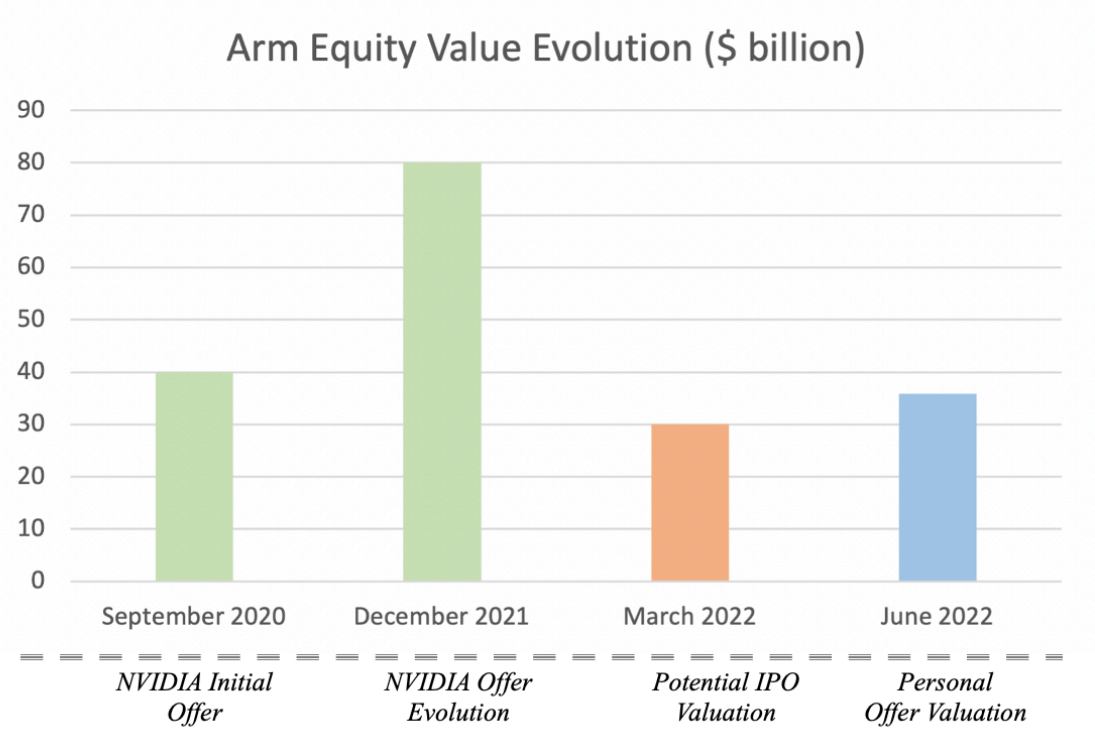

Figura 4: Valor del Equity de Arm Incluyendo la Valoración Personal. Fuente: [5]

En febrero de 2022, el acuerdo fue descartado por ambas empresas debido a la persecución de las autoridades competentes. El seguimiento del acuerdo no se detallará en este resumen, pero las partes que bloquearon el acuerdo fueron las siguientes: La Autoridad de Competencia y Mercado (Reino Unido), la Comisión Federal de Comercio (Estados Unidos), el Regulador Chino y el Regulador Europeo.

THE NVIDIA-ARM DEAL AND ITS IMPACT ON THE SEMICONDUCTOR INDUSTRY

ABSTRACT

Events such as the COVID-19 and the blockage of the Suez Canal put an enormous pressure on global supply chains and, particularly, on the semiconductor one. Nowadays, these materials are strategic and play an important role on the manufacturing of chips that are used in almost every industry worldwide.

In the middle of these events, on September 13th 2020 the American company NVIDIA announced a deal with the Japanese company SoftBank Group to acquire Arm for approximately $40 B to be paid in cash and NVIDIA's stock. NVIDIA is the leader in manufacturing three-dimensional graphics processors and related software, while Arm's main business is the designing of semiconductors (CPUs and NPUs), data engines and software that monetizes through the sale of licenses to manufacturing companies such as NVIDIA and other competitors.

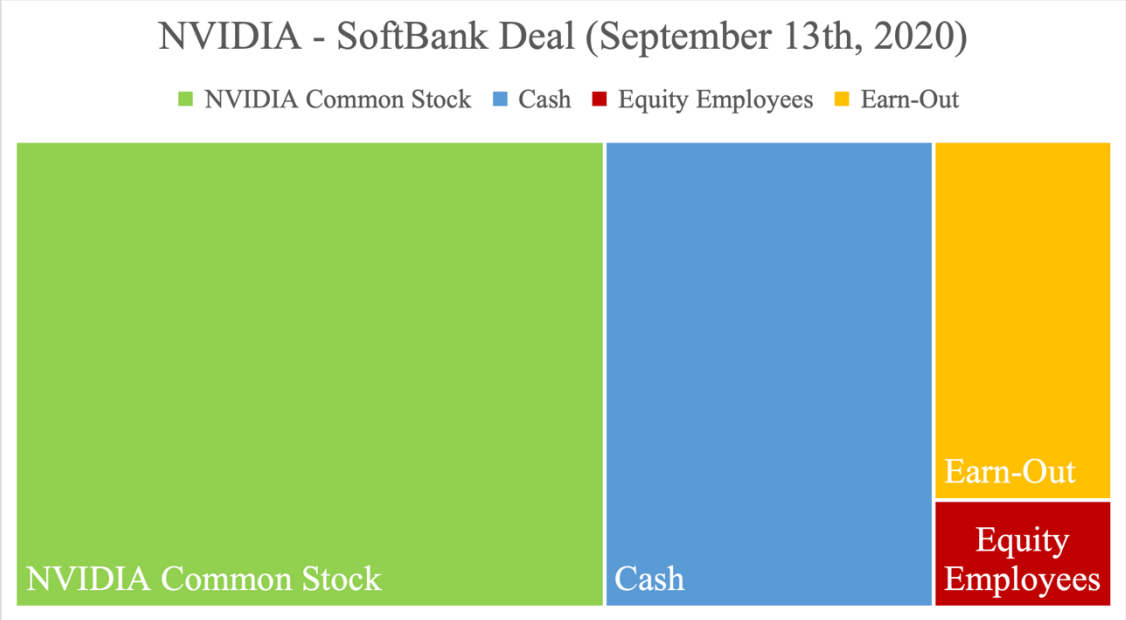

Figure 1: SoftBank Equity Stakes Value (¥T) March 2022. Source: [1]

The majority shareholder of Arm is SoftBank Group and its main business used to be telecommunication services, although today SoftBank is known by its big stakes in leading companies such as Alibaba and T-Mobile.

	LICENSE	DESIGN	MANUFACTURING	ASSEMBLY, QUAL. TEST & PACKAGING
COMPANY	arm	NVIDIA	tsmc SAMSUNG	BYD Amkor Technology KYEC SPIL
LOCATION				

Figure 2: NVIDIA Partners. Source: [2]

Arm has surpassed Intel by slowly gain market share by focusing much more on efficiency and portability than on velocity. The niche in which Arm already leads is the mobile processor market, chips for mobile phones, tablets, TVs, laptops or biometric systems. The critical point to understand is that Arm does not actually manufactures those processors. Arm's business focuses on designing CPU architectures and licensing them to producers (i.e., Apple, Samsung or Qualcomm). This is the reason why the deal behind this project has enormous critics from regulators and NVIDIA's competitors, since Arm is a critical supplier for all of them.

Every computer chip requires an Instruction Set Architecture (ISA) and that is what Arm, as well as other competitors, provides them with. An ISA describes the characteristics of the instruction the chip can process, the format of both input and output and the chip-RAM interaction. So, can be understood as the set of rules for the CPU to operate that breaks apart all processes into several smaller operations of 32- or 64-bits long.

The main differentiation among ISAs architectures is Reduced Instruction Set Computing (RISC) and Complex Instruction Set Computing (CISC). ARM's ISA is RISC and this is what makes ARM so attractive for big players in chip makers industry. This RISC architecture means that every order specifies an action the CPU has to perform, whereas a CISC architecture results in a much more complex mechanism.

The point here may be why to choose a RISC ISA, if performance may be lower. The answer is that not only performance is considered. Arm RISC ISA needs less power, so its differentiating point is efficiency because when talking about mobile phones, the key limitation are heat and power consumption. In the market it is typical to find CISC-based chips in computers and RISC-based chips in mobile phones. Everything is based on efficiency and Arm is the leader on this area because of its RISC ISA because the

architecture can be much simpler. Therefore, Arm chips cannot run as many operations at once as a CISC-based x86 chip, but saves more energy.

The second differentiating feature of Arm chips is its pioneering big-little computing architecture on the same chip. Two alternatives on the same chip: a powerful energy-consuming one and a less powerful energy-saving one. The chip itself analyzes the system utilization to determine which core to run. Arm explains that this innovation can lead to around 75 % savings in power. The Arm's chip not only lowers power consumption as a traditional desktop CPU when load is lower (this makes that some parts never shut off), but completely turn of a core. This innovative process is key to save energy and conserving how extended Arm technology is, this is a fantastic way to reduce global emissions by reducing energy consumption. This is related to United Nations' Sustainable Development Goal Number 13: Climate Action, which focuses on taking urgent action to combat climate change and its impacts.

According to the World Economic Forum, digital solutions could bring emissions down by 15 % by 2030. In this sense, the digital technology and cloud services growth need to be balanced with greater efficiency on all terminals, maximizing performance in low-power processing. To achieve this, Arm will increase new chip performance around 30 % with no extra energy use. This would reduce the energy sector contribution to global CO_2 emissions that account for around 76 % of total CO_2 emissions.

As can be extracted, the design of a processor is a trade-off between power and consumption. In 2010, Arm controlled around 95 % of mobile phones processors market thanks to its innovative RISC architecture. Nowadays, this percentage is not that high because some companies saw the opportunity and entered the market, but the dominancy is still clear.

The third great advantage of Arm architecture is related to what is called System on a Chip (SoC) space, typically referred as the next step after CPUs. The trend in the mobile market is towards integrated designs where power requirements and space are more and more strict. The goal of a SoC is improving efficiency by combining several components on a chip (CPU, memory, graphic, power management, etc.). Thus, this is fantastic for mobile phone makers.

Clients choose the proprietary Arm's chip-features to implement them into their chips. Some of these clients are Apple, Huawei, Samsung, NVIDIA, Broadcom, AMD or Qualcomm. Not only they use this know-how on mobile phones, but also on computers (i.e. Apple and its M1 macOS or Windows and its Surface Pro X). Also, Arm architecture is now present on IoT gadgets such as Google Home Mini or Amazon Echo [3].

Once the dominancy of Arm has been detailed, it is obvious why NVIDIA competitors need to stop the deal, so the American company alone cannot control such a powerful actor in the market, and so strategic for NVIDIA and competitors.

This is the root of the problem and the challenge for the acquirer: how to convince regulators that Arm will still operate independently. Will NVIDIA's competitors have access to existing and future Arm's licenses under the same conditions and at reasonable prices? Will the semiconductor market continue being a competitive market?

Since the announcement of the deal the NVIDIA stock increased a lot in price until the end of 2021. This meant a much more attractive offer for SoftBank because the total deal was valued much higher due to the increase in value of the NVIDIA stock stake. This situation changed in 2022, when as inflation rose, the Ukraine-Russia war began and the central banks announced the increase in interest rates led to a bear market, particularly, the Nasdaq where tech companies' stocks started to go down.

Figure 3: NVIDIA Stock Price (Deal Date). Source: [4]

The evolution of the deal value is shown below:

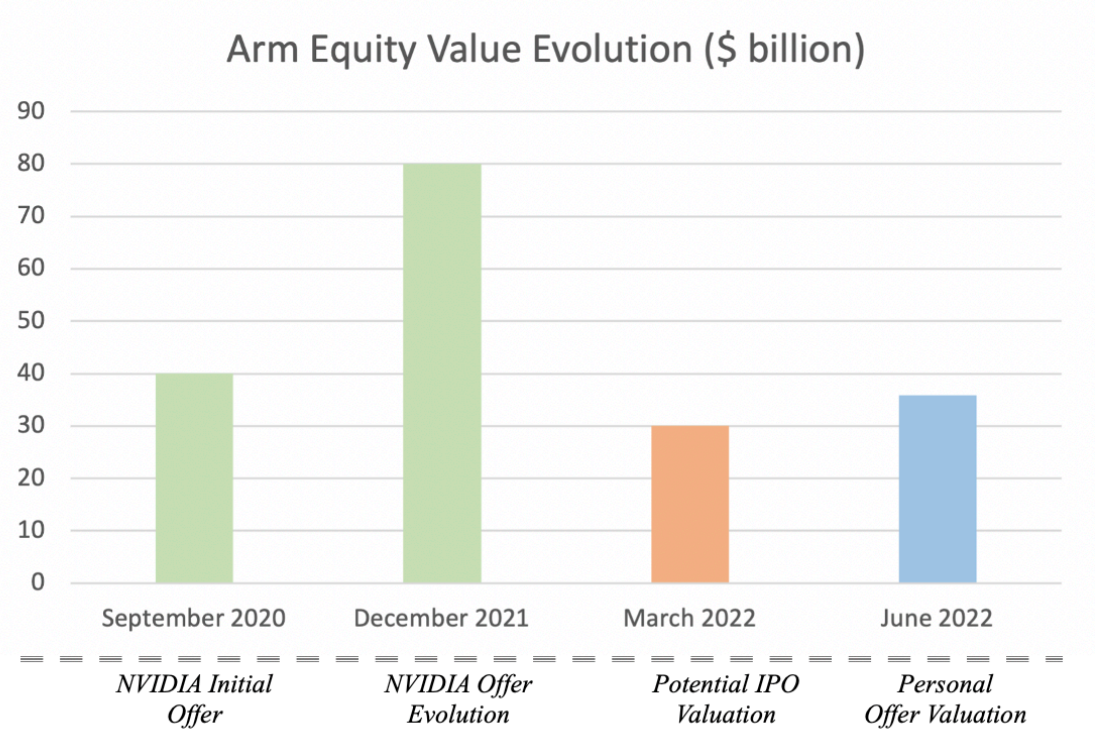

Figure 4: Arm Equity Value Evolution Including Personal Valuation. Source: [5]

In February 2022, the deal was discarded by both companies due to the prosecution of competence authorities. The deal follow-up will not be detailed in this abstract, but the parties blocking the deal were the following: Competitions and Market Authority (United Kingdom), Federal Trade Commission (United States), the Chinese Regulator and the European Regulator.

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1 Supply Chain post-Covid Spread

1.1 Global Supply Chain Disruption

The Coronavirus, technically called the COVID-19, was a new highly infectious disease which was declared to be a pandemic by the World Health Organization (WHO). Not formerly identified by humans before, this virus resulted in an unprecedent spread of viral pneumonias across the globe. The origin of COVID-19 was specifically identified in Wuhan, Hubei Province, China, in December 2019 and was followed by a fast spread across this region and the rest of China. Later on, the first case of COVID-19 was detected on February 21st 2020 in Tuscani, region in the center of Italy and few weeks later all Western countries started to set restrictions to achieve the only effective measure available at that time: social distancing [6].

Since March 2020, the COVID-19 has altered the way society lives and has affected the whole world in multiple ways creating unprecedented challenges for the economy and society. The virus has already spread across almost every country in the world and infected around 352 M people at least once and deaths account for near 6M people until the 24th of January 2022 [7].

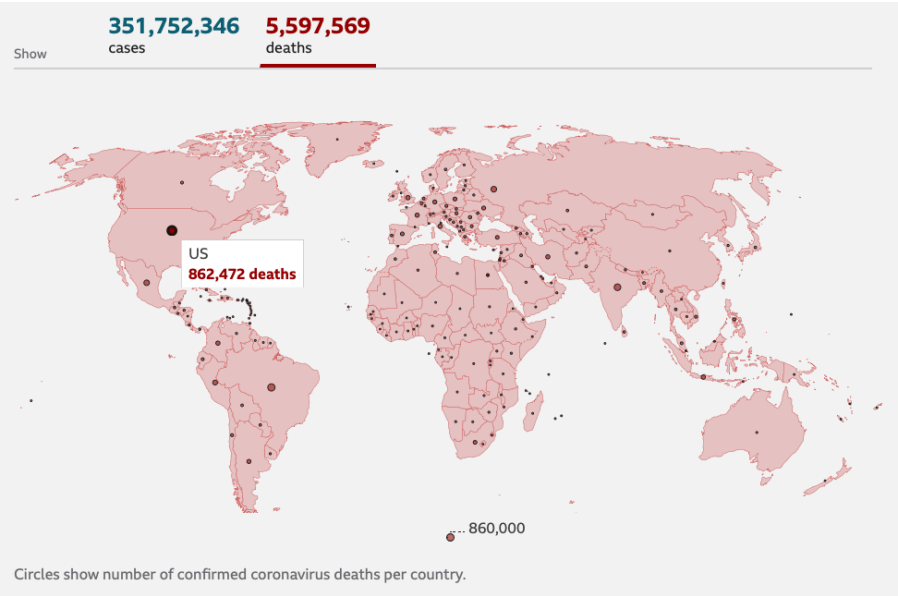

Figure 5: COVID Spread around the World

Among the many consequences of the pandemic there are some that stand out: economic downturn and increased unemployment. The consumer spending pattern changed during the first months of the pandemic too, in terms of timing and volume of purchases. Media caused a considerable part of this erratic social conduct according to the American Psychological Association that affirms a correlation between anxiety and distress because of media exposure during lockdowns [8].

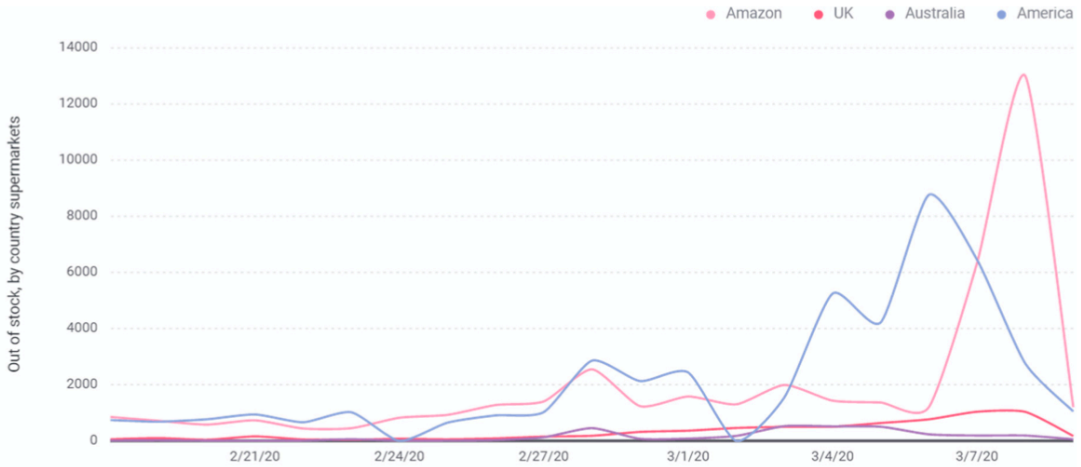

Figure 6: Mentions of "Out of Stock" alongside a Store Name. Source [9]

Another point to consider is the inexistence of a vaccine until November/December 2020 when the first doses began to be administered in the UK, becoming the first Western country to approve and administer a vaccine against the COVID-19. This way, putting together the international scope of the pandemic as well as the inexistence of a vaccine, made uncertainty even higher so the unstable spending pattern and volatile stoke prices were long to stay [10].

The global market has shown to be weak under a severe impact such as a general lockdown and as observed it takes long time to recover. The shortages have turned into higher prices for many products, not only because of the scarcity but also due to a sometimes completely irrational demand as outcome of general panic, also known as panic buying. The continuous shortages meant unprecedent delays from the suppliers to both industrial producers and end costumers.

The sectors with the deepest impact were those with intermediate goods coming exclusively from China. These mainly Western industries had the greatest delays in receiving those shipments what turned into declines in production as well as employment. Input as well as output prices increased along the value chain, showing that the bottleneck came from the supply side and was not driven by a rise in demand.

The National Bureau of Statistics of China elaborates a month over month measure of the industrial production growth of different sectors integrated along the economy such as manufacturing, utilities and mining. For the year 2021, the Chinese industrial production grew by 9,6 % (YoY) [11]. The downturn in February 2020 was tremendous achieving a -22,1 % on the value added by the Chinese Industry, even more if noticed that it was the first month with negative figures since 2011 when the latest data is available. The average percentage since February 2012 is 0,73 %. The recovery was even faster than the drop with a 36,6 % in March 2020.

Figure 7: China Value Added of Industry MoM since January 2016. Source: [11]

Although the effects in the Chinese economy were huge, there are some other actors who suffered even more. The American Trade Deficit was one of Trump's greatest battles during its mandate that brought the trade war with China, whose situation is completely the opposite, the highest trade surplus in the world. The following Bloomberg graph is quite popular and represents the trade flow from and to the American's greatest trading partners.

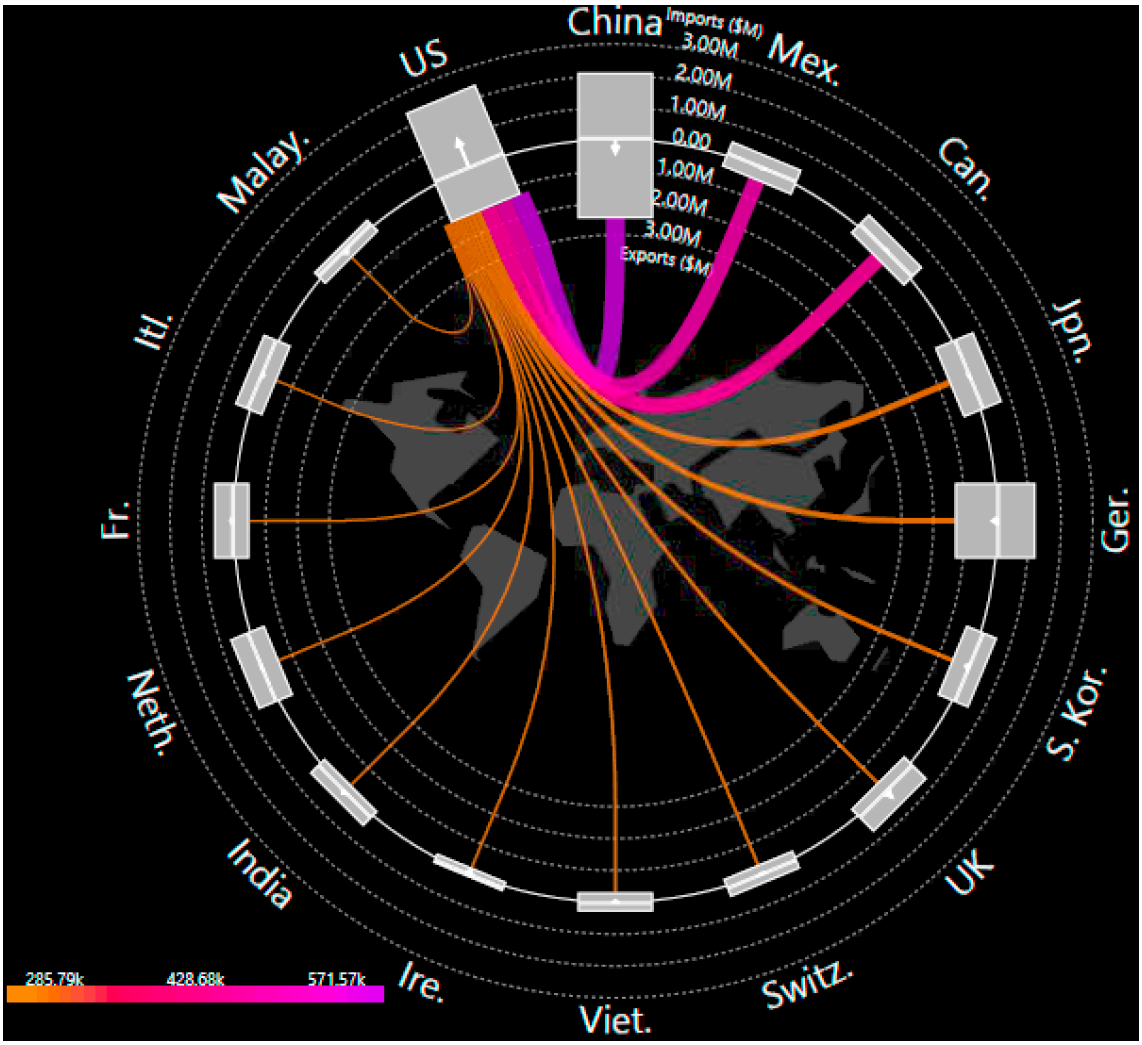

Figure 8: US Global Trade Flow. Source: [2]

Since several of the countries in the above graph are global powers, it makes sense to set a comparison about the trade of these countries with the US. Most of them are quite well-balanced with a net deficit close to zero. However, there are two cases that must be outlined. On the one hand, the Chinese trade balance in China in 2020 was record high since 2015 with $535,37B. On the other hand, the US hit record trade deficit high in 2020 with around $938B [2].

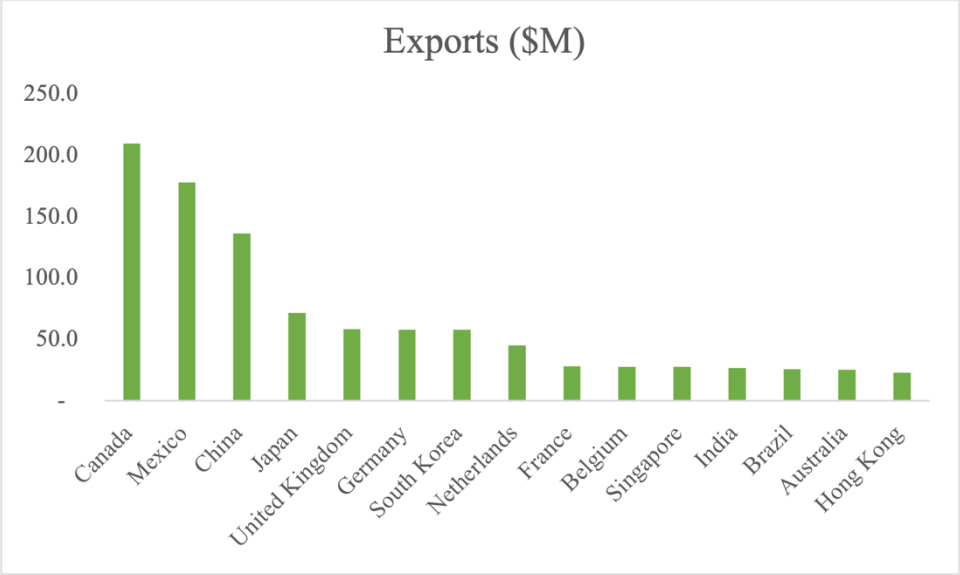

Figure 9: American Greatest Trade Partners - Export. Source: [2]

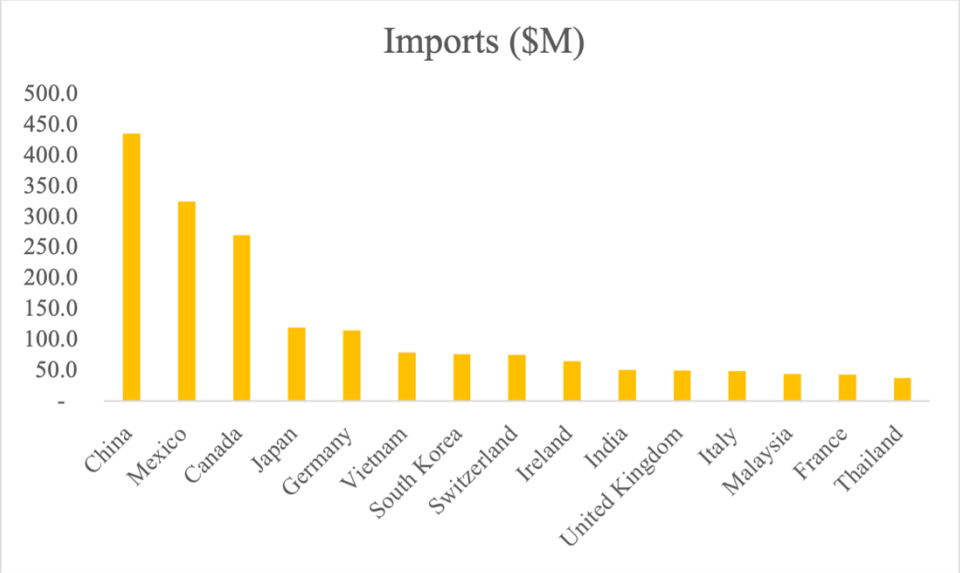

Figure 10: American Greatest Trade Partners 2020 - Import. Source: [2]

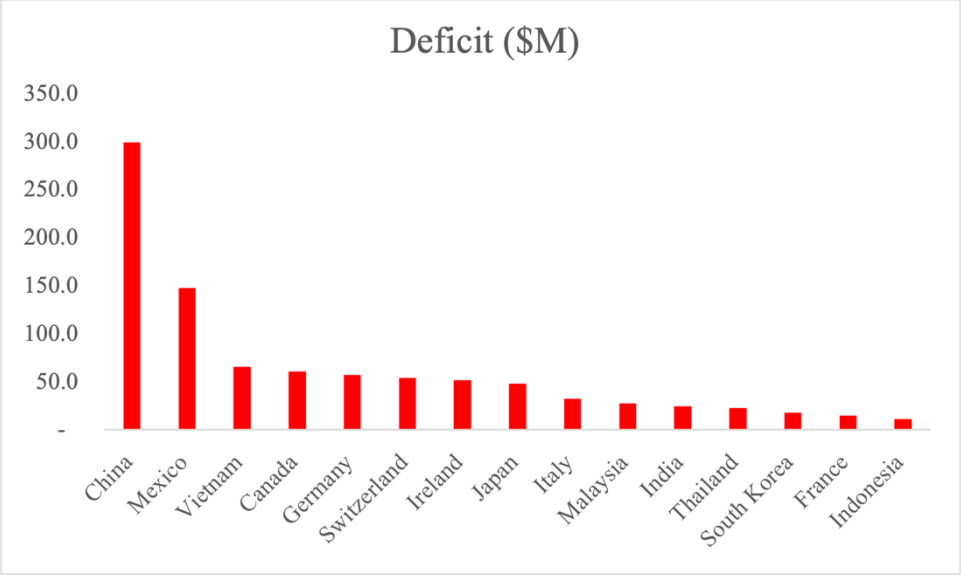

Figure 11: American Greatest Trade Partners - Deficit. Source: [2]

This situation is far to change for the US' interests and China will not help since this global trade order gives China a position of power over the US, as well as the EU. In 2021, the Chinese trade surplus increased by almost 30 % to reach $676 B, in fact, the balance in December 2021 hit a record $94,4 B [12]. In the other side of the Pacific, the US trade deficit was even higher than the previous year with $1090 billion [13].

The implications of this global situation are huge for the NVIDIA-ARM deal and will force all regulators to protect their national interests in such a strategic industry as semiconductors. As shown, supply chain is very dependent on geopolitical factors.

Value chains have globally grown in length as well as in complexity as firms moved around the globe looking for ways to improve their margins. According to McKinsey Global Institute, lean manufacturing made possible to get shorter lead times, more appropriate inventory levels and on-time deliveries. However, these advanced changes create some weaknesses too in terms of operating risks such as resilience and transparency, as well as transoceanic distances to cover. The current value of intermediate goods traded around the world is three times higher than at the beginning of the 21st century accounting for around $10 trillion a year [14].

In March 2021, another event hit the semiconductor supply chain. A container ship blocked the Suez Canal for a week. Of course, the blockage affected the whole shipping industry. The ship belonged to Evergreen Marine, one of the largest container vessels.

Around 12 % of global trade goes through the canal every day, so canal's revenues around $14 -$15 million were lost per day. The alternative to Suez Canal is Cape of Good Hope. However, the following scheme shows that instead of a 25.5-day trip, it takes 34 days since the alternative sails for extra 6,500 km [15].

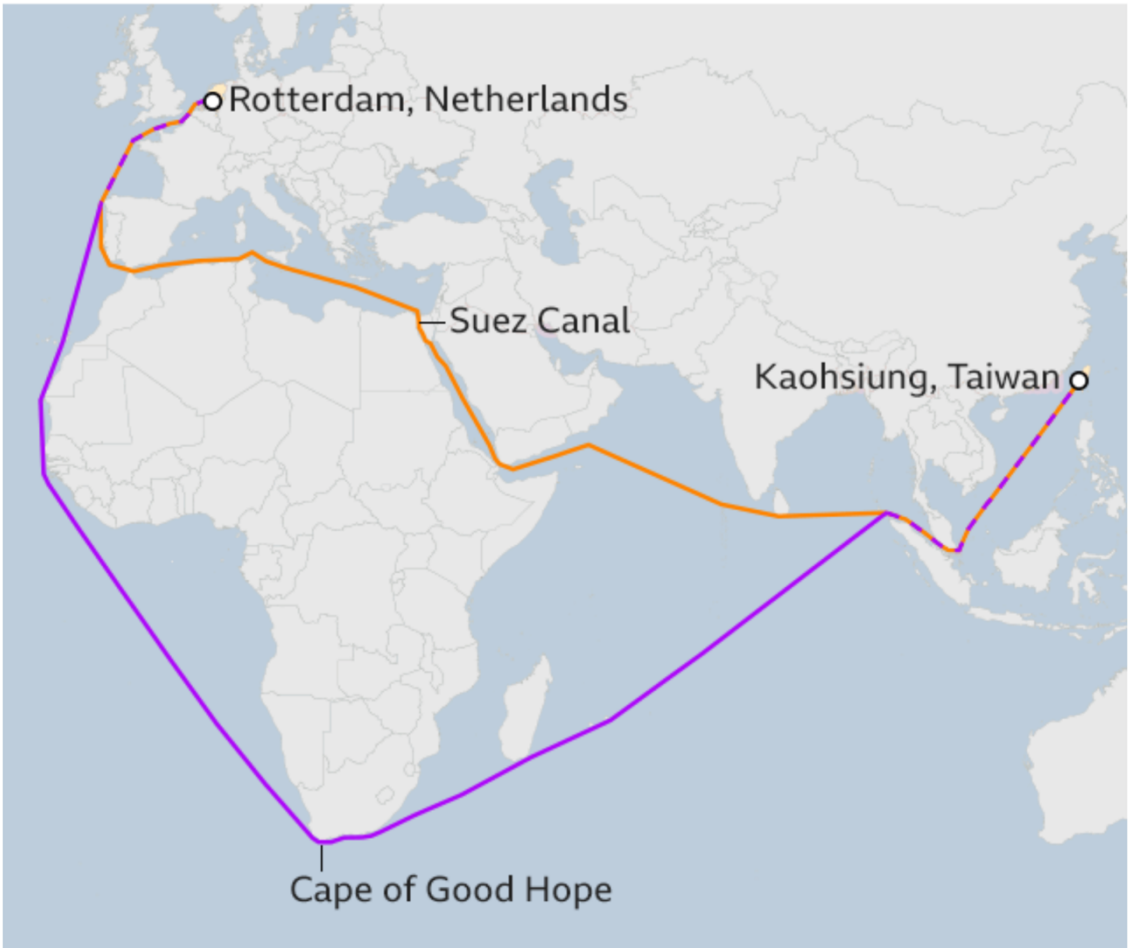

Figure 12: Alternative to Suez Canal. Source: [15]

1.2 Semiconductor Shortage and Effects

Semiconductors are materials which make possible to conduct a little current through them and, even more important, this current flows in a controlled way. In fact, these materials have a different resistance to the flow of current depending on the direction (i.e., a diode is an application of this characteristic). Among the elements used in the industry, Silicon (Si) is the most popular one. There are others also used such as Germanium (Ge), Silicon Carbide or Gallium Arsenide.

Chipmakers need silicon (Si) wafer to process them into chips. In the supply chain, producers or silicon wafer sells it in two different ways: bare or raw silicon. A wafer is a very thin portion of semiconductor from 25 to 300 mm [16].

The current silicon wafer market is extremely concentrated. In the 90s, there were about 20 players competing worldwide. However, nowadays only a few of them survive. The reasons behind this market reorganization are merger and acquisitions between companies. For instance, last year the German company Wacker Chermie announced the operation to sell its 30.8 % stake in the also German silicon wafer producer Siltronic to Taiwan's GlobalWafers which turns to be a competitor of Siltronic at that time [17]. This deal was approved by regulators and has change the table of largest silicon wafer makers. The top five producers own 95 % share of the market, as it is shown in the following table:

Company	Market	Share (%)	Logo
Shin-Etsu	Japan	29.4	
Siltronic	Germany	26.7	
Sumco	Japan	21.9	
SK Siltron	South Korea	11.4	
Soitec	France	5.5	

Figure 13: Largest Producers of Silicon (2021). Source: [17].

The pandemic spread is the origin of the greatest and longest-lasting shock in the semiconductor value chain in recent history. However, there were some unusual occurrences during the last decade that represented a challenge to companies in the semiconductor industry.

Japan is well known for its automotive industry, but in 2011 many of its massive factories in charge of serving electronic components to carmakers such as Toyota or Nissan in Japan and others worldwide were affected by the earthquake in the Pacific Coast on the 11th of March. But not only in Japan, assembly lines in all continents were also affected [14]. There are from 1,000 to 3,500 semiconductors in an average car [18].

Carmakers were deeply shocked, but personal computers were also affected as well when the Japanese brand Shin-Etsu was knocked out by the earthquake. This company is even today the leader producer of silicon wafers, a fundamental part for chipmakers. Shin-Etsu and competitors produce and deliver bare or even raw silicon to companies that turn it into chips. This market is growing since there is still a boom in demand [17].

The earthquake that hit Japan was not the only occurrence to shock the semiconductors supply chain that year. In the 2011 Monsoon season, Thailand suffered floods in the north and center of the country inundating in October part of Bangkok. These floods hit PC hard drive suppliers since Thailand was the world greatest magnetic hard drive manufacturer [19].

In 2017, another occurrence affected the oil industry, although not directly related to semiconductors, plastics play an important role in the semiconductor supply chain when manufacturing the final product. The hurricane Harvey hit Louisiana and Texas where the majority of the great petrochemical plants and oil refineries are located. This Category-4 storm created trouble as these industries provide others with resins and key plastics.

However, natural disasters are not the only threats to the semiconductor supply chain. Other risks such as cyberattacks, terrorism or military conflict are less frequent, but need also to be considered to reduce their impact if took place. The McKinsey Global

Institute analyses these causes according to their length, their ripple effects and the possibility that not only the supply side is hit, but the demand side too. The objective of this report is to make supply chains more resilient after the pandemic. As a couple of datapoints from the report: 1) Supply chain shocks that last at least one month takes place every 3.7 years nowadays. 2) During a decade, global companies should be ready to lose around half a year's profits in disruptions [14].

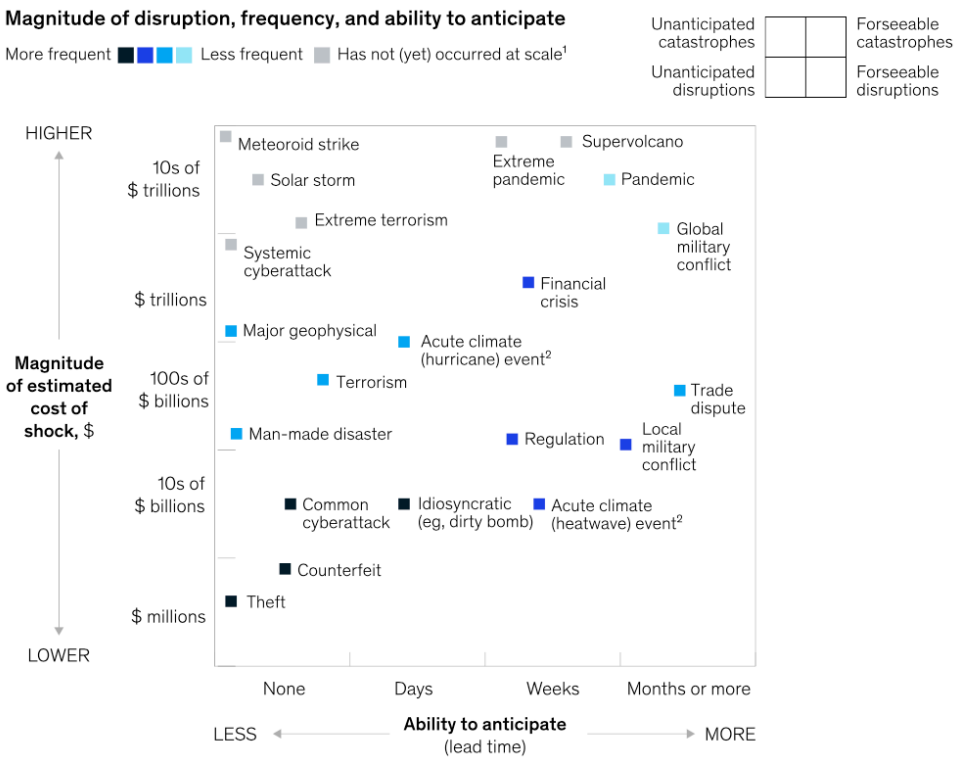

Figure 14: Magnitude of Disruption, Frequency and Ability to Anticipate. Source: [14]

Figure 15: Expected Frequency by Disruption Duration. Source: [14]

To conclude this section, the "Taiwan Customs Volume Wafer of Silicon Dimension: 8 to 12 inch" is a popular index used to understand the feeling in the silicon wafer industry. The following graph from Bloomberg shows the hits in Taiwanese exports

due to the pandemic, the blockage of the Suez Canal and the Russia-Ukraine war. The graph shows the value of those exports in USD millions.

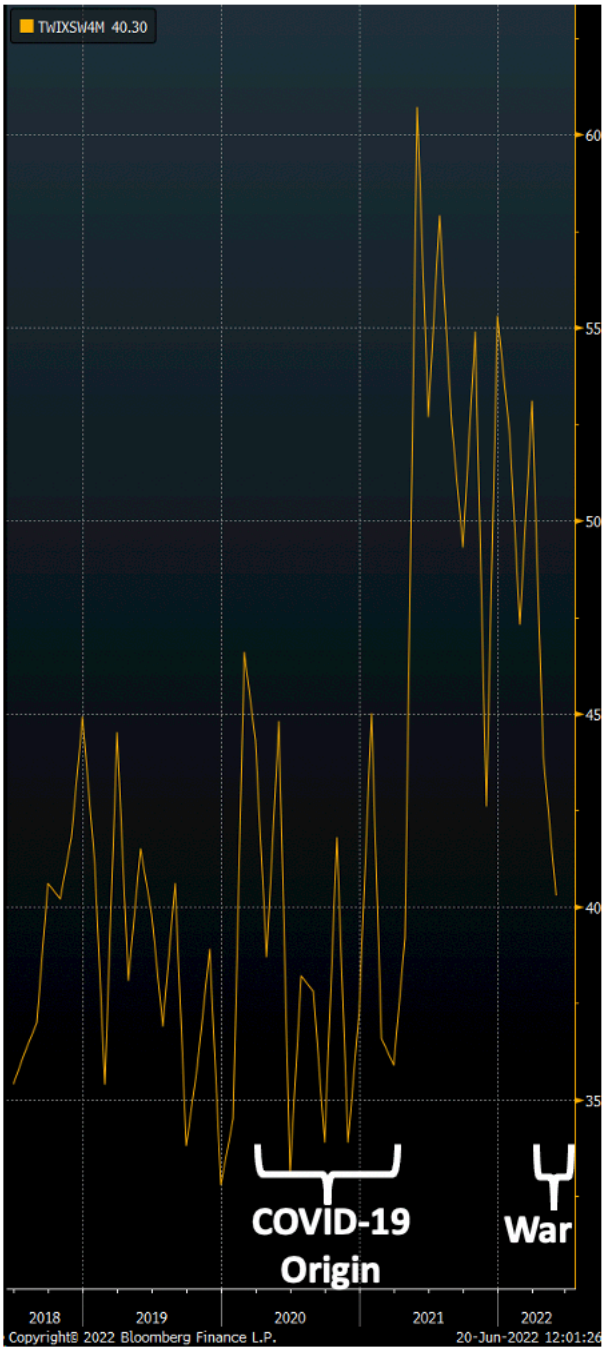

Figure 16: Taiwan Customs Exports Value of Silicon Wafer – Dimension: 8 to 12 inches. Source: [2].

Going deeper on the industry analysis, to understand the value chain seems logical. Another consulting company, Accenture, prepared a report called “Harnessing

the power of the semiconductor value chain" in February 2022, based on the global chip shortage in any industry worldwide.

One of the key conclusions is that no company can execute all operations in the value chain itself. For instance, big techs outsource most of the operations and just focused on a few very detailed tasks. The parties are well aligned so they can share their intellectual property with upward and downward global partners in this very vertical industry.

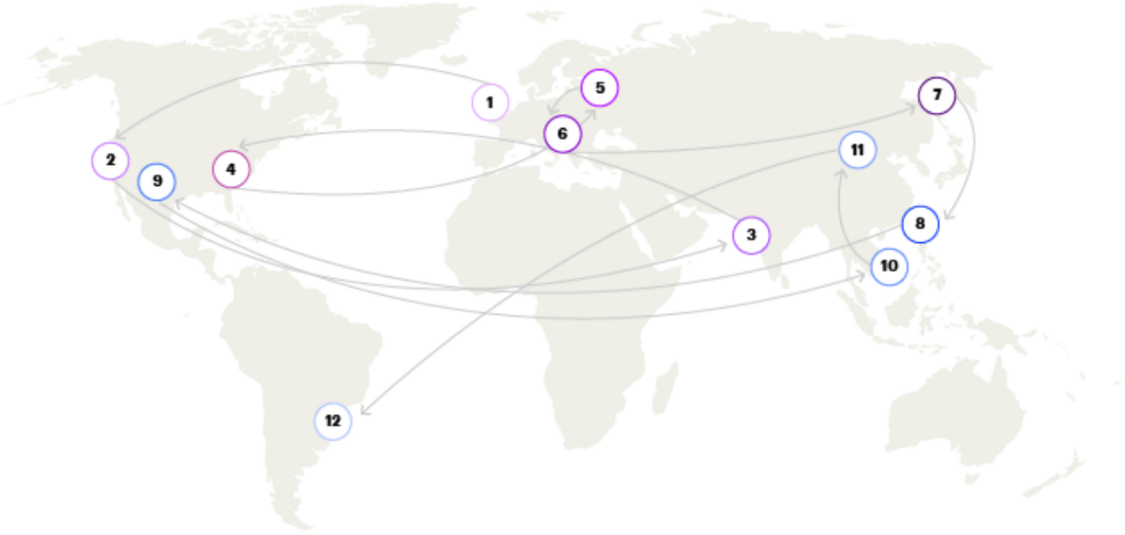

Figure 17: Flow of the Semiconductor Value Chain. Source: [18]

The report gives a very illustrative example of the semiconductor value chain ecosystem:

1. United Kingdom - Semiconductor Intellectual Property firms sell their licenses to fabless firms. This is where Arm is located.
2. United States - Fabless firms design complex chips with electronic design automatized software. A fabless firm is one that manufactures semiconductors lacking an own manufacturing plant of silicon wafers and just focused on design and market those chips. This is where NVIDIA is located. In fact, NVIDIA was the second fabless company with the highest revenue in 2021, just after Qualcomm. Just to make this point clear, the alternative to a fabless

firm is an integrated device manufacturer, what is known in the industry ad IDM [20].

3. India - Verification teams ensure specifications.
4. United States – Original equipment manufacturer locks in chip design for end products.
5. Netherlands – Process equipment used by fabs to manufacture chips.
6. Germany – Chemicals and fab consumable suppliers equip fabs with key fabrication and facility cleaning products.
7. Japan – Materials companies form silicon ingots from pure silicon and slice into silicon wafers.
8. Taiwan – Foundries etch tens of layers of interconnected wires and transistors onto wafer to develop integrated circuits.
9. United States – Test equipment firms design and manufacture equipment.
10. Malaysia – Assemble, package, and test semiconductor chips.
11. China – Electronic manufacturing services players integrate those integrated circuits into original equipment manufacturers' end product electronics.
12. Argentina – Consumer buys smartphone.

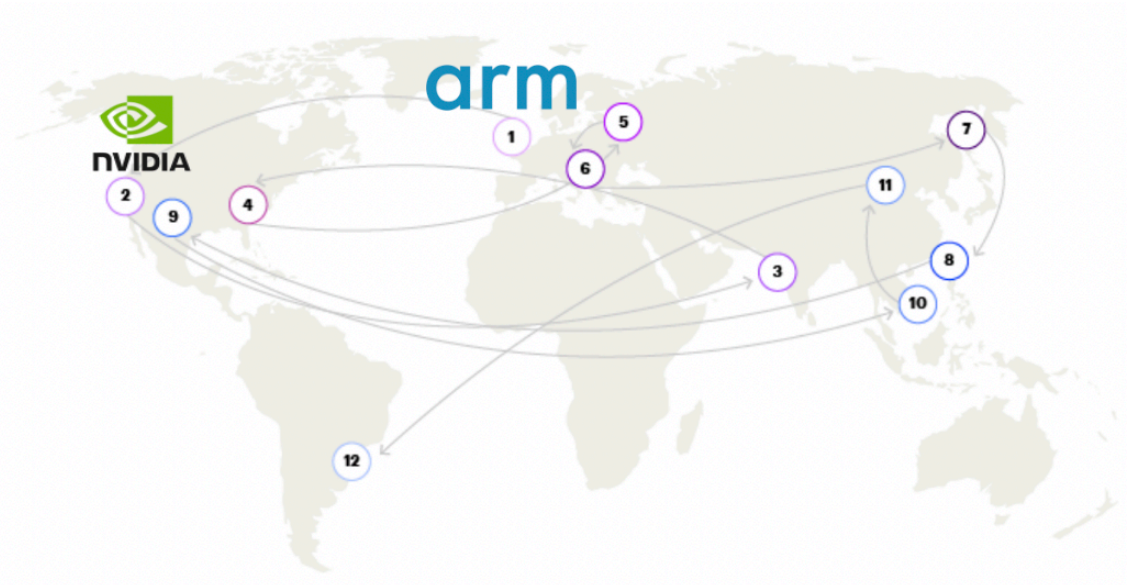

Figure 18: Flow of the Semiconductor Value Chain Including NVIDIA and Arm. Source: [18]

In short, the semiconductor supply chain is one of the most sophisticated nets and that sophistication makes the industry quite vulnerable to multiple circumstances. The deal announcement coincided with the toughest lockdowns in recent history and complicated the issue because regulators saw themselves in a position where competitors

accused the deal of potentially make competition disappear meanwhile most companies in almost any industry were lacking chips due to the mentioned shortage.

2 NVIDIA Description and Analysis

2.1 Company Description

NVIDIA Corporation ('NVIDIA') has its headquarters in Santa Clara, California (US) and offices in three continents: America, Asia, and Europe.

Jen-Hsun Huang was a Taiwanese engineer who studied in Stanford. He first worked for Advanced Micro Devices (AMD) and LSI and at the age of 30, in 1992, he decided to raise a company starting from scratch with other engineers such as Curtis Priem and Chris Malachowsky.

The company became famous in 1997 when it launched a processor with top speed in the market and this growth has continued until today. Next year, it increased its revenue over $100 million, two year later over $300 million and the third one over $700 million. This amazing growth made possible that the company became a huge actor in the GPU market. In 1999 the IPO took place and in 2000 Microsoft signed a partnership with the company to be the exclusive supplier of the chips for its brand-new videogame console Xbox. That year the company outperform the competitor ATI Tech. in market capitalization. From then on, the company has acquired other companies to acquire the unique capabilities it has nowadays. In 2020, not only NVIDIA announce the deal with ARM, but also announced the acquisition of the also California-based Mellanox which produced also chips and other hardware for around $7 billion. The market where NVIDIA considers can benefit from synergies are cloud computing and hardware for datacenters.

Figure 19: NVIDIA Market Cap Log-Evolution. Source: [2]

The offer will be detailed afterwards, but just to put into context the size of the deal, SoftBank would acquire a stake close to 10 % of NVIDIA, so the Japanese Group would probably become the greatest shareholders of the company and surpassing the Vanguard Group.

Stockholder	Stake	Shares	Total value ($)
The Vanguard Group	7.53%	188,460,263	35,189,300,307
Fidelity Management & Research	5.47%	136,999,607	25,580,566,619
BlackRock Fund Advisors	4.63%	115,981,458	21,656,057,838
SSgA Funds Management	3.84%	96,099,151	17,943,633,475
T. Rowe Price Associates	2.12%	53,129,332	9,920,308,871
Geode Capital Management LLC	1.73%	43,390,541	8,101,881,816
Northern Trust Investments	1.11%	27,866,371	5,203,208,793
Norges Bank Investment Management	0.85%	21,349,893	3,986,452,021
Jennison Associates LLC	0.82%	20,532,093	3,833,752,405
BlackRock Investment Management	0.79%	19,722,710	3,682,624,411

Figure 20: Top 10 NVIDIA Owners on June 17th 2022. Source: [21]

During recent years there has been a shift in sales towards Asia where almost 70 % of NVIDIA's sales are located, into several countries (Taiwan, China, Japan, Korea, India, etc.). In fact, only Taiwan accounts for around 25 % of NVIDIA's sales. China is also a great client with also around 25 %, while the rest of Asia-Pacific mean the remaining 20 %. The 30 % revenue left is split into the US, accounting for 20 % of sales, Europe around 5 % and others (i.e., Canada, South Africa) with 5 %.

The main business of NVIDIA consists of the designing, developing, and selling of three-dimensional graphics processors and related software. The Company main market is therefore the personal computer market. These graphics processing units (GPUs) are deeply appreciated in innovative areas such as applications for autonomous vehicles and deep learning (artificial intelligence). The company owns several well-known brands such as GeForce (videogames), Quadro/NVIDIA RTX GPUs (workstation graphics) and DGX (research).

NVIDIA has different business segments which were known as GPU and Tegra Processor until January 2021 when it was changed to Graphics and Compute &

Networking. As mentioned before, the markets keep being the same ones: Videogaming, Professional Visualization, Automotive, OEM and Data Centers.

Looking at the revenue per market:

- Graphics mean around 60 % of revenue which is split into Personal Computers, the GeForce GPUs (mainly gaming), GeForce NOW (service that provides streaming gaming) and other minor business lines related to gaming; Quadro/NVIDIA RTX GPUs for professional graphics; vGPU software for visual cloud computing; and automotive platforms.

- Compute & Networking account for about 40 % of revenue and in this section the systems included are Data Center platforms and others for HPC, AI and accelerated computing; Automotive AI Cockpit and other autonomous vehicle's business lines; Mellanox networking; and Jetson for robots mainly.

As mentioned in the example of the semiconductor supply chain, NVIDIA works as a fabless manufacturer whose main objective is semiconductor designing: chip size, interconnection among transistors and gates, and placement of memory and logic. So, once the design is defined, the business model of NVIDIA continues with the outsourcing of the manufacturing to two companies: Taiwan Semiconductor Manufacturing Co. Ltd. and Samsung Electronics Co. Ltd. The next step is assembling, quality testing and packaging. The companies in charge of these operational labors are BYD Auto Co., Amkor Technology, King Yuan Electronics Co., Omni Logistics, Hon Hai Precision Industry Co., Ltd., Siliconware Precision Industries Company and LLC.

	LICENSE	DESIGN	MANUFACTURING	ASSEMBLY, QUAL. TEST & PACKAGING
COMPANY	arm	NVIDIA	tsmc SAMSUNG	BYD Amkor Technology KYEC SPIL
LOCATION				

Figure 21: NVIDIA Partners. Source: [2]

Once the product is prepared to be sold, NVIDIA's own sales and marketing departments talks to mainly partner networks, although sometimes with end customers directly. These complex networks include retailers and distributors, hardware manufacturers, mapping firms, internet and cloud service companies, IT system builders, board makers, automotive manufacturers and top automotive suppliers, and other ecosystem participants.

One strategic strength of NVIDIA is that there exists no concentration of clients since no customer accounts for more than 10 % of sales. This point is crucial for the long-term empowerment of the company. Among the well-defined objectives of the company are the following: keep leading technology development market in AI and visual computing, lead the development of the autonomous vehicle, lever its patents and other intellectual assets and keep developing the position of the company in the computing system market.

To achieve the mentioned goals the company believes in its own platform strategy which joins all its internal and external activities and is controlled by an unified control that makes possible for all stakeholders to row in the same direction [2].

In fiscal 2021, NVIDIA increased its revenue to $16.7 B what means a 53 % increased if compared to fiscal 2020 ($10.9B). Accordingly, net income increased from $2.8 B to $4.3 B in fiscal 2021 [Appendix II, III, IV].

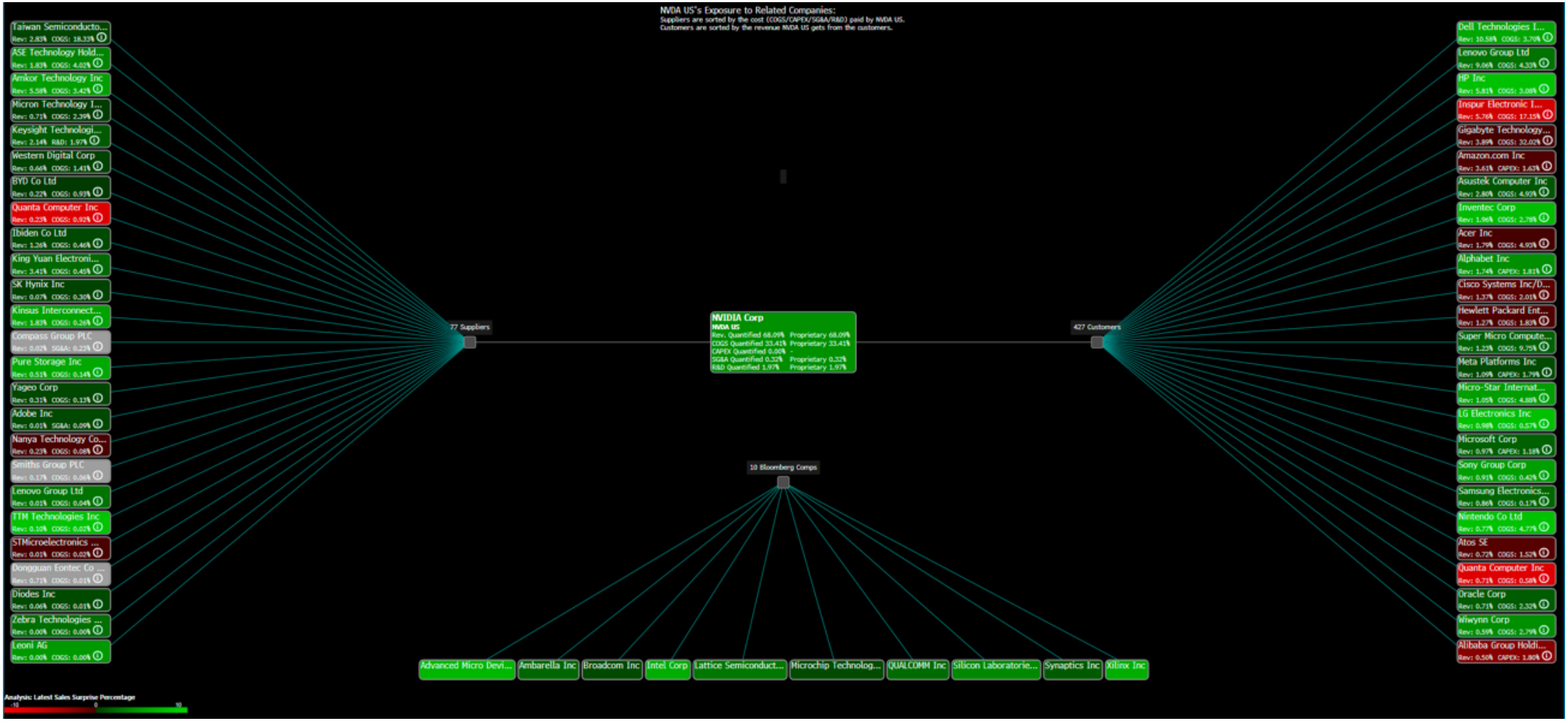

Figure 22: NVIDIA Exposure to Related Companies. Source: [2]

2.2 How the Pandemic Affected the Company

NVIDIA had a strong financial performance during the first months of the pandemic and before the deal announcement, achieving record quarter sales due to the increase of revenues in online gaming and remote computing coming from the lockdowns and changes in routine worldwide. Gaming segment revenue increased by 26 %.

Figure 23: NVIDIA Stock Price (Deal Date). Source: [4]

Not all divisions benefited from the lockdowns. Professional visualization segment revenue decreased 30 % because many clients delayed contracts on workstation spending. Another affected segment was the automobile sector since the stop in production meant a cancellation of many huge contracts. This sector revenue went down 47 % year-over-year.

Jensen Huang, founder and CEO of NVIDIA, emphasized in August 2020 that the company was well positioned to grow in segments such as AI, cloud computing, autonomous machines and gaming [22].

From the announcement of the deal on, the stock price rose a lot in the middle of a big bubble of Nasdaq technological companies where these firms were valuated at tremendously high ratios.

3 ARM Description and Analysis

3.1 Company Description

Arm Holdings (previously Advanced RISC Machine and, originally, Acorn RISC Machines) is a British Company owned by the Japanese SoftBank Group Corporation through the SVF Holdco (UK) Limited. Arm main business is the designing of semiconductors (CPUs and NPUs), data engines and software. Its software platforms and processor designs are active in over 180 billion chips worldwide in any device such as phones, computers or even vehicles. The sectors in which Arm is present are quite varied: wireless industries, security, healthcare, smart cities and homes, digital image, mass storage or automotive, from the chip to the cloud through AI. In these sectors the company has created a great network of around 1,000 tech partners. In fact, Arm microprocessor design are their main asset since this intellectual property and the related technology. It is the world's most licensed and used semiconductor intellectual property of its kind.

Arm was a dual-listed company in New York and London. When it was acquired by SoftBank in 2016 it was delisted. As the owner of the subsidiary has much to say in the deal, it seems interesting to understand a bit what SoftBank Group Corporation ('SoftBank') is. Softbank headquarters are in Tokyo (Japan).

To understand the deal, it is fundamental to describe the current owner of Arm, SoftBank Group, how it typically operates and which its motivations are.

The founder of SoftBank Masayoshi Son grew up in Japan, but moved to the US and studied at Berkeley where invented the Sharp Wizard handheld organizer. He was paid $1 million by the patent and this is why he is known as the Japanese Bill Gates. It was later in 1981 when he founded SoftBank taking advantage of those funds. In 1994 the IPO took place and during that decade SoftBank started purchasing stakes in companies such as Kington Technology (80 %) or Yahoo! in 1999.

The best deal SoftBank has achieved until today was acquiring a stake of AliBaba in 2000 for around $20 million that turned into a return around $100 billion.

The main purpose of SoftBank is telecommunication services. Other lines of business are the sale of designed software, microprocessors and related technologies. But, since some decades ago, SoftBank focuses deeply on investments. The Group is invested with considerable stakes in AI, internet services, telecommunications and clean energy tech providers. SoftBank is deeply focused on smart disruptive companies. For instance, the short-term objective is to invest more than $100 billion in entrepreneurs that have ideas to transform industries. Another interesting point is that SoftBank has raised the greatest venture capital fund in Latin America. A similar one was founded in 1981 in the US with $100 million.

Dividing the Group into segments, there exist four of them:

- Companies Segment

This segment means around 90 % of sales of the Group. The main activities are communications services, broadband, sale of mobile devices, etc., in Japan.

- SoftBank Vision Fund and Other SBIA-managed Funds Segment

The purpose of this segment is leading the market by allowing growth firms to be the first in their market. The market is mainly AI.

- SoftBank Segment

The firms invested in this segment are around 120 portfolio companies such as T-Mobile, The We Co. and Alibaba.

- Arm Segment

This segment's percentage of total revenue is less than 5 %

In fiscal 2021, SoftBank increased its revenue to ¥5,628,167 million what means a 5.37 % increase if compared to fiscal 2020 (+ ¥389.2 billion). Accordingly, net income increased from ¥4,987,962 million to 5,949,538 million in fiscal 2021 [Appendix V].

The strategy SoftBank has is to understand the value that AI adds to any business and identify those opportunities in global markets because those companies are becoming the leaders of the Information Revolution.

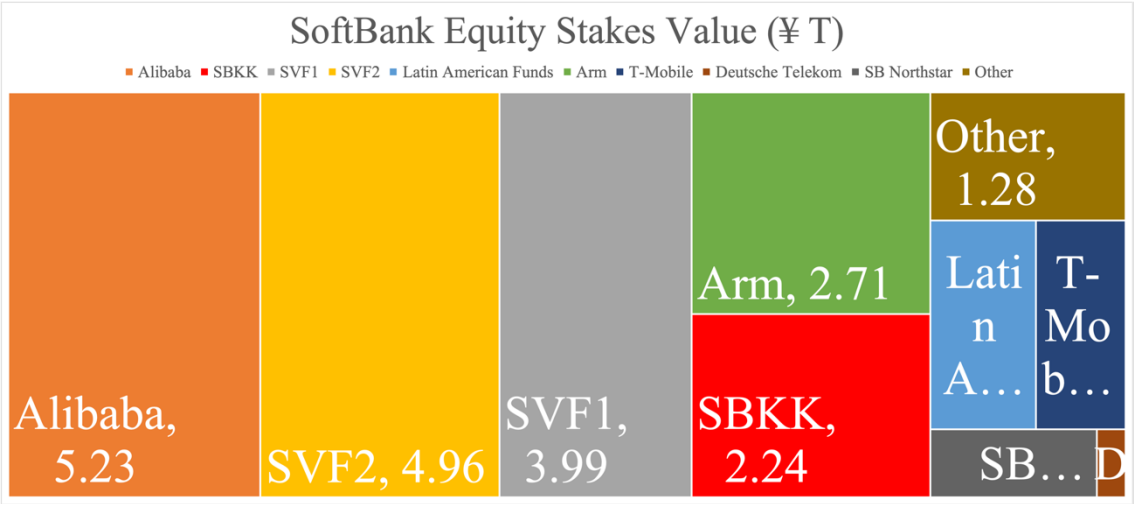

Figure 24: SoftBank Equity Stakes Value (¥T) March 2022. Source: [1]

3.2 Strategic Position. Unique Capabilities and Business Model.

Historically, Intel has been recognized as the leading company in chip making. However, Arm has slowly gained market share by focusing much more on efficiency and portability than on velocity. The niche in which Arm already leads is the mobile processor market, chips for mobile phones, tablets, TVs, laptops or biometric systems.

The critical point to understand is that Arm does not actually manufactures those processors. Arm's business focuses on designing CPU architectures and licensing them to producers (i.e., Apple, Samsung or Qualcomm). This is the reason why the deal behind this project has enormous critics from regulators and NVIDIA's competitors.

To start with, a Central Processing Unit (CPU) follows a number of instructions to run some operation on a group of inputs. Programs are compiled into a set of low-level

instructions (1s and 0s) called assembly language as part of an Instruction Set Architecture (ISA). This is the group of instructions that the CPU can understand and execute (otherwise, high-level instructions may be C++ or Python). Some of the most popular ISAs are MIPS, x86, Arm, PowerPC, and RISC-V. Each ISA has a particular syntax, as well as every programming language [3].

An ISA defines all aspects of a processor work and, therefore, is not a physical component. An ISA describes the characteristics of the instruction the chip can process, the format of both input and output and the chip-RAM interaction. So, can be understood as the set of rules for the CPU to operate. ISAs can be split into two categories: variable-length and fixed-length depending on the predefined number of bits in every instruction.

Every computer chip requires an ISA and that is what Arm, as well as other competitors, provides them with. Although all processors cover three main processes: read and execute instructions, and refresh their status at the end, the ISAs break apart these processes into several smaller operations of 32- or 64-bits long.

The main differentiation among ISAs architectures is Reduced Instruction Set Computing (RISC) and Complex Instruction Set Computing (CISC). Arm's ISA is RISC and this is what makes Arm so attractive for big players in chip makers industry. This RISC architecture means that every order specifies an action the CPU has to perform, whereas a CISC architecture results in a much more complex mechanism. A popular comparison is the following: When building a house, if using a RISC ISA, the CPU has basic hammer and saw, meanwhile when using a CISC system, the CPU dozens of different types of hammers, drills and saws.

CISC	RISC
Push complexity to hardware	Push complexity to software
Many different types and formats for instructions	Instructions follow similar format
Few internal registers	Many internal registers
Complex decoding to break up instruction parts	Complex compiler to write code with granular instructions
Complex forms of memory interaction	Few forms of memory interaction
Instructions take different number of cycles to finish	All instructions finish in one cycle
Difficult to divide and parallelize work	Easy to parallelize work

Table 1: CISC vs. RISC Features Summary. Source: [3]

The point here may be why to choose a RISC ISA, if performance may be lower. The answer is that not only performance is considered. Getting back to the previous

example, the CISC ISA would need to hire many more builders for any operation when building the house (higher cost). Therefore, Arm RISC ISA needs less power, so its differentiating point is efficiency because when talking about mobile phones, the key limitations are heat and power consumption, experts say that this will continue like this until batteries' technology improves. Large computer processor may be much faster that the ones in our mobiles currently. However, mobile phones would get too hot and the battery would last just several minutes. As a summary, in the market it is typical to find CISC-based chips in computers and RISC-based chips in mobile phones. Everything is based on efficiency and Arm is the leader on this area because of its RISC ISA because the architecture can be much simpler. Therefore, Arm chips cannot run as many operations at once as a CISC-based x86 chip, but saves more energy.

The second differentiating feature of Arm chips is its pioneering big-little computing architecture on the same chip. Two alternatives on the same chip: a powerful energy-consuming one and a less powerful energy-saving one. The chip itself analyzes the system utilization to determine which core to run. Arm explains that this innovation can lead to around 75 % savings in power. The Arm not only lowers power consumption as a traditional desktop CPU when load is lower (this makes that some parts never shut off), but completely turn of a core.

As can be extracted, the design of a processor is a trade-off between power and consumption. In 2010, Arm controlled around 95 % of mobile phones processors market thanks to its innovative RISC architecture. Nowadays, this percentage is not that high because some companies saw the opportunity and entered the market, but the dominancy is still clear.

The third great advantage of Arm architecture is related to what is called System on a Chip (SoC) space, typically referred as the next step after CPUs. The trend in the mobile market is towards integrated designs where power requirements and space are more and more strict. The goal of a SoC is improving efficiency by combining several components on a chip (CPU, memory, graphic, power management, etc.). Thus, this is fantastic for mobile phone makers.

Continuing now with Arm's business model, the company leaves aside the construction of chips themselves, since it is a low-margin business that requires huge CAPEX investments and focuses on licensing its Intellectual Property (IP). Clients choose the proprietary Arm's chip-features to implement them into their chips. Some of these clients are Apple, Huawei, Samsung, NVIDIA, Broadcom, AMD or Qualcomm. Not only they use this know-how on mobile phones, but also on computers (i.e. Apple and its M1 macOS or Windows and its Surface Pro X). Also, Arm architecture is now present on IoT gadgets such as Google Home Mini or Amazon Echo [23].

Once the dominancy of Arm has been detailed, it is obvious why NVIDIA competitors need to stop the deal, so the company alone cannot control such a powerful actor in the market.

Arm's market share has turned the company into the key player in growth industries.

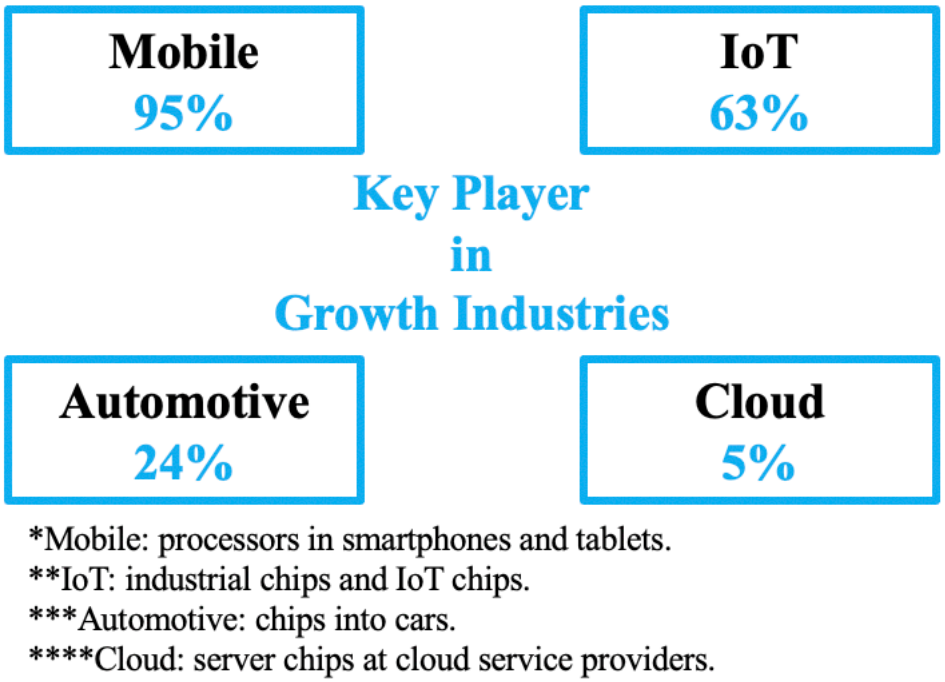

Figure 25: Arm Market Share 2021. Source: [24]

3.3 NVIDIA Offer

Back in September 2020, NVIDIA announced the agreement between the American company and the Japanese SoftBank Group to acquire Arm Limited in a deal valued at $40 billion. NVIDIA explained that the unique capabilities the company would acquire meant the origination of the leading computing company for the incoming age of artificial intelligence.

Going deeper on the deal, NVIDIA would pay $21.5 billion in NVIDIA common stock and $12 billion in cash. From these $12 billion, $2 billion would be payable at signing. To achieve this, NVIDIA would issue 44.3 million shares, based on the average closing price of NVIDIA during the previous 30 trading days.

There existed an earn-out clause that could reach $5 billion in NVIDIA common stock or cash depending on the fulfillment of several goals. Additionally, the American company would issue $1.5 billion in equity to Arm employees.

NVIDIA explained that all cash to be paid would come from the company's balance sheet [5].

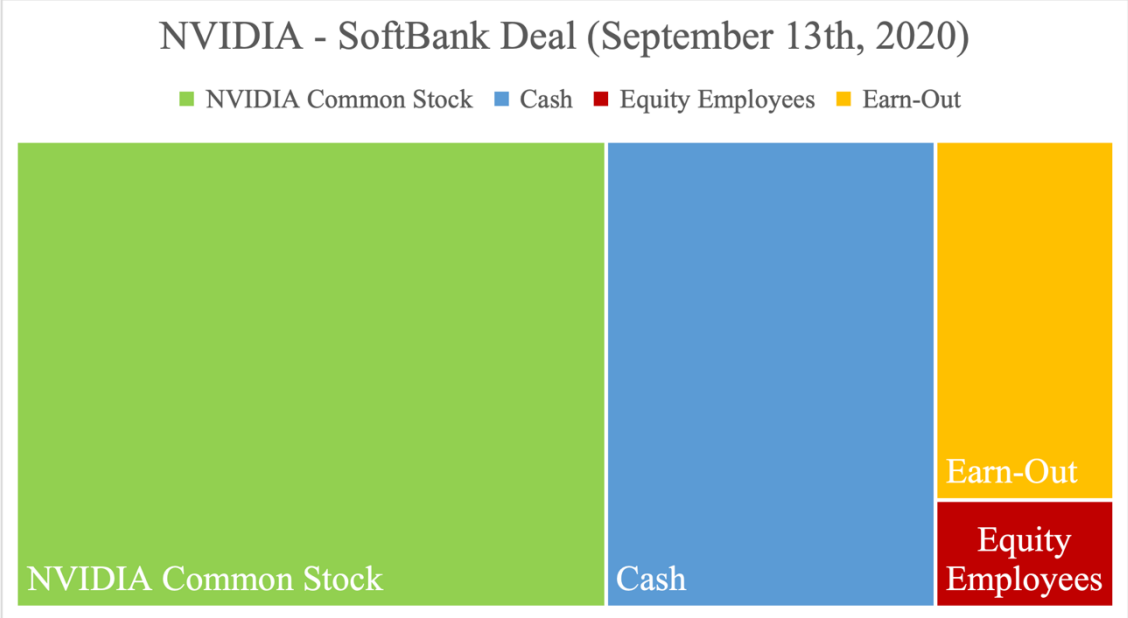

Figure 26: Deal Breakdown [5]

3.4 Arm Valuation

Once the NVIDIA offer has been detailed, a Comparable Company Analysis will be run trying to find what is Arm's equity value since SoftBank announced its plan to take the company public once the deal with NVIDIA is almost dead. This new opportunity will probably not be as profitable as NVIDIA's offer. As it will be explained for NVIDIA, this multiple valuation methodology is based on fundamental multiples of other competitors, it is possible to obtain the relative Enterprise Value of the researched company. Typically, the Enterprise Value obtained from the average of the following three ratios is used: Enterprise Value / Revenue, Enterprise Value / EBITDA and Enterprise Value / EBIT. However, a special ratio will be used this time since it is the typical way to value semiconductor companies with royalty revenue.

The key difference here is that Arm is still a subsidiary of SoftBank Group. The Japanese company is currently considering taking Arm public, so the goal here is to understand how valuable Arm could be if finally going public. This announcement was made in the Fiscal Year Ending Presentation in March 2022. SoftBank prepared an earnings investor briefing in which, among other very interesting points, the company detailed the value of its equity holdings and the calculation methodology.

According to SoftBank, its Arm's stake total equity value in March 2022 is ¥2.71 trillion and its ownership stake is 75.01 %. The stake value before adjustment is ¥3.68 trillion, but there exists some asset-backed finance (¥961.5 billion).

$$SoftBank's\ Arm\ Stake\ Equity\ Value = ¥3.68\ \text{T} * 75.01\ \% - ¥0.96\ \text{T} = ¥2.71\ \text{trillion}$$

As a result, the total equity value to consider in this chapter is the total equity value calculated by SoftBank considering all equity holders less the asset-backed finance:

$$SoftBank's\ Arm\ Stake\ Equity\ Value = \frac{¥3.68\ \text{T}}{0.7501} - ¥0.96\ \text{T} = ¥3.95\ \text{trillion}$$

In June 2022, the USD$ value of this equity value is around $30 billion. However, this is not the value the owners would accept to sell the company because a control

premium is typically paid in M&A deals, if the acquirer, in this case NVIDIA, gains a considerable power.

The Arm segment of SoftBank achieved a huge growth in revenue in 2021, with a YoY 43 % growth in net sales. Softbank splits Arm income into technology royalty revenue and technology non-royalty revenue. The first one increased by 20.1 % because of the strong industry growth and market share gains. The non-royalty one rose by 61 % thanks to the new products coming from significant research and development (R&D) investments for several years.

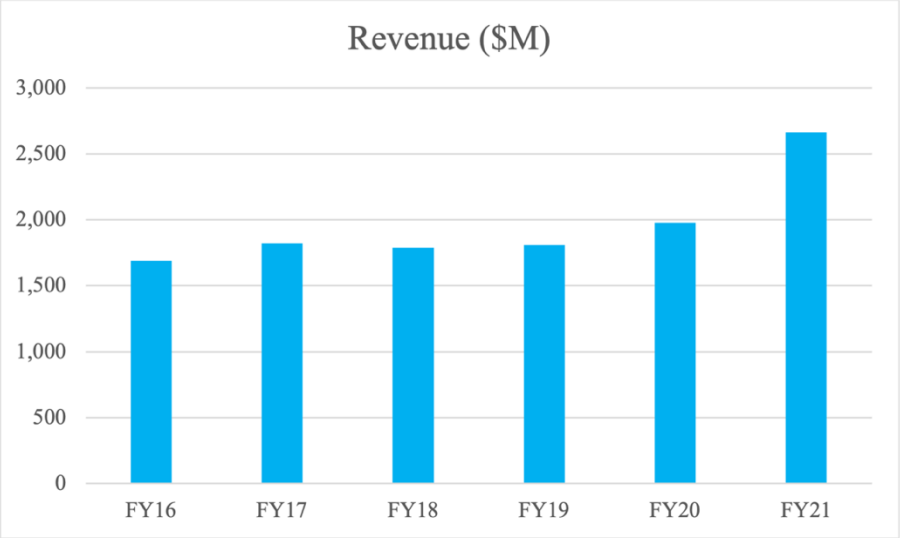

Figure 27: Arm Revenue. Source: [24]

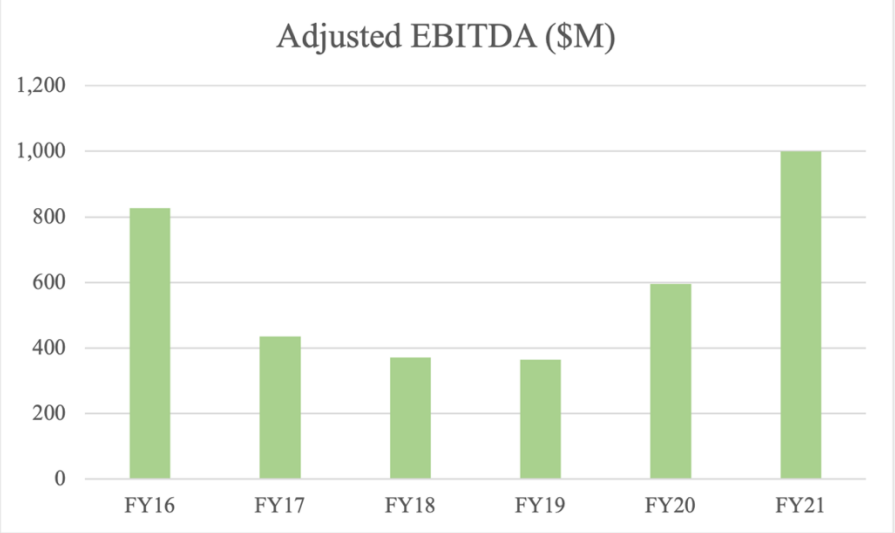

Figure 28: Arm Adjusted EBITDA. Source: [24]

In this Fiscal Year Ending Consolidated Financial Report (March 2022), SoftBank explained that there exists an increase in the number of customers adopting Arm signed licenses for its CPU and GPU intellectual property that these customers will eventually use in end markets such as networking equipment, automotive vision systems, smartphones and servers.

Since Arm obtains much of its revenue from lucrative royalties, this industry has a ratio of 10 to 12 times of average market capitalization to revenue ratio according to the Philadelphia Stock Exchange Semiconductor Index. So, the valuation range would go from $26 to $31 billion if revenue in 2021 is considered [25].

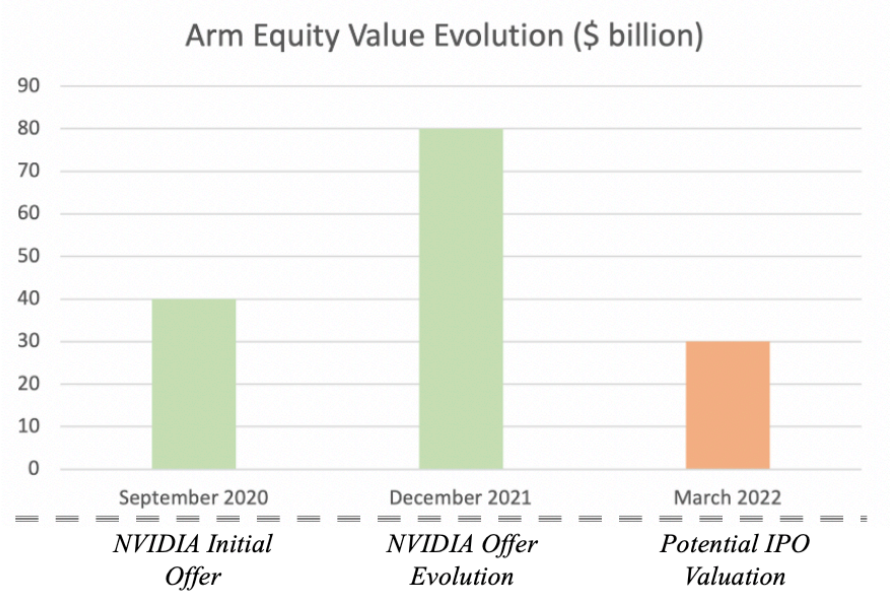

Figure 29: Arm Equity Value Evolution. Source: [26]

As a result, the Arm equity value has suffered great volatility during these first two post-pandemic years. The initial NVIDIA offer was around $40 billion in September 2020 and that deal included a significant NVIDIA's stock component that, as the trading stock value fluctuation changes the amount that SoftBank would receive. Thus, the offer was tied to NVIDIA's stock value.

Figure 30: NVIDIA Stock Price Trend. Source: [2]

During the toughest moments of the global chip shortage (December 2021), NVIDIA's stock price shot up and the Arm valuation reached $80 billion because of the control SoftBank would take of almost 10 % of NVIDIA [26].

3.5 NVIDIA Company Valuation to Discover How Valuable the Offer for Arm is

NVIDIA's offer on the 13th of September of 2020 included $21.5 billion in NVIDIA common stock based on the average closing price of NVIDIA during the previous 30 trading days. The goal of this section is to find out the value of a share of NVIDIA, so the value of the stake SoftBank would receive can be calculated and, therefore, how valuable the offer is in June 2022.

Valuation can be defined as the analytical framework to obtain the worth of a company or an asset. The many different methodologies can be categorized as absolute valuation and relative valuation. On the one hand, absolute valuation focuses on the fundamentals of the entity being analyzed to obtain the value. Some examples of absolute valuation techniques are discounted cash flow, asset-based model, residual income model and dividend discount model. On the other hand, relative valuation compares the company being evaluated to similar ones and relies on the ratios of the comparables to come up with the value. Some examples of relative valuation techniques are price-to-earnings multiples.

Two methodologies will be used to obtain the Enterprise Value that is the core business value to all owners: Discounted Cash Flows and Multiples.

3.5.1 Intrinsic Valuation: Discounted Cash Flow Analysis

This fundamental valuation methodology tries to estimate the current value of a company based on its expected future cash flows.

The Discounted Cash Flow (DCF) methodology is typically said to be the most reliable way to capture the intrinsic value of a company based on taking predictable future cash flows back to the present. Thus, as based on cash flows from operations, it does not consider revenue and non-monetary items. These items are determined by management and quite dependent on their subjective decisions. There are two main alternatives when modeling a DCF and the decision to take is whether the objective is to obtain the Enterprise Value that is the value of the core operations of the company to all stakeholders or the equity value, the value of the whole company to shareholders.

On the one hand, to obtain the Enterprise Value of a company, the capital structure is not directly considered in the cash flows, except to derive the discount rate (weighted-average cost of capital) in which the weights of debt and equity play an important role. The key point here is to use pre-interest lines from the Profit & Loss Statement, this is typically referred as unlevered cash flows. On the other hand, the process to capture the Equity Value is usually referred as Dividend Discount Model (DDM) which focuses on levered cash flows that consider the capital structure of the company that once discounted, represent the equity value of the company. In this second approach, the discount rate used is the cost of equity (one of the inputs of the weighted-average cost of capital) and the cash flows are already free of interests, therefore not considering creditors. This second approach will not be used in this project.

For tax considerations, the tax rate used has been the internationally accepted one: 25 %.

3.5.1.1 Weighted Average Cost of Capital (WACC)

The cost of capital is the opportunity cost for the suppliers of capital, both equity and debt investors, or the return they expect by lending money to a company. So, the investor to be willing to invest in the company, he requires at least that the expected return is equal to the level of risk. Depending on the instrument to raise capital (equity, bond or preferred bonds), the risk and return is different. Particularly, the weighted average cost of capital (WACC) focuses on the marginal cost of capital, or similarly, how costly it is to continue raising funds.

The marginal cost of each instrument is weighted taken into consideration the market value of the current capital structure of the company:

$$WACC = w_E * k_E + w_P * k_P + w_D * k_D * (1 - t)$$

$w_E = market - value\ weight\ of\ equity\ in\ the\ capital\ structure$
$k_E = marginal\ cost\ of\ equity$
$w_P = market - value\ weight\ of\ preferred\ shares\ in\ the\ capital\ structure$
$k_P = marginal\ cost\ of\ preferred\ shares$
$w_D = market - value\ weight\ of\ debt\ in\ the\ capital\ structure$
$k_D = before\ tax\ marginal\ cost\ of\ debt$
$t = company's\ marginal\ tax\ rate$

NVIDIA is a company with a very particular capital structure. The company does not issue preferred shares, something that is usual, but what is more unusual, the heavy equity-orientation the company has.

On the 1st of June of 2022, the day when this methodology was recalculated to consider the effects of the Russia-Ukraine war on this American company, the equity weight on the capital structure was $464,416.9M (97.5 %), short-term debt weight was $147 M (0.0 %) and long-term debt $11,699 M (2.5 %).

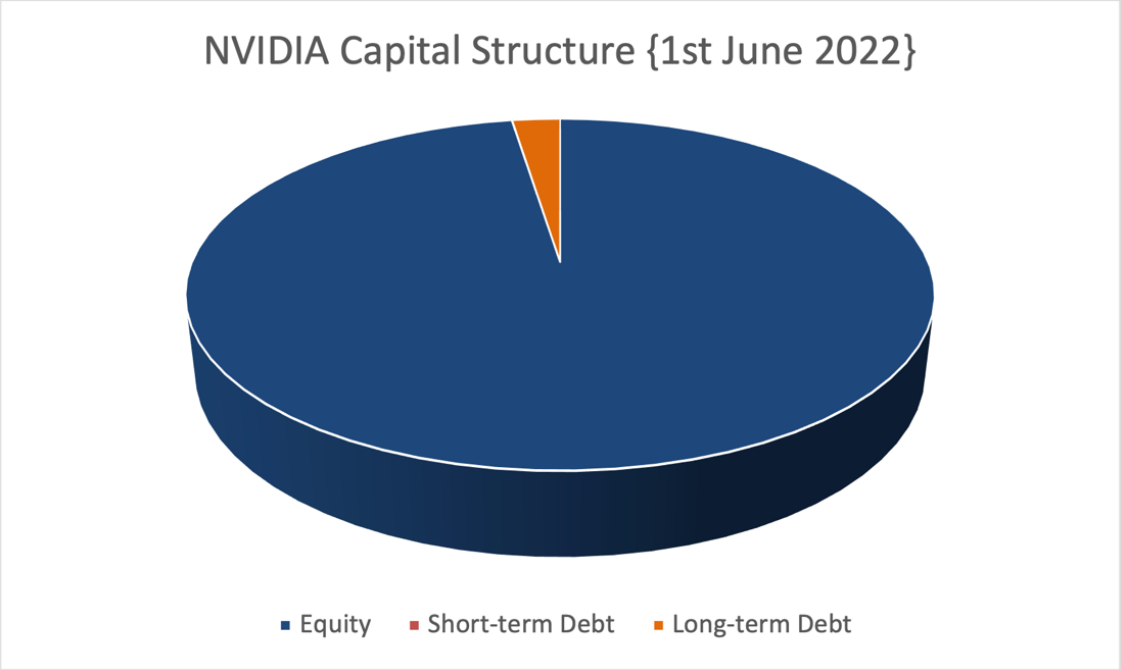

Figure 31: NVIDIA Capital Structure. Source: [2]

As mentioned before, looking at the company's capital structure, NVIDIA is a tremendously low levered company since the company prefers equity to raise capital. The interesting point here is that the marginal cost of debt to enter into the WACC is the cost of debt after considering the tax shield debt provides with because in the calculation, the allowable deduction for interest on debt reduces the value and it depends on the country's tax law. Apparently, the company could reduce its WACC by issuing new debt.

Following Bloomberg's methodology to obtain the cost of debt (k_D):

$$k_D = (Note\ Rate * ST\ to\ Total\ Debt + Bond\ Rate * LT\ to\ Total\ Debt) * Debt\ Adjustment\ Factor * (1 - Effective\ Tax\ Rate)$$
$$= (0.012\ \% * 2.58\ \% + 0.988\ \% * 2.86\ \%) * 1.29 * (1 - 0.25)$$
$$= 3.59\ \%$$

**Note Rate = based on a very recent issue of a note*

**Bond Rate = based on a very recent issue of bond*

The calculation of the cost of equity is based on the Capital Asset Pricing Model (CAPM). This methodology affirms that the expected return of a stock ($E(R_i)$) is the

addition of the risk-free rate (RFR) and the premium from the market risk considering the relation the stock has with the market, Beta (β):

$$E(R_i) = RFR + \beta * (E(R_m) - RFR) = 2.87\ \% + 1.6 * (9.76 - 2.87) = 13.88\ \%$$

So, once the cost of debt and equity are calculated, the WACC for NVIDIA on the 1st of June of 2022 is the following:

$$WACC = w_E * k_E + w_D * k_D * (1 - t) = 13.6\ \%$$

3.5.1.2 Growth Rate and Perpetual Growth Rate.

NVIDIA is a top company in the Nasdaq, so expected high range of growth diminishing until terminal growth rate at the end of the forecasted period.

The methodology used is the following: Bloomberg offers a consensus estimate of revenue for two year-time. Therefore, taking the next year forecasted revenue over the current year, it is possible to obtain the expected growth rate for 2023. Once this is done, this rate decreases along the forecasting period until it arrives to the terminal growth rate.

Perpetual Growth Rate: Accepted average annual growth rate in developed countries' GDP. It is set at 3 %.

3.5.1.3 Projections

a) Selling, General and Administration (SG&A)

The growth is in line with revenue growth.

b) Research and Development (R&D)

The average of previous years is about the same % of revenue. So, it is set at 19,6 % of Revenue. This number is quite high, but considering the fast development of the industry in which NVIDIA competes may be reasonable.

c) Other Operating Expense

This number has been growing along time and results in a positive outcome for the company. The average since 2016 is chosen as a percentage of revenue.

d) Depreciation and Amortization (D&A)

The method chosen is the average percentage over revenue since 2016.

e) Capital Expenditures (CAPEX)

Same methodology than D&A.

f) Working Capital (WK)

Summary of the historical working capital until the 30th of January of 2022.

In Millions of USD	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Average	Years
12 Months Ending	01/31/2016	01/29/2017	01/28/2018	01/27/2019	01/26/2020	01/31/2021	01/30/2022		
Current Operating Assets									
Accounts & Notes Receiv	505.00	826	1,265.00	1,424.00	1,657.00	2,429.00	4,650.00		
%Revenue	10.1%	12.0%	13.0%	12.2%	15.2%	14.6%	17.3%	**13.5%**	16-22
Inventories	418.00	794	796	1,575.00	979	1,826.00	2,605.00		
%COGS	19.2%	28.0%	20.5%	34.9%	23.7%	31.4%	28.7%	**26.6%**	16-22
Other ST Assets	93.00	118	86	136	157	239	366		
%Revenue	1.9%	1.7%	0.9%	1.2%	1.4%	1.4%	1.4%	**1.4%**	16-22
Current Operating Liabilities									
Payables & Accruals	298.00	489	629.00	602.00	748.00	1,262.00	4,335.00		
%COGS	13.7%	17.2%	16.2%	13.3%	18.1%	21.7%	47.7%	**34.7%**	21-22
Other ST Liabilities	636.00	499	509	727.00	945	1,543.00	0.00		
%Operating Expenses	34.1%	23.5%	19.6%	21.7%	24.3%	28.3%	0.0%	**21.6%**	16-22

Table 2: Operating WK Average Last Years

In Millions of USD	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Average	Years
Operating WK	82.00	750.00	1009.00	1806.00	1100.00	1689.00	3286.00		
%Revenue	1.6%	10.9%	10.4%	15.4%	10.1%	10.1%	12.2%	**10.1%**	16-22

Table 3: Operating WK Direct Average Last Years

This second alternative included in Table 2 was at first considered, but once each individual operating number was obtained it was discarded.

3.5.1.4 DCF

DISCOUNTED CASH FLOW - NVIDIA

Tax Rate		25%											
Perpetual Growth Rate		3%	Growth		28%	25%	22%	20%	16%	12%	9%	7%	5%	3%
Discount Rate (WACC)		13.60%												
EV/EBITDA MULTIPLE (Comparables)		18.32		FY 01/30/2022	FY 01/30/2023	FY 01/30/2024	FY 01/30/2025	FY 01/30/2026	FY 01/30/2027	FY 01/30/2028	FY 01/30/2029	FY 01/30/2030	FY 01/30/2031	FY 01/30/2032
Current NVIDIA EV/EBITDA		33.57		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
				$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS	$ MILLIONS
		Revenue		26,914.00	34,364.30	40,056.40	48,868.81	58,642.57	68,025.38	76,188.43	83,045.38	88,858.56	93,301.49	96,100.53
		COGS	-	9,086.00	- 11,259.73	- 12,909.34	- 15,583.79	- 18,580.73	- 21,507.17	- 24,088.03	- 26,255.95	- 28,093.87	- 29,498.56	- 30,383.52
		Gross Profit		17,828.00	23,104.57	27,147.06	33,285.02	40,061.84	46,518.21	52,100.40	56,789.43	60,764.69	63,802.93	65,717.01
		Gross Margin		*66.2%*	*67.2%*	*67.8%*	*68.1%*	*68.3%*	*68.4%*	*68.4%*	*68.4%*	*68.4%*	*68.4%*	*68.4%*
		SG&A	-	2,016.00	- 2,448.88	- 2,715.69	- 3,152.02	- 3,598.48	- 3,971.23	- 4,231.47	- 4,388.00	- 4,466.82	- 4,462.07	- 4,372.42
		Research & Development	-	5,265.00	- 6,722.45	- 7,835.96	- 9,559.87	- 11,471.84	- 13,307.34	- 14,904.22	- 16,245.60	- 17,382.79	- 18,251.93	- 18,799.48
		Other Operating Expense		140.00	229.18	267.14	325.91	391.09	453.67	508.11	553.84	592.61	622.24	640.90
		EBIT		10,687.00	14,162.42	16,862.55	20,899.04	25,382.62	29,693.31	33,472.82	36,709.68	39,507.69	41,711.17	43,186.02
		Operating Margin		*39.7%*	*41.2%*	*42.1%*	*42.8%*	*43.3%*	*43.7%*	*43.9%*	*44.2%*	*44.5%*	*44.7%*	*44.9%*
		Less tax payment	-	2,671.75	- 3,540.60	- 4,215.64	- 5,224.76	- 6,345.65	- 7,423.33	- 8,368.20	- 9,177.42	- 9,876.92	- 10,427.79	- 10,796.50
		NOPAT		8,015.25	10,621.81	12,646.91	15,674.28	19,036.96	22,269.99	25,104.61	27,532.26	29,630.77	31,283.38	32,389.51
		Plus Dep&Amort		1,174.00	1,378.86	1,607.25	1,960.85	2,353.02	2,729.50	3,057.04	3,332.18	3,565.43	3,743.70	3,856.01
		NOPAT+D&A		9,189.25	12,000.67	14,254.17	17,635.13	21,389.98	24,999.49	28,161.65	30,864.43	33,196.20	35,027.08	36,245.52
		Capex	-	976.00	- 1,658.59	- 1,933.32	- 2,358.65	- 2,830.37	- 3,283.23	- 3,677.22	- 4,008.17	- 4,288.74	- 4,503.18	- 4,638.28
TV Gordon	239,570.44	Increase in Operating NWC		1,597.00	- 1,023.49	2,684.75	3,323.67	4,037.91	4,731.68	5,346.30	5,876.01	6,336.75	6,702.96	6,952.42
TV Exit Multiple	861,673.68	Unleverage FCF		6,616.25	11,365.58	9,636.10	11,952.81	14,521.70	16,984.57	19,138.14	20,980.25	22,570.70	23,820.94	24,654.82

Table 4: NVIDIA DCF

3.5.1.5 Entreprise Value

a) Exit Multiple: Sensitivity Analysis

Sensitivity Analysis Terminal Value Enterprise Value				
Terminal Value		823,235.49	861,673.68	940,840.56
Enterprise Value		EV/EBITDA		
		17.50	18.32	20.00
Discount Rate	12.00%	355,094.11	367,470.18	392,959.80
	13.60%	313,414.70	324,154.10	346,272.83
	14.00%	303,925.76	314,294.23	335,649.00

Table 5: Enterprise Value Sensitivity Analysis – Terminal Value through Exit Multiple

b) Terminal Growth Rate: Sensitivity Analysis

Sensitivity Analysis Terminal Value Perpetual Growth				
Enterprise Value		Perpetual Growth		
		2.50%	3%	3.50%
Discount Rate	12.00%	175,683.24	180,882.53	186,693.49
	13.60%	147,016.98	150,342.34	153,996.94
	14.00%	141,139.16	144,135.82	147,417.87

Table 6: Enterprise Value Sensitivity Analysis – Terminal Value through Terminal Growth

3.5.1.6 Terminal Value

a) Terminal Growth Model

This model is used to calculate the value remaining after the period considered in the discounted cash flow based on a constant growth rate at which the company is expected to grow indefinitely. This is why it is called terminal growth.

This terminal value is calculated in the following way:

$$Terminal\ Value = \frac{Unl.FCF_n(1 + g_T)}{WACC - g_T}$$

g_T (Terminal growth rate): assumed to be 3 % according to the average growth rate of developed countries' GDP.

b) Exit Multiple

Although the Discounted Cash Flow methodology was said to obtain an intrinsic value of the company analyzed, by using an exit multiple to obtain a terminal value, there exists a component of relative valuation in the analysis.

The multiple used corresponds to the current EV/EBITDA of the comparables and that is the one used in the Multiples Framework coming next.

There exists an argument here because the EV/EBITDA multiple of NVIDIA should decrease in some point, so using the current one in the industry seems to optimistic. The reason why the one used is that is because nowadays the NVIDIA multiple is far higher than the rest of competitors in the industry (EV/EBITDA: 53) as can be extracted from the Appendixes [Appendix II, III, IV]. Therefore, although the multiple is expected to decrease as the company matures (2032), a good proxy may be the current EV/EBITDA in the industry.

3.5.2 Relative Valuation: Comparable Companies Analysis

Another popular methodology is Comparable Company Analysis, through which based on fundamental multiples of other competitors, it is possible to obtain the relative Enterprise Value of the researched company. Typically, the Enterprise Value obtained from the average of the following three ratios is used: Enterprise Value / Revenue, Enterprise Value / EBITDA and Enterprise Value / EBIT.

To run this methodology, the process is as follows:

- Select the right set of comparable companies: Typically, start with a broad set of companies and then narrow it based on industry, size and geography. Around 5-10 companies is a good target.
- Determine the metrics and multiples you want to use: Since the analysis' goal is to obtain NVIDIA's Enterprise Value, all ratios will be pre-interest (i.e., EV / Revenue, EV / EBITDA and EV / EBIT), so using unlevered cash flows to consider not just the value of the company to equity holders, but to creditors too.
- Calculate the metrics and multiples for all the companies.
- Apply the median (or 25th or 75th percentile, or other) multiples to get rid of outliers.

3.5.2.1 Comparable Competitors

Instead of following the previous process to find comparables, the selection of these companies is carried out in an indirect way, so taking advantage of the magnificent Peer Barometer tool Bloomberg created some years ago. This tool creates a customized list of peers for the chosen company and can even compare companies' performance in the same industry [27].

The companies selected are the following:

- Advanced Micro Devices (AMD): This American company produces and sells semiconductor products and devices, and is particularly interesting because AMD announced in February 2022 that it has completed the acquisition of

Xilinx. AMD's catalogue includes microprocessors, embedded microprocessors, graphics, chipsets and multimedia products and supplies it to third-party foundries, as well as provides testing, assembling, and packaging services. AMD, as well as NVIDIA, serves customers worldwide [2].

- Synaptics: This American company makes custom-designed user interface solutions such as touch-sensitive pad for cursor movement or screen navigation. Its main clients are makers of mobile phones, handheld computers and notebooks. Around 95 % of its sales are in Asia. In mid-2020, Synaptics completed the acquisition of DisplayLink Corporation [2].

- Intel: This American company is focused on computer components. The Company major products include microprocessors, graphic, chipsets, embedded processors and microcontrollers, flash memory, network and digital imaging products. The distribution of sales worldwide is very homogeneous [2].

- Broadcom: This American company main products are controllers, storage adapters, wireless RF components, switches, motion control encoders, networking processors, fiber optic modules, and optical sensors. So, the Broadcom designs, develops, and sells digital and analog semiconductors worldwide [2].

- Qualcomm: This American company operates as a multinational semiconductor and telecommunications equipment company. The Company develops and delivers digital wireless communications products and services based on CDMA digital technology. Qualcomm serves customers worldwide. In 2021, Qualcomm announced the acquisition of Nuvia [2].

- Lattice Semiconductor: This American company focuses on semiconductors and, particularly, video connectivity application specific standard products, programmable logic devices and millimeter wave devices. Lattice

Semiconductor operates worldwide and designs, develops, and sells these logic devices [2].

- Texas Instrument: This American company designs and manufactures analog ICs and embedded processors. Texas Instruments serves customers worldwide. In 2021, Texas Instrument announced the acquisition of Micron Technology's 300-mm semiconductor facilities [2].

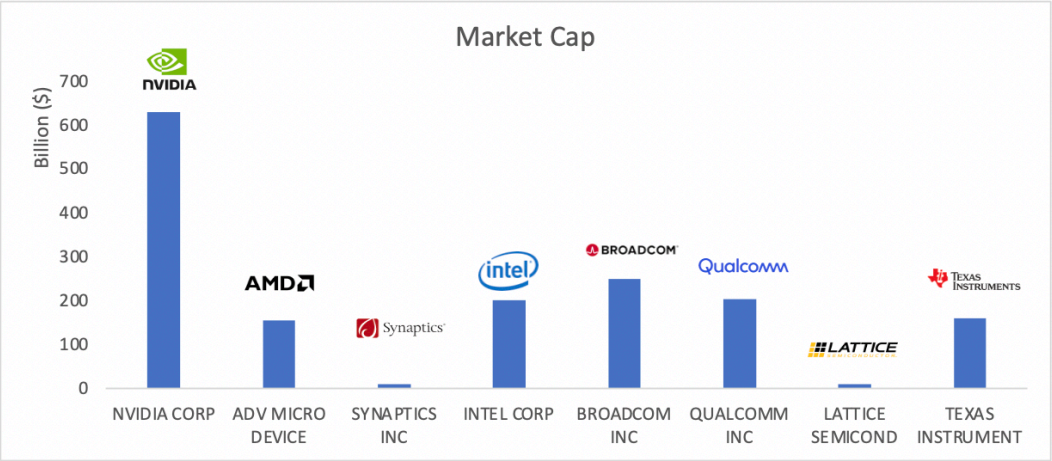

Figure 32: Market Capitalization of NVIDIA and Competitors{23rd February 2022}. Source: [2]

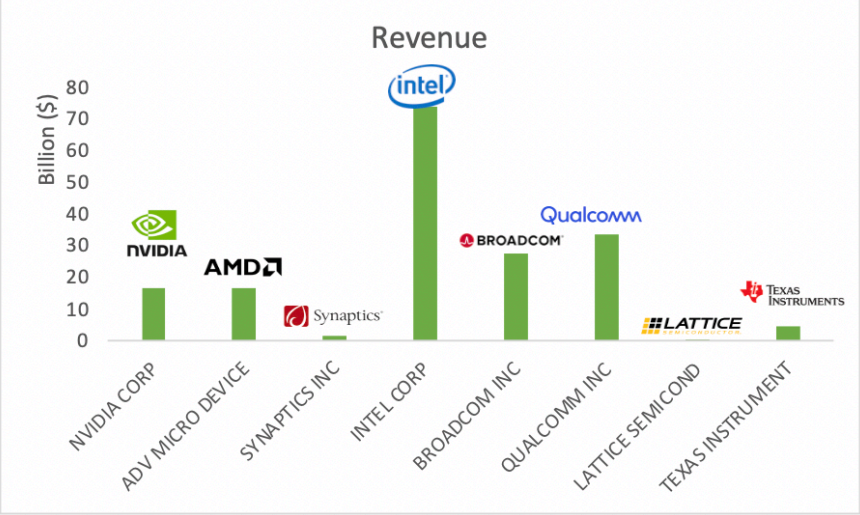

Figure 33: Revenue of NVIDIA and Competitors Year 2021. Source: [2]

3.5.2.2 Comparables Key Data

Company	Ticker	Market	Price ($) {6/10}	LTM EV ($M)	LTM Revenue ($M)	LTM EBITDA ($M)	LTM EBIT ($M)
Advanced Micro Devices	AMD	NASDAQ	98.8	155,731.0	18,876.0	5,038.0	4,117.0
Synaptics	SYNA	NASDAQ	140.01	5,836.5	1,591.1	550.0	397.2
Intel	INTC	NASDAQ	40.01	156,115.9	74,505.0	29,228.0	16,990.0
Broadcom	AVGO	NASDAQ	556.22	258,809.5	29,994.0	16,952.0	11,397.0
Qualcomm	QCOM	NASDAQ	136.71	157,249.2	39,265.0	14,680.0	13,015.0
Lattice Semiconductor	LSCC	NASDAQ	49.88	6,918.3	550.1	152.6	120.9
Microchip Technology	MCHP	NASDAQ	66.63	44,477.1	6,820.9	3,036.0	1,892.5
Texas Instruments	TXN	NASDAQ	161.58	146,915.4	18,960.0	10,718.0	9,791.0

Table 7: Comparables Data. Source: [2]

Company	Ticker	Market	Price ($) {6/10}	LTM Revenue ($M)	LTM EBITDA ($M)	LTM EBIT ($M)
Nvidia	NVDA	NASDAQ	180.48	29,541.0	13,187.0	11,787.0

Table 8: NVIDIA Data. Source: [2]

3.5.2.3 Comparables Results

Company	Ticker	EV/Rev	EV/EBITDA	EV/EBIT
Advanced Micro Devices	AMD	8.25	30.91	37.83
Synaptics	SYNA	3.67	10.61	14.69
Intel	INTC	2.10	5.34	9.19
Broadcom	AVGO	8.63	15.27	22.71
Qualcomm	QCOM	4.00	10.71	12.08
Lattice Semiconductor	LSCC	12.58	45.34	57.22
Microchip Technology	MCHP	6.52	14.65	23.50
Texas Instruments	TXN	7.75	13.71	15.01

Table 9: Comparables Ratios

	EV/Rev	EV/EBITDA	EV/EBIT
Average	6.69	18.32	24.03

Table 10: Comparables Average Ratios

	EV {EV/Rev} ($M)	EV {EV/EBITDA} ($M)	EV {EV/EBIT} ($M)
Nvidia	197,530.26	241,547.64	283,227.01

Table 11: NVIDIA EV Based on Comparables Average Ratios

	Average EV ($M)
Nvidia	240,768.30

Table 12: NVIDIA Resulting EV

3.5.3 Football Field Chart

Football fields typically show ranges for each methodology. In this case, the decision was to run each of them to obtain a particular result for enterprise value.

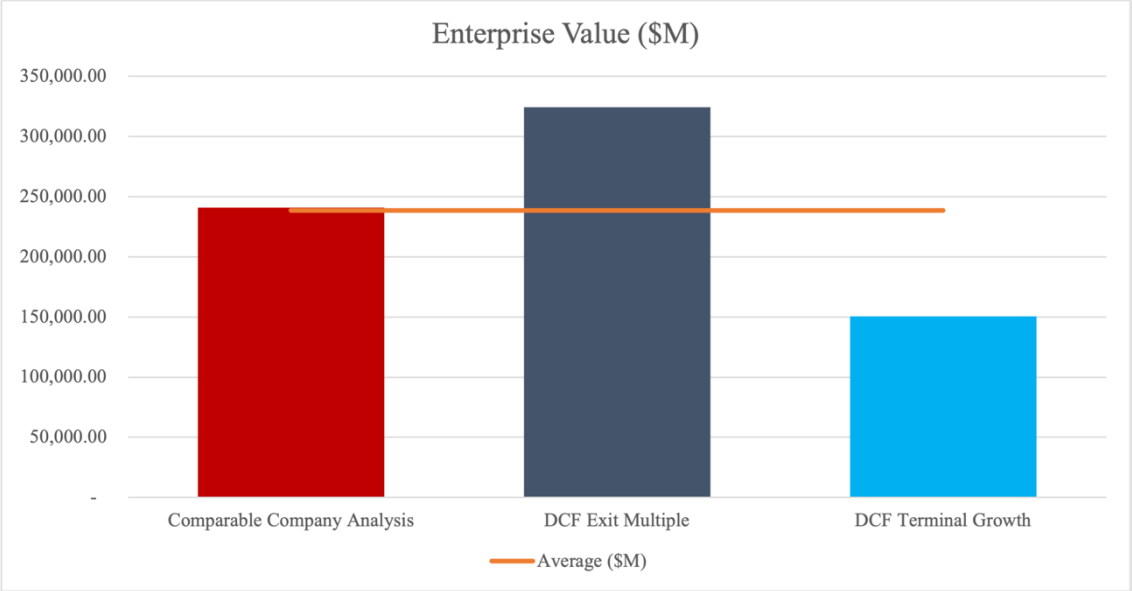

Table 13: NVIDIA Enterprise Value Football Field

The average Enterprise Value of the three methods is $238.4 billion.

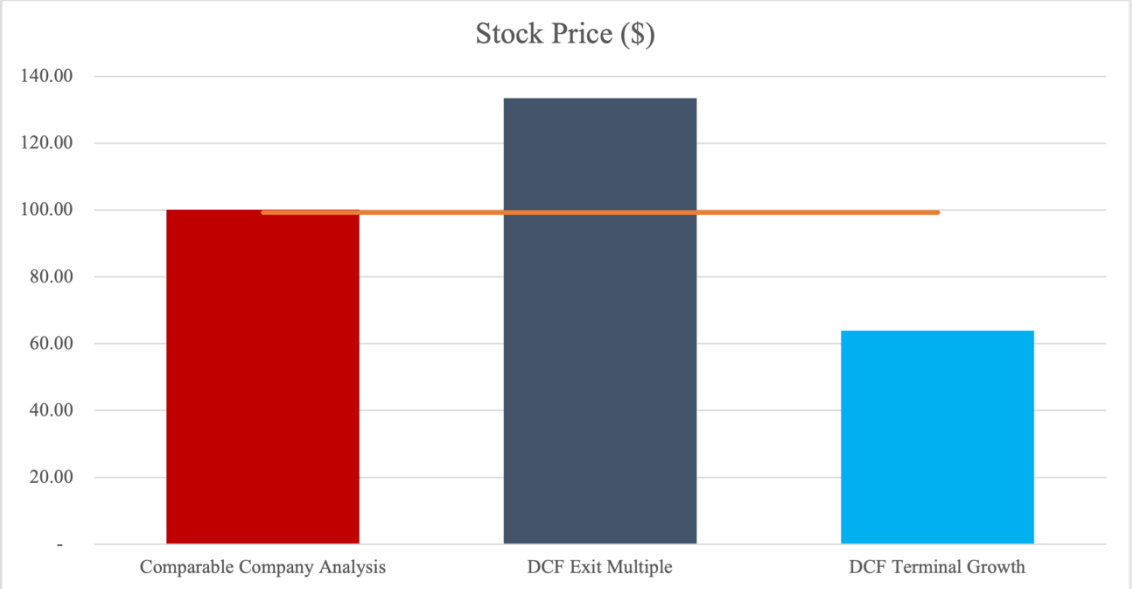

Table 14: NVIDIA Stock Price

The average Stock Price of the three methods is $99.18, $81.30 less than the current NVIDIA's stock price ($180.48) on the 1st of June of 2022. This means an upside potential of negative 45 %.

Going back to the deal, NVIDIA's offer on the 13th of September of 2020 included $21.5 billion in NVIDIA common stock based on the average closing price of NVIDIA during the previous 30 trading days. The first date of that period was the 31st of July and the last one the 11th of September. The average price in those 30 days was $121.67, so the $21.5 billion over the price agreed means 176.7 M shares [2].

If those shares are valued at the prices obtained during the valuation of NVIDIA, the result is the following:

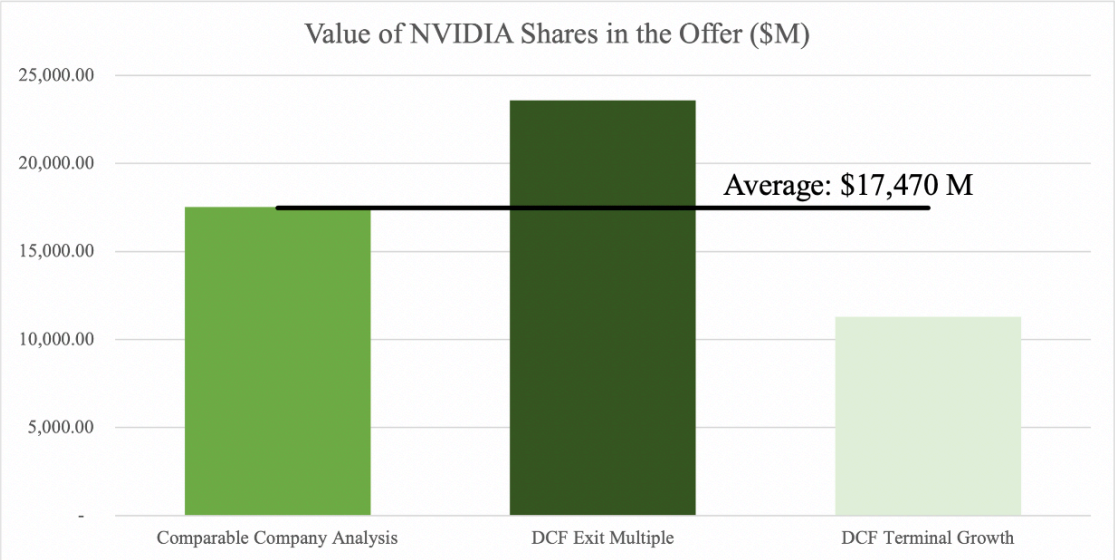

Figure 34: Average Value of the NVIDIA Stake Included in the Arm Offer

Updating the chart shown during the analysis of the offer, the total payment would be the lowest during the whole period (if the deal was still alive).

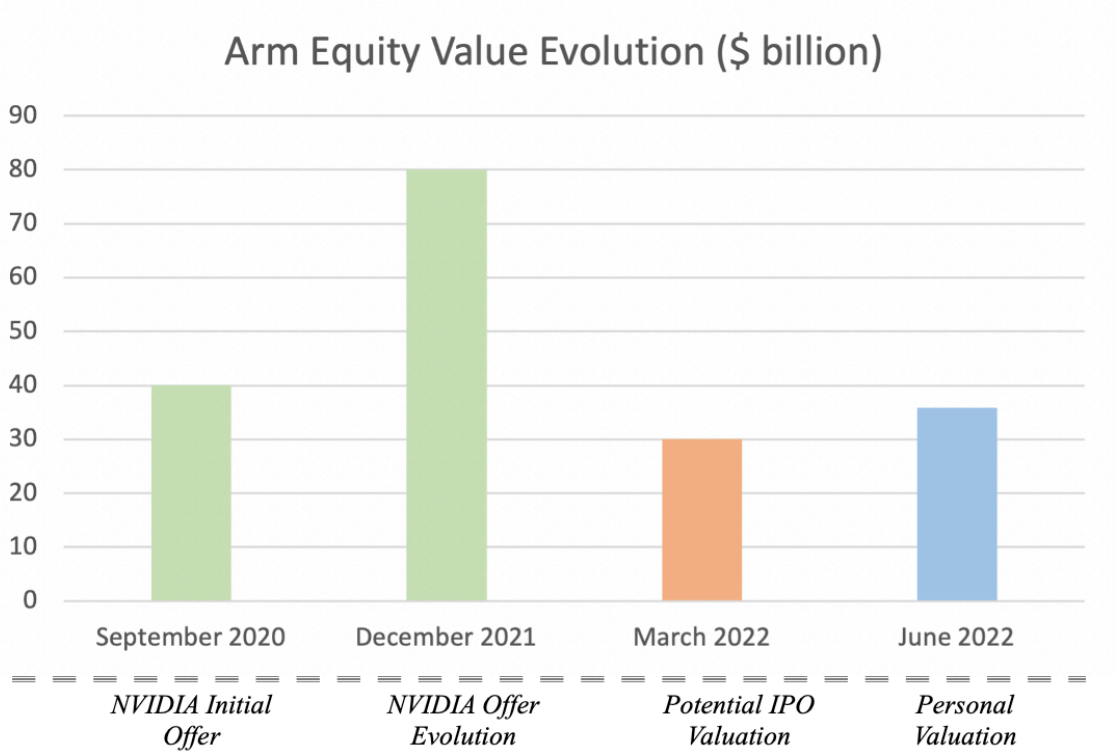

Figure 35: Arm Equity Value Evolution Including Personal Valuation

4 Deal

4.1 Economic Value Added if the Deal Takes Place

The idea behind the deal according to the press release NVIDIA shared on the 13th of September of 2020 was to put together the Arm's immense computing ecosystem with the American company's leadership in artificial intelligence to become the entity who lead innovation for customers in very diverse industries. To achieve this, NVIDIA would create new facilities to enhance research and development in the Arm's headquarters in Cambridge (United Kingdom). The focus of this new center would be artificial intelligence and the building of a supercomputer to lead research. According to NVIDIA, this is great for customers and the industry too. The main areas for research would be life sciences, robotics, healthcare and self-driving automotive. NVIDIA would maintain the Arm's name and brand identity, as well as the Arm's intellectual property registration in the United Kingdom [5].

Many companies argued that the Arm's open-license business model was at risk since NVIDIA could change this model to find a most profitable business. However, the American company tried to calm those Arm's customers by ensuring the open-licensing model and the neutral customer treatment were ensured. Furthermore, NVIDIA would promote the expansion of Arm's licensing business with NVIDIA technology and leading graphics processing units (GPUs). An important point for the deal success was the commitment SoftBank showed by accepting a 10 % stake in NVIDIA as well as an earn-out payment that will align interest between both parties involved.

Jensen Huang, founder and CEO of NVIDIA, explained that artificial intelligence is the most powerful technology nowadays and has made possible a new era of computing that will make possible the internet-of-things (IoT) era where NVIDIA would lead. In this sense, NVIDIA could move from the era of smartphones, personal computers, the cloud, self-driving cars and robots to the expansion of IoT to any place of the world.

SoftBank Group also explained that NVIDIA was the adequate partner for its subsidiary Arm, as its founder, Masayoshi Son, explained. He affirmed that this deal would continue the path of growth and innovation Arm followed since SoftBank acquired

it, so Arm would expand its business to new areas where a strong world leader as NVIDIA could accelerate the process. The great NVIDIA stake SoftBank would acquire makes SoftBank a key stakeholder that needs to promote the wellbeing of the combined business. The Arm's CEO, Simon Segars, announced his excitement about joining NVIDIA to write the chapter in hardware and software innovation with a partner such as NVIDIA.

In short, the three parties involved ensure the commitment with the open-licensing model as well as maintaining the customer neutrality that made possible the sale of 180 billion chips until September 2020.

On the 12th of May, SoftBank's Financial Report, the Japanese company explains how Arm has invested during the year and what the main developments are during the fiscal year 2021 ending March 31st.

On the Mobile Computing segment, Arm controls around 95 % of the market, so almost every mobile worldwide works thanks to an Arm chip. Furthermore, Arm has achieved to progressively increase the royalties charged per chip. Three new processors were launched: Cortex-A510, Cortex-A710 and Cortex-X2 (based on Armv9), and three new graphics processors: Mali-G310, Mali-G510 and Mali-G710. These six new processors are designed for the mobile industry. Samsung Electronics, Qualcomm Technologies and Mediatek announced the creation of their first chips based on Arm's Armv9 architecture. During the fourth quarter, Lenovo Group announced the launch of the first laptop based on an Arm chip developed by Qualcomm Technologies.

On the Infrastructure segment, the market share continues growing and there exists a starting position in data center servers. The supercomputer developed by Fujitsu Limited and Riken based on Arm technology for servers continue being considered the fastest supercomputer worldwide. Oracle Corporation launched its own Cloud Infrastructure based on Arm servers. Marvell Technology and NVIDIA, both announced their new 5G infrastructure based on Arm chips. Cloudfare launched a blueprint for a zero-emission internet with Arm technology. Amazon and Alibaba presented their state-of-the-art chips for data centers with Armv9 technology.

On the Automotive segment, the company expects to keep growing as vehicles keep progressing towards smart cars. Arm position will allow to gain market share since

several companies have already been licensed to develop their own chips. For instance, there exists a collaboration between Arm and NXP Semiconductors, Denso Corporation and Audi AG to set the standards for self-driving cars. Arm launched a new platform that will make possible to develop software-defined cars. Intel, through its subsidiary Mobileye Technologies announced a license to implement the Mali-G78AE and Maki-C78AE for EyeQ technology.

On the IoT segment, Arm continues improving the safety of its technology to manage data in IoT networks with measures such as more code-sharing and code-reuse for developers to reduce time for software to advance, initiatives to allow software development in parallel to chip-designing [24].

The semiconductor industry will deeply affect Arm's performance deeply since the correlation the British company has with the trends existing in this industry is total. Semiconductors have benefit from more and more products depending on these materials (i.e., cars offering more information to the driver, smartphones improving cameras, etc.). Particularly, the 5G market has grown a lot in fiscal year 2021, something that has been very positive for Arm since the company's exposure in this segment is the greatest and technology royalty revenue is very profitable. This industry growth has made possible that Arm's clients to accelerate the designing and innovating in their particular industries what means more Arm licenses to equip the new products.

However, being so dependent on the industry is not always positive. Trade disputes during the pre-pandemic years affected the industry due to the trade war between China and the USA. Sanctions against particular firms would also affect Arm since the number of licenses would decrease and considering how vertical this industry is, there could exist a shock for smartphone and automotive manufacturers.

4.2 Social and Environmental

On December 31st 2020, just three months after the announcement of the deal, Arm made a press release where the British company affirmed it would achieve net-zero carbon emissions even before the target set during the Paris Climate Agreement. Arm would achieve this target 20 years before the target, in 2030. This United Nations' agreement will reduce global temperature, at least to 1.5 degree Celsius over pre-industrial temperature. This is related to United Nations' Sustainable Development Goal Number 13: Climate Action, which focuses on taking urgent action to combat climate change and its impacts.

Figure 36: Sustainable Development Goal Number 13: Climate Action

The main policy is to reduce the level of carbon in the atmosphere since the increasing levels after the industrial revolution trap more and more heat. Arm will contribute to this goal by cutting total emissions coming from its activities by 42 %, by always selecting low-carbon activities.

According to Arm's statistics, 70 % of global population daily uses Arm technology. Although Arm does not directly manufacture chips, more than a thousand partners worldwide based their technology on Arm's intellectual property. Therefore, any advance on efficiency on Arm architecture would have a tremendous impact in multiple industries around the world [28].

According to the World Economic Forum, digital solutions could bring emissions down by 15 % by 2030. In this sense, the digital technology and cloud services growth

need to be balanced with greater efficiency on all terminals, maximizing performance in low-power processing. To achieve this, Arm will increase new chip performance around 30 % with no extra energy use. This would reduce the energy sector contribution to global CO_2 emissions that account for around 76 % of total CO_2 emissions.

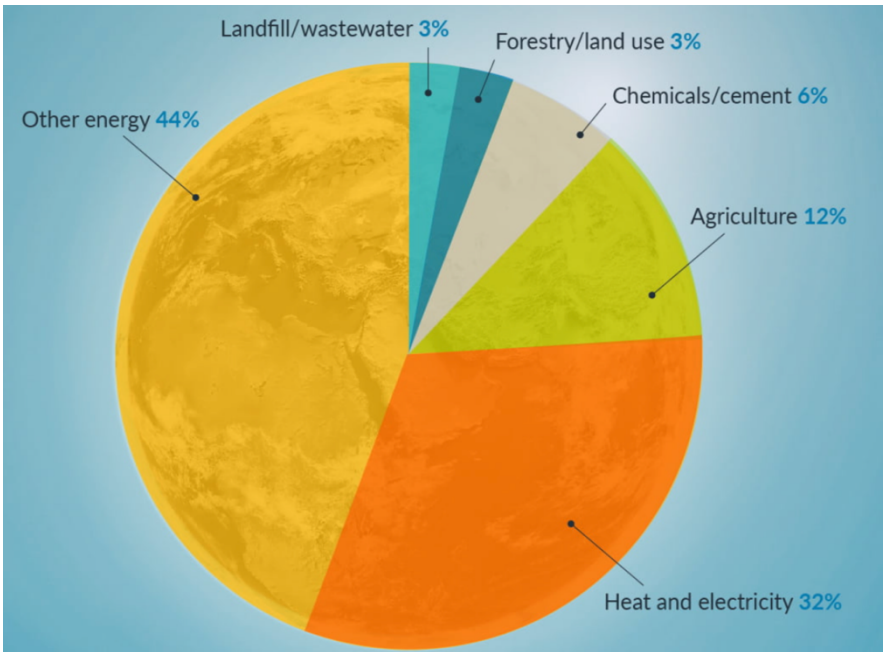

Figure 37: CO2 Emissions per Sector in 2021. Source:[28]

To mention some of the already implemented Arm high-efficiency solutions:

- In Datacenter industry, NVIDIA developed the Bluefield-3, a data processing unit (DPU) containing 16 Arm chips that lower power consumption.
- In Housing industry, there exist companies such as Johnson Controls using Arm chips in their state-of-the-art net zero building.
- In Utilities, the company Korea Electric Power (KEPCO) uses Arm chips to manage energy consumption with their smart meters.
- In Transportation, some innovation based on flexible Arm chips will make possible to set processors in every battery cell of an electric vehicle [24].

4.3 Controversy and Parties Blocking the Acquisition

Since the announcement of the deal, some regulators began an investigation to find out whether Arm would raise prices or decrease the quality of its licenses to the many NVIDIA's competitors the moment NVIDIA acquired Arm. Also, some big player in the semiconductor industry asked regulator to act on this issue.

Alternatives for competitors barely exist. The big alternative to ISA based on RISC is an ISA based on CISC. However, as explained before, the efficiency of those chips would be lower and the device in which they would be included would definitively need a greater battery.

Another point in favor of RISC ISAs is the possibility that regulators could enforce the use of chips that are energy efficient, something that has to do with the Arm's big-little computing architecture. This is very related to the United Nations' Sustainable Development Goal Number 13: Climate Action, and could eventually happen.

So, the only big alternative to Arm nowadays is apparently RISC-V. This is an open-source ISA, so does not require a top-tier license and in-house design team to as Arm or x86 (Intel and AMD are behind x86). Installation of RISC-V CPU cores is expected to increase at a CAGR of 146 % until 2025. Although the industry has reacted positively to this, it is still far from Arm [18].

The main and first regulator to appear was the Competitions and Market Authority because started receiving third parties to listen to their opinions. In April, this situation turned into a formal investigation. As the period allowed for the investigation concluded, a new round started to keep deliberating.

The American Federal Trade Commission appeared later, but has been the most determinant actor. It announced the initiation of a formal investigation in February and completely block the deal because the conclusion was that NVIDIA acquiring Arm would distort competence in such a strategic industry.

The Chinese and European regulators also explained they were investigating the deal but have not explained their conclusions yet.

4.4 Deal Follow-up

As mentioned along the project, the deal could not be closed. Since September 2020 there have been many occurrences that will be detailed below.

On September 16th of 2020, NVIDIA announced its plan to purchase Arm from SoftBank for $40 billion. In this way, NVIDIA's artificial intelligence unique capabilities were put together with Arm's CPUs.

On January 8th of 2021, the United Kingdom's regulator, through the Competitions and Market Authority, started receiving third parties to show their vies on the after-deal British chip market. Particularly, the Competitions and Market Authority tried to find out whether Arm would raise prices or decrease the quality of its licenses to the many NVIDIA's competitors. In fact, the Competitions and Market Authority chief executive, Andrea Coscelli, explained that the British Authority would work with other regulators worldwide to measure the impact of the deal.

In February 2021, competitors started to raise objections despite the many explanations that NVIDIA and Arm offered about the neutrality after the takeover. Big tech companies such as Microsoft, Google and Qualcomm all raised complaint to the Federal Trade Commission about how the deal would harm competition [29].

On April 20th of 2021, the United Kingdom's Competitions and Market Authority presented a formal investigation referring to the deal as national security. The investigation immediately started and would last until the end of July.

As the Chinese chipmakers are one of the greatest Arm markets, NVIDIA wrote to the Chinese Regulator to request the acceptance of the deal, so to have an important regulator's approval. However, some big companies such as Hi Silicon and SMIC argued that the USA would have to much control over their designs. The Chinese regulator explained that their decision could take around 18 months [30].

On July 2nd of 2021, many industry insiders started speculating about SoftBank taking Arm public. Something that Simon Seagars, Arm CEO, denied, since the business combination with NVIDIA was far batter for their investors and Arm than going to the markets.

One of the big announcements when the deal was made public was the Cambridge-1 supercomputer. On July 8th of 2021 and in the middle of the uncertainty about the success of the deal, NVIDIA launched the top performance machine (41st fastest in the world).

On October 27th of 2021, another regulator joined. The European Union announced a formal investigation because of the fears related to how the deal could damage the competition in European industry. Particularly, whether the Arm's intellectual property licenses model would change and harm strategic industries such as automotive, IoT or datacenters.

On November 16th of 2021, the United Kingdom's Competitions and Market Authority started what was known as "Phase 2" investigation. A 24-week investigation focusing antitrust and the country security.

On December 2nd of 2021, the deal suffered a huge setback. The Federal Trade Commission explained that "this proposed deal would distort Arm's incentives in chip markets and allow the combined firm to unfairly undermine Nvidia's rivals". This announcement started an administrative trial that will begin on August 9 of 2022 to decide what to do with the deal [31].

On December 6th of 2021, the European Regulator stopped the investigation due to delays because of the pandemic in antitrust investigations.

On January 11th of 2022, NVIDIA and Arm showed their opinion to the British regulator in the following way: "Trying to foreclose Arm licensees would immediately reduce Arm's licensing revenue, immediately damaging Nvidia's investment," the submission says. "No economically rational, publicly traded entity would embrace such a self-defeating strategy", to explain how Arm's licensing business-model has the only chance to keep being neutral [31].

On January 25th of 2022, the first information related to NVIDIA abandoning the acquisition was made public as the company told to some of its main partners. This is the moment when SoftBank started to consider relisting Arm to finance the projects they had in mind [32].

On February 8th of 2022, NVIDIA and SoftBank announced the takeover collapse due to enormous regulatory challenges despite good faith by both parties. The Japanese company also announced its plan to relist Arm the following year [31].

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6 Appendix I: Stages in the Semiconductor Value Chain

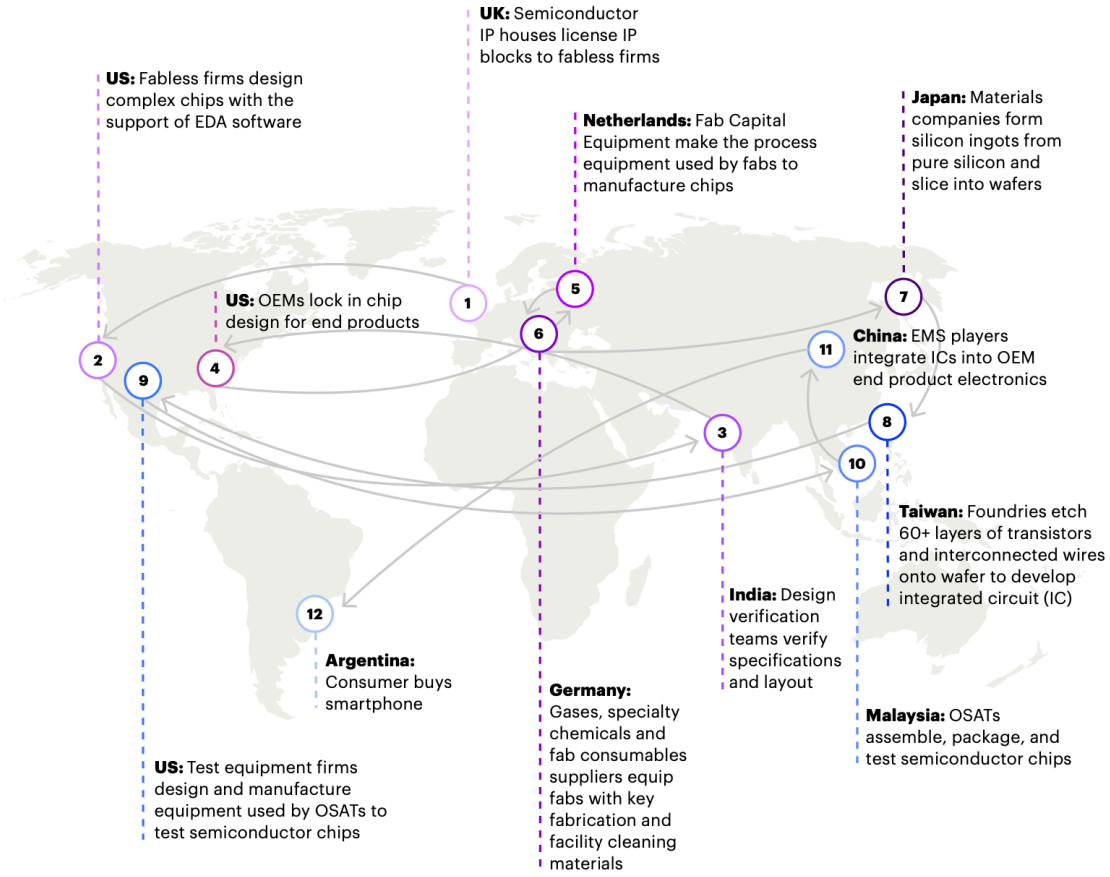

Figure 38: Flow of the Semiconductor Value Chain (Extended).

Source: [18]

7 Appendix II: NVIDIA Balance Sheet January 30th 2022

NVIDIA CORPORATION AND SUBSIDIARIES
CONSOLIDATED BALANCE SHEETS
(In millions, except par value)

	January 30, 2022	January 31, 2021
ASSETS		
Current assets:		
Cash and cash equivalents	$ 1,990	$ 847
Marketable securities	19,218	10,714
Accounts receivable, net	4,650	2,429
Inventories	2,605	1,826
Prepaid expenses and other current assets	366	239
Total current assets	28,829	16,055
Property and equipment, net	2,778	2,149
Operating lease assets	829	707
Goodwill	4,349	4,193
Intangible assets, net	2,339	2,737
Deferred income tax assets	1,222	806
Other assets	3,841	2,144
Total assets	$ 44,187	$ 28,791
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current liabilities:		
Accounts payable	$ 1,783	$ 1,149
Accrued and other current liabilities	2,552	1,777
Short-term debt	—	999
Total current liabilities	4,335	3,925
Long-term debt	10,946	5,964
Long-term operating lease liabilities	741	634
Other long-term liabilities	1,553	1,375
Total liabilities	17,575	11,898
Commitments and contingencies - see Note 13		
Shareholders' equity:		
Preferred stock, $0.001 par value; 2 shares authorized; none issued	—	—
Common stock, $0.001 par value; 4,000 shares authorized; 2,506 shares issued and outstanding as of January 30, 2022; 3,859 shares issued and 2,479 outstanding as of January 31, 2021	3	3
Additional paid-in capital	10,385	8,719
Treasury stock, at cost (None as of January 30, 2022 and 1,380 shares as of January 31, 2021)	—	(10,756)
Accumulated other comprehensive income (loss)	(11)	19
Retained earnings	16,235	18,908
Total shareholders' equity	26,612	16,893
Total liabilities and shareholders' equity	$ 44,187	$ 28,791

Figure 39: NVIDIA Balance Sheet Year Ended January 30th 2022

8 Appendix III: NVIDIA Income Statement January 30th 2022

NVIDIA CORPORATION AND SUBSIDIARIES
CONSOLIDATED STATEMENTS OF INCOME
(In millions, except per share data)

	Year Ended		
	January 30, 2022	January 31, 2021	January 26, 2020
Revenue	$ 26,914	$ 16,675	$ 10,918
Cost of revenue	9,439	6,279	4,150
Gross profit	17,475	10,396	6,768
Operating expenses			
Research and development	5,268	3,924	2,829
Sales, general and administrative	2,166	1,940	1,093
Total operating expenses	7,434	5,864	3,922
Income from operations	10,041	4,532	2,846
Interest income	29	57	178
Interest expense	(236)	(184)	(52)
Other, net	107	4	(2)
Other income (expense), net	(100)	(123)	124
Income before income tax	9,941	4,409	2,970
Income tax expense	189	77	174
Net income	$ 9,752	$ 4,332	$ 2,796
Net income per share:			
Basic	$ 3.91	$ 1.76	$ 1.15
Diluted	$ 3.85	$ 1.73	$ 1.13
Weighted average shares used in per share computation:			
Basic	2,496	2,467	2,439
Diluted	2,535	2,510	2,472

Figure 40: NVIDIA Balance Sheet Year Ended January 30th 2022

9 Appendix IV: NVIDIA Cash Flow Stat. January 30th 2022

NVIDIA CORPORATION AND SUBSIDIARIES
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In millions)

	Year Ended		
	January 30, 2022	January 31, 2021	January 26, 2020
Cash flows from operating activities:			
Net income	$ 9,752	$ 4,332	$ 2,796
Adjustments to reconcile net income to net cash provided by operating activities:			
Stock-based compensation expense	2,004	1,397	844
Depreciation and amortization	1,174	1,098	381
Deferred income taxes	(406)	(282)	18
(Gains) losses on investments in non-affiliates, net	(100)	—	1
Other	47	(20)	4
Changes in operating assets and liabilities, net of acquisitions:			
Accounts receivable	(2,215)	(550)	(233)
Inventories	(774)	(524)	597
Prepaid expenses and other assets	(1,715)	(394)	77
Accounts payable	568	312	194
Accrued and other current liabilities	581	290	54
Other long-term liabilities	192	163	28
Net cash provided by operating activities	9,108	5,822	4,761
Cash flows from investing activities:			
Proceeds from maturities of marketable securities	15,197	8,792	4,744
Proceeds from sales of marketable securities	1,023	527	3,365
Purchases of marketable securities	(24,787)	(19,308)	(1,461)
Purchases related to property and equipment and intangible assets	(976)	(1,128)	(489)
Acquisitions, net of cash acquired	(263)	(8,524)	(4)
Investments and other, net	(24)	(34)	(10)
Net cash provided by (used in) investing activities	(9,830)	(19,675)	6,145
Cash flows from financing activities:			
Issuance of debt, net of issuance costs	4,977	4,968	—
Proceeds related to employee stock plans	281	194	149
Payments related to tax on restricted stock units	(1,904)	(942)	(551)
Repayment of debt	(1,000)	—	—
Dividends paid	(399)	(395)	(390)
Principal payments on property and equipment	(83)	(17)	—
Other	(7)	(4)	—
Net cash provided by (used in) financing activities	1,865	3,804	(792)
Change in cash and cash equivalents	1,143	(10,049)	10,114
Cash and cash equivalents at beginning of period	847	10,896	782
Cash and cash equivalents at end of period	$ 1,990	$ 847	$ 10,896
Supplemental disclosures of cash flow information:			
Cash paid for income taxes, net	$ 396	$ 249	$ 176
Cash paid for interest	$ 246	$ 138	$ 54

Figure 41: NVIDIA Balance Sheet Year Ended January 30th 2022

10 Appendix V: SoftBank Income Statement

SoftBank Group

SoftBank Group Corp. Consolidated Financial Report
For the Fiscal Year Ended March 31, 2022

(2) Consolidated Statement of Income and Consolidated Statement of Comprehensive Income

Consolidated Statement of Income

(Millions of yen)

	Fiscal year ended March 31, 2021	Fiscal year ended March 31, 2022
Continuing operations		
Net sales	5,628,167	6,221,534
Cost of sales	(2,753,238)	(2,955,960)
Gross profit	2,874,929	3,265,574
Gain on investments		
Gain on investments at Investment Business of Holding Companies	945,944	104,362
Gain (loss) on investments at SVF1, SVF2, and others	6,292,024	(3,738,825)
Gain on investments at Latin America Funds	196,556	111,070
Gain on other investments	94,482	88,651
Total gain on investments	7,529,006	(3,434,742)
Selling, general and administrative expenses	(2,271,497)	(2,551,722)
Finance cost	(307,250)	(382,512)
Foreign exchange loss	(137,166)	(706,111)
Income on equity method investments	616,432	341,385
Derivative gain (loss) (excluding gain (loss) on investments)	(480,251)	1,234,708
Change in third-party interests in SVF1 and SVF2	(2,246,417)	972,674
Other gain	92,670	391,184
Income before income tax	5,670,456	(869,562)
Income taxes	(1,303,168)	(592,637)
Net income from continuing operations	4,367,288	(1,462,199)
Discontinued operations		
Net income from discontinued operations	710,948	-
Net income	5,078,236	(1,462,199)
Net income attributable to		
Owners of the parent	4,987,962	(1,708,029)
Net income from continuing operations	4,276,729	(1,708,029)
Net income from discontinued operations	711,233	-
Non-controlling interests	90,274	245,830
Net income from continuing operations	90,559	245,830
Net income from discontinued operations	(285)	-
Net income	5,078,236	(1,462,199)
Earnings per share		
Basic earnings per share (Yen)		
Continuing operations	2,243.80	(1,018.58)
Discontinued operations	375.81	-
Total basic earnings per share	2,619.61	(1,018.58)
Diluted earnings per share (Yen)		
Continuing operations	2,062.55	(1,025.67)
Discontinued operations	374.74	-
Total diluted earnings per share	2,437.29	(1,025.67)

Figure 42: SoftBank Income Statement Year 2021. Source: [1]

11 Appendix VI: NVIDIA Weighted Average Cost of Capital

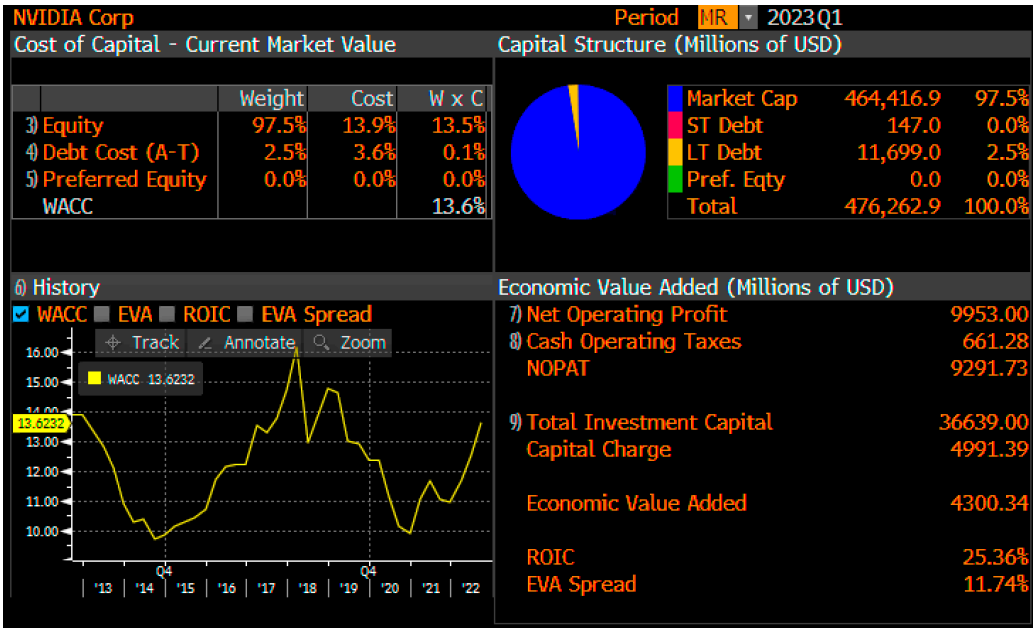

Figure 43: NVIDIA WACC Information on June 1st 2022. Source: [2]