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How Capital Structure and Debt drive Valuation: an empirical study on Volkswagen AG

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A mia madre, a mio padre, alla mia famiglia

Per tutte le volte che credevo di non farcela

INTRODUCTION TO THE FINAL DISSERATION

In 2015, the German automotive manufacturer Volkswagen Automotive Group was hit by a scandal related to cheating in carbon emission tests: in just a few days its ordinary share price dropped by 19% and EUR 14 Billion in market capitalization were burn. However, if we consider the last decade, that one was not the only negative and impactful event on the company's market value: also Covid-19 spread and the recent Ukraine war were relevant in this context. This could look as a normal situation for every company that faced a decrease in market Equity value, but the case involving this group is particular if we also consider its high level of indebtedness and the fact that only external events (so not directly related to the productivity and profitability of the firm) impacted on its market cap. Despite a successful IPO of what previously was just a brand under the group, Porsche AG, the automotive group's 2022 common shares closing price of EUR 147.65 looks too poor with respect to the huge investments made in the last few years by the company in the perspective of a Battery Electric Vehicle transition. Recently, various stakeholder of the company, as the management and the State of Lower Saxony, one of the company's main shareholders, affirmed that the company was really undervalued according to their perspective. Moreover, also institutional investors and banks as BNP Paribas, JP Morgan, Morgan Stanley and Jefferies affirmed that the market is strongly undervaluing the potential of the German automaker. The main purpose of this final dissertation is to carry a realistic valuation of the firm and state if the company is really undervalued. We will also investigate if and how the high level of debt (and so the tax shields generated by high interest expenses) can contribute to determine target price.

Moreover, this final dissertation will investigate Volkswagen Automotive Group, referred to as Volkswagen AG, VW AG or the target, in all its aspect. The valuation of the company is carried according to different valuation methods, based either on the market or on the company's ability to generate cash flows.

This thesis is divided in four different chapters. The first two chapters recall a theoretical background, in the context of the estimation of a firm's value, referring to the firm's value theory by Modigliani and Miller. The reader will first understand the theory behind the computation of cost of capital and why different discount rates are applied for cash flows directed to equity holders, debt holders or for an entire firm's cash flows. Several theories related to the estimation of Cost of Equity are presented and the validity, at least in the practical approach by professionals, of the Capital Asset Pricing Model is affirmed. After, the main valuation methods to value the Enterprise or Equity Value of a firm will be discussed. The main characteristics, advantages and drawbacks of each of the enounced methods are considered. The third chapter, core of this study, analyzes Volkswagen AG from different perspectives. After the historical background of the company is given, its shareholding structure is presented. In fact, even if our main objective is to value the fair price of ordinary shares (VOW), it is necessary, for the same purpose, to include and consider also preferred shares (VOW3) into the estimation. VW AG high absolute amount of financial debt, computed through a balance sheet reclassification, and its inconstant level of market D/E ratio will be displayed and play a key role in this context. We will finally dive deep into the high level of Fixed Costs,

CapEx and R&D of Volkswagen AG with respect to its peers and understand which is the relation between these high investments, the highly leveraged financing and the Green Financing Framework, under which the group aims to increase its revenue pool deriving from new generation Battery Electric Vehicles.
In the fourth and final chapter, some of the most valid and fitting valuation methods for our case will be exploited. From relative methods, the most reliable ranges of fair price for VW AG ordinary shares will be selected and compared with the price ranges obtained from intrinsic valuation methods. We will so be able to affirm which method attributed the closest price to the one implicitly attributed to the market. Moreover, each method will not be analyzed only considering its final output but also how the Enterprise Value "value creation" is driven and if and how interest tax shields, given the high debt level of the group, are able to contribute to the price computation.
The dissertation will so try to answer to the following questions:

- Are Volkswagen Automotive Group correctly/under/overpriced according to the main valuation methods?
- Which method highlights the most the benefits related to Interest Tax Shields and is the best to apply? Which method highlights them the less?
- Which are the advantages of Adjusted Present Value?

CHAPTER 1: VALUATION – COST OF CAPITAL

In *Chapter 1* of this final dissertation the main components of cost of capital for a target's valuation will be analyzed.

First, theory by Modigliani and Miller will be analyzed, in order to understand clearly why, for a company presenting leverage in its capital structure, both Cost of Equity and Cost of Debt are necessary to compute the overall company Cost of Capital. A relevant section, also given by their importance in the following chapters, is granted to Tax Shields and to the Theory of Capital Structure.

After, each single component will be better defined with the relevant formulas to obtain it.

So, both Capital Asset Pricing Model and other Multifactor Models (Arbitrage Pricing, Fama-French 3 factor, Carhart 4 factor and Fama-French 5 factor models) will be covered in the perspective of computing the target's Cost of Equity. Various methodologies to capture the Default Spread, a key input in the estimation of Cost of Debt, are presented.

Finally, after a clear understanding on how to estimate these two main inputs, *Chapter 1* concludes introducing the Weighted Average Cost of Capital (the overall company Cost of Capital).

The first chapter of this dissertation represents, with the second one, the conceptual base on which Volkswagen's valuation will be carried in *Chapter 4*.

1.1 MODIGLIANI & MILLER CONTRIBUTION

Financing a firm exclusively with equity is not the entrepreneur's only option: capital can also come from debt financing. An obvious question coming to mind is: how does the capital structure of a company (so the mix of equity and/or debt financing) impact firm's valuation and price? Is there a particular rule able to explain which is the best capital structure a company could adopt?

In an important paper *Modigliani and Miller* (M&M)[1] developed a rationale to be adopted regarding the financing decisions of any firm, when returns of securities or cash flow are uncertain. They first developed their propositions in absence and after in presence of taxes.

Given no taxation, M&M theorem argues that the value of a firm is unaffected by its financial structure[2]. This statement went against the common view of the times which stated that, even with perfect capital markets, leverage would affect a firm's value. Therefore, it is inappropriate to discount the cash flows of levered equity at the same discount rate used for unlevered equity.

M&M elaborate this theory in the context of Perfect Capital Markets[3]. In this environment:

- Investors and firms can trade the same set of securities at competitive market prices equal to the present value of their future cash flows;
- There are no taxes, transaction costs, or issuance costs associated with security trading;
- A firm's financing decisions do not change the cash flows generated by its investments, nor do they reveal new information about them.

M&M 1st proposition affirms that *in a perfect capital market, the total value of a firm's securities is equal to the market value of the total cash flows generated by its assets and is not affected by its choice of capital structure*.

$$V_{UNLEVERED} = V_{LEVERED}$$
$$V_{UNLEVERED} = E_{UNLEVERED}$$
$$V_{LEVERED} = E_{LEVERED} + D_{LEVERED}$$

The overall value of a company is only related to the profitability and risk characteristics of its real asset and changes in capital structure are irrelevant to determine its value.

To understand now M&M 2nd proposition, we start using M&M 1st proposition to derive an explicit relationship between leverage and the equity cost of capital. Let E and D denote the market value of equity

[1] Modigliani and M. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review* 48(3) (1958): 261–297.

[2] Modigliani, F. and Miller, M. H. (1958) 'The Cost of Capital, Corporation Finance and the Theory of Investment', *The American Economic Review*, 48 (3), pp. 261-297.

[3] Berk, DeMarzo, "Corporate Finance" (2017), pag 525

and debt if the firm is levered, respectively; let U be the market value of equity if the firm is unlevered; and let A be the market value of the firm's assets. 1st proposition states that:

$$E + D = U = A$$

So, regardless of the proportion of debt and equity, the overall value of the company will not change. We can also interpret it in another way: by holding a portfolio of the firm's equity and debt, we can replicate the cash flows from holding unlevered equity. Because the return of a portfolio is equal to the weighted average of the returns of the securities in it, this equality implies the following relationship between the returns of levered equity (R_E), debt (R_D), and unlevered cost of capital (R_U):

$$\frac{E}{E+D}R_E + \frac{D}{E+D}R_D = R_U$$

Rearranging the above formula, we get the one representing M&M 2nd proposition:

$$R_E = R_U + \frac{D}{E}(R_U - R_D)$$

This equation reveals the effect of leverage on the return of the levered equity. The levered equity return equals the unlevered return, plus an extra "kick" due to leverage. This extra effect pushes the returns of levered equity even higher when the firm performs well ($R_U > R_D$), but makes them drop even lower when the firm does poorly ($R_U < R_D$). The amount of additional risk depends on the amount of leverage, measured by the firm's market value debt-equity ratio, D/E.

M&M 2nd proposition can be sum up: *the cost of capital of levered equity increases with the firm's market value debt-equity ratio.* Cost of equity of a levered firm depends on just 3 elements: the firm's required rate on return on assets, the cost of debt and the debt-to-equity ratio[4].

In addition to that, because we are in a setting of perfect capital markets, there are no taxes, so the firm's WACC (that will be covered deeply in *Paragraph 1.2.4*) and unlevered cost of capital (that will be covered more deeply in *Paragraph 2.2.5*) coincide:

$$R_{WACC} = R_U$$

With perfect capital markets, a firm's WACC is independent of its capital structure and is equal to its equity cost of capital if it is unlevered, which matches the cost of capital of its assets[5]. As the firm borrows at the low cost of capital for debt, its equity cost of capital rises according to 2nd proposition equation. The net effect is that the firm's WACC is unchanged (*Figure 1*).

[4] Berk, DeMarzo, "Corporate Finance" (2017), pag 531
[5] Berk, DeMarzo, "Corporate Finance" (2017), pag 532

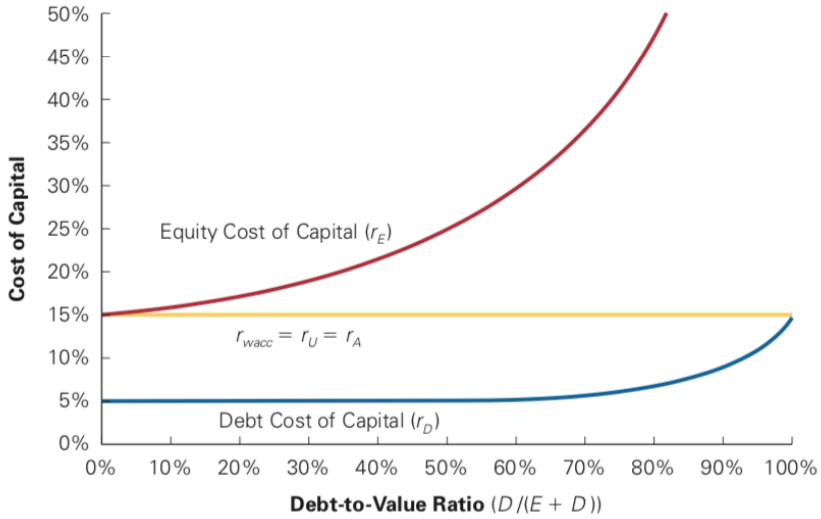

Figure 1: WACC and Leverage with Perfect Capital Markets
Source: Berk, DeMarzo, "Corporate Finance" (2017), pag 532

Despite of what was previously described, in real world, capital structure matters. Thus, if capital structure matters, then it must stem from a market imperfection. In this context, market imperfection are taxes. Corporations must pay taxes on the income they earn. Because they pay taxes on their profits after interest payments are deducted, interest expenses reduce the amount of corporate tax firms must pay. This feature of the tax code creates an incentive to use debt[6].

Modigliani and Miller, to create a model applicable in real world, dropped the no-taxation hypothesis and re-formulated M&M 1st and 2nd propositions in presence of taxes. They demonstrated that *the value of a company is correlated positively to its debt, or better, to the tax benefit associated with its debt*[7]. The gain to investors from tax deductibility of interest payments is referred as the Interest Tax shield and represents the additional amount that a firm would have paid in taxes if it did not have leverage. We can calculate the amount of the interest tax shield each year as follows:

$$\text{Value of Interest Tax Shield} = \text{Corporate Tax Rate} \times \text{Interest Payments}$$

In the case analyzed by M&M, debt and cash flows of the company are in the form of perpetuity[8], and The Value of the Interest Tax Shield is discounted at R_D to get its Present Value.

$$\text{Present Value of Interest Tax Shield} = \text{Corporate Tax Rate} \times \text{Debt}$$

M&M 1st proposition in presence of taxes becomes:

[6] Berk, DeMarzo, "Corporate Finance" (2017), pag 552
[7] Modigliani, F. and Miller, M. H. (1963) 'Corporate Income Taxes and the Cost of Capital: A Correction', *The American Economic Review*, 53 (3), pp. 433-443.
[8] The firm borrows a certain amount D of debt and maintains that exact level of debt permanently

$$V_L = V_U + \text{Corporate Tax Rate} \times \text{Debt}$$

Each year a firm makes interest payments, the cash flow it pays to investors will be higher than it would be without leverage by the amount of the interest tax shield. M&M 1st proposition in presence of taxes states that *the total value of the levered firm exceeds the value of the firm without leverage due to the present value of the tax savings from debt* [9].

M&M 2nd proposition equation becomes:

$$R_E = R_U + \frac{D}{E}(R_U - R_D) \text{ (1- Corporate Tax Rate)}$$

As in the no-taxation hypothesis, the financial leverage increases the cost of equity. WACC is no longer equal to R_A(Return on company's assets), R_U(Unlevered Cost of Capital) and the pre-tax WACC, but it is lower, due to the tax advantage provided by interest payments.

$$R_{WACC} = \frac{E}{E+D}R_E + \frac{D}{E+D}R_D\ (1 - Corporate\ Tax\ Rate)$$

$$R_{WACC} = \frac{E}{E+D}R_E + \frac{D}{E+D}R_D - \frac{D}{E+D}R_D(Corporate\ Tax\ Rate)$$

Technically, after all that was described above, one could think a firm could totally substitute equity with debt to increase its value (without taking in consideration side effects of debt financing as financial distress). In fact, following Modigliani and Miller's logic, the more debt increases, the more the firm's value increases.

In real world, debt financing always presents a certain degree of riskiness. Nevertheless, each firm should understand which is the optimal capital structure that allows to maximize its value in relation to the underlying characteristics of the firms itself and its investors. As the proportion of debt in the capital structure increases, WACC gradually decreases due to the tax deductibility of interest expense. WACC continues to decrease up to the point where the *optimal capital structure*[10] is reached (*Figure 2*). Once this threshold is surpassed, the cost of potential financial distress (i.e., the negative effects of an over-leveraged capital structure, including the increased probability of insolvency) begins to override the tax advantages of debt. As a result, both debt and equity investors demand a higher yield for their increased risk, thereby driving WACC upward beyond the optimal capital structure threshold. This theory takes the name of *Static*

[9] Modigliani, F. and Miller, M. H. (1963) 'Corporate Income Taxes and the Cost of Capital: A Correction', *The American Economic Review*, 53 (3), pp. 433-443

[10] Rosenbaum, J. and Pearl, J. (2013) *Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions*. 2nd edn. Hoboken, New Jersey: John Wiley & Sons, p.132

Theory of Capital Structure, or Trade-Off Theory[11]. It argues that a firm borrows up to the point where the tax benefit from an extra dollar in debt is exactly equal to the cost that comes from the increased probability of financial distress.

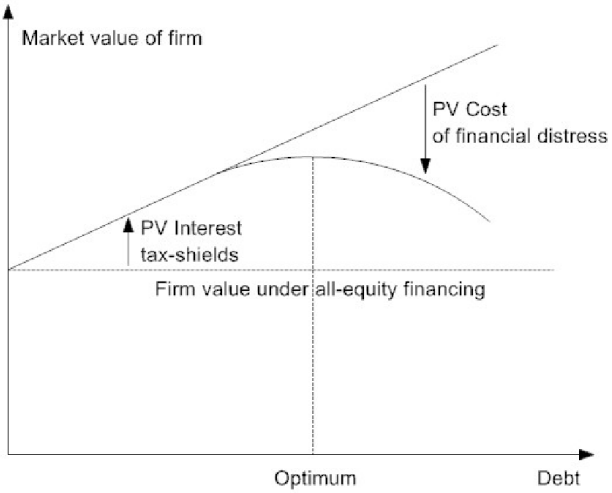

Figure 2: Trade-Off Theory
Source: Rosenbaum, J. and Pearl, J. (2013) Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions. 2nd edn. Hoboken, New Jersey: John Wiley & Sons, p.133

From this theory it can be deduced that there is an optimal Debt to Equity ratio which maximizes the value of the firm by minimizing the WACC. After such threshold, an increase in the financial leverage would result in an increase in the cost of debt and WACC.

1.2 COST OF CAPITAL

The cost of capital of the entire firm is the minimum rate of return on the company's investments that can satisfy both shareholders (the Cost of Equity) and debtholders (the Cost of Debt). The cost of capital is thus the company's total cost of financing[12].

1.2.1 COST OF EQUITY

Cost of equity (COE) is defined as the return that a company requires for an investment or project, or the return that an individual requires for an equity investment.[13] Considering that equity has not to be repaid on a pre-defined schedule as bond's coupon rates and nominal values and that equity holders are Residual Claimants (so entitled to receive what is left over in the company after subtracting the claims of debt holders and preferred shareholders)[14], COE will be generally higher than Cost of Debt (COD) and provide a higher rate of return. As previously showed, COE rate is driven by the riskiness of the underlying investment and has a positive correlation with debt.

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[11] Kraus, A. and Litzenberger, R. H. (1973) 'A State-Preference Model of Optimal Financial Leverage', Journal of Finance, 28 (4), pp. 911-922.)
[12] Vernimmen, P. (2014), 'Corporate Finance Theory and Practice', p.528
[13] Damodaran, A. (2006) *Damodaran on Valuation*. 2nd edn. United States of America: John Wiley & Sons, p. 35.
[14] https://www.morganstanley.com/im/publication/insights/articles/article_costofcapital.pdf?1676472943960, accessed on 11/06/2023

When it comes to estimating COE, we have different options according to different models:

1.2.1.1 CAPITAL ASSET PRICING MODEL

Capital Asset Pricing Model (CAPM) is the most known and popular method to estimate COE. CAPM derives theoretical equilibrium asset prices if investors hold efficient Markowitz portfolios. CAPM is a useful tool to determine market price for risk, correct measure of risk and find correct price/expected return for a single asset[15]. Before diving deep into the CAPM, it is necessary to discuss about the theory on which it relies. Markowitz, in 1952, wrote an important dissertation on "Portfolio Selection", introducing what was called "Modern Portfolio Theory"[16]. In this theory, Markowitz argued that assets' returns and risks are generally correlated one another with a certain degree: investors could have limited the overall degree of risk of their portfolio with diversification.

In fact, any generic asset present two different risk components:

- Specific risk, that can be eliminated through proper diversification
- Systematic risk, common to the overall market and non-diversifiable

Two assets can present a correlation coefficient between -1 and 1. In the first case the two assets are perfectly negatively correlated and move in opposite directions, while in the second case are perfectly positively correlated and move in the same direction. In addition, a correlation coefficient of 0 means that there is no correlation between the two assets returns. Below formula explains the non-linear relationship between the variance of a portfolio composed of only two assets A and B and the assets themselves.

$$\sigma^2 = x\sigma^2{}_A + y^2\sigma^2{}_B + 2x\,y^2\rho\sigma_A\sigma_B$$

where

σ^2 is the variance of return of the portfolio composed by stock A and B

x is the weight of stock A in the portfolio

$\sigma^2{}_A$ is the variance of return of stock A

y is the weight of stock B in the portfolio

$\sigma^2{}_B$ is the variance of return of stock B

ρ is the correlation coefficient between stocks A and B

Moreover, the further the correlation between A and B will be from 1, the higher are the benefits deriving from diversification. For example, for a correlation between two assets returns of -1, the minimum variance

[15] Fama, E. F., & French, K. R. (2004). The Capital Asset Pricing Model: Theory and Evidence. *The Journal of Economic Perspectives*, *18*(3), 25–46.

[16] Markowitz, H. (1952) 'Portfolio Selection', *The Journal of Finance*,

portfolio is risk free[17]. Markowitz assumes investors are risk-adverse and only care about mean and variance as objective of their investments (following the parameter-preference approach)[18].
Portfolios chosen by investors will lay on the Risk-Efficient Frontier. All portfolios lying on the frontier will:

- minimize variance (risk), given a certain level of preferred return
- maximize return, given a certain level of preferred variance (risk)

An example of risk-efficient frontier for a feasible set of many assets case is in *Figure 3*.

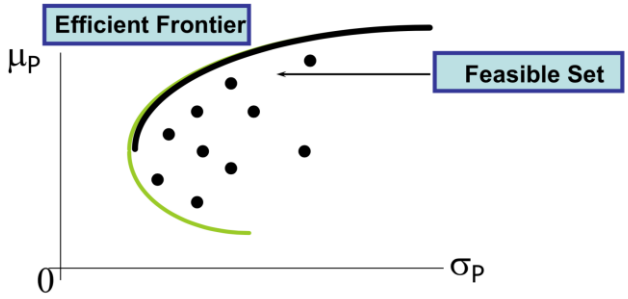


Figure 3: Risk-Efficient Frontier for a feasible set of many assets case
Source: Prof. Dr. Christoph Kaserer, Department of Financial Management and Capital Markets TUM

An additional improvement to Modern Portfolio Theory was brought by James Tobin[19] in 1958 who added a riskless instrument to the model. If we include it in the previous case there will be now three possible assets to choose: risky asset M, risky asset H and the riskless asset. Then we should assume to be able to borrow and lend at the risk-free rate, supposing that part of our wealth will be invested in such a riskless asset and the remaining in one of the risky assets. With the possibility to borrow or lend at the risk-free rate, risk and return now present a linear combination. *Figure 4* gives an example of this linear combination: each point on the line connecting the riskless asset with one of the two risky assets (in this case assets M and H) represents a particular allocation in which each point on the line connecting the riskless asset with one of the two risky assets represents a particular allocation of wealth.

[17] Clarke, R. et alt, 'Minimum-Variance Portfolio Composition', 2013
[18] Prof. Dr. Christoph Kaserer, Department of Financial Management and Capital Markets TUM
[19] Tobin, J. (1958) 'Liquidity Preference as Behavior towards Risk', *The Review of Economic Studies*

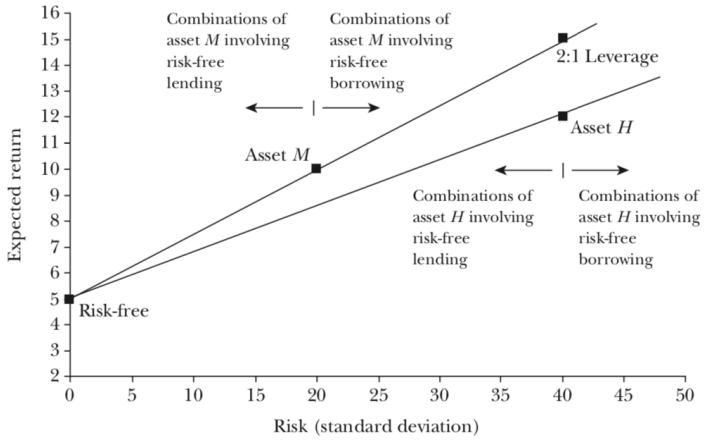


Figure 4: Combining a Risky Asset with Risk-Free Lending and Borrowing

Source: Perold, A. F. (2004) 'The Capital Asset Pricing Model', The Journal of Economic Perspectives, p. 6

The slope of the Efficient Frontier is now called the Sharpe Ratio[20]: equivalent to the difference between the return of a risky asset and the risk-free rate (so the risk premium), divided by the standard deviation of the risky asset.

$$\text{Sharpe Ratio} = \frac{\text{E(R risky asset)} - \text{R}_\text{f}}{\sigma \text{ risky asset}}$$

A rational investor will always aim at maximizing the Sharpe Ratio of its portfolio. The highest Sharpe Ratio matches the point in which the line starting from the riskless asset is tangent to the efficient frontier. The line maximizing the Sharpe Ratio is called Capital Market Line and represent all the portfolios that optimally combine the risk-free rate of return and the market portfolio of risky assets.

$$\text{Capital Market Line equation: R portofolio} = \text{R}_\text{f} + \frac{\text{E(R risky asset)-R}_\text{f}}{\sigma \text{ risky asset}} \times \sigma \text{ portofolio}$$

Figure 5 gives an example of risk-return combination in case of investments with 2 risky assets with correlation of 0 and the highest Sharpe Ratio in the point indicated.

[20] Bernstein, L. and Fabozzi, F.J. 'The Best of The Journal of Portfolio management, p. 169

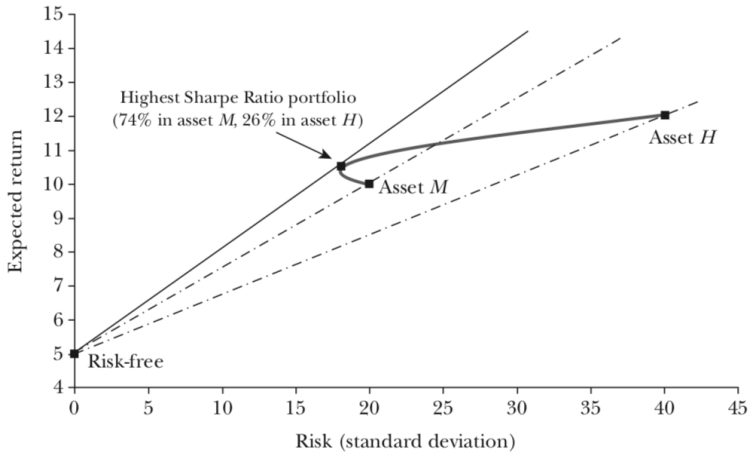


Figure 5: Efficient Frontier with two Risky Assets

Source: Perold, A. F. (2004) 'The Capital Asset Pricing Model', The Journal of Economic Perspectives, p. 12

Figure 6 offers a general illustration in case many risky assets are present in the market. According to the Fund Separation Theorem[21] investors with the same expectations will all invest in the portfolio of "fund" of risky assets that presents the highest ratio, but will select different allocations between this fund of risky assets and the riskless lending or borrowing asset, based on their risk tolerance.

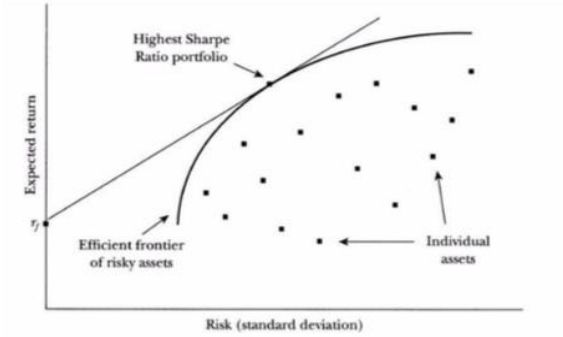


Figure 6: Efficient Frontier with Many Risky Assets

Source: Perold, A. F. (2004) 'The Capital Asset Pricing Model', The Journal of Economic Perspectives, p. 12

The steps above described to select a combination of assets able to maximize the Sharpe Ratio allow to derive the CAPM. The CAPM includes strong Normative and Additional assumptions [22] (the latters can be relaxed to better model real world).

Normative assumptions are: perfect and frictionless capital markets (no transaction costs, no taxes, perfectly divisible assets, all assets are marketable), risk averse and non-satiated investors, all assets return must follow a multivariate normal distribution, homogeneous expectations

[21] Cass, D. and Stiglitz, J. E., 'The structure of investor preferences and asset returns, and separability in portfolio allocation: A contribution to the pure theory of mutual funds' (1970), pp. 122-160

[22] Prof. Dr. Christoph Kaserer, Department of Financial Management and Capital Markets TUM

Additional assumptions are: one period investment horizon, risk-free asset exists, risk-free rate is the same for all investors

In a scenario where all the Normative assumptions hold, investors will all detect the same highest Sharpe Ratio and, depending on their personal risk tolerance, each investor will allocate a portion of wealth to this optimal portfolio and the remainder to risk-free lending/ risk-free borrowing. All the investors will so hold risky assets in the same relative proportion, and those proportions must be respected in the market portfolio (the portfolio collecting all available shares of risky assets). In this context, when equilibrium exists, the market portfolio is the one with the highest Sharpe Ratio.

Around 1960 Sharpe, Treynor, Lintner and Mossin applying a rule for portfolio improvement, were able to derive the CAPM formula[23]. In equilibrium, the expected return of an asset is given by:

$$E(R) = R_f + \beta(R_m - R_f) \qquad \textit{(formula 1.1)}$$

where

R_f = Risk-free rate

β = Systematic risk of the stock under analysis

$R_m - R_f$ = Equity risk premium (ERP)

R_m = Expected return from a portfolio consisting of all risky securities on the market

In the case in which the above formula would not hold, any investor could take advantage of this situation detecting a combination of assets able to lead to a higher Sharpe Ratio. But once all the other investors have noticed, stock prices would change until a new equilibrium is reached and *formula 1.1* holds.

CAPM has several important implications in the context of business valuation:

- the expected return of an asset does not depend on its stand-alone, idiosyncratic, specific risk. The expected return of an asset is driven only by its beta, representing its non-diversifiable systematic risk;
- Beta offers a method of measuring the risk of an asset that cannot be diversified away (beta will be analyzed more deeply in *Paragraph 1.2.1.4*);
- a stock's expected return does not depend on the growth rate of its expected future cash flows.

If we make CAPM formula explicit, it is possible to obtain Security Market Line (SML) equation

[23] Perold, André, F. 2004. "The Capital Asset Pricing Model." *Journal of Economic Perspectives*, 18 (3): 3-24.

$$E(R_i) = R_f + \beta_i (R_m - R_f) \qquad \text{with } \beta_i = \frac{\sigma_{im}}{\sigma^2{}_m}$$

where

β_i = Beta coefficient of company i

σ_{im} =Covariance between company i's return and its stock market index's return

$\sigma^2{}_m$ = Market index's return variance

According to CAPM, all what is necessary to know about a specific company to obtain its expected return is the beta of its shares, a parameter much easier to estimate than the expected future cash flow of the firm. The Security Market Line (*Figure 7*) graphs the risk of an asset measured by beta on the horizontal axis and the return of the same asset on the vertical axis. If the market is in equilibrium, all assets must lie on this line. If not, as stated before, investors will be able to obtain a higher Sharpe ratio and after equilibrium will be restored.

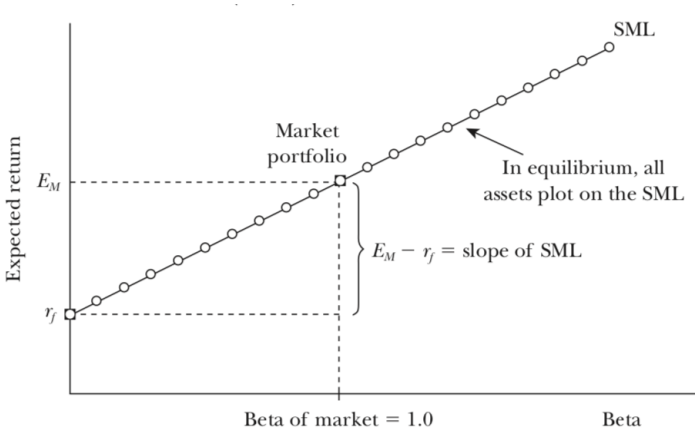


Figure 7: The Securities Market Line

Source: Perold, A. F. (2004) 'The Capital Asset Pricing Model', The Journal of Economic Perspectives, p. 18

Now that CAPM formula has been presented, we will dive deeper into every single term composing formula in the next paragraphs.

1.2.1.2 RISK-FREE RATE

The risk-free interest rate in the CAPM model corresponds to the risk-free rate at which investors can both borrow and save. The risk-free saving rate is generally determined using yields on US Treasury Securities or German Bonds, considered as the safest securities respectively in the American and European markets[24]. Damodaran lists a set of rules[25] to respect when selecting the security for the risk-free rate:

[24] Berk, DeMarzo, "Corporate Finance" (2017), pag 443

[25] Damodaran, A., What is the Risk-Free Rate? A Search for the Basic Building Block' (2020), pag.12

- it must be "real risk-free": in case a certain security might face even some inner risks like default, then it should not be risk-free at all;
- if cash flows under our valuation analysis are in real terms, also the risk-free rate should be aligned in real terms, and be expressed in the same currency of cash flows;
- the analyst choosing a risk-free rate for the computation of CAPM should never be influenced about its own personal and subjective expectations about future interest rate;
- an investment can be deemed as risk-free if two conditions are met: no default link with cash flows and no reinvestment risk must exist.

Another important element when it comes to select the risk-free rate is to clarify the correct investment horizon to refer. The precise yield to use depends on investors' horizon and propensity to borrow and save. A valid option, if we are considering valuing an investment for a certain time horizon, could be to select the rate of a riskless asset with the same maturity of that possible investment. However, when surveyed most large firms and financial analysts reported to use the yields of long-term (10 to 30 years maturity) government bonds to determine the risk-free interest rate[26].

1.2.1.3 EQUITY RISK PREMIUM

Damodaran defines Equity Risk Premium (ERP) as the price of risk of equity markets. He also states that is not just a key input in estimating cost of equity and capital in both corporate finance and valuation, but it is also a key metric in assessing the overall market[27].

ERP reflects fundamental judgments analysts make about how much risk they see in an economy/market and what price they attach to that risk. It is going to affect the expected return on every risky investment and consequently on how wealth is allocated among a set of disposable assets. Mathematically, the value of ERP reflects its definition: it is the sum of the risk-free rate and the premium required by the investor to invest in the market and take a higher risk. ERP should not only reflect the risk that investors see in equity investments but also the price they attach to that risk. Several factors concur to determine its value[28]:

- Investors' risk aversion (Age, Preference for current Consumption)
- Specific Economy Status (Inflation, Employment rate, GDP growth)
- Level of access to companies' financial and non-financial information
- Liquidity/Illiquidity
- Government policies, Monetary policies, Politics, Taxation

[26] Robert Bruner, et al., "Best Practices in Estimating the Cost of Capital: Survey and Synthesis," Financial Practice and Education 8 (1998): 13–28.
[27] Damodaran, A. (2022) 'Equity Risk Premium (ERP): Determinants, Estimation, and Implications - The 2022 Edition', *Stern School of Business*, p. 1.
[28] Damodaran, A. (2022) 'Equity Risk Premium (ERP): Determinants, Estimation, and Implications - The 2022 Edition', *Stern School of Business*, pp. 10-21.

- Irrational Components

Damodaran also presents three main estimation methods to calculate, given a certain risky equity asset, ERP on a particular investment. The three methods are:

1) INVESTORS' SURVEY APPROACH

If the equity risk premium is what investors demand for investing in risky assets, according to Damodaran, the most logical way to estimate it is asking to the investors what they require as expected returns. The challenge here is finding a subset of investors that can replicate the overall market. While survey premiums have become more accessible, very few practitioners seem to be inclined to use them as they are sensitive to a lot of uncontrollable variables.

2) HISTORICAL PREMIUM APPROACH

Even if our goal is to estimate an ERP for the future, much of the data we will use is based on the past. This is the widely most used approach, and it is based on estimate and compare the actual returns earned on stocks over a long period to the actual returns on a default-free security (usually a government bond). The difference, on an annual basis, between the two returns represents the historical risk premium. Despite the fact ERPs obtained through this method are extrapolated by analysts looking at the same historical data, the difference of results obtained by different analysts can be huge (ranging from 3% to 12%)[29].
These differences in results are a consequences of different assumptions one can take in the calculation process:

- Time period covered

  It is highly relevant, in this context, to use an historical period that matches the same duration of the period used for the risk-free interest rate. As is it possible to see from *Table 1*, the larger the historical estimation period considered for computing Equity Risk Premium, the lowest will be its estimation standard error.

Estimation Period	*Standard Error of Risk Premium Estimate*
5 years	20%/ √5 = 8.94%
10 years	20%/ √10 = 6.32%
25 years	20% / √25 = 4.00%
50 years	20% / √50 = 2.83%
80 years	20% / √80 = 2.23%

[29] Damodaran, A. (2022) 'Equity Risk Premium (ERP): Determinants, Estimation, and Implications – The 2022 Edition', *Stern School of Business*, pp. 31-33.

TABLE 1: Standard error associated with the risk premium, calculated on the annual standard deviation in stock prices3 between 1926 and 1997
Source: Damodaran, A. (2022),'Equity Risk Premium (ERP): Determinants, Estimation, and Implications – The 2022 Edition', p.31

- If the premium is calculated as pre-tax or post-tax
- Market Index choice
- Different Risk-free security chosen and different maturity of the latter (Short-term vs Long-term)
- The Averaging Approach used to calculate the premium (Geometric Average vs Arithmetic average)

3) IMPLIED PREMIUM APPROACH

The criticalities related to any historical premium approach is that it is backward looking. The Implied Premium Approach, on the opposite, relies on future cash flows growth. In fact, assuming that all the companies in the market will pay their cash flows ad dividends in perpetuity, we can calculate ERP. First, it will be necessary to take advantage of the Dividend Discount Model (DDM). In the DDM (that will be discussed more deeply in *Paragraph 2.2.1*) the value of equity of a company is equal to the present value of expected dividends from the investment. In the special case where dividends are assumed to grow at a constant rate forever, we can apply the Stable Growth or Gordon Growth Model[30].

$$\text{Value of Equity} = \frac{\text{Expected Dividends Next Period}}{\text{Required Return on Equity-g}}$$

In this formula, the only unknown parameter is ROE (considering Value of Equity, Expected Dividends for Next Period and Expected Growth Rate of Dividends in perpetuity g are known) and solving for it we can get an implied expected return for stocks. After, subtracting the risk-free rate we obtain the implied ERP.

Other two factors that are worth mentioning, able to influence ERP independently of the approach chosen to calculate it, are two "additional Premiums" for companies with the specific characteristics:

- *Small Cap Premium*: this is the premium that analysts can choose to add to the CAPM formula when computing COE for a firm with a small market capitalization. Historically, in fact, it seems that firms with a small market capitalization have produced higher returns than the ones predicted by CAPM[31]. *Banz (1981)* looked at return on stocks from 1936 to 1977 In NYSE and observed that the 20% bottom market cap firms resulted having a COE 6% higher, adjusting for risk, of the largest cap companies[32].

[30] Gordon, M. J. and Shapiro, E. (1956) 'Capital Equipment Analysis: The Required Rate of Profit', *Management Science*, 3 (1), pp. 102-110.
[31] Damodaran, A. (2022) 'Equity Risk Premium (ERP): Determinants, Estimation, and Implications - The 2022 Edition', *Stern School of Business*, p. 47
[32] Banz, R.W., 'The relationship between return and market value of common stocks', p. 15

This phenomenon is called as "size effect". However, there is still an ongoing debate about the reliability of this reasoning and, even if there is no clear and conventional opinion about adjusting ERP for size effect, Damodaran suggests if deemed appropriate to include it in valuation. He observes that size effect, with respect to S&P500 Index 1926-2011, is about 3,4%[33].

$$ERP = \text{Base Premium for Mature Equity Market} + \text{Small Market Cap Risk Premium}$$

Small Cap premium, in the purpose of this dissertation, will not be relevant in the valuation of *Chapter 4*. In fact, Volkswagen (at 31/12/2022) had a market capitalization of EUR 67,484 Million [34].

- *Country Risk Premium*: this is the premium that analyst can choose to add to the CAPM formula when computing COE for a firm incorporated into the legislation of an emerging country. There is still an actual and current discussion about the validity of theories in favor or against adding a Country premium to ERP. Donadelli and Prosperi (2011)[35], looking at historical risk premiums in 32 countries between 1988 and 2010 (13 developed and 19 emerging) concluded that the latters' companies had higher average returns of 0,97%-2,40%. They suggest that, even if well-diversified, the significant home bias that remains in investor portfolios exposes investors disproportionately to home country risk.

Considering the relatively small importance of Country Risk Premium in the purpose of this dissertation, motivated by the fact that the company that will be analyzed in *Chapter 4* and valued after is incorporated under German law, only the main and most know method to derive Country Risk Premium will be covered. The Default Spreads is not only the most frequent method used, but also the easiest to implement. It represents the default spread investors "charges" to the company to invest in stocks issued in the specific country / currency. Mathematically, it is calculated as "*Issuing Country bond yield (denominated in EUR) - German Government Bund yield with the same maturity"*.

German government bonds are chosen, as appear in *Table 2*, because are the instruments deemed as risk-free in the US and also in the Eurozone. The spread against Bunds (German government bond) is positive for the all Euro-Zone and US (Table 2).

[33] Damodaran, A. (2022) 'Equity Risk Premium (ERP): Determinants, Estimation, and Implications - The 2022 Edition', *Stern School of Business*, p. 53
[34] https://companiesmarketcap.com/volkswagen/marketcap/, accessed on 24/05/2023
[35] Donadelli, M. and L. Prosperi, 2011, *The Equity Risk Premium: Empirical Evidence from Emerging Markets*, Working Paper

Country	Latest Yield (10 year to Maturity)	Spread vs Bund
Australia	3.68%	+1.19
Austria	3.18%	+0.69
Belgium	3.19%	+0.70
France	3.06%	+0.58
Germany	**2.49%**	--
Greece	3.91%	+1.42
Ireland	2.89%	+0.40
Italy	4.34%	+1.86
Netherlands	2.86%	+0.37
Portugal	3.28%	+0.79
Spain	3.54%	+1.05
UK	4.14%	+1.65
US	3.76%	+1.27

Table 2: 10 year Euro-Zone and US government bonds vs German bund
Source: Own elaboration based on https://markets.ft.com/data/bonds/government-bonds-spreads, accessed on 23/05/2023

1.2.1.4 BETA

Beta coefficients were initially defined by Sharpe[36] as the slope term in the simple linear regression function where the rate of return on a market index is the independent variable and a security's rate of return is the dependent variable. Berk and DeMarzo (2017), giving a more intuitive definition, define the beta of a security as the expected % change in its return given a 1% change in the return of the market portfolio[37]. Accurate estimation of beta coefficients is important not also for understanding the risk-return relationship in capital market theory, but also in for the investment decision process.

When it comes to estimating betas, there are two basic characteristics of the latters to keep in mind[38]. The first one is that they measure the risk added on to a diversified portfolio, rather than total risk: it is possible for an investment to be high risk in terms of individual risk, but to be low risk in terms of market risk. The second characteristics that all beta share is that they measure the relative risk of an asset, and thus are standardized around one.

The techniques to compute a security's beta differ depending on if the firm issuing it is listed or less.

1) PUBLIC COMPANIES

From a statistical point of view, beta coefficient is measured by regressing the returns on any asset against returns on an index representing the market portfolio, over a reasonable time period where the returns on the asset represent the Y variable, and the returns on the market index represent the X variable[39]. Note that the regression equation that we obtain is as follows:

[36] Sharpe, W. F., 'THE CAPITAL ASSET PRICING MODEL: A "Multi-Beta" Interpretation, (1977), pp.127-135
[37] Berk, DeMarzo, "Corporate Finance" (2017), pag 375
[38] Damodaran, A., "Estimating Risk Parameters"(2009), pag 30
[39] Damodaran, A., "Estimating Risk Parameters"(2009), pag 54

$$R_i = a + bR_M$$

where

R_i is the return on investment I

R_M is the return on the market index

b is the slope of the regression because it measures the risk added on by that investment to the index used to capture the market portfolio

a is the value of R_i when $R_M = 0$

If the company under analysis is listed, and so a company whose shares are bought and sold on a particular stock market, its beta can also be defined as the covariance between the rate of return on its issued security and the overall market return[40].

$$\beta_i = \frac{\sigma_{im}}{\sigma^2{}_m}$$

However, there is a number of measurements criticalities with this regression/formula:

- Choice of market index: in practice, there are no indices that measure or even come close to the market portfolio. Instead, we have equity market indices and fixed income market indices, that measure the returns on subsets of securities in each market. In addition, even these indices are not comprehensive and include only a subset of the securities in each market;
- Choice of time period: by going back further in time, we get the advantage of having more observations in the regression, but this could be offset by the fact that the firm itself might have changed its characteristics, in terms of business mix and leverage, over that period;
- Choice of a Return Interval: The final choice that can affects beta estimates is the return interval, used to measure returns historically. Returns can be measured daily, weekly, monthly, quarterly or annually.

The intermediate beta value obtained with regression is defined as the "Raw Beta" of the company. It is called as that because it derives from a formula only looking at past data and possesses no inner references to forecasts of future movements in the market. The literature provides us 2 techniques to arrive to rectify the "Raw Beta" into an "Adjusted Beta".

[40] Di Marcantonio M., La stima del costo del capitale. dalla teoria al processo valutativo, (Torino, G. Giappichelli Editore, 2017)

- *1st technique: Blume*

A first theory, developed from different models by Blume and Bloomberg[41], has as foundation the fact that in the medium and long-term beta coefficients of companies tend to move towards 1 (the beta of the market portfolio). Why adjust betas towards 1? The rationale can be traced to studies that indicate that, over time, there is a tendency on the part of betas of all companies to move towards one. Intuitively, this should not be surprising. Firms that survive in the market tend to increase in size over time, become more diversified and have more assets in place, producing cash flows. All of these factors should push betas towards one.

In this perspective, the Adjusted beta is calculated as the weighted average between the beta of stock i (with weight of 2/3) and the beta of the overall market taken as reference (with weight of 1/3). As we mentioned, beta of the market is always equal to 1 and so:

$$\beta^{\text{BLUME}} = \frac{2}{3}\,\beta_i + \frac{1}{3}\,\beta_{\text{Market}} = \frac{2}{3}\,\beta_i + \frac{1}{3} \qquad \textit{(formula 1.2)}$$

where

β^{BLUME} = adjusted Beta (Blume)

β_i = Raw Beta of Stock I

β_{Market} = Average Market Beta = 1

Blume Betas is easy to use and will be used during the practical application in this dissertation, but it is important to say that does not take in consideration that the speeds with betas converge to one vary across companies and industries.

- *2nd technique: Vasicek*

The second technique to arrive to the Adjusted beta of a company is the Vasicek (1973) technique. This second formula is going to adjust the Raw Beta as a function of the ratio between the volatility of the beta of security i and the volatility of the betas of companies comparable to the target company considered for estimation purposes, where volatility is measured in terms of historical variance. In this case, the higher beta in the equation is given to the least volatile beta, and so the weights of the two betas are inversely proportional to their respective standard deviations.

$$\beta^{\text{VASICEK}} = \frac{{\sigma_{\beta m}}^2}{{\sigma_{\beta m}}^2 + {\sigma_{\beta i}}^2}\,\beta_i + \frac{{\sigma_{\beta i}}^2}{{\sigma_{\beta m}}^2 + {\sigma_{\beta i}}^2}\,\beta_{\text{Market}}$$

where

β^{VASICEK}= adjusted Beta (Vasicek)

[41] Blume, M. E. (1975) 'Betas and Their Regression Tendencies', *The Journal of Finance, pp. 785-795*

β_i =Raw Beta of stock i

β_{Market} = Average Market Beta = 1

$\sigma_{\beta i}^2$ = variance of β_i

$\sigma_{\beta m}^2$ = variance of β_{Market}

2) NON-PUBLIC COMPANIES

In some case the company we want to analyze is not listed and the above explained techniques and formulas for the beta estimation can't be used due to the lack of public available historical data. If it is not possible to directly extract beta from by a market regression, an alternative method can be exploited. It is also possible to extract it from a sample of peers comparable companies and even if the target is listed, to have a beta extracted directly "from the market" and with a new target D/E ratio[42]. The formula we can implement in this scenario was developed by Hamada in 1972.

$$\beta^{\text{LEVERED}} = \beta^{\text{UNLEVERED}} \left[1+\frac{D}{E}(1-T)\right] \qquad \textit{(formula 1.3)}$$

where

β^{LEVERED} = Beta of company I with a given $\frac{D}{E}$ ratio

$\beta^{\text{UNLEVERED}}$ = Beta of a company with D = 0

$\frac{D}{E}$ = leverage ratio of company i

T = Reference corporate Tax rate

After the identification of a comparable set of public traded firms, the steps to be followed in order to compute the firm's Levered Beta (this process is called the Bottom-Up approach) are:

- compute the regression betas of set of peers;
- compute the average (or median) of the regression betas that had been computed previously to find the unlevered beta for the target;
- estimate current market debt and market equity values of the target and compute the levered beta using Hamanda formula *(In the context of our valuation the Market value of debt will be equal to the Book value of debt).*

[42] Hamada, R. S. (1972) 'The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks', *The Journal of Finance*, 27 (2), pp. 435-452.

1.2.1.5 MULTIFACTORAL MODELS

CAPM has, over time, been criticized and modified by academics and economists due to its peculiarity of being a single factor model and its dependance upon the market portfolio (takes in consideration only the market risk (*Beta*) when computing its output). Next, 4 different models, that still had as basis CAPM for their development, are presented. Given the fact they take in consideration several factors in addition to beta, they are called Multifactor Models[43].

1) Arbitrage Pricing Theory

Arbitrage Pricing theory (APT) is built on the premise that 2 investments with the same exposure to risk should be priced to earn the same expected returns[44]. This model, elaborated in 1976 by Ross, also implies that if two portfolios have the same exposure to risk but offer different expected returns investors can buy the portfolio that has the higher expected returns and sell the one with lower expected returns, until the expected returns converge. At the difference of the CAPM, the APT does not assume that investors hold efficient portfolios. However, it holds three underlying assumptions which are[45]: asset returns are explained by systematic factors, investors can build a portfolio of assets where specific risk is eliminated through diversification, no arbitrage opportunity exists among well-diversified portfolios.

As stated, unlike CAPM, the APT assumes that the return of an asset is generated by a multiple factors model. Each factor can be viewed as a specific beta coefficient towards a specific risk premium. Several researchers have investigated stock returns and have requested the use of three to five factors in the APT. For instance, Stephen Ross and collaborators have identified the following macroeconomic factors: inflation, growth rate in industrial production, spread between long-term and short-term interest rates of same securities, spread between high rated and low rated bonds. A Multifactor generalist formula follows:

$$E(Ri)=Rf+\beta_1^i(\delta 1-Rf)+\beta_2^i(\delta 2-Rf)+\cdots+\beta_n^i(\delta n-Rf)$$

where

Rf = risk-free rate

β = the asset sensitivity respect to a certain factor, each of them distributed with mean 0

The limitation of APT is that does not suggest factors of systematic risk for a particular stock or asset[46]. Investors have to perceive the risk sources or estimate factor sensitivities. In practice, one stock would be

[43] Connor, G., Korajczyk,R., 'Chapter 4 The arbitrage pricing theory and multifactor models of asset returns'(1995), pp.87-144

[44] Ross, S. A. (1976) 'The Arbitrage Theory of Capital Asset Pricing', *Journal of Economic Theory*, 13 (3), pp. 341-360.

[45] Nguyen, T. et alt, 'The Capital asset pricing model and the Arbitrage pricing theory', (2017), pp. 6-7

[46] Bodie et alt., 'Principle of investments', (2013)

more sensitive to one factor than another and the use of a wrong factor or the not consideration of an important one can led to incorrect estimates of assets returns.

2) Fama-French 3-Factor Model

Fama and French (1992) determined, analyzing a large of sample US stocks and completing a regression, that some firms' characteristics could predict returns after controlling for the beta. The two authors analyze the cross-section of stock returns for market beta, size, book-to-market ratio, leverage, and earnings-to-price[47]. They stated that stocks with a low capitalization (small cap firms) and the ones characterized by a high Book-to-Market Ratio tend to have higher returns than the market. To reflect the impact of these two additional factors on stock returns Fama and French have therefore extended the CAPM in the following formula:

$$E(Ri) = Rf + \alpha i + \beta mrkt * [E(Rm) - Rf] + \beta_{SMB} * SMB + \beta_{HML} * HML$$

The three-factor model shows that for portfolios in excess of risk-free rate $[E\ (Ri) - Rf]$ the expected return is explained through the return sensitivity to three factors:

- excess return on a broad market portfolio $(Rm - Rf)$, providing an extra compensation for the investor for the additional volatility held;
- size, specifically the difference between a return related to portfolio made up of small stocks and those with large stocks (SMB);
- the difference between the return of a portfolio composed of stocks that hold a high Book-to-Market value and the return on another portfolio which on contrary is made up of low Book to Market value (HML).

The size factor is defined as the share price multiplied by the number of stocks on the market. Book-to-Market Value is calculated by dividing the Book value of the Equity (BE) with the Market value of Equity (ME). The main results according to the Fama and French three-factor model can be summed up as follows:

- in the long-term, small companies overperform large companies
- companies with high BME tend to have persistently low earnings
- companies with low BME tend to have persistently high earnings
- value companies overperform companies that are growing
- the model is capable to explain about the 95% return of a diversified portfolio

[47] Fama, E. F. and French, K. R. (1992) 'Common Risk Factors in the Returns on Stocks and Bonds', *Journal of Financial Economics*, 33 (1), pp. 3-56.

- as well as CAPM, also this model is based on the assumption that the more the risk the more the return.

3) Carhart 4-Factor Model

Carhart introduced a 4-factor model related to equity expected return calculations. Carhart developed a model including the (annual) momentum factor[48]. "Momentum" is described as the tendency of the price of a stock to continue rising if it is going up (and vice versa to continue falling if it is going down). A stock is characterized by this momentum factor if the average of its returns over the previous twelve months is positive. Carhart, in this way, overcomes a previous void in Fama-French 3 factor model that did not consider the short-term persistence of stock returns. Carhart's model predicts the existence of a return premium linked to the choice of assets that have performed best in the past:

$$E(Ri) = Rf + \alpha i + \beta mrkt * [E(Rm) - Rf] + \beta_{SMB} * SMB + \beta_{HML} * HML + \beta_{PR1YR} * PR1YR$$ [49]

4) Fama-French 5-Factor Model

The 3-factor model, even after Carhart intervention, has been criticized because of further lack in incorporating other factors that could explain variation in average returns. In 2015, after a series of empirical tests, Fama and French decided to include the additional factors of Profitability and Investments in the model[50]. The 5-factor model so includes also RMW (Robust Minus Weak, the difference between stocks' portfolio returns with high and low profitability) and CMA (Conservative Minus Aggressive, the difference between high and low investments firms stocks' portfolio returns).

$$E(Ri) = Rf + \alpha i + \beta mrkt * [E(Rm) - Rf] + \beta_{SMB} * SMB + \beta_{HML} * HML + \beta_{\mathrm{RMW}} * \mathrm{RMW} + \beta_{\mathrm{CMA}} * \mathrm{CMA} + \varepsilon_i$$

Brounen, et al. (2004) carried survey on a sample of 2,500 European consulting companies in order to understand which was the most common practice to calculate COE in the real world[51]. Out of 313 respondents, there were practitioners from UK, Netherlands, Germany and France: the most popular approach to cost of capital estimation resulted being CAPM, followed by Average Historical Returns and Multi-Factor CAPM (*Table 3*).

[48] Carhart, M. M. (1997) 'On Persistence in Mutual Fund Performance', *The Journal of Finance*, 52 (1), pp. 57-82.
[49] ($R1YR$ *represents stocks'excess returns characterised by a positive annual momentum*)
[50] Fama, E. F. and French, K. R. (2015) 'A Five-Factor Asset Pricing Model', *Journal of Financial Economics*, 116 (1), pp. 1-22.
[51] Brounen, Dirk and de Jong, Abe and Koedijk, Kees G., Corporate Finance in Europe Confronting Theory with Practice (March 15, 2004), pag. 85

Most popular COE estimation	UK	Netherlands	Germany	France
CAPM	47%	56%	34%	45%
Multi-Factor CAPM	27%	15%	16%	30%
Average Historical Return	31%	31%	18%	27%
Dividend Discount Model	10%	11%	10%	10%
Investor Expectation	19%	45%	39%	34%

Table 3: Survey Responses to the Question: "Does your firm estimate the Cost of Equity Capital? If yes, How do you determine your firm's cost of equity capital?"

Source: Own elaboration from Brounen, Dirk and de Jong, Abe and Koedijk, Kees G., Corporate Finance in Europe Confronting Theory with Practice (March 15, 2004), pag. 85

Cost of capital practice among European investors was also investigated by Petersen, Plenborg and Scholler (2006). A survey of 42 respondents indicated a relative popularity of CAPM[52]. 71% of surveyed private equity and corporate financial investors adopt CAPM and 46% of respondents rely on their experience. Some respondents argued that "common sense approach" is appropriate for smaller firms where reliable beta estimates cannot be obtained easily. None of the respondent reported using other methodologies as APT. In most cases, dependent corporate financial advisors and private equity firms declared to adopt CAPM, while independent financial advisors seemed to favor approaches based on their personal experience. They conclude that, despite CAPM popularity, the difference between the latter and other techniques remains insignificant. For the above reasons, in the context of valuation in *Chapter 4*, CAPM will be used to compute Volkswagen AG COE.

1.2.2 COST OF DEBT

Damodaran[53] defines Cost of Debt (COD) as "the measure of the current cost of the firm of borrowing funds to finance projects". COD will reflect not only the default risk of the company itself, but also the level of interest rates in the market and the tax advantage associated to that debt.

The pre-tax cost of debt is calculated as follows:

[52] Petersen, C., Plenborg, T., & Schøler, F. (2006). Issues in Valuation of Privately Held Firms. *The Journal of Private Equity*, *10*(1), 33–48

[53] Damodaran, A. (2014) *Applied Corporate Finance*. 4th edn. United States of America: John Wiley & Sons, p. 137

$$\text{Pre-tax Cost of Debt} = \text{Risk-free rate} + \text{Default Spread} \qquad \textit{(formula 1.4)}$$

And the after-tax cost of debt is calculated as follows:

$$\text{After-tax Cost of Debt} = (Rf + \text{Default Spread}) * (1 - \text{Marginal Tax rate}) \qquad \textit{(formula 1.5)}$$

As emerges from *formula 1.5* the higher the tax rate, the higher the amount of taxes that can be deducted. To estimate the after-tax or pre-tax COD we need to estimate the Default Spread of the company. The Default Spread of a specific company depends on:

- current level of interest rates: if they rates rise, so will the cost of debt for all companies;
- the simple default risk of the issuing company, depending on its ability to repay debt and financial reliability;
- the tax advantage associated with debt as emerges from *formula 1.5*.

There are several ways to estimate the Default Spread of a company, depending on the information already available on it or if it has issued debt instruments or not.

1) METHODS TO ESTIMATE COD IF ISSUER DEBT INSTRUMENTS ARE RATED (COD can be directly estimated)

- *Estimate pre-tax COD through Debt Yield*

This is a base scenario in which the company has long-term bonds traded on the market. Recalling the fact that the Yield to Maturity (YTM) of a bond is the IRR an investor will earn from holding the bond to maturity and receiving its promised payments, we can use the bond's YTM as an estimator of investors' expected return. This method is appropriate if there is little risk that the firm will default. On the other side, if there is a significant risk that the firm will default on its obligations the YTM of those bonds (which is the promised return) will overstate investors' expected return.

- *Estimate COD using CAPM*

Alternatively, it is possible to estimate the debt cost of capital using the CAPM. It could also be possible to estimate debt betas using historical return as for equities, following the same logic of *Paragraph 1.2.1.1*. However, given that bank loans and corporate bonds are traded infrequently, it is difficult to obtain reliable data on past performances. Is it possible to approximate debt betas using estimates of betas of bond indices by rating category (*Table 4*). Debt betas tend to be low, though they can be significantly higher for risky debt with a low credit rating and a long maturity.

By Rating	*A and above*	*BBB*	*BB*	*B*	*CCC*
Avg. Beta	< 0.05	0.10	0.17	0.26	0.31
By Maturity	(BBB and above)	*1–5 Year*	*5–10 Year*	*10–15 Year*	> 15 *Year*
Avg. Beta		0.01	0.06	0.07	0.14

Table 4: Average Debt Betas by Rating and Maturity across industries

Source: S. Schaefer and I. Strebulaev,"Risk in Capital Structure Arbitrage", Standfors GSB working paper, 2009

2) METHODS TO ESTIMATE DEFAULT SPREAD IF ISSUER DEBT INSTRUMENTS EXIST BUT ARE NOT FREQUENTLY TRADED

- *Bond Rating approach*

In the case in which bonds issued by the company exist, but they are not frequently traded, we can use their associated default spreads provided by debt agencies as Standard & Poor's, Moody's, Fitch Ratings. Examples of default spreads related to a given Rating are presented in *Table 5*. However, the major drawback of this approach is that it assumes that that the rating of the issued bonds matches perfectly with the "rating and reliability" of the company from a broader perspective.

Rating:	AAA	AA	A	BBB	BB	B	CCC	CC-C
Default Rate:								
Average	0.0%	0.1%	0.2%	0.5%	2.2%	5.5%	12.2%	14.1%
In Recessions	0.0%	1.0%	3.0%	3.0%	8.0%	16.0%	48.0%	79.0%

Table 5: Annual Default rates by Debt rating (1983-2011)

Source: "Corporate Defaults and Recovery rates, 1920-2011", Moody's global Credit Policy, 2012 (Average rates are annualized based on a 10-year holding period)

3) METHODS TO ESTIMATE DEFAULT SPREAD IF ISSUER DEBT INSTRUMENTS EXIST BUT ARE NOT TRADED AT ALL

- Use the interest rate that a bank/another financial institution required for borrow money to the firm if this operation has happened in recent times. This method comes with the major drawback of relaying on an agreement concorded by two parties that defined it on a subjective basis.

- *Synthetic Rating Approach*

A very last approach considered by Damodaran is now presented. Damodaran proposes to assign a hypothetic rating to any company looking at its Interest Coverage Ratio, and after find the related spread of that firm. This ratio is also called Times Interest Earned Ratio because it finds how many times a company can sustain its financial expenses on is outstanding debt through its EBIT[54].

[54] https://corporatefinanceinstitute.com/resources/accounting/coverage-ratio-overview/, visited on 15/05/2023

$$\text{Interest Coverage Ratio} = \frac{\text{EBIT}}{\text{INTEREST EXPENSES}} \qquad \textit{(formula 1.6)}$$

In the analysis of this ratio, with the purpose of assigning to each company a precise rating, Damodaran distinguishes between high market cap companies (>5 billions of dollars) and low market cap companies (<5 billions of dollars) and financial services companies. Only the table referring to High market cap companies will be reported in *Table 6*, given the already described market cap characteristics of Volkswagen.

>	*≤ to*	*Rating is*	*Spread is*
-100000	0.199999	D2/D	20.00%
0.2	0.649999	C2/C	17.50%
0.65	0.799999	Ca2/CC	15.78%
0.8	1.249999	Caa/CCC	11.57%
1.25	1.499999	B3/B-	7.37%
1.5	1.749999	B2/B	5.26%
1.75	1.999999	B1/B+	4.55%
2	2.2499999	Ba2/BB	3.13%
2.25	2.49999	Ba1/BB+	2.42%
2.5	2.999999	Baa2/BBB	2.00%
3	4.249999	A3/A-	1.62%
4.25	5.499999	A2/A	1.42%
5.5	6.499999	A1/A+	1.23%
6.5	8.499999	Aa2/AA	0.85%
8.50	100000	Aaa/AAA	0.69%

TABLE 6: Relation between the interest coverage ratio of a firm to a "synthetic" rating and a default spread that goes with that rating

Source:https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ratings.html(Accessed:15/05/2023)

1.2.2.1 HYBRID INSTRUMENTS IN THE CONTEXT OF COST OF CAPITAL

When it comes to calculate the cost of capital for a company, between debt and equity, there are some hybrid instruments that it is necessary to analyze separately, in voice of their hybrid nature.

Convertible Bonds

Convertible bonds are a type of debt security that provides an investor with a right to exchange the bond for a predetermined number of shares in the issuing company at certain times of a bond's lifetime. Being a hybrid instrument, it possesses features of both debt and equity. Like regular bonds, a convertible bond comes with a maturity date and pays interest to investors and if investor does not convert its bond in equity, she will receive the bond's face value at maturity. On the other hand, is investor converts the bond it will just become equity. In the valuation process of a convertible bond, the latter can be valued splitting its price in 2 parts:

- bond part: as it was a straight bond using cost of debt as interest rate;

- equity part: the option to convert the bond in equity is equal to the difference between the price of the convertible bond and the price of a straight bond from the same issuer with the same time to maturity.

Preferred Stocks

Preferred stock differs from common equity in several ways. A beneficial distinction is that preferred shareholders are first in line to receive any dividend payments. In the event of liquidation, preferred shareholders are also the first to receive payments after bondholders, but before common equity holders. The cost of preferred stock formula is:

$$\text{Return on Preferred Stock} = \frac{\text{Expected Preferred Dividend}}{\text{Price of Preferred Stock}}$$

These dividends are not tax deductible, so the cost of preferred stock is always higher than the cost of debt, for which we remember interest payments are tax deductible. The cost of preferred stock is usually less than the cost of common stock, for which investors demand an even higher return on investment.

1.2.3 WEIGHTED AVERAGE COST OF CAPITAL

After having described the process to compute a firm's COE and COD, it is necessary to estimate its Weighted Average Cost of Capital (WACC). WACC is defined as the discount rate that must be applied to a levered company when calculating the NPV to finance one of its projects or to value the entire company[55].

$$\text{WACC} = \frac{E}{V} \times COE + \frac{D}{V} \times COD \times (1 - T) \qquad \textit{(formula 1.7)}$$

Formula 1.7 captures the tax benefit received by investors, for investing in an unlevered firm. Because interest expense is tax deductible, the WACC is less than the expected return of the firm's assets. In a world with taxes, the WACC can be used to evaluate a project *with the same risk and the same financing as the firm itself*.

After the two separate cost of financing theories analyzed in the previous paragraphs, the remaining parts that still are left to estimate the WACC are the proportions of Equity and Debt in the capital structure of the firm. Even if scholars' best practice is to consider their Market Value, most of the analysts use Book value of Debt to calculate WACC.

The Market Value of Equity can be calculated simply multiplying the number of outstanding common shares in the market per the market price of a single common share (and add the same calculation for preferred stocks, if present). On the other hand, estimating Market Value of Debt can be much more difficult,

[55] Berk, DeMarzo, "Corporate Finance" (2017), pag 461

considering that most of the firms' debt is composed of Book Debt and outstanding Market Debt (mainly bonds or other debt issued instruments). As most analysts do in real life, for the purpose of this dissertation we will consider Market Value of Debt = Book Value of Debt when it comes to valuation. In addition to that, another choice that an analysts could face is select the "kind" of Debt to use in the purpose of WACC calculation. In fact, one could both use Gross Financial Debt, the overall interest-bearing value found in the company's Balance Sheet or the Net Financial Position, that is obtained subtracting Cash and Cash Equivalents from the Gross Financial Debt to reflect how cash could be used to repay part of that debt.

CHAPTER 2: VALUATION – RELATIVE vs ABSOLUTE

After having estimated discount rates, the main valuation methods for a target are presented. These are divided into two main groups, depending on the rationale they are based on:

- *Relative valuation methods*: where the target is evaluated comparing it to a set of other peers comparable companies (Comparable firms) to assess which value the market confers them or to a set of peers that previously faced an acquisition at a certain price (Precedent Transactions);
- *Absolute valuation methods*: discount rates find their best use in what are called the Absolute (or Intrinsic, or Discounted Cash Flow) valuation methods. Absolute methods aim at discounting future cash flows generated by an asset/firm/project in a forecasted period to their Net Present Value (NPV) today. Implementing the specific project means receiving its NPV today. Following the same rationale, we are able to find the intrinsic value of a company's stock today projecting the cash flows it will generate (and compare also that value to its actual market value in order to understand if that target is undervalued or overvalued).

  Moreover, Absolute methods can be sorted according to their target value:

  - Equity (if they aim to directly understand the Equity intrinsic value of the company): Dividend Discount Model and Flow to Equity;
  - Firm (if they aim to first derive the overall Enterprise intrinsic value of the company): Flow to Firm (or WACC approach) and Adjusted Present Value. The latter, who best captures the tax benefits deriving from leverage, presents different calculation methodologies of present value of Tax Shields depending on the leverage policy adopted by the company. In addition, we explain how there is no "globally recognized way" to compute APV's Tax Shields and to choose the appropriate discount rate.

Some of the valuation method described in *Chapter 2*, who best fits the purpose of showing of debt can change/drive valuation, will be after applied in *Chapter 4* to value Volkswagen Equity and Firm values.

It is also necessary to highlight how, in the real-world, practitioners do not use just a single method to value a target but it is a best practice to take an overall overview of the outputs from several valuation methods in order to assess how much to pay for a certain target/company/asset.

2.1 RELATIVE VALUATION

2.1.1 COMPARABLE FIRMS

According to the method of "Comparable" firms (also called "Comps"), a firm's value is not determined by cash flows directly, but it is based on the value of other firms or investments that are expected to generate very similar cash flows in the future. Consider, hypothetically, the case in which one firm is equal to another that is publicly traded: if these firms generate equal cash flows, then the Law of One Price[56] implies their value is the same. Of course, two identical companies do not exist and, even if similar and pertain to the same sector or industry, they are probably different in size or scale. Valuation multiples help in adjusting for this scale differences.

For Damodaran[57], the main steps to value a company through the method of comps are:

- identify comparable firms/assets and obtain market values of these;
- convert these market values into standardized values since the absolute prices cannot be compared: this process of standardizing will create price multiples;
- compare the standardized value or multiple for the firm being analyzed to the standardized values for comparable firm, controlling for any differences between the firms that might affect the multiple, to judge whether the firm is under or overvalued.

Certain characteristics should be deeply investigated when building the universe of peers for comparison and value estimation. From the business/strategy point of view, it is necessary to find similarities in geography, business, products, customers. Regarding the financial characteristics of possible peers, it is necessary to analyze their dimension, key financial statements indicators, performance indicators and credit rating.

Analytically, multiples are given by the ratio of two measures at numerator and denominator. While various sectors may employ specialized or sector-specific valuation multiples, the most generic and widely used multiples employ a measure of market valuation in the numerator (e.g., Enterprise value, Equity value) and a universal measure of financial performance in the denominator (e.g., EBITDA, Net Income). For Enterprise Value multiples, the denominator employs a financial statistic that flows to both debt and equity holders, such as Sales, EBITDA, and EBIT. On the opposite, for Equity Value multiples the denominator employs a financial statistic referred only to equity holders.

When it comes to computing multiples, there are 2 important rules to understand:

[56] https://www.sciencedirect.com/science/article/abs/pii/0304405X81900052, accessed on 15/05/2023
[57] https://pages.stern.nyu.edu/~adamodar/pdfiles/execval/relval.pdf, accessed on 15/05/2023

- Both the value (numerator) and the standardizing variable (denominator) should be referred to the same claimholders in the firm. In other words, as already explained, the value of equity should be divided by equity earnings or Equity Book Value, and firm value should be divided by firm earnings or Firm Book Value.
- The variables used in defining the multiple should be estimated uniformly across assets in the "comparable firms" list. So, for example, if earnings-based multiples are used, the accounting rules to measure earnings should be applied consistently across assets.

2.1.1.1. EQUITY VALUE MULTIPLES

P/E ratio, calculated as current market share price divided by diluted EPS is the most widely recognized trading multiple. Assuming a constant share count, the P/E ratio is equivalent to Equity value to Net Income multiple. These ratios can be viewed as a measure of how much investors are willing to pay for a dollar of a company's current or future earnings.

$$\frac{\text{P}}{\text{E}} = \frac{\text{Market Price per Share}}{\text{Earnings per Share}}$$

$$\frac{\text{P}}{\text{E}} = \frac{\text{Market Capitalization}}{\text{Net Income}}$$

There are a number of variants on the basic P/E ratio in use. They are based upon how the price and the earnings are defined. Price is usually the current market price of the firm but can also be the average price during the Last Twelve Months (LTM). As earnings per share, you can have earnings per share in most recent financial year, or earnings per share in LTM or the forecasted earnings per share next year (Forward P/E).

The P/E ratio is particularly relevant for mature companies that have a demonstrated ability to consistently grow earnings. However, while the P/E ratio is broadly used and accepted, it has certain limitations. For example, it is not a good indicator for companies with little or no earnings as the denominator could even be negative. Net income (and EPS) is net of interest expense and, therefore, dependent on capital structure. As a result, two otherwise similar companies in terms of size and operating margins can have substantially different net income margins (and consequently P/E ratios) due to differences in leverage. Similarly, accounting discrepancies, such as for depreciation or taxes, can also produce meaningful disparities in P/E ratios among comparable companies.

P/BV ratio, on the other hand, compares the target's current market value with the Book Value of its Shareholder's Equity. This Book Value is the amount that would be left if the company liquidated all of its assets and repaid all of its liabilities.

$$\frac{\text{P}}{\text{BV}} = \frac{\text{Market Capitalization}}{\text{Book Value of Equity}}$$

This multiple is used to compare a business's net assets that are available in relation to the sales price of its book and it is typically used to show the market's perception of a particular stock value.

2.1.1.2 ENTERPRISE VALUE MULTIPLES

Given that Enterprise value represents the interests of both debt and equity holders, it is used in combination with unlevered financial statistics such as EBITDA, EBIT and Sales. The most generic and widely used enterprise value multiples are EV/EBITDA, EV/EBIT and EV/Sales.

EV/EBITDA serves as a valuation standard for most sectors. It is independent of capital structure and taxes, as well as any distortions that may arise from differences in Depreciation&Amortization (D&A) among different companies. There are some variants of multiples that use LTM EBITDA or Adjusted EBITDA at the denominator.

$$\frac{\text{EV}}{\text{EBITDA}}$$

EV/EBIT is less commonly used than EV/ EBITDA. However, EV/EBIT may be helpful in situations where D&A is unavailable or for companies with high CapEx. As with the P/E multiple, this multiple is higher for firms with high growth rates and low capital requirements (so that free cash flow is high in proportion to EBITDA). There are some variants of multiples that use LTM EBIT or Adjusted EBIT at the denominator.

$$\frac{\text{EV}}{\text{EBIT}}$$

EV/Sales is typically less relevant than the other multiples discussed. Sales may provide an indication of size, but it does not necessarily translate into profitability or cash flow generation. Consequently, EV/Sales is used largely as a sanity check on the earnings-based multiples discussed above. In certain sectors, however, as well as for companies with little or no earnings, EV/ Sales may be relied upon as a meaningful reference point for valuation. For example, EV/Sales may be used to value an early-stage company that is aggressively growing sales but has yet to achieve profitability.

$$\frac{\text{EV}}{\text{SALES}}$$

Once the multiple extracted from the universe of peers has been calculated, we can multiply it by the value of our target firm's appropriate financial performance indicator (Earnings per Share or Net Income if the multiple was an Equity multiple, EBITDA or EBIT or Sales if the multiple was an Enterprise multiple) to get its Equity or Enterprise values.

As reported by academics and professionals[58], there are a lot of pros in exploiting multiples for valuation:

- they are market-based, and so information used to derive for the target is based on actual public market data, so reflecting market's growth and risk expectations
- their relativity: easily measurable and comparable versus other companies
- quick to calculate with respect to Absolute Valuation Methods
- need less inputs and assumption (less, not none) with respect to Absolute Valuation Methods
- valuation is based on market data updated daily and so always current and adjourned
- useful also for other valuation methods: as we will see for FTE and WACC methods, multiples can be used to calculate the terminal value of an investment

On the opposite, multiple valuation is characterized also by different weaknesses:

- being completely market based, the valuation can be skewed during periods of irrational exuberance or bearishness
- absence of relevant peers: companies perfectly comparable are difficult to find and identify and sometimes do not exist at all
- potentially disconnected from cash flows

2.1.2 PRECEDENT TRANSACTIONS

Precedent transactions analysis ("precedent transactions" or "precedents"), like comps, employs a multiple-based approach to derive an implied valuation range for a given firm or asset. It is premised on multiples paid for comparable companies in prior M&A transactions. Precedents have a broad range of applications, most notably to help determine a potential sale price range for a target company in an M&A, capital markets, or restructuring transaction. The selection of an appropriate universe of comparable acquisitions is the foundation for performing precedent transactions. This process incorporates a similar approach to the one for determining a universe of comparable companies. The best comparable acquisitions typically involve companies similar to the target on a fundamental level of sharing key business and financial characteristics.

However, it is not uncommon to consider transactions involving companies in different, but related, sectors that may share similar end markets, distribution channels, or financial profiles. As a general rule, the most recent transactions occurred in the past two or three years are the most relevant as they likely took place under similar market conditions to the contemplated transaction. Multiples for precedent transactions are analytically built similarly to comps: Offer Price per Share to EPS / Equity Value to Net Income, Enterprise

[58] Rosenbaum, J. and Pearl, J. (2013) Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions. 2nd edn. Hoboken, New Jersey: John Wiley & Sons

Value to EBITDA, EBIT, and Sales. Generally, *all the precedent transaction multiples also include the premium paid at their numerator.* It represents the incremental dollar amount per share that the acquirer offers relative to the target's unaffected share price, expressed as a percentage. In calculating the premium paid relative to a given date, it is important to use the target's unaffected share price to isolate the true effect of the purchase offer. For this characteristic incorporation of a premium, usually Precedents lead to higher valuations than Comps.

2.2 INTRINSIC-ABSOLUTE VALUATION

We recall that the rationale behind these models is that the value of any risky asset is the present value of its expected future cash flows discounted at a rate appropriate to the riskiness of the cash flow.

2.2.1 DIVIDEND DISCOUNT MODEL

In the strictest sense, the only cash flow that an investor receives from a firm buying a publicly traded stock is the dividend[59]. The simplest model for valuing Equity is the dividend Discount Model (DDM), for which the value of a stock is the present value of expected future dividends the stock is expected to pay. From another point of view, leading to the same conclusion, an investor buying a stock expects two types of cash flows: dividends during holding period and expected price at the end of the holding period. And since the expected price itself at the end of the period is determined by expectations on dividends, the value of a stock is the present value of dividends. The general model for DDM follows:

$$\text{Value per share of stock at time 0} = \sum_{t=1}^{t=\infty} \frac{E(\text{Div}_t)}{(1+\text{COE})^t} \qquad \textit{(formula 2.1)}$$

where

$E(Div_t)$ = Expected dividend per share in year t

The appropriate discount rate for the DDM is obviously COE, since dividends are entirely directed to shareholders, and it just requires two main inputs: expected dividends and COE. To obtain the expected dividends, we make assumptions about expected future growth rates of firm's earnings and its payout ratio policy. For what relates to cost of equity, we recall the theory shown in *Paragraph 1.2.1*. However, DDM is flexible enough to allow for time-varying discount rates, where the time variation is caused by expected changes in interest rates across time[60].

Constant dividend growth model / Gordon growth model

Estimating value of dividends and their growth rate is complex, especially if analyst intention is projecting them for the distant future. A common approximation is to assume that in the long run, dividends will grow

[59] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 283
[60] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 307

at a constant rate in perpetuity[61]. The Gordon growth model can be exploited to value a target firm that is in a 'steady state'[62]. According to the model, the value of the target depends on the dividend level for the coming year, divided by the equity cost of capital adjusted by the expected growth rate of dividends.

$$P_0 = \frac{Div_1}{COE\text{-}g} \qquad \textit{(formula 2.1.1)}$$

Obviously, this formula is valid only when firm's COE is higher than its dividends' growth rate.

In addition, rearranging *formula 2.1.1*, we obtain:

$$COE = \frac{Div_1}{P_0} + g \qquad \textit{(formula 2.1.2)}$$

We also know that the total expected return of a stock, after 1 holding period, is given by the present value of the sum of the dividend expected at the end of the period and the price of the stock at the end of the period.

$$P_0 = \frac{Div_1 + P_1}{1 + COE}$$

We can rewrite *formula 2.1.2* as:

$$COE = \frac{Div_1 + P_1}{P_0} - 1 = \frac{Div_1}{P_0} + \frac{P_1 - P_0}{P_0} \qquad \textit{(formula 2.1.3)}$$

Comparing *formula 2.1.2* and *formula 2.1.3*, we see that g equals the expected capital gain rate: with constant expected dividend growth the expected growth rate of the share price matches the growth rate of dividends.

Constant long term growth model / Two-stage DDM

The two-stage growth model[63] allows for two stages of growth:

- an initial phase where the growth rate is not a stable growth rate
- a subsequent steady state where the growth rate is stable and is expected to remain at that level for the long term.

Value of Stock at time 0 = PV of Dividends during extraordinary phase + PV of Terminal Value

[61] Gordon, M. J. (1959) 'Dividends, Earnings, and Stock Prices', *The Review of Economics and Statistics*, 41 (2), pp. 99-105.
[62] with dividends growing at hypothetic rate that can be sustained forever
[63] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 328

While, in most cases, the growth rate during the initial phase is higher than the stable growth rate, the model can be adapted to value companies that are expected to post low or even negative growth rates for a few years and then revert back to stable growth. The value of the stock, in the context of the Two-stage DDM, is the present value of dividends during extraordinary growth phase plus the present value of the terminal value of the target growing indefinitely and in perpetuity at steady rate.

$$\text{Po} = \sum_{t=1}^{t=n} \frac{E(\text{Div}_t)}{(1+\text{COE})^t} + \frac{\text{TV}_n}{(1+\text{COE})^t} \text{ where } \text{TV}_n = \frac{E(\text{Div}_{n+1})}{\text{COE}-g} \qquad \textit{(formula 2.2)}$$

where
$E(\text{Div}_t)$ = Expected dividend per share in year t

COE = Cost of Equity

TV = Terminal Value at the end of year n

g = Steady state growth rate forever after year n

There are mainly three issues with the model defined above:

- it is not easy to define the length of the extraordinary growth period and individuate exactly when the steady period begins;
- it is assumed that the growth rate, reasonably high during the initial period, is "overnight" transformed into a lower stable steady rate. While these sudden transformations in growth can happen, it is much more realistic to assume that the shift from high growth to stable growth happens gradually over time;
- as in the basic DDM model, the focus in dividends in this model can lead to skewed estimates of value for companies that are not paying what they can afford in dividends and underestimate value of the ones that accumulate cash and pay out too little in dividends.

To conclude, since the Two-stage DDM is based on 2 clearly separated growth stages, it is best suited for firms which are in high growth and expect to maintain that growth rate for a specified time period, after which this momentum disappears.

2.2.2 FLOW TO EQUITY METHOD

The dividend discount model we previously described is based on the premise that the only cash flows received by stockholders are dividends. We will now use a more expansive and larger definition of cash flows to equity: the ones left over after meeting all the financial obligation, including debt payments, and after covering capital expenditures and working capital needs[64].

[64] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 351

To estimate how much cash a firm can afford to return to its stockholders, we begin with net income (accounting measure indicating stockholders' earnings during the period under examination) and convert it into a Free Cash Flow to Equity (FCFE). Three are the main elements to take in consideration to derive FCFE starting from Net Income:

Net capital expenditures: First, D&A current period are added back, since they are not a cash expense. After, any capital expenditures (defined broadly to include any acquisition) are subtracted from the net income since they represent cash outflows. The difference between CapEx and D&A (Net Capital Expenditures) is usually a function of the growth characteristics of the firm. High-growth firms tend to have high net capital expenditures relative to earnings, whereas low-growth firms may have low, and sometimes even negative, Net Capital Expenditures.

Net Working Capital (NWC): the broader definition of NWC would be "Current Assets – Current Liabilities", but considering we are only interested in in cash flow effects, it is better to consider only changes in noncash Working Capital. Indeed, firm's excess cash is usually invested in risk-free assets as short-term government bonds or commercial papers while items as accounts receivable do not earn a fair return, and so cash should not be included in working capital calculation.

We will so use the following general formula for computing NWC value in the context of our valuation:

$$\text{NWC} = (\text{Acc Rec} + \text{Inv} + \text{Prep Exp}) - (\text{Acc Pay} + \text{Accr Liab})$$

An increase in Net Working Capital drains a firm's cash flow (cash outflow) while a decrease in Net Working Capital increases cash available to investors (cash inflow). As an example, Accounts Receivable tend to increase in line with sales growth, which represents a use of cash as it is incremental cash that has not yet been collected. Conversely, an increase in Accounts Payable represents a source of cash as it is money that has been retained by the company as opposed to paid out.

Net Borrowing: only for the computation of FCFE (and not with the WACC approach, as will be discussed later in the chapter), equity investors have to consider the effects of changes in the levels of debt of their cash flows. Repaying the principal of existing debt represents a cash outflow, but the debt repayment could be counter-balanced by the issue of the new debt, which is a cash inflow. Netting the repayment of old existing debt against the new debt issue provides the effective measure of the cash change in debt: Net Borrowing

$$\text{Net Borrowings} = \text{New Debt Issued} - \text{Principal Repayments} = \text{Financial Debt}(t+1) - \text{Financial Debt}(t)$$

Allowing for the cash flow effects of net capital expenditures, changes in working capital, and net changes in debt on equity investors, we can define the cash flows left over after these changes as the free cash flow to equity (FCFE): This is the cash flow available to be paid out as dividends.

Free Cash Flow to Equity = Net Income – (Capital Expenditures - Depreciation) – (Change in non-cash Working Capital) + (New Debt issued – Debt Repayments) *(formula 2.3)*

This calculation can be simplified if we assume that the net capital expenditures and working capital changes are financed using a fixed mix of debt and equity. If δ is the proportion of the net capital expenditures and working capital changes that is raised from debt financing, the effect on cash flows to equity of these items can be represented as follows. Note that the net borrowing item is eliminated, because debt repayment are financed with new debt issues to keep the D/E ratio fixed.

Free Cash Flow to Equity = Net Income – (Capital Expenditures - Depreciation) $\times (1 - \delta) -$
$(\Delta \text{ Working Capital}) \times (1 - \delta)$

Another important element to highlight about the above formulations of FCFE is that it was assumed there are no preferred dividends paid. If there were, and since the equity value we are interested in is only common equity, it would be necessary to modify *formula 2.3* for the existence of preferred stocks and preferred dividends:

Free Cash Flow to Equity = Net Income – (Capital Expenditures - Depreciation) – (Change in noncash Working Capital) + (New Debt issued – Debt Repayments) – (Preferred Dividends + New Preferred Stock issued)

Constant growth FCFE model

The constant growth FCFE model is designed to value firms that are growing at a stable growth rate and are hence are in a steady state. The value of equity, under a constant growth model, is a function of the expected FCFE in the next period, the stable growth rate, and the required rate of return.

$$\text{Value of equity today} = \frac{\text{FCFE}_1}{\text{COE} - \text{g}} \qquad \textit{(formula 2.4)}$$

where
FCFE_1 = Expected FCFE of next year

COE = Cost of Equity

g = Growth rate in FCFE of the firm in perpetuity

This model is similar the Gordon growth model for DDM an also works under the same conditions: the growth rate used in the model for the steady state must be reasonable in relation to the growth rate in the economy in which the firm operates and should not exceed it. This model, like the stable growth DDM, is best suited for firms growing at a rate comparable to or lower than the nominal growth in the economy. According to Damodaran[65], it is the better to use FCFE model rather than the DDM model for firms that pay out dividends that are unsustainably high (because they exceed FCFE by a significant amount) or are significantly lower than the FCFE. *However, if the firm is stable and pays out its entire FCFE as dividend, the value obtained from this model will be the same as the one obtained from the Gordon growth model.*

Two-stage FCFE model

The Two-stage FCFE model is designed to value a firm that is expected to grow at a faster growth rate in an extraordinary growth period and at a stable rate after. The equity value of the target is the present value of the FCFE per year for the extraordinary growth period plus the present value of the terminal price at the end of the period.

$$P_0 = \sum_{t=1}^{t=n} \frac{FCFE_t}{(1+COE)^t} + \frac{TV_n}{(1+COE)^n} \quad \text{where} \quad TV_n = \frac{E(FCFE_{t+1})}{COE-g} \qquad \textit{(formula 2.5)}$$

where

$FCFE_t$ = Expected Free Cash Flow to Equity of the firm in year t

COE = Cost of Equity

TV = Terminal Value at the end of year n

g = Steady state growth rate forever after year n

For what concerns TV, there are two widely accepted methods used to calculate a company's terminal value—the *Exit Multiple Method* and the *Perpetuity Growth Method*[66].

- EXIT MULTIPLE METHOD: calculates the remaining value of a company's FCFE produced after the projection period based on a multiple of its terminal year Net Income. This multiple is typically based on the current LTM trading multiples for comparable companies.

  Terminal Value = Net Income * Equity Exit Multiple

- PERPETUITY GROWTH MODEL: The same caveats that apply to the growth rate for the stable growth rate DDM model apply here as well. In addition, the assumptions made to derive the free cash

[65] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 362

[66] Rosenbaum, J. and Pearl, J. (2013) Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions. 2nd edn. Hoboken, New Jersey: John Wiley & Sons

flow to equity after the terminal year have to be consistent with this assumption of stability. For instance, while capital spending may be much greater than depreciation in the initial high-growth phase, the difference should narrow as the firm enters its stable growth phase.

$$\text{Terminal Value} = \frac{\text{FCFE}_n * (1+g)}{\text{COE} - g}$$

Both the DDM and the FCFE will output the same equity valuation result only in two distinct scenarios[67]:

- If dividends and FCFE projected are the same (obviously maintaining all the other assumptions in common as timing of dividends/cash flows and COE)
- If FCFE is larger than dividends, but the excess cash (FCFE – dividends) is invested by the firm in projects whose NPV = 0.

Nevertheless, most of the time the result from FCFE method will be higher from the one of DDM method: when the FCFE are larger than dividends and the excess cash either results in earnings below market returns or is invested in projects with negative NPVs, then the value from FCFE model will be higher than the value from DDM.

2.2.3 FLOW TO FIRM / WACC METHOD

The Free Cashflow to Firm (FCFF) is defined as the sum of the cashflows to all claim holders in the firm, including stockholders, bondholders and preferred stockholders. There are two ways of measuring the FCFF.

1) Add up the cashflows to the claim holders, which would include cash flows to equity (defined either as free cash flow to equity or dividends), cashflows to lenders (which would include principal payments, interest expenses and new debt issues) and cash flows to preferred stockholders (usually preferred dividends). In this way we are simply we are reversing the process that we used to get to Free Cash Flow to Equity, where we subtracted out payments to lenders and preferred stockholders to estimate the cash flow left for stockholders.

Free cash Flow to Firm = Free Cash Flow to Equity + Interest Expenses (1-T) + Principal Repayments – New Debt issued + Preferred Dividends

2) A more immediate way of getting to FCFF is to estimate the cash flows prior to any of these claims. Thus, is it possible to begin with Earnings before Interest and Taxes, net out taxes and reinvestment needs (Working Capital and CapEx) and arrive at an estimate of the free cash flow to the firm.

$$\text{FCFF} = \text{EBIT (1-T)} + \text{Depreciation\&Amortization} - \text{Capital Expenditures} - \Delta\, Working\ Capital$$

[67] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 373

(formula 2.6)

Since the cash flow we obtained is prior to any debt repayment, FCFF is often referred to as Unlevered cash Flow. Note FCFF we computed does not incorporate any of the tax benefits due to interest payments. This is obvious, because the use of the after-tax cost of debt in the WACC estimation (the discount rate used for the method) already considers this benefit and including it in the cash flows would double count it. Differences between FCFE and FCFF characteristics, computations and calculation are expressed in *Table 7:*

	FCFF	FCFE
Cash Flow to be discounted	Unlevered Cash Flow (residual cash flow after paying all operating expenses, CapEx and taxes, but prior to any repayment to providers of finance)	Levered Cash Flow (residual cash flow after paying all operating expenses, CapEx and taxes, but prior to any repayment to providers of equity finance)
Appropriate Cost of Capital	WACC	COE
Valuation	Enterprise Value	Equity value (to all shareholders)

Table 7: Main differences between FCFF and FCFE
Source: Corporate Finance Institute, Investment Banking Manual, pag.173

Constant growth FCFF

As it happens in the DDM and FTE models, a firm that is growing at a rate (stable growth rate) that it can sustain in perpetuity can be valued using a stable growth model[68]. The Enterprise Value of a target with Free Cash Flows to Firm growing at a stable growth rate can be valued using the following equation:

$$\text{Value of equity today} = \frac{\text{FCFF}_1}{\text{WACC} - \text{g}} \qquad \textit{(formula 2.7)}$$

where

$\text{FCFF}_1 =$ Expected FCFF in next year

WACC = Weighted Average Cost of Capital

g = Growth rate in FCFF of the firm in perpetuity

Two conditions need to be met to use this model: the growth rate used in the model as it happens for the DDM and FTE models has to be less than or equal to the growth rate in the economy and the characteristics of the firm must be consistent with assumptions of stable growth. In particular, the reinvestment rate used to

[68] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 380

estimate FCFF should be consistent with the stable growth rate. The best way of enforcing this consistency is to derive the reinvestment rate from the stable growth rate.

$$\text{Reinvestment Rate in Stable Growth} = \frac{\text{Growth rate}}{\text{Return on Capital}}$$

Like all stable growth models we have analyzed so far, this one is sensitive to assumptions about the expected growth rate. This is accentuated, however, by the fact that the discount rate used in valuation is the WACC, which is significantly lower than the cost of equity for most firms. Furthermore, the model is sensitive to assumptions made about CapEx and Depreciations: the FCFF can be inflated (deflated) by decreasing (increasing) capital expenditures relative to depreciation. If the reinvestment rate is estimated from the return on capital, changes in the return on capital can have significant effects on firm value.

Two-stage FCFF model

The Two-stage FTF model is designed to value a firm that is expected to grow at a faster growth rate in an extraordinary growth period and at a stable rate after. The enterprise value of the target is the present value of the FTF per year for the extraordinary growth period plus the present value of the terminal price at the end of the period[69].

$$P_0 = \sum_{t=1}^{t=n} \frac{FCFF_t}{(1+WACC)^t} + \frac{TV_n}{(1+WACC)^n} \quad \text{where} \quad TV_n = \frac{E(FCFF_{t+1})}{WACC-g} \qquad \textit{(formula 2.8)}$$

where

$FCFF_t$ = Expected Free Cash Flow to Firm of the firm in year t

WACC = Weighted Average Cost of Capital

TV = Terminal Value at the end of year n

g = Steady state growth rate forever after year n

In the formula above, the projected FCFF and terminal value are discounted to the present at the target's WACC. The present value of the FCF and terminal value are summed to determine an enterprise value, which serves as the basis for the DCF valuation. The WACC and terminal value assumptions typically have a substantial impact on the output, with even slight variations producing meaningful differences in valuation. As a result, a DCF output is viewed in terms of a valuation range based on a range of key input assumptions, rather than as a single value. If strong and defensible assumptions regarding financial projections are taken, this will help in shielding the final valuation from market distortion. On the other side, inconsistent assumptions will lead to invalid estimations. The impact of these assumptions on valuation is tested using

[69] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 383

sensitivity analysis. The most important inputs (and so object of sensitivity analysis) for this model are: high-growth period, the high-growth FCFFs, the cost of capital (WACC) and the terminal value.

Similar to the FCFE case, as it is infeasible to project a company's FCFF indefinitely, a terminal value is usually determined to capture the value of the company beyond the projection period. Terminal value, in the WACC valuation approach, is typically calculated on the basis of the company's FCFF (or a proxy such as EBITDA) in the final year of the projection period. As in the FCFE model case, the Terminal Value can usually account for a substantial portion of the firm's value and there are two main methods to calculate it: the *Exit Multiple Method* and the *Perpetuity Growth Model*.

- EXIT MULTIPLE METHOD: calculates the remaining value of a company's FCFF produced after the projection period based on a multiple of its terminal year EBITDA or EBIT. This multiple is typically based on the current LTM trading multiples for comparable companies.

  Terminal Value = EBITDA or EBIT * Enterprise Value Exit Multiple

- PERPETUITY GROWTH MODEL: The same caveats that apply to the growth rate for the stable growth rate DDM model apply here as well. In addition, the assumptions made to derive the free cash flow to firm after the terminal year have to be consistent with this assumption of stability. WACC is used instead of ROE.

  $$\text{Terminal Value} = \frac{\text{FCFF}_n * (1+g)}{\text{WACC} - g}$$

There a lot of pros in using intrinsic and absolute method as FCFF and FCFE:

- they are cash flow-based (more fundamental approach to valuation with respect to relative valuation)
- they are market independent (or less dependent than relative valuation)
- self-sufficient and not rely entirely on comparable companies or precedent transactions, in particular in the case ii which there are no or few peers to compare to the firm under investigation
- flexibility: allows sensitivity analysis and scenario manager to understand how the output the valuation changes with main inputs variation

And weaknesses:

- strong dependence on the financial projections, especially for long periods
- strong sensitivity to assumptions
- terminal value weight: the present value of the terminal value can represent as much as three quarters or more of the valuation, decreasing the overall relevance of the projected period
- in particular for the WACC approach: it assumes a constant capital structure and does not provide flexibility to change firm's D/E ratio over the projection period

2.2.4 EQUITY BRIDGE

Once the present values of the FCFF for the forecasted period and the present value of the Terminal Value for the steady period are sum up, the overall Enterprise value of the firm is obtained. There are still more passages to conclude to arrive at the equity value (and price per share) of the target company. To derive implied equity value, the company's net debt, preferred stock, and noncontrolling interest are subtracted from the calculated enterprise value.

$$\text{Equity Value} = \text{Enterprise Value} - \text{Net Financial Position} - \text{Preferred Stock} - \text{Noncontrolling Interests}$$

(formula 2.9)

Other non-equity claims as Unfunded Pensions Liabilities and Investments in Associates can be subtracted/added from *formula 2.9*.

For publicly traded companies, implied equity value is divided by the company's fully diluted shares outstanding to calculate an implied share price

$$\text{Implied Share Value} = \frac{\text{Implied Equity Value}}{\text{Fully Diluted Shares Outstanding}} \qquad \textit{(formula 2.10)}$$

To find the correct number of fully diluted shares outstanding (so the number of firm's shares outstanding in the market considering other equity claims as outstanding warrants, options, and convertible securities) two methods can be exploited: Treasury Stock Method and If-Converted Method[70].

In the *Treasury Stock Method (TSM)* approach, it is implicitly assumed that the proceeds obtained from the sale of options are in turn used to buy the shares at the current price. The since the options were bought by the investors in the first place because they were in-the-money, it is clear that the firm will use the same total amount of money to repurchase the shares: but since the shares are listed at a price higher than the one paid by the investors, the firm will be able to afford fewer of them, thus implying more shares outstanding anyway and a dilution effect. An example of TSM is given in *Figure 9*.

[70] Rosenbaum, J. and Pearl, J. (2013) Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions. 2nd edn. Hoboken, New Jersey: John Wiley & Sons, pag 31 and pag 33

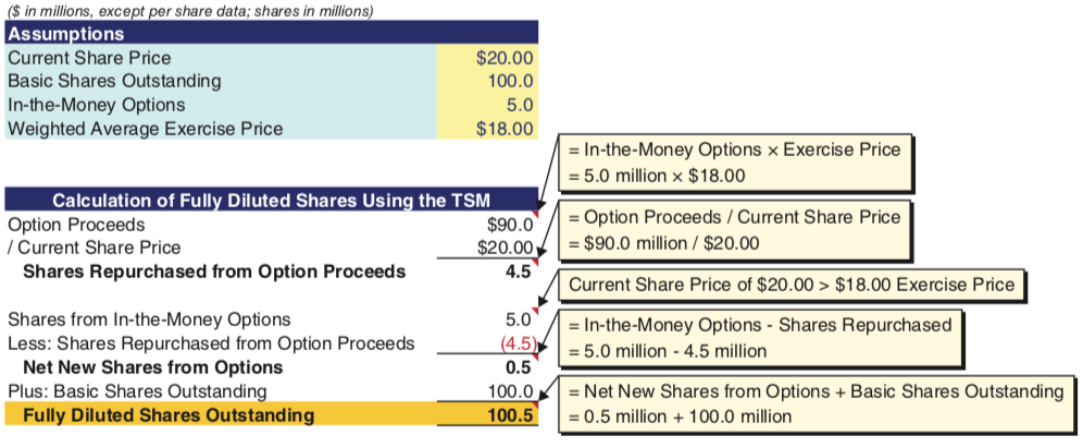


Figure 9: Calculation of Fully Diluted Shares Using the Treasury Stock Method
Source: Rosenbaum, J. and Pearl, J. (2013) Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions. 2nd edn. Hoboken, New Jersey: John Wiley & Sons, p.31

In the *If-Converted Method* approach, the conversion price is the exercise price at which the bondholder will buy the security provided if the share price is higher. Once the number of in-the-money convertible securities is set, this number is divided by the conversion price: we so obtain the number of incremental shares. An example of If-Converted Method is given in *Figure 9*.

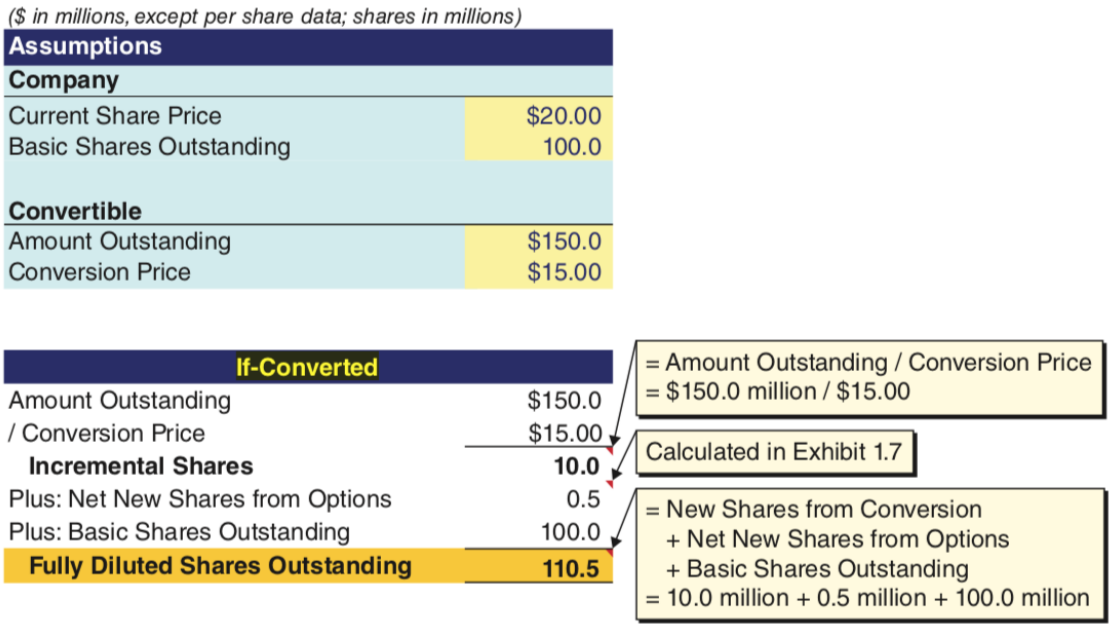


Figure 10: Calculation of Fully Diluted Shares using the If-Converted Method
Source: Rosenbaum, J. and Pearl, J. (2013) Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions. 2nd edn. Hoboken, New Jersey: John Wiley & Sons, p.33

2.2.5 ADJUSTED PRESENT VALUE METHOD

The Adjusted Present Value (APV) model was developed by Myers[71] in 1974, as a natural development of

[71] Myers, S. C. (1974). Interactions of Corporate Financing and Investment Decisions-Implications for Capital Budgeting. *The Journal of Finance*, *29*(1), 1–25. https://doi.org/10.2307/2978211

the theories by M&M, presented in *Paragraph 1.1* of this final dissertation. In the APV approach, we begin assessing the value of the firm without debt, so its Unlevered Value. As we add debt to the firm, we consider the net effect on value by including both the benefits and the costs of borrowing, obtaining the Levered Value of the target. To do this, we assume that the primary benefit of borrowing is a tax benefit to the firm and that the most significant cost of borrowing is the added risk of bankruptcy to the firm[72]. The major advantages of APV method are that it can be used, given coherent assumptions, regardless of any change in the capital structure during the forecasted period and highlights better than other models how debt impacts in the "creation" of the Levered Value of the asset. The base-case cash flow forecasts can be divided into separate cash flows associated with the buyer's value creation proposals. The base-line cash flows come from the current operating results and together with the various incremental initiatives give us the base-case value (the unlevered value of the firm).

The Levered Value of the target is so estimated in three different steps:

1) Compute Unlevered Value of the firm

The first step in this approach is the estimation of the value of the unlevered firm. This can be accomplished by valuing the firm as if it had no debt by discounting the expected free cash flow to the firm at the unlevered cost of capital R_U(from now on also called K_U)[73]. The company's Unlevered Cost of Capital represents the rate of return on its assets on the presumption that there is no leverage (the company is 100% equity financed). As in the FCFE and FCFF methods, in the special case where cash flows grow at a constant rate in perpetuity, the value of the firm is easily computed.

$$\text{Value of Unlevered Firm} = \frac{\text{FCFFop}\ (1+g)}{R_U - g} \qquad \textit{(formula 2.11)}$$

where

FCFFop = current after-tax operating cash flow of the firm

R_U = Unlevered Cost of Capital

g = expected growth rate of FCFF of the company in perpetuity

In case there are two different periods of growth, one for the forecasted period and one for the non-forecasted one, the formula that can be applied to obtain the Value of Unlevered Firms is similar to the one in the same case for DDM, FTE and FTF:

[72] Leland, H. E. (1994). Corporate Debt Value, Bond Covenants, and Optimal Capital Structure. *The Journal of Finance*, *49*(4), 1213–1252. https://doi.org/10.2307/2329184

[73] Berk, DeMarzo, "Corporate Finance" (2017)

$$\text{Value of Unlevered Firm} = \frac{\text{FCFFop}\,(1+g)}{R_U - g} + \frac{TV_n}{(1+R_U)^n} \text{ where } TV_n = \frac{E(\text{FCFFop}_{t+1})}{R_U - g} \qquad \textit{(formula 2.12)}$$

The inputs needed for this valuation are the expected cashflows, growth rates and the unlevered cost of capital. To estimate the latter, it is necessary to first assess the financing policy the firm wants to maintain during the projection period.

2) Compute *Expected Tax Benefit from Borrowing*

The second step in this approach is the calculation of the expected tax benefit from a given level of debt. According to Myers, this tax benefit is a function of the tax rate of the firm and is discounted at the cost of debt to reflect the riskiness of this cash flow[74]. In this scenario, Interest tax Shields are computed as the interest expenses at time t multiplied by the tax rate, with interest expenses equal to the pre-tax cost of debt multiplied by debt at time t-1. The tax rate used here is the firm's marginal tax rate and it is assumed to stay constant over time.

$$\text{Tax Shields t} = \text{Interest paid at t} * \text{Pretax Cost of Debt} \qquad \textit{(formula 2.13)}$$

While the validity of the first step (discounting at the Unlevered Free Cash Flows at the Unlevered Cost of Capital) is widely accepted among academics and practitioners, the same cannot be said about the second step just described. In fact, Myers assumes that it is appropriate to discount tax shields at firm's pre-tax COD because it is as risky as firm's debt. Conversely, several additional theories and formulas have been provided by academics to adjust and change APV. These different formulations are related to both the Value of Tax Shields and to the appropriate discount rate applied to it. As we will see, the leverage policy of the target is a relevant criterion to determine the right formula to choose the correct discount rate for tax shields.

Technically, also personal taxes should be considered in the context of the computation of Expected Tax Benefits, but for the purpose of this dissertation personal taxes will be neglected.

3) Estimating Expected Bankruptcy Costs and Net Effect

The third step consists in evaluate the effects of the given level of debt on the default risk of the firm and on expected bankruptcy costs. The rationale behind this third step comes from Damodaran's theory. The professor provides an additional formula to subtract from classical APV calculation[75]:

[74] Myers, S. C. (1974). Interactions of Corporate Financing and Investment Decisions-Implications for Capital Budgeting. *The Journal of Finance*, *29*(1), 1–25. https://doi.org/10.2307/2978211

[75] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 415

PV of expected bankruptcy cost = $\pi\alpha BC$

where

$\pi\alpha$ = Probability of default after the additional debt

BC = Present value of the bankruptcy costs

Subtracting the Present Value of expected bankruptcy cost from the value obtained in the first two steps makes sense, especially considering that a firm's credit worthiness is directly related to its default/bankruptcy chances: lower the credit strength of the firm the higher the event of its default/bankruptcy. From the valuation point of view the consequences of this considerations are evident: higher costs of leverage lead to a lower equity valuation.

However, as argued by Damodaran itself[76], this third step is often avoided because of the difficulty (and impossibility) to estimate directly the probability of default/bankruptcy and the related costs. Indeed, the just discussed formula will not be considered in the practical computation of Volkswagen APV in *Chapter 4*.

2.2.5 APPROPRIATE DISCOUNT RATE AND TAX SHIELDS ACCORDING TO THEORIES AND LEVERAGE POLICIES

This paragraph lists different theories related to the second step of APV calculation, partitioning them with respect to the leverage debt policies to which they refer. The fundamental paper in which all these theories are summarized and retrieved is Fernandez (2019)[77].

- **CONSTANT LEVERAGE POLICY**

In this case, the firm targets a certain market value-based or book value-based D/E ratio that has to be infinitely preserved. In case the firm under valuation maintains a constant leverage policy, we calculate the unlevered cost of capital as the target's pre-tax WACC. The pretax WACC represents investors' required return for holding the entire firm (equity and debt). Thus, it will depend only on the firm's overall risk. As long as the firm's leverage choice does not change the overall risk of the firm, the pretax WACC must be the same whether the firm is levered or unlevered. Of course, this argument relies on the assumption that the overall risk of the firm is independent of the choice of leverage.

$$\text{Pre-tax WACC} = \frac{E}{V} \times COE + \frac{D}{V} \times COD = K_u \qquad \textit{(formula 2.14)}$$

[76] Damodaran A., "Investment Valuation" 2nd Edition (2002), pag. 416

[77] Fernández, P. (2019) 'Valuing Companies by Cash Flow Discounting: 10 Methods and 9 Theories', *IESE Business School*

For what concerns the correct discount rate for tax shields in case the company preserves a constant D/E ratio, we examine now two different perspectives:

Miles and Ezzel (1980) argue that a firm that wishes to keep a constant D/E ratio must be valued in a different manner from the firm that has a preset level of debt. For a firm with a fixed D/E they calculate VTS as "Tax Rate × Debt × COD" and claim that the correct discount rate is COD during the first year and Cost of Unlevered Capital K_u for the following years.

Harris & Pringle (1985) try to find a general model able to capture the reliability of discount rates in the context of APV[78]. According to them, VTS is calculated as the same but must be discounted at the Cost of Unlevered Capital K_u also for the first year. Their argument is that the interest tax shields have the same systematic risk as the firm's underlying cash flows and, therefore, should be discounted at the required return to assets (that is equal to K_u).

If the firm adjusts its debt continuously to maintain a target D/E the firm's debt and interest payments will vary with the firm's value and cash flows and it is so reasonable to expect that the risk of the tax shield will be equal to the firm's cash flows.

- **FIXED DEBT POLICY**

With this leverage policy, a company's financial debt levels are predetermined. In particular, debt repayment schedule can be fixed in advance and be independent from the firm's growth or be a constant perpetuity. When debt levels are pre-determined, the firm will not adjust its debt based on fluctuations to its cash flows or value according to a target leverage ratio. As a result, the firm's pre-tax WACC will no longer coincide with its Unlevered Cost of Capital. K_u, under a fixed debt policy, will be equal to the Unlevered Cost of Equity of the firm. The latter, Based on the CAPM formula previously seen in *Chapter 1*, is given by:

$$\mathrm{COE_{UNLEVERED}} = \mathrm{R_f} + \beta^{\mathrm{UNLEVERED}} (\mathrm{R_m} - \mathrm{R_f}) \qquad \textit{(formula 2.15)}$$

The necessary formula to extract the target's Unlevered Beta from its peers and use it in the above equation is the following:

$$\beta^{\mathrm{UNLEVERED}} = \frac{\beta^{\mathrm{LEVERED}}}{[1+\frac{\mathrm{D}}{\mathrm{E}}(1-\mathrm{T})]} \qquad \textit{(formula 2.16)}$$

[78] Harris, R. and Pringle, J., "Risk-adjusted discount rates-extensions from the average-risk case", pp. 237-244

When it comes to the computation of the present value of the tax shields, under fixed debt policy, several academics have tried to develop a consistent theory.

Modigliani And Miller, recalling exactly what has already been discussed in *Paragraph 1.1*, assume that the company and its debt are in perpetuity and that the Value of Tax Shields (VTS) is simply the value of Debt multiplied by the tax rate. This result is only correct for perpetuities[79]. As Fernandez demonstrates, discounting the tax savings due to interest payments on a risk-free debt at the risk-free rate provides inconsistent results for growing companies[80].

Myers (1974) proposes calculating VTS by discounting the tax savings (Debt × Tax Rate × COD) at the cost of debt COD. The argument is that the risk of the tax saving arising from the use of debt is the same as the risk of the debt. This is the same approach followed by Damodaran (1994)[81].

Luehrman (1997) calculates and discounts VTS discounting them at a discount rate higher than the firm's COD and lower than its Unlevered COE. He defines APV as a "method that always works and needs less inputs than WACC approach"[82]. Moreover, he states that "APV unbundles components of value and analyze each one separately. On the opposite, WACC bundles all financing side effects into the discount rates. WACC is obsolete." In fact, APV has the extraordinary characteristic of being able to extract and show exactly how much value of the company derives from tax shields, while large part of this value in the WACC approach incorporated into WACC, the cost of capital.

Ehrhardt & Daves (1999) examined the combined impact of firm growth (growth rate) and tax shield on the values of the company[83]. They compared the different approaches, showing that if the tax shield of a growing company is discounted at a rate that is less than the cost of the unlevered capital, then the valuation results are inconsistent with intuitive sense and everyday observations. In particular, the authors refer to the specific case in which the unlevered cost of capital is less than the levered cost of equity, and the cost of capital decreases when the capital increases, as if the amount of debt were increasing.

Copeland, Koller and Murrin (2000) treat the Adjusted Present Value in their Appendix A[84]. They conclude to leave to the reader's judgment to decide which approach best fits his or her situation". They also claim

[79] Fernández, P., "The Correct value of Tax Shields: An Analysis of 23 Theories"(2016) IESE Business School, pag.8
[80] Fernández, P., "Valuing Companies by Cash Flow Discounting: 10 Methods and 9 Theories" (2019) *IESE Business School,pag. 22*
[81]
[82] Luehrman TA. What's it worth? A general manager's guide to valuation. Harv Bus Rev. 1997 May-Jun;75(3):132-142
[83] Ehrhardt, M. & Daves, P. , "The Adjusted Present Value: The Combined Impact of Growth and the Tax Shield of Debt on the Cost of Capital and Systematic Risk" (1999)
[84] Copeland, T., Koller, T. and Murrin, J. (2000) Valuation—Measuring and Managing the Values of Companies. John Wiley Sons, New York

that “the finance literature does not provide a clear answer about which discount rate for the tax benefit of interest is theoretically correct.”

Fernandez (2007) shows that Myers’s theory yields consistent results only if the expected debt levels are fixed. He also states that the Present Value of Tax Shields does not depend from the nature of the Unlevered Free Cash Flows of the firm, whose risk it totally different and independent form the one of the tax shields. The discount rates for Cash Flows and Tax Shields should so be different and reflect different opportunities and risks.

- **CONSTANT INTEREST COVERAGE RATIO**

If a firm is using leverage to shield income from corporate taxes, then it can adjust its debt level so that its interest expenses grow with its earnings. In this case, it is natural to specify the firm’s incremental interest payments as a target fraction, *k*, of the project’s free cash flow:

$$\text{Interest Paid in Year } t = k * FCF_t$$

When the firm keeps its interest payments to a target fraction of its FCF, we say it has a *Constant interest coverage ratio.* In that case:

$$PV(\text{Interest Tax Shield}) = PV(t\,k * FCF) = t\,k * PV(FCF) = tk * V_{UNLEVERED}$$

That is, with a constant interest coverage policy, the value of the interest tax shield is in proportion to the project’s unlevered value.

2.2.5.2 APV IN VOLKSWAGEN AG VALUATION

For the purpose of Volkswagen’s valuation in *Chapter 4*, we will use the APV method under the assumption of a pre-determined debt schedule. In fact, as we will see in *Chapter 3*, Volkswagen AG is characterized by an inconstant and highly volatile D/E ratio (It is important to recall that for the purpose of this dissertation Market Value of Debt = Book Value of Debt, while for the Equity Value we will consider Market Capitalization). We will already see the valuation of the group under the WACC method, that by definition is going to assume a constant D/E ratio over all the projection period. Comparing WACC result with the result of Adjusted Present Value method under a constant leverage policy assumption would be redundant and show a similar output. The Adjusted Present Value method will so be carried assuming a Pre-determined Debt Schedule for the company, and this will let us relax the unrealistic assumption of target’s management continuing adjusting debt to maintain a certain ratio and focus more on the projected Change in Net Borrowings and related Interest expenses of the group in the forecasted period.
The rate at which discount Unlevered Free Cash Flows will be the Unlevered COE while, given the

inexistence of a shared rate at which discount Tax Shields, we decide to apply the theory by Myers/Damodaran in which tax shields are as risky as Debt: their discount rate will be equal to pre-tax Cost of Debt.

CHAPTER 3: VOLKSWAGEN AUTOMOTIVE GROUP ANALYSIS

In the third chapter of this final dissertation, the overall profile of the company under our analysis, Volkswagen AG, will be analyzed from different perspectives.

First, the background history of the German group will be presented, with a focus on the origins of Volkswagen brand and a reference to the different brands and car manufacturers acquired during its 86 years history. After, it will be shown how the company is split between an Automotive division (under which fall all the different categories of vehicle brand held by VW AG) and the Financial Services division. The following paragraph will after take in consideration the governance aspect of our object of investigation and dive deep into the Supervisory and Management Board. The first macro-area of this chapter ends with a discussion on the Shareholding structure of the group, held primary by Porsche Automobil SE ad institutional investors/private shareholders and the difference in shareholding and voting structures deriving from the presence of preferred stocks in the firm's equity. However, it is also highlighted how for simplification and comparison consistency reasons the valuation in the next chapter the capital will be carried only on ordinary shares.

Consolidated Financial Statements (BS, IS, CF) of the group for the years 2018-2022 are presented and a strategic reclassification of the Balance Sheets is put in practice in order to calculate important elements as Net Operating Assets and Net Financial Position. Next, a heavy analysis of debt characteristics of the company is conducted: Solidity Analysis (Liquidity + Solvency) will show the short-term and long-term reliability profile of VW AG. A complete overview of the firm's debt, main object of study of this final thesis, the 2022 group debt's components are visualized and the funding mix, maturity mix, currency and interest rate mixes are presented. Last 12 years credit rating by Moody's and S&P Global are reported to conclude that, even with a high amount of debt, VW AG is considered able to "bear" its short and long-term interest payments.

Next, the group's market capitalization is analyzed and the impact of external events during the last decade as the 2015 Emission scandal, COVID-19 spread and Russian-Ukraine war outbreak on it are shown. The high difference between the company's NFP/Market Cap and NFP/Book Equity, coming from these external factors, is discussed.

Finally, a space of discussion is left for a deep dive into the high Fixed, CapEx and R&D costs that Volkswagen AG bears with respect to its competitors in order to improve its future BEV sales in the context of PowerCo Plants and Future Revenue Pools projects.

The chapter ends with an overview of the Green Finance Framework, the Green bond issuance program aiming at financing BEV and Software development and increase the company's BEV market share. The relation between the framework, high R&D and CapEx, high debt and debt financing is clarified.

3.1 VOLKSWAGEN AG PROFILE

3.1.1 Presentation and History

Volkswagen Automotive Group (VW AG) is the largest (by 2022 revenue) global vehicles manufacturer, founded in 1937 by the German government[85]. Its headquarters are located in Wolfsburg, Germany. It is a public company, that was first listed on the in April 1961 on Wolfsburg stock exchange. Preference shares were introduced in September 1986 and its shares are currently traded on the following stock exchanges[86]: Berlin, Dusseldorf, Frankfurt, Hamburg, Hanover, Stuttgart.

The group operates in 120 different production plants in 29 different countries (19 European and 10 across Americas, Asia and Africa). In 2022, 668.000 employees operated in business-related fields or directly in the production of vehicles, after sold in 153 countries. Always during 2022, Volkswagen AG produced approximately 8.283.000 vehicles, which resulted in Sales Revenues of EUR 279.2 billion by the company[87]. Despite the company is globally first in 2022 automotive manufacturers business with respect to revenues, it is only third if we consider the number of units sold with a 6.8% market share, versus the leader Toyota (12.1%) and Ford (6.9%), followed by Hyundai (6.4%) and Nissan (6.3%).
Refinitiv classifies Volkswagen AG according to several characteristics, following the Global Industry Classification Standards (*Table 9*).

Sector	Consumer Cyclical & Discretionary
Industry Group	Automobiles & Components
Industry	Automobiles
Sub-Industry	Automobile Manufacturers

Table 9: Global Industry Classification Standards for Volkswagen Automotive Group
Source: workspace.refinitiv.com/web/Apps/Corp/?s=VOWG.DE&st=RIC, accessed on 30/05/2023

Volkswagen brand has a long history that starts at the beginning of the last century. In late 1920s, the vision of mass motorization along American lines gained momentum in Germany. Designers and engineers started to work to transform the idea of a car for personal use a concrete opportunity also in the country. The National Socialists take up this concept, turning mass motorization into a propaganda tool for their social and utopian program of government. In 1934, the German Labor Front hired Austrian automotive engineer Ferdinand Porsche to be responsible of the original design of the hypothetic "mass car" and in 1937 the *"Gesellschaft zur Vorbereitung des Deutschen Volkswagen"* (literally "Company for the preparation of the German people's car) was founded. The outbreak of World War II in 1939 occurred before mass production

[85] https://www.volkswagen-newsroom.com/en/history-3693, accessed on 01/06/2023
[86] https://www.volkswagen-group.com/en/faqs-16035, accessed on 02/06/2023
[87] https://annualreport2022.volkswagenag.com/group-management-report/summary.html, accessed on 01/06/2023

could begin and the factory built for that purpose was reorganized to produce military equipment and vehicles. The production of the first Volkswagen, the "Beetle", finally began in 1946 under British supervision. After the end of the war in 1949, control of Volkswagen was transferred to the West German government and so to the state of Lower Saxony, that still today owns a significant stake in the company. During 1950s the production volume grew rapidly and Volkswagen effectively became part of the evidence of Germany's economic miracle. However abroad sales, in particular in the United States, were initially sluggish because of the origin of Volkswagen, connected to the Nazi party. This gap was filled only thanks to an unconventional market campaign about the Beetle and so the company reached popularity also in the USA. In 1961, as anticipated, Volkswagen became listed. In 1964, the Wolfsburg car producer successfully managed his first acquisition buying another car producer: Auto Union (after known as Audi). Between 1970 and 1980 the company evolved and developed several new popular models as Passat, Golf and Polo. In 1986, the Spanish car producer Seat is incorporated under the company and in 1998 four important luxury brand are acquired: Bentley, Lamborghini, Rolls Royce (sold to BMW in 2002) and Bugatti (not anymore in the portfolio). In 2012, Volkswagen for the first times acquired, trough Audi AG, 100% of shares of a motorcycle manufacturer: Ducati Motor Holding SPA.

Relationship with Porsche AG

Probably, the most important M&A event in Volkswagen history is the one involving Porsche, car house founded by Ferdinand Porsche himself who, as already mentioned, designed the Volkswagen Beetle. During 2008 crisis, Porsche SE (the holding company of Porsche family who controlled Porsche automotive group) tempted to acquire Volkswagen AG but failed in the purpose of a hostile takeover. In fact, Porsche SE was not able to raise sufficient capital to buy 75% of VW AG outstanding shares. In 2009, Porsche SE and Volkswagen AG reached an agreement to merge, only in 2011, the car manufacturing operations of Porsche AG and VW AG in order to form an "Integrated Automotive Group". After the plan approval by the Supervisory Boards of the two groups the final structure reached is the following: Porsche SE holds the largest stake in Volkswagen AG capital (and the majority of voting rights, as will be later shown) and VW AG controls Porsche Automotive Group. Only on the 29th of September 2022, Porsche AG was listed on the Frankfurt stock exchange. With a value of EUR 78 billion, Porsche AG IPO is the largest primary listing ever carried in Europe and the all-time largest in automotive sector by market capitalization[88].

2015 emission scandal

One of the most relevant events in Volkswagen recent history is the emission scandal spread in 2015. The USA Environmental Protection Agency found that the control procedures on all company vehicles' emissions were only activated and reported during laboratory testing (and so not during real road test). The

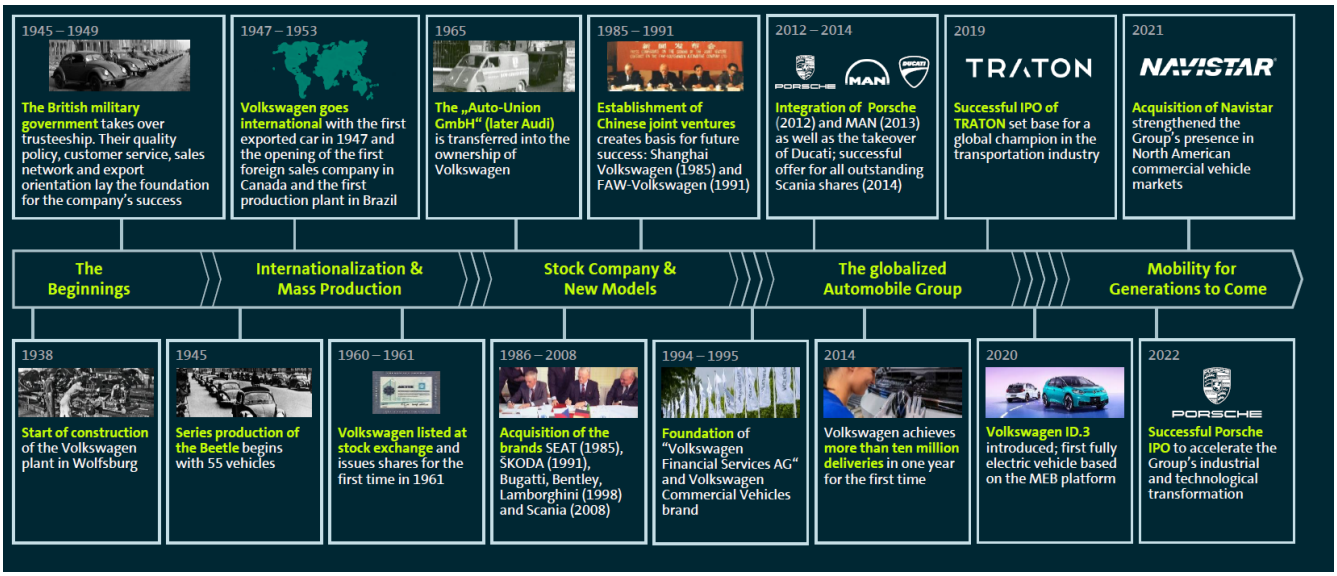
[88] https://newsroom.porsche.com/en/2022/company/porsche-ag-initial-public-offering-p911-frankfurt-stock-exchange-29830.html, accessed on 05/09/2023

implications of this approach adopted by Volkswagen was that, during laboratory tests, NOx emissions were 40 times lower than what would have been in road tests. After this unfairness was found also by other regulators several consequences had place: the stock price of the group felt, former Volkswagen AG CEO Martin Winterkorn resigned, the group was forced to retire 11 million of cars not respecting emission standards from the market and faced an overall penalty of USD 25.3 billion.

Outlook for the future

Recently, Volkswagen AG has committed itself to new goals for the future thanks to the NEW AUTO strategy. This project aims on one hand to guarantee more sustainable vehicles and on the other side to improve the use of the group 4 technology platforms: Mechatronics, Software, Battery & Charging and Mobility Solutions. The use of these platforms, according to Volkswagen CEO, could help the company to increase the future revenue pools of Battery Electric Vehicles (BEV) and Software of the group to more than EUR 300 Billion in 2025 and EUR 500 Billion by 2030[89]. To aim those targets, in particular with regard to the sale of electric vehicles, the group intends to offer customers a one-stop solution from charging hardware. Volkswagen AG, together with international partners, affirms that it will implement an overall of 18,000 high-power charging points in Europe, 17,000 in China and 10,000 in US and Canada[90]. It is also important to highlight the PowerCO Plants project consisting in the construction of six Battery plants to support the development of NEW AUTO.

A temporal map of the most important events in Volkswagen history, extracted from 2022 Company's Report and including the most important M&A deals, is presented in *Figure 11*.



[89] https://www.volkswagen-newsroom.com/en/press-releases/new-auto-volkswagen-group-set-to-unleash-value-in-battery-electric-autonomous-mobility-world-7313, accessed on 05/06/2023

[90] https://www.volkswagen-newsroom.com/en/press-releases/volkswagen-group-has-already-set-up-more-than-15000-hpc-points-around-the-world-15423, accessed on 19/06/2023

Figure 11: Volkswagen History, from National Leader to Global Champion
Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 5, accessed on 03/06/2023

3.1.2 Group structure

Volkswagen AG, at the end of 2022, is organized across two major divisions: Automotive Divisions and Financial Services Division. An overview of this structure, extracted from 2022 Company Report, is the one in *Figure 12*. In turn the Automotive Division comprises ***Passenger Cars***, ***Commercial Vehicles*** and ***Power Engineering*** business areas.

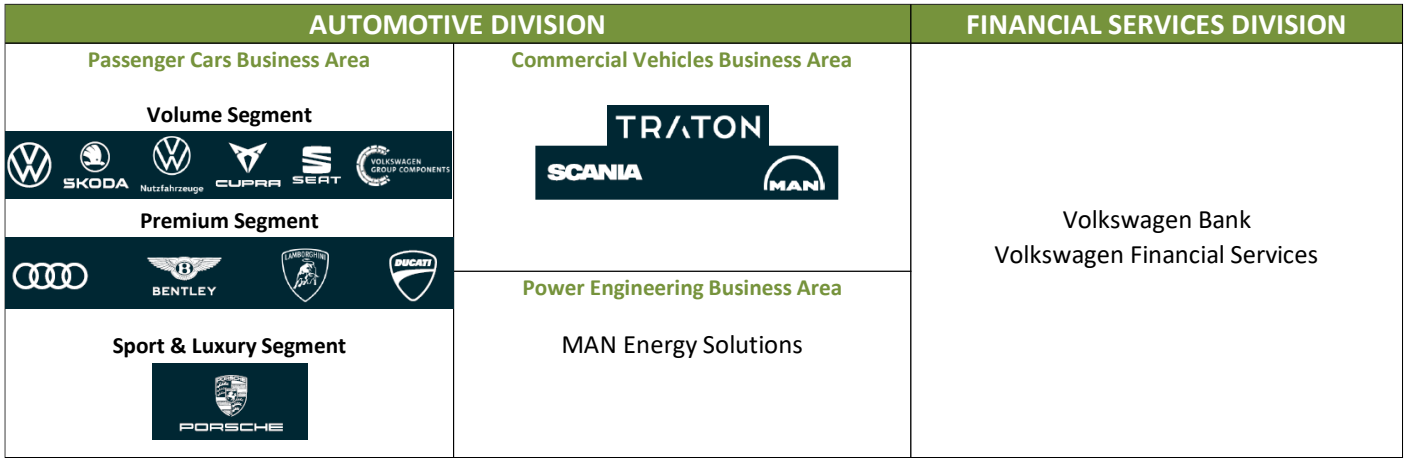


Figure 12: Volkswagen AG Divisions Structure 2022
Source: Own elaboration from https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 6, accessed on 03/06/2023

Passenger Cars Business Area is related to development[91] of vehicles as cars, trucks, buses and motorcycles and gathers 10 strong brands divided into *Volume segment* (Volkswagen, Volkswagen Commercial Vehicles, Skoda, Seat and Cupra), *Premium segment* (Audi, Lamborghini, Bentley, Ducati) and *Sport&Luxury* segment (Porsche). Bugatti brand was dismissed at the end of 2021.

Volume segment is the main vehicle sales and revenue drivers for Volkswagen, with 4.069.000 Vehicle during the period of Jan-Dec 2022. Despite this value means a light reduction from the volume of Volume segment vehicles sold in 2021, the company registered an increase in sales revenue of +12% between 2021 and 2022. In the past year, this segment led to a +403% increase in Net Cash Flow, generating EUR 1.1 billion of Free Cash Flow.

Premium segment represents the second group for profitability in the Passenger Cars universe. Despite the fact that they all grew in vehicle sales / revenues / operating result, the four brands of the Premium segment generated a Net Cash Flow of EUR 4.8 billion, 42% less than the one generated in 2021.

[91] https://annualreport2022.volkswagenag.com/divisions/volkswagen-passenger-cars.html, accessed on 21/06/2023

The only brand representing the *Luxury&Sport segment*, Porsche, had a balanced and positive growth in units sold, revenues, operating result and net cash flow, above the solid levels of the previous year.

The most successful model of the German group, for number of vehicles sold in 2022, is the Tiguan model with 458.000 units sold worldwide. All the 8 highest selling models of the group in 2022 pertained to the Volume segment (*Table 10*). Moreover, they all fall under the pure Volkswagen brand.

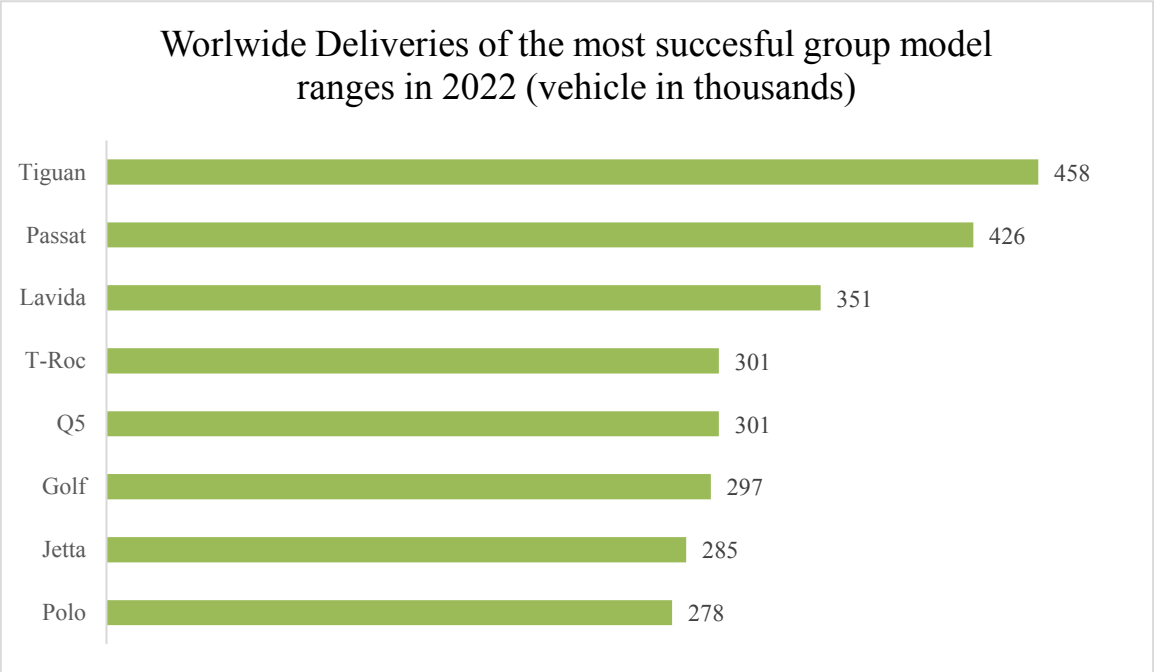


Table 10: Worlwide Deliveries of the most succesful group model ranges in 2022 (vehicle in thousands)
Source: Own production elaborated from Volkswagen Group Annual Report 2022, pag 126

For what regards the overall business area delivers to customer by geographic market in 2022, *Figure 13* shows that the region in which more cars of the Volkswagen group (always referring to Passenger Cars business segment) were sold was the Asia-pacific and Western Europe is only second. In addition, Passenger Cars by Volkswagen AG faced a reduction in units delivered in every country in the world between 2021 and 2022: the only exception is represented by India, where there was an increase of 86%. The European country in which the highest number of cars were delivered is Germany and the Asia-Pacific one is China. Another notable element in this report is the change in cars units delivered in Russia that, given the spread of the Ukrainian-Russian conflict, decreased by the 98%.

	DELIVERIES (UNITS)		CHANGE
	2022	2021	(%)
Europe/Other Markets	**3,297,402**	**3,698,948**	**–10.9**
Western Europe	**2,615,864**	**2,761,629**	**–5.3**
of which: Germany	998,000	959,748	+4.0
France	211,430	238,365	–11.3
United Kingdom	377,449	422,594	–10.7
Italy	223,864	248,414	–9.9
Spain	192,311	220,151	–12.6
Central and Eastern Europe	**418,513**	**624,801**	**–33.0**
of which: Czech Republic	103,223	114,250	–9.7
Russia	41,864	204,772	–79.6
Poland	112,389	120,831	–7.0
Other Markets	**263,025**	**312,518**	**–15.8**
of which: Türkiye	102,735	121,885	–15.7
South Africa	71,437	72,847	–1.9
North America	**759,791**	**876,558**	**–13.3**
of which: USA	564,705	647,521	–12.8
Canada	85,860	98,829	–13.1
Mexico	109,226	130,208	–16.1
South America	**397,539**	**436,852**	**–9.0**
of which: Brazil	277,806	311,519	–10.8
Argentina	48,263	56,186	–14.1
Asia-Pacific	**3,502,556**	**3,598,344**	**–2.7**
of which: China	3,182,428	3,301,334	–3.6
India	97,610	52,481	+86.0
Japan	61,112	65,549	–6.8
Worldwide	**7,957,288**	**8,610,702**	**–7.6**
Volkswagen Passenger Cars	4,563,340	4,896,874	–6.8
ŠKODA	731,262	878,202	–16.7
SEAT	385,592	470,531	–18.1
Volkswagen Commercial Vehicles	328,572	359,541	–8.6
Audi	1,614,231	1,680,512	–3.9
Lamborghini	9,233	8,405	+9.9
Bentley	15,174	14,659	+3.5
Porsche	309,884	301,915	+2.6
Bugatti[2]	–	63	x

Figure 13: Volkswagen AG Passenger Cars deliveries by market in 2022
Source: Volkswagen Group Annual Report 2022, pag 128

Commercial Vehicles Business Areas primarily comprises the development and production[92] of trucks and buses from Scania and MAN brands. The collaboration between these two commercial vehicles brands is coordinated in TRATON SE, a commercial entity under the control of Volkswagen AG which has been listed on the stock exchange since 2019.

Power Engineering Business Area, composed only by the company MAN Energy Solutions, combines the large-bore diesel engines, turbomachinery, special gear units, propulsion components and testing systems businesses[93].

Financial Services Division's activities comprise dealer and customer financing, vehicle leasing, direct banking and insurance activities, fleet management and mobility services[94].

3.1.3 Corporate Governance

Volkswagen AG presents a Two-Tier Board System in its Governance Structure, typical of German companies. In this system, strategy and service are executed by the Management Board while the Supervisory Board controls these activities[95]. Dual boards structures grant employees more influence over the appointment of Supervisory Board members who best represent their interests. Volkswagen AG

[92] https://annualreport2022.volkswagenag.com/divisions/volkswagen-commercial-vehicles.html, accessed on 21/06/2023
[93] Volkswagen Group Annual Report 2022, pag 110
[94] https://annualreport2022.volkswagenag.com/divisions/volkswagen-financial-services.html, accessed on 21/06/2023
[95] Volkswagen Group Annual Report 2022, pag 44

Shareholders' Meeting will so exercise their rights of participation and control electing their representatives in the Supervisory Board (20 members) that will in turn appoint, monitor and advise a Management Board of 9 members[96].

Supervisory Board

Volkswagen AG Supervisory Board consists of 20 members (10 Shareholders representatives and 10 Employees representatives according to the German Codetermination Act). In addition, in accordance with Article 11 of the Articles of association of Volkswagen AG, the State of Lower Saxony is entitled to appoint two of the Shareholders representatives, considering that it holds at least 15% of the ordinary shares of the firm[97]. The Chair of the Supervisory Board is generally a shareholder representative, and the Deputy Chair is generally an employee representative. Both are elected by the other members of the Supervisory Board. A Qualification Matrix, regarding the singular skills and backgrounds of the 2022 Supervisory Board of Volkswagen AG, has been extracted from the Company 2022 Report and reported in *Figure 14*. From the latter, it is evident how all the components of the Board of Directors have deep knowledge and previous experiences in the world of automotive industry and almost all of them in vehicle manufacture/sales and management. However just 6 of them report knowledge in accounting & finance, 3 in Digitalization/IT and only 2 in Research/development. We can conclude that, even if this Board looks to have a deep understanding of the automotive sector, it presents lack of background variety.

[96] Volkswagen Group Annual Report 2022, pag 45
[97] Volkswagen Group Annual Report 2022, pag 50

QUALIFICATION MATRIX[1]

	Vehicles – manufacture/ sale	Automotive industry	Research/ development	Digitalization/ IT	Management/ supervision	Law/ compliance	Sustainability/ ESG	Finance/ accounting/ auditing	Human resources	Employee matters
Hessa Sultan Al Jaber	x	x	x	x	x	x		x		
Mansoor Ebrahim Al-Mahmoud		x			x		x	x	x	
Harald Buck	x	x							x	x
Daniela Cavallo		x			x				x	x
Matías Carnero Sojo	x	x			x	x			x	x
Julia Willie Hamburg					x		x			
Marianne Heiß	x	x		x	x	x	x	x	x	
Jörg Hofmann		x			x		x		x	x
Arno Homburg	x	x	x		x	x	x		x	x
Günther Horvath		x			X	X			X	
Simone Mahler		x		x					x	x
Peter Mosch	x				x				x	x
Daniela Nowak	x	x								x
Hans Michel Piëch	x	x			x	x			x	
Ferdinand Oliver Porsche	x	x			x	x		x	x	
Wolfgang Porsche	x	x			x				x	
Hans Dieter Pötsch	x	x			x	x	x	x	x	
Jens Rothe	x	x			x				x	x
Conny Schönhardt	x	x			x	x		x		x
Stephan Weil		x			x	x	x		x	

1 The skills, knowledge and professional experience associated with the respective key words can be found in the profile of skills. A skill can be attributed to a Supervisory Board member even if they have expertise in just one subsection of the skill, i.e. for skill in vehicles, for example, either in the area of manufacture or in sales.

Figure 14: 2022 Volkswagen AG Supervisory Board Qualification Matrix
Source: Volkswagen Group Annual Report 2022, pag 56

Board of Management

Dr. Oliver Blume has been Chairman of VW AG Management Board since September 2022. In addition, he has been Chairman of the Board of Porsche AG since 2015. The Board is formed by 9 members with different backgrounds and generally meets weekly, at least twice a month[98]. Each Board member is responsible for one or more functions within the Volkswagen Group. A summary of the single responsibilities of each of the 9 members is in *Table 11*.

Management Board of Volkswagen Automotive Group	
Role	***Board member***
Chairman of the Management Board of Volkswagen AG and Porsche AG	*Dr. Oliver Blume*
Finance & Operations	*Dr. Arno Antlitz*
Member of the board of Volkswagen AG for China	*Ralf Brandstatter*
Integrity & Legal Affairs	*Dr. Manfred Doss*
Group 'Premium'	*Markus Duesmann*
Human Resources and Group 'Truck & Bus'	*Gunnar Kilian*
CEO of Volkswagen Passenger Cars	*Thomas Schafer*
Technology	*Thomas Schamll von Westerhold*
HR	*Hauke Stars*

Table 11: 2022 Management Board of VW AG

[98] Volkswagen Group Annual Report 2022, pag 47

Source: Own production elaborated from https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 5, accessed on 03/06/2023

3.1.4 Shareholding Structure

The shareholding quotas distribution in Volkswagen AG capital is presented (*Figure 15*). At 31/12/2022, the largest stake in Volkswagen AG Capital is held by Porsche Automobil Holding SE, the holding of Porsche family: 31.90% of overall outstanding shares. After, foreign institutional investors follow with 22.20% of shares. Other relevant investors, who hold a stake higher than the 3% and so object of public disclosure, are Qatar Holding LLC and the State of Lower Saxony. The remaining 23.60% of capital is distributed among individual investors and German institutional investors.

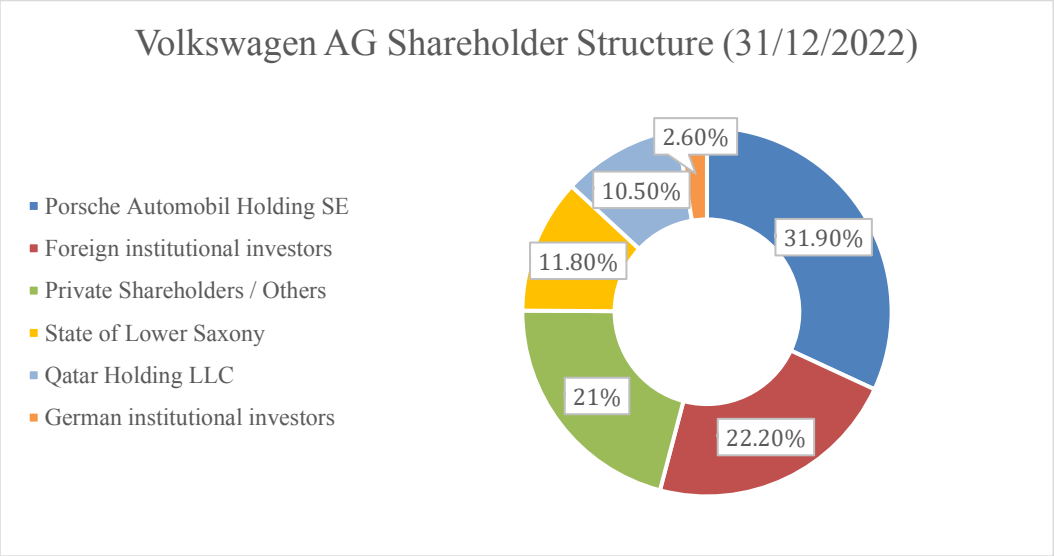


Figure 15: 2022 Volkswagen AG Shareholding Structure
Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 59, accessed on 03/06/2023

However, the proportions of voting rights that each shareholder can exploit in the Shareholders' meetings is different from the ones related to ownership. In fact, as visible from another graph (*Figure 16*), Porsche Automobil Holding SE has 53.3% of the voting rights despite of a stake that, as previously seen, is only around 31.90%. In this context, the State of Lower Saxony is the second most powerful shareholder, in terms of voting rights, and so it is able to appoint two of its representatives in the Supervisory Board.

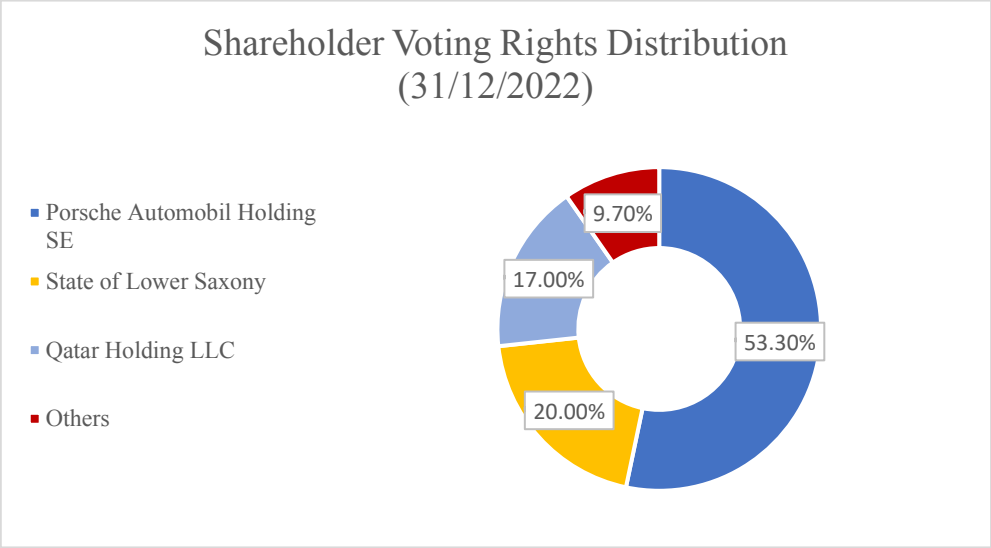


Figure 16: 2022 Volkswagen AG Voting Structure
Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 59, accessed on 03/06/2023

The asymmetry between the Shareholder Share structure and the Voting rights structure is obviously caused by the existence of two different categories of shares: Ordinary Shares, giving voting rights to the owner, and Preferred Shares, that have priority in dividends distribution but no or reduced voting rights in the Shareholders meeting. Analyzing the graph contained in *Figure 17* (in comparison with the previous two graphs), it is possible to understand how shareholders as Porsche Automobil Holding SE hold a higher number of Ordinary Shares with respect to Foreign Institutional investors who, probably preferring dividends over the control of the group, prefers to hold Preferred Shares. It is important to highlight that, for the purpose of this final dissertation and in particular for the valuation of Volkswagen AG in *Chapter 4*, we will aim at understanding the fair value of only ordinary shares.

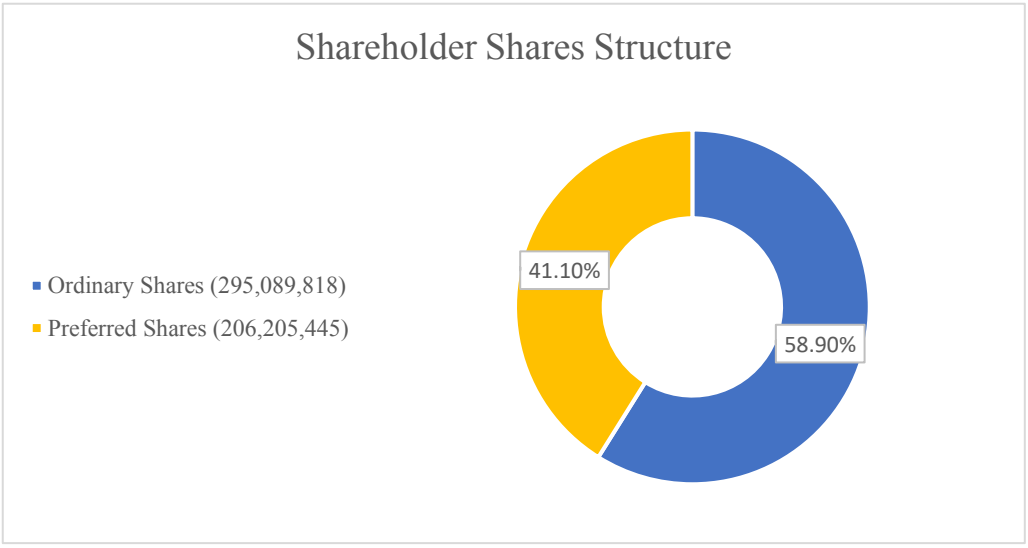


Figure 17: 2022 Volkswagen AG Share Distribution

Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 59, accessed on 03/06/2023

3.2 VOLKSWAGEN AG FINANCIAL ANALYSIS

3.2.1 Consolidated Financial Statements and Strategic Balance Sheet

Consolidated Volkswagen AG Income Statement, Balance Sheet and Cash Flow Statement are now reported and analyzed. In order to consider as "historical" only definitive and past data, the latest period taken in consideration is the one related to the reporting year 2022. The forecasting of future cash flows, necessary for the real application of valuation methods of *Chapter 4*, will so start projecting year 2023. Data reported in the financial statements will be used not only for the purpose of Volkswagen AG ordinary stock valuation, but will also be re-organized and exploited in the next paragraphs in order to calculate the main financial ratios of Volkswagen AG and understand its reliability as borrower. The main source for the 3 financial statements is Volkswagen AG Annual reports (from 2018 to 2022)[99], but the values of each item were also crossed with the respective data on Refinitiv[100] and Yahoo Finance[101] platforms, in order to have a double-check on them.

Consolidated Income Statement Volkswagen AG (2018-2022)

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Sales Reveue from Goods and Services	**235,849**	**252,632**	**222,884**	**250,200**	**279,232**
Cost of Sales	(189,500)	(203,490)	(183,937)	(202,959)	(227,005)
Gross Result	**46,349**	**49,142**	**38,947**	**47,241**	**52,227**
SG&A expenses	(29,329)	(30,745)	(27,806)	(29,648)	(31,529)
Distribution Expenses (Selling & Marketing)	(20,510)	(20,978)	(18,407)	(19,228)	(19,840)
Administrative Expenses (General & Administrative)	(8,819)	(9,767)	(9,399)	(10,420)	(11,689)
Other Operating Income	11,631	11,453	12,438	14,731	19,238
Other Operating Expenses	(14,731)	(12,890)	(13,904)	(13,049)	(17,812)
Operating Income	**13,920**	**16,960**	**9,675**	**19,275**	**22,124**
Share of the result of equity-accounted invetsments	3,369	3,349	2,756	2,321	2,395
Net Interest Income	(580)	(1,614)	(1,498)	(1,008)	883
Interest Income	967	910	793	810	1,325
Interest expenses	(1,547)	(2,524)	(2,291)	(1,818)	(442)
Other financial results	(1,066)	(339)	733	(463)	(3,359)
Earnings before Taxes	**15,643**	**18,356**	**11,666**	**20,125**	**22,043**
Tax Expenses (Germany + abroad)	(3,489)	(4,326)	(2,843)	(4,698)	(6,208)
Earnings after Taxes	**12,154**	**14,030**	**8,823**	**15,427**	**15,835**
of which attribbutable to					
Noncontrolling interests	17	143	(43)	46	393
Volkswagen AG hybrid capital investors	309	540	533	539	576
Net Inome for Volkswagen AG shareholders	**11,828**	**13,347**	**8,333**	**14,842**	**14,866**

Main operating margins, plus EBIT and EBITDA (calculated with the support of the Balance Sheet) are reported.

[99] https://annualreport2022.volkswagenag.com/consolidated-financial-statements/income-statement.html, accessed on 10/06/2023
[100] https://workspace.refinitiv.com/web, accessed on 11/06/2023
[101] https://finance.yahoo.com/quote/VOW.DE?p=VOW.DE&.tsrc=fin-srch, accessed on 11/06/2023

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
GROSS MARGIN	19.65%	19.45%	17.47%	18.88%	18.70%
Median	**18.88%**				
Average	**18.83%**				
EBIT	13,920	16,960	9,675	19,275	22,124
EBIT MARGIN	5.902%	6.713%	4.341%	7.704%	7.923%
Median	**6.71%**				
Average	**6.52%**				
EBITDA	36,481	41,399	36,744	46,748	52,794
EBITDA MARGIN	15.47%	16.39%	16.49%	18.68%	18.91%
Median	**16.49%**				
Average	**17.19%**				
NET INCOME MARGIN	5.02%	5.28%	3.74%	5.93%	5.32%
Median	**5.28%**				
Average	**5.06%**				

Consolidated Balance Sheet Volkswagen AG - Asset Side / Uses - (2018-2022)

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Current Assets	**183,536**	**187,463**	**194,944**	**200,347**	**224,309**
Cash & Short-Term Investments	**57,604**	**54,908**	**68,305**	**74,839**	**82,111**
Cash & Cash Equivalents	28,113	24,330	33,432	39,122	29,172
Cash Held for sale					566
Time deposits	825	1,593	477	601	0
Marketable securities	17,080	16,769	21,162	22,532	37,206
Other short-term Financial Assets	11,586	12,216	13,234	12,584	15,167
Short-Term Loans and Receivable	**80,186**	**85,018**	**82,816**	**81,110**	**89,758**
Trade Accounts & Trade Notes Receivable	17,888	17,941	16,243	15,521	18,581
Financial services Receivable (Short-Term)	54,216	58,615	58,006	56,498	61,549
Tax Receivables (Short-term)	1,879	1,190	1,186	1,618	1,732
Other Receivables	6,203	7,272	7,381	7,473	7,896
Inventories - Total	**45,745**	**46,742**	**43,823**	**43,725**	**52,274**
Inventories - Raw Materials	5,543	6,099	6,966	9,331	10,458
Inventories - Work in Progress	4,382	4,110	4,002	6,559	6,041
Inventories - Finished Goods	30,553	30,617	27,204	22,201	29,466
Inventories - Other - Total	5,267	5,916	5,651	5,634	6,309
Assets Held for Sale	**0**	**795**	**0**	**674**	**733**
Other Current Assets	**1**	**0**	**0**	**(1)**	**(1)**
Non-Current Assets	**274,620**	**300,608**	**302,170**	**328,262**	**340,463**
Intangible Assets - Total - Net	**64,613**	**66,214**	**67,968**	**77,689**	**83,241**
Goodwill/Cost in Excess of Assets Purchased	23,317	23,247	23,318	26,174	26,202
Intangible Assets - excluding Goodwill	41,296	42,967	44,650	51,515	57,039
Research & Development Costs - Net	22,424	23,985	25,534	28,884	33,431
Brands, Patents, Trademarks, Marketing & Artistic Intangibles - Net	16,868	16,793	16,828	17,572	17,528
Intangible Assets - Other - Net	2,004	2,189	2,288	5,059	6,080
Property, Plant and Equipment net of Depreciation & Impairment	**57,630**	**66,152**	**63,884**	**63,695**	**63,890**
Lease Assets	**43,545**	**48,938**	**50,686**	**59,699**	**59,380**
Investment Property	**496**	**538**	**558**	**615**	**610**
Equity-accounted Investments in Associates, Joint Ventures and Unconsolidated Subsidiaries	**8,434**	**8,169**	**10,080**	**12,531**	**12,668**
Other equity investments	**1,474**	**1,902**	**1,865**	**3,000**	**3,489**
Financial Services Receivables	**78,692**	**86,973**	**82,565**	**84,954**	**86,944**
Other Financial Assets	**6,521**	**5,553**	**7,834**	**9,156**	**13,832**
Other Receivables	**2,608**	**2,722**	**2,867**	**2,895**	**3,095**
Tax Receivables	**476**	**341**	**376**	**635**	**394**
Deferred Tax Assets	**10,131**	**13,106**	**13,486**	**13,393**	**12,921**
Other Non-Current Assets	**0**	**0**	**1**	**0**	**(1)**
Total Assets	**458,156**	**488,071**	**497,114**	**528,609**	**564,772**

Consolidated Balance Sheet Volkswagen AG – Capital Side/Sources - (2018-2022)

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Shareholders' Equity	**117,342**	**123,650**	**128,783**	**146,154**	**178,327**
Equity attributable to Volkswagen AG shareholders and hybrid capital investos	**117,117**	**121,780**	**127,049**	**144,449**	**165,377**
Shareholders' Equity - Attributable to Parent Shareholders - Total	**106,939**	**112,763**	**116,606**	**133,176**	**153,101**
Common Stock - Issued & Paid (Subscribed Capital)	1,283	1,283	1,283	1,283	1,283
Common Stock - Additional Paid in Capital including Option Reserve	14,551	14,551	14,551	14,551	14,551
Retained Earnings - Total	91,105	96,929	100,772	117,342	137,267
Comprehensive Income - Accumulated	**(2,418)**	**(3,646)**	**(5,270)**	**(3,166)**	**(1,845)**
Investments - Unrealized Gain/Loss	228	295	30	541	870
Hedging Reserves	1,161	(882)	578	(1,001)	546
Foreign Currency Translation Adjustment - Accumulated	(3,576)	(2,824)	(5,659)	(2,351)	(2,256)
Revaluation Reserves	(231)	(235)	(219)	(355)	(1,005)
Hybrid Financial Instrument - Equity Portion attribbutable to VW AG hybrid capital investors	**12,596**	**12,663**	**15,713**	**14,439**	**14,121**
Minority Interest	**225**	**1,870**	**1,734**	**1,705**	**12,950**
Current Liabilities	**167,968**	**167,923**	**165,411**	**164,393**	**182,992**
Financial Liabilities (Short-term)	**89757**	**87912**	**88648**	**78584**	**83,448**
Bonds	19132	19789	25909	21722	**21,284**
Commercial papers and notes	22381	18103	16146	16781	**17,239**
Deposits	28555	30252	26734	24243	**24,107**
Liabilities to banks	18455	17337	18060	12786	**18,840**
Loans	1183	1429	794	1944	**876**
Lease liabilities	51	1002	1005	1108	**1,102**
Accounts payabale	**23607**	**22745**	**22677**	**23624**	**28,748**
Tax Payabale	**456**	**408**	**340**	**614**	**726.0**
Other financial Liabilities	**11269**	**10858**	**10590**	**13002**	**19820**
Negative fair value of derivatives financial instruemnts	3292	2245	1474	2375	2281
Interest payable	661	691	604	638	837
Miscellaneous financial liabilities	7316	7922	8512	9989	16702
Other liabilities	**17593**	**19320**	**17979**	**19890**	**22655**
Payemnts received on account of orders	6936	7474	7483	8653	9579
Liabilities related to other taxes, docial security and wages	8118	9270	8411	9003	10876
Miscellaneous non-financial liabilities	2539	2576	2085	2234	2200
Deferred Tax - Liability - Long-Term (Provisons for taxes)	**1412**	**1876**	**2213**	**2863**	**2,586**
Current provisions	**23874**	**24434**	**22964**	**25578**	**24851**
Liabilities associated with assets held for sale	**0**	**370**	**0**	**238**	**158**
Non-Current Liabilities	**172,846**	**196,498**	**202,920**	**218,062**	**203,453**
Debt - Long-Term - Total (Financial Liabilities)	**101126**	**113557**	**114809**	**131619**	**121,737**
Bonds	62417	68841	66717	76318	**71,835**
Commercial papers and notes	18975	20147	21380	20796	**18,034**
Deposits	1455	2395	2411	2589	**2,642**
Liabilities to banks	15447	15337	17273	25904	**23,266**
Loans	2433	1629	1909	875	**677**
Lease liabilities	399	5208	5119	5137	**5,283**
Other financial Liabilities	**3219**	**4500**	**4256**	**4466**	**8188**
Negative fair value of derivatives financial instruemnts	1134	1950	1935	2047	5565
Interest payable	113	116	97	108	215
Miscellaneous financial liabilities	1972	2434	2224	2311	8188
Other liabilities	**6448**	**7271**	**7905**	**8430**	**9021**
Payemnts received on account of orders	4300	5202	5540	5791	6301
Liabilities related to other taxes, docial security and wages	1102	1303	1182	1063	1186
Miscellaneous non-financial liabilities	1046	766	1183	1576	1534
Deferred Tax - Liability - Long-Term	**5030**	**5007**	**4890**	**5131**	**10,734**
Provisions	**57,023**	**66,163**	**71,060**	**68,416**	**53,773**
Post Employment Benefits	33097	41389	45081	41,550	**27,553**
Provisions for Taxes	3047	2991	3292	3392	4320
Other long-term provisions	20879	21783	22687	23474	21900
Total Liabilities	340,814	364,421	368,331	382,455	386,445
Total Shareholders' Equity + Liabilities	**458,156**	**488,071**	**497,114**	**528,609**	**564,772**

Consolidated Cash Flow Statement Volkswagen AG (2018-2022)

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Cash and Cash equivalents at the beginning of the period (previous period end)	**18,038**	**28,113.00**	**24,330.00**	**33,432.00**	**39,122.00**
Earnings before tax	15,643.00	18,356.00	11,667.00	20,126.00	22,044.00
Income taxes paid (1)	(3,804.00)	(2,914.00)	(2,646.00)	(4,216.00)	(4,415.00)
Depreciation and amortization of, and impairment losses on, intangible assets, property, plant and equipment, investment property and lease assets	22,561.00	24439	27069	27473	30670
Change in pension provisions	524.00	342	806	992	898
Share of the result of equity-accounted investments	244.00	460.00	536.00	787.00	575.00
Other noncash expense/income (2)	445.00	(734.00)	(2,461.00)	(1,473.00)	(511.00)
Change in Working Capital	**(28,342.00)**	**(21,966.00)**	**(10,070.00)**	**(5,055.00)**	**(20,765.00)**
Change in inventories	(5,372.00)	(674.00)	1,334.00	2,110.00	(8,385.00)
Change in receivables (excluding financial services)	(6,400.00)	(893.00)	712.00	1,888.00	(3,207.00)
Change in liabilities (excluding financial liabilities)	3,645.00	2,297.00	540.00	1,856.00	8,586.00
Change in provisions	(1,286.00)	1,304.00	(2.00)	951.00	(2,754.00)
Change in lease assets	(11,647.00)	(13,204.00)	(12,914.00)	(16,205.00)	(8,711.00)
Change in financial services receivables	(7,282.00)	(10,796.00)	260.00	4,345.00	(6,294.00)
Cash flows from operating activities	**7,271.00**	**17,983.00**	**24,901.00**	**38,633.00**	**28,496.00**
Investments in intangible assets (excluding development costs), property, plant and equipment, and investment property	(13,729.00)	(14,230.00)	(11,273.00)	(10,655.00)	(12,948.00)
Additions to capitalized development costs	(5,234.00)	(5,171.00)	(6,473.00)	(7,843.00)	(9,723.00)
Acquisition and disposal of subsidiaries and other equity investments	(705.00)	(913.00)	(1,037.00)	(6,151.00)	(3,219.00)
Proceeds from disposal of intangible assets, property, plant and equipment, and investment property	282.00	237.00	411.00	469.00	437.00
Change in investments in securities, loans and time deposits	(2,204.00)	(1,069.00)	(4,319.00)	(1,948.00)	(16,368.00)
Cash flows from investing activities	**(21,590.00)**	**(21,146.00)**	**(22,690.00)**	**(26,128.00)**	**(41,822.00)**
Capital contributions/capital redemptions	1,491.00	–	2,984.00	(1,071.00)	(235.00)
Dividends paid	(2,375.00)	(2,899.00)	(2,952.00)	(3,022.00)	(4,362.00)
Capital transactions with noncontrolling interest shareholders	(28.00)	1,368.00	(238.00)	(590.00)	16,198.00
Proceeds from issuance of bonds	35,308.00	25,916.00	25,181.00	32,659.00	23,876.00
Repayments of bonds	(15,290.00)	(19,784.00)	(19,815.00)	(30,557.00)	(25,638.00)
Changes in other financial liabilities	5,488.00	(4,509.00)	3,577.00	(3,928.00)	(4,366.00)
Repayments of lease liabilities	(29.00)	(957.00)	(1,100.00)	(1,246.00)	(1,248.00)
Cash flows from financing activities	**24,565.00**	**(865.00)**	**7,637.00**	**(7,754.00)**	**4,225.00**
Effect of exchange rate changes on cash and cash equivalents	(173.00)	243.00	(745.00)	942.00	(285.00)
Change of loss allowance within cash and cash equivalents	-	1.00	0.00	(1.00)	1.00
Net change in cash and cash equivalents	**10,073.00**	**(3,784.00)**	**9,103.00**	**5,691.00**	**(9,385.00)**
Cash & cash Equivalents at the end of the period (3)	**28,113.00**	**24,329.00**	**33,433.00**	**39,123.00**	**29,171.00**

(1) Income taxes paid appearing in the Cash Flow statements of years 2018-2022 change from income taxes indicated on the Income Statements owning to the deference in tax actual payments (both in Germany and abroad), as explained in VW AG Annual Report 2022;

(2) Other noncash expense/income refer to measurements effect in connection with financial instruments and to fair value changes relating to hedging transactions;

(3) VW AG 2022 Cash Flow Statement report does not consider Cash Held for Sale for Cash & Cash Equivalents computation at the end of the period in 2022.

While Standard GAAP Balance Sheet reporting separates assets and liabilities in terms of current and non-current and ranks assets in terms of liquidity and liabilities in terms of urgency, in the Reformulated Balance Sheet financing activities (do not add value to the business) are separated from operating activities (add value to the business)[102].

Operating assets are those relative to operating revenues and/or operating expenses and the general rule is that an asset is considered operating if it contributes to the operating profit (and therefore to the Free Cash Flow). On the other hand, financial assets are instruments not needed for operations and that do not contribute to the computation of NOPAT (Net Operating Profit after taxes).

[102] Magnanelli B. S., Reformulated Balance Sheet and Income Statement, p.5

Operating liabilities are those related to operating revenues and/or expenses and they generally represent credit granted to the firm by operating creditors, with the cost of credit reducing NOPAT. Financial liabilities comprise borrowings from financial institutions, capital markets and other nonoperating interest-bearing contractual obligations. The general rule states that a liability is considered as financial if it is interest bearing.

For what concerns the strategic reclassification of shareholders' equity there are two main points to highlight: hybrid financial instruments as convertible bonds are considered as debt because generally their claims are fixed and minority interests are taken separated from the overall Shareholders' equity[103].

Reformulated Balance Sheet Volkswagen AG (2018-2022)

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Operating Assets	**261,886**	**281,628**	**275,779**	**284,430**	**306,914**
Current Operating Assets	**125,932**	**132,555**	**126,639**	**125,508**	**142,764**
Short-Term Loans and Receivable	80186	85018	82816	81110	89758
Inventories - Total	45745	46742	43823	43725	52274
Assets Held for Sale	0	795	0	674	733
Other Current Assets	1	0	0	-1	-1
Non-Current Operating Assets	**135,954**	**149,073**	**149,140**	**158,922**	**164,150**
Intangible Assets - Total - Net	64613	66214	67968	77689	83241
Property, Plant and Equipment net of Depreciation & Impairment	57630	66152	63884	63695	63890
Investment Property	496	538	558	615	610
Other Receivables	2608	2722	2867	2895	3095
Tax Receivables	476	341	376	635	394
Deferred Tax Assets	10131	13106	13486	13393	12921
Other Non-Current Assets	0	0	1	0	-1
Operating Libilities	**135,443**	**147,594**	**150,028**	**154,784**	**153,252**
Current Operating Liabilities	**66,942**	**69,153**	**66,173**	**72,807**	**79,724**
Accounts payabale	23607	22745	22677	23624	28748
Tax Payabale	456	408	340	614	726
Other liabilities	17593	19320	17979	19890	22655
Deferred Tax - Liability - Long-Term (Provisons for taxes)	1412	1876	2213	2863	2586
Current provisions	23874	24434	22964	25578	24851
Liabilities associated with assets held for sale	0	370	0	238	158
Non-Current Operating Liabilities	**68,501**	**78,441**	**83,855**	**81,977**	**73,528**
Other liabilities	6448	7271	7905	8430	9021
Deferred Tax - Liability - Long-Term	5030	5007	4890	5131	10734
Provisions	57023	66163	71060	68416	53773
NET OPERATING ASSETS (NOA)	**126,443**	**134,034**	**125,751**	**129,646**	**153,662**

[103] Magnanelli B. S., Reformulated Balance Sheet and Income Statement, p.10

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Shareholders' Equity	**104,746**	**110,987**	**113,070**	**131,715**	**164,206**
Shareholders' Equity - Attributable to Parent Shareholders - Total	**106,939**	**112,763**	**116,606**	**133,176**	**153,101**
Common Stock - Issued & Paid (Subscribed Capital)	1,283	1,283	1,283	1,283	1,283
Common Stock - Additional Paid in Capital including Option Reserve	14,551	14,551	14,551	14,551	14,551
Retained Earnings - Total	91,105	96,929	100,772	117,342	137,267
Comprehensive Income - Accumulated	**(2,418)**	**(3,646)**	**(5,270)**	**(3,166)**	**(1,845)**
Investments - Unrealized Gain/Loss	228	295	30	541	870
Hedging Reserves	1,161	(882)	578	(1,001)	546
Foreign Currency Translation Adjustment - Accumulated	(3,576)	(2,824)	(5,659)	(2,351)	(2,256)
Revaluation Reserves	(231)	(235)	(219)	(355)	(1,005)
Minority Interest	**225**	**1,870**	**1,734**	**1,705**	**12,950**
Financial Liabilities	**217,967**	**229,490**	**234,016**	**242,110**	**247,314**
Current Financial Liabilities	**101,026**	**98,770**	**99,238**	**91,586**	**103,268**
Financial Liabilities (Short-term)	89757	87912	88648	78584	83448
Other financial Liabilities	11269	10858	10590	13002	19820
Non-Current Financial Liabilities	**104,345**	**118,057**	**119,065**	**136,085**	**129,925**
Debt - Long-Term - Total (Financial Liabilities)	101126	113557	114809	131619	121737
Other financial Liabilities	3219	4500	4256	4466	8188
Hybrid Financial Instrument - Equity Portion attribbutable to VW AG hybrid capital investors	12596	12663	15713	14439	14121
Financial Assets	**196,270**	**206,443**	**221,335**	**244,179**	**258,424**
Current Financial Assets	**57,604**	**54,908**	**68,305**	**74,839**	**82,111**
Cash & Short-Term Investments	57604	54908	68305	74839	82111
Non-Current Financial Assets	**138,666**	**151,535**	**153,030**	**169,340**	**176,313**
Lease Assets	43545	48938	50686	59699	59380
Equity-accounted Investments in Associates, Joint Ventures and Unconsolidated Subsidiaries	8434	8169	10080	12531	12668
Other equity investments	1474	1902	1865	3000	3489
Financial Services Receivables	78692	86973	82565	84954	86944
Other Financial Assets	6521	5553	7834	9156	13832
NET FINANCIAL POSITION (NFP)	**21,697**	**23,047**	**12,681**	**(2,069)**	**(11,110)**

This reformulation is in particular useful to compute the value of two specific KPIs: NOA (Net operating Assets) and NFP (Net Financial Position).

NOA represents the difference between a company's Operating assets and Operating Liabilities. It is useful to give an insight about operational efficiency and how well the target uses its assets to generate revenue. Here it is the value of Volkswagen AG NOA for the last 5 years, that was always highly positive in the past years, with an average of EUR 133,907 Million.

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
NOA	126,443.00	134,034.00	125,751.00	129,646.00	153,662.00
Average	**133,907.20**				

NFP represents the difference between a company's Financial Liabilities and only Cash & Cash Equivalents. It is useful to give an insight about the level of indebtedness of the firm. It expresses the amount of financial liabilities that are not covered by the most liquid financial assets. Often it is compared to operating ratios as EBIT or EBITDA to understand the ability of the company to cover its outstanding obligations and used as numerator of the D/E ratio to understand the company's level of financial leverage. Here it is the value of Volkswagen AG NFP for the last 5 years, with an average of EUR 177,808 Million.

€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
NFP	174,039.00	179,856.00	178,359.00	169,007.00	187,779.00
Average	**177,808.00**				

3.2.2 Solidity Analysis

Next, the main Ratios related to the financial reliability of Volkswagen AG are presented. These ratios are involved in the Liquidity Analysis (short-term financial solidity of the company) and Solvency Analysis (medium and long-term financial solidity of the company).

Liquidity Analysis

	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Current Ratio = Current Assets / Current Liabilities	1.09	1.12	1.18	1.22	1.23
Average	**1.17**				
Quick Ratio = (Cash + Trade Receivables + Marketable Securities) / Current Liabilities	0.45	0.43	0.51	0.55	0.55
Average	**0.50**				
Cash Ratio = (Cash + Marketable Securities) / Current Liabilities	0.27	0.24	0.33	0.38	0.36
Average	**0.32**				

Current Ratio tells if company's current assets are able to cover current liabilities, if they were entirely converted in cash. Good practice states that this ratio should be higher than 1.8. In this case, Volkswagen AG is below this point, with an average ratio of 1.17 during the past 5 years. However, being always higher than 1, it means that Volkswagen AG has been able to cover current liabilities with current assets.

Quick Ratio tells if a company's most liquid current assets (so mainly excluding inventories) are able to cover its current liabilities. Good practice states that this ratio should be higher than 1. In this case, Volkswagen AG is below this point, with an average ratio of 0.5 during the past 5 years.

Cash Ratio tells is a company is able to cover its current liabilities only with its Cash & cash equivalents. Good practice states that this ratio should be higher than 0.2. In this case, Volkswagen AG is around this level, with an average ratio of 0.32 during the past 5 years.

Solvency Analysis

	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Equity to Fixed Assets = Shareholders' Equity / Fixed Assets	0.39	0.38	0.39	0.41	0.45
av.	**0.40**				
Equity and Long-Term Liabilities to Fixed Assets Ratio	1.02	1.03	1.06	1.07	1.05
av.	**1.04**				

Equity to Fixed Assets Ratio tells us if and how much the equity is financing/covering the Fixed Assets. In this case, Volkswagen AG presents an average ratio of 0.40 during the past 5 years.

Equity and Long-Term Liabilities to Fixed Assets Ratio tells us if the Fixed Assets are entirely financed with long-term sources of capital. It is calculated in the case the Equity to Fixed Assets Ratio is lower than 1. It

must be higher than 1 or it means that part off the Fixed (Non-Current) Assets are financed with short-term debt, and the latters generally generate liquidity in the long-term. Volkswagen AG is around this level, with an average ratio of 1.04 during the past 5 years.

Interest Coverage Ratio and Net Debt/EBIT are other useful financial Ratios in the context of our analysis.

	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
Interest Coverage Ratio	9.00	6.72	4.22	10.60	50.05
av.	**16.12**				
Net Debt / EBIT	22.46	20.05	34.61	17.81	16.15
av.	**22.22**				

As argued in *Chapter 1*, the *Interest Coverage Ratio* express how many time the firm's EBIT is able to cover the firm's annual interest expenses. Volkswagen AG had an average ratio of 16.12 during the past 5 years, with a peak of 50.05 during 2022 and a lower point of 4.22 during 2020, depending on the singular year EBIT and interest expenses deriving by financial liabilities of the same period.

Net Debt/EBIT expresses how many periods are needed to cover the Overall Debt of the company trough Earnings before Interests and Taxes. Generally, this ratio is calculated using Earnings before Interests, Taxes, Depreciation&Amorizarion as proxy of the firm's Free Cash Flow. However, given the capital-intensive nature of Volkswagen AG and the heavy use that it does of Capital Expenditures to carry its operations, it was decided to use EBIT to include Depreciation&Amortization in this reasoning. Volkswagen AG had an average ratio of 22.22 during the past 5 years.

3.3 Focus on Volkswagen AG Debt

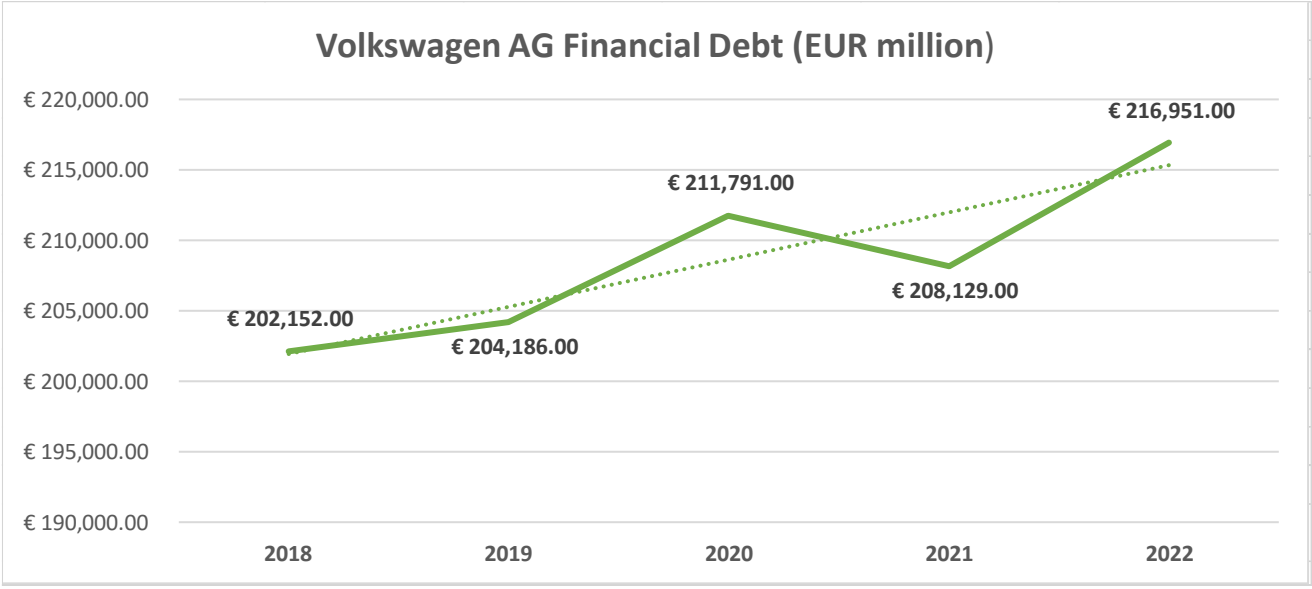


Figure 18: Volkswagen AG Financial Debt 2018-2022
Source: own elaboration on raw data from Refinitiv

As anticipated in the introduction, the group's financial debt is a key element for the purpose of this final dissertation. The group is one of the most indebted companies in the world and the company reporting the highest financial debt in Europe[104]. The 2022 ending financial debt, calculated from the company's strategic Balance Sheet previously shown (and so considering only interest-bearing liabilities as financial), amounts to € 216.951 Million. In addition, over the past 5 years and due to the needs of financing for the construction of new generations plants and BEV R&D, VW AG debt has increased at a CAGR of 1.42%. This particular high debt will be exploited in *Chapter 4* for intrinsic valuations, in which it will be possible to understand the value creation that high tax shields can generate.

[104] https://www.gfmag.com/global-data/economic-data/companies-largest-debt-world, accessed on 20/08/2023

3.3.1 Debt Breakdown and Credit Profile

Overall debt profile, with particular focus on funding mix and maturity, is presented in *Figure 19.*

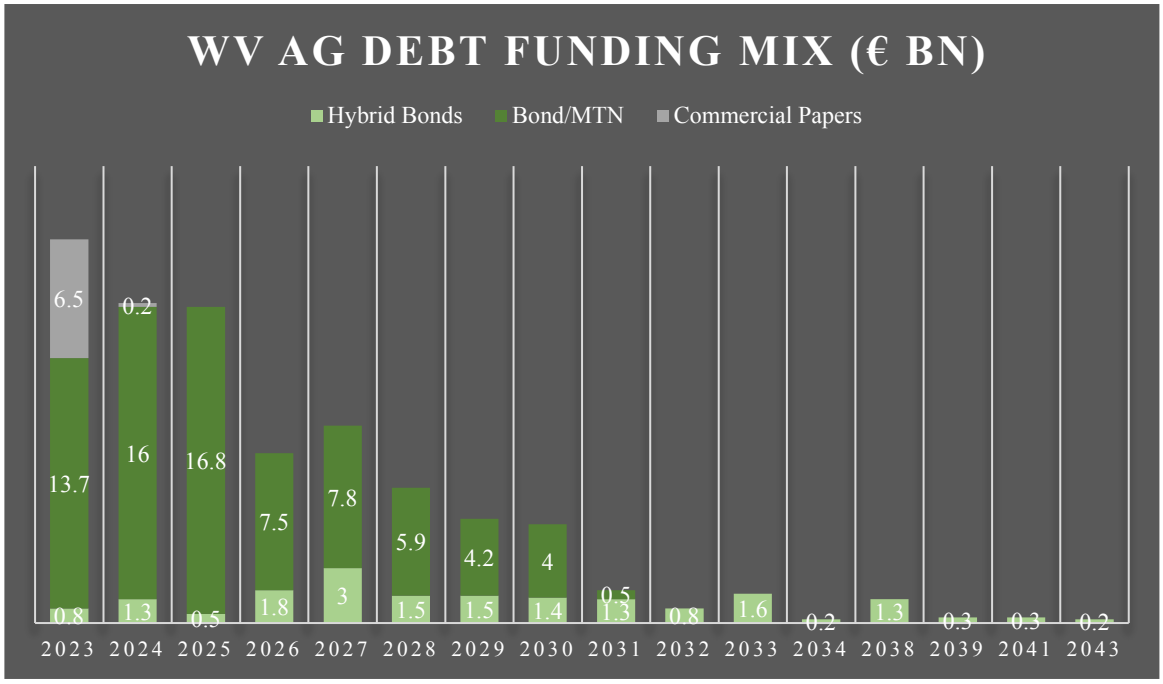


Figure 19: Volkswagen AG Debt Funding mix at 31/12/2022
Source: Own elaboration from https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 48, accessed on 03/06/2023

The majority of this debt (*Figure 20-A*), the overall 76%, is composed of Bond/Medium-Term Note. The remaining part of interest-bearing debt is formed by issued Hybrid Bonds (18%) and Commercial Papers (6%). This 6% is obviously determined by the short-term and unsecured nature of Commercial Papers. Year after year, at the maturity of those Commercial Papers, new ones will be issued.
We also denote (*Figure 20-B*) a well-balanced debt maturity profile with focus on shorter duration: in fact, at 31/12/2022, 20.75% of overall company funding liabilities have maturity within 1 year, and 33,89% within 2025. 27.0% of outstanding debt will on the opposite face maturity between 4 and 6 years and remaining 17.0% is projected to face maturity after 6 years.

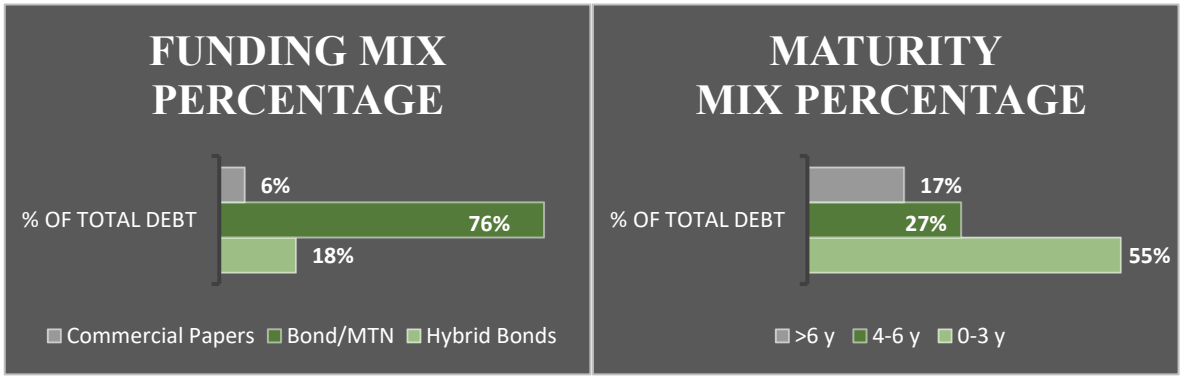


Figure 20-A and 20-B: Volkswagen AG Funding Debt Mix and Maturity percentage
Source: Own elaboration from https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 48, accessed on 03/06/2023

In addition to what described above about the company's Debt Financing Mix, it is important to add that that VW AG focused also in diversification in Commercial Paper's and Bonds' currencies (*Figure 21-A*). However, an important 70.0% of those borrowings are in Euro currency. Moreover, excluding Hybrid Bonds, 89.3% of company's issued bonds are characterized by a Fixed interest rate while the remaining part, 10.7%, by Floating interest rate (*Figure 21-B*).

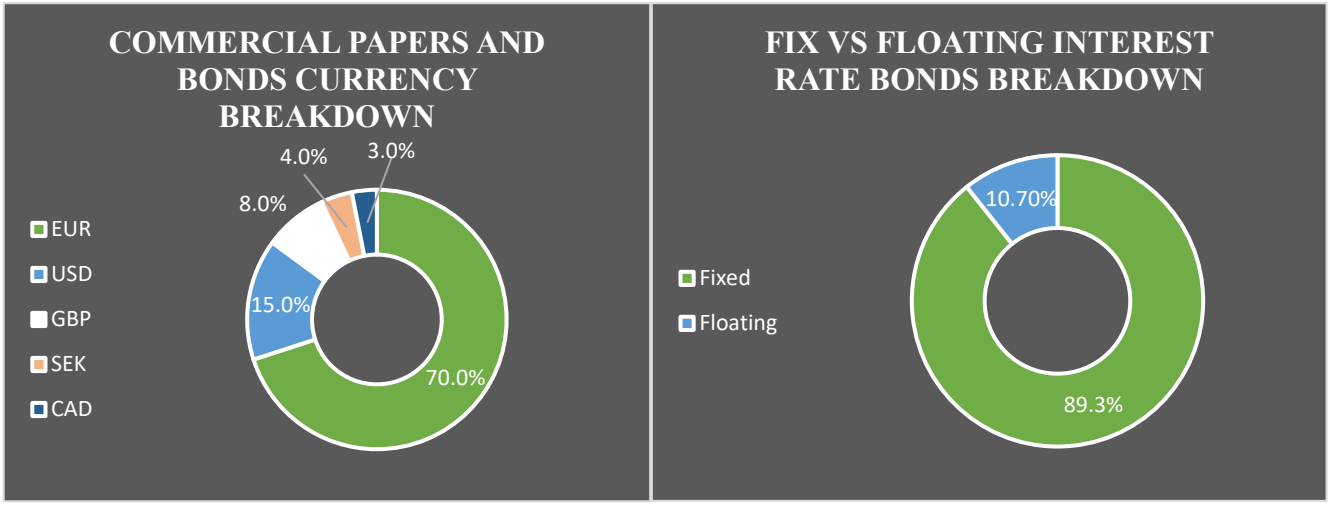


Figure 21-A and 21-B: Volkswagen AG Debt Currency and Interest Rate Breakdown
Source: Own elaboration from https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 49, accessed on 03/06/2023

It could be interesting for the purpose of this research to understand how this high level of debt (in absolute terms and, as we will see, with respect to market/book value of equity) is perceived by rating agencies in the perspective of a credit evaluation.

The first rating agency of our interest, Moody's, gave summary feedback on VW AG credit worthiness, "testifying Volkswagen Group's diversified product landscape and resilient and integrated business model". However, even if Volkswagen in the last 20 year has been considered as a first "range" borrower, its ranking has consistently been A3, with the only exception of 2016 when the company's credit rating was A2. As visible from Moody's ranking descriptions, A3 rank is attributed to "obligations considered upper-medium-grade and subject to low credit risk". The main KPI on which Moody's focuses to attribute a certain rating to a company is its Debt / EBITDA value (*Figure 22*).

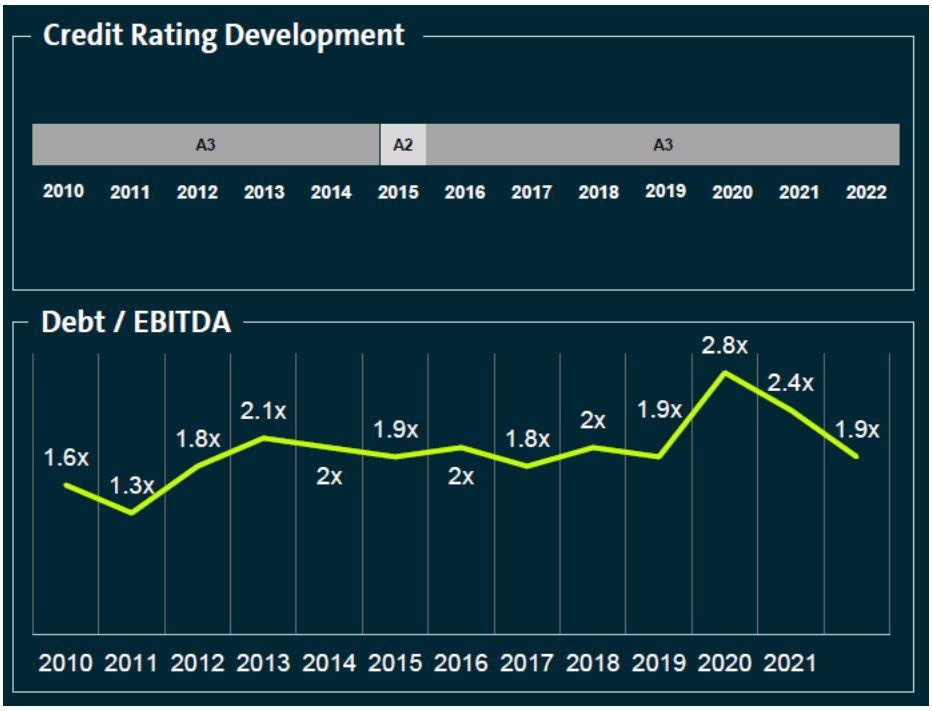


Figure 22: Moody's WV AG Credit rate Development
Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 46, accessed on 03/06/2023

Diving deeper, Moody's also separately ranks Volkswagen AG (considered as the overall vehicle production division of the company) and Volkswagen Financial Services AG, with a distinction between long-term and short-term credit worthiness, affirming that the two divisions have a stable profile both in the Long-Term (A3) and Short-Term (Prime-2) (*Figure 23*).

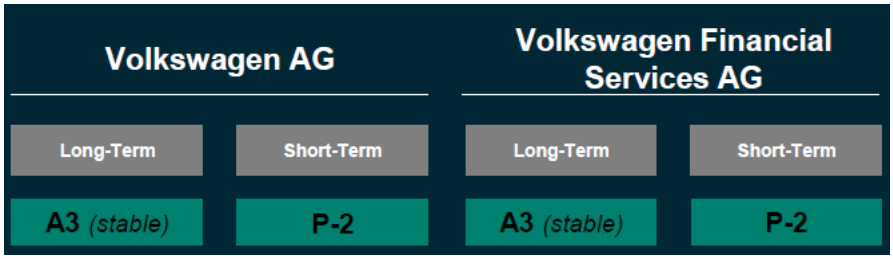


Figure 23: Moody's WV AG Credit rate Development (LT vs ST)
Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 46, accessed on 03/06/2023

The second credit rating agency, S&P Global, has on the other hand decreased WV AG credit worthiness over time. Between 2010 and 2014 it was described as an A ranked borrower. From the beginning till the end of 2014 increased at an A level and for the first six months of 2015 returned to A-. After, until the end of 2022, S&P Global finally decreased it to BBB+. From S&P Global website, it is possible to understand this rank is given to companies that "exhibit adequate protection parameters. Only strong adverse economic circumstances and conditions are more likely to lead to a weakened capacity". Also for S&P Global, Debt/EBITDA is the main indicator in assessing the company credit profile (*Figure 24*).

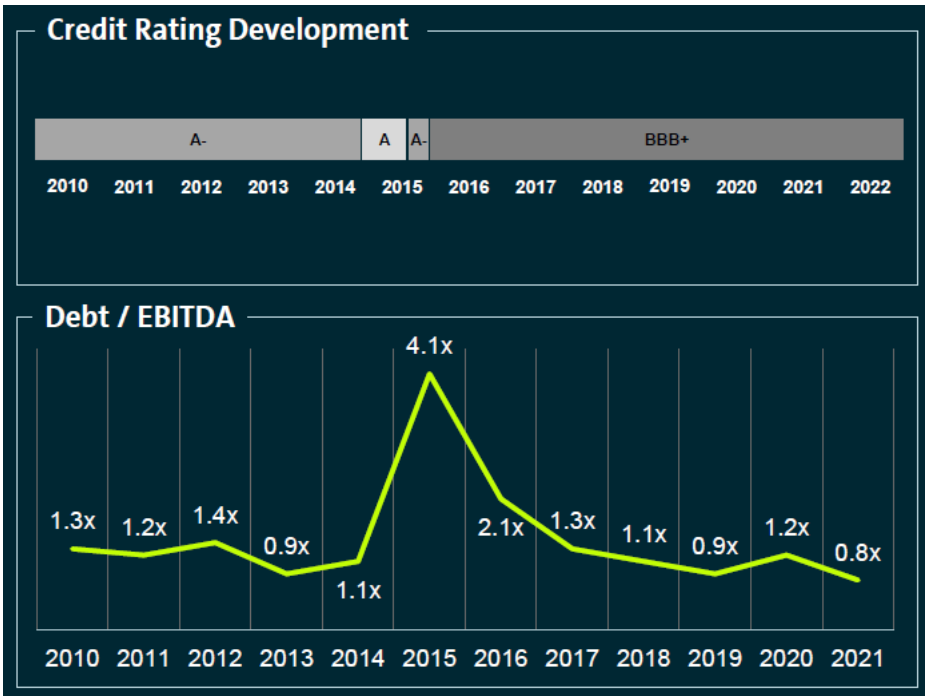


Figure 24: S&P Global's WV AG Credit rate Development
Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 47, accessed on 03/06/2023

Diving deeper, S&P Global also separately ranks Volkswagen AG (considered as the overall vehicle production division of the company) and Volkswagen Financial Services AG, with a distinction between long-term and short-term credit worthiness, affirming that the two divisions' short-term profile (A-2) is slightly more secured that long-term profile (BBB+) which in turn is still stable (*Figure 25*).

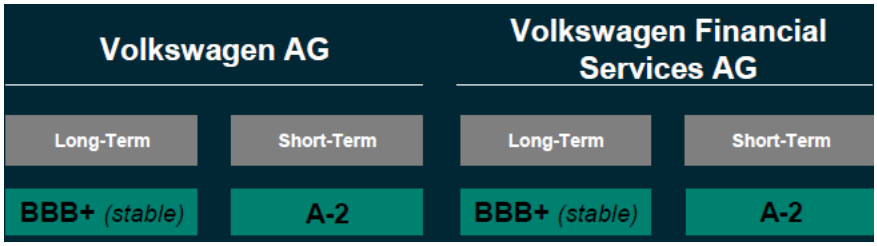


Figure 25: S&P Global's WV AG Credit rate Development (LT vs ST)
Source: https://www.volkswagen-group.com/en/publications/presentations/volkswagen-group-presentation-volkswagen-at-a-glance-1738 , pag 47, accessed on 03/06/2023

We can conclude that, even considering the high amount of debt (in absolute terms and, as will be after discussed, with respect to its levels of equity), Volkswagen Automotive Group is considered a firm able to "bear" its interests and debt repayments. It is possible to finally affirm that Moody's and S&P Global conferred stability to VW AG credit profile considering its operating results able to "cover" its incredible amount of debt.

3.4 Focus on Volkswagen AG Market Capitalization

As outlined in the introduction to this chapter, during the last decade the group has been characterized by a highly variable level of market capitalization. As example, while the closing market capitalization of year 2022 was of € 67,576.45 Million (given by the sum of the number of outstanding ordinary and preferred shares respectively multiplied by their 2022 closing price), the previous year market cap was almost 67% higher, reaching the all-time high.

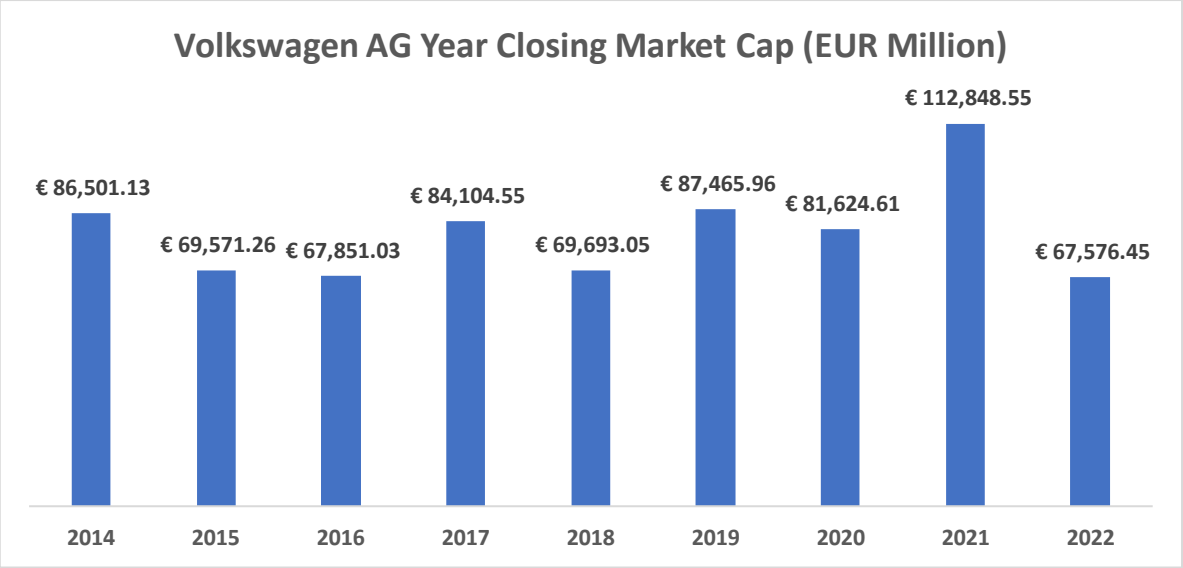


Figure 26: Volkswagen AG Year Closing Market Cap 2018-2022
Source: own elaboration on Refinitiv raw data

As previously stated in the company history, in 2015 the group was object of a scandal related to the "Emission Gate". From 2009 onward the company was facing a stock value increase in its ordinary shares, but between the 18th and the 22nd of September 2015 EPA announced fines against the group, a big class action was conducted against it on behalf of owners and the company was forced to re-call 11 million vehicles. The result was a drop in ordinary shares price by 19% and a drop in market cap by EUR 14 billion[105]. Market cap of the firm after faced an irregular modest increase until 2020, when the combination of the spread of COVID-19 and ship shortage impacted negatively newly on the share price of the stock, with a 10-year low of EUR 101.5 per ordinary share. Only in 2021, when the rumored Porsche IPO was confirmed, the company ordinary shares benefitted of an all-time high of EUR 327.2 and its market cap return to pre-scandal levels. One year after and despite the successful IPO of Porsche AG, the spread of the war in Ukraine and the consecutive implications for automotive producers and suppliers negatively impacted not only Volkswagen, but also its competitors, pushing down the 2022 closing market cap of the group at € 67,576.45 Million.

[105] https://annualreport2015.volkswagenag.com/, accessed on 20/08/2023

These changes have obviously been generated by the variation in the company's ordinary and preferred stocks' market price changes. *Figure 27* indicates the year closing prices of VOW (ordinary shares) and VOW3 (preferred shares) over 2014-2022 period.

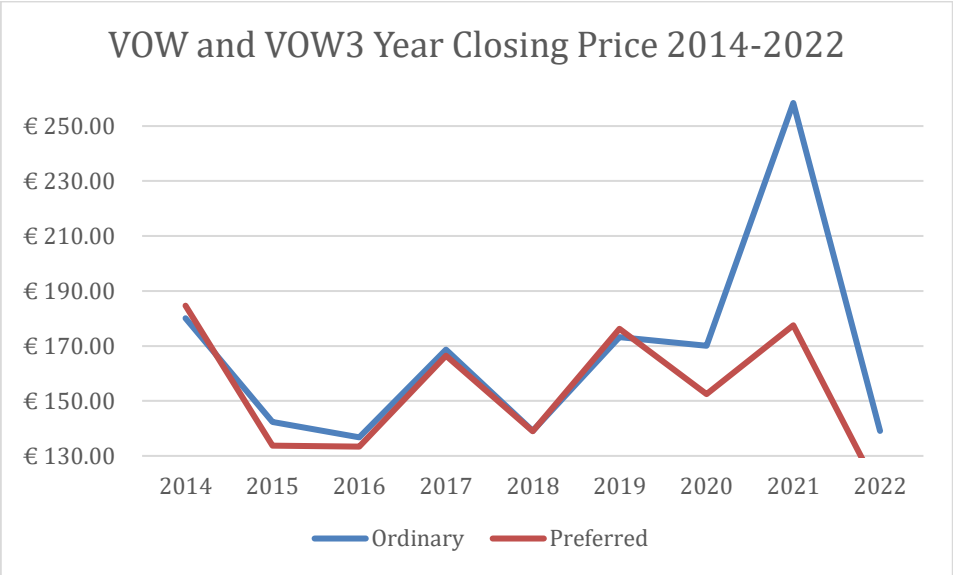


Figure 27: Volkswagen AG Ordinary and Preferred Shares Closing Price 2014-2022
Source: own elaboration from VW AG Annual Group reports 2014-2022

3.4.1 Focus on 2022 Shares' Performance

The outbreak of the Ukrainian-Russian conflict in February 2022 and the pre-existing rise of commodity and energy prices that drove up inflation put the international stock markets under pressure during the past year. Moreover, the tight restrictions under the zero-Covid policies of the Chinese Government placed additional strain on international supply chains that, by definition, are a key element in the running of any automotive firm. Also, the tighter policies adopted by central banks, aiming at contrasting inflation, impacted on the performance of markets[106].

The DAX (the German stock market index) suffered both the investors changing sentiment and the interest rate turnaround implemented by the European Central Bank, added to an increasing fear of recession. Even if stock prices rose significantly in 2022 last quarter, the DAX closed the year 12% lower than the previous one.

Volkswagen AG ordinary and preferred shares, respectively indicated with the tickers VOW and VOW3 shared the trend of the German, S&P 500 and international stock markets, where cyclical and automotive stocks dropped their value. VW AG shares performance had a moment of breath only in which the sure listing of Porsche AG was announced. Despite the fact that the operating results of the Volkswagen Group were received positively by the market, the impact of these combined crisis was too huge to not be effective.

[106] https://annualreport2022.volkswagenag.com/group-management-report/shares-and-bonds.html, accessed on 15/06/2023

Ordinary and Preferred Shares price development is now reported in *Figure 25*: the 2022 year-end closing price of ordinary shares was down by 42.9% with respect to the closing one of 2021 (however, it is important to highlight how 2021 ordinary shares stock price faced a 51.9% increase driven by a rebound from 2020 Covid impact). It is also clear, to confirm the highly stock volatility affirmed in the previous paragraph, how between the past 5 years the company touched an all-time low of EUR 101.50 per ordinary share and an all-time high of EUR 327.20 per share.

Share price development[2]		2022	2021	2020	2019	2018
Ordinary share						
Closing	€	147.65	258.40	170.10	173.25	139.10
Price performance	%	–42.9	+51.9	–1.8	+24.6	–17.5
Annual high	€	279.40	327.20	183.10	182.50	188.00
Annual low	€	145.00	165.70	101.50	135.60	131.10
Preferred share						
Closing	€	116.42	177.48	152.42	176.24	138.92
Price performance	%	–34.4	+16.4	–13.5	+26.9	–16.5
Annual high	€	193.10	246.55	185.52	184.24	188.50
Annual low	€	114.88	144.80	87.20	134.76	133.70

Figure 28: VW AG Ordinary and Preferred Shares price development 2018-2022
Source: https://annualreport2022.volkswagenag.com/group-management-report/shares-and-bonds.html, accessed on 15/06/2023

Volkswagen market cap at the moment of valuation (31/12/2022), already mention in *Paragraph 1.2.1.3*, has so been calculated multiplying the number of outstanding ordinary shares by their 2022 closing price and adding to that amount the number of outstanding preferred shares multiplied by their 2022 closing price, obtaining a value of EUR 67,576.45 Million. This value has also been checked and confirmed on Refinitv Platform. Given data above and the highly variable Market Capitalization of the company, previously showed at the start of this chapter, is it easy to affirm that this final dissertation should not be limited at valuing the fair value of the ordinary shares with respect to their 2022 closing price, but also to understand which is the correct price range on which we should collocate them.

3.4.2 Focus on D/E Ratios

Figure 29 finally well explains the effect driven by the combination of a high financial debt and an irregular and unstable Market Capitalization. The difference among the two Debt to Equity ratios taking respectively in consideration Book Value of Equity and Market Capitalization is related to the controversial and difficult history of the group's stock performance. The optimal level of D/E Ratio varies by industry, but generally

should not be more than 2.0. In this case, Volkswagen AG is above this level, with an average NFP ratio of 1.3 on Book Value of Equity but 2.2 on Market Value of Equity during the past 5 years. 2021 was the only year in which the two measures were comparable, when ordinary shares' closing market price of EUR 258.48 touched its all-time high. *Figure 29* shows also, and most importantly in the context of our valuation, how the market D/E ratio of the company is and has been irregular across years. At the moment of hypothetic valuation (31/12/2022) and with a Net Financial Position of EUR 187,779 Million and a Market Capitalization of EUR 67,484 Million, the market D/E ratio is at its highest level ever at 2.78.

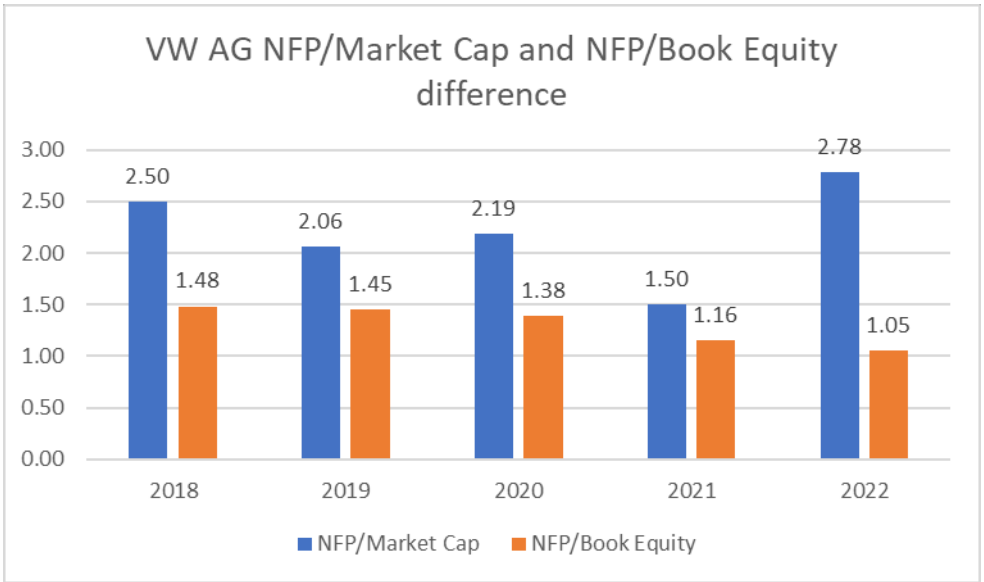


Figure 29: VW AG NFP/Market Cap vs NFP/Book Equity 2018-2022
Source: own elaboration on Refinitiv raw data

3.5 Operative Costs and Future Investments under Green Finance Framework

In addition to the external factors that have impacted VOW (ordinary) and VOW3 (preferred) performance, the low price attributed to the group by the market could also be caused by some of its operative characteristics. It is highly relevant, in the context of Volkswagen AG analysis and given that the company is the automotive manufacturer with the highest revenues, to understand its fixed costs structure.
In Fixed costs area, Volkswagen AG spends far more than peers as % of Sales and on both R&D and SG&A[107]. The below graph shows how the group spent on Fixed Costs is almost 17.50% of its Sales in 2022. Also, when it comes to costs related to the sale of a single unit, the group spends heavily more than its major US and European peers. In 2022, VW spent EUR 9,000 per unit sold on Capex against a peers' average of EUR 6,180 (*Figure 31-B*) and EUR 3,750 per unit sold on R&D against a peers' average of EUR 2,650 (*Graph 31-A*).

[107] BNP Paribas, Automotive Equity Research 2023

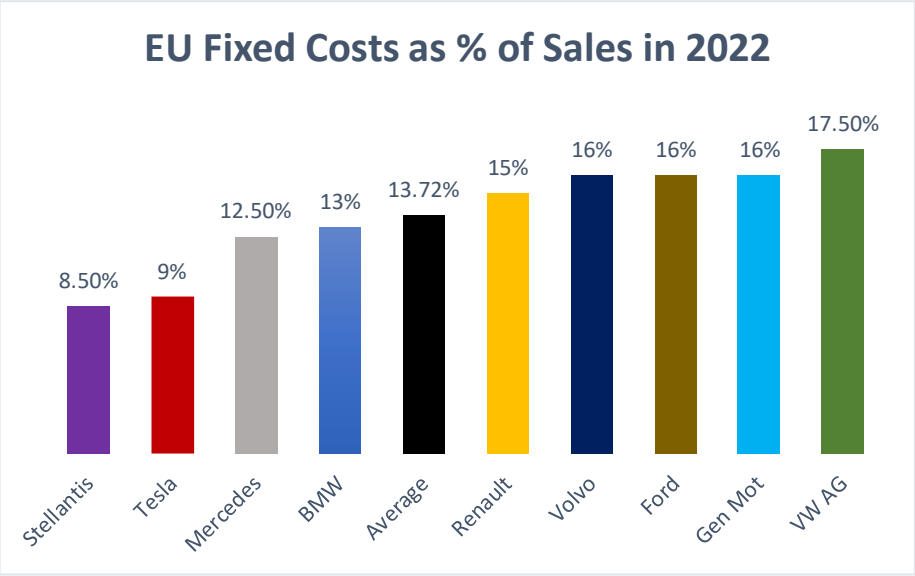
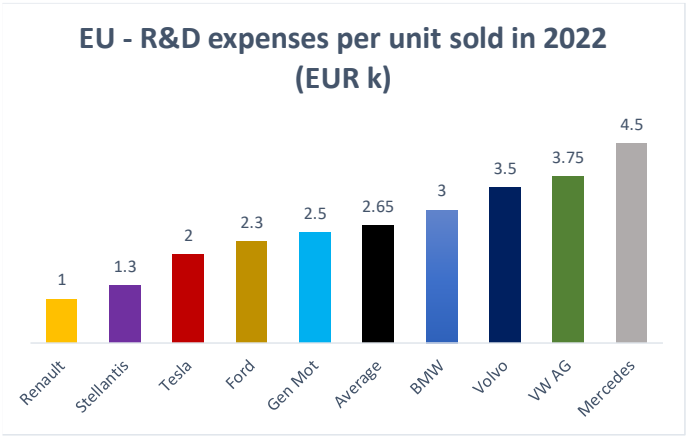


Figure 30: EU and US VW AG peers Fixed Costs as % of Sales in 2022
Source: BNP Paribas Automotive Equity Research Report, 2023



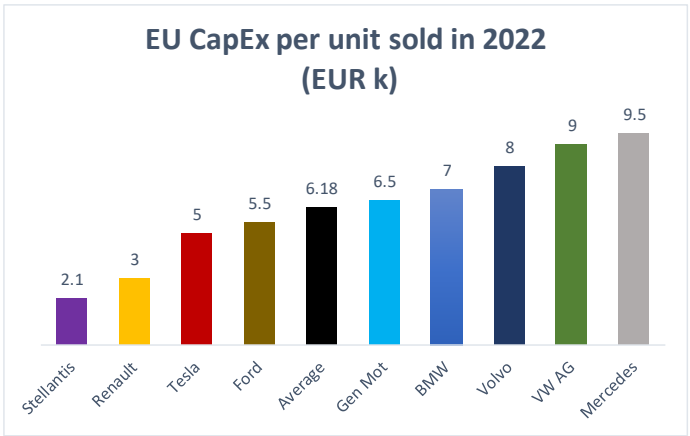


Figure 31-A and 31-B: EU and US VW AG peers R&S and CapEx as % of Sales in 2022
Source: BNP Paribas Automotive Equity Research Report, 2023

The reasons behind these high costs for Volkswagen, with respect to its main peers, could be the following:

Scale & Complexity: some of the European competitors and Tesla have better positioning regarding the average volume sold per models. In particular, Tesla is characterized by an ultra-narrow model range consisting of merely two main products (Tesla Model 3 and Model Y)[108]. This line-up simplicity merely

[108] https://www.tesla.com/ns_videos/2022-tesla-impact-report-highlights.pdf, accessed on 01/07/2023

represents a cost advantage. On the opposite, as previously seen in *Table 10*, VW relies on different models for the majority of its revenues.

PowerCo Plants Capital Expenditures and R&D expenses: while other automotive manufacturers decided to outsource/collaborate with partners for their production, Volkswagen went in the opposite direction. VW aims to fully produce its own batteries in the future and plans to build six battery giga factories in EU, North America and China. Spending much on insourcing for R&D and CapEx for new technologies (in particular Battery Electric Vehicle and Software) can have slowed cash flow generation in the long-term, but have a positive impact on mid and long-term earnings in the future. Given the fixed cost intensive nature of the company, it is strongly reasonable to believe that, once sales accelerates and the fixed costs spread gets better, earnings and cash flow could improve a lot.

Figure 32 is able to confirm our consideration about VW effort on investments: if we compare the average of R&D and Capex, as % of Sales, between 2018 and 2022 of the target with the other 5 European and US car manufacturers who have their business model more oriented on BEV[109] and new generation cars (Mercedes AG, BMW, Renault, Stellantis and Tesla) it is clear how Volkswagen has been the only company to continuously increase their ratio and not reduce it (WV 5.7% CAGR vs average CAGR of -6%).

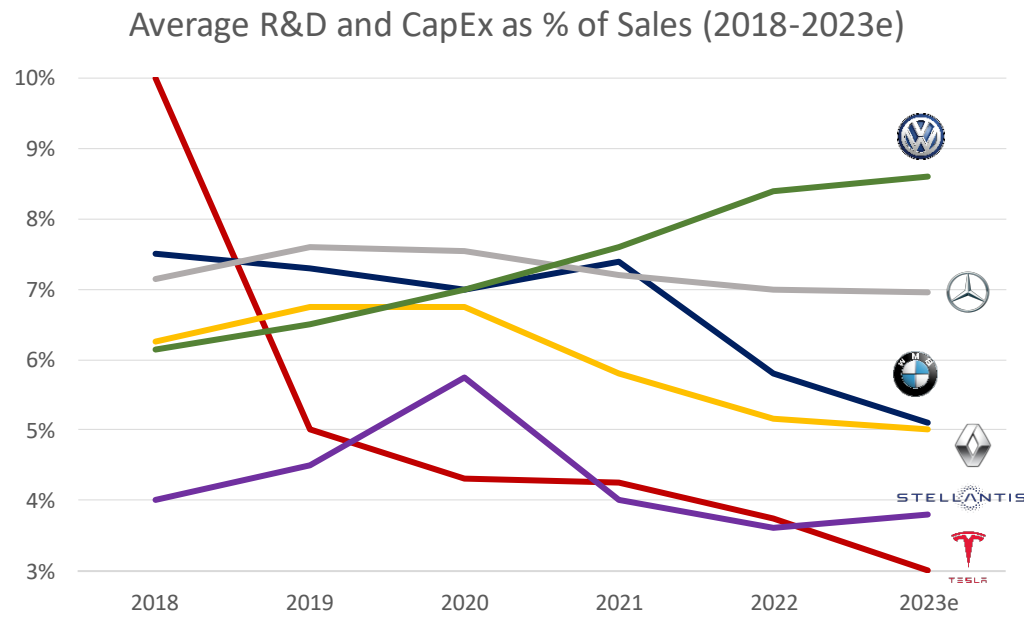


Figure 32: BEV oriented manufacturers Average R&D and Capex as % of Sales in 2022
Source: BNP Paribas Automotive Equity Research Report, 2023

[109] BNP Paribas, Automotive Equity Research 2023

Figure 33, extracted from 2022 group operative outlook, describes in a simple way the main objective of insourcing strategy, strong R&D and investments: increase in the mid-term the revenue pool coming from BEV and Software and decrease the ones coming from classic Internal Combustion Engines.

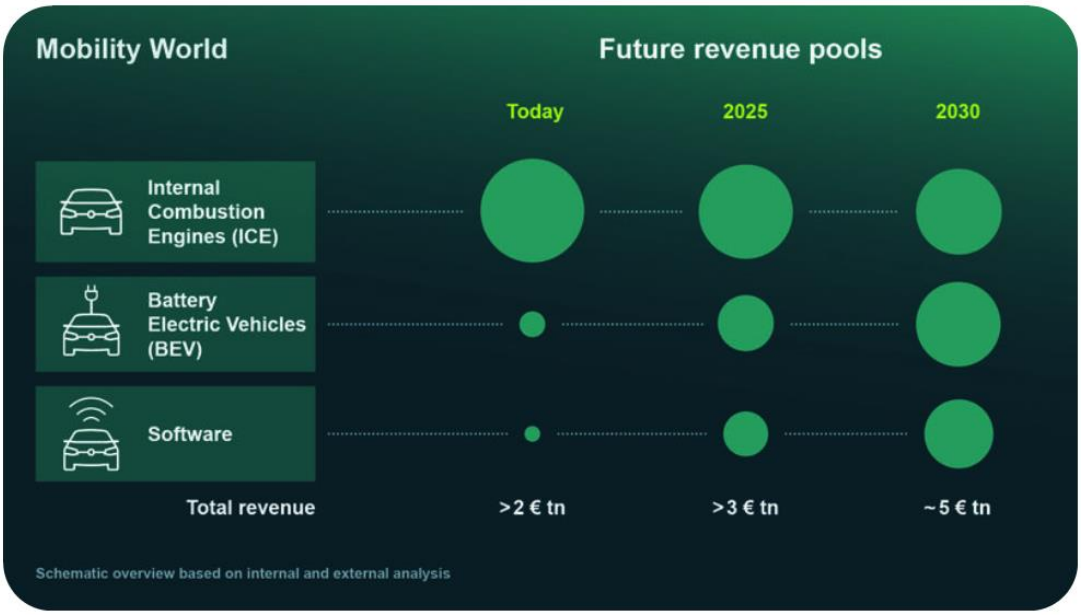


Figure 33: Volkswagen Group Revenue pool strategy outlook
Source: Strategy | Volkswagen Group (volkswagen-group.com), accessed on 18/08/2023

3.5.1 Green Finance Framework

How to relate this high level of past, current and future investments for BEV development and giga factories plants, in the context of the NEW AUTO project? Are those high R&D and Capex related to the level of indebtedness of the group? Financing for investments needed for this purpose is strictly related to the Green Finance Framework. The Green Finance Framework is a project started by the group in March 2020. Green Finance Framework mainly consists in different issues of sustainable debt financial instruments contributing to the sustainable development of the company[110]. In 2020, Volkswagen affirmed[111] that "to support increasing investments in electrification we simultaneously aim to increase the share of Green Debt Instruments in our finding mix". In addition, money raised through Green Finance Framework will be used on Capital Expenditures related only to the production of pure BEV and on R&D expenses for Batteries and Software, while hybrid vehicles and vehicles with combustion engines are fully excluded. The main investments the company has and will continue to make are the ones related to the construction of six giga factories for the production of batteries and BEV, each one with a minimum production of 40 GWh (able to serve 500K vehicles each per year). Until the end of 2022, VW AG has issued Green bonds for a face value of EUR 3.5 billion[112], but it is now planning to go further. To completely align its production to the new EU

[110] https://www.volkswagen-group.com/en/green-finance-15752, accessed on 10/08/2023
[111] https://www.volkswagen-group.com/en/green-finance-15752, accessed on 10/08/2023
[112]https://uploads.vwmms.de/system/production/files/cws/035/807/file/15c1638ce5cb84f009062423cbf5b546fd77679e/Volkswagen_-_Green_Finance_Framework_-_2022_10.pdf?1681825127, accessed on 10/08/2023

manufacturing taxonomy and to invest in BEV that will generate more revenues in the mid/long-term, the GFF will be used to link the Group's decarbonization goals with its financing strategy. Dr. Arno Antlitz, current CFO and COO of the group, has affirmed that the overall group will keep previous years' pace in relation to the emission of further Green bonds[113]. From this information, it is correct to assume that in the next future, Change in Net Borrowings of the group will grow at least at previous year rate and the overall financial debt will increase. This approach is not only consistent with the objective of re-balancing revenues sources of the group toward BEV, but also to re-establish the group reputation after 2015 heavy scandal. Of the six giga factories planned to be built in the next decade, and financed exclusively under the Green Finance Framework, three locations have already been chosen. Salzgitter (Germany) will be the group's battery hub and its production is expected to start in 2025 while operations in Sagunt (Spain) will start in 2026. The third and largest giga factory will be in St.Thomas (Canada) and will help the group in increasing its BEV market share in North America and compete with Tesla. Volkswagen is the third electric vehicle car maker by market share in 2022[114] (8.2%), just under BYD (18.4%) and Tesla (13%), but with the latters having their business model focused only on electric vehicles. As a more general cars manufacturer, VW Group aims to increase its market share in the next years.

[113]https://uploads.vwmms.de/system/production/files/cws/035/827/file/cc1b500bcf7e88547412fad6ab8339aec14a6f7d/2022_11_01_Volkswagen_Green_Finance_Framework_2022.pdf?1681828988, accessed on 08/08/2023
[114] https://www.statista.com/outlook/mmo/electric-vehicles/worldwide#revenue, accessed on 09/08/2023

CHAPTER 4 – VOLKSWAGEN AUTOMOTIVE GROUP VALUATION

In the last chapter of the dissertation, Volkswagen Automotive Group ordinary share valuation will finally take place. The valuation(s) will be conducted according to the most relevant methodologies already described in *Chapter 2*. Intrinsic valuation methods will be applied and their results will be compared to the ones coming from Relative ones (Comparables).

It is important to remember and take in consideration some remarkable assumptions, coming from the company's analysis of *Chapter 3*. VW AG is, in fact, characterized by the following elements:

- High level of absolute financial debt;
- Financial debt that will continue to increase due to the issuance of instruments as Green bonds, in the context of Green Finance Framework;
- High Fixed Costs, financed by debt issuance in the context of GFF started in 2023, but motivated by insourcing and high R&D and Capex expenditures on BEV, that will positively impact on the company cash flow generation starting from the period of projection and from the mid-long term;
- Given its mid-term aim of decreasing revenues coming from CIE and increase ones coming from BEV and so increase also its BEV market share, we can take as a correct assumption that the company will still continue to invest in "Green" R&D and Capex during the projection period;
- Unstable and high D/E (NFP/Market Cap) ratio caused by exogenous impactful factors. It is so important to consider a method, in particular the APV, able to relax the hypothesis of a company maintaining a target D/E ratio for all the projected period;
- Good credit profile, testified by a good ICR and rating agencies;
- We don't see the importance of VW AG Green investments correctly reflected into 2022 ordinary shares closing price;
- Heavy tax shields related to high level of debt should be captured into VW AG price.

To understand the "most reliable price range" for the target, we are going to consider the range given by the most appropriate Market Multiples and after compare it to target prices given by intrinsic valuation and see which one between Free Cash Flow to Firm, Free Cash Flow to Equity and Adjusted Present Value is the closer to market valuation. Given the original aim of this final dissertation, and so understanding which valuation method is the one driven the most by the group's tax shields, for each valuation method (when possible) the % of Enterprise Value driven by tax shields will be made explicit.

4.1 INTRINSIC VALUATION METHODS

4.1.1 Discount Rates and Beta estimation

Risk-free estimation

The first step to estimate WV AG Cost of Equity is estimate the Risk-free Rate. As a proxy for the Risk-free rate, we can consider the Yield to Maturity of the 10-year Germany's government bond in 2022. According to Refinitiv, at 31/12/2022, the Yield to Maturity of 10-year YTM German Government Bund is 2.58%. This will be the Risk-free rate used in our analysis.

Beta

With the bottom-up approach, already explained in *Chapter 1*, we will first compute the unlevered beta of the target. The latter will after be modified according to Blume, assuming that in the long-run the unlevered beta of the target will overlap and coincide with the one of the market (Beta market always equal to 1). In order to compute the Unlevered Beta of the WV AG at 31/12/2022 we need to first report the Levered Betas of the peers. Also, their D/E ratio and applied tax rates are necessary. Peers' 5-year (2018-2002) horizon Levered Betas are estimated through a linear regression. For the purpose of computing betas, peers', S&P 500 and short-term German Bund between 2018 and 2022 adjusted closing prices are downloaded from Yahoo Finance. An example of Levered Beta computation, for BMW, can be found in *Appendix A*. Peers' 2022 Market D/E ratios have been calculated through a re-classification of their Balance Sheets and Market Cap downloaded from Refinitiv, while tax rates are derived from their Income Statement's average tax rate between 2018 and 2022[115].

The median peers' unlevered beta resulting from the table above is equal to 0.60. Hamada Levered Beta is now computed according to *formula 1.5* and Blume Levered Beta is computed according to formula *1.3*. For the purpose of WV AG's beta computation, we will consider as tax rate the one it was subject to during the 2018-2022 historical period. The average tax rate applied on the target's Income Statement was 23.6%. Let us therefore consider this tax rate for Levered Beta. As a best practice, usually the D/E ratio used in Levered Beta formula is the average one in target's peers and sector. The assumption underlying this reasoning is that the company D/E ratio will converge to the one its peers. Given this, we will compute the average between the 2022 Financial Debt/Market Capitalization ratio held by the company, 2.78, and the median market ratio of its peers, 1.30, The target D/E assumed in the valuation is so 2.04.

[115] DEBU2501= BV (refinitiv.com), accessed on 30/06/2023

Company	Country	Levered beta	NFP/Market Cap	Tax rate	Unlevered beta (Hamanda)
Tesla, Inc	USA	1.66	0.19	14.6%	1.43
General Motors Company	USA	1.74	0.95	24.0%	1.01
Ford Motor Company	USA	1.63	2.03	23.0%	0.64
Ferrari NV	Italy	0.80	0.03	14.2%	0.78
Stellantis NV	Netherlands	1.27	1.52	27.1%	0.60
BMW AG	Germany	1.07	1.12	29.9%	0.60
Mercedes-Benz AG	Germany	1.26	1.30	24.1%	0.63
Volvo	Sweden	1.10	0.67	27.8%	0.74
Renault	France	0.71	1.30	34.0%	0.38
Hyundai Motor Company	South Korea	0.95	2.20	23.0%	0.35
Honda Motor CO	Japan	0.73	0.57	27.6%	0.52
Toyota Motor CO	Japan	0.57	0.91	27.1%	0.34
Nissan Motor CO	Japan	0.94	2.38	25.7%	0.34
Mazda Motor CO	Japan	1.33	1.51	23.4%	0.62
Suzuki Motor CO	Japan	1.06	1.48	25.0%	0.50
BYD Company Limited	China	0.64	0.70	16.9%	0.40
Bajaj Auto	India	1.12	1.65	32.0%	0.53
Median			1.30		0.60

Current NFP/Market cap VW AG	2.78
Peers' Unlevered Beta median	0.60
Target D/E Ratio	2.04
Hamanda Levered Beta	1.53
Tax Rate	23.60%
Blume Beta	**1.36**

Given what above, the resulting Levered Beta for Volkswagen AG is 1.36.

Equity Risk Premium

The only element left in *formula 1.2* is the Equity Risk Premium. To calculate it, since it is concerned, the Historical Premium Approach previously discussed will be used. We will calculate ERP as the simple difference between the market return and the risk-free rate. To prove the consistency and reliability of our assumptions, we will use S&P 500 as market index: this is the same market used to carry the linear regression of peers' betas. According to S&P Global[116], the 10-year annualized return on S&P 500 Index, at 31/12/2022, is 10.61%. Considering that we used 10-year YTM of German Bunds, we consider 10-year as an appropriate backward-looking period. The riskless return considered is still 2.58%. The estimated ERP for WV AG is 8.03%.

[116] https://www.spglobal.com/spdji/en/indices/equity/sp-500/, accessed on 15/07/2023

EQUITY RISK PREMIUM	8.03%
S&P 500 - 10y annualized return	10.61%
Risk-free rate	2.58%

Having now estimated all the necessary elements to compute the company's Cost of Equity, the latter is computed according to Capital Asset Pricing Model. VW AG Levered COE is 13.47%.

COST OF EQUITY	13.47%
Risk-free rate	2.58%
EQUITY RISK PREMIUM	8.03%
Blume Beta	1.36

Cost of Debt

WV AG applied COD is now calculated, leveraging *formula 1.6,* and in particular taking advantage of the Synthetic Rating Approach to estimate the Default Spread. Default Spread is so given by Damodaran's *Table 6*. According to the latter, the Default Spread applied to a company is 0.69%. Adding this value to the risk-free previously iterated, we will find that VW AG COD is about 3.27%. This low level of Default spread is perfectly matching with the target's good credit profile attributed by rating agencies. Moreover, its after-tax COD will be equal, given a 2018-2022 average Net Income tax rate of 23.6%, to 2.50%.

COST OF DEBT	3.27%
AFTER-TAX COST OF DEBT	2.50%
Risk-free rate	2.58%
Default spread	0.69%
Tax rate	23.60%

WACC

Once COE and COD has been found, only the weight of the Market Value of Equity and the weight of the Book Value of Debt are missing to compute the target's WACC according to *formula 1.8.* An applied D/E ratio of 2.04 implicitly implies a Market Cap weight of 32.90% and a Debt weight of 67.10%. According to *formula 1.8*, with respect to the previously calculated COE and COD, the estimated Weighted Average Cost of Capital is 6.11%. The expected dividend on preferred stocks is set to zero, so they are included in equity as ordinary shares.

WACC	6.11%
D/E	2.04
Debt %	67.10%
Market Equity %	32.90%
COD	3.27%
COE	13.47%
Tax Rate	23.60%

Unlevered Cost of Equity

Unlevered Cost of Equity, useful for the group's Ordinary shares valuation according to the APV method, is equal to 7.40% according to *formula 2.15*.

Unlevered COST OF EQUITY	**7.40%**
Risk-free rate	2.58%
EQUITY RISK PREMIUM	8.03%
Unlevered Beta	0.60

4.1.2 PRO-FORMA 5 YEAR Projections

The first step to evaluate Volkswagen AG's Ordinary Shares according to intrinsic valuation methods is to project its 3 Financial Statements, its NWC Schedule, its Debt Schedule and CapEx and Depreciation Schedule for the forecasted period 2023-2027. The different assumptions are now presented:

Income Statement assumptions

- A reformulated IS is needed. For the purpose of visualizing EBITDA and EBIT of the company, the past 5 years IS are analyzed in order to understand how Depreciation Amortization expenses are "distributed" among every year official IS's COGS and Operating Expenses;
- After analyzing various sources of information, it has been decided that the Compounded Annual Growth Rate at which the company will grow from year 2023 to year 2027 is 2.5%. This is in fact an annual growth for mature automotive companies that McKinsey indicates between 2023 and 2028, as an intermediate level between the slow growth in North America and Europe and the highest growth in Asian countries[117]. Moreover, this growth rate is coherent with Volkswagen revenue pool aims shown in *Figure 33*, where the projected revenue by the growth for 2025 amount to EUR 300,000 Million;
- Gross Profit Margin and EBITDA Margin for the forecasted period will be respectively the 27.4% and the 16.5% of Revenues, median values of the Historical period;
- D&A and Interest Expenses assumptions will be explained in their own schedules;
- Tax Rate applied to EBT will be the average tax rate of the Historical period: 23,6%;
- Given the difficulty in forecasting these elements, Equity Accounted Investments will be set equal to the ones of 2022 and Net Income portions for Noncontrolling Interests and Hybrid Capital investors are set equal to the ones of 2022.

[117] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/disruptive-trends-that-will-transform-the-auto-industry/de-DE, accessed on 10/07/2023

INCOME STATEMENT / P&L (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Revenue	**235,849**	**252,632**	**222,884**	**250,200**	**279,232**	**286,101**	**293,139**	**300,350**	**307,739**	**315,309**
YoY g%		7.1%	-11.8%	12.3%	11.6%	2.5%	2.5%	2.5%	2.5%	2.5%
COGS	(171,195)	(183,366)	(161,872)	(180,261)	(201,811)	(207,659)	(212,767)	(218,001)	(223,364)	(228,859)
Gross Profit	**64,654**	**69,266**	**61,012**	**69,939**	**77,421**	**78,442**	**80,372**	**82,349**	**84,375**	**86,450**
% of Rev	27.4%	27.4%	27.4%	28.0%	27.7%	27.4%	27.4%	27.4%	27.4%	27.4%
OpEx	(28,173)	(27,867)	(24,268)	(23,191)	(24,627)	31,276	32,046	32,834	33,642	34,469
EBITDA	**36,481**	**41,399**	**36,744**	**46,748**	**52,794**	**47,166**	**48,326**	**49,515**	**50,733**	**51,981**
% of Rev	15.5%	16.4%	16.5%	18.7%	18.9%	16.5%	16.5%	16.5%	16.5%	16.5%
D&A	(22,561)	(24,439)	(27,069)	(27,473)	(30,670)	(28,315)	(28,467)	(28,621)	(28,775)	(28,929)
EBIT	**13,920**	**16,960**	**9,675**	**19,275**	**22,124**	**18,851**	**19,859**	**20,894**	**21,958**	**23,052**
% of Rev	5.9%	6.7%	4.3%	7.7%	7.9%	6.6%	6.8%	7.0%	7.1%	7.3%
Interest expenses	(1,646)	(1,953)	(765)	(1,471)	(2,611)	(7,094)	(7,411)	(7,742)	(8,089)	(8,451)
Equity Acc Inv	3,369	3,349	2,756	2,321	2,395	2,395	2,395	2,395	2,395	2,395
EBT	**15,643**	**18,356**	**11,666**	**20,125**	**21,908**	**14,152**	**14,843**	**15,547**	**16,265**	**16,995**
Taxes	(3,489)	(4,326)	(2,843)	(4,698)	(6,208)	(3,335)	(3,498)	(3,664)	(3,833)	(4,005)
% of EBT	22.3%	23.6%	24.4%	23.3%	28.3%	23.6%	23.6%	23.6%	23.6%	23.6%
Net Income	**12,154**	**14,030**	**8,823**	**15,427**	**15,700**	**10,816**	**11,345**	**11,883**	**12,432**	**12,990**
% of Rev	5.2%	5.6%	4.0%	6.2%	5.6%	3.8%	3.9%	4.0%	4.0%	4.1%
Noncontrolling interests	17	143	(43)	46	393	393	393	393	393	393
Hybrid cap inv	309	540	533	539	576	576	576	576	576	576
VW shareholder's NI	**11,828**	**13,347**	**8,333**	**14,842**	**14,731**	**9,847**	**10,376**	**10,914**	**11,463**	**12,021**

Balance Sheet Assumptions

Balance Sheet has been re-organized and "compressed" to fit better for our modelling purposes.

The main assumptions for Uses are:

- Cash & Cash equivalents will be derived from the Cash Flow Statement
- Accounts Receivable and Inventory values will be derived from the NWC schedule and Fixed Assets (PPE+Intangible) value will be derived from the CapEx and D&A Schedule;
- Other Short-Term Financial Assets, Asset Held for Sale, Lease assets, Deferred Tax Assets, Other long-term Assets and Financial Services Receivable will stay constant at the 2022 level.

BALANCE SHEET - USES (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Total Assets	**458,156**	**488,071**	**497,114**	**528,609**	**564,772**	**584,448**	**606,595**	**629,798**	**654,060**	**679,415**
Current Assets	**183,536**	**187,463**	**194,944**	**200,347**	**224,309**	**243,235**	**264,628**	**287,074**	**310,574**	**335,163**
Cash and cash equivalents	28,113	24,330	33,432	39,122	29,172	39,929	57,627	76,287	95,908	116,523
Other short-term financial assets	29,491	30,578	34,873	35,717	52,373	52,373	52,373	52,373	52,373	52,373
Accounts receivable	80,186	85,018	82,816	81,110	89,758	96,412	98,784	101,214	103,704	106,255
Inventory	45,745	46,742	43,823	43,725	52,274	53,789	55,112	56,468	57,857	59,280
Asset Held for Sale	1	795	0	673	732	732	732	732	732	732
Non-Current Assets	**274,620**	**300,608**	**302,170**	**328,262**	**340,463**	**341,213**	**341,966**	**342,724**	**343,486**	**344,252**
Fixed assets (PPE+intangible)	132,904	127,629	122,677	132,555	139,304	140,054	140,807	141,565	142,327	143,093
Lease Assets	43,545	48,938	50,686	59,699	59,380	59,380	59,380	59,380	59,380	59,380
Deferred Tax Assets	10,131	13,106	13,486	13,393	12,921	12,921	12,921	12,921	12,921	12,921
Other long-term	9,348	23,962	32,756	37,661	41,914	41,914	41,914	41,914	41,914	41,914
Financial Services Receivable	78,692	86,973	82,565	84,954	86,944	86,944	86,944	86,944	86,944	86,944

The main assumptions for Sources are:

- Accounts Payable will be derived from the NWC schedule;
- Other Current Liabilities, Provisions and Other Liabilities will stay constant over time;
- Short-term Financial Liabilities and Long-term Financial Liabilities will be derived from the Debt Schedule;

- Common Equity, Additional Paid in Capital, Comprehensive Income – Accumulated, Hybrid Financial Instruments and Minority Interests values will stay constant over time;
- Retained Earnings will be equal to the sum of past year values plus the current year WV AG shareholders Net Income, minus Dividends.

BALANCE SHEET - SOURCES (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Total Liabilities & Shareholders' Equity	458,156	488,071	497,114	528,609	564,772	584,448	606,595	629,798	654,060	679,415
Current Liabilities	**167,968**	**167,923**	**165,391**	**164,393**	**182,992**	**185,827**	**190,285**	**194,925**	**199,721**	**204,679**
Accounts payable	24,063	23,153	23,017	24,238	29,474	28,654	29,327	30,049	30,788	31,546
Other current liabilities	42,879	46,000	43,136	48,569	50,250	50,250	50,250	50,250	50,250	50,250
Short term financial liabilities	101,026	98,770	99,238	91,586	103,268	106,923	110,707	114,626	118,683	122,883
Non-Current Liabilities	**172,846**	**196,498**	**202,940**	**218,062**	**203,453**	**209,478**	**215,822**	**222,502**	**229,536**	**236,943**
Provisions and other liabilities	71,720	91,082	90,387	101,519	89,770	89,770	89,770	89,770	89,770	89,770
Long term financial Liabilities	101,126	105,416	112,553	116,543	113,683	119,708	126,052	132,732	139,766	147,173
Shareholder's Equity	**117,342**	**123,650**	**128,783**	**146,154**	**178,327**	**189,143**	**200,488**	**212,371**	**224,803**	**237,793**
Common equity	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283
Additional Paid in Capital	14,551	14,551	14,551	14,551	14,551	14,551	14,551	14,551	14,551	14,551
Retained earnings	91,105	96,929	100,772	117,342	137,267	148,083	159,428	171,311	183,743	196,733
Comprehenisve Income - Accumulated	(2,418)	(3,646)	(5,270)	(3,166)	(1,845)	(1,845)	(1,845)	(1,845)	(1,845)	(1,845)
Hybrid Financial Instruemnts	12,596	12,663	15,713	14,439	14,121	14,121	14,121	14,121	14,121	14,121
Minority Interests	225	1,870	1,734	1,705	12,950	12,950	12,950	12,950	12,950	12,950

NWC Schedule assumptions

For the forecasted period the only relevant changes in New Working Capital will be related to just the main 3 important items: Accounts Receivable, Inventory and Accounts Payable.

- Accounts Receivable for the forecasted period will be calculate based on the Median Days Sales Outstanding of the Historical Period;
- Inventory for the forecasted period will be calculate based on the Median Days Inventory in Stock of the Historical Period;
- Accounts Payable for the forecasted period will be calculate based on the Average Payment Period of the Historical Period.

NWC Schedule (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Accounts receivable	**80,186**	**85,018**	**82,816**	**81,110**	**89,758**	**96,412**	**98,784**	**101,214**	**103,704**	**106,255**
Days Sales Outstanding	124	123	136	118	117	123	123	123	123	123
Inventory	**45,745**	**46,742**	**43,823**	**43,725**	**52,274**	**53,789**	**55,112**	**56,468**	**57,857**	**59,280**
Days Inventory in Stock	98	93	99	89	95	95	95	95	95	95
Accounts payable	**24,063**	**23,153**	**23,017**	**24,238**	**29,474**	**28,654**	**29,327**	**30,049**	**30,788**	**31,546**
Average Payment Period	50	46	53	49	51	50	50	50	50	50
NWC	101,868	108,607	103,622	100,597	112,558	121,547	124,568	127,633	130,773	133,990
Change in NWC	**(8,127)**	**6,739**	**(4,985)**	**(3,025)**	**11,961**	**8,989**	**3,021**	**3,064**	**3,140**	**3,217**
Financial Services Receivable	78,692	86,973	82,565	84,954	86,944	86,944	86,944	86,944	86,944	86,944
Lease Assets	43,545	48,938	50,686	59,699	59,380	59,380	59,380	59,380	59,380	59,380
other relevant changes		1,553	17,715	(3,322)	7,133	0	0	0	0	0
Overall CHANGE IN NWC	7,272	21,966	10,070	5,055	20,765	8,989	3,021	3,064	3,140	3,217

Debt Schedule assumptions

- Short-term Financial Liabilities will face a yearly increase of at 3.12%, the average yearly increase of the historical period, and Long-term Financial Liabilities will face a yearly increase of 4.80%, the average yearly increase of the Historical period. Projecting a financial debt increase based on the average of historical levels is coherent with Green Finance Framework analyzed in *Paragraph 3.5.1*. Financial Interest Payments owed to debt investors will be based on an Interest Rate equal to the estimated COD. This assumption, implying the simplification that Short-Term and Long-Term financial liabilities are all bonds, nearly matches the reality considering that (as shown in *Paragraph 3.2.4*) the 94% of Volkswagen Financial Liabilities are Bonds/Convertible and the 89% of them incorporates a fixed interest rate.

Debt Schedule (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Short-term financial liabilities										
Beginning of period	88,301	101,026	98,770	99,238	91,586	103,268	106,923	110,707	114,626	118,683
Increase/Decrease	12,726	-2,256	468	-7,652	11,682	3,655	3,784	3,918	4,057	4,201
Rate of Increase/Decrease	14.4%	-2.2%	0.5%	-7.7%	12.8%	3.5%	3.5%	3.5%	3.5%	3.5%
End of period	101,026	98,770	99,238	91,586	103,268	106,923	110,707	114,626	118,683	122,883
Long-Term Financial Liabilities										
Beginning of period	88,402	101,126	105,416	112,553	116,543	113,683	119,708	126,052	132,732	139,766
Increase/Decrease	12,725	4,290	7,137	3,990	-2,860	6,025	6,344	6,680	7,034	7,407
Rate of Increase/Decrease	14.4%	4.2%	6.8%	3.5%	-2.5%	5.3%	5.3%	5.3%	5.3%	5.3%
End of period	101,126	105,416	112,553	116,543	113,683	119,708	126,052	132,732	139,766	147,173
Total change In Financial Borrowings	**25,450**	**2,034**	**7,605**	**(3,662)**	**8,822**	**9,680**	**10,128**	**10,598**	**11,091**	**11,607**
Interest Rate	0.93%	0.97%	0.37%	0.69%	1.25%	3.27%	3.27%	3.27%	3.27%	3.27%
Interest Payments	**(1,646)**	**(1,953)**	**(765)**	**(1,471)**	**(2,476)**	**7,094**	**7,411**	**7,742**	**8,089**	**8,451**

CapEx and D&A Schedule Assumptions

- D&A and CapEx will be projected based on their average % to Beginning Fixed Assets during the Historical Period. This leads to a value of 20.3% for D&A and of 20.9% for CapEx. With these assumptions we will so project a Maintenance Capex near to the value of D&A, coherent with the assumptions of stable growth previously made.

CapEx and D&A Schedule (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
BEGINNING FIXED ASSETS	136,457	132,904	127,629	122,677	132,555	139,304	140,054	140,807	141,565	142,327
D&A	**(22,516)**	**(24,439)**	**(27,069)**	**(27,473)**	**(30,670)**	**(28,315)**	**(28,467)**	**(28,621)**	**(28,775)**	**(28,929)**
CAPEX	**18,963**	**19,164**	**22,117**	**37,351**	**37,419**	**29,065**	**29,221**	**29,378**	**29,536**	**29,695**
ENDING FIXED ASSETS	**132,904**	**127,629**	**122,677**	**132,555**	**139,304**	**140,054**	**140,807**	**141,565**	**142,327**	**143,093**
D&A as % of Fixed Assets	16.5%	18.4%	21.2%	22.4%	23.1%	20.3%	20.3%	20.3%	20.3%	20.3%
CapEx as % of Fixed Assets	13.9%	14.4%	17.3%	30.4%	28.2%	20.9%	20.9%	20.9%	20.9%	20.9%

Cash Flow Statement assumptions

- While in the Historical Period Taxes paid on the IS were different from Cash Taxes (the effective amount of cash outflow), in the Forecasted Period Cash Taxes are set equal the IS taxes;
- Other Cash Flow from Investing Activities, Capital Contributions/Capital Redemptions and the Effect of Exchange Rates on cash, given their unpredictable nature, are set equal to zero;

- Payout Ratios for both Ordinary and Preferred shareholders, given the irrelevance of Dividends outflow for the purpose of this dissertation, are set to zero.

CASH FLOW STATEMENT (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Earnings before taxes	15,643	18,356	11,666	20,125	22,043	14,152	14,843	15,547	16,265	16,995
Cash Taxes	(3,084)	(2,846)	(3,765)	(3,910)	(3,453)	(3,335)	(3,498)	(3,664)	(3,833)	(4,005)
Depreciation	22,561	24,439	27,069	27,473	30,670	28,315	28,467	28,621	28,775	28,929
Change in NWC	27,848	21,966	10,070	5,055	20,765	8,989	3,021	3,064	3,140	3,217
Cash Flow from Operating Activities	**7,272**	**17,983**	**24,900**	**38,633**	**28,495**	**30,142**	**36,791**	**37,439**	**38,066**	**38,702**
Capex	(18,963)	(19,164)	(22,117)	(37,351)	(37,419)	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)
Other Cash Flow from investing activities	(2,627)	(1,982)	(574)	11,223	(4,402)	-	-	-	-	-
Cash Flow from Investing Activities	**(21,590)**	**(21,146)**	**(22,691)**	**(26,128)**	**(41,821)**	**(29,065)**	**(29,221)**	**(29,378)**	**(29,536)**	**(29,695)**
Capital contributions/capital redemptions	1,491	-	2,984	(1,071)	(235)	-	-	-	-	-
Dividends	(2,375)	(2,899)	(2,952)	(3,022)	(4,362)	-	-	-	-	-
Payout ratio	20.1%	21.7%	35.4%	20.4%	29.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Proceeds from debt/repayment of debt	25,450	2,034	7,605	(3,662)	8,822	9,680	10,128	10,598	11,091	11,607
Cash Flow from Financing Activities	**24,566**	**(865)**	**7,637**	**(7,755)**	**4,225**	**9,680**	**10,128**	**10,598**	**11,091**	**11,607**
Effect of Exchange Rates	(173)	243	(744)	942	(849)	-	-	-	-	-
Beginning cash	18,038	28,113	24,330	33,432	39,122	29,172	39,929	57,627	76,287	95,908
Increase/Decrease	10,075	(3,785)	9,102	5,692	(9,950)	10,757	17,698	18,660	19,621	20,615
Ending cash	**28,113**	**24,328**	**33,432**	**39,124**	**29,172**	**39,929**	**57,627**	**76,287**	**95,908**	**116,523**

4.1.3 Flow to Firm / WACC Valuation

In order to compute the FCFF of Volkswagen AG for the forecasted years, *formula 2.6* will be used. From 2023 EBITDA and D&A of the period, 2023 EBIT is obtained. After, the 23.6% Tax rate is applied directly on EBIT in order to obtain 2023 NOPAT (Net Operating Profit After Taxes), that measures the efficiency of a leveraged company operations net of taxes. Non-cash expenses D&A is after added back to NOPAT while the positive change in NWC with respect to 2022 and 2023 CapEx are subtracted. This process is repeated also for 2024, 2025, 2026 and 2027. Moreover, it is necessary to consider the cash flow that the firm will generate after the projection period "up to infinity", in the so-called Normalized Period. This step is necessary in order to compute the Terminal Value of the firm. Some adjustments for the Normalized Period are necessary: EBITDA is set at the 2027 level, D&A and Capex are set equal to 2027 Capex, the change in NWC is set equal to zero. We will so obtain the FCFF for the Normalized Period, that will be converted into the TV using Perpetuity Growth model of *formula 2.8*. Given that Volkswagen is a mature company, a growth rate of 1.00% has been set as its long-term g rate and the discount rate is the Weighted Average Cost of capital of 6.38% previously estimated in this chapter.

FCFF (€ million)	Forecasted					
	2023	2024	2025	2026	2027	Normalized
EBITDA	**47,166**	**48,326**	**49,515**	**50,733**	**51,981**	**51,981**
D&A	(28,315)	(28,467)	(28,621)	(28,775)	(28,929)	(29,695)
EBIT	**18,851**	**19,859**	**20,894**	**21,958**	**23,052**	**22,286**
TAXES	(4,443)	(4,680)	(4,924)	(5,175)	(5,433)	(5,252)
NOPAT	**14,408**	**15,179**	**15,970**	**16,783**	**17,619**	**17,034**
DEPR	28,315	28,467	28,621	28,775	28,929	29,695
D-NWC	(8,989)	(3,021)	(3,064)	(3,140)	(3,217)	-
CapEx	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)	(29,695)
Unl FCF	**4,670**	**11,403**	**12,148**	**12,882**	**13,636**	**17,034**

Discount Period	**1**	**2**	**3**	**4**	**5**	**5**
Discount Factor	94.2%	88.8%	83.7%	78.9%	74.3%	74.3%
Discounted Unl FCF	4,401	10,128	10,168	10,162	10,137	
PV of Unl FCF	**44,996**					
TV						336,723
Pv of TV	**250,327**					

EV	**295,323**
Net Financial Position	**187,779**
Minority Interest 2022	**12,950**
Pref Shares Value	**24,006**
Unfunded Pension Liabilities	**27,553**
Equity Investments	**12,668**
EQUITY VALUE	**55,703**

Oustanding Ordinary Shares	**295,089,818**
Intrinsic Ordinary Shares	**188.8 €**

Cumulative Unlevered Cash Flows and the Terminal Value are after discounted for their correct Discount Factor and sum in order to obtain the Enterprise Value of the company. As argued in *formula 2.9*, 2022 Net Financial Position of the company (given by Financial Liabilities minus Cash & Cash equivalents), 2022 Minority interests, the value of Preferred Shares (equal to their 2022 closing market value multiplied by the number of outstanding preferred shares), the value of 2022 Unfunded Pension Liabilities are subtracted and the amount of 2022 Balance Sheet Equity Investments is added in order to get the target's Equity Value. The latter is after divided by the number of outstanding ordinary shares equal, as stated in *Paragraph 3.1.4*, to 295,089,818. The If Converted method has been relaxed. The intrinsic share price obtained is EUR 188.8.

In order to analyze the main value drivers for the WACC method and understand which is the interest tax shields impact on the valuation we have to carry an additional valuation. In fact, in the WACC method, the benefits associated with tax shields are only indirectly captured by the Cost of Capital used to discount Free Cash Flows to Firm. In order to "extract" the tax shields from the WACC method, we must use the difference between the Pre-tax WACC and the WACC. The demonstration behind this reasoning follows:

Pretax WACC – WACC = E/V * COE + D/V * PRE-TAX COD – (E/V * COE + D/V * PRE-TAX COD* (1-Tax rate) = ~~E/V * COE~~ + D/V * PRE-TAX COD – ~~E/V * COE~~ - D/V * PRE-TAX COD* (1-Tax rate) = ~~D/V * PRE-TAX COD~~ - ~~D/V * PRE-TAX COD~~ + D/V * PRE-TAX COD * Tax rate = D/V * PRE-TAX COD * Tax rate = Interest Tax Shield %

This is also the formula expressed by Harris & Pringle[118] to compute the value of the tax shields in case the company sets a constant D/E ratio to follow.

We will then discount the Unlevered cash flows and the long-term TV (with the last calculated using the pre-tax WACC) at the pre-tax WACC of 6.63%. The difference between the Cumulative Cash Flows discounted using WACC and the ones discounted using pre-tax WACC will return the amount of Tax benefits implicitly calculated with the DCF, while the difference between the PV discounted using WACC and the PV discounted using pre-tax WACC will return the amount of TV tax benefits implicitly calculated with the DCF.

Discount Period	**1**	**2**	**3**	**4**	**5**	**5**
Discount Factor	93.8%	88.0%	82.5%	77.4%	72.6%	72.6%
Discounted Unl FCF	4,379	10,030	10,021	9,966	9,894	
PV of Unl FCF	44,289					
TV						305,737
Pv of TV	**221,826**					

Cumulative Unl FCF	44,289	15.0%
Pv of TV	221,826	75.1%
Cumulative Tax Shields	707	0.2%
PV of TV Tax Shields	28,501	9.7%
EV	295,323	100.0%

[118] Robert S. Harris and John J. Pringle, Journal of Financial Research, 1985, vol. 8, issue 3, 237-244

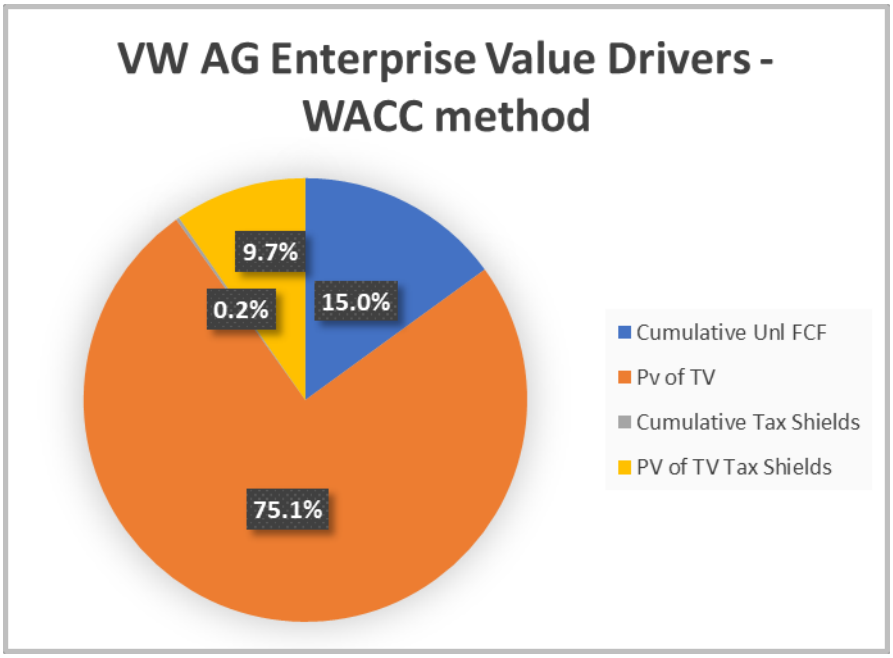


Figure 33: EV Value Drivers – WACC
Source: own elaboration

As visible from the above graph, the EV is driven only for the 0.2% by the Cumulative Tax Shields.

4.1.4 Flow to Equity Valuation

In order to compute the FCFF of Volkswagen AG for the forecasted years, *formula 2.3* will be used. The starting point with this valuation method is 2023 Net Income of the firm. Non-cash expenses D&A is after added back to Net Income while the positive change in NWC with respect to 2022 and 2023 CapEx are subtracted. 2023 Change in Net Borrowings with respect to previous year, representing a cash inflow, is added. This process is repeated also for 2024, 2025, 2026 and 2027. Moreover, it is necessary to consider the levered cash flow that the firm will generate after the projection period "up to infinity", in the so-called Normalized Period. This step is necessary in order to compute the Terminal Value of the firm. Some adjustments for the Normalized Period are necessary: Net Income is set at the 2027 level, D&A and Capex are set equal to 2027 Capex, the change in NWC is set equal to zero and the change in Net Borrowing is set equal to zero. We will so obtain the FCFE for the Normalized Period, that will be converted into the TV using Perpetuity Growth model of *formula 2.5*. Given that Volkswagen is a mature company, a growth rate of 1% has been set as its long-term g rate and the discount rate is the Levered Cost of Equity 13.47% previously estimated in this chapter.

FCFE (€ million)	Forecasted					
	2023	2024	2025	2026	2027	Normalized
Net Income	**9,847**	**10,376**	**10,914**	**11,463**	**12,021**	**12,021**
DEPR	28,315	28,467	28,621	28,775	28,929	29,695
D-NWC	(8,989)	(3,021)	(3,064)	(3,140)	(3,217)	-
CapEx	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)	(29,695)
Change In Net Borr	9,680	10,128	10,598	11,091	11,607	-
Lev FCF	**9,788**	**16,729**	**17,691**	**18,652**	**19,646**	**12,021**

Discount Period	**1**	**2**	**3**	**4**	**5**	**5**
Discount Factor	88.1%	77.7%	68.4%	60.3%	53.2%	53.2%
Discounted Lev FCF	8,626	12,992	12,108	11,250	10,442	
PV of Lev FCF	**55,419**					
TV						97,338
Pv of TV	**51,739**					

Equity Value	**107,157**	**Intrinsic Ordinary Shares**	**213.8 €**

Cumulative Levered Free Cash Flows and the Terminal Value are after discounted for their correct Discount Factor and sum in order to obtain directly the Equity Value of the company. The latter is after divided by the overall number of shares outstanding. The intrinsic share price obtained is of EUR 213.8.

In the particular case of FCFE valuation, considering that the object of our analysis are Levered FCFs, so cash flows directed only to Equity holders and after interest payments, we are not able to extract how much value is generated from Tax Shields.

4.1.5 Adjusted Present Value Valuation

In the APV model, the cash flow projection is the same as the one explained for the WACC method. However, the Unlevered Free Cash Flows will not be discounted by the WACC but by the Unlevered Cost of Capital than in this case is the firm Unlevered COE. Cumulative Unlevered Cash Flows and the Terminal Value are after discounted for their correct Discount Factor. In this way, we obtain the Levered Value of the firm. We are only missing the estimation of the Present Value of the tax benefits associated with VW AG's Financial Interest Expenses. We will so take the Financial Interest expenses for each projected year and multiply them by the tax rate, obtaining the tax shields after discounted by the respective discount factor. We will after take Financial Interest expenses for year 2027 and apply *formula 2.13* to get Tax Shield TV, that will after be discounted by year 5 discount factor. Summing the present value of the cumulative tax benefits and the present value of the TV Tax Shield to the Unlevered Firm Value previously obtain, we get the Levered Value / Enterprise Value of the company.

APV (€ million)	Forecasted					
	2023	2024	2025	2026	2027	Normalized
EBITDA	**47,166**	**48,326**	**49,515**	**50,733**	**51,981**	**51,981**
D&A	(28,315)	(28,467)	(28,621)	(28,775)	(28,929)	(29,695)
EBIT	**18,851**	**19,859**	**20,894**	**21,958**	**23,052**	**22,286**
TAXES	(4,443)	(4,680)	(4,924)	(5,175)	(5,433)	(5,252)
NOPAT	**14,408**	**15,179**	**15,970**	**16,783**	**17,619**	**17,034**
DEPR	28,315	28,467	28,621	28,775	28,929	29,695
D-NWC	(8,989)	(3,021)	(3,064)	(3,140)	(3,217)	-
CapEx	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)	(29,695)
Unl FCF	**4,670**	**11,403**	**12,148**	**12,882**	**13,636**	**17,034**

Discount Period	**1**	**2**	**3**	**4**	**5**	**5**
Discount Factor	93.1%	86.7%	80.7%	75.2%	70.0%	70.0%
Discounted Unl FCF	4,348	9,887	9,807	9,683	9,543	
Cumulative Unl FCF	**43,267**					
TV						268,894
Pv of TV	**188,192**					
Discount Factor	96.8%	93.8%	90.8%	87.9%	85.1%	85.1%
Financial Expenses	(7,094)	(7,411)	(7,742)	(8,089)	(8,451)	
Tax Shields	1,672	1,747	1,825	1,906	1,992	
PV of Tax Shields	1,619	1,638	1,657	1,676	1,696	
Cumulative Tax Shields	**8,285**					
TV Tax Shields						88,619
PV of TV Tax Shields	**62,022**					

EV	**301,766**
Net Financial Position	**187,779**
Minority Interest 2022	**12,950**
Pref Shares Value	**24,006**
Unfunded Pension Liabilities	**27,553**
Equity Investments	**12,668**
EQUITY VALUE	**62,145**

Oustanding Ordinary Shares	**295,089,818**
Intrinsic Ordinary Shares	**210.6 €**

Cumulative Unlevered Cash Flows and the Terminal Value are after discounted for their correct Discount Factor and sum in order to obtain the Enterprise Value of the company. As argued in *formula 2.9*, 2022 Net Financial Debt of the company (given by Financial Liabilities minus Cash & Cash equivalents), 2022 Minority interests and the value of Preferred Shares (equal to their 2022 closing market value multiplied by the number of outstanding preferred shares) are subtracted in order to get the target's Equity Value. The latter is after divided by the number of outstanding ordinary shares equal, as stated in *Paragraph 3.1.4*, to 295,089,818. The *If Converted* method has been relaxed. The intrinsic share price obtained is EUR 210.6.

Cumulative Unl FCF	43,267	14.3%
Pv of TV	188,192	62.4%
Cumulative Tax Shields	8,285	2.7%
PV of TV Tax Shields	62,022	20.6%
EV	301,766	100.0%

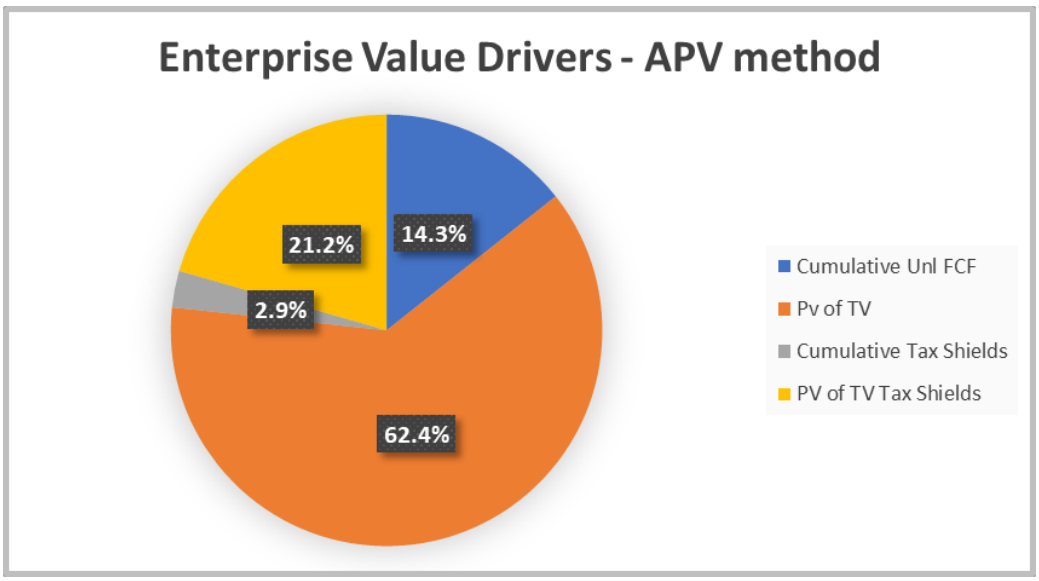


Figure 34: EV Value Drivers – APV
Source: own elaboration

As visible from the above graph, the EV is driven for the 2.9% by the Cumulative Tax Shields that, despite being still a low percentage, is more than 10 times the percentage obtain in the DCF method. In this case, using the DCF method, the value of ordinary shares is underestimated by 10.4% with respect to the value determined by the APV method and the EV is underestimated by 21.3%. This underestimation is certainly in part attributable to the approximation made in the explicit period in which using the WACC as constant discount rate, the benefits associated with debt in the first few years are underestimated and overestimated in the long-term period.

4.2 RELATIVE VALUATION

Through the use of Comparables, Volkswagen AG's ordinary shares will be valued with respect to its peers, similar companies operating in the same sector. To carry this kind of valuation, as stated in *Paragraph 2.1.1*, we need to first obtain Multiples: ratios between peers' Enterprise or Equity Value and an appropriate financial metric for an apple-to-apple comparison. Refinitiv is still used as source of data to analyze and important peers' balance sheets, re-organize them according to a financial/operating criteria and extract relevant measures: their EV, EBIT, EBITDA, NET INCOME, BOOK VALUE OF SHAREHOLDERS' EQUITY and MARKET CAPITALIZATION.

We after compute 2 Multiples related to the Asset side, using EV at the numerator and an income measure as EBIT and EBITDA at the denominator (financial proxy of FCFs for both shareholders and debt holders); and 2 Multiples related to the Equity Side, using Price at the numerator and Net Income per Share or Book Value of Equity per Share at the denominator. We after derive the Median and Average of these sets of Multiples.

MULTIPLES		ASSET SIDE		EQUITY SIDE	
Company	Country	EV/EBIT	EV/EBITDA	P/E	P/BV
Tesla, Inc	USA	26.6	21.2	30.9	8.6
General Motors Company	USA	13.7	3.2	7.7	1.2
Ford Motor Company	USA	22.4	10.1	2.6	1.1
Ferrari NV	Italy	37.2	25.7	47.3	17.0
Stellantis NV	Netherlands	0.8	0.7	2.6	0.6
BMW AG	Germany	8.9	5.5	3.1	0.6
Mercedes-Benz AG	Germany	8.7	4.9	4.5	0.8
Volvo	Sweden	10.0	5.4	11.8	2.3
Renault	France	19.7	6.7	5.7	0.3
Hyundai Motor Company	South Korea	13.4	8.4	5.0	0.4
Honda Motor CO	Japan	12.2	5.1	7.1	0.6
Toyota Motor CO	Japan	19.0	10.9	12.5	1.0
Nissan Motor CO	Japan	13.6	6.0	7.3	0.1
Mazda Motor CO	Japan	4.9	2.8	5.4	0.5
Suzuki Motor CO	Japan	7.3	4.8	10.7	0.9
BYD Company Limited	China	35.6	17.9	39.3	4.7
Bajaj Auto	India	21.3	18.5	11.6	4.5
Median		13.6x	6.0x	7.3x	0.9x
Average		16.2x	9.3x	12.7x	2.7x

The Median value of Multiples (chosen over Average value because it is able to ignore completely too high multiples as the ones of Tesla and Ferrari) is after multiplied by the relevant WV AG metric from 2022 Financial Statements. In case the Multiple is an Asset Multiple, we are able to get the implicit EV that the market confers to the target. As happened with WACC and APV methods, we after subtract NFP, Minority Interests, the value of Preferred stock, Unfunded Pension Liabilities and add Equity Investments from the EV, in order to get the target's Equity Value and divide it by the number of outstanding ordinary shares. In case the Multiple is an Equity Multiple, we simply divide the implicit Equity Value that the market confers to the target by the number of overall outstanding shares. Final fair prices related to each different Multiple are reported below.

Multiple	Median Multiple Value	VW AG Metric	Implied Price
EV/EBIT	13.6x	22,124	208.6 €
EV/EBITDA	6.0x	52,794	258.2 €
P/E	7.3x	14,731	214.5 €
P/BV	0.9x	178,327	334.6 €

4.3 COMPARISON OF RESULTS AND CONCLUSION

First, we can with certainty affirm that 2022 closing VW ordinary shares, according to the empirical analysis carried in this final dissertation, are undervalued. The closing price of EUR 147.65 does not reflect the fair

value of the company. This has been detected as true both in the context of intrinsic valuation and when it comes to relative valuation methods. A "Football Field" is presented in *Figure 35*. This chart does not only report the single target price that has been estimated according to each of the different valuation method (WACC, FTE, APV, EV/EBIT, EV/EBITDA, P/E, P/BV) but also the range of price given by each of them. The ranges are computed according to different criteria, depending if related to an intrinsic or relative method:

- sensitivity analysis based on +- 0.25% on growth rate g and +-0.75% on discount rates WACC, COE, Unlevered COE respectively for WACC, FTE and APV method;
- sensitivity analysis based on the highest and lowest multiple closer to the median one for relative valuation.

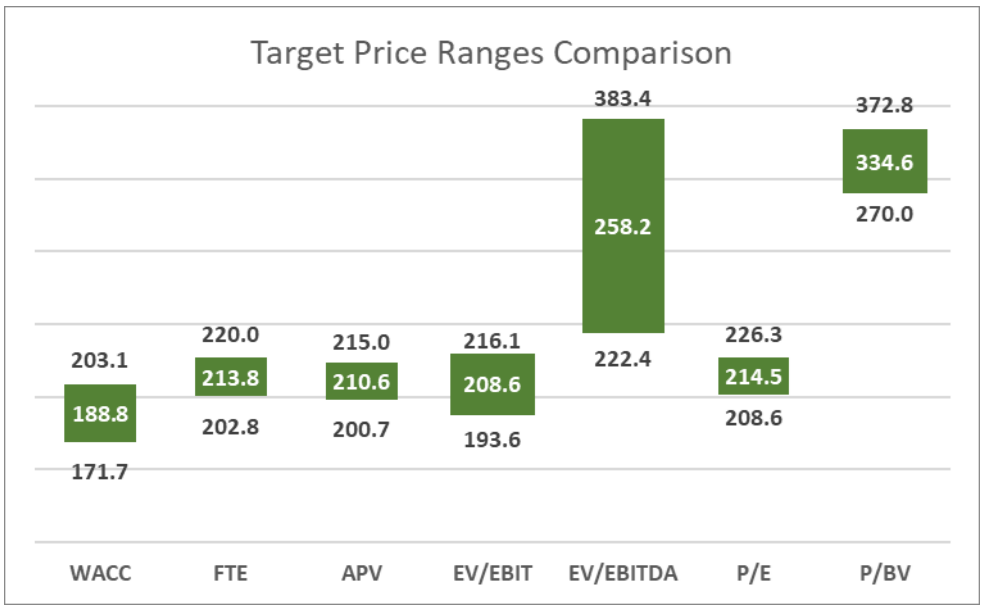


Figure 35: VW AG Ordinary Shares Target Price ranges comparison

Source: own elaboration

As visible from the comparison, different valuation methods lead (obviously) to different results, especially in the case of a practical approach. Our intention is to understand which valuation range and method is the most reliable among the others. It is evident how market multiples EV/EBITDA and P/BV resulted in too high ranges with respect to others. EV/EBITDA, as stated in *Chapter 2*, is not an appropriate multiple to use when it comes to company with huge CapEx as the ones in the automotive sector and the fact that EBIT recognizes D&A may it a more accurate measure of value. P/BV, on the other hand, is not completely reliable in case peers and target present, as in our case and previously discussed, a huge difference between book value of equity per share and market price per share. The remaining two multiples are EV/EBIT and P/E. The difference between the two is that the latter is dependent from the financial structure of the company.

EV/EBITDA, not considering the huge CapEx of VW AG, leads to a too broad and high price range (target price EUR 258.2, range EUR 222.4 – 383.4) while P/BV (target price EUR 334.6, range EUR 270.0 – 372.8), despite being a good ratio for manufacturing companies with important assets, multiplies for the Book Equity of the group that is 2.64 bigger than its market value. The ranges to take in consideration are so the ones given by EV/EBIT (target price EUR 208.6, range EUR 193.6 – 216.1) and P/E (target price EUR 214.5, range EUR 208.6 – 226.3).

Among the intrinsic methods, APV (target price EUR 210.6, range EUR 200.7 – 215.0) is the closest to these results. On the other side, WACC (target price EUR 188.8, range EUR 171.7 – 203.1) gives too distant output. Flow to Equity Method (target price EUR 213.8, range 202.8 – 220.0) resulted closer to APV method, despite the fact it is not able to show the amount of value generated by tax shields. Moreover, APV and FTE results (and EV/EBIT and P/E) are closer to the output of institutional equity research reports for Volkswagen Automotive Group valuation at the end of 2022: Bank of America reports a target price for ordinary shares of EUR 211.0[119], JP Morgan reports a fair price of EUR 203.0[120], stating that the company is undervalued and BNP Paribas reports a fair price of EUR 207.5[121]. The APV method overcomes the assumption of a constant D/E ratio (at least in the explicit period) and focuses on the actual development of the financial structure over time, reducing the level of approximation in the valuation process. This approximation can be significant in companies recording significant changes in debt level with respect to the value of the firm or market capitalization level. As seen in *Paragraph 4.1.5*, using WACC we underestimated by 10.4% the value of ordinary shares and by 21.3% the EV. For what concerns FTE valuation, despite the result was closer to APV, it still presents some drawback in considering a constant Levered COE for all the projected period (and so still a constant D/E ratio). In fact, while the intrinsic price obtained in the APV method will stay fixed at the fluctuation of the target D/E ratio and depends only on Unlevered COE (Unlevered Beta), the price obtained in the FTE method will change depending on the chosen target financial structure since discounted by Levered COE (Levered Beta).

We demonstrated the stronger reliability of the Adjusted Present Value Method over the Flow to Firm and Flow to Equity method, when it comes to companies with an unstable and unpredictable market financial structure.

After having confirmed our dissertation hypothesis that Volkswagen Automotive group ordinary shares are highly undervalued at 31/12/2022, it is important to conclude also which is the valuation method that

[119] Bank of America, Automotive Equity Research Report 2023
[120] JP Morgan Chase, Automotive Equity Research Report 2023
[121] BNP Paribas, Automotive Equity Research Report 2023

ultimately considered more the high level of VW AG debt (tax shields) for the Enterprise Value "value creation". We remark that:

- WACC method implicitly captures the value of tax shields in the discount rate WACC. To extract the amount of EV% driven by tax shields, it is necessary to recur to Harrys and Pringle formula shown in *Paragraph 4.1.3*. It was so determined that, in FCF, cumulative tax shields contributed for 0.2% of EV and the PV of tax shields Terminal Value contributed for 9.7%;
- FTE method, considering levered cash flows to discount, does capture the value of tax shields, but we are not able to directly extract how much value is driven by them;
- APV method explicitly shows cumulative tax shields and the PV of tax shields Terminal Value, that are discounted by the appropriate Cost of Debt, and adds them to the Value of Unlevered Firm, previously obtained discounting its unlevered free cash flows by the unlevered COE. Through these steps, the Levered Value of the company is computed. It was so determined that, in APV, cumulative tax shields contributed for 2.7% of EV and the PV of tax shields Terminal Value contributed for 21.2%;
- the Multiple method does not allow a split into different value drivers. It is so impossible to exactly determine which % of the numerator (and only in the case that numerator is Enterprise Value) is driven by tax shields.

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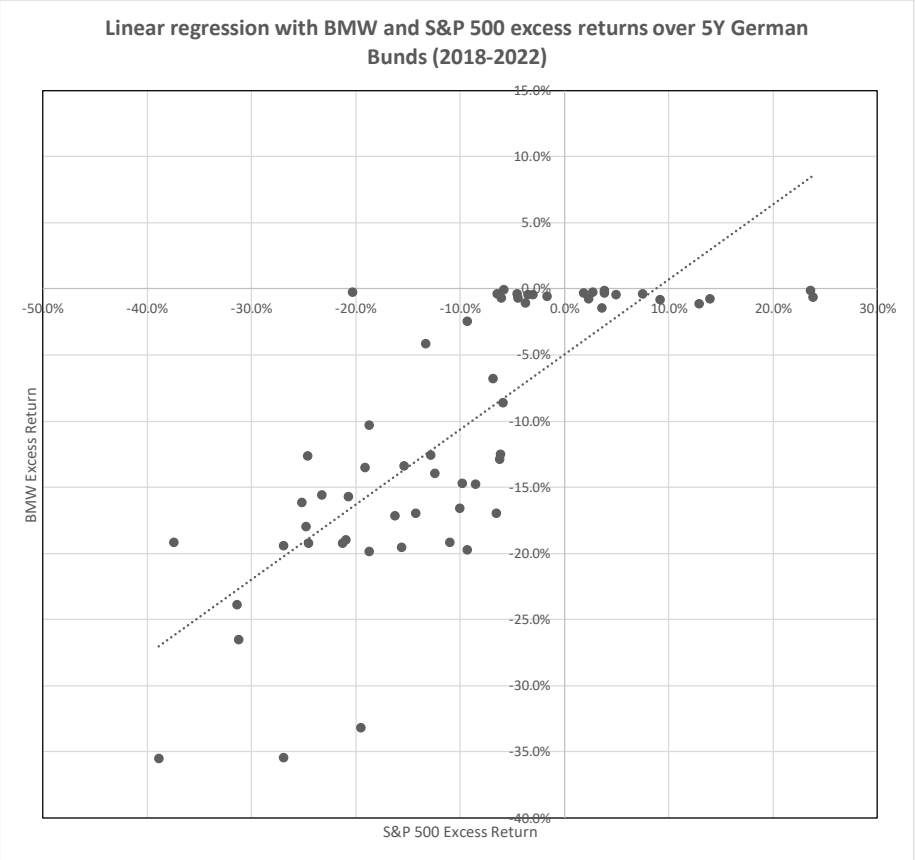
Appendix A

BMW		EXCESS RETURNS	
Date	Return	S&P 500	BMW
12/1/2022	-3.4%	-35.5%	-38.9%
11/1/2022	8.5%	-35.4%	-26.9%
10/1/2022	13.6%	-33.1%	-19.5%
9/1/2022	-4.7%	-26.5%	-31.2%
8/1/2022	-7.6%	-23.8%	-31.4%
7/1/2022	8.2%	-19.2%	-11.0%
6/1/2022	-2.0%	-13.3%	-15.3%
5/1/2022	2.7%	-8.6%	-5.9%
4/1/2022	-0.1%	-6.7%	-6.9%
3/1/2022	-9.2%	-4.1%	-13.3%
2/1/2022	-6.9%	-2.4%	-9.3%
1/1/2022	5.0%	-1.4%	3.6%
12/1/2021	4.1%	-0.3%	3.9%
11/1/2021	-2.6%	-0.4%	-3.0%
10/1/2021	5.4%	-0.4%	5.0%
9/1/2021	3.0%	-0.2%	2.7%
8/1/2021	-4.2%	-0.3%	-4.5%
7/1/2021	-6.1%	-0.3%	-6.4%
6/1/2021	7.9%	-0.3%	7.6%
5/1/2021	4.0%	-0.1%	3.9%
4/1/2021	-5.7%	0.0%	-5.8%
3/1/2021	23.7%	-0.1%	23.6%
2/1/2021	2.1%	-0.3%	1.8%
1/1/2021	-3.1%	-0.4%	-3.5%
12/1/2020	-1.1%	-0.5%	-1.7%
11/1/2020	24.5%	-0.6%	23.9%
10/1/2020	-5.3%	-0.7%	-6.0%
9/1/2020	3.1%	-0.7%	2.4%
8/1/2020	10.0%	-0.8%	9.2%
7/1/2020	-3.7%	-0.7%	-4.4%
6/1/2020	14.1%	-1.1%	13.0%
5/1/2020	-2.7%	-1.1%	-3.8%
4/1/2020	14.7%	-0.8%	14.0%
3/1/2020	-20.1%	-0.3%	-20.3%
2/1/2020	-8.4%	-10.3%	-18.7%
1/1/2020	-12.0%	-12.6%	-24.6%
12/1/2019	-0.2%	-12.5%	-12.8%
11/1/2019	6.7%	-12.8%	-6.2%
10/1/2019	6.4%	-12.5%	-6.1%
9/1/2019	6.2%	-14.8%	-8.5%
8/1/2019	-9.0%	-16.1%	-25.1%
7/1/2019	2.7%	-16.9%	-14.2%
6/1/2019	10.5%	-17.0%	-6.5%
5/1/2019	-18.3%	-19.1%	-37.4%
4/1/2019	10.4%	-19.7%	-9.3%
3/1/2019	-7.5%	-19.4%	-26.9%
2/1/2019	1.2%	-19.9%	-18.7%
1/1/2019	3.9%	-19.5%	-15.6%
12/1/2018	-2.1%	-19.2%	-21.3%
11/1/2018	-5.3%	-19.2%	-24.5%
10/1/2018	-1.9%	-19.0%	-20.9%
9/1/2018	-6.8%	-17.9%	-24.8%
8/1/2018	0.9%	-17.1%	-16.3%
7/1/2018	6.5%	-16.5%	-10.0%
6/1/2018	-5.0%	-15.7%	-20.7%
5/1/2018	-7.7%	-15.6%	-23.3%
4/1/2018	4.9%	-14.7%	-9.8%
3/1/2018	1.5%	-13.9%	-12.4%
2/1/2018	-5.6%	-13.5%	-19.1%
1/1/2018			

BETA	1.07
ALPHA	0.01
y = 0.01 + 1.07x	

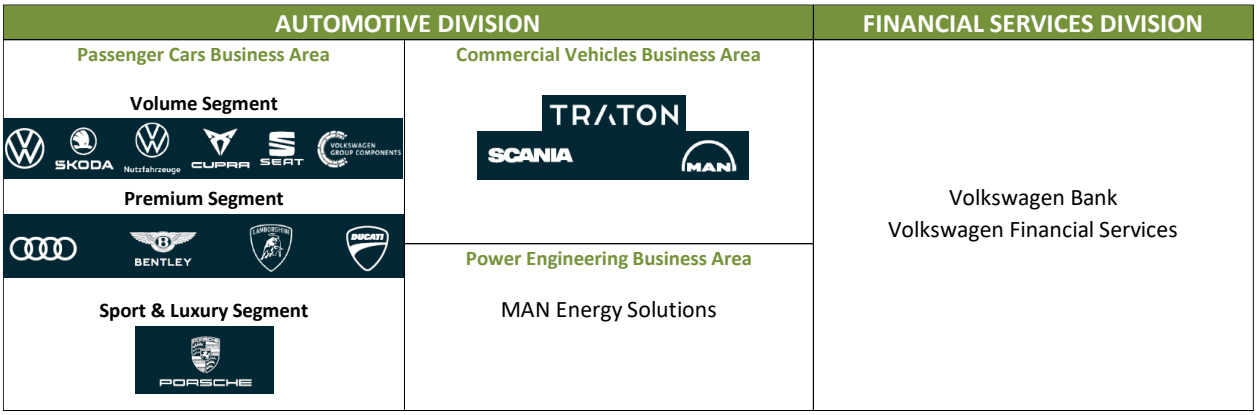


HOW CAPITAL STRUCTURE AND DEBT DRIVE VALUATION: AN EMPIRICAL STUDY ON VOLKSWAGEN AG

THESIS SUMMARY

Volkswagen Automotive Group

Volkswagen Automotive Group (VW AG) is the largest (by 2022 revenue) global vehicles manufacturer, founded in 1937 by the German government. Its headquarters are located in Wolfsburg, Germany. It is a public company, that was first listed on the in April 1961 on Wolfsburg stock exchange. Preference shares were introduced in September 1986. Volkswagen AG, at the end of 2022, is organized across two major divisions: Automotive Divisions and Financial Services Division. An overview of this structure, extracted from 2022 Company Report, is presented.

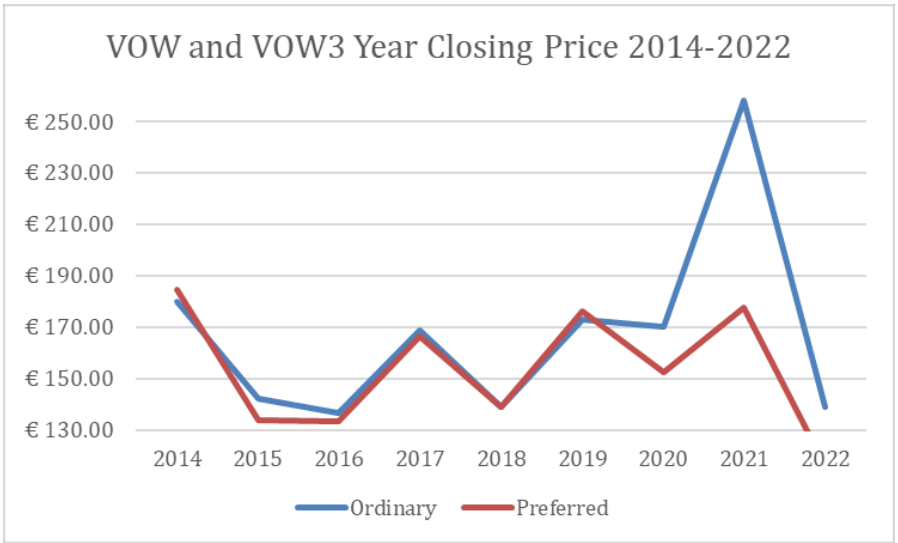


One of the most relevant events in Volkswagen recent history is the emission scandal spread in 2015. The USA Environmental Protection Agency found that the control procedures on all company vehicles' emissions were only activated and reported during laboratory testing (and so not during real road test). The implications of this approach adopted by Volkswagen was that, during laboratory tests, NOx emissions were 40 times lower than what would have been in road tests. After this unfairness was found also by other regulators several consequences had place: the stock price of the group felt, former Volkswagen AG CEO Martin Winterkorn resigned, the group was forced to retire 11 million of cars not respecting emission standards from the market and faced an overall penalty of USD 25.3 billion. However, recently, the group has committed itself to new goals for the future thanks to the NEW AUTO strategy that aims to guarantee more Battery Electric Vehicles.

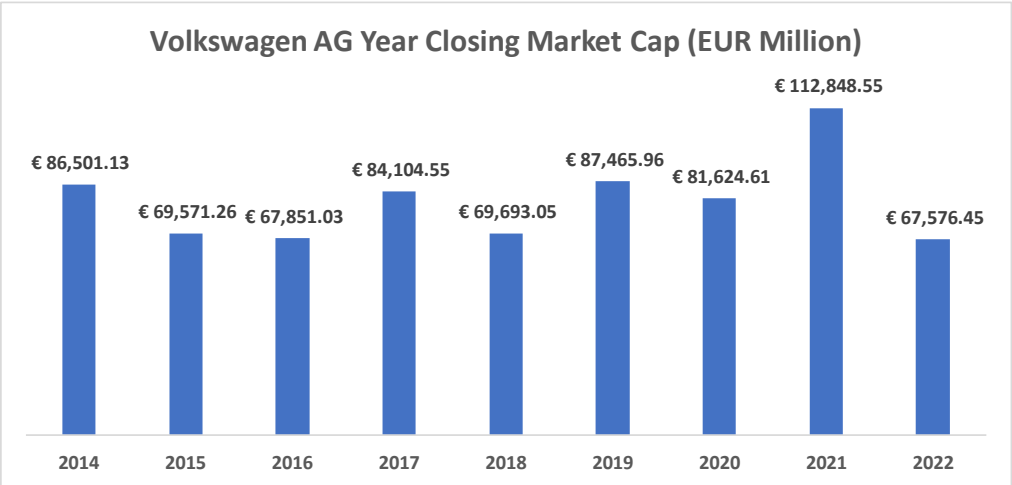
Focus on Market Capitalization

During the last decade the group has been characterized by a highly variable level of market capitalization. As example, while the closing market capitalization of year 2022 was of EUR 67,576.45 Million (given by the sum of the number of outstanding ordinary and preferred shares respectively multiplied by their 2022

closing price), the previous year market cap was almost 67% higher, reaching the all-time high. As previously stated, in 2015 the group was object of a scandal resulted in an ordinary shares price by decrease of 19% and a drop in market cap by EUR 14 billion. Market cap of the firm after faced an irregular modest increase until 2020, when the combination of the spread of COVID-19 and ship shortage impacted negatively newly on the share price of the stock, with a 10-year low of EUR 101 per ordinary share.

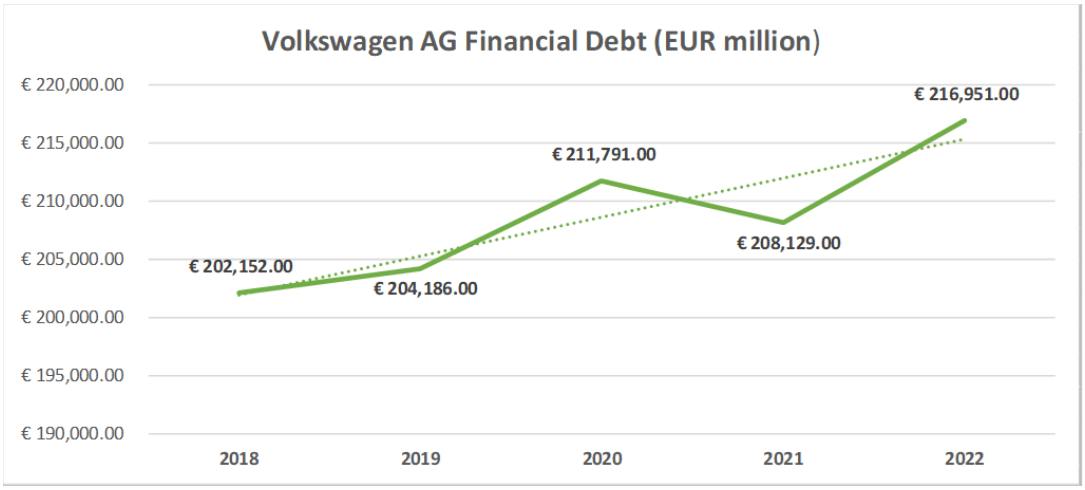


Only in 2021, when the rumored Porsche IPO was confirmed, the company ordinary shares benefitted of an all-time high of EUR 327 and its market cap return to pre-scandal levels. In 2022, despite the successful IPO of Porsche AG, the spread of the war in Ukraine and the consecutive implications for automotive producers and suppliers negatively impacted not only Volkswagen, but also its competitors, pushing down the 2022 closing market cap of the group at EUR 67,576.45 Million.

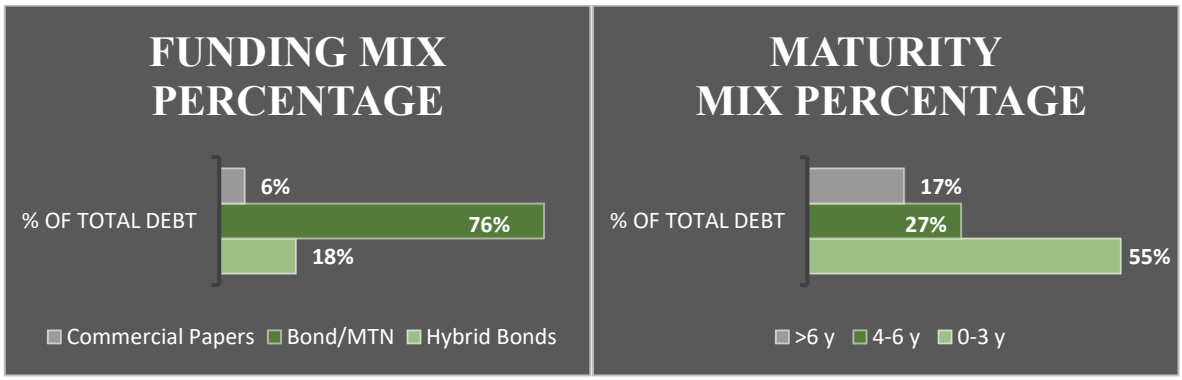


The automotive group's 2022 common shares closing price of EUR 147.65 looks too poor with respect to the huge investments made in the last few years by the company in the perspective of a Battery Electric

Vehicle transition. Recently, various stakeholder of the company, as the management and the State of Lower Saxony, one of the company's main shareholders, affirmed that the company was really undervalued according to their perspective. Moreover, also institutional investors and banks as BNP Paribas, JP Morgan, Morgan Stanley and Jefferies affirmed that the market is strongly undervaluing the potential of the German automaker. The main purpose of this final dissertation is so to carry a realistic valuation of the firm and state if the company is really undervalued. We will also investigate if and how the high level of debt (and so the tax shields generated by high interest expenses) can contribute to determine target price.
A special focus should be maintained also when it comes to the overall Financial Debt of the automotive maker. In fact, the group is one of the most indebted companies in the world and the company reporting the highest financial debt in Europe. The 2022 ending financial debt, calculated from the company's strategic Balance Sheet (and so considering only interest-bearing liabilities as financial), amounts to EUR 216.951 Million. In addition, over the past 5 years and due to the needs of financing for the construction of new generations plants and BEV R&D, VW AG debt has increased at a CAGR of 1.42%.



The majority of this debt, the overall 76%, is composed of Bond/Medium-Term Note. The remaining part of interest-bearing debt is formed by issued Hybrid Bonds (18%) and Commercial Papers (6%). We also denote a well-balanced debt maturity profile with focus on shorter duration: in fact, at 31/12/2022, 20.75% of overall company funding liabilities have maturity within 1 year, and 33,89% within 2025. 27% of outstanding debt will on the opposite face maturity between 4 and 6 years and remaining 17% is projected to face maturity after 6 years.

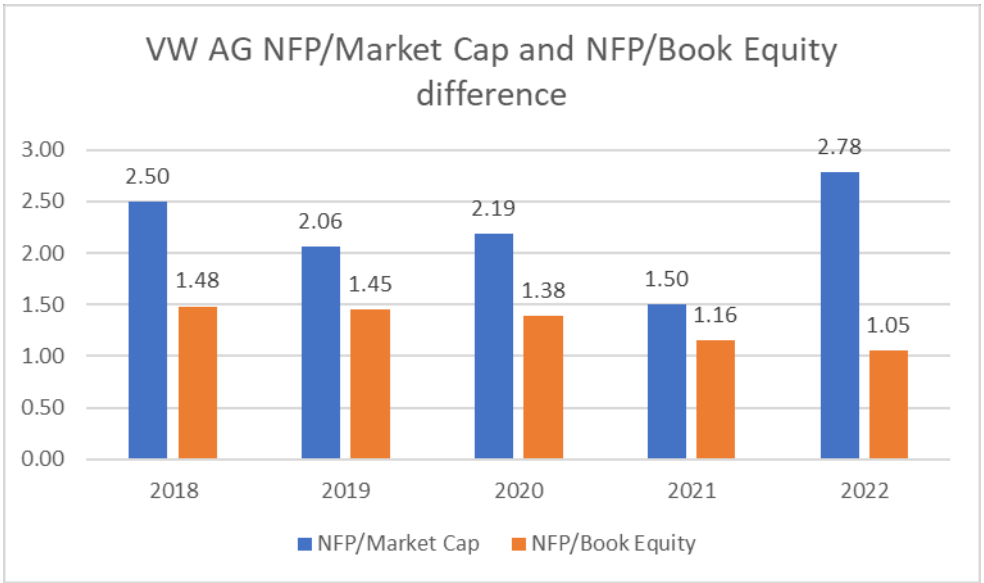


This final dissertation will so try to answer to the following questions:

- Are Volkswagen Automotive Group correctly/under/overpriced according to the main valuation methods?
- Which method highlights the most the benefits related to Interest Tax Shields and is the best to apply? Which method highlights them the less?
- Which are the advantages of Adjusted Present Value?

Focus on D/E Ratios

The below figure shows the effect driven by the combination of a high financial debt and an irregular and unstable Market Capitalization.



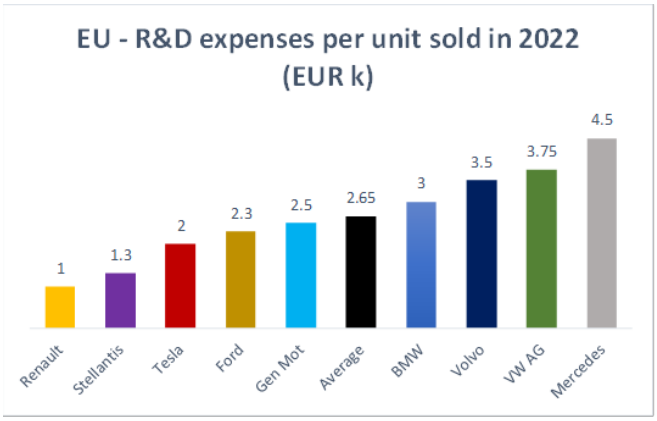
The difference among the two Net Financial Position to Equity ratios taking respectively in consideration Book Value of Equity and Market Capitalization is related to the controversial and difficult history of the group's stock performance. 2018-2022 Net Financial Position of the company is reported: for valuation purposes NFP is used as numerator in the D/E ratio formula.

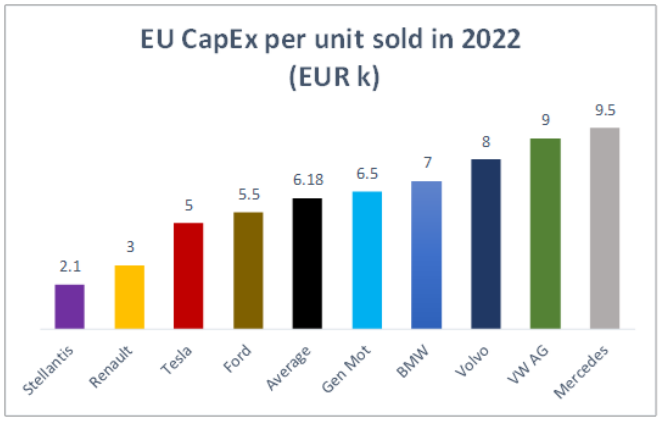
€ Million	31/12/2018	31/12/2019	31/12/2020	31/12/2021	31/12/2022
NFP	174,039.00	179,856.00	178,359.00	169,007.00	187,779.00
Average	**177,808.00**				

The optimal level of D/E Ratio varies by industry, but generally should not be more than 2. In this case, Volkswagen AG is above this level, with an average NFP ratio of 1.3 on Book Value of Equity but 2.2 on Market Value of Equity during the past 5 years. 2021 was the only year in which the two measures were comparable, when ordinary shares' closing market price of EUR 258.48 touched its all-time high. It is also important to highlight how the market D/E ratio of the company has been irregular across years. At the moment of hypothetic valuation (31/12/2022) and with a Net Financial Position of EUR 187,779 Million and a Market Capitalization of EUR 67,484 Million, the market D/E ratio is at its highest level ever at 2.78.

Focus on Operative Costs

In addition to the external factors that have impacted VOW (ordinary) and VOW3 (preferred) performance, the low price attributed to the group by the market could also be caused by some of its operative characteristics. In Fixed costs area, Volkswagen AG spends far more than peers as % of Sales and on both R&D and SG&A: the group spent on Fixed Costs is almost 17.50% of its Sales in 2022. Also, when it comes to costs related to the sale of a single unit, the group spends heavily more than its major US and European peers. In 2022, VW spent EUR 9,000 per unit sold on Capex against a peers' average of EUR 6,180 and EUR 3,750 per unit sold on R&D against a peers' average of EUR 2,650.



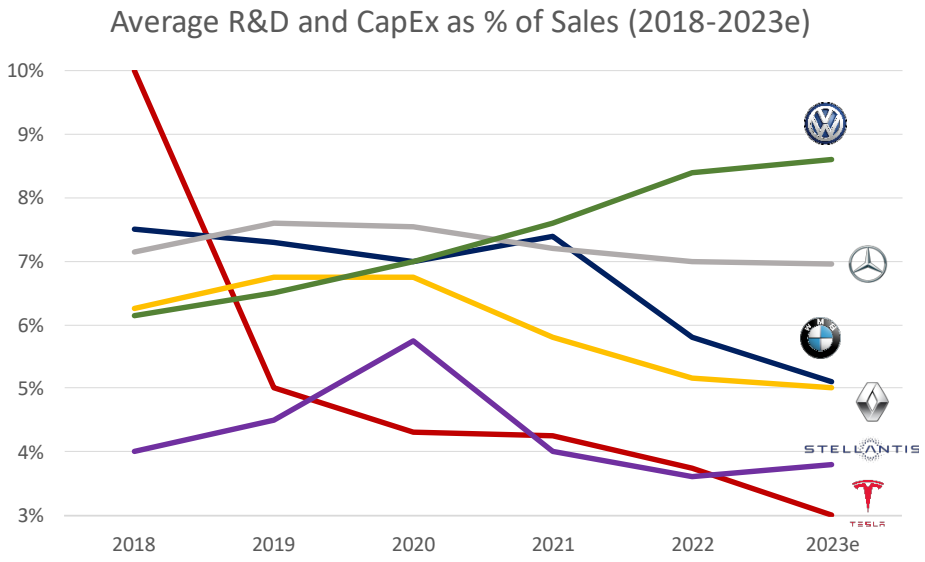


The reasons behind these high costs for Volkswagen, with respect to its main peers, could be both related to:

Scale & Complexity: some of the European competitors and Tesla have better positioning regarding the average volume sold per models. In particular, Tesla is characterized by an ultra-narrow model range consisting of merely two main products (Tesla Model 3 and Model Y).

PowerCo Plants Capital Expenditures and R&D expenses: while other automotive manufacturers decided to outsource/collaborate with partners for their production, Volkswagen went in the opposite direction. VW aims to fully produce its own batteries in the future and plans to build six battery giga factories in EU, North America and China. Spending much on insourcing for R&D and CapEx for new technologies (in particular Battery Electric Vehicle and Software) can have slowed cash flow generation in the long-term, but have a positive impact on mid and long-term earnings in the future. Given the fixed cost intensive nature of the company, it is strongly reasonable to believe that, once sales accelerates and the fixed costs spread gets better, earnings and cash flow could improve a lot.

The figure below is able to confirm our consideration about VW effort on investments: if we compare the average of R&D and Capex, as % of Sales, between 2018 and 2022 of the target with the other 5 European and US car manufacturers who have their business model more oriented on BE and new generation cars (Mercedes AG, BMW, Renault, Stellantis and Tesla) it is clear how Volkswagen has been the only company to continuously increase their ratio and not reduce it (WV 5.7% CAGR vs average CAGR of -6%).



Green Finance Framework

How to connect this high level of past, current and future investments for BEV development and giga factories plants, in the context of the NEW AUTO project? Are those high R&D and Capex related to the level of indebtedness of the group? Financing for investments needed for this purpose is strictly related to the Green Finance Framework. The Green Finance Framework is a project started by the group in March 2020. Green Finance Framework mainly consists in different issues of sustainable debt financial instruments contributing to the sustainable development of the company. Until the end of 2022, VW AG has issued Green bonds for a face value of EUR 3.5 billion, but it is now planning to go further. To completely align its production to the new EU manufacturing taxonomy and to invest in BEV that will generate more revenues in

the mid/long-term, the GFF will be used to link the Group's decarbonization goals with its financing strategy. Dr. Arno Antlitz, current CFO and COO of the group, has affirmed that the overall group will keep previous years' pace in relation to the emission of further Green bonds. From this information, it is correct to assume that in the next future, Change in Net Borrowings of the group will grow at least at previous year rate and the overall financial debt will increase. This approach is not only consistent with the objective of re-balancing revenues sources of the group toward BEV, but also to re-establish the group reputation after 2015 heavy scandal. Volkswagen is the third electric vehicle car maker by market share in 2022 (8.2%), just under BYD (18.4%) and Tesla (13%), but with the latters having their business model focused only on electric vehicles. As a more general cars manufacturer, VW Group aims to increase its market share in the next years.

Valuation

Yield to Maturity of the 10-year Germany's government bond in 2022 is taken as risk-free rate. We proceed to estimate the target's Beta, using the bottom-up approach. Peers' 5-year (2018-2002) horizon Levered Betas are estimated through a linear regression and their market D/E ratio are estimated trough a re-classification of their 2022 Balance Sheets, while tax rates are derived from their Income Statement's average tax rate between 2018 and 2022.

Company	Country	Levered beta	NFP/Market Cap	Tax rate	Unlevered beta (Hamanda)
Tesla, Inc	USA	1.66	0.19	14.6%	1.43
General Motors Company	USA	1.74	0.95	24.0%	1.01
Ford Motor Company	USA	1.63	2.03	23.0%	0.64
Ferrari NV	Italy	0.80	0.03	14.2%	0.78
Stellantis NV	Netherlands	1.27	1.52	27.1%	0.60
BMW AG	Germany	1.07	1.12	29.9%	0.60
Mercedes-Benz AG	Germany	1.26	1.30	24.1%	0.63
Volvo	Sweden	1.10	0.67	27.8%	0.74
Renault	France	0.71	1.30	34.0%	0.38
Hyundai Motor Company	South Korea	0.95	2.20	23.0%	0.35
Honda Motor CO	Japan	0.73	0.57	27.6%	0.52
Toyota Motor CO	Japan	0.57	0.91	27.1%	0.34
Nissan Motor CO	Japan	0.94	2.38	25.7%	0.34
Mazda Motor CO	Japan	1.33	1.51	23.4%	0.62
Suzuki Motor CO	Japan	1.06	1.48	25.0%	0.50
BYD Company Limited	China	0.64	0.70	16.9%	0.40
Bajaj Auto	India	1.12	1.65	32.0%	0.53
Median			1.30		0.60

The median peers' unlevered beta resulting from the table above is equal to 0.60. Volkswagen AG's Hamanda Levered Beta and Blume Levered Beta are after computed, taking as target D/E ratio the average of the group's 2022 ratio and the market median of its peers. The final Levered Beta is equal to 1.36.

Current NFP/Market cap VW AG	2.78
Peers' Unlevered Beta median	0.60
Target D/E Ratio	2.04
Hamanda Levered Beta	1.53
Tax Rate	23.60%
Blume Beta	**1.36**

After, all the relevant discount rates for the valuation are calculated. Levered Cost of Equity, equal to 13.47%, is originated trough the Capital Asset Pricing model: the used risk-free rate is equal always to the Yield to Maturity of the 10-year Germany's government bond in 2022, the Levered Beta is the one above mentioned and we take S&P 500 10-year annualized return as Market Return. Pre-Tax Cost of Debt of 3.27% is estimated taking advantage of the Synthetic Rating Approach, according to which the Default Spread applied to the company is 0.69%, the lowest possible. The WACC and the Unlevered Cost of Equity, used respectively for the WACC and the APV method, are equal to 6.11% and 7.40%.

Intrinsic Valuation

The first step to evaluate Volkswagen AG's Ordinary Shares according to intrinsic valuation methods is to project its 3 Financial Statements, its NWC Schedule, its Debt Schedule and CapEx and Depreciation Schedule for the forecasted period 2023-2027.

INCOME STATEMENT / P&L (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Revenue	**235,849**	**252,632**	**222,884**	**250,200**	**279,232**	**286,101**	**293,139**	**300,350**	**307,739**	**315,309**
YoY g%		7.1%	-11.8%	12.3%	11.6%	2.5%	2.5%	2.5%	2.5%	2.5%
COGS	(171,195)	(183,366)	(161,872)	(180,261)	(201,811)	(207,659)	(212,767)	(218,001)	(223,364)	(228,859)
Gross Profit	**64,654**	**69,266**	**61,012**	**69,939**	**77,421**	**78,442**	**80,372**	**82,349**	**84,375**	**86,450**
% of Rev	27.4%	27.4%	27.4%	28.0%	27.7%	27.4%	27.4%	27.4%	27.4%	27.4%
OpEx	(28,173)	(27,867)	(24,268)	(23,191)	(24,627)	31,276	32,046	32,834	33,642	34,469
EBITDA	**36,481**	**41,399**	**36,744**	**46,748**	**52,794**	**47,166**	**48,326**	**49,515**	**50,733**	**51,981**
% of Rev	15.5%	16.4%	16.5%	18.7%	18.9%	16.5%	16.5%	16.5%	16.5%	16.5%
D&A	(22,561)	(24,439)	(27,069)	(27,473)	(30,670)	(28,315)	(28,467)	(28,621)	(28,775)	(28,929)
EBIT	**13,920**	**16,960**	**9,675**	**19,275**	**22,124**	**18,851**	**19,859**	**20,894**	**21,958**	**23,052**
% of Rev	5.9%	6.7%	4.3%	7.7%	7.9%	6.6%	6.8%	7.0%	7.1%	7.3%
Interest expenses	(1,646)	(1,953)	(765)	(1,471)	(2,611)	(7,094)	(7,411)	(7,742)	(8,089)	(8,451)
Equity Acc Inv	3,369	3,349	2,756	2,321	2,395	2,395	2,395	2,395	2,395	2,395
EBT	**15,643**	**18,356**	**11,666**	**20,125**	**21,908**	**14,152**	**14,843**	**15,547**	**16,265**	**16,995**
Taxes	(3,489)	(4,326)	(2,843)	(4,698)	(6,208)	(3,335)	(3,498)	(3,664)	(3,833)	(4,005)
% of EBT	22.3%	23.6%	24.4%	23.3%	28.3%	23.6%	23.6%	23.6%	23.6%	23.6%
Net Income	**12,154**	**14,030**	**8,823**	**15,427**	**15,700**	**10,816**	**11,345**	**11,883**	**12,432**	**12,990**
% of Rev	5.2%	5.6%	4.0%	6.2%	5.6%	3.8%	3.9%	4.0%	4.0%	4.1%
Noncontrolling interests	17	143	(43)	46	393	393	393	393	393	393
Hybrid cap inv	309	540	533	539	576	576	576	576	576	576
VW shareholder's NI	**11,828**	**13,347**	**8,333**	**14,842**	**14,731**	**9,847**	**10,376**	**10,914**	**11,463**	**12,021**

BALANCE SHEET - USES (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Total Assets	**458,156**	**488,071**	**497,114**	**528,609**	**564,772**	**584,448**	**606,595**	**629,798**	**654,060**	**679,415**
Current Assets	**183,536**	**187,463**	**194,944**	**200,347**	**224,309**	**243,235**	**264,628**	**287,074**	**310,574**	**335,163**
Cash and cash equivalents	28,113	24,330	33,432	39,122	29,172	39,929	57,627	76,287	95,908	116,523
Other short-term financial assets	29,491	30,578	34,873	35,717	52,373	52,373	52,373	52,373	52,373	52,373
Accounts receivable	80,186	85,018	82,816	81,110	89,758	96,412	98,784	101,214	103,704	106,255
Inventory	45,745	46,742	43,823	43,725	52,274	53,789	55,112	56,468	57,857	59,280
Asset Held for Sale	1	795	0	673	732	732	732	732	732	732
Non-Current Assets	**274,620**	**300,608**	**302,170**	**328,262**	**340,463**	**341,213**	**341,966**	**342,724**	**343,486**	**344,252**
Fixed assets (PPE+intangible)	132,904	127,629	122,677	132,555	139,304	140,054	140,807	141,565	142,327	143,093
Lease Assets	43,545	48,938	50,686	59,699	59,380	59,380	59,380	59,380	59,380	59,380
Deferred Tax Assets	10,131	13,106	13,486	13,393	12,921	12,921	12,921	12,921	12,921	12,921
Other long-term	9,348	23,962	32,756	37,661	41,914	41,914	41,914	41,914	41,914	41,914
Financial Services Receivable	78,692	86,973	82,565	84,954	86,944	86,944	86,944	86,944	86,944	86,944

BALANCE SHEET - SOURCES (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Total Liabilities & Shareholders' Equity	**458,156**	**488,071**	**497,114**	**528,609**	**564,772**	**584,448**	**606,595**	**629,798**	**654,060**	**679,415**
Current Liabilities	**167,968**	**167,923**	**165,391**	**164,393**	**182,992**	**185,827**	**190,285**	**194,925**	**199,721**	**204,679**
Accounts payable	24,063	23,153	23,017	24,238	29,474	28,654	29,327	30,049	30,788	31,546
Other current liabilities	42,879	46,000	43,136	48,569	50,250	50,250	50,250	50,250	50,250	50,250
Short term financial liabilities	101,026	98,770	99,238	91,586	103,268	106,923	110,707	114,626	118,683	122,883
Non-Current Liabilities	**172,846**	**196,498**	**202,940**	**218,062**	**203,453**	**209,478**	**215,822**	**222,502**	**229,536**	**236,943**
Provisions and other liabilities	71,720	91,082	90,387	101,519	89,770	89,770	89,770	89,770	89,770	89,770
Long term financial Liabilities	101,126	105,416	112,553	116,543	113,683	119,708	126,052	132,732	139,766	147,173
Shareholder's Equity	**117,342**	**123,650**	**128,783**	**146,154**	**178,327**	**189,143**	**200,488**	**212,371**	**224,803**	**237,793**
Common equity	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283
Additional Paid in Capital	14,551	14,551	14,551	14,551	14,551	14,551	14,551	14,551	14,551	14,551
Retained earnings	91,105	96,929	100,772	117,342	137,267	148,083	159,428	171,311	183,743	196,733
Comprehenisve Income - Accumulated	(2,418)	(3,646)	(5,270)	(3,166)	(1,845)	(1,845)	(1,845)	(1,845)	(1,845)	(1,845)
Hybrid Financial Instruemnts	12,596	12,663	15,713	14,439	14,121	14,121	14,121	14,121	14,121	14,121
Minority Interests	225	1,870	1,734	1,705	12,950	12,950	12,950	12,950	12,950	12,950

NWC Schedule (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Accounts receivable	**80,186**	**85,018**	**82,816**	**81,110**	**89,758**	**96,412**	**98,784**	**101,214**	**103,704**	**106,255**
Days Sales Outstanding	124	123	136	118	117	123	123	123	123	123
Inventory	**45,745**	**46,742**	**43,823**	**43,725**	**52,274**	**53,789**	**55,112**	**56,468**	**57,857**	**59,280**
Days Inventory in Stock	98	93	99	89	95	95	95	95	95	95
Accounts payable	**24,063**	**23,153**	**23,017**	**24,238**	**29,474**	**28,654**	**29,327**	**30,049**	**30,788**	**31,546**
Average Payment Period	50	46	53	49	51	50	50	50	50	50
NWC	101,868	108,607	103,622	100,597	112,558	121,547	124,568	127,633	130,773	133,990
Change in NWC	**(8,127)**	**6,739**	**(4,985)**	**(3,025)**	**11,961**	**8,989**	**3,021**	**3,064**	**3,140**	**3,217**
Financial Services Receivable	78,692	86,973	82,565	84,954	86,944	86,944	86,944	86,944	86,944	86,944
Lease Assets	43,545	48,938	50,686	59,699	59,380	59,380	59,380	59,380	59,380	59,380
other relevant changes		1,553	17,715	(3,322)	7,133	0	0	0	0	0
Overall CHANGE IN NWC	7,272	21,966	10,070	5,055	20,765	8,989	3,021	3,064	3,140	3,217

Debt Schedule (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Short-term financial liabilities										
Beginning of period	88,301	101,026	98,770	99,238	91,586	103,268	106,923	110,707	114,626	118,683
Increase/Decrease	12,726	-2,256	468	-7,652	11,682	3,655	3,784	3,918	4,057	4,201
Rate of Increase/Decrease	14.4%	-2.2%	0.5%	-7.7%	12.8%	3.5%	3.5%	3.5%	3.5%	3.5%
End of period	101,026	98,770	99,238	91,586	103,268	106,923	110,707	114,626	118,683	122,883
Long-Term Financial Liabilities										
Beginning of period	88,402	101,126	105,416	112,553	116,543	113,683	119,708	126,052	132,732	139,766
Increase/Decrease	12,725	4,290	7,137	3,990	-2,860	6,025	6,344	6,680	7,034	7,407
Rate of Increase/Decrease	14.4%	4.2%	6.8%	3.5%	-2.5%	5.3%	5.3%	5.3%	5.3%	5.3%
End of period	101,126	105,416	112,553	116,543	113,683	119,708	126,052	132,732	139,766	147,173
Total change In Financial Borrowings	**25,450**	**2,034**	**7,605**	**(3,662)**	**8,822**	**9,680**	**10,128**	**10,598**	**11,091**	**11,607**
Interest Rate	0.93%	0.97%	0.37%	0.69%	1.25%	3.27%	3.27%	3.27%	3.27%	3.27%
Interest Payments	**(1,646)**	**(1,953)**	**(765)**	**(1,471)**	**(2,476)**	**7,094**	**7,411**	**7,742**	**8,089**	**8,451**

CapEx and D&A Schedule (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
BEGINNING FIXED ASSETS	136,457	132,904	127,629	122,677	132,555	139,304	140,054	140,807	141,565	142,327
D&A	**(22,516)**	**(24,439)**	**(27,069)**	**(27,473)**	**(30,670)**	**(28,315)**	**(28,467)**	**(28,621)**	**(28,775)**	**(28,929)**
CAPEX	**18,963**	**19,164**	**22,117**	**37,351**	**37,419**	**29,065**	**29,221**	**29,378**	**29,536**	**29,695**
ENDING FIXED ASSETS	**132,904**	**127,629**	**122,677**	**132,555**	**139,304**	**140,054**	**140,807**	**141,565**	**142,327**	**143,093**
D&A as % of Fixed Assets	16.5%	18.4%	21.2%	22.4%	23.1%	20.3%	20.3%	20.3%	20.3%	20.3%
CapEx as % of Fixed Assets	13.9%	14.4%	17.3%	30.4%	28.2%	20.9%	20.9%	20.9%	20.9%	20.9%

CASH FLOW STATEMENT (€ million)	Historical					Forecasted				
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Earnings before taxes	15,643	18,356	11,666	20,125	22,043	14,152	14,843	15,547	16,265	16,995
Cash Taxes	(3,084)	(2,846)	(3,765)	(3,910)	(3,453)	(3,335)	(3,498)	(3,664)	(3,833)	(4,005)
Depreciation	22,561	24,439	27,069	27,473	30,670	28,315	28,467	28,621	28,775	28,929
Change in NWC	27,848	21,966	10,070	5,055	20,765	8,989	3,021	3,064	3,140	3,217
Cash Flow from Operating Activities	**7,272**	**17,983**	**24,900**	**38,633**	**28,495**	**30,142**	**36,791**	**37,439**	**38,066**	**38,702**
Capex	(18,963)	(19,164)	(22,117)	(37,351)	(37,419)	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)
Other Cash Flow from investing activities	(2,627)	(1,982)	(574)	11,223	(4,402)	-	-	-	-	-
Cash Flow from Investing Activities	**(21,590)**	**(21,146)**	**(22,691)**	**(26,128)**	**(41,821)**	**(29,065)**	**(29,221)**	**(29,378)**	**(29,536)**	**(29,695)**
Capital contributions/capital redemptions	1,491	-	2,984	(1,071)	(235)	-	-	-	-	-
Dividends	(2,375)	(2,899)	(2,952)	(3,022)	(4,362)	-	-	-	-	-
Payout ratio	20.1%	21.7%	35.4%	20.4%	29.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Proceeds from debt/repayment of debt	25,450	2,034	7,605	(3,662)	8,822	9,680	10,128	10,598	11,091	11,607
Cash Flow from Financing Activities	**24,566**	**(865)**	**7,637**	**(7,755)**	**4,225**	**9,680**	**10,128**	**10,598**	**11,091**	**11,607**
Effect of Exchange Rates	(173)	243	(744)	942	(849)	-	-	-	-	-
Beginning cash	18,038	28,113	24,330	33,432	39,122	29,172	39,929	57,627	76,287	95,908
Increase/Decrease	10,075	(3,785)	9,102	5,692	(9,950)	10,757	17,698	18,660	19,621	20,615
Ending cash	**28,113**	**24,328**	**33,432**	**39,124**	**29,172**	**39,929**	**57,627**	**76,287**	**95,908**	**116,523**

WACC method

From 2023 EBITDA and D&A of the period, 2023 EBIT is obtained. After, the 23.6% Tax rate is applied directly on EBIT in order to obtain 2023 NOPAT (Net Operating Profit After Taxes), that measures the efficiency of a leveraged company operations net of taxes. Non-cash expenses D&A is after added back to NOPAT while the positive change in NWC with respect to 2022 and 2023 CapEx are subtracted. This process is repeated also for 2024, 2025, 2026 and 2027. Moreover, it is necessary to consider the cash flow that the firm will generate after the projection period "up to infinity", in the so-called Normalized Period. This step is necessary in order to compute the Terminal Value of the firm. Some adjustments for the Normalized Period are necessary: EBITDA is set at the 2027 level, D&A and Capex are set equal to 2027 Capex, the change in NWC is set equal to zero. Given that Volkswagen is a mature company, a growth rate of 1.00% has been set as its long-term g rate. The intrinsic share price obtained is EUR 188.8.

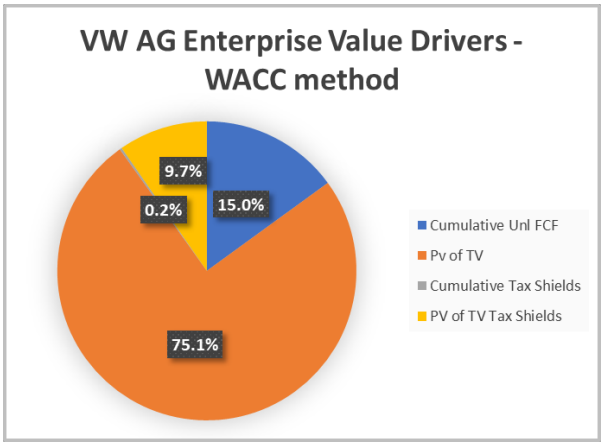
FCFF (€ million)	Forecasted					
	2023	2024	2025	2026	2027	Normalized
EBITDA	**47,166**	**48,326**	**49,515**	**50,733**	**51,981**	**51,981**
D&A	(28,315)	(28,467)	(28,621)	(28,775)	(28,929)	(29,695)
EBIT	**18,851**	**19,859**	**20,894**	**21,958**	**23,052**	**22,286**
TAXES	(4,443)	(4,680)	(4,924)	(5,175)	(5,433)	(5,252)
NOPAT	**14,408**	**15,179**	**15,970**	**16,783**	**17,619**	**17,034**
DEPR	28,315	28,467	28,621	28,775	28,929	29,695
D-NWC	(8,989)	(3,021)	(3,064)	(3,140)	(3,217)	-
CapEx	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)	(29,695)
Unl FCF	**4,670**	**11,403**	**12,148**	**12,882**	**13,636**	**17,034**

Discount Period	**1**	**2**	**3**	**4**	**5**	**5**
Discount Factor	94.2%	88.8%	83.7%	78.9%	74.3%	74.3%
Discounted Unl FCF	4,401	10,128	10,168	10,162	10,137	
PV of Unl FCF	**44,996**					
TV						336,723
Pv of TV	**250,327**					

EV	**295,323**
Net Financial Position	**187,779**
Minority Interest 2022	**12,950**
Pref Shares Value	**24,006**
Unfunded Pension Liabilities	**27,553**
Equity Investments	**12,668**
EQUITY VALUE	**55,703**

Oustanding Ordinary Shares	**295,089,818**
Intrinsic Ordinary Shares	**188.8 €**

In order to "extract" the tax shields from the WACC method, we must use the difference between the Present Values of the items contributing to the Enterprise Value at Pre-tax WACC and the WACC.



As visible from the above graph, the EV is driven only for the 0.2% by the Cumulative Tax Shields.

Flow to Equity method

The starting point with this valuation method is 2023 Net Income of the firm. Non-cash expenses D&A is after added back to Net Income while the positive change in NWC with respect to 2022 and 2023 CapEx are subtracted. 2023 Change in Net Borrowings with respect to previous year, representing a cash inflow, is added. This process is repeated also for 2024, 2025, 2026 and 2027. Moreover, it is necessary to consider the levered cash flow that the firm will generate after the projection period "up to infinity", in the so-called Normalized Period. This step is necessary in order to compute the Terminal Value of the firm. Some adjustments for the Normalized Period are necessary: Net Income is set at the 2027 level, D&A and Capex are set equal to 2027 Capex, the change in NWC is set equal to zero and the change in Net Borrowing is set equal to zero Given that Volkswagen is a mature company, a growth rate of 1% has been set as its long-term g rate. The intrinsic share price obtained is EUR 213.8.

FCFE (€ million)	Forecasted					
	2023	2024	2025	2026	2027	Normalized
Net Income	**9,847**	**10,376**	**10,914**	**11,463**	**12,021**	**12,021**
DEPR	28,315	28,467	28,621	28,775	28,929	29,695
D-NWC	(8,989)	(3,021)	(3,064)	(3,140)	(3,217)	-
CapEx	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)	(29,695)
Change In Net Borr	9,680	10,128	10,598	11,091	11,607	-
Lev FCF	**9,788**	**16,729**	**17,691**	**18,652**	**19,646**	**12,021**

Discount Period	**1**	**2**	**3**	**4**	**5**	**5**
Discount Factor	88.1%	77.7%	68.4%	60.3%	53.2%	53.2%
Discounted Lev FCF	8,626	12,992	12,108	11,250	10,442	
PV of Lev FCF	**55,419**					
TV						97,338
Pv of TV	**51,739**					

Equity Value	**107,157**	**Intrinsic Ordinary Shares**	**213.8 €**

In the particular case of FCFE valuation, considering that the object of our analysis are Levered FCFs, so cash flows directed only to Equity holders and after interest payments, we are not able to extract how much value is generated from Tax Shields.

Adjusted Present Value method

In the APV model, the cash flow projection is the same as the one explained for the WACC method. However, the Unlevered Free Cash Flows will not be discounted by the WACC but by the Unlevered Cost of Capital than in this case is the firm Unlevered COE. Cumulative Unlevered Cash Flows and the Terminal Value are after discounted for their correct Discount Factor. In this way, we obtain the Levered Value of the firm. We are only missing the estimation of the Present Value of the tax benefits associated with VW AG's

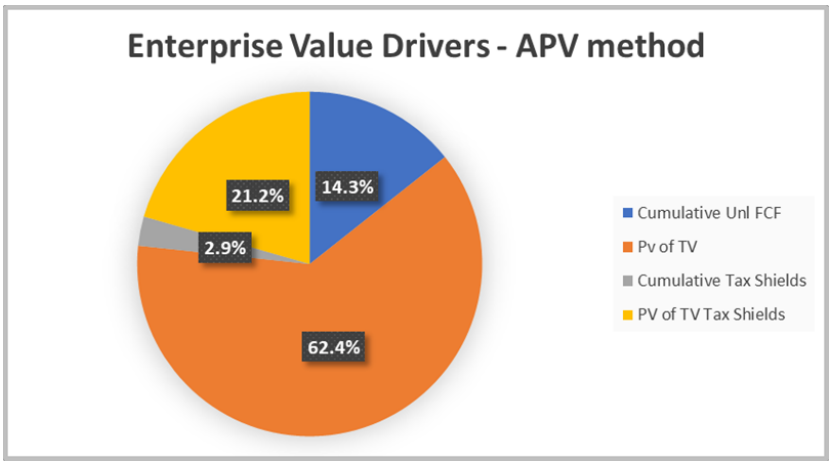
Financial Interest Expenses. We will so take the Financial Interest expenses for each projected year and multiply them by the tax rate, obtaining the tax shields after discounted by the respective discount factor. We will after take Financial Interest expenses for year 2027 and get Tax Shield TV, that will after be discounted by year 5 discount factor. Summing the present value of the cumulative tax benefits and the present value of the TV Tax Shield to the Unlevered Firm Value previously obtain, we get the Levered Value / Enterprise Value of the company. The intrinsic share price obtained is EUR 210.6.

APV (€ million)	Forecasted					
	2023	2024	2025	2026	2027	Normalized
EBITDA	**47,166**	**48,326**	**49,515**	**50,733**	**51,981**	**51,981**
D&A	(28,315)	(28,467)	(28,621)	(28,775)	(28,929)	(29,695)
EBIT	**18,851**	**19,859**	**20,894**	**21,958**	**23,052**	**22,286**
TAXES	(4,443)	(4,680)	(4,924)	(5,175)	(5,433)	(5,252)
NOPAT	**14,408**	**15,179**	**15,970**	**16,783**	**17,619**	**17,034**
DEPR	28,315	28,467	28,621	28,775	28,929	29,695
D-NWC	(8,989)	(3,021)	(3,064)	(3,140)	(3,217)	-
CapEx	(29,065)	(29,221)	(29,378)	(29,536)	(29,695)	(29,695)
Unl FCF	**4,670**	**11,403**	**12,148**	**12,882**	**13,636**	**17,034**

Discount Period	**1**	**2**	**3**	**4**	**5**	**5**
Discount Factor	93.1%	86.7%	80.7%	75.2%	70.0%	70.0%
Discounted Unl FCF	4,348	9,887	9,807	9,683	9,543	
Cumulative Unl FCF	**43,267**					
TV						268,894
Pv of TV	**188,192**					
Discount Factor	96.8%	93.8%	90.8%	87.9%	85.1%	85.1%
Financial Expenses	(7,094)	(7,411)	(7,742)	(8,089)	(8,451)	
Tax Shields	1,672	1,747	1,825	1,906	1,992	
PV of Tax Shields	1,619	1,638	1,657	1,676	1,696	
Cumulative Tax Shields	**8,285**					
TV Tax Shields						88,619
PV of TV Tax Shields	**62,022**					

EV	**301,766**
Net Financial Position	**187,779**
Minority Interest 2022	**12,950**
Pref Shares Value	**24,006**
Unfunded Pension Liabilities	**27,553**
Equity Investments	**12,668**
EQUITY VALUE	**62,145**

Oustanding Ordinary Shares	**295,089,818**
Intrinsic Ordinary Shares	**210.6 €**



As visible from the above graph, the EV is driven for the 2.9% by the Cumulative Tax Shields that, despite being still a low percentage, is more than 10 times the percentage obtain in the DCF method.

Relative Valuation

Refinitiv is still used as source of data to analyze and important peers' balance sheets, re-organize them according to a financial/operating criteria and extract relevant measures: their EV, EBIT, EBITDA, NET INCOME, BOOK VALUE OF SHAREHOLDERS' EQUITY and MARKET CAPITALIZATION. We after compute 2 Multiples related to the Asset side, using EV at the numerator and an income measure as EBIT and EBITDA at the denominator (proxies of FCFs for both shareholders and debt holders); and 2 Multiples related to the Equity Side, using Price at the numerator and Net Income per Share or Book Value of Equity per Share at the denominator.

MULTIPLES		ASSET SIDE		EQUITY SIDE	
Company	Country	EV/EBIT	EV/EBITDA	P/E	P/BV
Tesla, Inc	USA	26.6	21.2	30.9	8.6
General Motors Company	USA	13.7	3.2	7.7	1.2
Ford Motor Company	USA	22.4	10.1	2.6	1.1
Ferrari NV	Italy	37.2	25.7	47.3	17.0
Stellantis NV	Netherlands	0.8	0.7	2.6	0.6
BMW AG	Germany	8.9	5.5	3.1	0.6
Mercedes-Benz AG	Germany	8.7	4.9	4.5	0.8
Volvo	Sweden	10.0	5.4	11.8	2.3
Renault	France	19.7	6.7	5.7	0.3
Hyundai Motor Company	South Korea	13.4	8.4	5.0	0.4
Honda Motor CO	Japan	12.2	5.1	7.1	0.6
Toyota Motor CO	Japan	19.0	10.9	12.5	1.0
Nissan Motor CO	Japan	13.6	6.0	7.3	0.1
Mazda Motor CO	Japan	4.9	2.8	5.4	0.5
Suzuki Motor CO	Japan	7.3	4.8	10.7	0.9
BYD Company Limited	China	35.6	17.9	39.3	4.7
Bajaj Auto	India	21.3	18.5	11.6	4.5
Median		13.6x	6.0x	7.3x	0.9x
Average		16.2x	9.3x	12.7x	2.7x

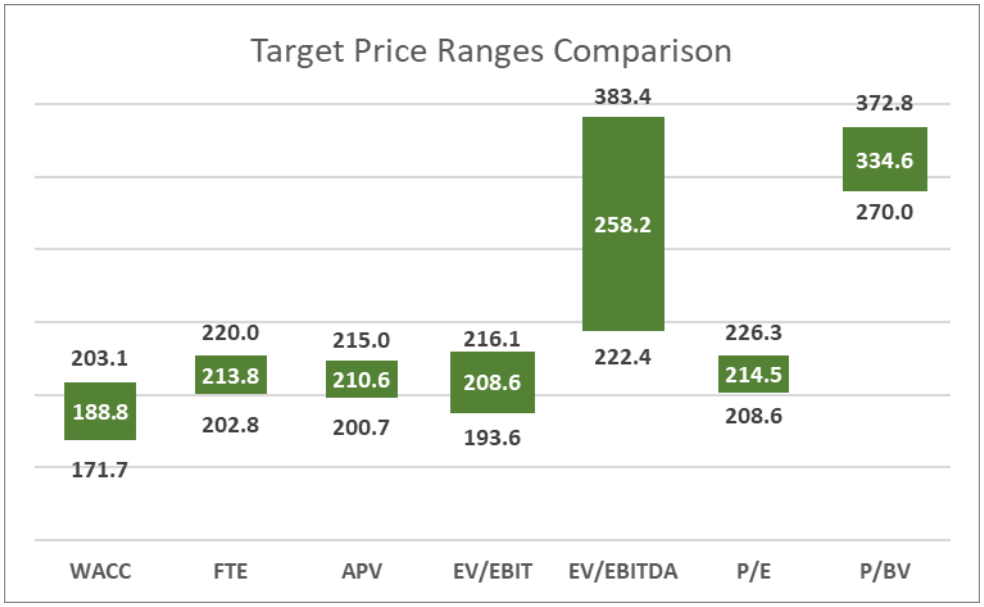
The different implied prices, coming from different multiples, are presented:

Multiple	Median Multiple Value	VW AG Metric	Implied Price
EV/EBIT	13.6x	22,124	208.6 €
EV/EBITDA	6.0x	52,794	258.2 €
P/E	7.3x	14,731	214.5 €
P/BV	0.9x	178,327	334.6 €

Comparison Of Results And Conclusion

First, we can with certainty affirm that 2022 closing VW ordinary shares, according to the empirical analysis carried in this final dissertation, are undervalued. The closing price of EUR 147.65 does not reflect the fair

value of the company. This has been detected as true both in the context of intrinsic valuation and when it comes to relative valuation methods, as visible from the "Football Field" below.



As emerging from the comparison, different valuation methods lead (obviously) to different results, especially in the case of a practical approach. Our intention is to understand which valuation range and method is the most reliable among the others. It is evident how market multiples EV/EBITDA and P/BV resulted in too high ranges with respect to others. EV/EBITDA is not an appropriate multiple to use when it comes to company with huge CapEx as the ones in the automotive sector and the fact that EBIT recognizes D&A may it a more accurate measure of value. P/BV is not completely reliable in case peers and target present, as in our case and previously discussed, a huge difference between book value of equity per share and market price per share. The remaining two multiples are EV/EBIT and P/E. The difference between the two is that the latter is dependent from the financial structure of the company. EV/EBITDA, not considering the huge CapEx of VW AG, leads to a too broad and high price range (EUR 222.4 – 383.4) while P/BV (EUR 270.0 – 372.8), despite being a good ratio for manufacturing companies with important assets, multiplies for the Book Equity of the group that is 2.64 bigger than its market value. The ranges to take in consideration are so the ones given by EV/EBIT (EUR 193.6 – 216.1) and P/E (range EUR 208.6 – 226.3). Among the intrinsic methods, APV (EUR 210.6) is the closer to these results. On the other side, WACC (EUR 188.8) gives too distant output. Flow to Equity Method (EUR 213.8) resulted closer to APV method, despite the fact it is not able to show the amount of value generated by tax shields. Moreover, APV and FTE results (and EV/EBIT and P/E) are closer to the output of institutional equity research reports for Volkswagen Automotive Group valuation at the end of 2022: Bank of America reports a target price for ordinary shares of EUR 211.0, JP Morgan reports a fair price of EUR 203.0, stating that the company is undervalued and BNP Paribas reports a fair price of EUR 207.5. The APV method overcomes the assumption of a constant D/E ratio (at least in the explicit period) and focuses on the actual development of

the financial structure over time, reducing the level of approximation in the valuation process. This approximation can be significant in companies recording significant changes in debt level with respect to the value of the firm or market capitalization level. Using WACC we underestimated by 21.3% the value of the company, with respect to APV. For what concerns FTE valuation, despite the result was closer to APV, it still presents some drawback in considering a constant Levered COE for all the projected period (and so still a constant D/E ratio). In fact, while the intrinsic price obtained in the APV method will stay fixed at the fluctuation of the target D/E ratio and depends only on Unlevered COE (Unlevered Beta), the price obtained in the FTE method will change depending on the chosen target financial structure since discounted by Levered COE (Levered Beta).

We demonstrated the stronger reliability of the Adjusted Present Value Method over the Flow to Firm and Flow to Equity method, when it comes to companies with an unstable and unpredictable market financial structure. After having confirmed our dissertation hypothesis that Volkswagen Automotive group ordinary shares are highly undervalued at 31/12/2022, it is important to conclude also which is the valuation method that ultimately considered more the high level of VW AG debt (tax shields) for the Enterprise Value "value creation". We remark that:

- WACC method implicitly captures the value of tax shields in the discount rate WACC. To extract the amount of EV% driven by tax shields, it is necessary to recur to Harrys and Pringle formula. It was so determined that, in FCF, cumulative tax shields contributed for 0.2% of EV and the PV of tax shields Terminal Value contributed for 9.7%;
- FTE method, considering levered cash flows to discount, does capture the value of tax shields, but we are not able to directly extract how much value is driven by them;
- APV method explicitly shows cumulative tax shields and the PV of tax shields Terminal Value, that are discounted by the appropriate Cost of Debt, and adds them to the Value of Unlevered Firm, previously obtained discounting its unlevered free cash flows by the unlevered COE. Through these steps, the Levered Value of the company is computed. It was so determined that, in APV, cumulative tax shields contributed for 2.7% of EV and the PV of tax shields Terminal Value contributed for 21.2%;
- the Multiple method does not allow a split into different value drivers. It is so impossible to exactly determine which % of the numerator (and only in the case that numerator is Enterprise Value) is driven by tax shields.