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Equity Valuation: NVIDIA Corporation

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Master in Finance

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BUSINESS
SCHOOL

Department of Finance

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Resumo

Este relatório foi desenvolvido com o intuito de determinar o justo valor das ações da NVIDIA a 29 de janeiro de 2023 e fazer uma comparação entre o valor obtido e o preço de fecho observado nessa data. O objetivo final é perceber se as ações estavam sobrevalorizadas ou subvalorizadas em relação ao preço de mercado.

A NVIDIA é uma das maiores empresas tecnológicas do mundo, fundada em 1993 por três cientistas informáticos e que, desde então, tem vindo a crescer em vários mercados. De salientar que a NVIDIA se tornou numa das poucas empresas a nível mundial a atingir uma capitalização de mercado de 1 bilião de dólares, impulsionada pelo seu posicionamento estratégico no crescente mercado da Inteligência Artificial.

O processo de avaliação é efetuado através de duas metodologias distintas. A primeira consiste nos Fluxos de Caixa Descontados, nomeadamente o Fluxo de Caixa Livre para a Empresa, seguida de uma Avaliação Relativa, ambas suportadas pela revisão da literatura. Todos os pressupostos utilizados são suportados por dados dos relatórios anuais da NVIDIA, tendências macroeconómicas e estudos do sector. Além disso, faço uma análise de sensibilidade para compreender como o valor se altera quando são considerados diferentes pressupostos.

Com base nos resultados obtidos através dos diferentes métodos de avaliação, verifica-se que as ações da NVIDIA estavam acima do seu justo valor no período em análise, sendo assim consideradas sobrevalorizadas.

Palavras-chave: NVIDIA; Avaliação de Empresas; Fluxos de Caixa Descontados; Múltiplos

Classificação JEL: G30; O22

Abstract

This report was developed to determine the fair value of NVIDIA's shares on 29 January 2023 and to make a comparison between the obtained value and the actual close price observed at that date. The final goal is to understand whether the shares were overvalued or undervalued in relation to the market price.

NVIDIA is one of the largest technology companies in the world, which was founded in 1993 by three computer scientists and has been growing ever since across several markets. Notably, NVIDIA became one of the select few companies globally to reach a market capitalization of $1 trillion, driven by its strategic positioning within the growing Artificial Intelligence market.

The valuation process is carried out by using two distinct methodologies. The first one consists of the Discounted Cash Flows, namely the Free Cash Flow to the Firm, followed by a Relative Valuation, both supported by the literature review. All the underlying assumptions are supported by data from NVIDIA's Annual Reports, macroeconomic trends, and industry research. Additionally, I make a sensitivity analysis to understand how the value changes when different assumptions are considered.

Based on the results obtained from the different valuation methods, NVIDIA's shares stood above their fair value at the period under examination, thus being considered overvalued.

Keywords: NVIDIA; Company Valuation; Discounted Cash Flow; Multiples

JEL Classification: G30; O22

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Glossary

ADAS – Advanced Driver Assistance System

AI – Artificial Intelligence

AMD – Advanced Micro Devices

APT – Arbitrage Pricing Theory

AV – Autonomous Vehicle

CAGR – Compound Annual Growth Rate

CAPM – Capital Asset Pricing Mode

CEO – Chief Executive Officer

CPU – Central Processing Unit

CRP – Country Risk Premium

D&A – Depreciation and Amortization

DCF – Discounted Cash Flow

DLSS – Deep Learning Super Sampling

EBIT – Earnings Before Interest and Taxes

EBITDA – Earnings Before Interest, Taxes, Depreciation, and Amortizations

EV – Enterprise Value

EVA – Economic Value Added

FCF – Free Cash Flow

FCFE – Free Cash Flow to Equity

FCFF – Free Cash Flow to the Firm

FY – Fiscal Year

GDP – Gross Domestic Product

GPU – Graphic Processing Units

IMF – International Monetary Fund

MRP – Market Risk Premium

NOA – Non-Operating Assets

NPV – Net Present Value

P/E – Price to Earnings Ratio

PC – Personal Computer

pp – percentage points

Q – Quarter

ROA – Return on Assets

ROE – Return on Equity

ROIC – Return on Invested Capital

SoC – System on Chip

TGR – Terminal Growth Rate

TV – Terminal Value

WACC – Weighted Average Cost of Capital

WC – Working Capital

Introduction

A correct valuation of a company is a crucial tool in the world of finance. Nowadays, we live in an environment filled with constant risks, uncertainty and instability, especially in the current macroeconomic and geopolitical framework. Investors who are proficient in valuation will have an edge in making good investments through wiser and informed decisions.

The aim of this report is to estimate the fair value of NVIDIA's shares. Therefore, in order to understand whether NVIDIA's shares were undervalued or overvalued, I will determine the target value of the company's shares at the beginning of 2023, more specifically on 29 January 2023, and compare it with the market close price observed on the same date.

NVIDIA is a prominent technology company founded in 1993, which has cemented its position as a powerhouse in the highly competitive semiconductor industry. Renowned for its groundbreaking graphics processing units (GPUs) and pioneering artificial intelligence (AI) technologies, NVIDIA has disrupted various sectors, including gaming, data centers, professional visualization, and autonomous vehicles. In FY2023 the company achieved $26.9 billion in revenues, representing a growth of 61% compared to FY2021. With a dedicated workforce comprising 26 196 employees, NVIDIA positions itself as a leader, driving significant advancements in the semiconductor industry. Accordingly, NVIDIA is a compelling company for this study due to its strong financial performance, the diverse business segments where it operates, and leading position to capitalize on the AI boom.

This project starts with the literature review, where I present different valuation methods, including their theoretical fundamentals, how and when they can be applied, and even some disadvantages.

In the second section, I introduce an overview of the company's business, including its history, its business model and a financial analysis. Then, I make an analysis of the macroeconomic conditions, an outlook of the industries where the company has a presence in and an examination of the competitive landscape. The following section is the core of this project, since it is where I will proceed to the valuation itself and obtain the value of the shares, starting with several assumptions followed by the application of the most appropriate models.

In the end, I will perform a sensitivity analysis, a comparison between the models and provide concluding insights regarding the fair valuation of NVIDIA's shares.

1. Literature Review

One of the keys to succeed in the world of corporate finance is the capability of performing an accurate company valuation by making sound and well supported decisions. Damodaran (2012) claims that a prerequisite to making sensible decisions is to understand what determines the value of a firm and how to estimate it. Thus, it is crucial to understand the several assumptions, the valuation process, advantages, and disadvantages that support the models to value a company.

It is important not to confuse value with price as Fernández (2007) draws attention to. He says that the price is the quantity agreed upon between the seller and the buyer when selling a company. This happens since many assumptions are made, so the value of an investment is considered a subjective estimate with a variety of biases that lead to it (Damodaran, 2012). Nevertheless, the significance of valuation remains and with diverse purposes like on one side the highest price a buyer should be willing to pay and on the other side the minimum price at which the seller should sell; or to decide whether is best to buy, hold or sell shares by comparing the value obtained using valuation methods with its price on the stock market (Fernández, 2007). The necessity of valuation is also highlighted by Luerhman (1997: 132) who states that it "is the financial analytical skill that general managers want to learn and master more than any other".

1.1. Valuation Methods

As mentioned before, there exist numerous valuation models which can be used, with different complexity levels, from more simplistic to more advanced, and with multiple assumptions. Despite this, Damodaran (2012) considers that these models have some characteristics in common, thus being able to be classified in deeper terms and allowing to have a better understanding of where the models fit in the overall view and grasp the logic behind the dissimilarities between them.

Accordingly, Damodaran (2012) defines three approaches to valuation: Discounted Cash Flows, Relative Valuation and Contingent Claim Valuation. In the following pages, I will analyze in more detail the first two approaches which will be the ones utilized to value NVIDIA, as they are the most commonly used.

1.2. Discounted Cash Flow Valuation

The Discounted Cash Flow Valuation (DCF) has been considered the most reliable method for many years since it is "the only conceptually correct valuation method" (Fernández, 2007: 17).

Damodaran (2012: 4) defines that "the value of an asset is the present value of the expected cash flows on that asset, discounted at a rate that reflects the riskiness of those cash flows". Basically, the goal is to obtain the value of an investment today based on projections of the amount it will generate in the future. Consequently, the forecasts of future cash flows play a pivotal role in this valuation.

In this regard, the value of an asset can be obtained as follows (Damodaran, 2012):

$$Value = \sum_{t=1}^{t=n} \frac{CF_t}{(1+r)^t} \quad (1)$$

where,

n = life of the asset;

CFt = Cash flow in period t;

r = Discount rate that reflects the riskiness of the cash flow.

There are several models within the DCF approach. As mentioned by Damodaran (2006), there are four versions, in practice, that can be utilized. The first approach consists of obtaining the value of the firm by discounting the expected cash flows at a risk-adjusted discount rate, this rate differs depending on the model applied, either the Free Cash Flow to the Firm (FCFF) or the Free Cash Flow to Equity (FCFE). The second version includes the Economic Value Added (EVA) model which uses the expected excess returns generated by the firm's investments to value the firm. In the third method, uncertain cash flows are transformed into certain equivalents before being discounted. Lastly, the value of the business can be estimated assuming an all-equity funding approach, and then the impact of debt on the value is computed separately. In the next sections, I will center my attention on the first two as they are considered standard practices for valuing businesses.

1.2.1. Free Cash Flow to the Firm

In the Free Cash Flow to the Firm model, the value of the firm is obtained by discounting the FCFF at the weighted average cost of capital (WACC), so it values the business as a whole, as Damodaran (2006) explains. The FCFF represents the amount of cash flows generated after netting taxes, expenses, fixed asset investments and working capital requirements.

Damodaran (2012) states that FCFF is the sum of the cash flows that are available to all claim holders of the firm, as shown in the following formula:

$$FCFF = EBIT * (1 - Tax\ rate) + Depreciation - Capex - \Delta\, Working\ capital \quad (2)$$

The enterprise value can then be obtained by discounting, at the WACC, the free cash flow to the firm and by considering the Terminal Value in perpetuity. Essentially, this approach corresponds to the present value of all anticipated future cash flows generated by the company, in accordance with the following formula:

$$Enterprise\ Value = \sum_{t=1}^{n} \frac{FCFF_t}{(1+WACC)^t} + \frac{TV_n}{(1+WACC)^n} \quad (3)$$

where,

$FCFF_t$ = Free Cash Flow to the Firm in year t;

g = Expected growth rate;

$WACC$ = Weighted Average Cost of Capital;

TV_n = Terminal value at the end of the forecast period (n).

The second part of this equation takes into account that the firm will eventually start growing at a constant growth rate, after n years, until perpetuity (Damodaran, 2012). This translates into the Terminal Value (TV), that provides the major fraction of the company's value, hence its importance. Lee (2003:5) notes that the significance of the Terminal value "is largely determined by the company's industry or production technology".

As such, the Terminal Value reflects the present value of all future cash flows that the company will generate beyond the specific terminal year (Schill, 2013). The following formula shows how to obtain the Terminal Value:

$$Terminal\ Value_n = \frac{FCFF_{n+1}}{(WACC - g)} \quad (4)$$

It is worth noting that the discount rate ($WACC$) and growth rate (g) in the previous formula are based on presently available information.

To achieve accurate valuation results, it is crucial to establish a realistic growth rate. Companies cannot sustain high growth rates indefinitely, which is why Damodaran (2012) recommends that the estimated growth rate of the company should be lower than or equal to the growth rate of the economy where it operates.

1.2.1.1. Weighted Average Cost of Capital

WACC is the most used discount rate in the valuation of firms that incorporate both equity and debt in their capital structure. It takes into account the tax shields associated with interest payments, which provide valuable tax benefits for the company (Berk & DeMarzo, 2019). Luehrman (1997) highlights that the usefulness of this rate lies in its simplicity and ease of calculation.

To obtain this discount rate it is fundamental to consider the proportion to which both the required return to debt and return to equity finance the firm, as exemplified in the following formula (Fernández, 2007):

$$WACC = r_E \times \frac{E}{D+E} + r_D \times \frac{D}{D+E} \times (1-t) \quad (5)$$

where,

r_E = Cost of equity;

E = Market value of equity;

r_D = Cost of debt;

D = Market value of debt;

t = Corporate income tax rate.

Despite its popularity, the weighted average cost of capital has limitations, as noted by Luehrman (1997). When dealing with complex capital structures, it is often necessary to make further adjustments to ensure an accurate reflection of the true cost of capital. Additionally, intricate tax positions and diverse fundraising strategies are among the factors that can introduce complexities and potential errors into the determination of the appropriate discount rate. Therefore, it is crucial to conduct a thorough evaluation of these factors to arrive at a more precise estimation of the cost of capital.

Furthermore, some authors like Koller et al. (2020) mention that the use of the WACC assumes a consistent target debt-to-equity ratio for a company. However, in practical situations, this assumption may not hold true as companies frequently adjust their capital structure over time.

In the following sections, I will explain how to obtain the cost of equity and the cost of debt needed to compute the WACC.

1.2.1.2. Cost of equity

The cost of equity can be defined as the rate of return that shareholders require from an equity investment. As stated by Koller et al. (2020), there are several models that financial analysts use to calculate the cost of equity, including the Capital Asset Pricing Model (CAPM), the Arbitrage Pricing Theory (APT), and the Fama and French three-factor model. Among these models, the CAPM stands out as a preferred choice, distinguished by its assessment of risk through the consideration of a stock's sensitivity to market movements.

The CAPM incorporates three key components: the risk-free rate, the market risk premium, and the stock's beta, which quantifies its volatility relative to the overall market. Its formula is presented as follows (Koller et al., 2020):

$$r_E = r_f + \beta_L * [E(r_M) - r_f] \quad (6)$$

where,

r_f = Risk-free rate;

β_L = Beta levered;

$E(r_M)$ = Expected market return.

The CAPM model relies on several assumptions, namely, that there is no asymmetry of information, no transactions costs and the market is efficient (Black et al., 1972). Despite the use of this model, it is important to understand that it is "based on many unrealistic assumptions" as Fama and French (2004: 30) state.

The components needed for the CAPM are going to be explained in the following sections.

Risk-free rate

A risk-free asset is defined as an investment that guarantees an expected return equal to its actual return (Damodaran, 2008). For this to happen, it is required that the asset has no default risk and no reinvestment risk. As such, government bonds are often considered as risk-free assets since they are backed by the government and typically offer reliable and stable income streams. Koller et al. (2020) point out that there should be a match between the duration of the cash flows and the duration of the risk-free asset when assessing investment risk and return.

Additionally, when choosing the risk-free rate, it is crucial to take into account the consistency between the currency used for valuing the cash flows and the government bond used as the risk-free asset. So, for companies located in Europe a commonly employed practice is to utilize the 10-year yield Germany Bond as the risk-free rate. On the other hand, for companies based in the United States of America the most suitable proxy is the US 10-year government bond.

Market Risk Premium

Berk and DeMarzo (2019) describe the Market Risk Premium (MRP) as the amount required by investors for owning the market portfolio compared to a risk-free asset. It basically quantifies the compensation investors seek for taking on the systematic risk associated with investing in the overall

market and corresponds to the difference between the expected return of the market and the risk-free rate.

The calculation of the MRP can be done by using different methods, including the use of implied premiums, the survey approach and the historical average realized returns (Damodaran, 2012). Among these approaches, the historical average is the most utilized, and offers insights into how stocks have performed historically compared to risk-free investments. It involves analyzing the returns earned on a portfolio of stocks over an extended period and comparing them with the returns from a long-term government bond (Schill, 2013).

Beta

The CAPM Beta plays a significant role in determining a stock's expected return (Koller et al., 2020). It quantifies the level of susceptibility of an asset's returns to fluctuations in the overall market return (Fama & French, 2004). Beta is also considered to reflect the level of systematic risk that the investment contributes to a market portfolio. As such, it is a useful tool to assess the risk of an investment.

According to Damodaran (2012), one approach to obtain an asset's beta is to divide the covariance of the asset's returns with the market portfolio by the variance of the market portfolio as seen below:

$$Beta\ of\ an\ asset\ x = \frac{Cov_{x,m}}{\sigma_m^2} \tag{7}$$

where,

$Cov_{x,m}$ = Covariance between the asset and the market

σ_m^2 = Variance of the market portfolio

The previous equation can lead to different interpretations depending on the value of the beta. Hence, a beta close to one indicates that there is a strong positive correlation between the asset and the market return. Conversely, a beta of zero means that changes in the market return have no effect on the asset's return. Additionally, a beta value between 0 and 1 typically indicates that the investment exhibits less volatility than the overall market, while a beta above 1 suggests that the investment tends to be more volatile, making it a relatively higher-risk asset when compared with the market.

There are three methods to estimate the beta of an investment, including a regression of the returns of the firm security on the market returns, by utilizing the fundamental characteristics of the investment, and by using accounting data (Damodaran, 2012). Among these methods, the regression approach is the most used, but it has some limitations. As noted by (Damodaran (1999), these

limitations arise from factors such as the selection of the market index, the time period, and the return interval, which can lead to biased results or estimates with high standard errors.

To address these limitations, authors like Damodaran (1999) and Koller et al. (2020) suggest employing the bottom-up beta approach. This approach avoids the need for historical prices of a firm or asset by considering the weighted average of the unlevered betas of companies that operate in the same industry as the firm under analysis. It considers both the current operating leverage and financial leverage of the firm.

Moreover, Damodaran (2012) underscores the importance of the financial structure for the calculation of beta since it can impact the accuracy of the beta. The author states that if the company is solely financed by equity, then we calculate the unlevered beta. However, if the company if financed by a combination of equity and debt, the levered beta is computed, which can be obtained by the following equation:

$$\beta_l = \beta_u * (1 + (1 - t) * \frac{D}{E}) \quad (8)$$

where,

β_l = Levered beta;

β_u = Unlevered beta;

t = Marginal tax rate;

$\frac{D}{E}$ = Debt-to-equity ratio.

The previous formula is based on the assumption that the beta of debt is zero, which means that debt does not carry market risk. Furthermore, by incorporating the debt structure, the levered beta accounts for the increased risk associated with debt financing and provides a more accurate measure of the asset's overall risk profile.

1.2.1.3. Cost of debt

The cost of debt corresponds to the effective cost that a company has for borrowing funds to finance its projects. In order to determine this component, the first step involves obtaining the pre-tax cost of debt which is computed by summing the risk-free rate with the default spread.

Moreover, the straightforward scenario to obtain the pre-tax cost of debt occurs when the company is widely trading long-term outstanding bonds that are liquid. In this case, the yield to maturity of the bond can be used to compute the cost of debt (Damodaran, 2012). It is important to recognize that the estimation of the default spread is related to the contingent on whether a company is listed or not. Accordingly, the author also states that for rated companies with less liquid outstanding

bonds, the default component can be obtained using the firm's rating and the associated default spreads. However, if the company is not rated, the best course of action is to analyze the recent borrowing history or estimate a projected synthetic rating.

However, taking into account the tax advantage resulting from interest expenses being tax deductible, it is fundamental to incorporate the interest tax shield in the valuation (Koller et al., 2020). Therefore, it is common to use the after-tax cost of debt when calculating the cost of debt for the company. It can be calculated by using the formula provided by Damodaran (2012):

$$After-tax\ cost\ of\ debt = Pre-tax\ cost\ of\ debt\ \times (1 - tax\ rate) \tag{9}$$

Concerning the tax rate, Koller et al. (2020) defends that the after tax should be computed using the marginal tax rate.

1.2.2. Free Cash Flow to Equity

Another DCF approach that Damodaran (2012) presents is the Free Cash Flow to Equity (FCFE). The FCFE represents the amount available to shareholders of a company to be paid out as dividends, after accounting for operating expenses, interest, debt payments, and reinvestments. Notably, one difference between FCFF and FCFE lies in the discounting process. While the cash flows of FCFF are discounted using the WACC, FCFE employs the cost of equity as the discount rate. According to Damodaran (2012), it can be expressed as:

$$\begin{aligned} FCFE = {} & Net\ Income - Capital\ Expenditures + Depreciation \\ & - Change\ in\ Non-Cash\ Expenditure + New\ Debt\ Issued \\ & - Debt\ Repayments \end{aligned} \tag{10}$$

Fernández (2007) demonstrated that this formula can be simplified by using the Free Cash Flow to the Firm and adjusting for after-tax interest expenses and new debt issuance, as seen by:

$$FCFE = FCFF - Interest\ Expenses * (1 - t) + \Delta\, Debt \tag{11}$$

The application of FCFE can provide distinct benefits in certain scenarios because it directly incorporates the company's capital structure into the cash flow analysis, which is also one of its limitations. This approach is particularly advantageous when the capital structure plays a critical role in determining the value of equity, such as banks, whose operating decisions and financing decisions cannot be valued separately (Koller et al., 2020).

1.2.3. Economic Value Added

The Economic Value Added model is a type of Excess Return Models that offers an alternative approach to the conventional models used in the Discounted Cash Flow valuation model. These types of models assert that for an investment to create value for a business, it must have a positive net present value and its returns on equity need to exceed the cost of equity (Damodaran, 2006).

Moreover, the EVA model is characterized for quantifying the additional dollar value generated by a company's current investments (Damodaran (2012). The calculation of EVA involves using accounting data and estimating the cost of capital, as shown by the following equation (Larrabee & Voss, 2013):

$$EVA = NOPAT - (Invested\ Capital * WACC) \tag{12}$$

where,

$NOPAT$ = Net Operating Profit After Tax;

$Invested\ Capital$ = Book value of capital that is invested in assets in place.

Damodaran (2012) explains that Economic Value Added (EVA) is based on the concept of Net Present Value (NPV), as investing in projects with positive NPV can increase the value of the firm, however, EVA offers a more comprehensive approach to evaluating a company's profitability. Additionally, the NPV can be computed using the following formula:

$$NPV = \sum_{t=1}^{t=n} \frac{EVA_t}{(1 + WACC)^t} \tag{13}$$

where,

EVA_t = Economic Value Added;

n = Project lifespan (in years).

Additionally, the author suggests that the value of a firm can be derived by considering the relationship between EVA and NPV (Equation 13), and by summing the capital invested in existing assets, along with the present value of EVA generated by these assets and the expected NPV of future investments.

However, some authors have pointed out limitations to this model. For instance, using the book value of invested capital instead of the market value can lead to inaccuracies in the EVA calculation, as noted by Fernández (2002).

1.3. Relative Valuation

The last model that is going to be described is the relative valuation through multiples, which is another method that can be used to value a company. It offers an alternative to the discounted cash flow model and is "based on the company's income statement" (Fernández, 2013: 5). While the DCF approach considers cash flow, growth, and risk characteristics to determine the value of an asset, the relative valuation aims to value an asset by analyzing how assets with similar characteristics are being priced in the market (Damodaran, 2012).

One of the advantages of using multiples, as suggested by Liu et al. (2002), is their simplicity to be understood and to be explained to others. Furthermore, Baker and Ruback (1999) reinforce this idea by stating that this type of valuation overcomes the challenges associated with selecting a theoretical model for the appropriate discount rate and estimating it using historical data. Furthermore, valuation through multiples allows for meaningful comparisons of the company's performance relative to similar firms (Koller et al., 2020).

According to Damodaran (2012), there are four main requirements that must be fulfilled in order to compute the standardized multiples:

1. Maintain consistency with the multiples used;
2. Be careful with the cross-sectional distribution of the multiple;
3. Understand fundamentals behind the multiple and how their variation affects the multiples;
4. Select the right group of comparable firms.

The selection of multiples is a critical aspect of this model and depends on the type of business and industry in which the company operates. Fernández (2001) categorizes the multiples into three main groups, which are presented below:

Table 1.1: Main groups of multiples. *Source: Adapted from Fernández (2001).*

Equity Value Multiples	P/E (Price to Earnings Ratio) P/S (Price to Sales) P/BV (Price to Book Value)
Enterprise Value Multiples	EV/EBITDA (Enterprise Value to EBITDA) EV/Sales (Enterprise Value to Sales) EV/FCF (Enterprise Value to Free Cash Flow)
Growth-referenced Multiples	PEG (Price/Earnings to Growth) EV/EG (Enterprise Value to EBITDA Growth)

According to Fernández (2001), EV/EBITDA and P/E are the more popular multiples, being the latter the one that is used the most among analysts due to its simplicity. However, it is important to note that the P/E ratio has its limitations. It can be influenced by factors such as the company's capital structure and nonoperating gains and losses, which can distort its interpretation and accuracy as a valuation measure (Koller et al., 2020). Nevertheless, it is an important multiple and can be computed as follows:

$$P/E = \frac{Market\ Price\ per\ Share}{Earnings\ per\ Share} \tag{14}$$

When selecting comparable firms, it is important to understand the criteria for their selection. Koller et al. (2020) defends that these companies should be part of the same industry and exhibit similar ROIC and growth prospects. Additionally, Bhojraj & Lee (2001: 408) emphasize this by stating that "the choice of comparable firms should be a function of the variables that drive cross-sectional variation in a given valuation multiple". If these characteristics are met, it is possible to create the peers group. However, if they are not met, the best approach is to use similar companies in terms of valuation fundamentals as recommended by Damodaran (2006).

Despite the advantages and great usage of this valuation method, there are some limitations to it. Damodaran (2012) emphasizes that since multiples are simple to calculate, the estimates may end up inconsistent by disregarding some key variables like risk, growth, and cash flow potential. He also alerts to the possibility of a sub or overvaluation of the asset, as the state of the market influences the valuation using multiples. These are some of the reasons that make the adoption of multiples "highly debatable" (Fernández, 2001:2).

Additionally, according Damodaran (2006), if the market prices assets correctly, the discounted cash flow and relative valuations are likely to align. However, when the market systematically overvalues or undervalues certain assets or sectors, there may be a disparity between the results of these two valuation methods, emphasizing the limitations previously presented.

This approach can still be useful to evaluate a company. Fernández (2001) defends that relative valuation can be used in the second stage of a valuation. Other authors agree with this, Koller et al. (2020) and Liu et al. (2002) suggest that it can help complement another valuation method, for instance, by comparing the differences between them or to obtain terminal values.

2. Company Overview

In this section, I make a comprehensive analysis of NVIDIA that includes NVIDIA's historical journey from its beginnings to the present. Additionally, I explore both its business model across diverse segments and its revenues by region, as well as a detailed evaluation of financial performance metrics to assess the company's financial health. To complete this analysis, I examine NVIDIA's stock performance, the composition of its shareholder base, and its approach to dividend distribution.

2.1. History

NVIDIA Corporation is an American technology company which was founded by Jensen Huang, Chris Malachowsky and Curtis Priem in 1993. Initially, the main focus of these three co-founders was the creation and development of graphics processing units (GPUs) since they believed that accelerated computing would solve the most difficult computational problems.

In 1995, NVIDIA introduced its first product to the market, which was the NV1 multimedia accelerator. Although the initial product did not meet the anticipated expectations, it helped to solidify the company's position in the market. As such, in 1997 the RIVA series of graphics processors was launched with significant success.

Early in 1999, the company became publicly traded on NASDAQ at $12 per share. Later that same year, the real breakthrough came when NVIDIA introduced the GPU with the launch of GeForce 256, marking a significant turning point in the computing industry.

Throughout the early 2000s NVIDIA kept expanding by securing contracts with Microsoft in 2000 to develop the graphics hardware for the Xbox, and with Sony in 2004 to help design the graphics processor for the PlayStation 3. During this decade, the company also entered the scientific computing market with the release of CUDA and introduced the Tesla GPU for high-performance computers.

During the 2010s, NVIDIA diversified its business into three distinct markets: gaming, automotive electronics, and mobile devices. The company released new technology capable of real-time ray tracing with NVIDIA RTX and developed the DRIVE platform to power autonomous vehicles. Additionally, NVIDIA continued to improve the Tegra Processor, which was initially launched in 2008, to offer better performance and power efficiency for smartphones and tablets.

As of 29 January 2023, NVIDIA Corporation employed 26 196 people across 35 countries and reported annual revenues of $26 974 million. It continues to drive innovation and progress in various industries, including transportation, healthcare, and financial services. Furthermore, NVIDIA's GPUs and software are supporting numerous researchers and scientists in different fields, ranging from climate forecasting to materials science. The company is also playing a key role in the development and adoption of artificial intelligence technology. As a result, it is no wonder that 70% of the 500 most

powerful computers in the world rely on NVIDIA. It also plays a pivotal role in the Omniverse, a simulation platform that enables the creation of physically realistic virtual worlds. When combined with AI, Omniverse has the potential to be used in a wide range of applications, such as product design, engineering, and architecture.

2.2. Business model

Starting from the first quarter of the fiscal year 2021, NVIDIA restructured the way it reports its operating segments. The company now categorizes its business into two main segments: Graphics and Compute & Networking. Additionally, within these two categories, NVIDIA develops products for four primary markets: Gaming, Professional Visualization, Data Center, and Automotive. The breakdown of revenues by market can be seen in the figure below:

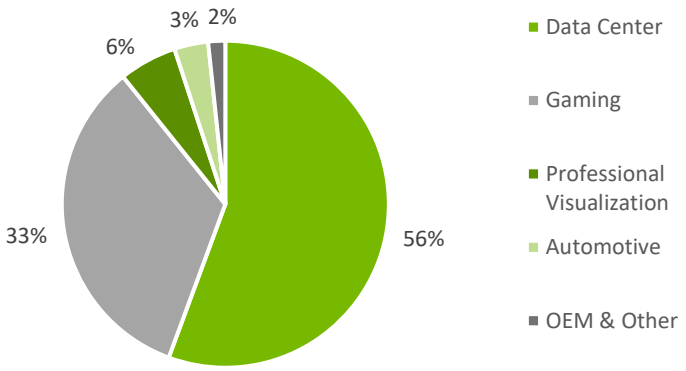


Figure 2.1: Revenues by market. *Adapted from NVIDIA's FY2023 Annual Report.*

2.2.1. Data Center

Companies that want to remain at the front of innovation need to have powerful data center GPUs to meet the ever-growing demands of AI and machine learning. Data centers play a crucial role in processing the vast amounts of data required to refine AI models, which in turn accelerates both deep learning and machine learning. These technologies are expected to be a key in solving innumerous future challenges.

In FY2023[1], the NVIDIA Ampere architecture GPUs had a significant impact on the success of the company's data center segment, which experienced a significant 41% increase in revenues compared to the previous year. This was due to the GPUs' ability to enhance cloud computing and AI services,

[1] FY2023 of NVIDIA started in January 2022 and ended in January 2023.

while also being energy efficient. Additionally, the company's focus on developing specific solutions to the needs of different industries has also contributed to its success in this area.

Given these factors, it is not surprising that NVIDIA's data center segment has been a major driver of the company's growth in recent years and will likely continue to be so in the future.

2.2.2. Gaming

Gaming remains the largest entertainment industry globally and is one of NVIDIA's primary sources of revenue, accounting for 33% of the company's total revenues in FY2023. This segment has experienced significant success over the years due to the growing popularity of gaming and eSports, which has led to an increasing demand for high performance graphics cards and advanced software.

One of NVIDIA's distinguished technologies in the gaming industry is its RTX GPU, which has gained even more games that support it. This technology enhances the gaming experience by offering advanced features, such as ray tracing (a rendering technique that simulates the physical behavior of light) and DLSS (an AI-powered upscaling technology that can improve the performance and image quality of games), making it more immersive and visually stunning. Moreover, NVIDIA's innovation in gaming software and hardware, including the launch of the GeForce NOW game streaming service and the powerful Ampere-based GPUs, has further strengthened its position in the market.

Despite the popularity of Gaming, NVIDIA's revenue saw a decline in this segment of 27% compared to the previous year, as the impact of global macroeconomic conditions and disruptions in China caused by the COVID-19 pandemic negatively impacted gaming demand.

2.2.3. Professional Visualization

NVIDIA's professional visualization segment focuses on accelerating workflows and improving efficiency in several industries, including engineering, design, and digital content creation, by primarily relying on partnerships with independent software vendors to optimize software offerings for NVIDIA GPUs.

NVIDIA's GPUs, including the NVIDIA RTX and Quadro, are designed to meet the unique needs of creative professionals by providing optimized video processing, 3D designs, and rendering capabilities. In addition, the company has also launched innovative software tools like NVIDIA Omniverse. Omniverse allows users to work together in real-time across different software applications, making it easier to develop complex designs.

Professional visualization is NVIDIA's third most significant segment in terms of revenues (6%), and it experienced significant success over the last years, driven by various factors. The increasing

demand for workstations that can support the requirements of a hybrid work environment and the ramp-up of NVIDIA Ampere architecture products are key drivers of growth.

2.2.4. Automotive

The automotive segment generated just 3% of the company's total revenues in FY2023. The company is developing solutions to create safer and more efficient vehicles, with the current focus being on cockpit Autonomous Vehicle (AV) platforms, AI-powered cockpit and infotainment solutions.

An important product for NVIDIA in this sector is the DRIVE platform, which provides the necessary computing power for real-time perception, mapping, and decision-making in self-driving vehicles. This platform has been adopted by leading companies, for instance, Mercedes-Benz and Toyota, enabling them to develop advanced autonomous vehicles. The Drive platform, when combined with the Orin System on Chip (SoC), makes it possible to leverage deep neural networks for processing data obtained from various sensors and cameras.

2.3. Revenue by region

NVIDIA operates its business in various regions around the world. The most significant geographies where the company is present are the following: United States, Taiwan, China (including Hong Kong) and other countries, as highlighted in its 2023 annual report.

As shown in Figure 2.2, the United States is the region which produced the most revenues accounting for 8 292 million dollars, in FY2023, representing 31% of total revenues (Figure 2.2). Additionally, NVIDIA has a strong presence in Asia, with Taiwan and China (including Hong Kong) standing for 26% and 21% of revenues, respectively. The remaining 22% are generated by other countries.

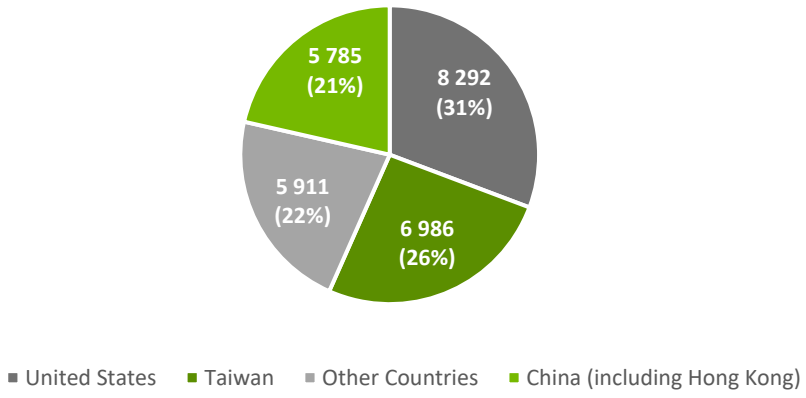


Figure 2.2: Revenues per region (% and million $). Adapted from *NVIDIA's FY2023 Annual Report.*

2.4. Financial Performance

From FY2019 to FY2023, NVIDIA experienced a steady growth of total revenues, presenting an increase of 15 258 million dollars. The following figure illustrates the revenue trends of NVIDIA over the past five years, categorized by various segments.

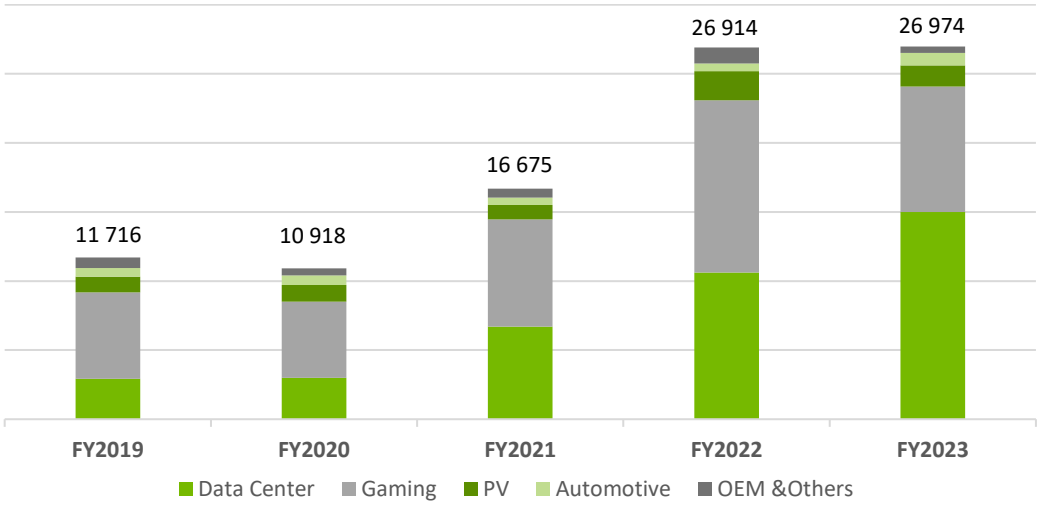


Figure 2.3: NVIDIA's total revenues breakdown (million $). *Adapted from NVIDIA's Annual Reports FY2019-2023.*

It is possible to observe in Figure 2.3 that the data center segment had a significant impact on the revenue growth, exhibiting an impressive Compound Annual Growth Rate (CAGR) during the period of FY2019 to FY2023 of 50%. This underscores the shift in NVIDIA's business strategy, with the data center segment accounting for a substantial 56% of the total revenues in FY2023, compared to just 25% in FY2019.

Moreover, over the past five years, NVIDIA has exhibited a good financial performance, with both its Earnings Before Interest and Taxes (EBIT) and Net Income showing some growth. EBIT, which provides a clear picture of a company's ability to generate profit from its operations before accounting for interest on loans and income taxes, has presented an upward trend, despite some volatility. Simultaneously, NVIDIA's Net Income, which represents the company's profit after all expenses, including interest and taxes, has shown steady growth (Figure 2.4). However, it is worth noting that FY2022 stands as an outlier in these metrics, with EBIT reaching $10 041 million and Net Income at $9 772 million. This exceptional performance was attributed to robust demand for NVIDIA's GPUs, cost-saving measures, and price increases.

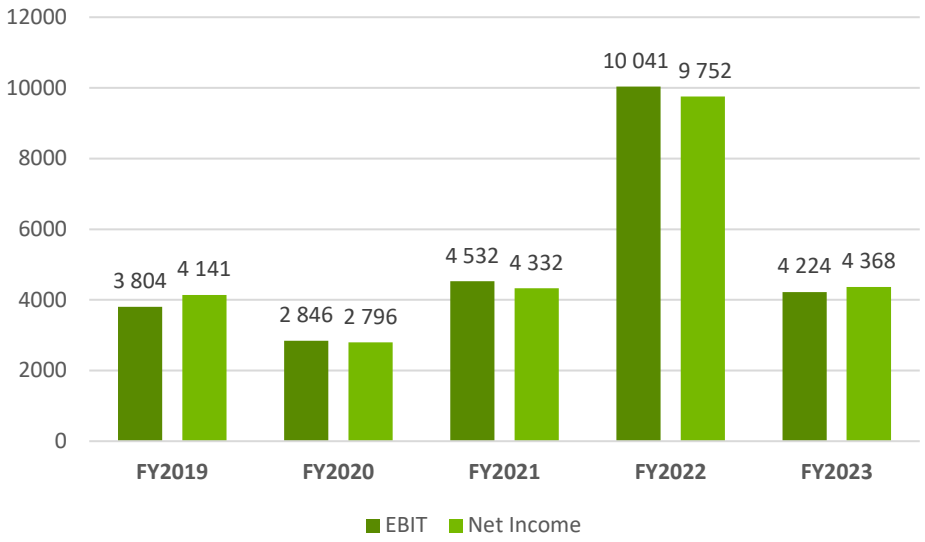


Figure 2.4: NVIDIA's EBIT and Net Income (million $). *Adapted from NVIDIA's Annual Reports FY2019-2023.*

Another important metric is the EBITDA margin that indicates a company's profitability and operating efficiency. As shown in the figure below, over the past five fiscal years, NVIDIA has maintained an average EBITDA margin of 32.2%. However, there was a substantial decline in this indicator in FY2023, from 41.7% to 21.4%. This can be mainly explained due to the increase in operating costs, including a $1.35 billion charge related to the termination of the Arm acquisition.

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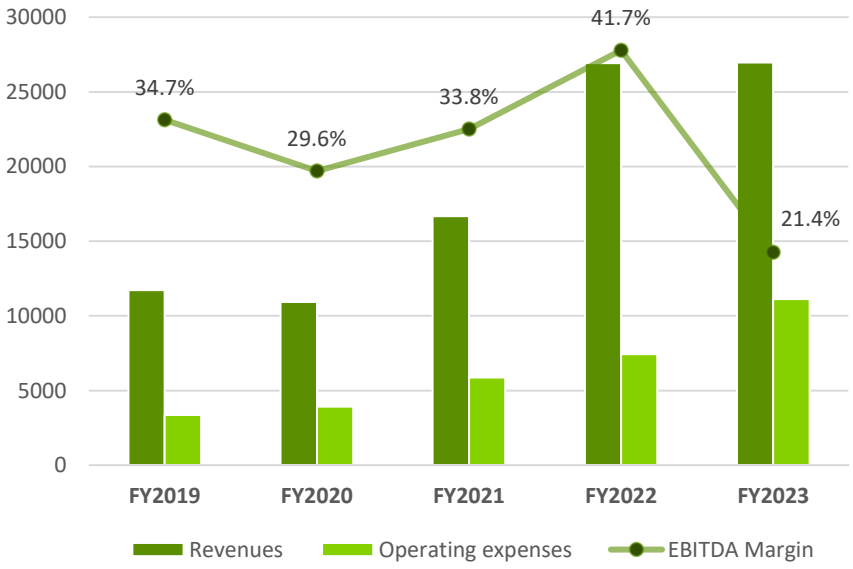


Figure 2.5 Revenues, Operating expenses, EBITDA Margin (in million $). *Adapted from NVIDIA's Annual Reports FY2019-2023.*

In recent years, NVIDIA has consistently demonstrated strong return ratios, reflecting its ability to deliver attractive returns to investors. These return ratios serve as key indicators for assessing the company's profitability and operational efficiency. However, there has been a notable decline in NVIDIA's profitability ratios, suggesting that the company may have difficulty sustaining its previous levels of profitability.

One critical metric used to assess profitability and efficiency is the Return on Invested Capital (ROIC), which considers both the company's earnings and the capital invested. Over the analyzed period, NVIDIA's ROIC has experienced a significant decline, dropping from 34.2% in FY2019 to 11.7% in FY2023. This decline can be primarily attributed to increased capital investments in new growth areas.

The Return on Equity (ROE) is another important metric, and it measures the profitability of a company from the perspective of its equity investors. In the case of NVIDIA, there has been a notable decline in the ROE from 44.3% in FY2019 to 19.8% in FY2023. This decrease can be explained by an increase in shareholders' equity, which was not accompanied by a corresponding increase in net profits.

Finally, the Return on Assets (ROA), which can be obtained by diving the net income by the total assets, provides insights into the company's profitability in relation to its total assets. It is possible to observe that it also experienced a decline from 31.2% in FY2019 to 10.6% in FY2023, reflecting the impact of increased total assets.

It is important to highlight that the trend observed in these ratios was disrupted in FY2022, which marked a remarkable year for NVIDIA. During this period, the company achieved record-breaking performance across various indicators, including operating income and gross margin (please see Annex B).

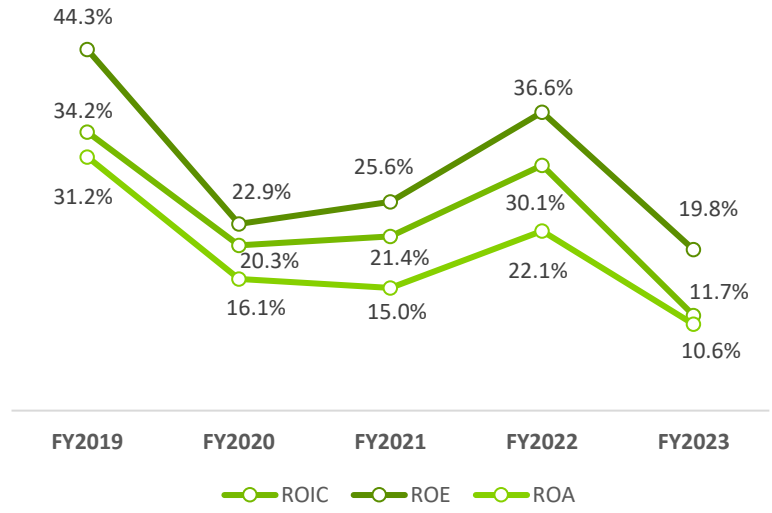


Figure 2.6: Return Ratios. *Adapted from NVIDIA's Annual Reports FY2019-2023, Own Estimates.*

The liquidity of a company is an important aspect to consider when assessing its financial position. It provides insights into the company's ability to meet its short-term obligations, manage cash flow effectively, and mitigate liquidity risks. Key liquidity ratios commonly used for analysis include the current ratio, the quick ratio, and the cash ratio, as depicted in Figure 2.7. These ratios serve as valuable indicators of the company's liquidity position and contribute to a comprehensive evaluation of its financial health and stability.

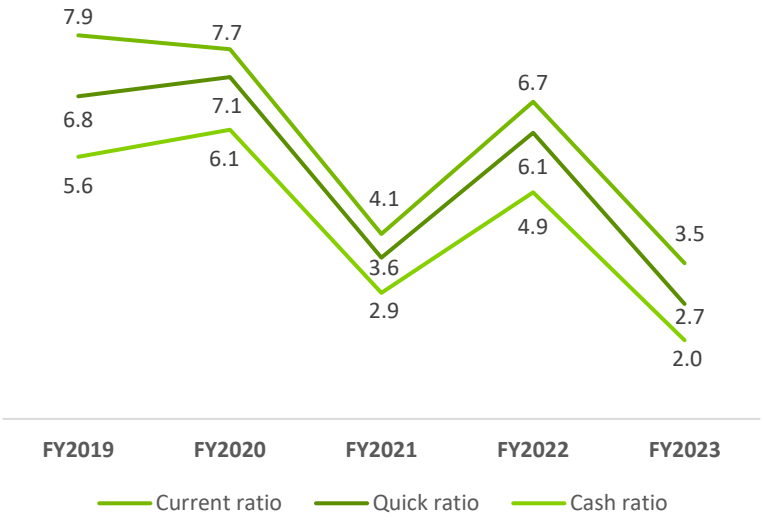


Figure 2.7: Liquidity Ratios. *Adapted from NVIDIA's Annual Reports FY2019-2023, Own Estimates.*

The first measure that is going to be analysed is the current ratio, which is useful to evaluate a company's ability to meet its short-term obligations within a year. It is computed by dividing the company's current assets by its current liabilities. Figure 2.7 showcases the fluctuation in the current ratio over the years, with a decline from 7.9 in FY2019 to 3.5 in FY2023. This decrease can be attributed to an increase in NVIDIA's current liabilities during the same period.

Regarding the quick ratio, it reflects changes in liquidity based on the same underlying principles as the current ratio. Nonetheless, the quick ratio provides a more focused assessment of the company's ability to meet short-term obligations using its most liquid assets, such as cash, marketable securities, and accounts receivable. It considers the company's capacity to quickly convert these assets into cash to fulfil immediate financial commitments. When analysing the trend over time, it is evident that the quick ratio has experienced a significant decline from 6.8 in FY2019 to 2.7 in FY2023, aligning with the fluctuations observed in the current ratio.

The cash ratio is another measure that resembles the quick ratio but excludes short-term investments and accounts receivable. It provides a more conservative measure by focusing solely on

the most readily available liquid assets. Similar to the other two ratios, the cash ratio has diminished, in this case from 5.6 to 2.

Significantly, all the ratios have consistently remained above 1 across the years under analysis, indicating that NVIDIA has maintained enough liquid resources to fulfil its short-term debts and obligations, despite the increase of current liabilities.

2.5. Stock Performance, Shareholder structure and dividend policy

2.5.1. Stock Performance

Since January 1999, NVIDIA has been listed on the NASDAQ stock exchange under the trading symbol NVDA. The company made its debut with an opening price of $12 and is currently included in S&P 500.

From 2018 until the end of 2021, NVIDIA's stock prices experienced a positive trend driven by the company's dominance in the graphics processing unit market and strong financial performance. Throughout this period, the stock price reached its lowest point on December 24, 2018, at $31.77/share. However, it reached an all-time high in November 2021 at $333.76/share. Moreover, it is worth mentioning that NVIDIA implemented a 4-for-1 stock split on July 20, 2021. Prior to the split, the stock was trading at around $750/share, and following the adjustment, the new stock price was approximately $187.50 per share.

During 2022, the share price of NVIDIA had some oscillations. Initially, it faced a negative trend, primarily attributed to macroeconomic conditions impacting GPU demand and supply chain constraints. On October 14, the stock hit its lowest point of $112.27 per share. After that it had an upward trend, reaching $191.62/share on January 29, 2023. The stock performance from 2018 until the beginning of 2023 can be seen in Figure 2.8, where it is clear that NVIDIA's shares are more volatile than the S&P500 index.

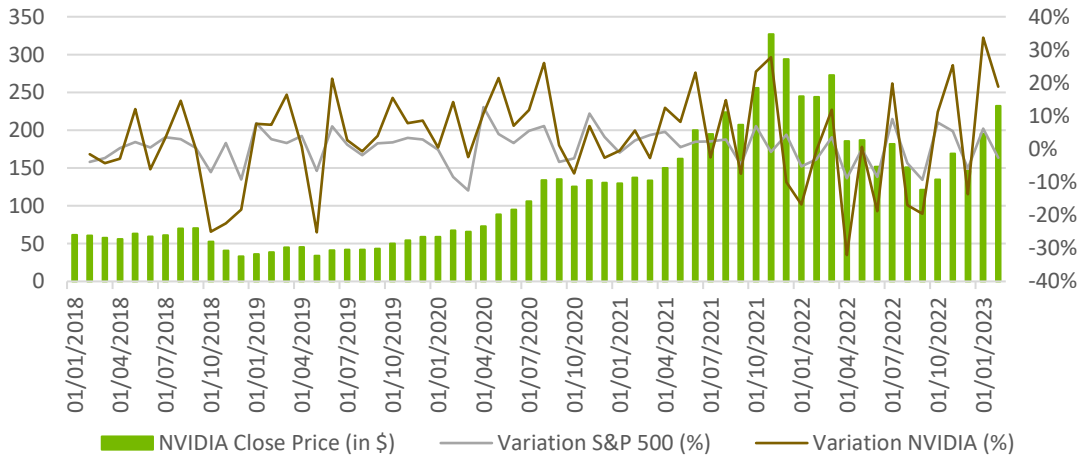


Figure 2.8: Stock performance (2018-2023). *Adapted from Reuters.*

2.5.2. Shareholder Structure

As of January 2023, NVIDIA Corporation had a total of 2.47 billion shares outstanding. According to NVIDIA's reports, these shares are mainly held by Institutional Investors, with 68% of total the company's outstanding shares. The Vanguard Group is the major shareholder, having a stake of about 8.27%, followed by BlackRock which owns 7.27% of shares outstanding and Fidelity Investments, representing 5.61%.

Regarding the other shares, 4% are held by individual insiders, such as directors and executive officers, with Jen-Hsun Huang (CEO) owning 86.4 million shares that corresponds to 3.5%. The general public hold a total of 28% of the total shares.

The figure presented below demonstrates the ownership breakdown:

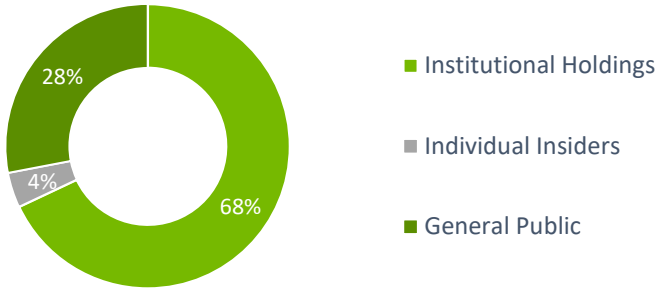


Figure 2.9: Ownership Breakdown. *Adapted from NVIDIA's FY2023 Annual Report.*

2.5.3. Dividend Policy

Since the end of 2018, NVIDIA has maintained a consistent cash dividend payment of $0.04 per share on a quarterly basis. Throughout FY2023, the company distributed dividends to shareholders, with the first payment made on March 22 and the last payment on November 30, which amounted to a total of $398 million in dividends to shareholders.

The company presented a relatively low payout ratio in FY2023, averaging about 9%. This ratio is significantly lower when compared to the average payout ratio of 30.4% observed in the technology sector. It can be explained by the fact that NVIDIA has focused more on reinvesting its profits into research and development, acquisitions, and expansion strategies, as well as its fast growth in recent years.

Moreover, the dividend yield was relatively small, with a value of 0.09% on the November 30 payment. This further highlights NVIDIA's focus on long-term value creation and sustained business development, as the company aims to reinvest its profits to drive future growth and innovation.

2.6. Summary analysis

NVIDIA remains one of the leading providers of GPU and artificial intelligence computing platforms and continued its upward trajectory in FY2023. The company's focus on innovation keeps it at the forefront, with recent product launches such as the RTX GPU, Ampere architecture GPU, GeForce Now and Drive platform playing a crucial role in several sectors, including gaming, healthcare, automotive and machine learning.

Benefiting from its strategic position in AI and gaming markets, NVIDIA reported robust financial performance with revenues of $26 974 million in FY2023, marking a substantial growth of 62% compared to FY2021. One notable highlight is the datacenter segment, which has emerged as a key revenue driver, contributing to 56% of the total revenues. Looking at additional performance metrics, NVIDIA showcased some growth in EBIT and Net Income, complemented by a strong operating efficiency, typified by an average EBITDA margin of 32.2% over the past five years. Moreover, the company exhibited strong return ratios, reflecting its efficiency and profitability, while liquidity ratios consistently exceeded 1, underscoring NVIDIA's ability to fulfill its short-term obligations.

Nonetheless, NVIDIA did face some challenges with the global chip shortage impacting the company's ability to meet demand, and the war in Ukraine disrupting supply chains, leading to oscillations in the share price throughout 2022. Despite these challenges, NVIDIA is well-positioned for long-term growth. The company is a leader in a rapidly growing market, and it has a strong track record of innovation. NVIDIA is also well-managed, with a strong balance sheet and a talented workforce.

3. Market Overview

The accurate valuation of a company is contingent upon an understanding of the broader macroeconomic and industry context since these factors can have a significant impact on a company's profitability and cash flow. As such, this section initiates a comprehensive examination of the macroeconomic overview, presenting global and domestic economic factors. The second subsection, industry overview, provides an in-depth investigation of the semiconductor industry. Finally, the competitors are analyzed to provide valuable insights into how NVIDIA measures up against its industry rivals within each segment it operates.

3.1. Macroeconomic Outlook

In this section, I explore the intricate landscape of global and domestic economic factors, considering both the broader global context and the economic indicators of the most influential countries where NVIDIA operates. This examination includes indicators such as GDP growth and inflation rates, providing valuable insights into market expectations and trends.

3.1.1 Globally

In 2022, the global economy experienced a notable slowdown influenced by various factors. One of them was the Russia's war in Ukraine, which resulted in an energy crisis in Europe, particularly marked by the increase of gas prices. Additionally, the resurgence of COVID-19 in China led to the implementation of new lockdowns measures, further impacting the global economic activity.

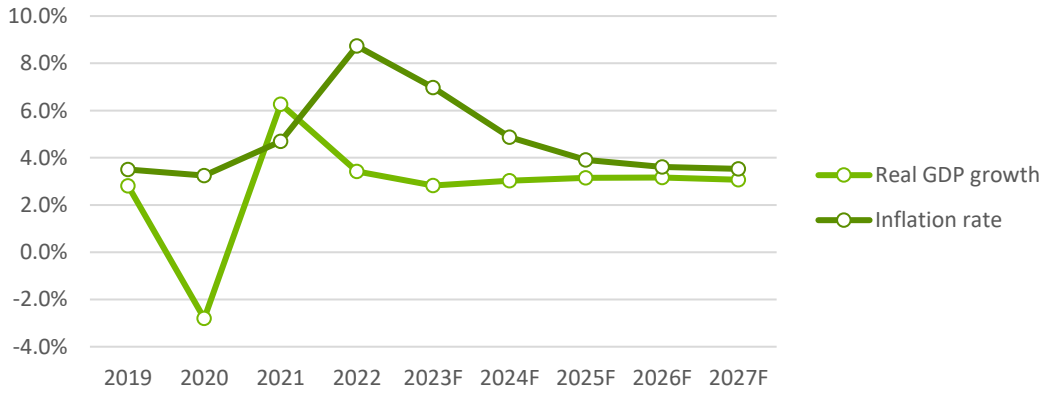


Figure 3.1: Global Indicators. *Adapted from IMF Database.*

The previously mentioned economic conditions can be observed by analyzing the GDP growth, it is also important to notice that, according to the International Monetary Fund (IMF), the projected growth of the global economy in upcoming years is expected to remain relatively constant, as

presented in Figure 3.1. Furthermore, looking at the year 2020 the effects of the pandemic are clearly visible, with a GDP growth of -2.81%.

This scenario of risk and uncertainty was accompanied by high inflationary pressures, originated by the increase in consumer prices and disruptions in supply chains. These circumstances have had adverse effects on both households and businesses. As the cost-of-living rises, individuals and families face the challenge of a smaller purchasing power of goods and services, while businesses confront increased production costs and limited access to essential inputs. In response to this high inflation, central banks have implemented various monetary policies, including a rise of interest rates. However, it is crucial to find the right balance between taming inflation and maintaining economic stability to avoid the risk of triggering a recession.

Upon examining Figure 3.1, it is possible to discern a distinct confirmation of what was previously mentioned, with a spike in the annual inflation rate clearly visible in 2022, reaching a value of 8.7%. This aligns with the previously provided explanations and insights. However, according to the 'IMF's projections, there is a forecasted decline in average consumer prices over the coming years. Specifically, the IMF anticipates a decrease to 7% in 2023, further declining to 4.9% in 2024 and reaching 3.9% in 2025. This reduction can be attributed to various factors, including the impact of interest rates hikes starting to take effect, the gradual normalization of demand leading to diminished supply constraints, and the adaptability of the food and energy industries in response to the global adverse scenario.

Moreover, geopolitical conflicts, particularly the tensions between Taiwan and China may cause implications for the global economy. These tensions have the potential to disrupt trade flows and hinder investment activities. A study conducted by Nikkei Asia has estimated that these conflicts may result in a substantial $2.6 trillion impact on the world economy.

3.1.2. United States

The United States, renowned as one of the world's leading economies, holds significant importance since it contributes to 39% of NVIDIA's total revenues. To gain valuable insights into the market, it is essential to examine the relevant macroeconomic indicators. In terms of GDP, it grew by 2.1% in 2022, mainly driven by the increase of consumer spending, however, it stands below the world GDP growth of 3.4%. According to the IMF, experts project a more moderate growth rate for the US in following years, with a forecast of 1.6% in Real GDP for 2023 and just 1% for 2024. This downward trend is attributed to a decrease in both private consumption and investment.

Another critical indicator to consider is inflation, which the Federal Reserve closely monitors to maintain price stability and avoid excessive inflationary pressures. In 2022 it reached 8%, as seen in

Figure 3.2, the highest since 1981. It is estimated that inflation will start to decline, with an estimated rate of 4.5% in 2023 and 2.3% for 2024, both values remain below the expected global trend.

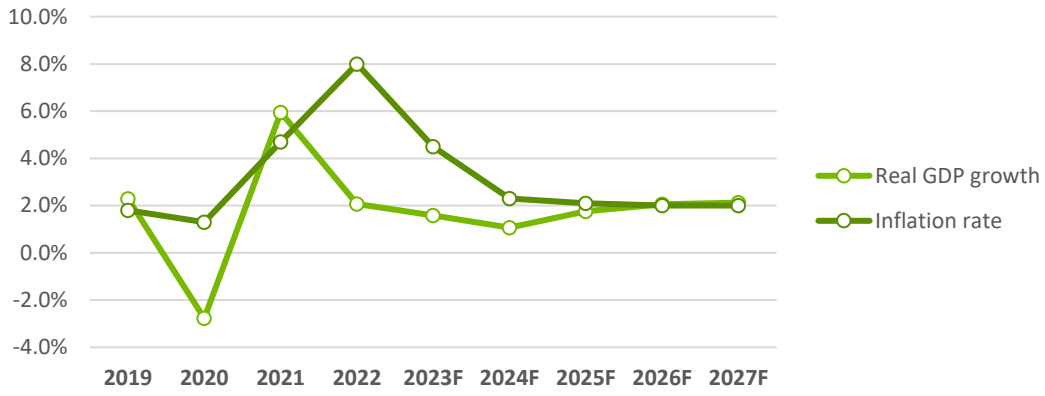


Figure 3.2: United States' Indicators. *Adapted from IMF Database.*

3.1.3. Taiwan

Taiwan has demonstrated a promising economic outlook in recent years, evident from its GDP growth rate of 6.5% in 2021. This expansion has been driven by the country's strong position in the global supply chain, particularly in the technology and electronics sectors. Notably, Bloomberg reports a significant year on year increase of 18.4% in Taiwanese semiconductor exports during 2022, underscoring their vital role in the global market, representing 60% of all microchips that are produced. Projections from the IMF further support this positive trend, forecasting continued economic growth for Taiwan with rates of 2.1% in 2023 and 2.6% in 2024.

The inflation outlook for Taiwan indicates a continuation of low levels. It is anticipated to decrease from 2.9% in 2022 to 1.7% in 2023, with a further decline to 1% in 2024, as shown in Figure 3.3. The government's firm controls, including measures like capping electricity and gas prices, combined with the underestimation of commodity prices, help to maintain inflation at levels below the global average. While these measures have been effective in the short term, there are concerns regarding their long-term sustainability. Eventually, as prices align with actual costs, there is a possibility of impact on consumers.

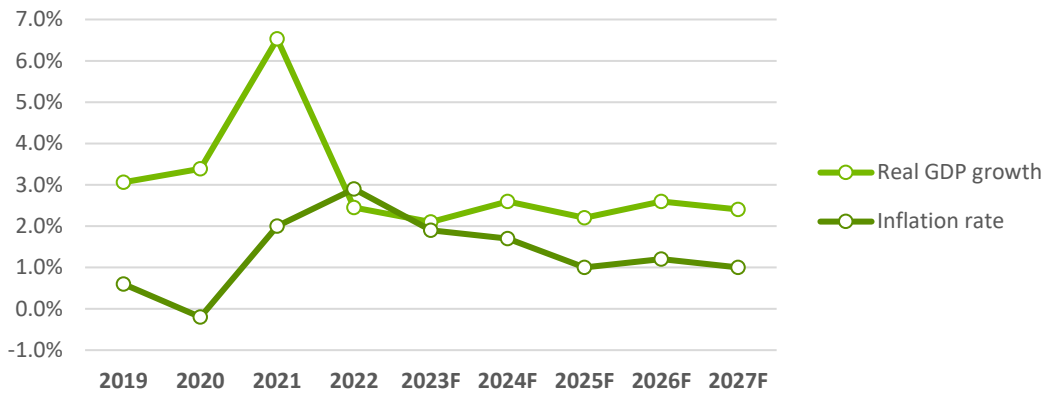


Figure 3.3: Taiwan's Indicators. *Adapted from IMF Database.*

3.1.4. China

In 2022, China experienced a notable slowdown of GDP growth reaching 3%. This represents a significant decrease compared to the 8.5% recorded in 2021. As explained before, this was mainly due to COVID-19 outbreaks and the implementation of strict public health measures. Nevertheless, the economy is expected to rebound in 2023, expanding by 5.2% (Figure 3.4) as consumer confidence improves, private consumption increases as well as services activities.

Inflation has been considerably low, being 1.9% in 2022 and is expected to reach a similar value in 2023 with 2% and 2.2% in 2024. It is important to note that in contrast to the relatively high inflation experienced in major economies worldwide, China exhibits low consumer inflation in its producer prices, accompanied by accommodative monetary policies.

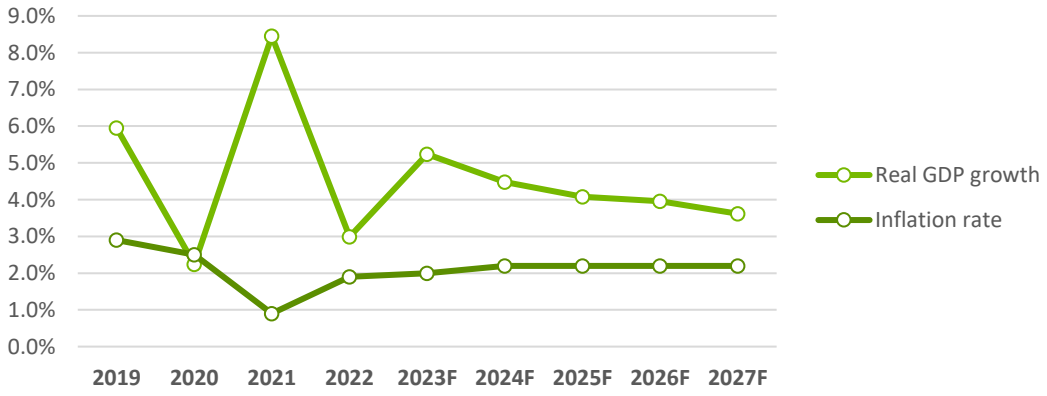


Figure 3.4: China's indicators. *Adapted from IMF Database.*

3.2. Industry Overview

This section provides an in-depth exploration of the semiconductor industry, segmented into the four key industry segments of NVIDIA. Understanding the value and growth prospects of these segments is

essential for gaining insights into how NVIDIA can maintain and potentially improve its competitive edge.

3.2.1. Data Center

The data center industry, which is valued at $263 billion, is experiencing a significant surge in growth and importance as the demand for data storage, processing, and cloud computing services continues to escalate. Additionally, the increasing adoption of AI and machine learning in a variety of industries further fuels this expansion. Accordingly, a share of its demand, that can be measured by the power consumption, is forecasted to grow by 10% a year in the US market alone until 2030.

With the shift to remote work and digital operations as a result of the pandemic, there has been a significant increase in data generation and storage needs. This surge in data has given rise to the emergence of hyperscale data centers, which can support robust and scalable applications, as well as handling significantly larger workloads. Companies such as Facebook, IBM, and Microsoft have been at the forefront of this trend, investing in the development of hyperscale data centers to meet the growing demand.

Moreover, as data centers consume substantial amounts of energy, there is an increasing focus on developing environmentally friendly practices and reducing carbon footprints. This presents a new business opportunity to develop computing solutions that not only prioritize optimized power consumption but also ensure high-quality data processing.

3.2.2. Gaming

The gaming market is continuously evolving, appealing to a diverse audience across various platforms. The rise of mobile gaming, online multiplayer experiences, and virtual reality technology has fueled the industry's growth and expanded its reach. According to BCG, the market is expected to reach a staggering $200 billion by 2025, representing a 15% increase. This growth is driven in part by the increased consumer base that surged during the pandemic and lockdowns. Moreover, the rise of Esports, which refers to organized competitive video gaming, has also had an impact on this growth. As more individuals discover the world of competitive gaming, professional gamers and esports teams seek products that provide the necessary performance and responsiveness required for competitive gaming.

As the gaming market continues to evolve, innovation and adaptability are crucial for companies like NVIDIA to stay at the forefront. With its ongoing investments in research and development, strategic partnerships, and advancements in technology, NVIDIA is well-positioned to capitalize on the industry's growth and cater to the evolving needs and preferences of gamers worldwide.

3.2.3. Professional Visualization

Professional visualization has a vast potential as technology continues to advance. Virtual reality and augmented reality are expected to play a pivotal role in transforming the way professionals visualize and interact with their designs. These immersive technologies enable users to step into virtual worlds and integrate digital information into the physical environment.

As industries across various sectors embrace digital transformation, the demand for professional visualization solutions has increased over the years and will continue to do so. This trend is evident in the report by Statista, which highlights that the global computer vision market, valued at $18.29 billion in 2022, is expected to reach $51 billion by 2030, marking a growth of 179%.

Furthermore, the rise of digital spaces, including the metaverse, introduces a captivating prospect for the future of professional visualization. The metaverse is envisioned as a platform that promotes collaboration, enabling individuals from different locations to work on projects of various sorts, share ideas, and collectively work on designs. However, the implementation of professional visualization solutions requires a highly skilled workforce and incurs significant installation costs for advanced workstations. These factors act as limiting factors to some extent.

3.2.4. Automotive

The automotive industry is undergoing a significant transformation driven by technological improvements and changing consumer demands. The rise of electrical vehicles is a prominent trend in this industry, with major automakers like Tesla, BMW and Mercedes investing heavily in electric vehicle technology, including computing platforms. Based on an article by Reuters, electric vehicles could represent nearly 26% of total vehicles produced globally, in 2029. Nevertheless, there are some constraints, such as the increase in prices of lithium-ion batteries (7% in 2022 when compared to the year before).

Another significant development is the progress in autonomous vehicles (AV). Breakthroughs in AI, sensor technology, and connectivity are paving the way for self-driving capabilities. According to McKinsey & Company, by 2035 the AV market has the potential to generate between $300 billion and $400 billion in revenue. Until developing fully autonomous and safe vehicles, some intermediate technologies have already been implemented and are experiencing growth. For instance, the Advanced Driver Assistance Systems (ADAS), which intends to reduce the number of accidents and mitigate the impact of those unavoidable.

3.3. Competitors

NVIDIA operates in a highly competitive market where several companies compete for market share and strive to establish their presence. Success in this dynamic industry is contingent upon pioneering innovation through extensive research and development, as well as leading the charge in technological advancements. Given NVIDIA's operations across multiple segments, it becomes crucial to assess the distribution of competitors within each market.

Regarding the gaming market, semiconductor company Advanced Micro Devices (AMD) offers a compelling alternative to NVIDIA's GeForce GPUs with their Radeon GPUs, particularly in terms of pricing. Furthermore, Intel Corporation, a dominant player in the Central Processing Unit (CPU) market, has ventured into the GPU gaming segment with their Intel Arc brand. Intel is starting to establish a strong presence in the discrete GPU market. Simultaneously it maintained an impressive 71% share of total PC GPU shipments in 2022, primarily driven by its integrated GPUs, as reported by Jon Peddie Research. However, it is worth noting that, according to the same research, NVIDIA maintained a dominant 85% market share of the discrete GPU market in Q4 FY2022, while AMD held 9% and Intel had 6%.

In the professional visualization segment, NVIDIA currently holds a significant 90% market share in graphics for workstations, according to its Q4 FY2023 presentation. Nevertheless, both AMD and Intel are emerging as competitors, with AMD's Radeon Pro GPUs and Intel's new Arc Pro series providing alternatives to NVIDIA's Quadro and RTX series.

Turning to the data center market, the previously mentioned companies continue to deliver high performance products designed for data processing and artificial intelligence workloads, specifically Intel's Xeon processors and AMD's Epyc CPUs. Notably, AMD's recent acquisition of Xilinx positions the company to exert significant influence on data center design. Additionally, companies like Dell Technologies, Cisco Systems and Hewlett Packard Enterprise also provide comprehensive data center solutions, including hardware, software, and services. Despite the intense competition, NVIDIA still powers 72% of the TOP500 supercomputers, as indicated in its Q4 FY2023 presentation.

In terms of the automotive segment, NVIDIA encounters competition from players that supply ADAS. Intel with its Mobileye platform and Texas Instruments with microcontrollers, processors, sensors, and power management devices are examples of such players. Another competitor is Qualcomm, a leading provider of mobile chipsets that also offers solutions for automotive infotainment systems and autonomous driving. Companies like Tesla, Inc which have internal teams focused on developing SoC products for internal use, present a potential threat to NVIDIA's expansion in the market.

3.4. Summary Analysis

In conclusion, the comprehensive market overview analysis encompassing the macroeconomic outlook, industry overview, and competitive landscape provides a well-rounded complement for the valuation of NVIDIA.

The examination of macroeconomic factors both globally and within key operating countries, namely the United States, China, and Taiwan, provided insights into the economic context that can impact the company's performance. Moreover, the forecasted moderate global economic growth and decreasing inflation levels are anticipated to drive demand for the industry's products and services.

Furthermore, the deep dive into the semiconductor industry, divided across various key segments, has highlighted the opportunities and growth potential within each sector where NVIDIA operates. The increasing demand for AI applications, cloud computing services, virtual reality technology, and advancements in the automotive industry are set to drive growth in these markets.

Lastly, the analysis of competitors has revealed NVIDIA's positioning within the competitive landscape, where it faces competition from companies like AMD and Intel across its business segments. While NVIDIA holds a significant market share across the different sectors, emerging competition in gaming and AI chip markets, for instance, highlights the need for continuous innovation to maintain its leadership position.

4. Valuation

As mentioned before, to initiate the valuation of NVIDIA, I start with the FCFF model in order to obtain the price of NVIDIA's shares by the end of January 2023. Additionally, a sensitivity analysis is performed to understand how changes in the WACC and Terminal Growth Rate (TGR) can influence the final share price. Lastly, the Relative Valuation is carried out by using a benchmark of similar companies to further enhance the analysis.

4.1. Assumptions

In the following sections, the several assumptions that were used to perform the valuation are presented and explained. These assumptions have been formulated after a comprehensive evaluation of various factors, including the company's historical performance, industry dynamics, prevailing macroeconomic conditions, and future outlook. The weight these assumptions carry in determining the results of the valuation makes it crucial to establish their coherence and provide robust justifications for their incorporation.

Moreover, regarding the DCF-FCFF model, it is important to understand that the cash flows were projected with a forecast period of 5 years (FY2024-FY2028), with a terminal growth rate being considered after the final year.

4.1.1. Revenues

Projecting revenue estimates is a pivotal aspect of this valuation due to its influence on several other critical inputs. When estimating the revenues growth, it is essential to avoid a generalized approach for the entire company, as it might oversimplify the valuation process, leading to inaccurate results. Instead, the various market segments where NVIDIA operates should be analyzed separately by considering both the historical performance of each business area and the main projections for the following years.

Starting with the data center segment, it has assumed a prominent role within NVIDIA over the past five years, showcasing an impressive CAGR of 51%, and has even surpassed the gaming segment in terms of revenue. The company's strategic dominance in AI chip demand places it in a favorable position to sustain its upward trajectory. Furthermore, industry reports, such as those from Statista, underscore this positive outlook by projecting a 42.3% CAGR in the AI chip market until 2028, driven in part by the increasing demand for AI applications such as generative AI.

The gaming sector is expected to grow in upcoming years due to the great demand for graphics cards used in gaming PCs as well as the rise of cloud gaming. NVIDIA currently has over 80% share of the discrete GPU market, so it is strategically positioned to capitalize on the growth projection. This

growth is expected to be greater than the previous five FYs which presented a CAGR of 10% mainly due to the decline in revenues in FY2023. Therefore, and according to some market reports, the gaming GPU market could grow at a 16.5% CAGR.

As the inventory correction is achieved, the professional visualization segment is poised for a rebound from its FY2023 dip, moving closer to its five-year 20% CAGR (FY2018-FY2022). The strong demand for workstations and the rise in popularity of the metaverse can also explain why the computer vision market is expected to show an annual growth rate of nearly 13% until 2030.

Regarding the automotive sector, NVIDIA has established itself as a leading provider of AI chips for self-driving vehicles, as well as the development of chips for infotainment and ADAS. Additionally, McKinsey's projections for the ADAS and autonomous driving sector to 2030 show a significant CAGR of 22%, which aligns with NVIDIA's strategic focus in this area.

Finally, the OEM & Other segment, historically volatile, has not been a major central point for NVIDIA. Hence, I have approached this segment conservatively, adopting a 1% annual growth assumption. This approach aims to moderately align the segment's growth trajectory with that of the broader company.

Table 4.1 presents the expected revenues of NVIDIA until FY2028:

Table 4.1: NVIDIA's Revenues Forecast. *Own Estimations.*

(in million $)	**FY2024 (F)**	**FY2025 (F)**	**FY2026 (F)**	**FY2027 (F)**	**FY2028 (F)**
Data Center	24 758	38 375	55 644	75 120	93 900
Growth	65.0%	55.0%	45.0%	35.0%	25.0%
Gaming	11 787	14 734	17 681	20 333	22 366
Growth	30.0%	25.0%	20.0%	15.0%	10.0%
Professional Visualization	1 930	2 355	2 802	3 250	3 673
Growth	25.0%	22.0%	19.0%	16.0%	13.0%
Automotive	1 129	1 383	1 659	1 950	2 242
Growth	25.0%	22.5%	20.0%	17.5%	15.0%
OEM & Other	460	464	469	473	478
Growth	1.0%	1.0%	1.0%	1.0%	1.0%
Total Revenues	**40 064**	**57 311**	**78 255**	**101 126**	**122 659**

Considering the previous forecasts and historical performances, I assumed an initial phase of relatively robust growth in the early projection years, gradually decreasing to a more conservative rate by FY2028. To ensure a smooth transition between these phases, I deducted a consistent value from the previous year for the interim years.

In conclusion, these projected revenues resulted in a CAGR (FY2024-FY2028) of 40% for Data Center, 17% for both Gaming and Professional Visualization, 19% for the Automotive segment, and 1% for OEM & Other.

4.1.2. EBITDA Margin

Over the past years, NVIDIA has focused on increasing its operational efficiency and profitability, by investing ahead of its competitors in the growth markets for the chip business, streamlining its operations and developing more profitable products. This approach has led to higher levels of profitability margins than its competitors, which has helped NVIDIA to become a dominant player in the semiconductor industry.

To forecast the EBITDA for the explicit period, I used the average of the EBITDA's margin over the last five years. This assumption suggests that operating expenses rise proportionally with revenues. Therefore, I calculated the average of EBTIDA as a percentage of revenues from FY2019 until FY2023, obtaining a value of 33.2% (please see Annex D). It is important to note that I excluded an expense related to the termination of the Arm share purchase agreement from FY2023, as this was a one-time event and could bias the results. Additionally, the average EBITDA margin obtained was only used for the first year of the projection. For the following years, I smoothed the values to reach 40% (closer to FY2022) by the final year. This is because I expect NVIDIA to bounce back from the dip in 2023 due to its competitive advantages and economies of scale.

In the following table, it is possible to observe the projection of NVIDIA's EBITDA by applying the EBITDA margin explained before:

Table 4.2: NVIDIA's EBITDA. *Own Estimations.*

(in million $)	**FY2024 (F)**	**FY2025 (F)**	**FY2026 (F)**	**FY2027 (F)**	**FY2028 (F)**
Revenues	40 064	57 311	78 255	101 126	122 659
EBITDA Margin	33%	36%	37%	39%	40%
EBITDA	**13 309**	**20 592**	**29 179**	**39 079**	**49 063**

4.1.3. Depreciation and Amortization (D&A)

The D&A covers the allocation of costs related to property and equipment depreciation and the gradual expensing of intangible assets. According to the FY2023 annual report of NVIDIA, these calculations are performed using the straight-line method, considering the estimated useful lifespan of each asset.

To forecast the D&A, I computed the historical values of D&A as a percentage of revenues over the past five years. Afterwards, the simple average of this ratio was calculated arriving at a value of

4.5% (please see Annex E). This average was applied to the projected revenues from FY2024 to FY2028, obtaining the following results for the D&A:

Table 4.3: NVIDIA's D&A Forecast. *Own Estimations.*

(in million $)	FY2024 (F)	FY2025 (F)	FY2026 (F)	FY2027 (F)	FY2028 (F)
Revenues	40 064	57 311	78 255	101 126	122 659
D&A/Revenues	4%	4%	4%	4%	4%
D&A	**1 795**	**2 567**	**3 505**	**4 530**	**5 494**

It is possible to observe in Table 4.3 an upward trajectory in D&A across the projected years. This trend mirrors NVIDIA's strategic focus on investing in new products, technologies and in intellectual assets.

4.1.4. CAPEX

Capital Expenditure (CAPEX) can be defined as the financial resources directed towards acquiring or improving long-term assets, such as property, plant and equipment. NVIDIA's FY2023 annual report does not provide specific details about CAPEX, so I used the item purchases related to property and equipment and intangible assets from FY2019 to FY2023 as a proxy. The value of this item increased over the years, but with some fluctuations along the way.

To estimate the company's future capital expenditures, I computed the average ratio of CAPEX over the revenues within the historical period and obtained a value of 5.4% (please see Annex F). This value was applied to the projected revenues:

Table 4.4: NVIDIA's Capex Forecast. *Own Estimations.*

(in million $)	FY2024 (F)	FY2025 (F)	FY2026 (F)	FY2027 (F)	FY2028 (F)
Revenues	40 064	57 311	78 255	101 126	122 659
CAPEX/Revenues	5.4%	5.4%	5.4%	5.4%	5.4%
CAPEX	**2 146**	**3 070**	**4 192**	**5 418**	**6 571**

The previous table shows that the CAPEX is expected to continue to grow in the coming years, following the rising trend observed in previous years. This demonstrates NVIDIA's ongoing investment in new products and expansion into new markets, which is essential for the company to maintain its competitive edge.

4.1.5. Effective Tax Rate

NVIDIA is subject to complex income tax laws and has consistently reported an effective tax rate that is much lower than the US statutory rate of 21%. This is due to a number of tax advantages that the company has, including the Foreign-Derived Intangible Income deduction, tax benefits related to stock-based compensation, and the US federal research tax credit.

Considering the previous benefits, it is expected that NVIDIA will continue to maintain a tax rate well below the 21% corporate tax rate of the US. Therefore, I opted to compute the average effective tax rate from FY2017 instead of FY2019, as there are two years showcasing income tax benefits, until FY2023. As shown in Annex G, the effective tax rates varied over the years, with an average of 5.3%. This average rate was used as a benchmark for the forecasting period.

4.1.6. Working Capital

Working capital (WC) is a measure of a company's short-term liquidity and operational efficiency, it can be calculated by the difference between operating current assets and operating current liabilities. A positive working capital indicates that a company has enough current assets to cover its current liabilities, which means that the company is able to meet its short-term financial obligations and grow its business. Moreover, it can indicate that the company requires additional funding.

The operating current assets include accounts receivables, inventories and prepaid expenses and other current assets. While the operating current liabilities include accounts payable, accrued expenses and other current liabilities. The WC of the historical years can be observed in the table below:

Table 4.5: NVIDIA's Historical WC. *Annual Reports from 2019 to 2023 & Own Estimations.*

(in million $)	**FY2019**	**FY2020**	**FY2021**	**FY2022**	**FY2023**
Accounts receivable, net	1 424	1 657	2 429	4 650	3 827
Inventories	1 575	979	1 826	2 605	5 159
Prepaid expenses and other current assets	136	157	239	366	791
A. Operating Current Assets	3 135	2 793	4 494	7 621	9 777
Accounts payable	511	687	1 201	1 783	1 193
Accrued Expenses	635	756	1 276	1 553	3 032
Other Current liabilities	183	341	449	999	1 088
B. Operating Current Liabilities	1 329	1 784	2 926	4 335	5 313
Working Capital (A-B)	**1 806**	**1009**	**1 568**	**3 286**	**4 464**

Overall, the WC increased over the years, with inventories and accounts receivable having the most weight, as well as accrued expenses.

To forecast the WC for the period FY2024-FY2028, I estimated the average Working Capital/Revenues ratio between FY2019 and FY2023, due to its strong correlation, obtaining a value of 13% (please see Annex H). In line with previous assumptions, I applied this average ratio to the expected revenues and obtained the following results:

Table 4.6: NVIDIA's WC Forecast. *Own Estimations.*

(in million $)	**FY2024 (F)**	**FY2025 (F)**	**FY2026 (F)**	**FY2027 (F)**	**FY2028 (F)**
Revenues	40 064	57 311	78 255	101 126	122 659
Working Capital/Revenues	13%	13%	13%	13%	13%
Working Capital	**5 033**	**7 200**	**9 832**	**12 705**	**15 410**
ΔWC	**569**	**2 167**	**2 631**	**2 873**	**2 705**

As anticipated, the WC is expected to grow in future years along with the revenues, suggesting NVIDIA's capability to fund its operations. Moreover, it is important to note that the change in WC is what will be necessary in the DCF computation, which is why it is presented in Table 4.6.

4.2. Discounted Cash Flow Valuation

To perform the DCF valuation, I began by estimating the Free Cash Flows to the Firm, the cost of capital and the terminal growth rate. Afterwards, I computed the equity value to arrive at the value per share, concluding this section with a sensitivity analysis.

4.2.1. Free Cash Flow to the Firm

After determining the main growth drivers for NVIDIA, it was possible to compute the Free Cash Flows for the explicit period using equation 2. It shows how much cash flow the company is generating after taking into account all of its expenses, including taxes, capital expenditures, and changes in working capital. The Free Cash Flow to the Firm is expected to increase over the years, as shown in Table 4.7:

Table 4.7: NVIDIA's Forecasted FCFF. *Own Estimations.*

(in million $)	**FY2024 (F)**	**FY2025 (F)**	**FY2026 (F)**	**FY2027 (F)**	**FY2028 (F)**
EBITDA	13 309	20 592	29 179	39 079	49 063
D&A	(1 795)	(2 567)	(3 505)	(4 530)	(5 494)
EBIT	11 514	18 025	25 674	34 549	43 569
Tax Value Rate: **5.3%**	(615)	(963)	(1 372)	(1 846)	(2 328)
NOPLAT	10 695	16 448	23 091	30 792	38 757
D&A	1 795	2 567	3 505	4 530	5 494
CAPEX	(2 146)	(3 070)	(4 192)	(5 418)	(6 571)
ΔWC	(569)	(2 167)	(2 631)	(2 873)	(2 705)
FCFF	**9 874**	**13 961**	**20 038**	**27 335**	**35 225**

4.2.2. Estimating the Cost of Capital

In this section, I present the key elements required to estimate the cost of capital, including the capital structure, the cost of equity and its components, and, lastly, the cost of debt.

4.2.2.1. Capital Structure

Concerning the market value of equity, it can be obtained by multiplying the number of shares outstanding at the end of FY2023 by the stock price on the same date. The FY2023 annual report states that there were 2 466 million shares outstanding, and according to Reuters on January 29, 2023, NVIDIA's stock stood at $191.62 per share. This means that the market value of equity for NVIDIA is $472 535 million.

The market value of NVIDIA's debt was determined by the fair value of its traded bonds, specifically senior unsecured notes. As of January 29, 2023, these notes were valued at $9 805 million. I also added the present value of operating leases, which is specified in the annual report to be $1 078 million. This led to a market value of debt of $10 833 million.

4.2.2.2. Cost of Equity

To obtain the cost of equity for NVIDIA, I used the Capital Asset Pricing Model. The CAPM is a model that estimates the expected return of an asset based on its beta, the risk-free rate, and the market risk premium.

Risk-free Rate

As suggested in the literature review, I used the US 10-year Treasury bill as a proxy for the risk-free rate. However, the observed yield of the bond at the end of January 2023 was 3.51%, which is notably higher when compared to previous years. This is due to the current macroeconomic conditions and geopolitical tensions, which have led to increased inflationary pressures.

While it is possible that these conditions will continue in the long term, it is unlikely. To account for this volatility, I computed the daily average of the 10-year Treasury yield over the last 2 years, resulting in a more accurate estimate of the risk-free rate at 2.1% that can be used in perpetuity.

Beta

The levered beta, which measures the volatility of a company's stock price relative to the market, was computed by using the bottom-up approach.

Firstly, it was necessary to obtain the unlevered beta. According to Damodaran's database[2], the unlevered beta of the semiconductor industry was 1.48 as of January 2023. This was computed by estimating the weighted average of the betas of the publicly traded companies that operate in this sector. Then, the levered beta, which considers the financial leverage, was estimated by using equation 8. This computation required to incorporate the debt-to-equity ratio of 0.023, the previously obtained unlevered beta and the tax rate of 5.3%, which resulted in a levered beta of 1.5.

Market Risk Premium

The market risk premium measures the additional return that investors demand for taking on the risk of investing in the stock market. Since NVIDIA is located in the United States, I considered the average market risk premium of the United States in 2022 provided by Statista, which was 5.6%.

Country Risk Premium

Another important variable to consider is the country risk premium, given NVIDIA's widespread operations across different countries. The Country Risk Premium (CRP) is a measure of the additional risk that investors face when investing in a foreign country, such as political instability, economic instability, or currency risk.

To compute the CRP, I used Damodaran's website database of January 2023 to obtain the values for the countries where NVIDIA is present. Afterwards, I calculated the weighted average of this variable per region by using the reported revenues for FY2023 as weighting factors. This approach yielded a country risk premium of 1.3% (please see Annex I).

[2] https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html.

Using the CAPM equation and the inputs calculated, I estimated the cost of equity, arriving at a value of 11.5%, as observable in the following table:

Table 4.8: NVIDIA's Cost of Equity. *Own Estimations.*

	Value
Risk Free Rate	2.1%
Levered Beta	1.5
MRP	5.6%
CRP	1.3%
Cost of Equity	**11.5%**

4.2.2.3. Cost of Debt

The cost of debt is an essential factor in determining the WACC and it reflects the risk associated with the company's borrowing. To determine this variable, since NVIDIA is rated, I followed Damodaran's suggestion to use the risk-free rate and adding it to the default spread on bonds associated with the rating of the company.

For the purpose of calculating the default spread I took into account NVIDIA's credit ratings in January 2023 as provided by both Moody's (A2) and Standard & Poor's (A). Consulting Damodaran's table (please see Annex J), which relates the rating of a company with a default spread, it is possible to observe that these ratings align with a spread of 1.42%. Therefore, by considering the risk-free rate computed before and the default spread, it was estimated a cost of debt of 3.5%. Given the applicable tax rate of 5.3%, the after-tax cost of debt was subsequently determined to be 3.3%.

4.2.2.4. WACC

After estimating all the variables, including the cost of debt, the cost of equity, the target capital structure, and the effective tax rate, I used equation 5 to calculate the WACC. The table below summarizes the inputs used in the calculation, which resulted in a WACC of 11.3%:

Table 4.9: NVIDIA's WACC. *Own Estimations.*

	Value
Cost of Debt	3.5%
Cost of Equity	11.5%
Equity/Capital	97.7%
Debt/Capital	2.3%
Tax Rate	5.3%
WACC	**11.3%**

4.2.3. Terminal Growth Rate

The TGR is the constant rate at which a company's free cash flows are assumed to grow in perpetuity after a certain point in time. It is an important measure in discounted cash flow valuation models since it helps to compute the terminal value of the company.

To calculate the TGR, I considered the GDP growth rate of the regions where NVIDIA operates (US, Taiwan, China, and other countries). Firstly, I used the average forecasted real GDP growth from 2023 to 2027 based on the projections of the IMF. I then applied a weighted percentage of the revenues per region, as provided by NVIDIA's annual report, to these rates (please see Annex K). This resulted in a terminal growth rate of 2.8%. It is worth noting that the contributions from emerging markets, especially China, played a significant role in arriving at this relatively high value.

4.2.4. Enterprise Value

Given the Free Cash Flow to the Firm computed before (see Table 4.7), the WACC of 11.3% and the terminal growth rate of 2.8%, it was possible to obtain the enterprise value. First, I had to discount the estimated cash flows generated by the company in each year at the WACC to account for their present value. Afterwards, assuming cash flows would grow at a constant rate in perpetuity, I applied a growth rate of 2.8% (TGR) to the FCFF of FY2028 to derive the FCFF in perpetuity. This allowed me to compute the Terminal Value using equation 4, which was then discounted to obtain its present value. As expected, the terminal value significantly contributes to the overall enterprise value, constituting 78% of the total value. Finally, the enterprise value was computed by summing the present value of the FCFF and the present value of Terminal Value.

Table 4.10: NVIDIA's Enterprise Value. *Own Estimations.*

(in million $)	**FY2023**	**FY2024 (F)**	**FY2025 (F)**	**FY2026 (F)**	**FY2027 (F)**	**FY2028 (F)**	**Perpetuity**
FCFF	-	9 978	14 392	20 984	28 942	37 459	38 525
WACC	-	-	-	-	-	-	11.3%
PV FCFF	-	8 961	11 609	15 201	18 830	21 888	
TGR	-	-	-	-	-	-	2.8%
Terminal Value	-	-	-	-	-	-	453 240
PV Terminal Value	-	-	-	-	-	-	264 837
Enterprise Value	**341 325**	-	-	-	-	-	-

4.2.5. Equity Value

To estimate NVIDIA's price per share, it was still necessary to compute the equity value. This is done by subtracting the company's debt and adding the value of its Non-Operating Assets (NOA). NVIDIA's NOA include cash and cash Equivalents, marketable securities, goodwill and investment in equity securities (please see Annex L). The equity value of $348 409 million was then divided by the 2 466 million shares outstanding, giving a target price of $141.29 per share, as shown in Table 4.11:

Table 4.11: NVIDIA's Equity Value. *Own Estimations.*

(*in million $*)	**FY2023**
Enterprise Value	341 325
NOA	17 967
Debt	(10 883)
Equity Value	**348 409**
Shares Outstanding	2 466
Value per Share (in $)	**141.29**

4.2.6. Sensitivity Analysis

The accuracy of the discounted cash flow method relies on the accuracy of the estimated variables, as more plausible assumptions lead to more precise valuations. To understand how changes in these assumptions could affect the estimated value of NVIDIA's share price, I conducted a sensitivity analysis.

The first variables considered were the terminal growth rate and the WACC, due to their high impact on the final value of the company. In this case, I explored the effects of deviating these variables several times by ±0.3% for both TGR and WACC from their initial values. The results of the sensitivity analysis are shown in the following table:

Table 4.12: NVIDIA's Sensitivity Analysis ($ per share). *Own Estimations.*

USD per share		**WACC**					
		10.7%	11.0%	**11.3%**	11.6%	11.9%	12.2%
TGR	1.9%	141.05	135.86	131.00	126.46	122.19	118.18
	2.2%	144.81	139.32	134.20	129.42	124.94	120.73
	2.5%	148.84	143.03	137.62	132.58	127.86	123.44
	2.8%	153.19	147.02	**141.29**	135.95	130.98	126.33
	3.1%	157.87	151.30	145.21	139.57	134.31	129.40
	3.4%	162.95	155.92	149.44	143.44	137.87	132.69

By analyzing the different scenarios presented, it is possible to observe that NVIDIA's share price ranged from a minimum of $118.18 (-16.4%) to a maximum of $162.95 (+15.3%). This demonstrates the sensitivity of the share price to changes in the WACC and TGR. Additionally, the WACC and the TGR have opposite effects. While an increase of the WACC decreases the share price, an increase of the terminal growth rate leads to a higher price. These changes in the growth rates can be due to a stronger or weaker performances of the main economies where NVIDIA operates; and the fluctuations of the WACC can be consequences of the financing programs in place or changes of the company's risk profile, for instance. The percentage changes previously mentioned can be observed in Table 4.13:

Table 4.13: NVIDIA's Sensitivity Analysis (% change). *Own Estimations.*

% change		WACC					
		10.7%	11.0%	**11.3%**	11.6%	11.9%	12.2%
TGR	1.9%	-0.2%	-3.8%	-7.3%	-10.5%	-13.5%	-16.4%
	2.2%	2.5%	-1.4%	-5.0%	-8.4%	-11.6%	-14.5%
	2.5%	5.4%	1.2%	-2.6%	-6.2%	-9.5%	-12.6%
	2.8%	8.4%	4.1%	**0.0%**	-3.8%	-7.3%	-10.6%
	3.1%	11.7%	7.1%	2.8%	-1.2%	-4.9%	-8.4%
	3.4%	15.3%	10.4%	5.8%	1.5%	-2.4%	-6.1%

Furthermore, examining the impact of revenue changes on the final price is of particular interest, as many assumptions are contingent on this variable. To do so, I decided to change the annual growth rate of the segment most susceptible to fluctuations, specifically the data center segment, where forecasts are heavily influenced by the evolution of the AI market and NVIDIA's competitive positioning. As such, each annual forecasted growth rate was subject to consistent fluctuations of ±2.5 percentage points (pp), for instance, in FY2024 instead of 65% growth rate, the value would be 67.5%. The resulting share prices are presented in Table 4.14:

Table 4.14: NVIDIA's Sensitivity Analysis (Revenues Growth Rate). *Own Estimations.*

	Growth Rate of Data Center								
	-10.0 pp	-7.5 pp	-5.0 pp	-2.5 pp	**0.0 pp**	2.5 pp	5.0 pp	7.5 pp	10.0 pp
USD per share	114.04	120.01	126.79	133.81	**141.29**	149.23	157.68	166.65	176.16
% Change	-19.3%	-15.1%	-10.3%	-5.3%	**0.0%**	5.6%	11.6%	17.9%	24.7%

Table 4.14 shows that the share price of NVIDIA fluctuates from $114.04 (-19.3%) to $176.16 (+24.7%) when compared to the DCF method. Notably, a 10 pp increase in the annual growth rate of the data center segment results in a share price of $176.16, closely mirroring the historical 5 year CAGR of 50%. This analysis shows that a less conservative approach and stronger confidence in the AI sector's future potential can yield considerably higher valuation outcomes.

In conclusion, the accurate estimation of the share price is a complex task, as small deviations of the variables can lead to relatively large changes in the value of the company.

4.3. Relative Valuation

As stated in the literature review, the relative valuation can be used to complement the Discounted Cash Flow model. This requires understanding how the market is pricing similar companies.

The first step is to choose an appropriate peer group. NVIDIA lists a number of companies in its annual report as its peers. These companies have well-established businesses with a similar market presence and level of complexity. Moreover, they tend to be aligned in terms of revenue and/or market capitalization. However, in order to have a more suitable peer group, companies that do not operate in the semiconductor industry were excluded from the sample under analysis.

Next, it was important to choose pertinent multiples to perform this valuation. Two distinct approaches were carried out, one based on the Equity Value and the other on Enterprise Value. As such, one multiple was chosen from each group, the Price to Earnings Ratio and the Enterprise Value to EBITDA, respectively.

Based on the data provided by Reuters, it was possible to obtain the values of the multiples per company. Then, I computed the comparable average for each multiple, as shown in the following table:

Table 4.15: NVIDIA's Peer Group. *Reuters.*

Company	P/E	EV/EBITDA
NVIDIA (NVDA)	116.9	63.34
Advanced Micro Devices, Inc. (AMD)	77.09	20.01
Broadcom Limited (AVGO)	19.67	13.6
Intel Corporation (INTC)	14.25	7.49
Qualcomm Incorporated (QCOM)	12.63	9.7
Texas Instruments Incorporated (TXN)	18.57	14.38
Comparable Average	**28.44**	**13.04**

Note. Tickers from each company are in brackets.

It is important to note both of NVIDIA's multiples are well above the ones obtained from the average of the peer group. This could mean that the market is pricing NVIDIA at a premium or that the company may be overvalued compared to its peers. This is consistent with the results of the discounted cash flow valuation.

To calculate the share price using the P/E multiple (28.44x), the net income of NVIDIA in FY2023 was multiplied by the ratio and then divided by the number of outstanding shares, which led to a share price of $50.38. Regarding the EV/EBITDA ratio, the average multiple was used together with the EBITDA of FY2023 to calculate an enterprise value of $75 192 million. Then, the equity value was deduced using a similar approach to the FCFF valuation, obtaining a value per share of $33.36 (Table 4.16).

Table 4.16: NVIDIA's Relative Valuation. Own Estimations, NVIDIA's Annual Report 2023.

(*in million $*)	**P/E**	**EV/EBITDA**
Multiple	28.44x	13.04x
Net income	4 368	-
EBITDA	-	5 768
Enterprise Value	-	75 192
NOA	-	17 967
Debt	-	10 883
Equity Value	124 235	82 276
Shares outstanding	2 466	2 466
Value per share	**$50.38**	**$33.36**

4.4. Valuation Results

The following table summarizes the different outputs that result from the estimation of the fair value of NVIDIA through the DCF model and the Relative Valuation at the end of January 2023.

Table 4.17: Valuation Results. *Own Estimations, Yahoo Finance.*

Model	**Share Price**
Market Value	$191.62
FCFF	$141.29
P/E	$50.38
EV/EBITDA	$33.36

Table 4.17 shows that the FCFF model yielded the highest price, with a value of $141.29, representing a decrease of 27% when compared to the market value ($191.62) at the reference date. The disparity can be justified by various reasons, such as the model's inherent limitations or the assumptions made due to the current period of uncertainty. However, the most probable explanation is the high expectations of investors in the AI market, leading to very optimistic growth assumptions. However, should these growth projections fall short of expectations, NVIDIA's stock price could become vulnerable to a decline. Therefore, according to the FCFF methodology, the indication is that the fair value of NVIDIA's shares is lower than the one observed in the market, hence they are overvalued.

According to the relative valuation, the final recommendation remains unchanged, to sell, as the derived price was lower than the reference market value. Furthermore, as previously stated, NVIDIA exhibits substantially larger multiples than its peers, with a P/E of 116.9x (4 times bigger than the comparable average) and an EV/EBITDA of 63.34x (nearly 5 times bigger than the comparable average). This further reinforces the idea that investors may be paying a premium for the company's growth prospects.

It is worth noting that NVIDIA's share prices have demonstrated significant volatility, often inclined towards growth. For instance, at the end of 2022, they were worth $146, having been valued at $180 merely two weeks earlier. This highlights the challenges of predicting and capturing its market behavior.

In conclusion, when navigating the complexities of valuation, it is crucial to recognize that while the current market sentiment may drive elevated valuations, such optimism must be weighed against the company's fundamental performance and potential risks. With this in mind, the results of this valuation underscore the belief that, at the end of January 2023, the market was assigning a premium to the value of NVIDIA's shares which potentially exceeded their intrinsic worth.

Conclusion

The main purpose of this report was to estimate the fair value of NVIDIA's shares as of 29 January 2023 and compare it with the actual closing price. Therefore, and to reach trustworthy results, I employed two distinct valuation methodologies, the DCF method, using the FCFF approach, and the Relative Valuation method to complement the analysis.

The FCFF method, as my primary approach, involved projecting future cash flows and discounting them to their present value using an appropriate discount rate, the WACC. This model relied on several assumptions that had to be carefully established to reflect the dynamic landscape in which NVIDIA operates, considering factors such as the evolving semiconductor industry, technological advancements, current macroeconomic trends and historical company data. Moreover, a sensitivity analysis was performed to address the uncertainty surrounding these assumptions, which could impact the final price.

Regarding the Relative Valuation, it provided an additional perspective by comparing NVIDIA to a carefully selected group of five peer companies within the semiconductor industry. This method involved the use of relevant financial multiples, specifically the P/E and EV/EBITDA. The greater the similarity between the chosen peer companies and NVIDIA, the more precise the results, and the better they complemented the conclusions derived from the DCF model.

Despite the variations observed in the valuation results, both methods indicated that NVIDIA's stock was overvalued at the end of January 2023 (close price of $191.62). Among the models explored, the DCF-FCFF model generated the highest share price estimate at $141.29. Even in the most optimistic scenarios presented in the sensitivity analysis, the valuation remained significantly lower than the market price. This was followed by the P/E ratio valuation, yielding a price of $50.38, while the EV/EBITDA reached a target price of $33.36.

It is crucial to acknowledge that the findings of this report are influenced by both the constraints inherent to the valuation methods employed and the assumptions formulated. Additionally, while this analysis provides insights into NVIDIA's valuation at a specific point in time, the company's prospects may evolve in response to changing market dynamics. For instance, there may be an unforeseen surge in demand for AI applications, surpassing initial forecasts, with more supercomputers being built and AI driven solutions being created for existing and new markets.

Finally, it is advisable that future equity valuations of NVIDIA are conducted with updated information regarding the evolving landscape of AI and after the initial phase of intense market enthusiasm has subsided.

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Annexes

Annex A: Historical Balance Sheet

(in million $)	FY2019	FY2020	FY2021	FY2022	FY2023
ASSETS					
Current assets					
Cash and cash equivalents	782	10 896	847	1 990	3 389
Marketable securities	6 640	1	10 714	19 218	9 907
Accounts receivable, net	1 424	1 657	2 429	4 650	3 827
Inventories	1 575	979	1 826	2 605	5 159
Prepaid expenses and other current assets	136	157	239	366	791
Total Current assets	**10557**	**13 690**	**16 055**	**28 829**	**23 073**
Non-current assets					
Property and equipment, net	1 404	1 674	2 149	2 778	3 807
Operating lease assets	-	618	707	829	1 038
Goodwill	618	618	4 193	4 349	4 372
Intangible assets, net	45	49	2 737	2 339	1 676
Deferred income tax assets	560	548	806	1 222	3 396
Other assets	108	118	2 144	3 841	3 820
Total Non-Current assets	**2735**	**3 625**	**12 736**	**15 358**	**18 109**
Total assets	**13 292**	**17 315**	**28 791**	**44 187**	**41 182**
LIABILITIES					
Current liabilities					
Accounts payable	511	687	1 201	1 783	1 193
Accrued and other current liabilities	818	1 097	1 725	2 552	4 120
Short-term debt	-	-	999	-	1 250
Total current liabilities	**1 329**	**1 784**	**3 925**	**4 335**	**6 563**
Non-current liabilities					
Long-term debt	1 988	1 991	5 964	10 946	9 703
Long-term operating lease liabilities	-	561	634	741	902
Other long-term liabilities	633	775	1 375	1 553	1 913
Total non-current liabilities	**2 621**	**3 327**	**7 973**	**13 240**	**12 518**
Total liabilities	**3 950**	**5 111**	**11 898**	**17 575**	**19 081**
EQUITY					
Preferred stock	-	-	-	-	-
Common stock	1	1	1	3	2
Additional paid-in capital	6 051	7 045	8 721	10 385	11 971
Treasury Stock	(9 263)	(9 814)	(10 756)	-	-
Accumulated other comprehensive loss	(12)	1	19	(11)	(43)
Retained earnings	12 565	14 971	18 908	16 235	10 171
Total equity	**9342**	**12 204**	**16 893**	**26 612**	**22 101**

Source: NVIDIA's Annual Reports from 2019 to 2023.

Annex B: Historical Income Statement

(in million $)	FY2019	FY2020	FY2021	FY2022	FY2023
Revenues	11 716	10 918	16 675	26 914	26 974
Cost of Revenue	4 545	4 150	6 279	9 439	11 618
Gross Profit	**7 171**	**6 768**	**10 396**	**17 475**	**15 356**
Operating Expenses					
Research and development	2 376	2 829	3 924	5 268	7 339
Sales, general and administrative	991	1 093	1 940	2 166	2 440
Acquisition termination cost	-	-	-	-	1 353
Total operating expenses	**3 367**	**3 922**	**5 864**	**7 434**	**11 132**
Income from operations	**3 804**	**2 846**	**4 532**	**10 041**	**4 224**
Interest income	136	178	57	29	267
Interest expense	(58)	(52)	(184)	(236)	(262)
Other,net	14	(2)	4	107	(48)
Other income expense,net	**92**	**124**	**(123)**	**(100)**	**(43)**
Income before taxes	**3 896**	**2 970**	**4 409**	**9 941**	**4 181**
Income tax expense (benefit)	(245)	174	77	189	(187)
Net consolidated income	**4 141**	**2 796**	**4 332**	**9 752**	**4 368**
Other comprehensive income (loss), net of tax					
Available-for-sale debt securities	11	8	-	(16)	(30)
Cash flow hedges	(5)	5	18	(14)	(2)
Total other comprehensive income (loss), net of tax	**6**	**13**	**18**	**(30)**	**(32)**
Total comprehensive income	**4 147**	**2 809**	**4 350**	**9 722**	**4 336**

Source: NVIDIA's Annual Reports from 2019 to 2023.

Annex C: Revenues per segment

(in million $)	FY2019	FY2020	FY2021	FY2022	FY2023
Data Center	2 932	2 983	6 696	10 613	15 005
Growth	-	2%	124%	58%	41%
Gaming	6 246	5 518	7 759	12 462	9 067
Growth	-	-12%	41%	61%	-27%
Professional Visualization	1 130	1 212	1 053	2 111	1 544
Growth	-	7%	-13%	100%	-27%
Automotive	641	700	536	566	903
Growth	-	9%	-23%	6%	60%
OEM & Other	767	505	631	1 162	455
Growth	-	-34%	25%	84%	-61%
Total Revenues	11 716	10 918	16 675	26 914	26 974

Source: NVIDIA's Annual Reports from 2019 to 2023, Own Calculations.

Annex D: Historical EBITDA Margin

(in million $)	FY2019	FY2020	FY2021	FY2022	FY2023
Revenues	11 716	10 918	16 675	26 914	26 974
EBITDA	4 066	3 227	5 630	11 215	7 121
EBITDA Margin	35%	30%	34%	42%	26%

Source: NVIDIA's Annual Reports from 2019 to 2023, Own Calculations.

Annex E: Historical Depreciation & Amortization/Revenues

(in million $)	FY2019	FY2020	FY2021	FY2022	FY2023
Revenues	11 716	10 918	16 675	26 914	26 974
D&A	262	381	1 098	1 174	1 544
D&A/Revenues	2%	3%	7%	4%	6%

Source: NVIDIA's Annual Reports from 2019 to 2023, Own Calculations.

Annex F: Historical CAPEX/Revenues

(in million $)	FY2019	FY2020	FY2021	FY2022	FY2023
Revenues	11 716	10 918	16 675	26 914	26 974
CAPEX	600	489	1 128	976	1 833
CAPEX/Revenues	5.1%	4.5%	6.8%	3.6%	6.8%

Source: NVIDIA's Annual Reports from 2019 to 2023, Own Calculations.

Annex G: Computation of the Historical Tax rate

(in million $)	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023
Income before taxes	1905	3196	3 896	2 970	4 409	9 941	4 181
Income tax expense (benefit)	239	149	-245	174	77	189	-187
Tax rate	13%	5%	-	6%	2%	2%	-

Source: NVIDIA's Annual Reports from 2019 to 2023, Own Calculations.

Annex H: Historical Working Capital/Revenues

(in million $)	FY2019	FY2020	FY2021	FY2022	FY2023
Revenues	11 716	10 918	16 675	26 914	26 974
Working Capital/Revenues	15%	9%	9%	12%	17%
Working Capital	**1806**	**1009**	**1568**	**3286**	**4464**
ΔWC	-	(797)	559	1 718	1 178

Source: NVIDIA's Annual Reports from 2019 to 2023, Own Calculations.

Annex I: Computation of the Weighted CRP

Country	Revenues (million $)	Revenues (%)	Weighted CRP (%)
US	8 292	31%	0.0%
Taiwan	6 986	26%	0.3%
Other Countries	5 911	22%	0.8%
China (including Hong Kong)	5 785	21%	0.3%
Total	**26974**	**100%**	**1.3%**

Source: NVIDIA's Annual Reports from 2019 to 2023, Damodaran's Database, Own Calculations.

Annex J: Credit Risk Rating

Rating	Spread
D2/D	20.00%
C2/C	17.50%
Ca2/CC	15.78%
Caa/CCC	11.57%
B3/B-	7.37%
B2/B	5.26%
B1/B+	4.55%
Ba2/BB	3.13%
Ba1/BB+	2.42%
Baa2/BBB	2.00%
A3/A-	1.62%
A2/A	1.42%
A1/A+	1.23%
Aa2/AA	0.85%
Aaa/AAA	0.69%

Source: Damodaran's Database.

Annex K: Computation of the Terminal Growth rate

Country	Weights	Average GDP Growth	Weighted Growth Rate
US	31%	1.7%	0.5%
Taiwan	26%	2.5%	0.6%
Other Countries	22%	3.2%	0.7%
China (including Hong Kong)	21%	4.5%	1.0%
Total	**100%**	**-**	**2.8%**

Source: IMF Database, Own Calculations.

Annex L: Non-operating Assets (FY2023)

Inputs	Value (million $)
Cash and Cash Equivalents	3 389
Marketable Securities	9 907
Goodwill	4 372
Investments in Equity Securities	2 99
NOA	**17 967**

Source: NVIDIA's Annual Report of 2023, Own Calculations.