

POLITECNICO DI TORINO

M. Sc. In Engineering and Management - Finance

Master's Thesis

Bond Risk Assessment from Fundamental Analysis to Portfolio Optimization



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INTRODUCTION

The present Master Thesis regards Bond Risk management, providing an overall perspective of each one of its components. The main topic of the central part is the assessment of Credit Risk, while in the final part the focus switches to portfolio management, with the application of optimization models to bond portfolios.

“Credit Risk” is a quite simple notion, completely understandable even by people without any specific knowledge in Economics, as most citizens have to deal with it on a daily basis, since developed societies and economic systems are based on the concepts of trust and credit.

It is in fact defined as the probability that an entity, either a single person or a global corporation, may not meet its financial obligation: in simple words, the aforementioned entity is not able to return the money it borrowed to the lender, which would see its credit instantly becoming worthless, with potentially catastrophic effects.

The debt institution played a leading role in the growth of the modern developed countries, allowing every economic entity to resort to borrowing in order to finance their businesses, sometimes creating giant corporations and leading to a more dynamic economic environment, sensibly improving the overall well-being.

Actually, the concept of lending and borrowing money is almost as old as humanity itself, as the first recorded evidence of a debt system dates indeed back to 3500 BC, in the Sumer Civilization, in the historical region of southern Mesopotamia.

Then the debt system vastly appears in the Bible, in ancient Israel, in the Greek and Roman civilizations, and in the Eastern great empires such as China and India. Over the years many ethical concerns have arisen around the practice of lending money to get interest payments from the borrower, and many religions, including the Christian one, consider it deeply immoral.

Some authors even identify debt as the first means of trade ever used, with cash and barter transactions being later developments ⁽¹⁾. Even though this thesis is in contrast with the universally accepted standard economic theory, debt has been undoubtedly embedded in the economic system since the beginning.

Consequently, it is natural to understand why it has always been so important to determine if the one asking for money to borrow would be able, or willing, to return it back to the lender, along with the defined interest payment, once the debt contract would come to its maturity.

The debt institution is also prone, by nature, to be exploited by multiple sorts of criminals, which in several cases disappeared with the borrowed money, leaving the lender with a worthless credit - the infamous “long firm fraud”-. On the other hand, in history, several delinquents and criminal organizations have lent money to desperate people asking for exaggerated interests -a crime called usury - with the ultimate purpose of taking possession of their goods, using threats and violent retaliations to be satisfied in their dishonest requests.

Even though this thesis doesn’t focus specifically on the ethical and legal aspect of debt, merely measuring the credit risk without taking into account possible frauds and assuming that the borrower, if able, will pay its debt, the reader will certainly have understood why it is so fundamental for a healthy society to submit the debt institution to some kind of control.

The necessity to assess the capital solidity of the borrower and to satisfy the creditors as much as possible in case of insolvency has gradually brought to the modern system, where every economic entity willing to borrow money must submit itself to strict surveillance and must demonstrate to be a trustworthy counterpart.

In the ancient societies it was a common practice to draw up lists of so-called Bad Payers, people which in their past had contracted a debt without paying it back, and it was nothing but a primitive form of creditworthiness assessment.

With the rapid progress of global economy and finance, the rise of more complex economic entities and the introduction of more sophisticated instruments to borrow money, the control on debt-seekers has also gone through a massive evolution process.

In particular, the opportunity to borrow money on the public markets, through various kinds of bonds - a financial instrument which will be described in detail in the first chapter – allowed the borrower to operate without a defined counterpart possessing the means and the specific interest to effectively control the bond issuer and discipline it.

This uncertainty used to be a problem for the lenders, but also for the bond issuers, because retail investors, scared by the accentuated information asymmetry, would not have lent them money except for the promise of enormous interests. The solution has been found in more transparent capital markets and in the introduction of the concept of Rating.

The rating process is an assessment run on those companies, mainly public but it could be also applied -on private ones- which are interested in borrowing money, either by issuing bonds or, more rarely, using loans. The firm is submitted to a thorough analysis, examining *in primis* its balance sheets, to calculate ratios, to forecast future cash flows and to determine its financials, then concentrating on several different internal and external factors.

The analysis is then concluded with the assignment of a grade, precisely called Rating, which will be used by investors to determine if they are willing to lend their money to the company, and, if so, which would be a fair return on their capital considering the risk they choose to assume.

The creation of the Rating agencies, financial companies whose core business is precisely to rate companies, have provided both investors and issuers with entities gathering some of the most skilled and prepared analysts, which have started to act as hopefully impartial judges of companies' creditworthiness in global markets.

However, even these companies are not completely beyond their own interest and they have sometimes made mistakes. The saddest and most notorious one is certainly the Global Crisis, leading credit agencies to face heavy criticism by the public opinion, questioning the evident conflict of interest in their business relationships with firms.

It is here that the focus of this dissertation starts to take form: Credit Risk will be thoroughly analyzed in every aspect, broadly introducing the debt market and the fixed income, and eventually running an analysis applying methodologies actually used in real business world.

in fact, in addition to the academic research work previously anticipated, this paper will benefit from the expertise of Tosetti Value S.I.M Spa, an Italian company operating in the wealth management sector.

One of the company's core businesses is indeed investing in fixed income. For this purpose, it developed its own independent scoring method, thanks to the high-level of experience in big companies of its board members, with the goal of providing a different point of view, which gets eventually compared to the big rating agencies' evaluations.

Moreover, a complete peer analysis of competitor public companies will form the central part of the dissertation, running a complete assessment in order to determine which titles are worth investing in.

This process will be reported from a real working environment, and it will be used to make decisions over actual investments on the capital markets, under the supervision of a skilled professional. The assessment will be showing as clearly as possible how an actual company, in a real business environment, deals with Credit Risk while managing its customers' money.

The final part will instead be more quantitative and more experimental: it arises from the idea of extending the quantitative optimization models, elaborated over the last decade and widely used for equities, to bond portfolios, in order to facilitate the risk management, discussing their suitability for a potential application to real customers' portfolios.

1. DEBT AND CREDIT RISK: THE BACKGROUND

1.1 An Overview of Business Financing: The Pecking Order

To successfully compete and grow in a challenging environment, every organization, including Governments, needs to collect money to finance its business activity. It is possible to identify three main options among which the entity must choose.

The Pecking Order Theory, originally suggested by Donaldson in 1961 and later modified by Myers and Majluf in 1984, ranks the three forms of business financing basing on their cost for the enterprise, deriving from different levels of information asymmetry, causing an imbalance in transactional power.

The following paragraphs will briefly describe the difference between the three methodologies, from the least to the most expensive.

1.1.1 Internal Financing

It consists in the enterprise using retained earnings to finance its future activities. This is the least expensive choice, as it does not imply any information asymmetry, so it does not require any compensation for the risk such as interest payments. According to the Pecking Order Theory, every company should resort to self-financing as much as possible, but it is not always an available way. In fact, it implies the shareholders renouncing to dividends in order to achieve larger, but uncertain, future earnings. Moreover, self-financing is not available if the company is not achieving positive earnings, making it impossible to rely on internal financing when the company is in its early stage, or when it is going through hard times.

1.1.2 Debt

It basically consists in borrowing money in the present from one or more entities, to eventually return it in the future. In addition to the initial capital, the borrower is charged with interests, which cover the opportunity cost the lender incurs by renouncing the chance to invest its capital, giving up a potential return. This financing form is more expensive than internal financing, since the lender cannot be absolutely sure the borrower will honor its obligation, either because its business activity failed or for any other reasons. This information asymmetry creates a risk, the Credit Risk, which must be fairly remunerated by the borrower.

In addition, a higher debt leads to a higher default probability, which must be considered while calculating the actual cost of debt.

There are two main instruments an entity could use to get into debt.

- **LOANS:** the company receives the required amount of money from a bank, committing to progressively return the borrowed capital along with interests, usually defined in advance by the two counterparts. The exact repayment structure varies from a contract to contract. This is the most popular form of debt financing in Bank-Centered economic systems, such as continental Europe.
- **BONDS:** a bond is a financial instrument through which an institution can borrow money on the public markets. The institution divides the capital it needs to raise in several smaller parts, each one represented by a bond, which can be bought by investors on specific

markets, lending money to the company and becoming the owners of a financial obligation, i.e. the right to receive future payments with an entity and a timing defined by the contractual form of the bond. Of course, these instruments are securities to all effect, and thus they are tradable in the secondary market, so that the buyer obtains the right to receive the payments in the future paying a certain price in the present. This is the most common form of debt in Market-Centered Systems like the US and the UK.

1.1.3 Equity

According to the Pecking Order Theory, it is the last option the management should consider while determining how to finance future projects.

It consists in issuing new stocks, offering them to the public markets, where the investors could decide to buy them, entering to all effect the capital structure, or increasing their shares if they already were shareholders.

New Equity is the most expensive form of business financing, since the shareholders are the least protected stakeholders of the company, being remunerated only after every other interest has been satisfied. Through buying shares, an investor completely accepts the enterprise risk: he will realize a return on his investment only if the company performs as well as expected, and he could potentially lose his entire capital in case of default.

Considering one of the most popular financial notions, according to which to a higher risk must correspond a higher return, investors ask for a higher return for buying stocks instead of sticking to the safer fixed income markets.

Nevertheless, the main reason for the higher cost of financing through new equity lies once again in the concept of information asymmetry. The shareholders can evaluate a company through the information they can find from the outside, but they don't have an internal overview as precise as the management's one.

Several researchers have investigated the interest conflicts between management and shareholders, the so-called agency problems, which could sometimes incentivize the managers to maintain as much uncertainty as possible on their activity inside the enterprise and on their result, in order to avoid any kind of control and pursue their self-interest instead of the property's one.

As clearly demonstrated by several theories, the agency problems lead to sub-optimal resource allocation and business choice, even though there are some solutions, such as incentivizing contracts and controlling functionaries, but then who controls the controller? ⁽⁴⁾.

In conclusion, the management itself pays its information asymmetry advantage by sustaining a higher cost of equity, since the potential shareholders, aware of their disadvantage and knowing the destiny of their entire investment will depend on the decisions of potentially dishonest managers, demand a discount on share price as massive as the disadvantage they think to be suffering because of information asymmetry.

Managers usually try to mitigate the effect of agency problems by accepting a stricter control by independent audit companies, in order to communicate transparency and make the investors feel more confident about the company, so that they may accept to pay a higher price while buying new equity. In addition to giving as many information as possible to the markets, managers also need to show their personal commitment and interest alignment with the property. To do so, they usually accept very incentivizing payment schemes, where the main part of their salary is conditioned by the company's performance, and they become shareholders themselves through stock options.

The last reason which makes equity issuing the most expensive and least convenient form of financing must be researched in the market dynamics. The price of the stocks, and consequently the capital a potential buyer must invest in the company in order to buy shares, is variable and it is correlated to the market sentiment towards the company.

The announcement of a capital increase is not usually a positive news for the markets ⁽⁵⁾, and it generally leads to a reduction of the share price, reducing the amount of capital the company is able to raise with the same capital dilution. The capital dilution itself could also be a problem in certain conditions, since it could reduce the voting power of existing shareholders among the shareholders' meetings.

1.2 Fixed Income

The term Fixed Income indicates those financial instruments which grant a pre-determined and fixed flow of regular payments to their holder, so it basically refers to the bonds.

The bond market's main function is simply setting the price of borrowing and lending, and it is affected by macroeconomic factors, primarily interest rates and inflation. It is worth about 78 trillion dollars, more than the world GDP and the world Stock Market, hence it is the biggest financial market in the world.

The biggest bond market is the one related to government bonds, also called Sovereign Debt Market, through which every government borrows money to afford its enormous expenses and to finance its deficit. The total amount of government bonds outstanding issued by a country is defined as the country's public debt.

Countries may also decide to trade bonds to keep the value of their home currency under control: selling bonds means accumulating reserves to protect home currency against inflation, while buying foreign bonds, usually from US government, selling their currency, weakens it in order to stimulate the economic system.

Bonds can also be issued by companies, to raise capital through debt and increase their financial leverage, potentially raising the return on their equity and benefit from the tax shield.

US government bonds, anyway, are considered the safest form of fixed income investments, so that their yield is used as risk-free rate, i.e. the return an investor could obtain on the financial markets without risk, applied in almost any financial model.

The next paragraph illustrates the pricing of a bond and yield calculation from a simple academic point of view, that is assuming the borrower will certainly meet its obligations, ignoring therefore the credit risk, which will be introduced afterwards.

1.2.1 Pricing of a Bond

The formula for bond pricing is basically the calculation of the present value of the probable future cash flows, which comprises of the coupon payments and the par value, which is the redemption amount on maturity. The rate of interest which is used to discount the future cash flows is known as the yield to maturity (YTM).

The pricing formulas for the main kind of bonds are shown below. The yield to maturity will be indicated as R , while F will be the par value. The letter C indicates the coupons.

- **Zero Coupon Bond:** It is the simplest kind of bond available. It provides no intermediate payments to the owner, which will only receive the par value when it comes due.

$$Price = \frac{F}{(1 + R)^T}$$

- Fixed Coupon Bond: It is the most common kind of bond. It grants regular payments to the owner, generally provided every year or every six months. In addition, the bondholder will receive the par value at maturity. Coupons are calculated as a percentage of the par value, called coupon rate, which is fixed and won't change over time.

$$Price = \sum_{i=1}^n \frac{C}{(1 + R)^i} + \frac{F}{(1 + R)^T}$$

- Perpetual Bond: Also known as a "consol bond" or "prep". Although it is a debt instrument to all effect, it is often considered more of an equity share. In fact, this security doesn't have a maturity date, it is supposed to keep on paying coupons perpetually, at least until the company continues its business activity. The similarity with a dividend-paying stock is very easy to notice, the only difference is the mandatory nature of coupons: the company can decide not to pay dividends, but it is forced to regularly pay coupons to perpetual bondholders, since they are interest payments. The backlog for the pricing of preps is the mathematical concept of geometric series.

$$Price = \frac{C}{R}$$

- Variable Coupon Bond: For this kind of bond, the coupon yield is not fixed anymore, but it can change over time. It is usually related to interest rates, such as Libor or Euribor, or it can be adjusted taking account of the inflation. These bonds are meant to protect the bondholder from the fluctuation of some economic variables which can potentially reduce the value of the coupons. The pricing formula is the same, but it is necessary to calculate the expected coupon values using the most recent forecasts of the coupon value for each period.

1.2.2 The Yield To Maturity and the Yield Curve

The previous paragraph has shown the pricing of a bond considering the yield to maturity as a known term of the equation. Nevertheless, analysts on the bond market apply the opposite process: they observe the bond prices on the markets, and they use it to determine the yield to maturity, which is the most important indicator to evaluate a bond.

Hence, the yield to maturity is the actual return the bondholder obtains on his investment, and it changes day by day following several factors: fixed income is indeed just fixed in words.

The yield curve is drawn on a Cartesian plane, which reports the yields on the y-axis, and the different maturities of the bonds on the x-axis.

The most renowned yield curve is the US Government Bonds curve, whose yields are used as risk-free rates, because it communicates precious information about the world's first economy.

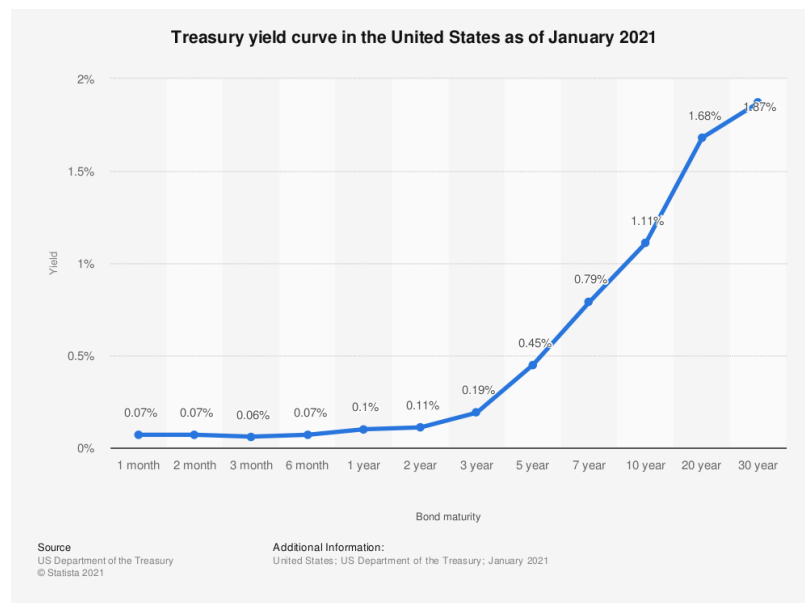


Figure 1.1 The U.S. Treasury Yield Curve

The government yield curve has also an impact on corporate bonds, which are usually riskier, and therefore they provide higher yields. The risk premium between government and corporate securities tends to be constant over time, so it is fair claiming corporate bonds depend on government bonds.

The short-term yields are on the left side of the yield curve, and they are essentially determined by the Central Bank, while the long-term yields, on the right side of the curve, depend on multiple factors, such as Gdp forecasts and interest rates expectations, although the most important is inflation expectations.

The type of government yield curve can communicate a lot about the economic system.

- Steep: Long term yields are higher than short terms, since investors expect an economic boom, leading to a rise in inflation. It indicates an accelerating economy.
- Flat: Central Bank hikes short term rates in order to slow down inflation
- Reverse: Long term yields are lower than short terms, because investors buy long term bonds expecting a cut in interest rates, making the price grow and the yield fall. It is a bad signal, since investors expect an economic slowdown, leading to low rates and deflation.

1.2.3 The Drivers of YTM

The price of a bond, and consequentially its yield to maturity, is determined by two groups of factors.

1. MACROECONOMICS

Macroeconomic factors, especially short-term interest rates and inflation, don't have to do with the issuing company's business activity in itself, but they are fundamental for the fixed income valuation. It is due to their capacity to influence the actual value of the fixed coupons granted by the bond.

Example: Let's consider a bond with a par value of 100\$ and a coupon rate of 5%. It grants annual payments and the term of the bond is 2 years.

The price of the bond is $\frac{5}{1,03^1} + \frac{105}{1,03^2} = 103,8269\$$

If the interest rate was higher, for example 5%, the coupon would be less valuable, because there would be a risk-free investment on the market which would grant a higher return.

The price would now be $\frac{5}{1,05^1} + \frac{105}{1,05^2} = 100\$$

If investors expected a future inflation, the nominal value of the payments would be the same, but their actual purchasing power would be lower. They would then pay a lower price for the bond. Conversely, in case of expected deflation the price of the bond would rise proportionally.

2. CREDIT RISK

In the previous examples, the bonds have been evaluated assuming the issuer will be able and willing to pay the bondholder when necessary, so the yield to maturity equals the risk-free rate. But what if the issuing organization defaulted before the bond comes due?

This question is the backdrop for a vast branch of finance, which is also the main topic of this work: Credit Risk.

Example: Consider a zero coupon bond with par value of 100\$, the term is 3 years and the risk free rate is 3%.

The fair price is $\frac{100}{1,03^3} = 91,5141\$$ and the YTM is indeed 3%.

Now, let's assume the issuer is not so trustworthy and so the investors forecast a default probability of 25%, with a recovery rate of 30%, meaning that, in case of default, the bondholder won't get 100\$, but he would just obtain 30 \$.

The new price is $\frac{(100*0,75)+(30*0,25)}{1,03^3} = 74,499\$$ and the annual YTM is now 10,3%.

The simple example shows quite clearly the effect of credit risk on fixed income market, since the investors want to be remunerated for the additional risk they take, paying a lower price and thus obtaining a higher yield.

The risky borrowers will then have a higher borrowing cost, paying higher interest to convince investors to lend them money.

Debt disciplines governments: yield is nothing but a measure of the opinion of investors about the government's management of economy.

There are two main indicators of credit risk an investor should look at:

- **Credit Ratings:** Rating agencies rate government and corporate bonds. High rating bonds are called Investment Grade, while low rating ones are called Speculative, High Yield or simply Junk.
- **Credit Default Swap:** It is a contract by which two counterparts agree to exchange a periodical fixed payment with a single massive payment if a certain entity default. An increase in the CDS rates mean a higher default probability, so basically a lowering of the creditworthiness.

1.3 Credit Risk and Rating

Credit Risk is commonly defined as the risk that an entity may not meet its contractual financial obligations as they come due, causing the lender to suffer a loss which might extend to the whole capital he invested. This risk is inherent in bank loans, fixed-income securities and other financial products that are amongst the building blocks of the world's capital markets. Credit ratings and research help investors analyze the credit risks associated with fixed-income securities and other financial obligations.

Credit Ratings are scores assigned to each economic entity whose solvency needs to be assessed, representing a common language every investor can immediately understand. Ratings provide the investor with an evaluation of the default probability, either that of the entire company or that of the single financial obligation, in fact it is common to find debt securities with a different rating than that of the issuing company.

For an entity, the rating process is generally about assessing the solidity of the business, its growth perspectives and the probability that its future cash flow will be sufficient to remunerate every bondholder.

Getting a deep insight of a company's creditworthiness is a very complex process, which doesn't only focus on performing a complete analysis of the firm's past performances and forecasted results for the future, but requires also a complete understanding of the whole industry, to predict the future trends and their effect on the firm's cash flows.

Once a company has been rated, the following step is about evaluating every class of bond it has issued.

When it decides to issue new debt, a company can choose between several securities, which essentially differ in their priority in case of default.

There are several classes of bonds, usually called tranches, with different priorities and guarantees for the holders. The riskier ones require of course a higher yield.

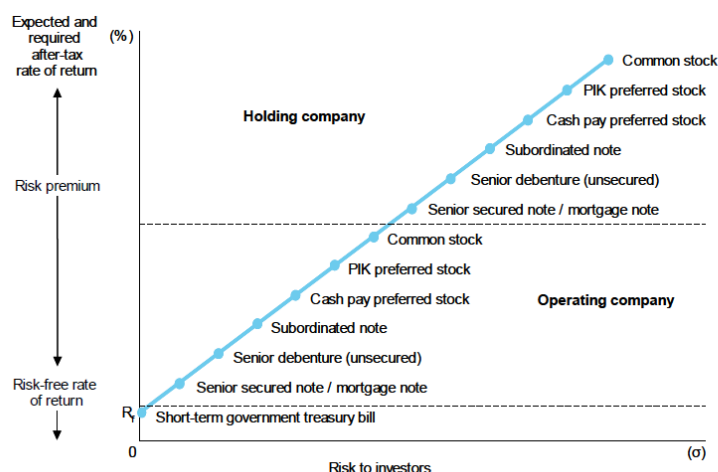


Figure 1.2 Hierarchy of securities from the most secure to the most risky

1.3.1 The Hierarchy of Debt

Examining the features of every single kind of bond goes beyond the purposes of this research, however the two main kinds of debt will be briefly pointed out. This approach only applies to corporates, since it is difficult to find different levels of debt for governments.

- **Senior Debt:** typically takes the loan form and is the first recovery component of the capital structure. For non-investment grade transaction, the senior debt typically enjoys security over the company's assets or shares. In investment grade loans or bonds, the lenders usually do not benefit from any security at all or at most. However, the debt ranks senior because of the absence of priority debt ahead of it, along with the low default probability. The senior debt, as shown in the graph, provides the lowest yield.
- **Subordinated Debt:** it typically includes high yield bonds, mezzanine loans and PIK debt. These forms of debt have various levels of subordination in the capital structure: they can be subordinated by a legal contract or by way of structure. This kind of debt is protected by a first insolvency loss by the company's regular stocks, the riskiest securities, but take losses afterwards.

While rating a single tranche of bonds, in addition to the seniority the instrument enjoys in case of default, an analyst should also look at the different forms of security protecting it.

- **Guarantee:** An entity agrees to take charge of the obligations of another entity in case of its insolvency.
- **Asset Security:** This can take the form of a fixed charge, where the lender has a pledge over a specified asset, or a floating charge, where the pledge is general over the entire company's asset base. In case of default, the lender can sell the assets he has the pledge on, receiving the proceeds to satisfy its obligation.
- **Share Security:** Similar to asset security, but the pledge is on the company's shares. It is less attractive than the asset security, because in case of default the share value would fall dramatically.

1.3.2 Covenants

To protect the interest of lenders, debt is usually structured with various covenants, to discipline the issuing company or act as an early signal of underperformance. Covenants can take various forms:

- **Maintenance Based Covenants:** The issuing company is asked to maintain certain credit ratios and follow a certain behavior, regularly reporting about its business activity. If the test is not met in a certain period, it represents a default event, acting as a buffer in the case of temporary underperformance. Financial covenants are meant to measure values such as minimum earnings or cash flows, maximum leverage and adequate liquidity. Covenants can be either positive, to enforce certain behaviours, or negative, to limit the company's ability to undertake certain actions, such as raising leverage or perform M&A operations.
- **Incurrence Based Covenants:** They are basically meant to restrict the company's behavior, providing thresholds it can't exceed. The typical actions targeted by Insurance based covenants are usually debt incurrence, changes of control and M&A operations.

The firm can also face restricted payments, usually not being allowed to use more than 50% of its cumulative net income for dividends, purchases or retirement of equities or similar payments.

However, the previous examples are only a part of the possible effects of Incurrence Based Covenants, which could target almost every aspect of a company's business activity.

If the borrower breaches a covenant, even though it is not economically in a default state, the lenders are theoretically allowed to claim the credit defaulted and require the debt to be instantly repaid. However, this is almost never the best choice, since covenants typically include actions the lenders can take to discipline borrower's behavior. For example, a typical measure for financial covenants, mainly for the ones concerning liquidity, is blocking the dividends for shareholders until the ratios are back above the contractual thresholds.

In addition, lenders can also obtain additional control rights on the borrower's business activity, in order to monitor him more efficiently.

To summarize, the rating of a bond is a very complex process, which includes various steps.

To start, analysts must assess the creditworthiness of the entire borrowing company, performing a complete analysis of its business activity and of the entire industry it competes in. Once the issuing entity has been rated, it is necessary to focus on the seniority of the single bond, examining its priority level respect to other outstanding debt instruments and determining an expected recovery rate in case of default, i.e. the percentage of the entire payment bondholders will be likely to obtain if the issuer faces insolvency problems. To conclude, credit analyst must focus on the contractual form of the bond, examining any guarantees and covenants, which are likely to reduce the risk connected to the bond.

1.4 The Rating Agencies: The Realm of the Big Three

A rating agency is basically a company, operating in the financial services industry, whose core business is to analyze and evaluate borrowers, especially large ones such as global firms and governments, to assess their solvency and to determine the risk of lending money to them, giving to each company a school-like grade according to a universally recognized model. In fact, even a person without any kind of financial education would easily recognize that “BBB” rating given to the Italian bonds on the newspaper.

There are several rating agencies around the world, but over the last century, and even before, the market has been dominated by three names, which has gotten so big and important to deserve the appellation of “Big Three”.

Standard & Poor's (S&P), as the oldest, comes first. It was begun in 1860 by Henry Poor, who wrote a history of the finances of railroads and canals in the United States as a guide for investors. The "Standard" part came into being in 1906, when the Standard Statistics Bureau was set up to examine finances of non-railroad companies. The two businesses joined forces in the 1940s.

Moody's was started in 1909 by John Moody, who published an analysis of the tangled and uncertain world of railway finances, grading the value of its stocks and bonds.

These are now mighty concerns, with operating income in the high hundred million dollars, and they each have 40% apiece of the business of rating major companies and countries.

Fitch, with another eponymous founder, John Fitch, was set up in 1913 and is a smaller version of the other two.

Despite the amount of rating agencies currently active, these three businesses seem to be the only ones everyone watches, and the follow paragraphs will investigate the why.

Part of the answer lies with the SEC (Securities and Exchange Commission), the American institution in charge of watching over the financial markets, which in 1975 acknowledged these three as Nationally Recognized Statistical Rating Organizations (NRSRO).

An endorsement from an NRSRO makes life quicker and easier for countries and financial institutions wishing to issue bonds. It basically tells investors a firm has a track record and indicates how likely it is to be able to pay back the money.

Further impetus for NRSROs comes from the fact that certain regulated investment funds are required by the SEC to hold only those bonds that have a very high rating from accredited agencies. The SEC actually has 10 NRSROs on its approved list, including a Canadian agency and two Japanese ones. The big three - Standard & Poor's, Moody's and Fitch - remain the industry standard-bearers. This is partly because they make their ratings available freely to investors – making money from charging the organizations who want their bonds rated - something some believe can create a conflict of interest.

As a statement from the European Commission put it: "As a rating agency has a financial interest in generating business from the issuer that seeks the rating, this could lead to assigning a higher rating than warranted in order to encourage the issuer to contract them again in the future."

The rating method of S&P, as an example, will be further discussed in the next paragraphs.

Even though they're kind of an oligopoly in their industry, since the crisis began in 2007 the Big Three have come in for heavy criticism, considering the huge mistake they made giving the very best grades to mortgage-backed security, which eventually turned out to be worthless.

The US SEC is tightening up on the way they behave. Such an impressive power to influence entire markets concentrated in the hands of private entities is potentially dangerous and has to be attentively monitored.

The EU is not satisfied either: The potential for a downgrade to destabilize a country was so feared that the European Parliament this year agreed a set of rules designed to rein them in.

Hence, governments stated that agencies can issue ratings on countries no more than three times a year, and only after markets have closed.

Europe also wants to dilute the power of the Big Three rating agencies by encouraging financial firms and others to do their own credit assessments. Michael Barnier, the Internal Market Commissioner, claimed Ratings have a direct impact on the markets and the wider economy and thus on the prosperity of European citizens, and thus they must be submitted to stricter control.

But the agencies' power does not always cause mass market upheaval, and more recent downgrades have not prompted swings in investors' behaviour.

After the mighty US received its downgrade in 2011, rather than its cost of borrowing going up, it dropped down, as lenders decided that the US government was still one of the safest bets in the world. And although the UK government long spoke of the importance of maintaining its triple-A status, when it was downgraded for the first time in more than 30 years, economists suggested that it would have limited impact.

1.5 Rating Guidelines: The S&P case

This section will examine the rating methodology applied by Standard & Poor's, the most ancient global rating agency. It is worth remembering that the criteria may vary between different industries, securities and geographical markets. To perform an actual assessment, analysts use specific criteria for each category of financial instrument, in addition to general ones.

However, the principal guidelines are available to be examined by the retail investor as they are public by law, and they provide the backdrop for every rating assessment.

To maintain the discussion as fluid as possible, this paper will only focus on the general criteria, which are anyway considered sufficient to completely understand the basis of the Standard & Poor's rating process. Despite the general methodology being described quite accurately, the quantitative aspects, such as threshold ratios, performance indicators and other numerical values won't be pointed out, since they differ between industries and countries.

Actually, even general criteria show a certain distinction basing on the macro-group of securities they must be applied to. Therefore, it is possible to divide them in two different groups, the ones meant to rate structured finance products or portfolios and the ones referring to corporates and governments.

1.5.1 Structured Finance

1. Credit Quality of the Securitized Asset

The first step is usually determining the credit support necessary to maintain a "AAA" rating level, equivalent to estimating the losses the securitized asset would suffer under extreme stress conditions. This process might be organized in steps, estimating asset default frequencies and loss severities separately, then combine them to form overall lost estimate.

For some asset classes, S&P may define an archetypical asset pool to use as a benchmark, in order to determine default frequency basing on historical data. The level of expected losses usually corresponds to the amount of credit enhancement associated with the “B” level.

2. Legal and Regulatory Risk

S&P’s legal assessment focuses on the degree to which a securitization structure isolates the securitized assets from the insolvency risk of the entities participating in the transaction. The analysis is usually focused on the entities that originated and owned the assets before. To achieve asset isolation in a securitization, the originator usually sells the subject assets to a special purpose entity (SPE), so the analysis also considers the bankruptcy risk of the SPE itself.

3. Payment Structure and Cash Flow Mechanics

The objective of the analysis is to determine whether the cash flows from the securitized assets would be sufficient to make timely interest payments and ultimate payment of principal to the related securities. The analysis encompasses diverse features of payment structure, from the basic priorities inherent in a deal, i.e. the hierarchy of tranches, to the impact of performance covenants. Finally, it is necessary to take into considerations if the security embodies any support facility from third parties, such as insurance policies, guarantees or derivative instruments.

4. Operational and Administrative Risk

This part of the analysis focuses on key transaction parties, including transaction servicers, asset managers of a collateralized debt obligation (CDO), the trustee and the paying agent. In securitizations including many asset classes the S&P’s purpose is to verify the manager’s ability to perform its duties, from the receipt of timely payments to the reporting. For example, for actively managed portfolios, the portfolio manager’s reliability is assessed considering his past performances and his capabilities.

The analysis also takes into account the opportunities to find a substitute or a successor if a servicer becomes unable or unwilling to perform its duties.

5. Counterparty Risk

The fifth and last part focuses on third party obligations to either hold assets, including cash, or make financial payments that may affect the creditworthiness of structured finance instruments. The assessment considers both the type of dependency and the rating of the counterparty for each counterparty relationship.

1.5.2 Corporate And Governments

1. Creditworthiness Before External Support

Assessing the creditworthiness of an entity means gauging the resources available to it to fulfil its commitments. This is a forward-looking exercise, since it aims to estimate the future cash flows and income, as well as their potential variability. The quantitative side is typically focused on a financial analysis and evaluates also obligor’s accounting principles and practices. For corporates quantitative factors include profitability, leverage, cash flow adequacy, liquidity and financial flexibility, along with some off-balance sheet items, such as derivatives expositions and pension liabilities.

For governments, S&P considers macroeconomic factors, including demographics, wealth, GDP, and growth prospects. Sovereign obligors are also affected by fiscal policy flexibility, monetary policy flexibility, international investment position and contingent liabilities deriving from potential support to the financial sector.

Qualitative factors for businesses include country risk, industry risk, considering growth perspectives and technological aspects, and some entity-specific factors, concerning the position of the obligor compared to its peers.

For governments, qualitative factors are mainly represented by political risks, including the effectiveness of policymaking, the transparency of processes and the accountability of the institutions. Moreover, political risk also embodies any potential for wars and other security problems. Then S&P usually considers revenue forecasting, expenditure control, debt management and contingency planning, to estimate the country's default probability as accurately as possible.

2. External Influence

In addition to the obligor's stand-alone creditworthiness, S&P's analysis also considers the potential amount of external support (or influence) which can enhance (or diminish) the obligor's creditworthiness. When an obligor has a contractual guarantee from a higher-rated entity, it might raise its rating, but only if the guarantee satisfies certain conditions and guarantees full and timely payments.

Another common source of guarantees can be found in affiliated business entities, for which S&P determines strategic importance and likelihood of receive support form a stronger parent, along with the parent's capacity to provide such support.

For governmental support, the analysis considers government-related entities (GREs), determining the nature of their links to the government and therefore the likelihood to receive support in case of distress. A similar process applies to the potential for extraordinary governmental support to banks that have a systemic importance in the national economy. For sovereign debt, S&P considers the potential for assistance from multilateral institutions (e.g. International Monetary Fund).

In some cases, external support can have a negative impact on entity's creditworthiness, for example it happens when a weaker business partner drains cash from a stronger subsidiary through dividends or in other ways.

3. Notching and Analysis of Specific Instruments

This section includes consideration of priorities within an obligor's capital structure and the potential effect on collateral and recovery estimates in the event of default. The analysis applies to instruments that rank above or below the obligor's senior and unsecured debt: subordinated debt is generally rated below senior debt.

Notching also applies to structural subordination of debt issued by operating subsidiaries or holding companies, which are part of an enterprise. For example, the debt of an holding company might be ranked lower than the debt of its subsidiaries, which holds the operating assets and cash flows.

2. THE COMPLETE SPECTRUM OF BOND RISKS

Credit risk is just one of the multiple aspects an investor should take into consideration while evaluating a bond. This chapter is meant to introduce and explain the other main risks of investing in debt securities.

In fact, risks could arise from one of the three critical aspects of a bond:

- **The Issuer:** bond yields are strictly related to the creditworthiness of the issuer, which must be able and willing to meet its obligations. The risks arising from the issuer's financial position are generally gathered under the denomination of Credit Risk.
- **The Issuance:** A bond is essentially a contract, and thus course it can have several features. The same issuer can be resort to multiple kinds of bonds, and their features have a deep influence on the riskiness for a potential investor.
- **The Market Risk:** Bonds are negotiated every day on the stock markets, and they are prone to a continuous pricing process, just like stocks. A bondholder is not supposed to accept enterprise risk, so bonds are generally less risky than stocks, but it doesn't mean they are immune from the financial markets' dynamics.

In the following pages the reader will find the most important risk factors which, in addition to credit risk, are the main drivers of bond prices and yields.

Downside risk can be viewed as resulting from two sources: exposure and the risk factor. This decomposition is essential because it separates risk into a component over which the risk manager has control (exposure) and another component that is exogenous (the risk factors).

2.1 Market Risk

Market risk measurement attempts to quantify the risk of losses due movements in financial market variables. The variables include interest rates, foreign exchange rates, equities, and commodities. Positions can include cash or derivative instruments.

In the past, risks were measured using a variety of ad hoc tools, none of which was satisfactory. These included notional amounts, sensitivity measures, and scenarios. While these measures provide some intuition of risk, they do not measure what matters, that is, the downside risk for the total portfolio. They fail to consider correlations across risk factors.

So, the most widely used method to assess the market risk is the Value at Risk (VAR) Method. It measures the total portfolio risk, taking into consider portfolio diversification and leverage. The VAR method has become very common between risk analysts because it synthesizes a complex assessment process in one number. Nevertheless, it is only one of the measures risk managers focus on, and it is usually complemented with stress testing. The VAR method will be briefly discussed in the following paragraph.

2.1.1 Cataloging Market Risks

It is useful to divide risks according to their characteristics in order to better understand the following dissertation.

The first decomposition is between absolute risks and relative risks:

- **Absolute Risk:** Measured in terms of shortfall relative to the initial value of the investment. It should be expressed in the relevant base currency.

- **Relative Risks:** Measured in relative to a benchmark index and represents active management risk. It is expressed as a percentage of the target benchmark.

The choice of whether to use absolute or relative risk measures depends on how the portfolio manager's performance is measured.

Investors should include market risk in their evaluations in addition to return. The Sharpe Ratio (SR) measures the ratio of the average rate of return $\mu(R_p)$, in excess of the risk-free rate R_F , to the absolute risk:

$$SR = [\mu(R_p) - R_F] / (\sigma R_p)$$

Market risk can be further classified into directional and nondirectional risks:

- **Directional Risks** involve exposures to the direction of movements in major financial market variables. These directional exposures are measured by first-order linear approximations such as:
 - Beta for exposure to general stock markets movements
 - Delta for exposure to the level of interest rates
 - Duration for exposure to the level of interest rates, used in the bond valuation and functional to the purpose of this dissertation
- **Nondirectional Risks** involve other remaining exposure such as nonlinear exposures, exposure to hedged positions or to volatilities. Providing a deep insight on these risk components goes beyond the purpose of this master thesis.

2.1.2 Measuring Market Risk: The Value at Risk

VAR is a summary measure of the downside risk, expressed in the investor's home currency. A general definition is:

"VAR is the maximum loss over a target horizon such there is a low, prespecified probability that the actual loss will be larger"

It is hence a useful summary measure of risk, because it can summarize the effect of multiple risk factors, considering their correlations, in one single number.

A general parametric definition of VAR is:

$$VAR = \text{Market Value} * \text{Modified Duration} * \text{Worst Risk Factor Performance at confidence level}$$

It is hence a useful summary measure of risk, because it can summarize the effect of multiple risk factors, considering their correlations, in one single number.

Anyway, VAR does not describe the worst possible loss, because it is expected to be exceeded $(1-c)$ times, being c the chosen confidence level. Moreover, VAR doesn't tell show anything about the distribution of losses in the left tail, but it just indicates the probability of such a value occurring. For the same VAR number, however, we can have very different distribution shapes.

Value at Risk is measured with some error, since it is based on historical data to forecast the future behaviour of a certain risk factor. It is then subject to normal sampling variation, because using different periods of observation or statistical methodologies will certainly lead to different VAR numbers.

In addition to the historical volatility of the risk factor and the market value of the asset, which can be calculated, VAR depends on two quantitative parameters, which instead need to be defined arbitrarily by the analyst.

- **Confidence Level:** The higher the confidence level (c), the greater the VAR measure. Varying the confidence level provides useful information about the return distribution and potential extreme losses. It is not clear, however, whether one should stop at 99%, 99.9%, 99.99% and so on. Each of these values will create an increasingly larger loss, but less likely. The choice of the confidence level depends on the use of VAR. The more conservative the investor wants to be, the higher he must set confidence level. Of course, a confidence level of 99.99% would imply one exceedance out of 10000 trading days, so it is almost impossible to verify through backtesting. Thus, the most common confidence levels reported on financial analysis are 95% and 99%.
- **Horizon:** The longer the horizon (T), the greater the VAR measure. This extrapolation depends on two factors, the behavior of the risk factors, and the portfolio positions. To extrapolate from a one-day horizon to a longer horizon, we need to assume that returns are independently and identically distributed. This allows us to transform a daily volatility to a multiple-day volatility by multiplication by the square root of time. We also need to assume that the distribution of daily returns is unchanged for longer horizons, which restricts the class of distribution to the so-called “stable” family, of which the normal is a member.

$$VAR(T \text{ days}) = VAR(1 \text{ day}) * \sqrt{T}$$

The choice of the horizon also depends on the characteristics of the portfolio, if the position changes quickly and the investors doesn't expect to keep the bonds to maturity, increasing the horizon will create “slippage” in the VAR measure. Hence, the horizon mainly depends on portfolio's holding period.

The holding period must also facilitate the backtesting. Shorter time intervals create more data points matching the forecast VAR with the actual, subsequent Profit&Loss. As the power of statistical tests increases with the number of observations, it is advisable to keep the horizon quite short.

2.2 Liquidity Risk

Liquidity risk is sometimes viewed as a component of market risk. Lack of liquidity can cause the failure of an institution, even when it is technically solvent. Commercial banks have an inherent liquidity imbalance between their assets (long-term loans) and their liabilities (bank deposits) that provides a rationale for deposit insurance. The problem with liquidity risk is that it is less amenable to formal analysis than traditional market risk. The industry is still struggling with the measurement of liquidity risk. Often, liquidity risk is loosely factored into VAR measures, for instance by selectively increasing volatilities. These adjustments, however, are mainly ad-hoc.

There are two main kind of liquidity risk:

- **Funding Liquidity Risk**, also called cash flow risk, arises when the institution cannot meet its obligation.
- **Asset Liquidity Risk** arises when transactions cannot be conducted at quoted market prices due to the size of the required trade relative to normal trading lots.

While considering the purchase of a bond, it is very important to assess its liquidity. Portfolio managers want to preserve their possibility to get out of the position if needed, so they got to make sure they will always have an available counterparty on the financial markets.

Illiquidity can be either asset-specific or market-wide. Large-scale changes in market liquidity seem to occur on a regular basis, most recently during the bond market rout of 1994 and the credit crisis of 1998. Such crises are characterized by a flight to quality, consisting in a shift of demand to high-grade securities from low-grade securities, which instantly become illiquid.

Liquidity can be measured by a price-quantity function, which describes how the price is affected by the quantity transacted. However, the liquidity of a bond is generally estimated observing the bid-ask spread.

Bid-ask spread is the amount by which the ask price exceeds the bid price for an asset in the market. It is essentially the difference between the highest price that a buyer is willing to pay for an asset and the lowest price that a seller is willing to accept. An individual looking to sell will receive the bid price while one looking to buy will pay the ask price. In a perfectly liquid market, bid and ask would spontaneously meet at a fair level.

A low bid-ask spread means the investor can sell bonds at approximately the same price they would pay to buy them. It implies there are a high number of available counterparties, which are in competition with each other lowering the price they require to be more competitive.

On the other hand, a higher bid-ask spread denotes a less fierce competition due to the small number of counterparties, which can impose lower ask prices. The asset is therefore very illiquid and if the investor needed to divest it, he would lose a relevant part of the value paying a significant commission to the dealer.

Asset liquidity is then a critical component in the asset allocation of a fixed income portfolio, and it can be managed by setting limits to certain markets or products and by means of diversification.

2.3 Currency Risk

Currency Risk arises from potential movements in the value of foreign currencies. The investor should pay attention to this issue when considering an investment in a bond which is denominated in a different currency than his home currency. Currency risk includes currency-specific volatility, correlations across currencies and devaluation risk. It arises in the following environments:

- In a *Pure Currency Float*, the external value of a currency is free to move, to depreciate or appreciate, as pushed by market forces. An example is the dollar/euro exchange rate.
- In a *Fixed Currency System*, a currency's external value is fixed (or pegged) to another currency. An example is the Hong Kong dollar, which is fixed against the U.S. dollar. This does not mean there is no risk, however, due to possible readjustments in the parity value, called devaluations or revaluations.
- In a *Change in Currency Regime* a currency that was previously fixed becomes flexible, or vice versa. For instance, the Argentinian peso was fixed against the dollar until 2001 and floated thereafter. Changes in regime can also lower currency risk, as in the recent case of the euro.

Before investing in a financial security, a careful investor never forgets to analyze the denomination currency: no European investor indeed would want to receive periodic cash flow in a currency which is weakening against the euro.

Currency volatility is measured as the standard deviation of the empirical distribution of the currency value against a target currency, usually the dollar. It is usually expressed on a yearly, monthly or daily basis and it is calculated using historical data. Of course, on a daily basis, the data

concerning the last year are enough to calculate the volatility. Conversely, to assess the yearly volatility of a currency the analyst should look back at least twenty years.

The currency volatility to examine has a lot to do with the period the investors expects to keep its position, which is called holding period. In fact, the fixed income market gathers various investors, with different profiles, from the one purchasing almost risk-free bonds and keeping them for several years in order to protect its capital and receive a low but steady return, to the one trading bonds on the short-term speculating on the price volatility.

Anyway, fixed income portfolio managers usually tend to give extreme priority to preserve their customers' capital. Tosetti Value is no exception, so we tend to prefer the least volatile securities.

Some currencies, such as the Hong Kong dollar, have very low volatility, reflecting their pegging to the dollar. This does not mean that they have low risk, however. They are subject to Devaluation Risk, which is the risk that the currency peg could fail. This has happened to Thailand and Indonesia, which in 1996 had low volatility but converted to a floating exchange rate regime, which had higher volatility in 2002.

In addition, it is advisable to consider the correlation between the different currencies, in order to forecast how a movement in the denomination currency would impact the investor's home currency. Correlations between currencies are generally low, mostly in the range of -0.10 to 0.20. There are, however, blocks of currencies with high correlations. European currencies, such as the DKK, SEK, NOK, CHF, have high correlation with each other and the Euro, on the order of 0.90. The GBP also has high correlations with European currencies, around 0.60-0.70.

Currency risk is also related to other financial risks, mainly to interest rate risk. Often, interest rates are raised in an effort to stem the depreciation of a currency, resulting in a positive correlation between the currency and the bond market. These interactions should be considered when designing scenarios for stress-tests.

2.4 Interest Rate Risk

The pricing of a bond, which has been introduced and explained in the first chapter, is deeply correlated with macroeconomic data. Interest rate is arguably the most relevant one, and it is also one of the main sources of risk investors must look at.

Interest rate risk is defined as the risk of change in the value of an asset as a result of volatility in interest rates. It either renders the security in question non-competitive or increases its value. Though the risk is said to arise due to an unexpected move, generally, investors are concerned with downside risk.

This risk directly affects the fixed-rate security holder. Whenever the interest rate rises, the price of the fixed-income bearing security falls and vice-a-versa.

It is common to use interest rates as discount rates to calculate the present value of future cash flows, and accordingly to this principle, the fair price of a bond. This process aims to compare the return on the investment to the one granted by the best opportunities available on the markets at a similar risk level.

In fact, looking at the pricing formula for a fixed income security, the dependence on the discount rate immediately catches the eye. Normally, a bond is priced using risk free rates, represented by government bonds coming due in ten years.

Interest rates on the markets are set by central banks, which decide to raise or to cut the cost of borrowing money in order to regulate the economic system.

The return of available risk-free investments is an important factor for the bondholders: for instance, holding a fixed income security with a coupon rate of 4% every year puts the investor in a

strong position if lending money to a stable government only provides a 0,5% coupon rate, but if the risk-free rate was instead 7%, the price of the security held by the hypothetical investor would suffer a drastic reduction.

2.4.1 Why Interest Rates Change

As previously said, Central Banks, between their several functions, have the responsibility of setting government interest rates. This is a very important duty because of the effect interest rates have on the entire economic system.

In different period, the Central Bank may consider necessary to set higher or lower interest rates relating to the point of the economic cycle reached by the country, and that's why they change multiple times a year and the bondholder must check them out regularly.

Usually, when economies hit the expansion phase the whole system starts to grow, production increases, salaries raise, people can spend more money and the living standards get higher and higher, leading to major spending and eventually increasing the average income of all the selling activities.

The side effect of this heavenly scenario is hyperinflation, due to the large availability of money along with the raising demand of every sort of goods and services, lowering the value of money. A controlled inflation is normally positive, because it stimulates investments and drives economic growth, but if it gets out of control its effect can be disastrous.

The erosion of money value respect to goods and services leads to an exaggerated weakening of currency, which can render it worthless if not dammed on time. Hyperinflation ultimately saps tax revenues, shuts business, raises the unemployment rate and drives cost of living so high to cause political instability. An interesting instance might be found in Germany in the Twenties, with inflation rate reaching 29000% and people literally bringing wheelbarrows full of banknotes for their everyday purchases.

To avoid hyperinflation, central banks must reduce the cash availability on the markets, helping the currency to strengthen again. This purpose is usually achieved by raising interest rates, increasing the cost of borrowing money and limiting inflation to an acceptable level.

The opposite issue emerges when economies hit recession periods. Those are usually very painful days for people and for the entire country, with a general deceleration of economy leading to a vicious cycle.

A lowered demand of goods causes the decreasing of companies' revenues, so they must reduce costs through cutting salaries and limiting investments. Less money available for employed people causes the fall of their expenditures, leading to a general crisis in the consumer goods sectors. It provokes further troubles to many companies, which are forced to scale down their businesses or even to completely close them, raising unemployment and compelling Governments, which are already facing a dramatical reduction of tax income, to sustain unemployed people through subsidies.

During recession, many businesses can't stand the fierce competition, and the ones resisting must keep lowering prices in order to make people keep on buying their products. Of course, not many companies have resources to invest in these periods, and financial institutions often refuse to lend money because of the reduced creditworthiness of most economic entities.

In this scenario, with lowering prices and many people and companies desperately needing cash, money becomes the most important asset, continuously gaining value in a process known as deflation. In addition, entities maintaining good cash availability won't lend money to struggling corporates, except for exaggerated interest rates, because of the high risk of insolvency. They won't invest their money either, because of the high value of cash respect to any other asset, which moreover implies taking the enterprise risk in a very dangerous environment. They then prefer

sticking to Government bonds, which remain the most secure investments, granting fixed future cash flows and taking also advantage of a further deflation.

To fight deflation, Central Banks usually lower interest rates. With lowered interest rates, Governments are enabled to introduce liquidity in the markets driving the economic recovery.

This countermeasure reduces the convenience of Government Bonds investments, pushing liquidity holders to invest their money in the stock markets or in corporate bonds, reducing the exaggerated currency value and driving spending, eventually attracting foreign investments in the country's economy.

The most recent deflation crisis is the one due to Covid19 pandemic which came twelve years after the global Financial Crisis in 2007-2008, causing recessions in many countries all over the world. Those two crunches, even though they were completely different from one another for what concerning the main triggers, were both fought by the Central Banks with super-low interest rates in order to sustain the business activities.

Central Banks just set government yields, but the risk premium between government and corporate yields is usually constant over time, so it is fair to say that government bond yields provide the base for the corporate bond yields.

Understanding the macroeconomic dynamics driving interest rates is thus essential for bond investors, which need to be always aware of the latest events in the world; being an analyst or an investor has a lot to do with the understanding of the environment surrounding us.

2.4.2 Reinvestment Risk and Callable Bonds

The reader might now have clear in his mind how much interest rates movements are relevant for every fixed income security holder but the ultimate reasons for this are still to be explained. Considering interest rates affect the price of bonds, the more intuitive issue for an investor emerges if he wants to close his position selling the bond before it comes due. This may happen because he needs liquidity to seize another investment opportunity or because it needs to face an urgent or unexpected expense, or he simply might be trading bonds to speculate on the markets in the short run. Whichever the reason is, an investor certainly prefers his assets to be as valuable as possible, to keep for himself the opportunity to free his invested capital in every moment without facing heavy losses. From this point of view, interest rate risk is definitely one of the drivers of market risk. However, interest rates movements have a non-negligible impact even on that investor which is sure to keep the bonds to maturity and already knows the exact amount of the cash flows he will get. In fact, the investor knows how much money he will have in his hands at maturity, but he doesn't know the return he will be able to get if he wants to invest it again. The risk of not finding on the market an investment with the same return at the same risk is known as Reinvestment Risk. Moreover, there is another important aspect of bonds that makes them more vulnerable to reinvestment risk: the call options. Economic entities can decide to issue Callable bonds, that simply means bonds with a call option linked to them, which allows the issuer to buy back the securities, usually on fixed dates. The pre-determined price normally implies a consistent premium respect to the par value, and the option forces the issuer to grant a higher yield to maturity to investors. However, if the call gets eventually exercised, the bondholders remain with a consistent amount of cash and they must decide how to use it, being completely vulnerable to reinvestment risk.

The callability of bonds is then another important risk factor determining the overall convenience of the investments. Usually, investors hedge against the potential call options staggering the call options of their bonds over time in order to mitigate the risk of receiving too much cash to reinvest in the same moment.

Hence, bond investors fear high interest rates while they have fixed income securities in their portfolios, because it would reduce their value, but they likely hope for high interest rates at the same risk when they get the par value back and they need to invest it again.

2.4.3 Inflation Risk

Inflation is essentially the reduction of the purchasing power of money. It is discussed in this section because it is strongly related to interest rates, even though usually interest rates are set independently to inflation and not the opposite.

A fixed income security is essentially a contract providing the owner with cash flows over time, denominated in a specific currency. Although the nominal value of cash flows is fixed, the real value is not, and it precisely depends on inflation.

The inflation rate should be subtracted to the nominal yield of a bond to determine the real yield. For instance, an investor holding a bond with a nominal yield of 1% in a currency which is facing a yearly deflation of 2%, is practically getting a 3% return on its investment, but the exact same bond would be making the investor lose 1% every year if the currency was inflating by 2% a year.

In addition, as previously pointed out, inflation is among the main drivers of interest rates' movement.

Some countries issue bonds meant to protect investors from inflationary movements, known as Inflation Linked Bonds, which basically set the real coupon rate instead of the nominal one, tying coupons to inflation index such as the Consumer Price Index (CPI) in the USA.

2.4.4 Maturity and Duration

The potential impact of interest rate risk on the bondholder essentially depends on the holding period, which is the timespan the investor expects to keep the bond in his portfolio. Of course, if the investor considers holding the security until it comes due, the holding period coincides with the bond's maturity.

Interest rates indeed are not likely to cause many problems in the short run, except for the effect of unexpected events on a global scale, which are very unlikely however, but they can change substantially in the long run. So, the longer the investor expects to keep the bond, the closer the attention he got to pay to interest rate risk, as well as inflation.

Except for zero coupon bonds, anyway, the maturity date is not enough to determine the exposure to interest rate risk. In fact, the different size of the periodic coupons and to the par value has to be taken into account. Hence, the measure normally used to assess the actual exposure of a fixed income asset to the interest rate risk is the Duration.

Duration is one of the most important features of a fixed income security, and it aims to measure the price sensitivity of the security to the fluctuations of interest rates. Generally, the longer the duration is, the higher the sensitivity of the price to fluctuation in interest rates.

It is possible to identify several measures for duration, anyway the most widely used are three.

- 1. Macaulay Duration:** Introduced by the Canadian mathematic Frederick Macaulay, it is the weighted average of the times until cash flows are received. It can be considered as a measure of the time that an investor needs to be repaid for the bond price with total cash flows. It is measured in time units, usually years, and it is always shorter than maturity for coupon paying Bonds. In the following formula, PV_i is the present value of the cash flows received by the bondholder in each period (i), while V is the sum of every discounted cash flow, that is the fair price of the bond.

$$D = \sum_{i=1}^T t_i * \frac{PV_i}{V}$$

- 2. Modified Duration:** It derives from Macaulay Duration, and it is a more precise measure of price sensitivity, particularly suitable for bonds. Unlike the Macaulay Duration, it is measured in percentage, and it measures the percentage change in the bond value given a certain percentage variation of interest rate. In the formula, n is the frequency of compounding.

$$\text{Modified Duration} = \frac{\text{Macaulay Duration}}{(1 + \frac{YTM}{n})}$$

- 3. Effective Duration:** It aims to measure the price sensitivity to changes in the yield to maturity, taking into account possible variations in the cash flows provided by the bond. It is hence particularly suitable to be applied to bonds with embedded options, for example callable bonds.

$$\text{Effective Duration} = \frac{V_{-\Delta y} - V_{+\Delta y}}{2 * V_0 * \Delta y}$$

Where:

$V_{-\Delta y}$ = Bond price if yield falls by $\gamma\%$

$V_{+\Delta y}$ = Bond price if yield rises by $\gamma\%$

V_0 = Present Value of all cash flows from the bond

Δy = The yield changes

2.4.5 Modified Duration from a Quantitative Point of View

Modified duration is the most important price sensitivity measure for bonds, so it is worth to briefly introduce its origins.

If we want to see what happens to the price of a bond if the yield changes from its initial value, called y_0 to a new value $y_1 = y_0 + \Delta y$, without recomputing the value of the bond with the new yield, it is possible to use a shortcut, as long as the change is not too large.

The non-linear relationship between yield and price can be approximated using the Taylor expansion around its initial value.

$$P_1 = P_0 + f'(y_0) * \Delta y + \frac{1}{2} * f''(y_0) * (\Delta y)^2 + \dots$$

Where $f'(y_0) = \frac{dP}{dy}$ is the first derivative and $f''(y_0) = \frac{d^2P}{dy^2}$ is the second derivative of the price respect to the yield. The equation represents an infinite expansion with increasing powers of Δy , but in finance are usually considered only the first term, linear, and the second one, quadratic.

Taylor expansion is widely used in finance, not only to analyze bonds, but also to approximate the fluctuation in the value of a derivative, such as an option, respect to the movement of the underlying stock, and to determine hedging strategies. However, those applications won't be illustrated in this dissertation.

For fixed income instrument, the first and the second derivatives are so important they have been given a special name. The negative of the first derivative is called Dollar Duration.

$$-DD = f'(y_0) = -D_m * P_0$$

The term D_m is precisely the modified duration and P_0 represents the market price. The modified duration is hence a linear approximation of the sensitivity of market price to fluctuations in interest rates.

For small fluctuations it is enough to consider the linear term, but if the fluctuation gets more consistent it might be necessary to introduce the quadratic term, which is called Dollar Convexity. Convexity adds a non-linear term to the relationship between price and yield, making the approximation more precise if yields get far from the starting point. Anyway, it won't be explained mathematically because it doesn't take part in the scoring model which constitutes the core of this Master Thesis.

2.5 Tosetti Value, The Family Office

Tosetti Value is an Italian financial advisory firm, started in 1997 in Turin by Dario Tosetti under the name of Tosetti&Partners as a multi-family office, offering independent consulting to several families and entrepreneurs in the Turin area.

During the following years, it has experienced a steady growth in terms of customers and employees. In 2002 Tosetti Value was born as the research center of Tosetti&Partners, gathering a team of analysts, specialized in quantitative and qualitative analysis of financial instruments such as equity funds, alternative instruments and, naturally, bonds.

In 2008 the two realities gathered under the name of Tosetti Value SIM, which started to assist the customers of Tosetti&Partners.

In 2013 the firm added an Art Division, which deals with various forms of art helps the customers investing in art and managing their private collections. In 2018, recognizing the success achieved in the wealth management activity, the firm got awarded as the Italian Most Important Family Office, with more than 5 billion euros under management.

2.5.1 The Business

By definition, a family office is a private commercial organization which offers assistance and consulting to one or more wealthy families in the organization, management and protection of their entire wealth or part of it.

About 60% of the family offices worldwide are based in US, while 16% of those with more than a billion dollars under management are in the New York area.

Family offices could assist either a single family, operating as a business unit employed by the family itself, or a multi-family office, as Tosetti Value, which offers its services to multiple customers, either families or companies.

Companies resorting to family offices' services usually need assistance in the management of cashflows to decide how to allocate their excess liquidity in order to protect it and to potentially gain financial returns.

For what concerning families, the company focuses on a very specific financial market segment, acting as a consulting firm for VHNWI (Very High Net Worth Individuals), either individuals or legal entities. The goal is to protect and enhance the customers' wealth, allocating it to different financial and non-financial assets, optimizing the relationship with banks and providing tax and legal consultancy for extraordinary operations and successions.

As previously stated, the Family Office's role is approximately equivalent to that of an internal office whose purpose is to take care of the interest of the family, or company, as a full-time job.

Tosetti Value relies on several consultants which are in charge of managing the relationship with clients, which receive a completely customized assistance, taking into account the specific objectives and issues of every different family or entity.

According to a recent research, most family offices hold in their portfolios exposure to private equity and hedge funds, traditionally high-risk asset classes, but the Italian firm opts for a different investing philosophy.

In fact, Tosetti Value gives highest priority to the protection of the principal over time, focusing on risk management and diversification, preventing the customer from assuming exaggerated risks and making sure the ones he decides to assume anyway are equally remunerated.

Therefore, the firm's core business is currently fixed-income investing, a less risky asset class, although during the last years it has implemented a diversification towards equity portfolios, without abandoning the strict characteristic risk management policy.

Voluntarily remaining a consulting and analysis company, Tosetti value avoids the responsibility of directly execute purchase and sales orders on the financial markets.

Anyway, it takes charge of managing the relationship with other financial intermediaries, such as banks, to make sure the customer obtains the most advantageous conditions in terms of fees and other charges, leveraging long term relationships with multiple financial institution.

While consultants constitute the front office of the company, they are constantly in contact with the Research Center, a pool of analysts which don't have direct contacts with customers, but they provide the basis for any asset allocation proposal forwarded to the customer.

In particular, the research center, gathering multiple skilled analysts, performs several kinds of analysis, which can be resumed in four cornerstones

- **Macroeconomic Analysis:** Daily assessment of economic and political events in order to spot the major opportunities worldwide and to anticipate turmoils. Macroeconomic analysts spend the main part of their day examining the last news in order to elaborate their own vision about the events currently happening in the world. Moreover, they can also focus on a particularly important topic which are believed to have a disruptive impact on financial markets in order to elaborate forecasts to be used while adapting portfolios to take profit from new opportunities. The main contemporary examples of disruptive macroeconomic events are certainly the Covid-19 crisis and the elections of the new USA president. Macroeconomists also pay close attention to the movement of currency values and interest rates.
- **Asset Allocation:** Using macroeconomic analysis as a starting point, this phase consists in the continuous review of the entire asset class context to always be in the right positions on the markets.
- **Equity Funds Analysis:** Analysts maintain direct relationships with international fund managers in order to spot the most convenient equity investments. This kind of activity has been rapidly developing during the last year when the company has decided to extend its focus area to equities in order to provide a well-rounded assistance to customers, offering the best advices to both conservative and aggressive investor profiles.
- **Bonds:** the fixed income investments recommendations are based on a thorough assessment run by expert analysts which would be further discussed among the following paragraph.

Even though it doesn't have anything to do with the present master thesis, it is worth remembering Tosetti Value also differentiates its business through non-financial assets, especially contemporary art.

Although they are usually very volatile and consequently riskier, those alternative forms of investments are becoming a consolidated trend in asset management and help investors to diversify their exposure to markets. Family offices, as customer's all-around consultants, may have to deal

with artworks not only as investment but also from a collecting point of view, very common between high-net worth families.

Anyway, alternative non-financial asset classes are usually dealt with in a different perspective, almost opposite to the one characterizing fixed income, and thus they wouldn't be further explained within this dissertation.

2.5.2 Independence

Independence is the company's real competitive advantage, so relevant that its founder and current CEO also wrote a book on this topic.

Along with the features previously listed and the tailored assistance provided to every customer, the company considers independence as its main characteristic feature, allowing it to successfully compete with any other wealth management institution.

In fact, the company decides not to create its own financial instruments in order to sell them to customers. Moreover, although it has consolidated relationships with several financial intermediaries, consolidated during more than twenty years of activity, Tosetti Value doesn't sign contracts with any of them implying any sort of commissions for the sale of financial products.

This policy is to be considered compulsory for every employee dealing with customers and no fee can be received by the company itself or by any of its consultant apart from the wages stated by contract before the collaboration is started.

This rule is one of the fundamentals of the company's business model since it is an effective way of aligning firm's and customer's objectives and to avoid conflicts of interests.

From the very moment the collaboration starts, the only goal of consultants and analysts is to make the client as satisfied as possible delivering what they promised, in order to make him eager to keep on working together and to continue paying for the following period.

On his part, the customer is aware the company has no perverse incentive to push him towards sub-optimal investments and feels comfortable to trust consultants and analysts knowing they are doing their best.

Since he is able to check in real time the outcomes of the advice received confronting them with a pre-determined benchmark, the client enjoys the maximum transparency and he can ask for explanations or schedule an encounter with his consultant in order to discuss the next steps.

In conclusion, the company's business is centered on a limited number of high-net worth clients, a constant research activity, with a specific focus on independence.

Hence, the firm can offer its customers the highest care, with customized assistance in order to elaborate the best plan for each one basing on their objectives and desire, backed by the expertise of analysts and the alignment of interests resulting from independence.

2.5.3 Investing Methodology: Bonds

Tosetti Value implements a thorough due diligence procedure to evaluate the risks related to the issuer and the issuance of bonds.

The firm's analysts take into consideration three kinds of fixed income securities:

- government bonds issued by developed countries
- Corporate and Bank bonds, either senior or subordinated
- Supranational bonds denominated in emerging countries' currencies

The policy of the company states that analysts should only evaluate corporate bonds if the home country of the issuer is rated as Investment Grade by at least one major rating agency. If a bond is considered eligible by the company even though it doesn't meet the aforementioned requirement,

consultants need the authorization of the macroeconomic analysts to recommend it to the customers.

The parameters of the assessment are different depending on the kind of bond being analyzed, this master thesis is more focused on corporate bonds, for which the analyst should look at:

- The solidity of the issuer, looking at its balance sheet data and at its business situation
- The contractual relationship between the issuer and the investor (bond prospectus, regulation)
- Financial characteristics of the issuance: Prices, Maturity, Yield, Duration, Liquidity and Currency

The assessment procedure is constituted by several steps, which eventually bring to the security selection:

1. **Peer Formation:** For each industry, the team identify six issuing companies, usually multinational public companies because of the minor risk and the higher availability of data. The company are picked using several criteria, related to the currency, the size of the emission, the rating and the bid-ask spread.
2. **Internal Scoring Calculation:** The balance sheets of the previous three years are extracted using data providers like Bloomberg, then a mathematical model calculates a score for every company.
3. **Comparing of the three Risk Measures:** The internal scoring is compared to the Rating assigned by the top three rating agencies and with the Credit Default Swap curve, a proxy of the default risk, to spot potential misalignments.
4. **Spotting Eligible Issuers:** Analysts use the scores previously calculated to individuate the issuers which are reliable enough to potentially buy their bonds.
5. **Searching Optimal Risk-Reward Issuances:** Confronting the scoring with the market view of the risk-reward, the analyst tries to individuate the securities which are negatively mispriced by the markets, so that the credit spread is too high compared to the calculated risk.
6. **Communication to consultants:** Consultants will evaluate the data coming from the research center to decide which ones are the best fit for each individual customer and to eventually recommend the operation to him.

If a consultant requires an opinion about the risk-reward of a single issuer from a customer's portfolio, which cannot be inserted in a group to compare it with peers, or if the research center spots an interesting opportunity which should be explored quickly, the analysts prepare a quick assessment, aiming to analyze a single firm by itself in order to evaluate it.

Quick assessments are based on the same principles which form the backlog for peer analysis, using at least the most recent balance sheet and the income statements of the three previous years.

The research center is also in charge of the continuous monitoring activity on customers' financial positions, to be aware as soon as possible of any reason which could potentially motivate a re-allocation of the resources.

In particular, considering also the fixed nature of cash flows granted by bonds, analysts are very careful to exchange rates, both to find interesting opportunities in foreign currencies which are getting stronger against the Euro and to evaluate the liquidation of positions in weakening currencies.

Usually, analysts set a benchmark which could help them being more rational while evaluating portfolios' performances, choosing a comparable risk asset which could be either real or virtual, to use as a comparison for the assets held by the customers.

3. COMPARATIVE ANALYSIS OF PEERS

This chapter is meant to thoroughly describe the process of assessment of companies in order to determine whether to invest in their debt securities. Firms are gathered into groups of six ones, homogeneous in term of activities and so basically comparable, and they get eventually analyzed in every business-management aspect, comparing each company's data to its peers' ones to individuate which ones should be considered as eligible for customers' portfolios.

Even though analyzing each potential bond issuer separately could be enough to examine their risk profile, comparing different competitors provides a way more accurate verdict. The practice of comparing the target company to its peers is very common in equity research, where no decision is made without analyzing how the other players in the industry are behaving.

When it comes to bonds, comparative analysis is a little less exploited, also because of its cost in terms of time and money, but it provides the analyst with more detailed information about companies, considering trends affecting the whole market sector in order to forecast possible general problems which could threaten the financial stability of every player in the future.

In addition, confronts makes expert analysts able to individuate potential unclaritys in issuers' balance sheets, either deciding to further investigate them searching for more data or to stick to bonds issued by entities which provide more disclosure.

The process aims to individuate the most relevant risks related to each security and evaluate each one from both a qualitative and quantitative point of view. In particular, the analysis starts from the assessment of the bond issuers to determine the exposure to credit risk. Then the analyst examines the outstanding securities in multiple aspects for every suitable issuer and confronts them with the best opportunities currently available on the market. The process is meant to produce an output that is consequently delivered to Consultants to provide them with the adequate instruments to tailor customers' portfolio.

The following paragraphs will describe the process of analysis run by the author of the present master thesis during his internship period, taking also advantage of the experience of senior members of the firm.

3.1 Group Formation

It all starts with a request from Consultants and portfolio Managers, who can rely on the Research Center to analyze companies and market sectors. The present assessment activity responds to the need of updating the industry under monitoring, following the global changes in business and economy.

Considering the analysis takes place between the last quarter of 2020 and the first quarter of 2021, so the COVID-19 pandemic must be taken into consideration in every decision process.

As the reader certainly knows, the global pandemic has given birth to a completely new world, hitting hard most industries, but advantaging others, which have had an unpredictable boost to their business activities. Some services have thus become absolutely essential and the providers have enjoyed an oligopolistic global market, with most competitors instantly eliminated by lockdown measures and other restrictions.

Since the pandemic is hopefully a temporary issue, it should be fair assuming a return to the world as we used to know it. However, according to the majority of analysts, Covid-19 just accelerated global changes which were already in process, and thus they must be considered permanent while making forecasts about the world of tomorrow. The most argumentative debate among analysts

and investors worldwide is now about determining which companies, among the ones mainly favored by the global pandemic, are destined to remain elite players in the mid-long terms, as well as which players hardly hit by the pandemic are going to return to their previous level, maybe even exceeding them taking advantage of the reduced competition.

The choice of the industry to focus on largely depends on macroeconomic evaluations and business trends analysis, since investing in fixed income necessarily requires looking at the mid-long term, and customers want their money to possibly be invested in bonds issued by companies belonging to solid industries.

Thus, the decision falls on the E-Commerce sector, which in our opinion has the best balance between competitive advantage provided by pandemic and probability for this same advantage to last in the long run, also considering the trend observed on economic environment before Covid19 outbreak. E-commerce industry has been indeed extremely favored by lockdown measures and restrictions, but it was already profitable and consolidated in the previous years, showing a terrific growth that doesn't seem to have reached an end.

For what concerning the choice of the companies to confront to each other in order to assess credit risks we applied some specific criteria, functional to the investment logic of obtaining the best returns available on the markets limiting the risk as much as possible.

- **They must have at least a 1 billion \$ Market Capitalization:** Since we are not looking for a speculative investment with potential high returns but unacceptable risk levels, we decided to avoid the so called "small-caps", which usually provide a less complete disclosure and are followed by a limited number of analysts. They can also be more exposed to liquidity problems during financial turmoil and are statistically more likely to default on their obligations.
- **They must have outstanding bonds:** Even though it may seem obvious, the opportunity to buy company's securities must be available. It certainly means there must be bonds purchasable on markets, but the ones available must also meet some further requirements. However, this topic will be further discussed in the following paragraphs.
- **They must provide an adequate disclosure level:** A company doesn't necessarily need to be public to issue bonds, but the availability of certified financial data is a primary requirement for a company to be trustworthy. Public firms are forced to make their financial statements public and to accept the auditing of renowned auditing company, which accept under their own responsibility to certify the correctness of every statement. This makes data more readily available and reduces the room for companies to make numbers communicate different things than the ones they would be supposed to. Hence, we express a strong preference for public companies, accepting exceptions only in few cases, when issuers are established and well renowned companies, whose data are readily available and audited by trustworthy firms. Anyway, every company constituting the present peer group is currently listed.
- **They must have been started more than ten years ago:** In order to limit volatility, we decided to just focus on companies which already have some "history" on the markets. The motivation is indeed quite simple: focusing on the long term and privileging the delivering of constant value over the search for the winning bet, we choose companies whose business models have already been tested by markets and proven themselves effective and

sustainable. As already stated, this logic might limit the opportunity of individuating a new market winner in advance, but it has been proven effective over time in protecting investors from defaults of bonds in their portfolios.

- **They must have data available for at least three years backwards:** The balance sheets available for analysts must cover at least the entire timespan considered. The chosen horizon is three years because in our opinion it perfectly matches the need for briefness while presenting it to customers with a significant data set. In the vast majority of cases, looking three years backwards is enough to highlight the most important trends, potentially still ongoing today.
- **They must have comparable business models:** Even though it is not mandatory for companies to be active in the same precise segment, their business activities have to be similar to each other enough to make a comparison meaningful.

The selection process ends with the choice of the six more interesting players in the e-commerce sector. According to the criteria previously listed we chose the following companies:

- **Alibaba:** Chinese company based in Hangzhou and started in 1999 by Jack Ma. It is the biggest business-to-business e-commerce platform in the world. It was listed in 2007 at the Hong-Kong stock exchange and in 2014 it also listed on NYSE. It currently has a market capitalization of about 716 billion dollars.
- **eBay:** Very popular American company based in Silicon Valley, it was started in 1995 and listed on NASDAQ in 1998. It was the first company ever to promote online auctions and its growth has been impressive over time. Its market cap is currently 33,87 billion dollars.
- **Bed Bath and Beyond:** Historical American company based in Springfield and started in 1971. It was listed on NASDAQ in 1992 and currently accounts for 2,42 billion dollars of market capitalization.
- **Amazon:** The biggest e-commerce giant worldwide, based in Seattle and started in 1994 by Jeff Bezos under the name Cadabra.com. It went public in 1997 on NASDAQ. Its market capitalization reaches an impressive 1,56 trillion dollars.
- **Zalando:** Zalando is the most relevant European e-commerce company, headquartered in Berlin and started in 2008. It was listed on the Frankfurt Stock Exchange (XETRA) in 2014.
- **Expedia:** American company based in Seattle and founded in 1996 as a division of Microsoft. It is quite different from the other companies since it sells services rather than physical products, but its business model is so similar that it is fair to insert it in this assessment group. It went public in 1999 and currently has a market capitalization of 17,4 billion dollars.

Before selecting each company, the analyst checked if there are potentially interesting bonds available on markets for each issuer. The presence of bonds on financial markets is essential but their immediate suitability for customers' portfolios may not be mandatory. Even though some securities might not seem convenient to buy today, they may become more interesting in the future, or the company may decide to issue new bonds. This kind of assessment is meant to be kept updated over the years, potentially substituting components, so it is important for the analyst to gather the right number of companies to run a proper comparative analysis even if some don't have potentially interesting bonds at the moment.

3.1.1 The problem of Seasonality

Some companies may be authorized to register their fiscal year out of phase respect to the solar year, so that the yearly report may not be referred to the period from January to December, but it may be anticipated or delayed by one or even two or three quarters. When this problem occurs, the analyst must consider two main issues to decide if the companies are comparable: seasonality and, once again, disclosure.

If the industry doesn't show particular seasonality, being out of phase of just one quarter may not be a relevant issue, and so it could be fair to confront two annual reports even though they are delayed or anticipated by one quarter respect to each other. Anyway, it is not advisable to neglect differences of more than one quarter, because of the higher probability of being affected by structural macro-trends in the industry.

If the market sector is instead affected by seasonality, it is always necessary to compare reports referred to the same periods. Generally, annual reports are more accurate and complete, while half reports are usually much less detailed and may be unaudited. This issue is even more noticeable in quarterly reports. Hence, even though ratios could be adjusted to compare yearly reports with half or nine-months reports, this practice requires more attention.

In the specific case under consideration, the problem arises with Bed, Bath and Beyond, which concludes its financial on the last week of February, while Alibaba closes its fiscal 2020 on March 31.

The industry itself is not generally affected by relevant seasonality, apart from the month of December, but it won't be included for any of the firms. However, 2020 is a completely unique year, when every month is characterized by unexpected upheavals in the global environment, making it necessary to compare firms basing on contemporary data.

Fortunately, every company provides adequate disclosure in every financial report, and so we feel free to use quarterly reports and half-year reports to make meaningful comparisons, and the assessment work can be run with the selected companies.

Considering the yearly reports are normally published between February and April, the assessment will compare the financial statements of the first nine months of 2020. For Alibaba and Bed, Bath and Beyond the analysis will be run using the first half of their financial years, which extends from march to September, and ratios will be adjusted to be compared to the peers.

3.2 Financial Data Gathering & Qualitative Analysis

The first step of a complete group analysis consists in gathering the financial data of each firm, which will constitute the basis for the comparative credit risk assessment. As already mentioned while explaining the requirements each firm should meet, the analysis usually concentrates on three complete financial years, but since it must be run in December it will consider the first three quarters of 2020, with a partial exception for the two firms, Alibaba and Bed, Bath and Beyond, which close their financial years in March.

While the info sources are mainly their Annual Reports, issuers' financial data are collected using Bloomberg, the most widely used data provider in finance, also using Thomson Reuters either for a comparison or to search possibly missing data. Once collected, they are put in templates which would facilitate the quick visual comparison between companies.

The analyst's work starts with the analysis of each company as a single entity, before any comparison with peers, in order to run a due diligence of any of them from both a qualitative and a quantitative point of view.

This step of the process takes into account multiple aspects of the business activity of each firm, reporting the available information about the strategic direction of the management in the recent past and considering the most likely development in the future. In particular, the analyst should verify if there have been any M&A operation involving the company or the whole segment in which it is operating, because they could be precious indicators of the strategic line the management will give the company in the mid/long term.

After analyzing the most relevant business events, the focus switches to the values reported in the financial statements. The analyst looks for particularly outstanding numbers, both as absolute values and as differential with previous periods, identifying trends. When a particularly strange value emerges, it is necessary to further investigate its origins to find out whether it could endanger the future solvency of the company.

To perform this task, it is very important for the analyst to be particularly attentive to details and to have some experience in order to quickly identify unclarities and critical values, since sometimes the judgement parameters may vary from an industry to another.

The most quantitative part of the first assessment is the interpretation of ratios, particular indicators built combining data from the financial statement. They are divided in four areas:

- A&L: Ratios built combining in different ways data from balance sheets.
- MIXED: Ratios built combining data from income statement with data from balance sheet and cash flow statement.
- P&L: These ratios are built using exclusively data from the income statement and from the cash flow statement.
- PROFITABILITY INDICES: Those ratios are probably the most widely-used for financial analysis. However, for our purposes, we estimate to just need two of them: ROI and ROE.

A wide spectrum of ratios is important because it provides the analyst with a general overview of the company's performance over the last periods under several points of view.

Helped by the experience of senior professionals, we established thresholds for some indicators, beyond which the underlying financial situation is to be considered critical. A worrying indicator will be denoted with the red color to create a clear visual impact.

Even though those ratios are meant to cover almost every area of the overall performance of a company, there are some specific indicators which are to consider more relevant depending on the purpose of the assessment.

Moreover, the industry under observation has also to be taken into account while selecting more relevant ratios and thresholds.

The purpose of this analysis is to examine the future solvency of companies and to determine whether they will be able to meet their obligations in the future, so we tend to give more priority to those indexes concerning, for instance, financial stability and liquidity respect to indexes related to the evaluation of the business by the market, such as price/earnings, more useful in equity research.

Here it follows a list of the financial ratios we consider more relevant, along with the relative thresholds

- **Equity/Debt:** It is useful to assess the presence of the correct amount of capital belonging to the company's owners respect to the total debt. It is not a good indicator for lenders when the borrowing company is running business using almost only their capital, because it could imply less commitment to the actual surviving of the society and less resources to recover in case of default. The critical threshold for this indicator may be different depending on industries. Generally, more capital-intensive sectors tend to require a higher threshold. The default one is 0,3, but it can be lowered for less capital-intensive industries.
- **Equity/ Financial Net Debt:** The purpose is the same as the previous ratio, but it only considers financial liabilities, subtracting financial assets. It must not be used alone, because the evaluation of fair value of financial assets, especially if they're among the so called "level 3" assets, may distort the result.
- **Receivables/Short Term Liabilities:** Also called Acid Test, it aims to evaluate in what measure the money the company is supposed to receive covers the money it is supposed to pay in the short term. It provides a quick proxy of the short-term liquidity of the firm. It is considered critical if it is lower than 0,55.
- **Financial Net Debt/EBITDA:** It shows in what measure the company is able to cover its financial net debt with its EBITDA. It is sometimes used in the inverse form the inverse, which tells the analyst how many periods would it take to the firm to repay its financial net debt using its EBITDA.
- **CF/Financial Long-Term Liabilities:** The underlying logic is the same as that of the previous ratio. The purpose of this indicator is showing in what measure the firm is able to cover its whole long-term liabilities only using cash provided by its operational management. It is critical below 0,3.
- **Days of Trade Receivables – Days of Trade Liabilities:** Particularly important in a high-turnover industry, as e-commerce is, because it measures the gap between the average time to get paid by debtors and the time to pay creditors. It should be as low as possible, possibly way below zero, because the higher it gets, the more the company will face liquidity problems having to anticipate cash.
- **EBITDA/Total Revenues:** It is meant to evaluate the efficiency of the operational activity. The higher the percentage, the higher the ability of the firm to keep for itself the main part of revenues without too much money getting absorbed by operational expenses. Its standard values are extremely variable from an industry to another.

- **EBIT/Total Revenues:** The logic is the same as above, but this ratio also considers the impact of Depreciation and Amortization.
- **Profit/Total Revenues:** It evaluates the efficiency of the entire business activity. It is meant to identify the amount of revenues actually remaining in the company as profit. It is a proxy of the ability to generate revenues keeping all costs as low as possible, and it is variable between an industry to another.
- **CF/Total Revenues:** It only refers to operating cashflows. It explains the percentage of revenues actually becoming cash, excluding all accounted revenues not translating into a positive cash flow. Operating cash flows are very important in credit risk assessments, because the more cash a company is able to generate with its business activity, the more it will be likely to meet its future obligations. If it doesn't generate enough cash, it is forced to resort to more debt to repay its previous obligations, potentially falling in a vicious circle leading to insolvency and default.
- **EBITDA/Interest Expenses:** This ratio measures the weight of interest expenses respect to EBITDA. It aims to assess the if the company is able to pay the obligations of a certain period using the resources it generated with its operational activity. The analyst must be careful while analyzing it because it considers accounting quantities and not financial ones. If this indicator is regular it doesn't mean there is no liquidity problems for the period, because revenues may not correspond to actual entering cash flows. It must be higher than 2,2 in order to not be considered critical.
- **EBIT/Interest Expenses:** The logic is the same as the previous one, but it also considers depreciation and amortization. It must not be lower than 1,2. Obviously, a lower than 1 implies the need of a debt increase to pay interests.
- **Return on Equity (ROE):** It is simply the ratio between the profit for the period and the stockholders' equity. It measures the percentage of the money invested as equity that returns to the stockholders as earnings. It doesn't differentiate between retained earnings and earnings distributed as dividends. It must preferably not be negative, because it would imply a loss for the period, but it is extremely variable between an industry and another.
- **Return on Investment (ROI):** it is the ratio between the operating profit (the EBIT) and the total Capital Employed to generate it, considering both equity and debt. It indicates the return on capital invested in the operating activity, no matter if provided by shareholders, lenders or retained by the previous periods, which remains to remunerate lenders and shareholders once the operating expenses have been paid. As for ROE, ROI should never be negative, but it is extremely influenced by the industry being analyzed.
ROE and ROI may offer a proxy of the quality of financial leverage: if ROE is higher than ROI, the shareholders' capital is better remunerated, as it should be considering it's the riskiest one. Conversely, if ROI is higher than ROE it should be considered an alarm bell, since equity is less remunerated than debt even though its riskiness is higher.

The figures 3.1-3.6 show the output of the first step of individual analysis for each company, complete of ratio calculation and analyst's report. The ultimate goal of this first step is to determine if there is any firm which is particularly risky independently from its competitors. Moreover, ratios will provide the most relevant data set for the comparative scoring model and thus they will also be widely used among the following parts of the assessment.

ALIBABA GROUP HOLDING-SP ADR

BALANCE SHEET

RMB (mln)	Note	FY 2018	FY 2019	mar-20	set-20
Intangible assets		189.614	333.211	337.729	332.550
Property, plants, equipment (PPE)		66.489	92.030	128.287	118.037
Inv. & LT financial assets		204.166	269.562	384.046	460.104
Goodwill & consolid. difference		162.149	264.935	276.782	276.172
Non-current assets		460.269	694.803	850.062	910.691
Inventories		0	0	0	0
of which: Finished goods		0	0	0	0
Receivables, adv. Payments		256.855	270.273	462.923	522.935
* Trade receivables		7.284	13.771	19.786	98.852
of which: * Receivables from financial		210.210	203.165	363.215	314.889
* ...					
Other receivables		39.361	53.337	79.922	109.194
Assets held for sale					
Total Assets		717.124	965.076	1.312.985	1.433.626
Stockholders equity		368.823	499.076	764.504	865.436
Minority interests		70.616	116.326	115.147	115.787
Provisions					
Pension plans		0	0	0	0
Non-current liabilities		141.875	142.005	191.462	189.461
of which: Financial liabilities		119.525	111.834	139.676	116.885
Short term liabilities		135.810	207.669	241.872	262.942
* Trade liabilities		94.854	135.396	181.726	197.901
of which: * Financial		6.028	22.466	5.154	4.903
* Provisions st					
Other liabilities		34.928	49.807	54.992	60.138
Liabilities held for sale					
Total Liabilities		717.124	965.076	1.312.985	1.433.626
ctrl		0	0	0	0

INCOME STATEMENT

RMB (mln)	2018	2019	mar-20	set-20
Sales of goods	250.266	376.844	509.711	308.810
Total revenues	250.266	376.844	509.711	308.810
Cost of goods sold	-106.004	-202.838	-276.006	-186.459
SGA expenses	-43.540	-64.669	-78.870	-30.327
R&D expenses	-22.754	-37.435	-43.080	-49.821
Other operating Inc/exp	0	0	0	2.641
Labour Cost	0	0	0	0
EBITDA	77.968	71.902	111.755	44.844
Depreciation	-8.654	-14.818	-20.325	-17.816
Amortization				
EBIT	69.314	57.084	91.430	27.028
Finance income / expenses	31.089	39.137	75.215	30.423
of which: interest expenses	-3.566	-5.190	-5.180	-2.224
Operating profit	100.403	96.221	166.645	57.451
Extraordinary items				
Dividends	-20.792	566	-5.733	4.544
Income Taxes	-18.199	-16.553	-20.562	-13.035
Minorities	2.681	7.652	9.083	3.448
Net income cont. operations	64.093	87.886	149.433	52.408
Net income from disc. operations	0	0	0	0
Profit for the period	64.093	87.886	149.433	52.408
	0,0	0,0	0,0	0,0

CASH FLOW

Usd (Mil.)	2018	2019	mar-20	set-20
Net cash from operations	125.805	150.975	180.607	104.395
Net cash from inv. activities	-83.764	-151.060	-108.072	-136.781
Net cash from fin. activities	14.294	-4.147	74.953	1.293
Net cash flow	56.335	-4.232	147.488	-31.093
Employees	66.421	101.958	117.600	122.399

RATIOS	FY 2018	FY 2019	mar-20	set-20
Equity / fixed assets	0,80	0,72	0,90	0,95
Equity / debt	1,06	1,07	1,39	1,52
Equity / fin. net debt	-4,36	-7,25	-3,50	-4,48
Eq+non c.liab.-Fix.assets/GrossWcap	0,47	0,23	0,48	0,50
Receivables / Short term liabilities	1,89	1,30	1,91	1,99
Fin. net debt / EBITDA	-1,09	-0,96	-1,95	-2,15
CF / Financial long term liabilities	105,3%	135,0%	129,3%	178,6%
Net WCap / Total revenues	-35,0%	-32,3%	-31,8%	-16,0%
Trade receivable, days	10	13	14	58
Trade liabilities, days	322	240	237	191
Delta, days	-312	-227	-223	-133
Finished goods, days	0	0	0	0
Cost of goods sold / Total revenues	42,4%	53,8%	54,1%	60,4%
SGA expenses / Total revenues	17,4%	17,2%	15,5%	9,8%
R&D expenses / Total revenues	9,1%	9,9%	8,5%	16,1%
Labour cost / Total revenues	0,0%	0,0%	0,0%	0,0%
EBITDA / Total revenues	31,2%	19,1%	21,9%	14,5%
EBIT / Total revenues	27,7%	15,1%	17,9%	8,8%
Operating pr. / Total revenues	40,1%	25,5%	32,7%	18,6%
Profit from cont. op. / Total revenues	25,6%	23,3%	29,3%	17,0%
Profit / Total revenues	25,6%	23,3%	29,3%	17,0%
CF / Total revenues	50,3%	40,1%	35,4%	33,8%
Int. exp. / Total revenues	1,4%	1,4%	1,0%	0,7%
EBITDA / interests exp.	21,86	13,85	21,57	20,16
EBIT / interests exp.	19,44	11,00	17,65	12,15
ROE from continuing operations	17,4%	17,6%	19,5%	12,1%
ROI	19,5%	10,4%	13,8%	6,9%

REPORT

The balance sheet shows a very healthy company, with a solid capital structure. Leverage is extremely low respect to a way higher equity value, which experienced a steady growth during last years and doesn't seem to be approaching a trend inversion. Indeed, the financial net debt is negative and the firm has virtually illimited room to get resources for a further growth.

The net working capital is also negative, allowing the firm to collect money in advance and to delay payments, very important plus in a high-turnover business. During the last year this feature reduced a little bit its impact, possibly because of concessions to debtors which may face liquidity problems due to the global pandemic crisis.

Alibaba is an e-commerce giant with a continuously expanding market, as shown by revenues from march to september, growing at an even higher pace respect to previous years.

Moreover, the data available today don't consider the quarter september-december, which usually gives an impressive boost to revenues during "Black Friday", "Single Day" and year ending holidays.

The income statement is positive from all points of view, with no issues to report.

The same could be stated about operating cash flows, allowing Alibaba to finance an important investing activity without raising leverage.

Hence, the business model is successful and the growth looks set to continue at an impressive pace during the next years.

The only critical aspect regarding Alibaba respect to its peers is its strong addiction to Chinese market, which is both a pro and a con at the same time.

Chinese market is indeed the biggest one worldwide and it keeps on growing with millions of people coming out from poverty every year, turning into potential customers. However, the political situation and the heavy influence of the Government expose Chinese companies to a large spectrum of risks, which are hardly predictable and manageable with mitigation strategies.

Figure 3.1 Alibaba's Balance sheet and analyst's report

EBAY INC

BALANCE SHEET

Usd (Mil.)	Note	FY 2018	FY 2019	3Q 2020
Intangible assets		5.252	5.220	4.556
Property, plants, equipment (PPE)		1.597	2.138	1.800
Inv. & LT financial assets		8.844	6.110	5.326
Goodwill & consolid. difference		5.160	5.153	4.537
Non-current assets		15.693	13.468	11.682
Inventories		0	0	0
of which: Finished goods		0	0	0
Receivables, adv. Payments		7.126	4.706	5.623
* Trade receivables		712	700	477
of which: * Receivables from financial		4.915	2.825	3.660
* Other receivables		1.499	1.181	1.486
Assets held for sale				1.116
Total Assets		22.819	18.174	18.421
Stockholders equity		6.281	2.870	2.920
Minority interests		0	0	0
Provisions		0	0	0
Pension plans		12.084	11.238	11.661
Non-current liabilities		7.675	7.230	7.738
of which: Financial liabilities				
Short term liabilities		4.454	4.066	3.344
* Trade liabilities		2.700	2.691	2.843
of which: * Financial		1.546	1.192	17
* Provisions st		0	0	379
Other liabilities		208	183	105
Liabilities held for sale				496
Total Liabilities		22.819	18.174	18.421
ctrl		0	0	0

INCOME STATEMENT

Usd (Mil.)	2018	2019	3Q 2020
Sales of goods	10.746	10.800	7.403
Total revenues	10.746	10.800	7.403
Cost of goods sold	-2.091	-2.228	-1.260
SGA expenses	-4.522	-4.383	-2.585
R&D expenses	-1.285	-1.240	-788
Other operating Inc/exp	0	0	-245
Labour Cost	0	0	0
EBITDA	2.848	2.949	2.525
Amortization	-626	-628	-491
Depreciation			
EBIT	2.222	2.321	2.034
Finance income / expenses	496	-114	277
of which: interest expenses	-326	-311	-277
Operating profit	2.718	2.207	2.311
Extraordinary items			
Dividends	0	0	0
Income Taxes	-190	-415	-550
Minorities	0	0	0
Net income cont. operations	2.528	1.792	1.761
Net income from disc. operations	2	-6	3.061
Profit for the period	2.530	1.786	4.822
	0,0	0,0	

CASH FLOW

Usd (Mil.)	2018	2019	3Q 2020
Net cash from operations	2.658	3.114	1.661
Net cash from inv. activities	2.894	2.787	3.580
Net cash from fin. activities	-5.473	-7.124	-5.143
Net cash flow	79	-1.223	98
Employees	14.000	13.300	N/A

RATIO	FY 2018	FY 2019	3Q 2020
Equity / fixed assets	0,40	0,21	0,25
Equity / debt	0,38	0,19	0,19
Equity / fin. net debt	1,46	0,51	0,71
Eq+non c.liab.-Fix.assets/GrossWcap	0,37	0,14	0,60
Receivables / Short term liabilities	1,60	1,16	1,68
Fin. net debt / EBITDA	1,51	1,90	0,89
CF / Financial long term liabilities	34,6%	43,1%	28,6%
Net WCap / Total revenues	-18,5%	-18,4%	-24,0%
Trade receivable, days	24	23	17
Trade liabilities, days	465	435	609
Delta, days	-441	-412	-592
Finished goods, days	0	0	0
Cost of goods sold / Total revenues	19,5%	20,6%	17,0%
SGA expenses / Total revenues	42,1%	40,6%	34,9%
R&D expenses / Total revenues	12,0%	11,5%	10,6%
Labour cost / Total revenues	0,0%	0,0%	0,0%
EBITDA / Total revenues	26,5%	27,3%	34,1%
EBIT / Total revenues	20,7%	21,5%	27,5%
Operating pr. / Total revenues	25,3%	20,4%	31,2%
Profit from cont. op. / Total revenues	23,5%	16,6%	23,8%
Profit / Total revenues	23,5%	16,5%	65,1%
CF / Total revenues	24,7%	28,8%	22,4%
Int. exp. / Total revenues	3,0%	2,9%	3,7%
EBITDA / interests exp.	8,74	9,48	9,12
EBIT / interests exp.	6,82	7,46	7,34
ROE from continuing operations	40,3%	62,2%	220,2%
ROI	21,0%	27,4%	38,7%

REPORT

During the last quarter of 2019 eBay reached an agreement to sell StubHub to Viagogo for a consideration of 4,05 bn \$. The M&A operation was finalized during the first quarter of 2020, leading to 2,927bn \$ of extraordinary earnings. During 2019 the company launched a massive repurchasing plan, as shown by the equity reduction, the majority of which was paid in cash.

The fall of equity raises the percentage of debt in the capital structure, taking ratios in critical area. Nevertheless, the business remains solid, operating in a segment with a very little capital intensity and high resilience to external happenings such as Covid19.

eBay has a consolidated business model, strong brand identity and has had a long streak of positive income statements, with a steady growth of revenues during the last years.

The first three quarters of 2020 seems to be following this trend, even though revenues are a little bit lowering because of the StubHub sale. Anyway, costs have been reduced more than proportionally, leading to an income statements which remained almost indifferent to the pandemic.

Operating cash flows are positive as well, while high negative financial cash flows are mainly due to aggressive repurchasing plan. eBay is probably implementing a restructuring in its own business model, sticking to its core business.

The sale of StubHub reminds of other similar operations run by the firm during its history (PayPal and Skype), so probably eBay is now looking for new emerging companies to buy and eventually sell with high margins.

Hence, the sale of branches such as StubHub doesn't seem to be putting at risk the survival of the company.

Conversely, it is necessary to verify the meaning of the liquidation of capital by stock repurchasing. The ownership is largely diffused between several big investing funds, which own diversified portfolio and may be using the company as a cash cow.

Figure 3.2 eBay's balance sheet and analyst's report

BED BATH & BEYOND INC

BALANCE SHEET

USD (mln)	Note	FY 2018	FY 2019	FY 2020	sep 2020
Intangible assets		1,022	535	0	0
Property, plants, equipment (PPE)		1,909	1,853	3,438	3,210
Inv. & LT financial assets		139	273	527	486
Goodwill & consolid. difference		716	391	0	0
Non-current assets		3,070	2,661	3,964	3,696
Inventories		2,731	2,619	2,094	2,052
of which: Finished goods		2,731	2,619	2,094	2,052
Receivables, adv. Payments		1,240	1,291	1,732	1,692
* Trade receivables		0	0	0	0
of which: * Receivables from financial		724	995	1,386	1,442
* Other receivables		516	296	346	250
Assets held for sale					
Total Assets		7,041	6,571	7,791	7,439
Stockholders equity		2,889	2,560	1,765	1,697
Minority interests		0	0	0	0
Provisions					
Pension plans		0	0	0	0
Non-current liabilities		1,986	1,933	3,559	3,240
of which: Financial liabilities		1,492	1,488	1,591	1,190
Short term liabilities		2,166	2,078	2,467	2,503
* Trade liabilities		1,831	1,738	1,618	1,715
of which: * Financial		0	0	465	465
* Provisions st					
Other liabilities		335	339	384	323
Liabilities held for sale					
Total Liabilities		7,041	6,571	7,791	7,439
ctrl		0	0	0	0

INCOME STATEMENT

USD (mln)	2018	2019	2020	sep 2020
Sales of goods	12,349	12,029	11,159	3,995
Total revenues	12,349	12,029	11,159	3,995
Cost of goods sold	-7,593	-8,096	-7,784	-2,659
SGA expenses	-3,682	-3,681	-3,732	-1,574
R&D expenses	0	0	0	0
Other operating Inc/exp	0	0	0	0
Labour Cost	0	0	0	0
EBITDA	1,074	252	-358	-238
Amortization	-313	-339	-343	-142
Depreciation	-313	-339	-343	-142
EBIT	761	-87	-700	-380
Finance income / expenses	-66	-69	-65	36
of which: interest expenses	-66	-69	-65	-41
Operating profit	696	-157	-765	-343
Extraordinary items	1)			190
Dividends	0	0	0	0
Income Taxes	-271	19	151	69
Minorities	0	0	0	0
Net income cont. operations	425	-137	-614	-84
Net income from disc. operations	0	0	0	0
Profit for the period	425	-137	-614	-84

CASH FLOW

USD (Mil.)	2018	2019	2020	sep 2020
Net cash from operations	860	918	591	149
Net cash from inv. activities	-674	-510	91	552
Net cash from fin. activities	-327	-246	-184	-253
Net cash flow	-142	163	498	448
Employees	65,000	62,000	55,000	N/A

RATIO	FY 2018	FY 2019	FY 2020	sep 2020
Equity / fixed assets	0,94	0,96	0,45	0,46
Equity / debt	0,70	0,64	0,29	0,30
Equity / fin. net debt	3,76	5,19	2,64	7,96
Eq+non c.liab.-Fix.assets/GrossWcap	0,45	0,47	0,36	0,33
Receivables / Short term liabilities	0,57	0,62	0,70	0,68
Fin. net debt / EBITDA	0,71	1,96	-1,87	-0,45
CF / Financial long term liabilities	57,6%	61,7%	37,1%	25,0%
Net WCap / Total revenues	7,3%	7,3%	4,3%	4,2%
Trade receivable, days	0	0	0	0
Trade liabilities, days	87	77	75	116
Delta, days	-87	-77	-75	-116
Finished goods, days	80	78	-97	-139
Cost of goods sold / Total revenues	61,5%	67,3%	69,8%	66,6%
SGA expenses / Total revenues	29,8%	30,6%	33,4%	39,4%
R&D expenses / Total revenues	0,0%	0,0%	0,0%	0,0%
Labour cost / Total revenues	0,0%	0,0%	0,0%	0,0%
EBITDA / Total revenues	8,7%	2,1%	0,0%	-6,0%
EBIT / Total revenues	6,2%	-0,7%	-6,3%	-9,5%
Operating pr. / Total revenues	5,6%	-1,3%	-6,9%	-8,6%
Profit from cont. op. / Total revenues	3,4%	-1,1%	-5,5%	-2,1%
Profit / Total revenues	3,4%	-1,1%	-5,5%	-2,1%
CF / Total revenues	7,0%	7,6%	5,3%	3,7%
Int. exp. / Total revenues	0,5%	0,6%	0,6%	1,0%
EBITDA / interests exp.	16,36	3,62	-5,52	-5,88
EBIT / interests exp.	11,59	-1,25	-10,81	-9,37
ROE from continuing operations	14,7%	-5,4%	-34,8%	-9,9%
ROI	20,8%	-2,9%	-28,8%	-39,8%

REPORT

The capital structure looks decent: equity percentage is sufficient, also because of the repayment of part of long term debt. Liquidity situation is still positive and the firm is not suffering from that point of view, so it doesn't seem to need further measures to get liquidity.

The critical aspects are mainly related to the income statement: during the last three years the trend may cause some troubles, especially because of a steady decrease of revenues, not balanced by an adequate cost reduction, which leads to negative earnings in 2019, when the pandemic wasn't a factor yet.

The last semester, amid pandemic, is not as positive as its peers', but it shows instead a further drop in revenues due to the reliance on physical stores, still strong despite the heavy investments in e-commerce.

Anyway, an aggressive cost-cutting policy, which is meant to lead to the closing of 200 stores by the end of 2020, helps reducing the damage.

Operating cash flows are dropping as well during the last years, and the net cash flow is maintained positive by investing activities, which have nothing to do with the company's core business, which remains a relevant question mark.

The 189,5 million \$ of extraordinary items come from the sale of PMall to 1-800-Flowers.com, responding to the need of simplifying the group portfolio and sticking to core segments, strengthening operations with programs such as "buy-online-retain-in-store".

Although short term insolvency risk doesn't look worrying, the company seems in trouble and it is going through a transition moment. Next periods will be decisive to determine if it will ever be able to generate stable earnings, transforming its business model to meet the requirements of the future.

Figure 3.3 Bed, Bath and Beyond's balance sheet and analyst's report

AMAZON.COM INC

BALANCE SHEET

USD (Mil.)	Note	FY 2018	FY 2019	3Q 2020
Intangible assets		18.658	18.803	14.960
Property, plants, equipment (PPE)		61.797	97.846	134.100
Inv. & LT financial assets		7.092	12.265	20.150
Goodwill & consolid. difference		14.548	14.754	14.960
Non-current assets		87.547	128.914	169.210
Inventories		17.174	20.497	23.735
of which: Finished goods		17.174	20.497	23.735
Receivables, adv. Payments		57.927	75.837	89.234
* Trade receivables		16.677	20.816	20.832
of which: * Receivables from financial		41.250	55.021	68.402
Other receivables		0	0	0
Assets held for sale				
Total Assets		162.648	225.248	282.179
Stockholders equity		43.549	62.060	82.775
Minority interests		0	0	0
Provisions		0	0	0
Pension plans		0	0	0
Non-current liabilities		50.708	75.376	97.492
of which: Financial liabilities		23.495	23.414	32.929
Short term liabilities		68.391	87.812	101.912
* Trade liabilities		52.353	65.292	58.334
of which: * Financial	1)	9.502	11.191	34.327
* Provisions st				
Other liabilities		6.536	11.329	9.251
Liabilities held for sale				
Total Liabilities		162.648	225.248	282.179
ctrl		0	0	0

INCOME STATEMENT

USD (Mil.)	2018	2019	3Q 2020
Sales of goods	232.887	280.522	260.509
Total revenues	232.887	280.522	260.509
Cost of goods sold	-161.341	-190.819	-176.433
SGA expenses	-18.150	-24.081	-19.305
R&D expenses	-28.837	-35.931	-30.691
Other operating inc/exp	0	0	-421
Labour Cost	0	0	0
EBITDA	24.559	29.691	33.659
Depreciation	-12.138	-15.150	-17.633
Amortization			
EBIT	12.421	14.541	16.026
Finance income / expenses	-1.160	-565	387
of which: interest expenses	-1.417	-1.600	-1.233
Operating profit	11.261	13.976	16.413
Extraordinary items			
Dividends	0	0	-6
Income Taxes	-1.188	-2.388	-2.298
Minorities	0	0	0
Net income cont. operations	10.073	11.588	14.109
Net income from disc. operations	0	0	0
Profit for the period	10.073	11.588	14.109
	0,0	0,0	

CASH FLOW

USD (Mil.)	2018	2019	3Q 2020
Net cash from operations	30.723	38.514	35.633
Net cash from inv. activities	-12.369	-24.281	-42.574
Net cash from fin. activities	-8.037	-9.996	712
Net cash flow	10.317	4.237	-6.229
Employees	647.500	798.000	1.125.300

RATIO	FY 2018	FY 2019	3Q 2020
Equity / fixed assets	0,50	0,48	0,49
Equity / debt	0,37	0,38	0,42
Equity / fin. net debt	-5,28	-3,04	-72,23
Eq+non c.liab.-Fix.assets/GrossWcap	0,09	0,09	0,10
Receivables / Short term liabilities	0,85	0,86	0,88
Fin. net debt / EBITDA	-0,34	-0,69	-0,03
CF / Financial long term liabilities	130,8%	164,5%	144,3%
Net WCap / Total revenues	-7,9%	-8,5%	-4,0%
Trade receivable, days	26	27	22
Trade liabilities, days	117	123	89
Delta, days	-91	-96	-67
Finished goods, days	27	26	25
Cost of goods sold / Total revenues	69,3%	68,0%	67,7%
SGA expenses / Total revenues	7,8%	8,6%	7,4%
R&D expenses / Total revenues	12,4%	12,8%	11,8%
Labour cost / Total revenues	0,0%	0,0%	0,0%
EBITDA / Total revenues	10,5%	10,6%	12,9%
EBIT / Total revenues	5,3%	5,2%	6,2%
Operating pr. / Total revenues	4,8%	5,0%	6,3%
Profit from cont. op. / Total revenues	4,3%	4,1%	5,4%
Profit / Total revenues	4,3%	4,1%	5,4%
CF / Total revenues	13,2%	13,7%	13,7%
Int. exp. / Total revenues	0,6%	0,6%	0,5%
EBITDA / interests exp.	17,33	18,56	27,30
EBIT / interests exp.	8,77	9,09	13,00
ROE from continuing operations	23,1%	18,7%	22,7%
ROI	35,2%	34,9%	26,2%

REPORT

In addition to being a huge company operating all over the world, Amazon is probably one of the companies which have benefited the most from Covid19.

All indicators appear very positive: solid capital structure, expanding operating activity, no liquidity suffering.

As of september 2020, Amazon registers an equity book value eight times higher than five years before, and it operates with negative net financial debt.

The net working capital is negative as well, preventing liquidity problems, which would be covered anyway by 68 billion \$ in cash.

The probability of financial problems in mid-term is then almost inexistent.

The income statement is not less outstanding: revenues registered in the first three quarters of 2020 are almost as high as the ones of the entire previous year, and the same can be said for operating cash flows.

The growth of the company during last years is noticeable by revenues, almost triplicated in the last five years, and employees number, grown by an unreal 41% over the last nine months.

Cash flows used in Investing activities are also growing to sustain an extraordinary expansion, which now covers multiple sectors. Amazon allocates an impressive amount of money to R&D, investing more than 30 bn \$ during the first three quarters of 2020.

The only concern about Amazon's business activity is its almost-monopolistic position itself, which is starting to draw the attention of antitrust authorities in many countries, as will be further discussed in the legal section.

Figure 3.4 Amazon's balance sheet and analyst's report

EXPEDIA GROUP INC

BALANCE SHEET		TV		
USD (Mil.)	Note	FY 2018	FY 2019	3Q 2020
Intangible assets		10.112	9.931	8.880
Property, plants, equipment (PPE)		1.877	2.809	2.901
Inv. & LT financial assets		847	941	606
				557
Goodwill & consolid. difference		8.120	8.127	7.343
Non-current assets		12.836	13.681	12.944
Inventories		0	0	0
of which: Finished goods		0	0	0
Receivables, adv. Payments		5.197	7.735	6.735
* Trade receivables		2.151	2.524	839
of which: * Receivables from financial		2.471	3.841	5.078
				708
Other receivables		575	1.370	110
Assets held for sale				
Total Assets		18.033	21.416	19.679
Stockholders equity		4.104	3.967	3.112
Minority interests		1.577	1.584	1.022
Provisions				
Pension plans		0	0	0
Non-current liabilities		4.292	5.151	9.909
of which: Financial liabilities		3.717	4.721	8.826
Short term liabilities		8.060	10.714	5.636
* Trade liabilities		2.581	2.940	1.102
of which: * Financial		0	868	0
* Provisions st				177
Other liabilities		5.479	6.906	4.357
Liabilities held for sale				
Total Liabilities		18.033	21.416	19.679
ctrl		0	0	0

INCOME STATEMENT		TV		
USD (Mil.)		2018	2019	3Q 2020
Sales of goods		11.223	12.067	4.279
Total revenues		11.223	12.067	4.279
Cost of goods sold		-1.311	-1.980	-1.393
SGA expenses		-6.495	-6.893	-2.508
R&D expenses		-1.617	-1.763	-787
Other operating Inc/exp		0	0	11
Labour Cost		0	0	0
EBITDA		1.800	1.431	-398
Amortization		-1.086	-528	-122
Depreciation				
EBIT		714	903	-520
Finance income / expenses		-229	-128	-400
of which: Interest expenses		-190	-173	-258
Operating profit		485	775	-920
Extraordinary items	1)			-1.177
Dividends		0	0	0
Income Taxes		-87	-203	319
Minorities		8	-7	108
Net income cont. operations		406	565	-1.670
Net income from disc. operations		0	0	0
Profit for the period		406	565	-1.670

CASH FLOW		TV		
USD (Mil.)		2018	2019	3Q 2020
Net cash from operations		1.975	2.767	-3.449
Net cash from inv. activities		-559	-1.553	-107
Net cash from fin. activities		-1.628	178	4.540
Net cash flow		-212	1.392	984
Employees		24.500	25.400	N/A

REPORT

The company is undergoing a suffering period, as it was predictable considering the global situation. Despite having a similar business model to that of the other components of the group, the different core product influences the quality of the financial statements. In particular, Expedia has been severely damaged by the restrictions to traveling decided by the majority of western governments. The capital structure is quite critical, mainly due to equity reduction caused by the heavy loss for the period. It is possible to notice a further drop in capital structure ratios, already border line before the pandemic. It is also due to the massive raise in financial long term debt, almost doubled, decided by the firm to get the necessary liquidity to face the pandemic crisis. The income statement of the last three quarters is obviously negative because of the several restrictions to mobility both for leisure and for business, which lead to a conspicuous drop in revenues and to a massive loss. The performance is further lowered by extraordinary costs for impairments and restructuring, incurred by the company trying to deaden the future impact of the pandemic. Operating cash flows are heavily negative, limiting the opportunity for the company to invest in any new project. Excluding the heavy impact of Covid, which will almost certainly lead to further damages in the last quarter of 2020 and at least the first half of 2021, the company has shown itself healthy and solid during last years. In particular, it has a proven brand identity and strong market penetration, both leading to a steady growth in revenues. Contrary to the peers, which are mostly "Covid winners", Expedia is strongly reliant to the recovery from the pandemic, whose speed and effectiveness will be the most decisive factors in the company's short term business results. Nevertheless, Expedia looks well-positioned enough to survive the storm and to take maximum advantage from the post pandemic period.

Figure 3.5 Expedia's balance sheet and analyst's report

BALANCE SHEET

EUR (Mil.)	Note	FY 2018	FY 2019	3Q 2020
Intangible assets		189	193	200
Property, plants, equipment (PPE)		546	1,234	1,248
Inv. & LT financial assets		25	28	18
				16
Goodwill & consolid. difference		49	49	0
Non-current assets		760	1,455	1,482
Inventories		820	1,098	1,476
of which: Finished goods		820	1,098	1,476
Receivables, adv. Payments		1,654	1,780	3,472
* Trade receivables		395	462	470
of which: * Receivables from financial		1,047	1,012	2,692
Other receivables		212	305	309
Assets held for sale				
Total Assets		3,234	4,333	6,430
Stockholders equity		1,549	1,684	1,989
Minority interests		0	0	0
Provisions		34	43	39
Pension plans		0	0	0
Non-current liabilities		37	500	1,767
of which: Financial liabilities		8	488	1,244
Short term liabilities		1,614	2,107	2,635
* Trade liabilities		1,430	1,827	2,236
of which: * Financial		107	199	113
* Provisions st		0	0	49
Other liabilities		76	81	237
Liabilities held for sale				
Total Liabilities		3,234	4,333	6,430
ctrl		0	0	0

INCOME STATEMENT

EUR (Mil.)	2018	2019	3Q 2020
Sales of goods	5,388	6,483	5,409
Total revenues	5,388	6,483	5,409
Cost of goods sold	-2,428	-3,042	-2,677
SGA expenses	-2,093	-2,482	-2,086
R&D expenses	-55	-69	0
Other operating Inc/exp	19	18	15
Labour Cost	-636	-631	-315
EBITDA	195	278	345
Amortization	-76	-112	-155
Depreciation			
EBIT	119	166	190
Finance income / expenses	-17	-25	-36
of which: interest expenses	-16	-29	-33
Operating profit	102	141	155
Extraordinary items			
Dividends	4	4	0
Income Taxes	-54	-45	-60
Minorities	0	0	0
Net income cont. operations	51	100	95
Net income from disc. operations	0	0	0
Profit for the period	51	100	95
	0,0	0,0	0,0

CASH FLOW

EUR (Mil.)	2018	2019	3Q 2020
Net cash from operations	213	327	337
Net cash from inv. activities	-207	-290	-84
Net cash from fin. activities	-76	-55	1,366
Net cash flow	-70	-19	1,619
Employees	15,619	13,763	13,709

RATIO	FY 2018	FY 2019	3Q 2020
Equity / fixed assets	2,04	1,16	1,34
Equity / debt	0,92	0,64	0,45
Equity / fin. net debt	-1,66	-5,18	-1,49
Eq+non c.liab.-Fix.assets/GrossWcap	0,35	0,27	0,47
Receivables / Short term liabilities	1,02	0,84	1,32
Fin. net debt / EBITDA	-4,78	-1,17	-2,79
CF / Financial long term liabilities	2660,0%	67,0%	36,2%
Net WCap / Total revenues	-4,0%	-4,1%	-4,0%
Trade receivable, days	26	26	23
Trade liabilities, days	212	216	226
Delta, days	-186	-190	-203
Finished goods, days	55	61	-199
Cost of goods sold / Total revenues	45,1%	46,9%	49,5%
SGA expenses / Total revenues	38,8%	38,3%	38,6%
R&D expenses / Total revenues	1,0%	1,1%	0,0%
Labour cost / Total revenues	11,8%	9,7%	5,8%
EBITDA / Total revenues	3,6%	4,3%	6,4%
EBIT / Total revenues	2,2%	2,6%	3,5%
Operating pr. / Total revenues	1,9%	2,2%	2,9%
Profit from cont. op. / Total revenues	1,0%	1,5%	1,7%
Profit / Total revenues	1,0%	1,5%	1,7%
CF / Total revenues	3,9%	5,0%	6,2%
Int. exp. / Total revenues	0,3%	0,5%	0,6%
EBITDA / interests exp.	12,17	9,46	10,59
EBIT / interests exp.	7,45	5,64	5,84
ROE from continuing operations	3,3%	5,9%	6,3%
ROI	19,3%	12,2%	38,8%

REPORT

The capital structure looks adequate to avert any kind of concern regarding insolvency in the short/mid term. Equity has progressively grown during the years, every liquidity index is above the critical threshold and there are no critical issues or unclarity in the statements.

However, the company made a quite unusual move: during 2020 it raised its long term debt up to three times the year before's value. The cash raised this way has not been used yet and it is still available for the management. This solution is very common amid pandemic for companies heavily hit in their core businesses, trying to get the necessary liquidity to survive. However, a similar decision is very particular if made by a "Covid Winner" company, with solid business results and an already satisfying liquidity profile.

Consequently, it could be an indicator for future M&A operations or similar moves to significantly expand its market base.

The property, plant and equipment growth between 2018 and 2020 is mainly due to the raise in lease buildings and assets under construction, other indicator of expansion projects.

Looking at the income statement, there are no particular issues and the general situation is positive. As predictable, revenues experienced a growth compared to the corresponding period of the previous year. The last years show a positive trend for what concerning revenues, which have grown at fast and steady pace.

The cash flow profile is solid and testifies a solid operativity, regardless of the positive impact of restrictive measures.

The company is mainly active in Europe, where it has a strong brand identity and it is establishing itself as one of the most competitive players. From what declared by management in several reports, the firm seems intentioned to strengthen their influence in this area, while at the moment an expansion in other parts of the world seems very unlikely because of the high entry barriers.

Figure 3.6 Zalando's balance sheet and analyst's report

3.3.1 Individual Analysis Logic and Criteria

The Report section is meant to give the customer a quick but detailed resume of the company and its recent business activity, highlighting any important event and explaining every potential unclarity.

The analyst must notice any possible issue which could potentially affect the ability of the firm to meet its future obligation, and eventually highlighting it in order to facilitate consultants and clients, which may not have a technical financial education, to get aware of the most important features of what they're potentially buying.

Analysts must also be forward-looking, as they would be while analyzing equities, because they're interested in forecasting the company's trustworthiness for the next years, and the price movements of bonds are to be considered in case of position closing before maturity. Hence, trends must be analyzed very carefully, because the same data could assume different meanings in different trends.

Despite being all internet companies, the analyzed firms are undergoing very different phases of their business cycles, as it emerges at first sight. The period is also very particular, since data referring to 2020 are deeply affected by Covid19 pandemic, which makes any comparison with previous periods hardly significant.

Nevertheless, data from previous years are very important to determine whether companies are in trouble because of the difficult global situation, and are therefore supposed to come back to a good profitability once it gets better, or if they're suffering from structural problems which are way more worrying. Likewise, the goal is also to estimate the impact of a potential positive effect from pandemic and determine whether it will disappear in the mid-term.

Starting from Covid effect, the analysis shows every possible instance: Alibaba, Amazon and Zalando have been favored by restrictive measures, eBay has been approximately neutral while Bed, Bath and Beyond and Expedia have suffered a hard hit.

For both the three "Covid winners", especially Amazon and Alibaba, we examined the past periods noticing they were experiencing an impressive growth under every point of view even before the pandemic, which has given a boost to operations but certainly isn't the main reason of their success. We are particularly interested in financial solidity and liquidity indexes and in the capacity of firms to generate cash to repay their debt.

For instance, eBay has had a stable and profitable business activity for many years and doesn't seem to be in trouble, but the Equity/Debt ratio looks quite worrying, so it is necessary to investigate the reason of the drastic reduction over the years. Since leverage did not increase during the last three years, the responsible is a heavy reduction in equity, which is not due to losses but rather to an aggressive repurchase plan. It is less frightening for debt holders even though it is a relevant move whose reason must be identified.

Expedia also has a very low equity value, partially due to the period loss reducing equity and new debt issued to face the Covid crisis. However, it is noticeable how Equity/Debt was already low and decreasing before the pandemic. Moreover, the interest-bearing financial debt is increasing and it will weigh on the business activity of the next periods draining cash through periodical payments. Hence, the firm is dependent on its own profitability and must be monitored to assess if it would come back to a positive performance after the pandemic crisis. In a similar situation the solution is to examine the overall business of the firm and the other financial reports.

Therefore, we evaluate income statements and related ratios, helped by a general overview of firms' strategic moves and their impact related to industry trend and forecasts for the future.

While the other peers show solid data, Expedia and BBBY are the most suffering companies, with bad income statements caused by global pandemic. However, a more attentive analysis shows their situations are almost opposite.

BBBY was going through a tough period even before the pandemic outbreak, and it is trying to free itself from its dependence on physical stores, which are becoming less profitable, and switch to e-commerce. However, this is a very complicated process whose results are not granted: if it failed to be effective, the firm may enter an almost irreversible decline phase. Hence, pandemic has accelerated the impact of an already existent structural problem, which may cause a negative outlook for the future.

Conversely, Expedia was having positive performances over the recent years and its business model looks solid and profitable, providing several services in the traveling industry, reaching the entire world with its internet-based dimension. The almost complete cancellation of traveling, both for business and for leisure, has completely disrupted their capacity to make revenues, but they look strong enough to survive and ready to benefit from the post pandemic recovery.

The main question mark concerns the resumption of business traveling, which may be reduced by a more widespread adoption of virtual meetings and new technologies in general, but since Expedia mainly relies on leisure it should not be a big deal.

The analysis is concluded by an overview of the main indicators of future strategic direction in the examined period. We look for particular M&A operations or similar events which could signal the commitment by the management to a certain strategic line. We also aim to identify any marker of a scarce will by management or shareholders to continue the business activity in the future, and any other operation indicating criticalities not yet emerged on financial reports.

For instance, the sale of a non-core branch to take a profit could be a positive indicator as it could testify a commitment to a more efficient business. The sale of an important part of the company at a discounted price to obtain some immediate liquidity should instead be seen as a red flag and may affect the future trustworthiness of the firm.

In this specific case we didn't find traces of business dismantling through M&A operations, even though we reported the most relevant ones and we highlighted the cash-out policy run by eBay through the repurchase of its own stocks.

3.4 Shareholders Assessment

This phase points out the ownership structure of each company of the group. It is a quite quick step, but it must be run carefully because it might communicate precious data about the company's business.

The main objective of this assessment is to decide the right level of consolidation to which the group's accounts are to be referred. If there is a "de-facto" controlling group, the accounts have to be consolidated at his level.

In our analysis we decide to highlight every investor, either an individual or an institution, which owns more than 4% of the outstanding shares, considering the others as floating capital unless they have a particular relevance. For instance, an individual manager currently in charge who own a relevant participation in the company he's running could be interested, especially if he decided to sell part of his shares or to buy new shares in a new capital increase.

Among multinational big companies, as the one analyzed in this report, it is very common to have extremely widespread ownerships, especially in the Anglo-Saxon business world, while in Europe it is easier to find companies whose main participation is still held by the founder and his family.

The ownership structure doesn't affect the scoring model because it doesn't lead to a quantitative or semi-quantitative evaluation, but it is taken into account in the general decision as it may affect company's trustworthiness.

Shareholders' analysis may have indeed other multiple purposes:

- **Spotting Future inefficiencies:** If the ownership is too concentrated into a single subject's hands, it would have an unlimited power in the shareholders' meeting. This would be a relevant issue if it decided to use its influence privileging its own interests instead of the whole company's one. When majority shareholders advantage themselves to the detriment of minority ones we talk about second type agency problems, usually more relevant for equity investors, which are directly affected by them. However, also as potential bondholders we want to monitor those aspect because they could lead to inefficiencies in the company's business. A widespread ownership is not among mandatory requirements, but it is advisable to monitor very large shareholders, if any, to make sure they are competent enough and they have the right commitment to the prosecution of the business activity in the future.
- **Market Vision about the Company:** Knowing who the shareholders of the company are may let the analyst understand which investors had a positive perception of that firm for the future and invested their money in it. The majority of multinational companies have large amounts of shares held by institutional stakeholders such as banks and large equity funds. Having large research centers and extremely powerful means to evaluate investments, those financial intermediaries are usually supposed to make informed decisions. Hence, observing their opinion about a company may provide analysts with a more well-rounded vision. Moreover, it could also be worth observing the changes in the participations of large shareholders into each company.

Of course, it is fundamental to keep a critical vision, taking into consideration the kind of investor and its investment logic. For instance, if an investor is buying a company's equity just to speculate in the short term, its sales may have to be considered a taking of profit rather than an actual distrust act towards the company.

Nevertheless, while retail investors may sometimes fall into irrational behaviours, a massive sale by institutional shareholders must be taken into consideration and the reason behind it must be assessed thoroughly.

- **Individuating Potential Guarantors:** Large companies are almost never constituted by a single firm, but they are usually made of several firms gathered in a group, often shaping a very complex structure guided by a parent company or a financial holding having no physical assets but participation in other companies. Usually, the parent company is the biggest firm in the group and it publishes consolidated statements including every other component.

In most cases, the parent company is listed in financial markets and is the entity issuing debt, so examining the consolidated statements is enough to determine the actual credit profile, but there are also some exceptions.

Sometimes the entity issuing bonds is a subsidiary of a bigger and more trustworthy parent company, which could help avoiding its subsidiaries' default meeting their obligations in their stead.

Moreover, we also examine if there are any Governments, directly or through other institutions, among the shareholders of the company. Governments only participate large companies which are central for their economic systems and sometimes they entered their capital structure to save them in a difficult period, testifying they have interest in saving that company from default. Hence, at least in developed countries, the presence of Governments in the ownership structure of a firm is seen as an additional guarantee of future solvency.

In our specific cases the companies' ownership structure doesn't show any salient feature. They are all parent companies and they only rely on themselves to meet their obligations. They sometimes still have their founders among the shareholders but none of them could certainly be defined a family business. They're also still young companies and the participations of the founders' family are still owned by the founders themselves, avoiding any doubt about the suitability of heirs. For instance, in Amazon the most relevant participation held by an executive is in the hands of the founder, Jeff Bezos, which has proven to be exceptionally committed and skilled. Every company is heavily participated by institutional investors, especially Vanguard Group and Blackrock, the two biggest investment management corporations worldwide.

Company Shareholders

Alibaba

As of 15 december 2020, the largest shareholder is Softbank, a japanese financial holding, itself listed on the Tokyo Stock Exchange. It holds 24,9% of the total shares outstanding. The remaining participations are held by a very widespread group of investors. The biggest one is Jack Ma, the founder of the company, who still holds the 3,5% of the shares. Lately he has been progressively reducing his share and left his executive role in the company to focus on other projects.

eBay

The ownership structure is very widespread and mostly held by large investment funds. The largest participations are held by Vanguard Group (7,5%), Blackrock (6,45%) and State Street (4,63%)

Bed Bath & Beyond

Blackrock holds the 18,8% of the total shares, while the 11,92% is owned by FMR Investment Management, a financial institution based in Boston. The other two important entities are Vanguard Group and Contrarius Investment Management, respectively owners of the 9,48% and the 6,45% of the outstanding shares.

Amazon

The majority shareholders remains Jeff Bezos, the founder of the company, which still owns the 10,61% of ther shares. Then we can individuate the large institutional groups Vanguard (6,53%) and Blackrock (5,51%). The remaining part of the shares is spread between several entities which hold participations lower than 1%.

Zalando

Kinnevik, swedish financial company born in 1936, is the largest shareholder with 21,11%. It mainly invests in digital consumer businesses and it is listed on Stockholm Financial Market. The 11,53% of total outstanding shares is held by Bailie Gifford while Anders Hoch Povlsen, a wealthy danish entrepreneur, holds the 10,02%.

Expedia

The ownership is entirely in the hands of financial institutions, broken down as follows:

- 10,63% Vanguard Group
- 7,53% Melvin Capital
- 6,82 D1 Capital
- 6,62% Blackrock
- 5,36% FMR
- 5,36% Artisan Partners

Figure 3.7 Property Structure Report

3.4 Pension Plans

The company might be supposed to take charge of former employees' pension after their retirement. This obligation represents a potentially relevant periodic cost, which the firm must pay independently from its performance of the period, an interest-bearing liability to all effects.

The charge of group's former employees' pension has been common in the US and Europe until the 2000, but now alternatively, the company may provide its employees with public retirement plan, the so called 401(k) in U.S.A. It generally consists in employees contributing with a percentage of their salary, while the company commits to contribute with a certain amount of money for every dollar of employee's contribution.

While it raises labour cost for the firm, public retirements plans allow it to delegate any obligation towards former employees to the government, avoiding any kind of negative cash flow coming from pension plans. When the company adheres to a public retirement plan, we don't consider pension plans as a possible source of financial suffering and we eliminate it from our scoring model.

Conversely, when the company provides and receives retirement contribution by employees and commits to pay them pensions when they retire the analyst must determine whether it could turn into a problem in the long run.

The company usually funds directly and collects money from employees holding back part of their salaries, obtaining money in advance with the commitment to pay them some years later, with the opportunity of investing them in a segregated fund to create a cash flow, with a process similar to that of insurance companies.

In financial reports, companies must the discount rate to calculate the present value of pension payments and the yield of the pension funds, in order to determine if the retirement plan will be an important extra-cost or even an extra-profit in the long run.

The sustainability of pension plans is calculated as a cost in relation to the last three years earnings and to the percentage of equity respect to debt.

The analysis of pension plans is discussed quickly, since every company constituting the assessment provide its employees with public retirement plans and has no further contribution beyond the periodic payments they must pour monthly.

For completeness of information, the next page will show the data sheet related to pension plans, even though it won't be inserted in the scoring model because it doesn't represent a cost for any of the selected companies.

Pensions & benefit obligations

Alibaba: It doesn't pay post-retirement fees to employees, it limits itself to the monthly contribution to the local social welfare authorities, which eventually take care of medical, retirement and other welfare benefits. Alibaba has no further commitment beyond monthly contribution.

eBay: The company takes part in contribution plan defined by 401(k) code. Each employee may contribute with up to 50% of their eligible compensation, while the firm contributes with a dollar for each dollar a participant contributed, up to 4% of each employee's eligible compensation. Non-US employees are covered by various other savings plans, but none of them involves post retirement contribution by the company.

Bed Bath & Beyond: In their reports, the company doesn't mention its management of the retirement plan for regular employees. However, it clearly states that the management's members are covered by 401(k) plans. Considering they don't have any expenses or provisions for post retirement benefits, we are able to infer they also use Government pension plans for regular employees.

Amazon: Amazon adheres as well to 401(k) plan for its US employees and to similar plans in other countries. It takes charge of other expenses, like healthcare and other benefits for current employees, but it delegates every expense for former ones.

Expedia: It adheres to 401(k) plan and takes charge of contributing with 0,5\$ for each dollar a participant contributes in the plan. Expedia's contribution vests with employees once they complete two years of service.

Zalando: As well as its peers, Zalando participates to the German pension plan, since most of its employees are located in that area, and is therefore exempt from paying post retirement fees.

RATIO	fx	ALIBABA GROUP	EBA Y INC	BED BATH & BEYOND	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
Equity / tot.liabilities, %	X	58,2%	15,8%	39,0%	27,6%	38,9%	18,5%
Pension liabilities / tot.liabilities, %	Y	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Equity "coverage"	X / Y						
Discount rate - pension benefit obligations	TAIP						
NPV unit payments series	1 / TAIP						
Pension benefits obligations, NPV	VAB						
"virtual" annual payment	VAB / (1/TAIP)						
Pension funds yield	TRAP						
Pension funds assets	VAA						
"Virtual" revenues of funds	VAA / (1/TAIP)						
Deficit of pension assets revenues		0	0	0	0	0	0
Avg profit last three years (cont. oper.)		114.045	2.223	-307	13.491	-419	92
"coverage" (deficit / avg profit)		0	0	0	0	0	0

Table 3.1 Pension Plan Report

3.5 Legal Proceedings Assessment

The analysis is mainly centered on multinational companies, operating in many countries which could have extremely different legislative systems. They may therefore incur in many controversial situations, potentially leading to litigations and similar legal proceedings.

The exact description of the carrying out of legal dynamics is beyond the purpose of this dissertation, nevertheless individuating in advance possible future problems coming from them could protect investors from bad surprises.

Litigations happen when an economic entity, either a company or an individual, thinks its legal rights were harmed by another one and consequently decides to start a lawsuit. It usually implies a considerable expense at the beginning, independently from the position of the company, and may as well be relevantly harmful for the subject who is found guilty in the future.

Being involved in any form of lawsuit does not necessarily make a company less trustworthy from the financial point of view, but analysts must elaborate a forecast about the order of magnitude of possible damages coming from trials in the future. Those potential negative effects surely include cash outflows, but also other more subtle consequences must be taken into consideration. If a firm is found guilty of a blatantly unethical behavior it may be severely harmed in its business activity in a way worse measure than the one described by numbers, especially in an historical period where moral issues are getting more and more central in people's and investors' opinion.

If the company ever gets labelled as unethical it will face a hard opposition by several entities, which may turn into boycotts by customers and relevant expenses and investment to rehabilitate its public image.

Moreover, analysts should pay close attention to antitrust issues, which could lead to additional fees conditioning the business model of the company and, in the most severe cases, to forced dismemberment of groups in order to limit their market power. It is exactly what happened to Standard Oil Company, which was divided into thirty-four different companies to cancel its monopolistic position in North American oil market.

Most global companies are currently involved in some lawsuits, and they are requested by investors to communicate it publicly through their financial reports. Contentious with employees or similar issues are usually not extremely relevant from a financial point of view, but they may endanger the company's reputation, especially if they turn into class actions. Therefore, they often choose to vigorously defend their positions in a trial instead of simply find an agreement.

When conversely a company expects relevant economic consequences from pending lawsuits, it usually creates some contingency reserves in its balance sheet to be prepared for the future, registering losses in advance in order to reduce the uncertainty margin for the future, maintaining a conservative approach.

In our scoring model legal proceedings assessment is based upon two main criteria: disclosure and actual relevance of potential losses.

According to risk management principles, disclosure is a key feature in order to elaborate a complete overview of the issuing company. To determine if a company provides an adequate level of disclosure, analysts examine the last annual investor relation and look for the section about legal proceedings, whilst it's not always present on quarterly reports. It must inform investors about the most important pending legal causes involving the company, reporting their historical chronology

from the first lawsuit to the current situation, pointing out the potential consequences, either positive or negative, and how the firm intends to react in the future.

If a company doesn't mention any legal lawsuit in their reports, a further investigation is run to make sure it really doesn't have any pending proceeding, also exploiting the Company Litigation function on Bloomberg. If the company is found to have some relevant legal issues it didn't mention, it doesn't provide a good disclosure, and it will be reported in the evaluation.

Once the disclosure has been ascertained, a further step is to evaluate the impact of possible consequences on the company's future performances, considering how likely the firm is to be found guilty and eventually be forced to endure any damage to its business, along with the actual entity of the damage itself.

Analyst examine if the company already set aside any contingency provision, and then evaluates the probability for the actual fines to be higher, along with its amount compared to the financial resources of the company.

For instance, Amazon is involved in several lawsuits both as a group and for individual companies constituting it, but its impressive financial resources prevent the company from any kind of suffering from legal proceedings, considering also the firm could afford almost unlimited legal expenses if trials get long. We therefore concluded the American company has good disclosure about its legal situation and it doesn't put its trustworthiness at risk.

However, it is necessary to pay attention to the last happenings concerning Antitrust Authorities, both European and American, which are probably the only entities left which could get the e-commerce giant in trouble. Even though they don't seem about to start an open war against the firm, also considering they still haven't formally sued it, and they don't appear to be evaluating drastic measures, Antitrust issues carrying out could be extremely important for the future of Amazon.

The final evaluation is qualitative and it is better to be run gathering the opinions of two or three different analysts in order to create a more complete overview through a considerable amount of experience in finance.

In our opinion Zalando is the one currently giving less to worry about from the legal point of view, basically not having any pending proceeding. eBay comes second, with some issues currently happening but not critical in our opinion, while Amazon, although it provides good disclosure, is a little more volatile because of the unwanted attentions it has lately been receiving from antitrust authorities, which are likely to turn into future trouble. Nevertheless, its virtually unlimited resources allow the American company to conquer the third place.

Alibaba seems to be also providing an adequate disclosure, and it doesn't have particularly relevant pending legal proceedings. However, the several criticalities related to Chinese business and legal environment constitute a big question mark and what is happening in the last period of 2020, when Chinese authorities seem determined to target Alibaba with several accusations, cannot be ignored, especially considering its potential future implications. Chinese government enjoys absolute power and the resources of the company, although extremely big and healthy, may not be sufficient to put it away from significant damages.

In our opinion Alibaba shares the fourth place of the ranking with Expedia, which currently has to face several legal battles and class actions, and it will likely keep on suffering from this problem since its business model hurts many entities' interests.

The last position is occupied by Bed Bath and Beyond, which pays the inadequate disclosure about legal proceedings it is currently going through, making difficult to the analysts to properly assess its situation. In similar situations we prefer to be conservative.

Legal proceedings

ALIBABA

-The Company is incorporated in the Cayman Islands and considered as a foreign entity under PRC laws, so it is subject to certain contractual arrangements with Variable Interest Entities under the PRC govt. the Company's opinion, the current ownership structure and the contractual arrangements with the VIEs and their equity holders as well as the operations of the VIEs are in substantial compliance with all existing PRC laws, rules and regulations. However there may be sudden changes which may affect the firm's business activity

- RMB: The Company's sales, purchase and expense transactions are generally denominated in RMB and a significant portion of the Company's assets and liabilities are denominated in RMB. RMB is not freely convertible into foreign currencies. In the PRC, foreign exchange transactions are required by law to be transacted only by authorized financial institutions at exchange rates set by the People's Bank of China (the "PBOC").

-As of March 31, 2019, the Company accrued a settlement provision of US\$250 million (RMB1,679 million) for the settlement of a U.S. federal class action lawsuit in exchange for a full release of all claims brought in the lawsuit that has been pending since January 2015. The amount has been paid as of March 31, 2020.

- Apart from the one above, as of 31 march 2020 there are no other legal proceedings, even though Chinese Government can always be a problem. Good Disclosure.

EBAY

The company states amounts accrued for legal and regulatory proceedings for which they believe a loss is probable were not material for the year ended December 31, 2019. They have concluded, based on currently available information, that reasonably possible losses arising directly from the proceedings (i.e., monetary damages or amounts paid in judgment or settlement) in excess of our recorded accruals are also not material.

During the years the company has been involved from time to time into claims concerning intellectual property rights and it has sometimes been forced to litigate those claims. The risk arises the most when it enters new lines of business or runs acquisitions. The firm says those episodes are likely to happen again in the future.

-PayPal: They entered into a separation and distribution agreement and various other agreements with PayPal to govern the separation and relationship of the two companies. These agreements provide for specific indemnity and liability obligations and could lead to disputes between them and PayPal, which may be significant. In addition, the indemnity rights they have against PayPal under the agreements may not be sufficient to protect them and our indemnity obligations to PayPal may be significant.

To date, losses recorded in the company's consolidated statement of income in connection with its indemnification provisions have not been significant, either individually or collectively. Some risks for the future but no actual legal concern.

BED, BATH & BEYOND

The company doesn't provide any lawsuit section in their financial reports but, according to Bloomberg, they have had multiple allegations over last years. However, they don't look so serious to severely endanger company's future solvency.

AMAZON

-Hourly workers: many employees, beginning in August 2013, have sued Amazon claiming it failed to compensate hourly workers. Over the years many claims were dismissed by Courts and Amazon intends to defend against the remaining. Damages would not be relevant economically but could represent a problem for the brand

PATENT INFRINGEMENT ALLEGATIONS

-Zitovault, Enolas Technologies: Both allegations started in 2015 and concern patent infringement. They ask for an unspecified amount of damages. They both have been transferred to USA District Court of respectively Washington and California

- SRC Labs, Saint Regis Mohawk Tribe: Started in 2017, they ask for an unspecified amount of damages, interests and a compulsory ongoing royalty

- Rensselaer Polytechnic Institute, CFD Dynamic Advances LLC, VolP-Pal.com: Started in may 2018, they claim patent infringement in the Alexa Voice Software and related devices. They ask for unspecified damage, Amazon claimed to be ready to defend vigorously.

- Neodron: they filed a complaint in 2019 claiming a patent infringement in Amazon Fire H10 tablet, requesting for undetermined damages, a permanent injunction and enhanced damages.

- Kove IO, Vocalife, Saint Lawrence Communications: All complaints were filed during 2019, they all claim Amazon infringed U.S. patents by its vocal-controlling systems. They ask for undetermined damages and enhanced damages, Amazon denies any implication and claims it will defend itself in any necessary way.

ANTITRUST

- 10/11/2020: European Antitrust Commission opened a accused Amazon of violating competition law using non-public data it collects from third party merchants to unfairly compete against smaller sellers. It also opened a second investigation into Amazon's business practices related to the Prime label and the "Buy Box," which offers customers a one-click button to add a product to their shopping car. If Amazon was found guilty it could strengthen similar allegation by US Antitrust Authority, which already stated in the past that Amazon is operating in a Monopolistic market.

Anyway, the EU hasn't filed legal charges against Amazon, so it could be years before it announces any penalties. It could also reach a settlement with Amazon or drop the case altogether.

The EU and U.S. identified similar issues with Amazon's treatment of sellers, but the potential penalties and remedies they could settle on are likely to be different. Democratic staffers in the House Judiciary subcommittee on antitrust recommended a wide range of remedies, including forcing companies to prove mergers would not harm competition and splitting different business units. For Amazon, this could result in it spinning off the third-party marketplace from its core retail operations.

As for the FTC probe, Amazon could be hit with fines or the company could reach a settlement with the agency in which it agrees to certain business restrictions.

Similarly, the EU has a range of penalties it could propose, including a fine of up to 10% of Amazon's annual global revenue, or up to \$28 billion based on 2019 figures.

The EU could also propose behavioral remedies, which attempt to preserve competition by requiring the companies to refrain from certain business conduct. But behavioral remedies can be "hit or miss" in terms of effectiveness, since some companies may find it "more profitable to violate the remedy and just pay the fines if they're found in violation again".

EXPEDIA

-Buckeye Tree Lodge: Class action in federal district court against Expedia and other brands of the group, accused of false advertising. On march 13, 2019 the court denied certification of a damages class but granted certification for a narrow injunctive relief only class. The trial was scheduled for June 2020, but it was rescheduled because of pandemic.

- Israeli Class Actions: Between 2016 and 2018, two class actions suits were filed in two different Israeli district. The plaintiff generally alleges that the defendants violated Israeli consumer laws by limiting hotel price competition. The plaintiff has filed a motion for class certification which defendants will oppose.

- On March 15, 2016, a putative class action suit was filed in federal district court in Texas against HomeAway.com, Inc. related to its implementation of a service fee. rent. The complaint asserted claims against HomeAway for breach of contract, breach of the duty of good faith and fair dealing, fraud, fraudulent concealment, and violations of the state consumer protection statutes. Subsequently, three other putative class action lawsuits were filed making similar claims. Three of those were dismissed while one is waiting for a ruling

- Helms-Burton Litigation: September 11, 2019, a purported class action was filed in the U.S. District Court for the Southern District of Florida alleging violations of Title III of the Cuban Liberty and Democratic Solidarity Act, also known as the Helms-Burton Act. Between september '19 and January '20 two additional class actions and three individual actions alleging similar claims related to additional properties were filed. The Expedia Group entities have filed motions to dismiss in three of the six actions and decisions are pending

-Stockholders Litigation: Consolidates three lawsuits filed by Expedia shareholders about the acquisition of Liberty Expedia Holdings. These actions purported to assert, among other things, direct and derivative claims against current and one former members of the Company's board of directors, and the Company as a nominal defendant. complaint. On December 11, 2019, a Special Litigation Committee of the Board of Directors of Expedia Group, Inc. ("SLC") filed a motion to stay the litigation pending completion of the SLC's investigation into the allegations in the consolidated amended complaint.

- Competition Matters: Over the last several years, the online travel industry has become the subject of investigations by various national competition authorities ("NCAs"), particularly in Europe. Swiss and French government have dismissed all antitrust complaints not finding Expedia guilty of dominant position abuse, while in Italy and Germany the lawsuits remains open. Outside Europe, Brazilian association Forum de Operadores Hoteleiros filed a complaint with Administrative Council for Economic Defence (CADE), which Expedia solved in 2018 with a settlement. Expedia is now under investigation by Australia, Japan and Hong Kong, but there is no trial scheduled by now. On August 23, 2018, the Australian Competition and Consumer Commission, or "ACCC", instituted proceedings in the Australian Federal Court against trivago. The ACCC alleged breaches of Australian Consumer Law, or "ACL," relating to Trivago's advertisements in Australia concerning the hotel prices available on trivago's Australian site, trivago's strike-through pricing practice. The probable loss has been recorded with the proceedings as of december 31, 2019-

ZALANDO

There are no reported lawsuits involving the company.

	ALIBABA GROUP HOLDING-SP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
Qualitative Evaluation	UNFAIR+	FAIR-	UNFAIR	FAIR-	UNFAIR+	FAIR
Score	4,5	2,0	6,0	3,0	4,5	1,0

Figure 3.8 Legal Proceedings Report and Score

3.6 Financial Debt Sustainability

In this phase analysts examine the capacity of each company to meet its obligation using its operating cash flows, which are the resources it gets from its core business activity. In presence of an inadequate inflow of cash from operations, a company may be destined to contract new debt to pay the existing one, preventing it from using cash for growth projects and potentially leading to a vicious circle of debt cost raising until a default becomes inevitable.

The section considers the operating cash flows obtained by each company during the three previous financial periods, using the average value as a proxy of the ones the firm is going to get in the future. Such an approach has the limit of not considering any growing or decreasing of cash flows in the future, which could be extremely relevant in a fast and stormy business environment as the present one. It is therefore necessary to individuate the main drivers of the difference between the previous periods and evaluating which ones will have an effect in the future. Moreover, analysts must spot trends and qualitatively evaluating if they are likely to keep on having their influence on cash flows, even though the conservative approach makes very imprudent to rely on the growth of operating cash flow, whilst is mandatory to consider the risk of a future drop.

The section afterwards reports the companies' obligations coming due for each one of the next five years. Indeed, the data available on balance sheet are reporting the exact amount of the company's debt, but it tells nothing about the moment when it must be paid. However, companies must communicate each pending obligation specifying if it is a loan, a bond or a lease liability, the identity of the creditor, interest payments if any and maturity date.

Such an assessment is particularly useful to determine if the company will have enough liquidity to pay its obligations once they come due, avoiding possible insolvency and default. It will be also useful while deciding which bonds to invest in, because of the concept of Maturity Debt Wall.

The Maturity Debt Wall is the specific period in which the many existing debt arrangements come due, forcing the company to both gather a considerable amount of money at once and sometimes to issue a new debt at the present market conditions, facing the so-called Refinancing Risk.

The safest bonds are the one coming to maturity before the Wall of Maturity, whilst it is hazardous to possess bonds coming due contemporarily to the majority of debt arrangement or immediately after, because of the risk of being involved in a total or partial default of obligations.

It is particularly true if the company doesn't look able to generate enough cash flows with its operating activities, while conversely it is not worrying if the company is healthy and its business activity does not give signals of any kind of instability providing an adequate liquidity inflow.

3.7 Diversification

The purpose of this section is to determine the exposure of each company to different markets, in order to understand the possible impact of macroeconomic events to the firms' business.

It is necessary to perform a breakdown of the revenues of the company into different categories, both geographically and by segment.

The first table reports the breakdown of each group's revenues into geographical macro-areas, in order to quickly visualize where it has a higher market penetration and which are its target customers from a cultural point of view.

As a general guideline, a company is considered positively valuable if it earns most of its revenues in stable areas where unpredictable negative events preventing customers to buy are less likely to happen. However, this is not a stiff requirement because the potential development of markets and the consequent growth of demand are important parameters while forecasting the sustainability of revenues in the future. For instance, although China is undoubtedly a very particular environment which implies many more risks for companies than Europe or US, it is now considered critical for the future performance of many western companies thanks to its tremendous growth rate, which generates millions of new potential customers every year.

A higher geographic diversification is also a positive indicator, since it means the company has expanded itself in different areas of the world, penetrating more markets, consequently becoming at the same time more likely to raise its revenue in the future and more prepared to face possible crisis involving a particular zone. Conversely, a company that is very strong in a single area will have been more exposed to country risk.

Understanding geographic trends and forecasting which markets are likely to be strategic in the future is a very complex operation which may require a constant activity of inquiring and studying, it is hence advisable to ask for the opinion of a colleague who's in charge of macroeconomic analysis.

The second table divides the specific industry, in this case e-commerce, in different segments, performing another breakdown of revenues to analyze them from a different point of view.

This side of the diversification analysis is more complex than the previous one, but it helps the analyst elaborating a clearer vision of the business model of every single company. Although competing in the same industry, companies can be extremely different from one another in the customers they target, in the way they conceive their activity and obviously in the kind of good or service they are selling. Observing the breakdown of sales by segment, analyst can get aware of where the company is currently well positioned and in some cases it may be necessary to monitor the changing of the percentages over time to spot the firm's top management's vision about the future.

As well as we did with the geographic section, we analyzed the data to form an opinion about the positioning of each firm in the business environment. We are favorable to diversified companies, but an excessive horizontal integration could also be a negative feature, since it is difficult to be excellent in several segments at the same time. We want companies which have a prosperous and defined core business providing a solid pillar for expansion in different areas, possibly strategically related to the core one.

The macro trends are extremely important in this phase, because we aim to understand the future performance of companies basing on their positioning in the segments that are about to become strategic in our opinion. We also evaluate how a company's resources and internal competencies

could allow it to enter a new segment as a follower and quickly gain an important position if a sudden change in world's business tendencies takes over.

Once again, the support of a macroeconomic analyst might be useful, especially since he should have a more complete overall vision about the future of global economy and the impact it is likely to have on single industries.

For instance, hypothetically analyzing the automotive industry, it is fundamental to examine the portion of a company's revenues coming from electric cars, and especially its evolution over time. However, those data must be examined after having developed an informed opinion about whether electric cars will be the future of automotive sector or not, possibly after having asked for a macroeconomic analyst's opinion.

For both geographic and segmental breakdown we perform a qualitative analysis based upon the previously explained criteria and we rank the six companies from the best to the worst, allowing more than one entity to occupy the same position if they are considered equal by our assessment. The average between the positions the companies have obtained in each one of the two rankings will constitute its final score for this specific section.

3.7.1 Geographical Breakdown: Ranking

In our opinion Amazon is the most well positioned company from the geographic point of view. It operates in several macro areas of the world, enjoying an almost monopolistic market power in developed western countries, while keeping on expanding in other regions such as Asia. Its revenue growth has been impressive over the last years and it has managed to widely spread its influence while strengthening its position in the US, which remain its primary market.

The second position is shared ex-aequo between Expedia and eBay, which are both active in several areas of the world. They are the less capital-intensive components of the group, and thus they are facilitated in their expansion abroad. eBay has been investing in growth in foreign markets since its early days and can now enjoy a well-diversified geographic portfolio, while Expedia is in a good position to furtherly expand geographically because its business model doesn't imply the physical shipment of anything.

In the fourth position we can find Alibaba, which gets most of its revenues in China. As already mentioned, Chinese market is one of the most interesting ones for every global company, and Alibaba attracts new customers every year. Moreover, the Chinese firm is also expanding abroad during the last years. However, the conservative approach, which is essential while evaluating bonds, makes us interpret data with a fair level of skepticism, considering the inner instability of a market regulated by a self-referential government, which has almost absolute power and may change the rules any minute.

Zalando occupies the fifth position: although it is well established and steadily growing in Europe, it doesn't seem to have relevant growing margins out of this area. It is still dependent on German-speaking countries, where it was started. This is not necessarily a negative feature, but it looks difficult for the company to significantly expand out of Europe.

Bed Bath and Beyond has its whole revenues coming from North America and it is not likely to expand, but indeed it has experienced a contraction over the years. Its complete dependence to a single market made us put it in the last position of the ranking.

3.7.2 Segmental Breakdown: Ranking

Amazon is once again the most solid company in the ranking, because of its undisputed efficiency and growth in its core business along with a horizontal diversification which embraces new segments and business lines every year. Continuing to expand in the retail online industry, it is becoming a top player in Digital Media and technology in general, recently entering the entertainment sector with significant investments. Moreover, it invests an impressive amount of money in research activity, being constantly ready to exploit new growth opportunities.

Alibaba is less diversified and still doesn't reach the American giant's level in terms of expansion, but it is a leader in strategic segments and keeps on growing in different businesses through its well diversified companies' portfolio, ranging from business-to-business e-commerce services to cloud computing and digital payments.

Expedia and eBay share the third position with similar diversification levels and a strong position in segments with high growth potential, even though they don't seem able or willing to diversify very much outside of their core segment. However, for those companies it can be considered a positive feature.

Bed Bath and Beyond and Zalando are the less diversified companies, strongly relying on their core businesses and not planning to look beyond the retail market. Although they are very similar from this point of view, we consider the American company a little less well-positioned than the German one, considering its still significant dependence on physical stores, making it a less innovative firm with a lower growth potential.

Geographic & business diversification

Sales breakdown by area	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
North America	27,9%	40,2%	100,0%	69,1%	56,9%	-
South America		59,8%	-	-	43,1%	-
South Africa			-	-		-
Europe			-	14,1%		86,7%
Others			-	11,0%		13,3%
Asia/Oceania	72,1%		-	5,8%		-
TOTALE	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Qualitative ranking A	4	2,5	6	1	2,5	5
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Sales breakdown by business segment	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
Retail Commerce	85,6%	90,5%	100,0%	56,5%	81,0%	100,0%
B2B		-	-	-	17,7%	-
Digital Media & Entertainment	4,9%	-	-	12,5%	1,4%	-
Cloud Computing	8,8%	-	-	-	-	-
Innovation/others	0,7%	-	-	5,0%	-	-
Marketing Services	-	9,5%	-	6,8%	-	-
Third party seller Services	-	-	-	19,2%	-	-
	-	-	-	-	-	-
TOTALE	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Qualitative ranking B	2	3,5	6	1	3,5	5
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Avg A,B	3,00	3,00	6,00	1,00	3,00	5,00
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Table 3.2 Business Activity Report by Revenues Percentage

3.8 The Scoring Model

Once gathered the complete data about the companies, analyzing the financial reports and the general business situation of each entity, the analyst is ready to put every information together in order to formulate its conclusions about peers.

This phase aims to rank the companies basing on the data available and on the analysts' sentiment about the future. However, it doesn't necessarily mean the debt securities of the company with the worst score are necessarily a bad investment, because theoretically the six firms could be all eligible in a credit risk perspective.

Before giving a detailed description of the model, it is necessary to remind the reader that the aim is to spot the companies whose default risk is lower, not necessarily the best investments in an equity research logic. So, we are evaluating growth just as a warranty that the firm will keep on meet its obligations and we are not considering the implications it could have on market capitalization, as well as the perception of financial markets, with an only exception which will be described later.

The purpose is not to spot overrated and underrated firms to advice our customers about investments on stock markets, so the model doesn't include the most common equity research ratios such as Price/Earnings, Market Value/Book Value or any other multiple regarding enterprise value or price growth perspectives.

3.8.1 The Model

The scoring model operates in two main phases: the definition of the weights and the actual ranking of companies. The sections include different fields and each one is meant to be an evaluation parameter, which is given a weight to give the adequate priority to the most important characteristics in the final score.

Industries are divided in three macro-groups, for which the evaluation metrics are a little different because of the different characteristics of business dynamics, especially when it comes to capital structure evaluations.

- **Manufacturing:** It approximately include the so-called secondary sector. It is characterized by capital intensive companies which have production and transformation of goods as their core business. P&L margins are usually lower for industrial companies, since they usually must necessarily use expensive production means and they must buy raw materials in advance. To be defined trustworthy, a capital-intensive company must have a higher percentage of Equity on total debt respect to a company operating in services. For those companies the evaluation must also take a look at the inventory, differentiating between raw materials, work in progress and finished goods.
- **Retail/Services:** In the sectors included in this category, companies are less capital intensive and they provide services to other economic entities, either individuals or other firms. Although very different from one another, services company have an important feature in common: they're not production oriented, so they don't have the transformation of goods among their business activities. Thus, they usually have higher margins than industrial companies and they need a less relevant amount of equity respect to debt to be considered solid companies.
- **Engineering:** This category also includes companies which are often involved in major construction projects, either taking only care of the engineering or also being in charge of the entire project with EPC contracts or Turn-key contracts. The peculiar aspect of those companies lies in their particular way of financing their business activity, the Project Financing. The companies involved in very relevant and expensive projects are usually paid in several tranches throughout the construction works, but they have to anticipate some money because a high share of project expenses must be sustained in advance, so they resort to short term financing using their contracts with the ultimate owner as a warranty. The companies often rent the necessary machinery instead of possessing it and hire temporary workforce, or they may also outsource the construction works to subcontractors, so they don't need an enormous amount of equity in order to be trusted by potential lenders.

Once the category has been determined, analysts assign weights to the various indicators, which include all of the features already mentioned among this chapter: Financial Ratios, the Sustainability of Debt, the Legal Aspects, the Pension Benefit and the Diversification Assessment.

Analysts must evaluate which parameters in the recent past has been more often indicators of defaults and insolvencies among similar industries and give higher priority to those features. Of course, it is important to ask for more experienced colleagues' opinion in order to gather opinions and points of view to elaborate a more rational and correct overview.

For each indicator, the Model reports the relative weight and a boolean value, called operative, which can be worth 1 if the ranking must be read from the highest value to the lowest, and 2 if conversely it should be read from the lowest value to the higher.

Once the weights have been established, the scoring model ranks the six peers for every field, originating several different and independent categories.

The position of the company in every ranking gets then multiplied by the weight of the single feature to determine the score for that category. The single scores are then added together to determine the overall score of the company.

The six firms then get ordered from the lowest to the highest score, so that the one in the first position is the one we consider more financially healthy, and the one on the last position is the riskiest issuer in the group.

It is now necessary to specify some concept characterizing the underlying logic of the scoring model and the reasons why this methodology has been chosen.

The weights may vary from an industry to another, but they are generally similar to each other and no feature has ever a higher weight than 1,5. It means that the priority is given to companies being in good positions in a high number of rankings, penalizing companies who excel in certain ranking but are among the worst in others. This is due to the conservative approach guiding this analysis from its very beginning: the absolute priority is not to spot the more impressively growing company, but it is instead to be sure at a high confidence level that the company won't default on its obligations and the customers of the advisory firm won't lose their money.

The best company from the point of view of this analysis is not the one potentially becoming excellent thanks to very particular strength areas, but it is indeed the one having as little volatility and uncertainty points as possible. That is also why we decided to only look at the ranking of the firms and we deliberately decided not to take into consideration the difference between the different ratios, so that the first one in each ranking receives the same score regardless of whether it has a very little advantage over the second or it has doubled its value.

However, since financial ratios are not exactly independent from one another it is extremely rare for companies to be absolutely excellent in some areas of the balance sheet while being extremely in trouble elsewhere. Those cases may arise for very young and promising companies, which could be affording heavy losses in order to boost revenues for an eventual scaling up operation. Although they might be interesting from an equity point of view because of their high growth potential and the probable positive expectations of markets for the future, they're indeed very volatile and they are not the ones we want to recommend to our customers if they are looking for a secure fixed income investment.

Similarly, there are no veto values, i.e. thresholds under which a company gets an additional penalty or gets instantly put at the bottom of the overall ranking regardless from other companies' scores. That's because this scoring model is meant to order the companies by their credit risk level, not to yet evaluate their absolute eligibility, which will be assessed afterwards. In addition, very negative values in generally positive financial reports are not very likely and they usually have a precise reason, which the analyst must individuate and evaluate if it could compromise the creditworthiness of the company, but it would be too simplistic to put fixed thresholds for each ratio.

Finance is not an exact science, so as the reader may have noticed, many parts of the model are entrusted to the sensitivity of the analysts and to its experience to interpret data in relation to what happened in the past when similar data appeared.

3.8.2 The Data Set

Sep 2020	Ratios	op	weight	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
A/L Ratios	Equity / fixed assets	1	0,5	0,95	0,25	0,46	0,49	0,24	1,34
	Equity / debt	1	1,5	1,52	0,19	0,30	0,42	0,19	0,45
	Equity / fin. net debt	1	1,0	-4,48	0,71	7,96	-72,23	0,83	-1,49
	Eq+non c.liab.-Fix.assets/GrossWcap	1	0,5	0,50	0,60	0,33	0,10	0,16	0,47
	Receivables / Short term liabilities	1	1,0	1,99	1,68	0,68	0,88	1,19	1,32
Mixed Ratios	Fin. net debt / EBITDA	2	1,5	-2,15	0,89	-0,45	-0,03	-6,35	-2,79
	CF / Financial long term liabilities	1	1,0	1,79	0,29	0,25	1,44	-0,52	0,36
	Net WCap / Total revenues	2	0,5	-0,16	-0,24	0,04	-0,04	-0,05	-0,04
	Trade receivable, days	2	0,5	58	17	0	22	53	23
	Trade liabilities, days	1	0,5	191	609	116	89	214	226
	Finished goods, days	2		0	0	-139	25	0	-199
P/L Ratios	Cost of goods sold / Total revenues	2	1,0	0,60	0,17	0,67	0,68	0,33	0,50
	SGA expenses / Total revenues	2	0,5	0,10	0,35	0,39	0,07	0,59	0,39
	R&D expenses / Total revenues	1	0,5	0,16	0,11	0,00	0,12	0,18	0,00
	EBITDA / Total revenues	1	1,0	0,15	0,34	-0,06	0,13	-0,09	0,06
	EBIT / Total revenues	1	1,0	0,09	0,28	-0,10	0,06	-0,12	0,04
	Operating pr. / Total revenues	1	0,5	0,19	0,31	-0,09	0,06	-0,22	0,03
	Profit from cont. op./ Total revenues	1	0,5	0,17	0,24	-0,02	0,05	-0,39	0,02
	Profit / Total revenues	1	0,5	0,17	0,65	-0,02	0,05	-0,39	0,02
	CF / Total revenues	1	1,0	0,34	0,22	0,04	0,14	-0,81	0,06
	Interest expenses / Total revenues	2	1,0	0,01	0,04	0,01	0,01	0,06	0,01
	EBITDA / interest expenses	1	1,0	20,16	9,12	-5,88	27,30	-1,54	10,59
	EBIT / interest expenses	1	1,0	12,15	7,34	-9,37	13,00	-2,02	5,84
ROE & ROI	ROE from continuing operations	1	1,0	0,12	2,20	-0,10	0,23	-0,72	0,06
	ROI	1	0,5	0,07	0,39	-0,40	0,26	-0,09	0,39
Financial Debt Sustainability	Perspective sustainability '20 - '25	1	1,5	11,9	2,6	11,7	16,3	0,1	1,7
	Absolute sustainability	2	1,5	0,73	3,54	1,73	0,75	171,13	4,55
Legal	Qualitative evaluation	2	1,0	4,50	2,00	6,00	3,00	4,50	1,00
Pension Benefit	Equity coverage	1	0,0						
	Deficit / profit coverage	2	0,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Diversification	Qualitative evaluation	2	1,0	3,0	3,0	6,0	1,0	3,0	5,0

Table 3.3 Comparison of Companies' Financial Data and Weight of each Category

The categories are gathered into eight sections. The top four categories refer to the financial report indexes, which constitute the most significant part of the scoring model, examining companies from different points of view.

In the Assets/Liabilities section, the most important item is the Equity/Debt ratio, the most significant parameter in our opinion, since an adequately capitalized firm is less likely to undergo liquidity troubles and has more margin to get more cash at a lower cost if required. Since the industry is in the Retail/Services category, and thus not extremely capital intensive, the critical threshold is set to 0,2 instead of the default 0,3. The ratio correlating Equity and financial net debt is also important because it indicates how much debt is already covered by the firm's liquidity. On the short term we gave priority to the Acid Test as most significant indicator.

Among the mixed ratios, the priority given to the first one is due to the absolute importance operating activity has in the company's business sustainability. EBITDA is a proxy of the operating activities' results, while for this market sector investing and financial activities are considered as

collateral management. Analysts must select firms which are not relying on extraordinary items to sustain their own debt, but look instead able to pay debtholders using the cashflows generated from their core business.

Trade receivables and trade liabilities days are also to be evaluated in a retail market sector. It examines the delta between the average amount of days a company has to pay its short-term payables and the ones it usually takes to cash in its short-term receivables. If a company receives cash flows before paying its suppliers it has an important free financing source, while in the opposite situation it is forced to anticipate the money. However, the weight is lower than capital structure indexes because it is less likely to exercise an influence on the long term.

For what concerning the Profit & Loss ratios, the ones involving the profit are considered less significant than the other ones. In fact, profit is the money left to the firm to remunerate stockholders once bondholders and other creditors have been satisfied. Being focused on the remuneration of bonds, the analysis gives a higher priority to indexes involving EBITDA and EBIT, giving once again priority to the operating activity to the company, which is supposed to provide the firm with the cash to pay interest expenses.

ROE and ROI have a less

The last sections concern the collateral aspects of the business activity of the companies, which were separately assessed previously in this chapter. The priority is given to the sustainability of financial debt, which has the highest weight.

It is followed by the qualitative evaluations of legal proceedings and geographical and segmental diversification. Those are a little less significant for the credit profile than the previous indicator, although important in a long-term business sustainability logic.

The pension plan section has no weight because, as already explained, all of the companies adhere to public pension plans, so they don't owe any future payments to former employees and thus it won't affect their future debt sustainability.

The next step is about creating a ranking for every category in order to determine a basement for the final evaluation.

3.8.3 Intermediate Ranking

Ratios	op	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
Equity / fixed assets	1	1	4	3	2	5	0
Equity / debt	1	0	4,5	3	2	4,5	1
Equity / fin. net debt	1	1	5	3	0	4	2
Eq+non c.liab.-Fix.assets/GrossWcap	1	1	0	3	5	4	2
Receivables / Short term liabilities	1	0	1	5	4	3	2
Fin. net debt / EBIDTA	2	3	0	2	1	5	4
CF / Financial long term liabilities	1	0	3	4	1	5	2
Net WCap / Total revenues	2	4	5	0	1,5	3	1,5
Trade receivable, days	2	0	4	5	3	1	2
Trade liabilities, days	1	3	0	4	5	2	1
Finished goods, days	2	2	2	4	0	2	5
Cost of goods sold / Total revenues	2	2	5	1	0	4	3
SGA expenses / Total revenues	2	4	3	1	5	0	2
R&D expenses / Total revenues	1	1	3	4,5	2	0	4,5
EBITDA / Total revenues	1	1	0	4	2	5	3
EBIT / Total revenues	1	1	0	4	2	5	3
Operating pr. / Total revenues	1	1	0	4	2	5	3
Profit from cont. op./ Total revenues	1	1	0	4	2	5	3
Profit / Total revenues	1	1	0	4	2	5	3
CF / Total revenues	1	0	1	4	2	5	3
Interest expenses / Total revenues	2	3	1	2	5	0	4
EBITDA / interest expenses	1	1	3	5	0	4	2
EBIT / interest expenses	1	1	2	5	0	4	3
ROE from continuing operations	1	2	0	4	1	5	3
ROI	1	3	1	5	2	4	0
Perspective sustainability '20 - '25	1	1	3	2	0	5	4
Absolute sustainability	2	5	2	3	4	0	1
Qualitative evaluation	2	1,5	4	0	3	1,5	5
Equity coverage	1	2,5	2,5	2,5	2,5	2,5	2,5
Deficit / profit coverage	2	2,5	2,5	2,5	2,5	2,5	2,5
Qualitative evaluation	2	3	3	0	5	3	1

POSITION COUNTER	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
First	12	3	0	2	0	2
Second	3	5	3	14	3	8
Third	4	6	5	1	2	11
Fourth	3	4	11	3	9	3
Fifth	4	3	6	3	12	3
Sixth	0	1	3	1	1	2

Table 3.4 Intermediate Ranking

3.8.4 Final Scoring

	Ratios	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
A/L Ratios	Equity / fixed assets	1,0	2,5	2,0	1,5	3,0	0,5
	Equity / debt	1,5	8,25	6,0	4,5	8,25	3,0
	Equity / fin. net debt	2,0	6,0	4,0	1,0	5,0	3,0
	Eq+non c.liab.-Fix.assets/GrossWcap	1,0	0,5	2,0	3,0	2,5	1,5
	Receivables / Short term liabilities	1,0	2,0	6,0	5,0	4,0	3,0
Mixed Ratios		6,5	19,25	20	15	22,75	11
	Fin. net debt / EBITDA	4,5	9	6,0	7,5	1,5	3,0
	CF / Financial long term liabilities	1,0	4,0	5,0	2,0	6,0	3,0
	Net WCap / Total revenues	1,0	0,5	3,0	2,25	1,5	2,25
	Trade receivable, days	3,0	1,0	0,5	1,5	2,5	2,0
	Trade liabilities, days	2,0	0,5	2,5	3,0	1,5	1,0
	Finished goods, days	0	0	0	0	0	0
		11,5	15	17	16,25	13	11,25
P/L Ratios	Cost of goods sold / Total revenues	4,0	1,0	5,0	6,0	2,0	3,0
	SGA expenses / Total revenues	1,0	1,5	2,5	0,5	3,0	2,0
	R&D expenses / Total revenues	1,0	2,0	2,75	1,5	0,5	2,75
	EBITDA / Total revenues	2,0	1,0	5,0	3,0	6,0	4,0
	EBIT / Total revenues	2,0	1,0	5,0	3,0	6,0	4,0
	Operating pr. / Total revenues	1,0	0,5	2,5	1,5	3,0	2,0
	Profit from cont. op. / Total revenues	1,0	0,5	2,5	1,5	3,0	2,0
	Profit / Total revenues	1,0	0,5	2,5	1,5	3,0	2,0
	CF / Total revenues	1,0	2,0	5,0	3,0	6,0	4,0
	Interest expenses / Total revenues	3,0	5,0	4,0	1,0	6,0	2,0
	EBITDA / interest expenses	2,0	4,0	6,0	1,0	5,0	3,0
	EBIT / interest expenses	2,0	3,0	6,0	1,0	5,0	4,0
ROE & ROI		21	22	49	25	49	35
	ROE from continuing operations	3,0	1,0	5,0	2,0	6,0	4,0
	ROI	2,0	1,0	3,0	1,5	2,5	0,5
		5	2	8	3,5	8,5	4,5
Financial Debt Sustainability	Perspective sustainability '20 - '25	3,0	6,0	4,5	1,5	9,0	7,5
	Absolute sustainability	1,5	6,0	4,5	3,0	9,0	7,5
		4,5	12	9	4,5	18	15
Legal	Qualitative evaluation	4,5	2,0	6,0	3,0	4,5	1,0
		4,5	2	6	3	4,5	1
Pension Benefit	Equity coverage	0	0	0	0	0	0
	Deficit / profit coverage	0	0	0	0	0	0
Diversification		0	0	0	0	0	0
	Qualitative evaluation	3,00	3,00	6,00	1,00	3,00	5,00
		3	3	6	1	3	5

	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
Total Score	56,00	75,25	114,75	67,75	118,25	82,50
Ranking	1	3	5	2	6	4

Table 3.5 Final Scoring

3.8.5 Observations

The previous pages illustrate the last two steps, involving the final processing of data by the scoring model. In the first page, the model orders companies from the highest value to the lowest in each category, momentarily neglecting the direction of the scale.

The counter table below shows how many times each company classifies in each position. For this purpose, the type of scale is taken into account using the Boolean indicator on the left. For instance, the first position indicator is given by the sum of first positions on a scale characterized by a value “1” and sixth placements on “2” scales. Conversely, a company is the worst in the ranking every time it classifies first on a “2” scale or sixth in a “1” scale, and so on.

Later, the model proceeds considering the weights in relation to the direction of the scale, assigning a score to each company in every category. The situation is as positive as the score is low.

The final score for each section, in green, is hence the sum of every weighted score, which are subsequently combined returning the final ranking as an output.

The intermediate sections are particularly useful because they allow analysts to immediately notice where a company is superior to its peers and where conversely it is below average respect to competitors.

The results can be observed in the bottom table, and they will be part of the output given to consultant and customers.

The ranking doesn’t provide many surprises and is almost corresponding to the one most analysts would probably have elaborated in their minds while evaluating each company one by one.

However, there are some interesting points to observe.

According to the model, Alibaba obtains the best score, having a stable leadership in almost every section, both in terms of capital structure and efficiency of the Profit&Loss statement. Although it is not the one prevailing in most categories, it has solid fundamentals and it occupies the top spots almost everywhere, making very difficult to individuate any criticality. With the current financial data any kind of insolvency looks extremely unlikely.

Amazon comes second surpassing eBay by a little margin. It is a quite surprising feature in our opinion, because Amazon is a giant company, both well established and steadily growing. It is not so outstanding in terms of capital structure because it is more levered than top competitors and it is less efficient than Alibaba in turning its enormous revenues in profits, having lower margins. It probably depends on a more capital-intensive business and on the impressive investments required to the firm to sustain its enormous growth. However, the sustainability is good and revenues are more than enough to cover future interest expenses. In addition, its business has the most positive outlook for the future.

eBay, in the third position, is not as impressive and growing as the first two, and it has a low level of equity due to the impressive buyback plan. However, its good score is mainly due to its extreme efficiency in turning revenues into profits, thanks to the least capital-intensive business in the group. The sustainability is average but the profitability of both capital invested and Equity is the best by far.

Zalando has a very good capital structure but is less efficient than eBay in Profit&Loss statement, also because of the heavy investments required to sustain a steady growth. Moreover, it has lower return on capital and is less solid in terms of debt sustainability and thus it classifies in the fourth position behind the American firm.

Bed, Bath and Beyond precedes Expedia thanks to a good capital structure with quite low leverage and a better debt sustainability. However, Expedia's data, especially operating cash flows, have been devastated by Covid19 pandemic. The global turmoil also shocked BBB's activity, but in a less disruptive measure, so considering the unique historical moment it would be inaccurate to forecast anything about the future basing on this year's data.

Hence, we run the model again basing on Expedia's operating cash flows before Covid19, which were growing at a good pace, and observed the results again. As reported below, Expedia gets a higher score than BBB adjusting the estimate for Expedia's future operating cash flows. In conclusion, they must be considered almost at the same level in our evaluation model.

	ALIBABA GROUP	EBAY INC	BED BATH & BEYOND INC	AMAZON.COM INC	EXPEDIA GROUP INC	ZALANDO SE
Total Score	56,00	78,25	114,75	67,75	112,25	85,50
Ranking	1	3	6	2	5	4

Table 3.6 Hypothetical Scoring adjusting Expedia's expected future cash flows

As a conclusion of this section it is necessary to remind the reader about the purpose of the scoring model. It has no absolute implications but it is meant to compare different competitors among one industry with each other, even though the group is meant to include the most significant players. Hence, the credit rating doesn't mean the first company is completely free from any kind of credit risk and conversely buying a security issued by the company in the last position is not necessarily wrong under certain specific conditions.

3.9 Comparison With The Market

The analysis of financial data and general overview generates a ranking based upon the overall credit risk related to each issuer. It is a quite thorough analysis which includes a broad data spectrum, aiming to individuate as many critical aspects as possible in order to make the best decisions.

The next step consists of comparing the internal vision, determined by the scoring model and the single due diligences to the vision of financial markets, to determine whether the different points of view are matching and to investigate the reasons of a possible mismatch.

The opinion of financial markets is deduced from three different sources: CDS rates, Asset-Swap Spreads and Major Rating Agencies Ratings.

3.9.1 Credit Default Swap Rates

Credit default swaps (CDS) are a type of insurance against default risk by a particular company. The company is called the reference entity and the default is called credit event. Credit events can be either complete defaults, downgrades or other negative events specified in advance. CDS is a contract between two parties, called protection buyer and protection seller. Under the contract, the protection buyer is compensated for any loss emanating from a credit event in a reference instrument. In return, the protection buyer makes periodic payments to the protection seller. In the event of a default, the buyer receives the face value of the bond or loan from the protection seller. From the seller's perspective, CDS provides a source of easy money if there is no credit event. CDS was introduced by JP Morgan.

Credit Default Swaps allow the protection buyer to transfer the credit risk of particular instruments such as municipal bonds, emerging market bonds, mortgage-backed securities or corporate debt. It can be used for two different purposes: by bond investors to hedge against default risk buying protections or by speculators to "place their bets" about the credit quality of a reference entity.

This kind of contracts imply some risks, since they are traded over the counter in unregulated markets, and they can be traded very frequently making sometimes hard to know who stands at each end of the transaction. Moreover, it is possible than the risk buyer could not have the financial strength to abide by the contract's provisions getting insolvent himself, making it difficult to evaluate the contract.

Credit Default Swap rates reflect the opinion of financial markets about a certain entity, because the higher the probability of a credit event, the more numerous the group of investors looking for a protection and the higher the riskiness of selling that precise protection. Hence, when the market is worried about the credit quality of a specific company, Credit Default Swap rates usually skyrocket, while they tend to drop when markets are positive about the company.

The analysis compares the movements of CDS rates during the last years and their value with the opinion coming from the scoring model to spot particular differences.

The analysis is run using the current prices of the five-years Credit Default Swaps in dollars for each company, usually considering a period of five years backwards, even though sometimes there isn't any Credit Default Swap available back in time.

The observation of Credit Default Swaps is very common in the assessment of credit risk, because it is a forward-looking vision and it can be used to determine the vision the markets have for the next years today, but analysts can also observe the evolution of the opinion during the years basing on the movements of CDS rates.

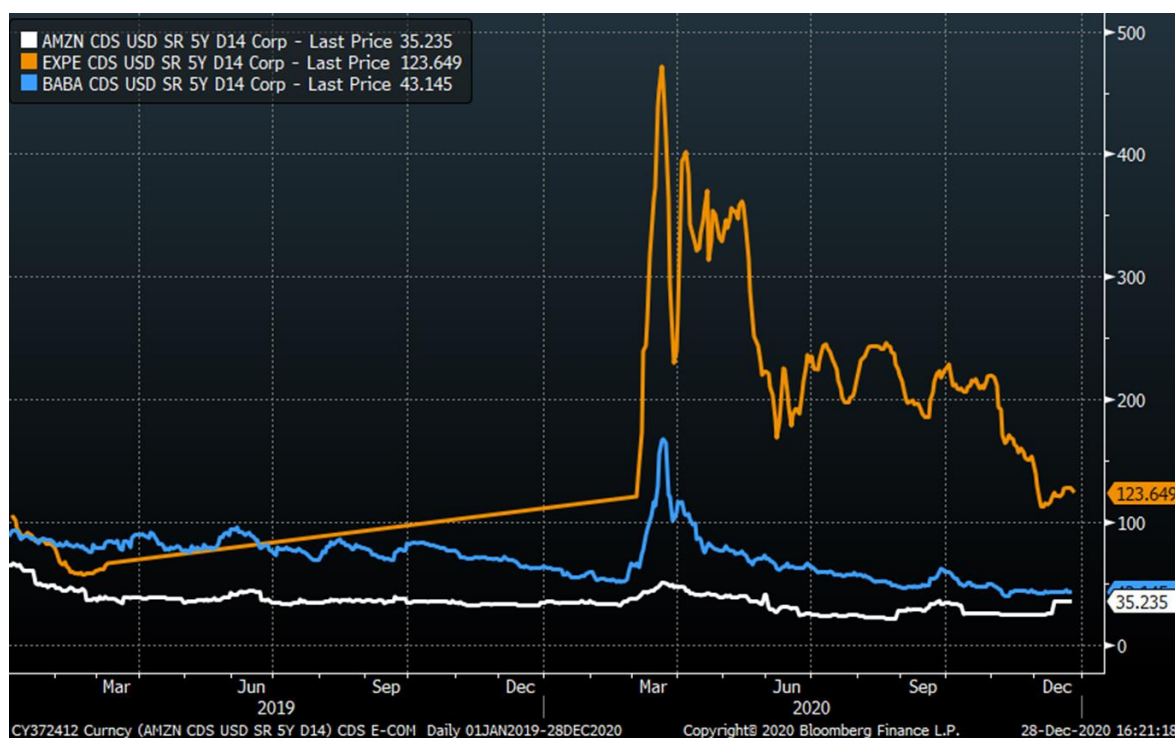


Figure 3.7 Credit Default Swap Rates

The chart above shows the price movements of the five-years USD Credit Default Swaps for the group components. Unfortunately, there isn't any CDS available for three companies out of six, so our analysis is necessarily incomplete. In addition, the data only look two years backwards, since there wasn't any CDS available for Alibaba and Amazon until 2018. This problem often arises while analyzing relatively young companies, so the Credit Default Swap analysis, although useful, cannot be the primary instrument for analysts to evaluate the market's sentiment.

However, the chart provides some useful information about the market sentiment about those three companies, even though they reflect the volatility and the panic due to the pandemic breakout.

As expected, financial markets consider Amazon extremely trustworthy, in fact the CDS rates have remained approximately steady and don't show any doubts by investors. Moreover, the period between February and March, characterized by volatility and irrationality on the markets has left them almost unchanged, showing no investors has ever been worried about a possible default on Amazon obligations. During December CDS rates show a little raise, probably due to the recent claims by antitrust authorities.

Alibaba's situation is approximately similar, except for the sudden raise of rates during the pandemic outbreak, anyway they quickly returned to their previous value and the overall trend is slightly decreasing.

Expedia used to enjoy an increasing trust by financial markets until the beginning of 2019. The straight line indicates the price didn't change because the CDS were not traded, indicating no investors wanted to buy an assurance on Expedia's credit events.

The pandemic made the CDS rates explode, also because of the company's business model, among the most severely hit by lockdown measures and mobility restrictions. Then, although they remain very volatile as reported by the chart, they started to decrease, with the last significant drop between November and December, driven by positive news about vaccine availability.

The opinion of financial markets about Expedia is almost completely dependent on the evolution of Covid pandemic, since they trust the company in normal conditions but they are worried about the effect of restrictions on it. An improvement of the global environment could restore Expedia among the companies with the most positive future outlook.

3.9.2 Market Spreads

Asset swaps are contracts where one party, called the protection buyer, makes a series of payments linked to the total return on a reference asset. In exchange, the protection seller makes a series of payments tied to a reference rate, such as the yield on an equivalent Treasury issue (usually LIBOR) plus a spread. If the price of the asset goes down, the protection buyer receives a payment from the counterparty; if the price goes up, a payment is due in the other direction.

This type of swap is tied to changes in the market value of the underlying asset and provides protection against credit risk in an MTM framework. The Asset Swap has the effect of removing all the economic risk of the underlying asset without selling it.

Unlike a CDS, however, the swap has an element of market risk because one leg of the payment is a fixed rate. Hence, an asset swap can be defined as the combination between a defaultable bond and a fixed-for-floating interest rate swap.

In an asset swap the asset swap buyer takes on the credit risk of the bond. If the bond defaults, the asset swap buyer has to continue paying on the swap, which can no longer be funded with the coupon from the bond, or the swap can be closed out at market value. The asset swap buyer also loses the par redemption of the bond, receiving whatever recovery rate the bond issuer pays. As a result, the buyer has a default contingent exposure to the mark-to-market on the swap and to the redemption on the asset. The buyer is exposed to the loss of the coupons and redemption on the bond, that is the difference between the bond price and recovery value. In economic terms the purpose of the asset swap spread is to compensate the asset swap buyer for taking these risks.

Looking at the spreads of Asset Swaps having a certain issuer's bonds as underlying assets, it is possible to deduce something about the opinion of financial markets concerning each company.

The following charts report the Asset Swap spread for companies' bonds, defined as the spread between the yield required by investors to buy them and the curve zero-coupon rates. This curve is meant to approximate a risk-free curve, and it is formed by Euribor rates for maturities lower than one year and by Interest Rate Swap rates for longer maturities.

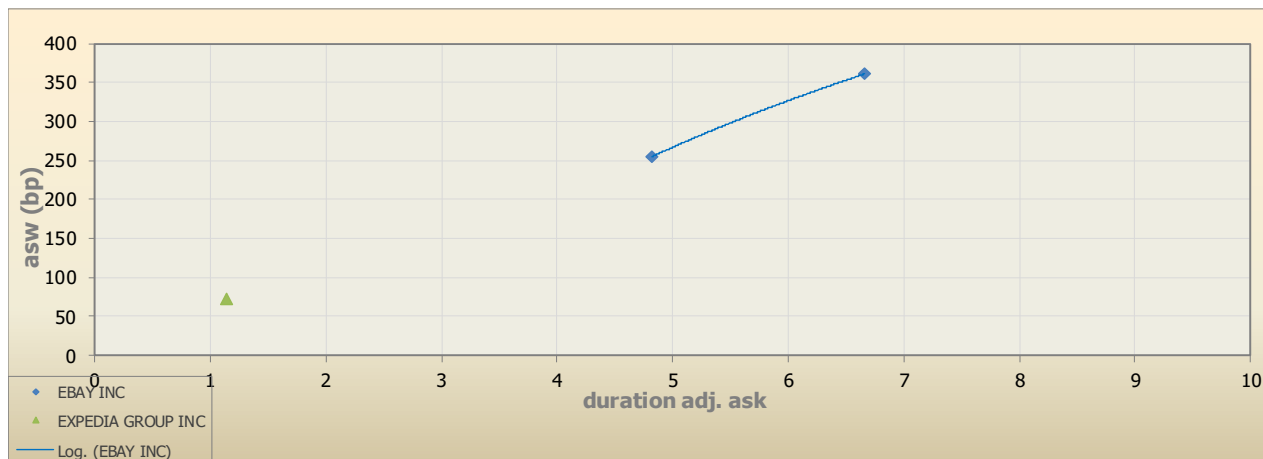
The majority of bonds is issued in USD, while only Zalando issued exclusively bonds in EUR. Hence, the most complete chart is the second one, which permits a detailed comparison between the securities. The charts only consider bonds with lower duration than ten years.

Market spreads retrace CDS rates, showing optimism towards eBay, which is considered almost as trustworthy as Alibaba in the long run, while Bed Bath and Beyond has the highest spreads, showing a bad reputation among bond investors.

Zalando's spread is extremely high, because it is a relatively young company which issued its first bonds quite recently. The steepness of the curve is also significant since it represents the uncertainty of financial markets about its future development raising the expected probability of a credit event over time. However, we don't completely agree with this view.

Market spreads Eur

ALIBABA GROUP			EBAY INC			BED BATH & BEYOND			AMAZON.COM INC			EXPEDIA GROUP INC			ZALANDO SE		
cur	duration	ASW	cur	duration	ASW	cur	duration	ASW	cur	duration	ASW	cur	duration	ASW	cur	duration	ASW
												Eur	1,14	72,72	Eur	4,82	255,27
												Eur	6,66	361,19			



Market spreads USD

ALIBABA GROUP			EBAY INC			BED BATH & BEYOND			AMAZON.COM INC			EXPEDIA GROUP INC			ZALANDO SE		
cur	duration	ASW	cur	duration	ASW	cur	duration	ASW	cur	duration	ASW	cur	duration	ASW	cur	duration	ASW
Usd	0,74	10,26	Usd	1,08	22,70	Usd	3,27	358,03	Usd	0,76	-2,17	Usd	1,14	72,72			
Usd	0,74	0,00	Usd	1,26	18,28	Usd	9,26	448,16	Usd	1,63	-1,97	Usd	2,74	97,39			
Usd	2,28	5,03	Usd	1,93	23,50				Usd	2,41	-5,87	Usd	3,10	154,07			
Usd	3,45	49,24	Usd	3,13	62,18				Usd	3,31	15,30	Usd	3,63	202,79			
Usd	3,43	0,00	Usd	3,94	37,41				Usd	3,47	11,49	Usd	1,28	204,86			
Usd	3,45	46,75	Usd	5,59	75,99				Usd	4,26	11,85	Usd	1,27	186,64			
Usd	6,02	88,44	Usd	7,92	93,62				Usd	4,23	20,40	Usd	3,63	190,05			
									Usd	6,01	38,53	Usd	4,29	205,38			
									Usd	5,80	38,65	Usd	4,29	208,52			
									Usd	8,54	45,69	Usd	4,29	208,52			
												Usd	5,44	212,98			
												Usd	5,44	202,50			
												Usd	5,98	205,37			
												Usd	7,60	188,17			
												Usd	7,61	191,91			

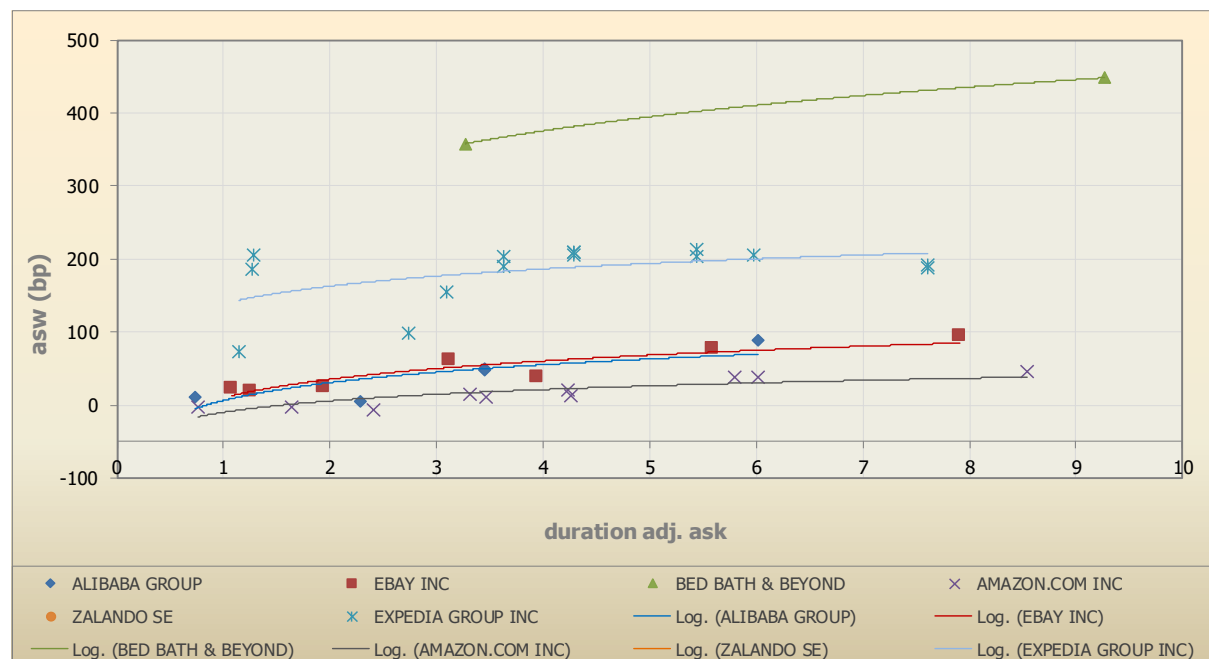


Table 3.7 Asset Swap Spread Profile

3.10 Conclusions

This is the conclusive report of the document, through which the analyst summarizes the results of his assessment work, and it constitutes the outcome which would be delivered to customers and consultants.

The purpose is to put together the collected data in order to determine which companies are trustworthy and which ones are not. It is mainly centered on credit risk, so it hardly mentions the outstanding bonds issued by the company, which are reported among the previous sections anyway. This section basically consists in a report gathering the previous analysis and commenting them in order to make them clearer and provide a complete overview. The analyst would highlight the most important and critical aspects of each firm, explaining the main reasons why the model ranked them in a certain way and motivating the most relevant choices. Among the previous sections of this dissertation, the majority of feature have already been deepened, explaining the underlying logic of every evaluation and the aim of the paperwork, so the explanation for this final phase has to be quite brief.

Conversely, the final report, which is shown in the following pages, has to be complete because it can theoretically be the only part customers and advisors are going to examine in order to make their decisions.

The table above presents the final results in a synthetic way, reporting the scoring model's ranking, along with CDS rates and majors' ratings, comparing the most recent results to those of the previous year. In this case there are no data for 2019, since the due diligence of the e-commerce sector has been performed this year for the first time. Every peer comparative analysis is meant to be updated every six months or at most every year, the section below aims to explain the results and draw final conclusions.

The section below aims to explain the results and draw final conclusions, opening with a brief review of the global situation, mentioning the pandemic raging all over the world since it has had an undisputed impact on financial data, considering our group contains both companies which have benefitted from the pandemic disruption and companies which have been severely damaged.

Then, the central paragraph illustrates the scoring model results and analyzes the most important or unexpected outcomes, briefly commenting each position in the ranking. Moreover, it is also necessary to highlight potential uncommon situations and criticalities met by the analyst while performing the assessment which may compromise the reliability of output. For instance, Expedia has probably been penalized too severely by last period's results, due to an extraordinary event more than a structural crisis, and thus it has been reported several times in the whole document.

To conclude, the report comments the comparison between the scoring model's results and CDS rates and majors' ratings, drawing the final conclusions.

A company is considered eligible not only when it is not likely to default, but also when it is not considered prone to any credit event such as a downgrade. In fact, Expedia and Bed, Bath and Beyond are not likely to default in the near future, but they are not solid enough to exclude any credit event.

Credit Risk analysis summary:

Issuer	Rating Consolidated, 31/12/20			CDS 5Y 2020	Ranking Scoring 2020
	S&P	Moody's	Fitch		
ALIBABA GROUP HOLDING-SP ADR	A+	A1	A+	43	56,00
AMAZON.COM INC	AA-	A2	A+	35	67,75
EBAY INC	BBB+	Baa1	BBB	-	78,25
ZALANDO SE	-	-	-	-	85,50
BED BATH & BEYOND INC	B+	Ba3	-	-	114,75
EXPEDIA GROUP INC	BBB-	Baa3	BBB-	124	112,25

CONCLUSION: Issuer Risk

Uncertainty and volatility represented the main keywords during 2020: the outbreak of an unexpected global pandemic had a disruptive effect on the whole business world, creating a new environment, almost unimaginable just a few months earlier. E-commerce sector was expanding even before pandemic drove by cultural and technological transition, and it has been one of the few industries to benefit from global restrictions.

However, even though the companies constituting the peer are competing in an healthy and expanding environment, their situations are extremely different, considering their business models may sometimes differ from one another.

In our opinion, the less risky company is **Alibaba**, thanks to its overall solid business activity leading to both excellent capital structure and Profit&Loss statement, low leverage and high debt sustainability. It shows an impressive trend over the years with further growth expected and almost no weaknesses, apart from antitrust issues which, although not neglectable, looks manageable by the firm with its impressive resources. **Amazon** is considered at least equally solid, but it comes second behind Alibaba, mainly because of the massive expenses it sustains in investments to expand its influence, along with a higher leverage. Moreover, Amazon is penalized in our ranking by lower margins, which are due to structural differences in business model and transversal expansion projects, but don't necessarily imply a less effective business management. In fact, the American company has the most impressive numbers among the group: for instance, while the entire world is trying to cut costs reducing workforce, Amazon almost doubled its employees, which are now an impressive 1,2 million. It also keeps on investing several billion dollars - more than 30 in the first three quarters of 2020 - in research activity to support its expansion towards different market sectors. Amazon and Alibaba don't require many further discussions, they are market leaders in their influence areas and their expansion is set to continue for several years, even outside their core businesses. They also managed to establish effective entry barriers in their core businesses, since the amount of resources to compete among

eBay is confirmed before Zalando thanks to its more efficient P&L statement, along with the less capital intensive activity of the whole peer. The leverage is very high compared to debt, but it is mainly due to a massive stock repurchasing plan reducing equity by 54,3% from 2018 to 2019, and thus it is not worrying from a creditworthiness point of view.

Zalando has a quite narrow business influence, limiting to Europe, where it is market-leader especially in fashion segment, but it has recently raised a considerable amount of extra-liquidity, which could signal a future strategic move, probably to strengthen the position in its core-area more than expanding outside Europe. It has been growing steadily over the past years, with a revenue growth (CAGR) of 119% from 2015 to 2019, regardless from Covid-19. It is the youngest company in the group and so it physiologically carries a higher uncertainty margin. It is unrated by major rating agencies and doesn't have CDS rates, thus it must still conquer the consideration of global markets. However, the outlook for the post-pandemic world is positive and makes it fair to forecast a further growth.

Expedia is considered the most high-risk company among its peers, but in our opinion it has been over-penalized by pandemic, which had a disruptive impact on the last months financial data, burning almost 3,5 billion dollars in its operating activity forcing the management to raise leverage to survive the storm. Along with BBB, Expedia is the only company which can't be defined "Covid Winner": its business model is based on traveling, completely annihilated by restrictions, causing a drop in revenues for the firm, which conversely had been showing a steady growth over the last years. It certainly is the biggest question mark among peers, since its near future results depend almost completely on the recovery from the pandemic, so we're going to monitor the next developments of vaccines with close attention in order to forecast a restart in both business and leisure travel.

Bed, Bath and Beyond doesn't come last, but it could be if we consider the terrible operating cash flows of Expedia in 2020 as an outlier due to the pandemic. In our opinion, BBB has the worst future perspective among its peers, since it is still reliant on physical stores and it will struggle to turn in a complete e-commerce company, as shown by the drop in every financial result caused by Covid, which has instead granted an important benefit to its competitors. The situation is indeed not dramatic, but it has shown a slight but steady shrinkage of revenues and earnings, with a heavy loss during financial year 2019: its future performances are then uncertain and it won't start 2021 with the best odds.

CDS rates are only available for three out of the six companies and they seem to confirm our evaluation. Amazon never lost markets' trust and always kept very low CDS rates, while Alibaba had shown an increase during the outbreak of the pandemic, especially because of its high exposure to China, where the virus started. However, it returned to its previous level very quickly, as soon as the panic reduced. Expedia's CDS rate, after experiencing a dramatic increase due to Covid-19, is now decreasing, with a drop in December following the optimistic news about vaccines. CDS rates consider both Amazon and Alibaba very unlikely to default, agreeing with our opinion.

Our opinion corresponds to that of the major rating agencies, except for Zalando, which is not rated by any of those. The uncertainty about the German company is also noticeable from Asset-Swap spreads, since they are way higher than Expedia's, which has a worse financial situation and more uncertainties concerning its future business results. However, although younger than peers and far from having reached their market penetration, it has good financial fundamentals and our opinion about it is positive. Expedia has an higher rating than Bed, Bath and Beyond and we don't disagree: as mentioned before, we are aware that results registered amid Covid-19 may excessively influence the scoring, so Expedia's score may have been too severe. However, we prefer being more conservative this time, reserving the right to adjust our opinion in the future when we'll have a clearer vision of the developments of post-pandemic world.

Alibaba, as previously mentioned, came before Amazon in our scoring model, even though its rating is slightly lower and it has a higher ASW. However, our opinion is still similar to that of the Rating Agencies in this case because both companies are extremely solid, and the difference between the two opinions is probably due and to the different importance given to parameters. Our preference for Alibaba is mainly due to the efficiency of its business and its extremely low leverage, which makes any financial suffering in the mid-long term hardly possible.

We rate Alibaba, Amazon, eBay and Zalando as eligible, while Expedia and Bed, Bath and Beyond are momentarily not eligible.

Figure 3.8 Conclusions and Final Report

4. QUANTITATIVE MODELS FOR PORTFOLIO MANAGEMENT

The logical path linking the different parts of the dissertation started from the presentation of the fixed income world, introducing every critical aspect an investor may have to face while dealing with this kind of security. Then, the focus switched to the risks related to the creditworthiness of the issuer, eventually examining the issued bond to anticipate any critical element coming from the issuance itself.

This chapter will introduce the conclusive phase of the dissertation, which is meant to illustrate a complete analysis of bond risk in multiple forms. It is meant to be a final step both conceptually and chronologically, since it concerns an activity which is subsequent to the credit risk assessment and must be continued by portfolio managers in order to keep the risk profile below the required standards.

This is also the most quantitative and experimental phase of the dissertation. Since finance is not an exact science, especially when it comes to forecasting the future, the sensibility and the experience of the analyst were crucial in the previous steps, while now the point of view switches to that of a data scientist describing the reality through mathematical models.

However, as the whole dissertation, this approach aims to produce useful results potentially suitable to be applied in operating activities. Consistently, the research work run inside the company aims to individuate a model constituting a reference point for portfolio management.

4.1 Purpose and Scope of Work

The final purpose is to individuate efficient portfolios providing optimal risk-return, protecting investors from damages may incur in case of a drop in financial securities' prices and, at the same time, granting them the maximum utility possible.

The logic underlying the model make us temporarily neglect the liquidity of the bonds, represented by bid-ask spread, which is supposed to have been thoroughly analyzed in advance. In fact, maintaining the conservative approach already inherent in the previous chapters, every security inserted in the model is assumed to have gone through the process described in the previous chapter.

Market risk management is a concern for investors during the whole holding period of the securities. Through the analysis run in the previous chapter, advisors aim to be sure the issuer will meet its obligations granting the payment of regular coupons and returning the principal to bondholders at maturity. However, it is only an exhaustive approach if investors are sure to keep bonds to maturity. Even though the purpose of fixed income investors is rarely speculating on price movements, there are several possible scenarios which may require to liquidate bonds before the due date. For instance, bondholders could need some liquidity to finance a project, to seize sudden opportunities or to simply sustain an unpredicted expense.

Hence, a drop in a security's price could cause several troubles even in the fixed income field, and it consequently requires advisors to spot them in advance and periodically adjust portfolios to prevent risk profile from skyrocketing following certain events.

A financial advisory company also needs to be compliant with market regulations, called MiFID in Europe, which are meant to protect investors from possible incautious or opportunistic behaviours by advisors.

This regulation forces every financial advisory firm to follow certain rules while managing a customer's portfolio, assessing each customer's risk profile basing on several parameters such as

age, possibility to tolerate losses and personal risk appetite level, evaluated through pre-determined surveys. For instance, an investor is considered conservative if he's extremely risk-adverse and gives priority to the safeguard of his wealth over its growth; this is very common for elderly people, whose investment portfolios must be tailored using low-risk asset classes such as government or investment grade bonds and liquidity. Conversely, an aggressive investor is placed at the opposite side of the spectrum, characterized by a more risk-prone attitude, willing to bet on more volatile investments giving priority to the growth of his capital accepting the risk of short-term losses. Usually, aggressive profiles are reserved for young people with a lot of time ahead or financial professionals. Advisors and portfolio managers are allowed to allocate a higher percentage of capital to high-risk asset classes in aggressive investors' portfolios, such as equities and high-yield corporate bonds, also considering private equity and non-orthodox investments.

Anyway, the aim of this work is to apply authoritative researches elaborated over the last decades to the optimization of a portfolio's asset allocation over time, giving priority to the maintenance of a low risk level, reserving the opportunity of adjusting it to more aggressive portfolios for the future. The majority of concept inspiring the dissertation were originally meant to be applied to equity stocks, the following chapters will test their effectiveness for fixed income securities in order to potentially apply them to optimize mixed portfolios in the near future. In fact, real life customers' portfolios are constituted by a mix of several asset classes, usually bonds, equities and liquidity, each one characterized by a certain risk level. While allocating money on different asset classes, portfolio managers must take into consideration the customer's profile which provides the thresholds they must not surpass.

Some other asset classes, such as derivatives and certificates; require a more peculiar approach, as well as private equity and contemporary art, which are gaining room in several institutional investors' portfolios. Those asset classes are particularly difficult to deal with as they are extremely volatile and difficult to describe through the usual quantitative parameters. Consequently, it would be a conceptual mistake to include them in the model as they are considered extraordinary investments and they must be discussed apart from the portfolio of the average customer.

Starting from a list of possible securities which may constitute the portfolio, the experimental work, as any other optimization model, will proceed through the following steps:

- **Gathering Data:** The analyst must gather the prices of each security for the selected period and the current yield-to-maturity, since momentarily the target securities are bonds. Those data will provide the basis for the subsequent analysis.
- **Calculating Statistical Measures:** Calculating logarithmic returns for each security and consequently the mean return for the selected period and the volatility, measured by the standard deviation of returns.
- **Evaluating Correlations Between Securities' Returns:** Analyst calculates correlation coefficient ρ for each couple of securities to form the Variance-Covariance Matrix.
- **Calculating a Volatility Measure for each Security:** After having selected the most appropriate risk measure, based on volatility, it must be calculated for every available security one by one.
- **Optimization:** The final goal of the model is to select the optimal portfolio combining the available securities. The modalities will be discussed among the next chapter.

As mentioned before, every available security potentially entering the portfolio is selected after it has been examined by the assessment described in the third chapter, so the trustworthiness of the issuer and the liquidity of bonds have already been certified.

4.2 Assumptions

The model relies on certain assumptions to be significant. Even though they contribute to simplify the model's description of reality, we think it remains sufficiently accurate to be implemented for real investments. However, the problems arising from those assumption will be described later, both for completeness and to possibly find a solution.

1. **Normal Distribution of Returns:** The model assumes logarithmic changes in market prices follow the normal distribution. Hence, between two periods:

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \cong \frac{\Delta P_t}{P_{t-1}}$$

If logarithmic returns are normally distributed, securities' prices are distributed according to a log-normal distribution. With normal distribution the likelihood of price changes remaining within a certain range is easily computable because of the symmetry of the distribution:

- $P(X \in \mu \pm \sigma) = 0,6826$
- $P(X \in \mu \pm 2\sigma) = 0,9544$

However, risk management doesn't consider the right tail of the distribution, but it is focused on potential losses, only considering the right tail.

- $P(X \leq \mu - \sigma) = 0,1587$
- $P(X \leq \mu - 2\sigma) = 0,0228$

This assumption is undoubtedly the most relevant and critical when it comes to portfolio optimization. Its precise implications will be discussed thoroughly among the following sections.

2. **Past Performances can be used to Forecast Future Ones:** Unless being able to assess every aspect of the future reality, creating one by one different scenarios containing forecasts of any possible unexpected turmoil, such as COVID-19, the model must be backward-looking. Even simulation processes must base on past observations to elaborate scenarios for the future. Creating hundreds of separate and customized scenarios, even though theoretically possible, is extremely expensive in terms of time and money. Few companies would be able or interested to implement such a process internally, so they would more likely resort to outsourcing, buying ready-made scenarios from external consulting companies and calculating the expected impact on every security, likely spending a considerable amount of money. Such a process must be repeated very often and would require a numerous team of macroeconomic and market analysts in order to always be updated, and, at least for our company, costs and inefficiencies would overcome advantages.

Therefore, in the hypothetical tradeoff between accuracy and feasibility, the most sensible decision is to estimate future volatility observing the past. The last decades contains almost every possible scenario, and a very long observation covering different phases of economic

cycle would also provide more robust data, partially justifying normality assumption. However, in this dissertation the samples will be shorter in order not to make the discussion excessively heavy. Anyway, the accuracy provided by this method is in most cases enough to give useful operative suggestions. It doesn't absolutely mean analyst can be exempted from a constant updating and monitoring activity, being always extremely attentive for possible future unexpected events.

For instance, including COVID-19 period in the data set would probably make the perceived volatility of securities skyrocket. Such an effect could be a plus especially in a period of extreme uncertainty, since when it comes to investments it is generally better to be wrong being too conservative than too aggressive. In fact, it has been scientifically demonstrated that human beings are more upset by a heavy loss than by an equal missed gain, and advisory firms' customers are no exception.

- 3. Issuers' Creditworthiness won't change over time:** The available securities have already been selected by a thorough analysis regarding the issuer and the characteristic parameters of the bond itself. Therefore, the present experimental work doesn't take into consideration any credit event such as downgrades, unlike, for instance, the CreditMetrics model.

The optimization work is instead meant to focus exclusively on risk management and asset allocation within portfolios. Of course, it must act in synergy with the analysis explained in the previous chapter and it must be updated periodically to check if the held securities are still the best options or if their issuers have suffered adverse conditions reducing their creditworthiness. Likewise, the analyst must periodically check for new potentially interest issuances, but those tasks must be performed separately from the model.

However, in order to minimize any possible distortion, we consider selecting, where possible, bonds whose issuer suffered a downgrade during the target period, to evaluate the impact a downgrade will likely have on bond prices in the future.

- 4. Each one of the chosen securities is available to be purchased:** This point partially reconnects to the previous one, since is up to the analyst making sure that every selected security has the right liquidity, resulting in a low bid-ask spread, and is available to be purchased through the customers' banks or with the help of the advisory firm.

In an embryonic stage this dimension will be neglected, but in the future, if this approach were to be put in practice, an adjustment of the model to consider purchasing fees and inefficiencies due to a low liquidity is not unlikely.

4.3 Value at Risk

Value at Risk is often used as a global risk measure thanks to its several important features, part of which has already been broadly introduced among the second chapter.

The first characteristic making VaR the most suitable measure for market risk measurements is its versatility: it is indeed commonly used for several financial models because it can comfortably be adapted to most securities. It allows the model to be extended not only to bonds but also to equity and any other asset class, as long as the market risk factors are correctly estimated and evaluated for each one.

In fact, the adoption of Value at Risk prevents analysts from using different sensitivity measures for every asset class, such as Duration for bonds and Beta for equities, creating obstacles in comparing the different positions and making it trickier to evaluate mixed portfolios and correlations between the different securities. Those aspects are brilliantly solved by using Value at Risk as a unique risk measure.

Moreover, Value at Risk is also a quite intuitive approach and provides a significant information without requiring a prohibitive calculation effort, being relatively easy to communicate and explain to both regulators and customers, which may not have so much familiarity with complex financial concepts.

VaR can be calculated in different ways, using either the Var-Cov method, a parametric approach which provides an exact result solving a closed mathematical formula, or the non-parametric one, which basically consists in the observation of the expected loss at a certain confidence level using either real data sample or artificial scenarios coming from simulation method such as Monte Carlo. The analytic formula to calculate parametric Value at Risk has been reported in the “Market Risk” section of the second chapter, nevertheless the reader may appreciate a reminder:

$$VAR = \text{Market Value} * \text{Modified Duration} * \text{Worst Risk Factor Performance at confidence level}$$

The last term of the product is defined as the percentile of a normal distribution corresponding to the desired confidence level. The process is hence about calculating mean and standard deviation for every security and eventually deriving the VaR from the formula above.

Despite its several positive features, Value at Risk, especially Var-Covar approach, has also some criticalities which analysts must be aware of. The following paragraphs are meant to broadly describe the main issues arising from using Value at Risk.

4.4 The Limits of Var-Cov Approach

4.4.1 Serial Independence of Market Factors’ Returns

Value at Risk model assumes market factors’ returns are independent and identically distributed, so that the return observed on a certain time window is meant to be totally independent from the ones observed in the past, even though they share the same random distribution.

Observations of economic variables’ real behavior have disproven this claim multiple times. In fact, financial markets are often affected by some sort of correlation between recent past and near future, favoring the development of trends in prices.

Financial literacy has been deepening this topic for a long time, elaborating the so-called Momentum Effect theory. Probably, the most famous paperwork on Momentum Effect was the one published by Narasimham Jegadeesh and Sheridan Titman in 1993 under the title of “*Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency*”.

The paper reports a study on the mid-term momentum effect, documenting that, over 3 to 12 months horizons, past winners continue to outperform past losers by around 1% per month, and it has been later confirmed several times by other researchers’ work. Studies concerning Momentum Effect have enjoyed a lot of interest by financial researchers and professional because they challenge the Efficient Markets Theory, which claims prices always discount every available information, and therefore they won’t change until new data get added to the equation.

According to Efficient Markets Theory it is not possible to predict future stock prices and to identify a continuously profitable trading strategy. Short-term price movements are sortable as background

noise, instances of a normally distributed random variable with null average, and they are indeed independent and identically distributed.

Momentum Effect may also confirm Behavioural Finance's Theory, which claims prices on financial markets may be influenced by non-rational behaviours by investors, which could for example follow the general sentiment on a security creating a trend, while going against the tide would be a wiser position.

However, since the present model has a mid/long-term perspective and Momentum Effect, although relevant, becomes more neglectable the longer the period, this is not an insurmountable obstacle to the application of Value at Risk to our purposes.

4.4.2 Variance-Covariance Matrix Stability

Assuming volatility, expressed by standard deviation and variance, and correlation between different securities are fixed and won't change over time is clearly a simplification. In fact, repeating the experiment using a different time horizon for data in the past the results would likely be different, although usually not that much.

This problem can be partially circumvented by choosing the most significant data set available in the past, which has the highest likelihood to fairly represent future volatility and correlations, making sure no extraordinary events are likely to happen in the future, and if so, taking it into account. Moreover, it could be a good practice to regularly update the model over time inserting the most recent observations.

However, those adjustments are not enough to completely fix the inaccuracies due to instability of variance-covariance matrix, and it is advisable to be a little more conservative while establishing thresholds values for VaR. Moreover, the chosen data set is very wide, in order to capture a whole economic cycle, obtaining the most significant measures available.

4.4.3 Normal Distribution of Market Factors

This is undoubtedly the most relevant problem of applying VaR to Risk Management, since it originates several inconsistencies, severely endangering the accuracy of the model.

1. **Negative Skewness in price movements:** Normal distribution is supposed to be symmetric, but empirical observations reveal a certain unbalance towards the negative side of the distribution. Such an effect has relevant implications in risk management, where the most serious mistake is to underestimate the risk of a loss.
2. **Time Sequences of Price Movements are not Random:** The movements of certain financial variables, such as interest rates, are not randomly distributed, and therefore they should probably not be modeled with a random variable. Those effects usually depend on monetary policy decisions and political events, which have a deep influence on currencies' price.
3. **Tail Independence:** Another problem due to asymmetry. The probability of observing an extreme value by one side is not always perfectly correlated with the likelihood to see an extreme value on the other side.
4. **Volatility is Stochastic:** In a normal distribution, volatility is a deterministic parameter which is assumed to be fixed over time. Conversely, empirical studies confirmed that volatility is not fixed but it should instead be modeled as a random variable itself.

5. **Fat Tails Problem:** Extreme values have been proven to be more frequent than what normal distribution would predict. For instance, in August 1998 the LTCM portfolio lost 1,71 trillion dollars in a month, corresponding to 8,3 times the standard deviation. Such a loss was expected to happen once every 800 trillion years, that means forty-thousand times the current age of the whole Universe. For further information please see “How Long-Term lost its capital”, published in 1999 by Philippe Jorion.

Fat tails may provoke dangerous underestimates of market risk, so that over time some solutions have been proposed:

- **Mixture of Normals:** Combination of different normal distributions with the same mean but different variance, in order to consider exceptional events:

$$P = P_1 * N_1(\mu_1, \sigma_1) + P_2 * N_2(\mu_2, \sigma_2)$$

The distributions must be at least two, with $P_1 \gg P_2$ and $\sigma_2 \gg \sigma_1$.

- **t-Student Distribution:** Defined by μ and σ such as a normal distribution, adding another parameter, v , which controls the degrees of freedom. With $v \rightarrow \infty$ the t-Student tends to a Normal distribution. Since the lower the v value, the thicker the tails of the t, choosing a lower degrees of freedom parameter means being more conservative.

While using mixture of normal might unnecessarily burden the model, replacing the normal distribution with a t-Student could be an interesting adjustment of the model in the future, since it would emphasize a conservative approach. However, in this phase, considering the remarkable amount of information within the data set and the good approximation provided by the normal distribution, this same distribution will be applied to the research, maintaining the possibility to perform adjustments in the future.

4.5 Conditional Value at Risk – The Expected Shortfall

Apart from the criticalities concerning Var-Cov approach, exhaustively listed in the previous paragraph, Value at Risk itself is burdened by two important limits:

- **Losses beyond Confidence:** VaR is a punctual measure, and thus it doesn't provide any information about the potential loss the investor may incur if the confidence threshold is surpassed. It doesn't describe the distribution's tail and so it doesn't consider the *Worst Loss*.
- **Lack of Sub-Additivity:** Sub-additivity is among the required features for a proper risk measure, as specified by Paul Embrechts in his second Integrated Risk Management (IRM) theorem. This is essentially related to Diversification Principle, the rule which states that a diversified exposure must always have a positive effect on risk, or at least not a negative effect. In practice, a portfolio formed by two different assets should never be riskier than the sum of two portfolios formed by the single assets. VaR is compliant with this principle as long as portfolios follow elliptical distributions, such as multi-variate normal, t-Student or Laplace, but it is not sub-additive for non-elliptical distributions. Hence, for portfolios following distributions

either asymmetric or fat-tailed, it may lead to misleading results while optimizing portfolios, since linear correlation between logarithmic return is not enough.

Thus, as several other measures in the classical financial theory, VaR is only a fair Risk-Measure in a world dominated by the normal distribution, or at least by elliptical ones. Although this might be a reasonable approximation, it is not necessarily correct, so other risk measures are necessary.

One of the most popular remedies for this problem is Expected Shortfall, also known as Conditional Value at risk, a one-sided risk measure, since it only considers risk only by one side of the distribution.

Definition: *Conditional Value at Risk is the average expected loss provided that losses are higher than VaR, that is the average loss in the distribution tail beyond VaR, that means the expected loss in the worst $\alpha\%$ of cases.*

$$ES_{\alpha}(L) = VaR_{\alpha}(L) + E[L - VaR_{\alpha} | L > VaR_{\alpha}]$$

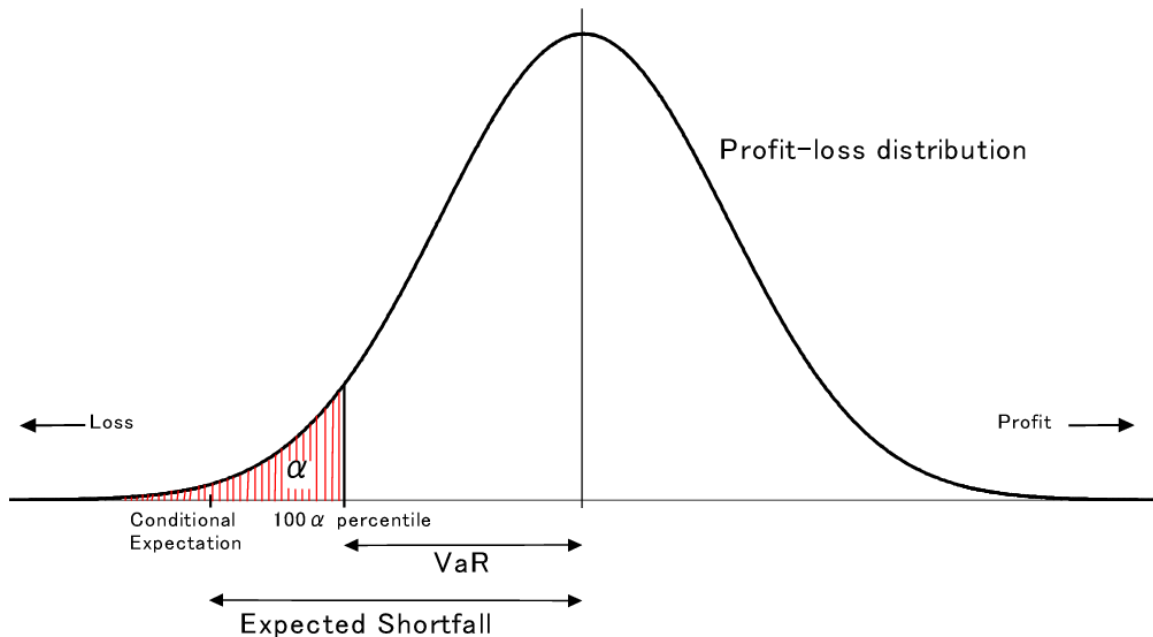


Figure 4.1 VaR and CVaR graphical representation under normality

The figure above illustrates the concept of Conditional VaR for a normal distribution, but, unlike VaR, C-VaR is an effective risk measure also for non-elliptical distributions, as it ensures sub-additivity for every distribution, regardless from symmetry and tail shape.

Using Conditional VaR instead of VaR allows to take into consideration the worst possible loss, promoting diversification and avoiding gambling portfolios thanks to its sub-additivity. Moreover, since CVaR is always higher than VaR, and the two measures are obviously correlated, so optimizing CVaR also means optimizing VaR.

For those main reasons Mean-CVaR approach has been one of the most successful portfolio optimization methodologies used by researches trying to push themselves beyond mean-variance approach.

4.6 Execution and Expected Results

The experimental work will take place in macro-phases:

- **Bond Selection:** The securities constituting the sample for the models must satisfy some requirements in order to make them more realistic and significant. In this phase it is not necessary for the bonds to have been previously gone through the credit risk assessment procedure, even though that will be a fundamental requirement if it will be put into practice in future.
 1. **Availability of Historical Data:** For the past data to be significant, it is necessary to have a sufficient number of observations, so the chosen bonds must have at least five years of observations, that means they must have been issued before January the 1st 2016. Unlike equities, which can potentially be outstanding for several decades, bonds usually stay on the markets for a limited period, except for perpetual ones. Hence, it may be necessary to rely on shorter data sets to evaluate bonds by their past performance, even though it may not be too big of a problem given their less volatile nature.
 2. **Coming from Different Markets:** Bonds issued in different markets provide a well-diversified list to choose the optimal portfolio, taking into account the potential happenings which may have caused differences between areas, including the effect macroeconomic events may have had on each market during the sample period. The securities will be chosen among United States, United Kingdom, Germany, France and Italy. Bonds denominated in Euros will be expressed in USD as well through the observation of the USD/EUR exchange day by day through the entire period.
 3. **Diversified between Industries:** Choosing bonds from different business sectors, as well as different geographic markets, allows to keep the correlation quite low and to avoid excessive exposure to a single market factor.
 4. **Maturity:** In compliance with the usual guidelines for bonds, which wouldn't recommend very long durations, the chosen securities are to come due before the end of 2026, avoiding perpetual bonds or too long maturities.
- **Model Implementation:** This is the central phase of the process, and it consists of the application of two different optimization models to the bond portfolios. The first approach will be a Mean-Variance optimization, which requires normality assumption for logarithmic returns, following the approach of Markovitz Model. The second phase is meant to apply a Mean-CVaR optimization, using Montecarlo simulation. The two processes will be thoroughly described among the next chapters, both from the conceptual point of view and from the analytic and quantitative one. The elaboration phase is run through MatLab software. Those two models were originally meant to be applied to equities, even though some researchers have already applied them to fixed income portfolios. Hence, the results of the two models will be compared to spot any difference and to eventually select the most suitable for our purposes.
- **Backtesting:** This is a very common and important practice to see if the elaborated model is suitable to be applied to real problems. It will be run pretending it's January the 1st 2016, choosing a group of bonds which currently have five years of historical data available and

are still currently active. Each model will be applied to the group in order to individuate optimal portfolios basing on past observations, and their performance for the four following years will be assessed. Then, the selected portfolios will be compared to the universal portfolio, which is simply a portfolio containing all of the chosen securities in equal proportion, to evaluate the effectiveness of the model. The main focus will be on the accuracy of the past in forecasting the future, observing the difference between expected return and actual ones, and on the effectiveness of optimization models in limiting the volatility of bond prices through the years. Of course, one single test is not enough to obtain statistically significant results, but reporting an exaggerated number of tests, which would of course be equal to each other apart from the data set, would burden the dissertation and would not be conceptually useful.

To run a proper test, we will be forced to relax some constraint in the choice of securities because there is no sufficient availability of bonds with the required characteristics and because some requirements are not central for the backtesting purpose. Hence, the securities will only be from US market and they are all denominated in USD.

The main goal of implementing a quantitative optimization model in the management portfolios is to take advantage of the enormous calculation power made available by modern technology to quickly process a variety of data and help analysts and consultants.

Subsequently, this phase is also meant to determine if processes originally meant for equities and usually applied to equities could also be suitable for bonds and if they could be suitable and helpful for the financial advisory firm.

Anyway, the goal is not to develop a framework able to individuate the best investments by himself reducing the importance of an expert and skilled analyst, whose importance still remains central in every branch of finance. However, the result to look for is a useful model which could provide some guidelines to analysts, while being easily understandable by customers.

5. LITERATURE AND THEORETICAL CONCEPTS

This chapter is going to describe the main concepts, models and researches used for this phase of the final dissertation.

At this point, it should be clear to the reader that the purpose is to find a way to optimize a bond portfolio, but what does it mean exactly? The optimization of a portfolio is essentially the selection of the best portfolio out of every possible portfolio obtainable combining a certain set of assets.

The assumptions behind optimization states that the return an investor can expect to get from an investment is positively correlated to the same investment's risk. It means the investor cannot hope to obtain more than a certain return out of its investments without accepting to raise the likelihood of losing part of the invested capital.

The risk-return approach relates the expected return of each investment to the implied risk, aiming to individuate the best combination, which provides the highest expected value to the investor.

In fact, if it is true that no extra return could be obtained without an additional risk, it would not be so smart to accept a high risk without expecting an adequate return, when the market permits to choose a more profitable solution with no additional expected volatility or an equally profitable one which is safer.

Hence, the purpose of optimization is to find the best risk-return solutions, making sure investors are fairly remunerated for every additional risk they take, individuating the best solutions markets are currently offering.

Expected return and expected risk could be either based on the behaviour of the assets in the past or on forecasts made by analysts considering their expectations on the future. In some cases, it is also possible to combine the two approaches to correct the backward-looking scenarios exploiting the experience and sensitivity of analysts.

The best portfolio is the one maximizing certain characteristics, typically the ones raising investor's perceived utility, or minimizing others, which are generally the parameters chosen to model risk. As partially mentioned in the previous chapter, the following pages will focus on two optimization approaches, the mean-variance and mean-CVaR, whose key principle is to maximize returns limiting risk, respectively measured by variance and CVaR, or conversely looking for the minimum-risk portfolio under constraints of minimum return.

In this chapter, the reader will therefore find a description of the main concepts which have inspired the research work and the related theoretical references, illustrating also the analytical methods applied to actually solve those optimization problems.

The next page provides a complete enumeration of the symbols used in the illustration of the analytical basis of optimization models, which are meant to help him finding his way around formulas and technical explanations.

SYMBOLS

- n = number of assets.
 C_0 = capital that can be invested, in euros.
 C_{end} = capital at the end of the period, in euros.
 R_p = total portfolio return, in euros.
 μ_p = expected portfolio return, in euros.
 σ_p^2 = variance of portfolio return.
 r_i = rate of return on asset i .
 μ_p = expected rate of return on asset i .
 ρ_{ij} = correlation between asset i and j .
 σ_{ij} = covariance of asset i and j .
 $\Sigma = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \dots & \sigma_{1n} \\ \sigma_{21} & \ddots & \dots & \sigma_{2n} \\ \vdots & \dots & \ddots & \vdots \\ \sigma_{n1} & \dots & \dots & \sigma_{nn} \end{pmatrix}$ = matrix of covariances of r .
 x_i = amount invested in asset i , in euros.
 μ_f = rate of return on the risk-free asset.
 R_f = total return on the risk-free asset.
 γ = parameter of absolute risk aversion.
 s = slope of the capital market line in mean-st.dev. framework.
 k_α = dispersion-standardized quantile of distribution at level α .
 z_α = dispersion-standardized quantile of distribution at confidence level α .
 Ω = $(n \times n)$ - dispersion matrix.
 $VarR_\alpha$ = Value at Risk at confidence level $(1 - \alpha)$

$$r = \begin{pmatrix} r_1 \\ r_2 \\ \vdots \\ r_n \end{pmatrix}, \quad \mu = \begin{pmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_n \end{pmatrix}, \quad x = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{pmatrix}, \quad \bar{1} = \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix}$$

EXPRESSIONS

$$C_{end} = C_0 + R_p$$

$$R_p = \sum_{i=0}^n r_i * x_i = r^T x$$

$$\mu_p = \sum_{i=0}^n \mu_i * x_i = \mu^T x$$

$$\sigma_p^2 = \sum_{i=0}^n \sum_{j=0}^n x_i x_j \sigma_{ij} = x^T \Sigma x$$

$$R_f = \mu_f C_0$$

5.1 Markowitz Portfolio Theory

The publication of Harry Markowitz's theory dates back to 1952, when he illustrated his theories to academic circle through the article "Portfolio Selection", published on the *Journal of Finance*.

From many points of view, Markowitz's publication represents a revolution for modern portfolio theory, emphasizing the importance of risk management, correlation between securities and diversification. Hence, his work is considered a turning point, in collaboration with Merton H. Miller and William Sharpe, which shared with him the Nobel Prize in Economics, in 1990.

Markovitz model consists of a calculation of an efficient frontier, which shows all efficient portfolios in a risk-return framework. Each portfolio can be considered either the one providing the minimum volatility subject to a certain expected return or the maximum expected return given a certain volatility.

An investor will always want to invest in an efficient portfolio, since there will be no reason to choose a lower return for the same volatility or a higher volatility for the same return.

This is true under the assumption of rationality and risk aversion of the investors, which basically mean investors will always make the most rational choices using the information at their disposal trying to maximize their own self-interest and they will always avoid choose the lowest risk level available all the rest being equal.

5.1.1 The Efficient Frontier with Short Selling

To draw the efficient frontier, it is necessary to minimize the risk, measured by standard deviation, given some expected return. In this phase the illustrated procedure executes the calculation of the efficient frontier through the Lagrange Method without inequality constraint, momentarily allowing short selling.

The minimization is accomplished through the setting of a non-linear optimization problem, which has variance as an objective function. Minimizing variance instead of standard deviation, which is simply its square root, is allowed since standard deviation is positive by definition.

$$var_{port} = var_{rend} = var(r^T x) = x^T \Sigma x$$

Depending on the characteristic of the final portfolio one wants to obtain, it is possible to insert a virtually unlimited number of constraints, but the following two are strictly necessary for the model to work even in its simplest form. The expected returns have to be fixed, and the investor can only invest the capital currently at his disposal, so analytically those two constraints are translated as follows:

$$\mu^T x = \mu_p \quad \text{and} \quad \bar{1}^T x = C_0$$

The problem is hence defined as:

$$\text{Min}\{x^T \Sigma x | A^T x = B\}$$

Where $A = (\mu \quad \bar{1})$ and $B = \begin{pmatrix} \mu_p \\ C_0 \end{pmatrix}$

This problem could be solved using the Lagrange method, with λ_0 being the Lagrange multiplier and the conditions specified as follows:

$$\begin{cases} 2\Sigma x + A\lambda_0 = 0 \\ A^T x = B \end{cases} \quad \text{with} \quad \lambda_0 = \begin{pmatrix} \lambda_1 \\ \lambda_2 \end{pmatrix} \quad (1.1)$$

The first equation must be solved for x with a redefinition of vector $\lambda = -1/2\lambda_0$ to obtain:

$$x = \Sigma^{-1}A\lambda$$

The second equation of (1.1) becomes: $A^T\Sigma^{-1}A\lambda = B \rightarrow \lambda = (A^T\Sigma^{-1}A)^{-1}B \equiv H^{-1}B$

Where H is a symmetric 2x2 matrix so that $H = A^T\Sigma^{-1}A$. Filling the expression in the variance formula, which is the objective function, we obtain:

$$\text{var}(R_p) = x^T\Sigma x = x^T\Sigma\Sigma^{-1}A\lambda = x^TA\lambda = (A^Tx)^TH^{-1}B = B^TH^{-1}B$$

Since H is symmetric, we can suppose that:

$$H \equiv \begin{pmatrix} a & b \\ b & c \end{pmatrix} \rightarrow H^{-1} = \frac{1}{ac-b^2} \begin{pmatrix} c & -b \\ -b & a \end{pmatrix}$$

We then calculate the determinant of the matrix $d = \det(H) = ac - b^2$, obtaining:

$$\begin{aligned} a &= \mu^T\Sigma^{-1}\mu \\ b &= \mu^T\Sigma^{-1}\bar{1} = \bar{1}^T\Sigma^{-1}\mu \\ c &= \bar{1}^T\Sigma^{-1}\bar{1} \\ d &= ac - b^2 \end{aligned}$$

Assuming the matrix Σ is positive definite, the inverse Σ^{-1} is positive definite as well, that means $y^T\Sigma^{-1}y > 0$ for all non-zero-vectors y . Hence, a and c are positive by definition, and this let us demonstrate d is positive as well.

The expression of the objective function becomes:

$$\text{var}(R_p) = \frac{1}{d} (\mu_p \quad C_0) \begin{pmatrix} a & -b \\ -b & c \end{pmatrix} \begin{pmatrix} \mu_p \\ C_0 \end{pmatrix}$$

Then we can derive the expression of the efficient frontier in a risk-return framework:

$$\text{var}(R_p) = \frac{1}{d} (c\mu_p^2 - 2bC_0\mu_p + aC_0^2)$$

This is the portfolio variance, and we can obtain the standard deviation expression by simply taking its square root. This is a parabola in a (σ_p^2, μ_p) space, but it is the right side of an hyperbole in an (σ_p, μ_p) space, that is the one most widely used.

The most important result is the expression which returns the efficient allocation of each assets, represented by the x vector, corresponding to an efficient portfolio for every desired return μ_p :

$$\begin{aligned} x_{EFF} &= \Sigma^{-1}A\lambda = \Sigma^{-1}AH^{-1}B = \frac{c\mu_p - bC_0}{d}\Sigma^{-1}\mu + \frac{aC_0 - b\mu_p}{d}\Sigma^{-1}\bar{1} \quad (1.2) \\ &= \frac{1}{d}\Sigma^{-1}((a\bar{1} - b\mu)C_0 + (c\mu - b\bar{1})\mu_p) \end{aligned}$$

5.1.2 Portfolio Selection

It is now clear that no investor would ever have a single reason to invest in a portfolio which is outside the efficient frontier, because he would obtain a sub-optimal solution, but the choice of which is the optimal portfolio on the frontier may vary from one investor to another.

Markowitz model's ultimate goal is to maximize investors' utility function, which can be modeled as follows:

$$u = E(C_{end}) - \frac{1}{2}\gamma * var(C_{end})$$

Utility function is expectedly function of expected return and portfolio variance, trying to maximize the first minimizing the second, but it has also an additional parameter γ , known as absolute risk aversion, which can be different for each investor and can vary over time.

Clearly, the higher the investor's risk aversion is, the more his utility will be lowered by a raise in volatility, reducing the positive effect of the corresponding raise in return. If conversely an investor is more risk-prone, he will give priority to a higher expected return even if it involves a higher volatility.

The utility function can be written as:

$$\begin{aligned} E(C_0) - \frac{1}{2}\gamma * var(C_{end}) &= E(C_0 + R_p) - \frac{1}{2}\gamma * var(C_0 + R_p) = C_0 + \mu_p - \frac{1}{2}\gamma * var(R_p) \\ &= C_0 + \mu^T x - \frac{1}{2}\gamma * \sigma_p^2 = C_0 + \mu^T x - \frac{1}{2}\gamma * x^T \Sigma x \end{aligned}$$

So that the optimization problem can be reformulated as:

$$Max \left\{ C_0 + \mu^T x - \frac{1}{2}\gamma * x^T \Sigma x \mid \bar{1}^T x = C_0 \right\}$$

This problem can be solved again using the Lagrange method to solve the set of equations 1.3, obtaining:

$$\begin{cases} \mu - \frac{1}{2}\gamma 2\Sigma x + \bar{1}\lambda = 0 \\ \bar{1}^T x = C_0 \end{cases} \quad (1.3)$$

The solution of this problem returns the optimal portfolio variance, and consequently the expected return, as a function of the risk aversion, which allows us to individuate the best choice for each investor depending on his specific goals, investing philosophy and personality.

However, this master thesis is focusing on the general case, looking at an hypothetical investor whose absolute risk aversion is unknown. Such an investor, given the hypothesis of rationality, is likely to choose between two optimal portfolios: the Minimum Variance Portfolio and the Tangency Portfolio.

5.1.3 Minimum Variance Portfolio

An investor may decide to invest his money to simply protect it, not caring about the profit he may get, but being absolutely focused on the preservation of his capital. Since being rational he will always choose an efficient portfolio, he will opt for the one on the efficient frontier which minimizes standard deviation, and therefore variance.

Such an investor will get the maximum utility minimizing the variance with the constraint that he can only invest the capital he has:

$$\text{Min}\{x^T \Sigma x | \bar{1}^T x = C_0\}$$

Then, using Lagrange, we have:

$$\begin{cases} 2\Sigma x + \bar{1}\lambda_0 = 0 \\ \bar{1}^T x = C_0 \end{cases} \quad \text{with } \lambda_0 \text{ a constant} \quad (1.3)$$

Solving the first for x with a new constant, $\lambda = -1/2\lambda_0$, returns $x = \Sigma^{-1}\bar{1}\lambda$, and consequently:

$$\lambda = \frac{C_0}{\bar{1}^T \Sigma^{-1} \bar{1}} \equiv \frac{C_0}{c}$$

Where $c = \bar{1}^T \Sigma^{-1} \bar{1}$ is the element in position (2,2) of the Hessian matrix H, introduced in the previous section. Using this expression in the above formulation for x we obtain:

$$x_{\text{minvar}} = \Sigma^{-1} \bar{1} \frac{C_0}{c}$$

That is the equation of the minimum variance asset allocation, whose variance could simply be calculated as $\sigma_{\text{minvar}}^2 = x_{\text{minvar}}^T * \Sigma * x_{\text{minvar}}$, or by simply differentiating the efficient frontier formula and set it equal to zero.

5.1.4 Tangency Portfolio

Another possible portfolio the investor could opt for is the one maximizing the Sharpe Ratio, which is defined as the expected return per unit of risk, therefore maximizing it means looking for the most risk-efficient portfolio. Graphically, the max-Sharpe-Ratio portfolio is the point where a line through the origin is tangent to the efficient frontier, in mean-standard deviation space.

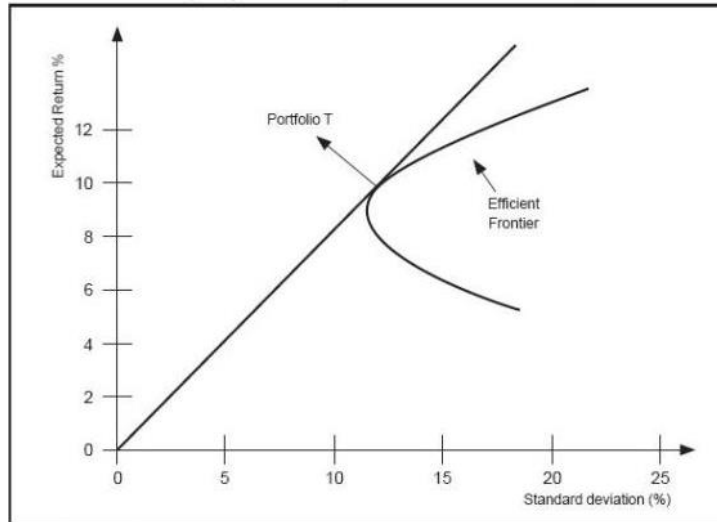


Figure 5.1 Graphical Representation of Tangency Portfolio

For the calculation we suppose tangency point has coordinates (σ_{tg}, μ_{tg}) , and the slope of the

tangency line is $\frac{\Delta \sigma_p}{\Delta \mu_p} = \frac{\sqrt{\frac{1}{a}(c\mu_p^2 - 2bC_0\mu_{tg} + aC_0^2)} - 0}{\mu_{tg} - 0}$

The slope of efficient frontier at the tangency point is the derivative of the efficient frontier at that point. The inverse of the slope is:

$$\frac{\Delta\sigma_p}{\Delta\mu_p} = \frac{1}{2} \left(\frac{1}{d} (c\mu_p^2 - 2bC_0\mu_{tg} + aC_0^2) \right)^{-1/2} \frac{1}{d} (2c\mu_p - 2bC_0) \Big|_{\mu_p=\mu_{tg}}$$

At the tangency point the two slopes must be equal, so:

$$\frac{\sqrt{\frac{1}{d}(c\mu_p^2 - 2bC_0\mu_{tg} + aC_0^2)}}{\mu_{tg}} = \frac{c\mu - bC_0}{\sqrt{\frac{1}{d}(c\mu_p^2 - 2bC_0\mu_{tg} + aC_0^2)}} \rightarrow \mu_{tg} = \frac{a}{b} C_0$$

Now it is possible to calculate σ_{tg} by filling μ_{tg} in the efficient formula:

$$\sigma_{tg} = \sqrt{\frac{1}{d} \left(c \frac{a^2}{c^2} C_0^2 - \frac{2ab}{b} C_0^2 + aC_0^2 \right)} = \frac{\sqrt{a}}{b} C_0$$

The calculation of the portfolio weights is calculated automatically using (1.2) and obtaining:

$$x_{tg} = \frac{c \frac{a}{b} C_0 - bC_0}{d} \Sigma^{-1} \mu + \frac{aC_0 - b \frac{a}{b} C_0}{d} \Sigma^{-1} \bar{1} = \Sigma^{-1} \mu \frac{C_0}{b}$$

5.1.5 The Risk-Free Asset

As some readers may already know, Markowitz model doesn't end with the calculation of the efficient frontier for risky securities' portfolios, but it offers the opportunity to add a risk-free asset, which should correspond to the interest rate the investor would obtain or pay if he decided to lend or borrow money to a completely trustworthy counterpart, precisely corresponding to the return he would get for a zero-risk investment. The risk-free asset is therefore positioned on the y-axis and the tangent line from the risk-free asset to the efficient frontier individuates the so-called Market Portfolio m.

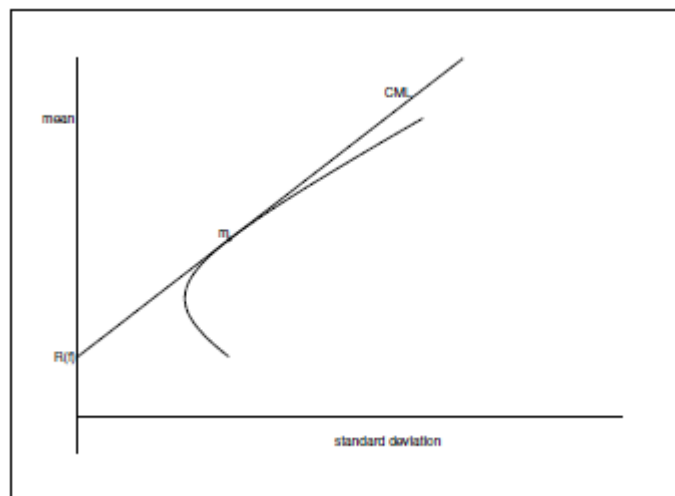


Figure 5.2 Capital Market Line with Risk-Free Asset

The tangent line uniting the two points is named Capital Market Line (CML), and it is possible to demonstrate that the optimal allocation should always be somewhere on the CML, that is a linear combination of market portfolio and risk-free asset.

However, the mathematics behind this theory won't be explained because our application of Markowitz model to bonds won't consider the risk-free asset. In fact, the focus is on how to efficiently allocating the available capital between a certain number of risky bonds we previously selected as eligible from a credit-risk point of view, so we are not interested in determining whether or not we should lend money at a risk-free rate. We also don't consider the possibility of borrowing more money to invest in the risky securities at the risk-free rate, both to follow the conservative policy dictated by being advisors for someone else's money and because it would be extremely unrealistic for an individual customer, although extremely wealthy, thinking he can borrow money at the same rate of, for example, US Government. Moreover, in the current time period, governments' rates are extremely low, often below zero, and it is perfectly rational to assume a null risk-free rate. The tangency line shows that with a risk-free asset with a rate equal to zero, which graphically would place it on the origin point, the market portfolio would be exactly coinciding with the Max-Sharpe portfolio.

5.1.6 Inequality Constraints: Eliminating Short-Selling Possibility

Until now Markowitz model have been thoroughly described from a mathematical point of view, but the attentive reader may have noticed that the Lagrange method has only been applied to a version of the model which doesn't have any inequality constraints. That means that short selling is allowed and securities can have negative weights in the efficient portfolios. We won't admit short selling of bond, so the version of the model we are going to apply necessarily needs to have at least one inequality constraint, being reformulated as follows:

$$\text{Min}\{x^T \Sigma x | A^T x = B, x \geq 0\}$$

Unfortunately, if there are any inequality constraints, the bare Lagrange method is no longer applicable to the problem, but the solution becomes way more complex and elaborated.

Hence, it is necessary to apply non-linear programming techniques, in particular Quadratic Programming, which is the best fit for problems whose objective function is non-linear whilst constraints are linear. The solution to the problem is calculated applying Karush-Kuhn-Tucker conditions, which allow the calculator to test if a solution is the optimal one for this kind of problems.

Please see Appendix for a complete explanation of both methods.

The reader should now have a clear overview of the theoretical foundations of Markowitz method and the procedures and techniques applied to calculate the efficient frontier, that will be applied to different bond portfolios.

In MatLab mean-variance optimization is accomplished through the Portfolio object, a function of the *Financial Toolbox* which allows the programmer to define the entire set of assets, possibly importing them from Microsoft Excel, and specify the desired constraint. The software would then be able to calculate the efficient frontier and find the maximum Sharpe Ratio allocation. The Matlab codes used for the optimization are reported in Appendix C.

5.2 Mean-Cvar Optimization

During the last few years of 20th century and the first years of 21st risk management has gained a lot of attention in financial world, with Value at Risk becoming one of the main trends, to the point that Basel Committee on Banking Supervision required banks to apply it to determine the minimum capital to support their trading portfolios. VaR has also become the most commonly used measure among financial professionals such as treasurers and fund managers, mainly thanks to its clarity and versatility.

However, as already specified before, researchers like Artzner, Delbaen, Eber and Heath (1999) are skeptical towards the effectiveness of VaR because of its lack of subadditivity and because it completely neglect the extreme possible losses.

Since a CVaR constraint is tighter than a VaR constraint it results in the investor selecting lower standard deviation portfolios, being more conservative. Under certain conditions, in fact, using VaR as a risk measure in optimization may result in the selection of gambling portfolios, that is what we absolutely want to avoid. It is hence fair to say that a CVaR constraint dominates a VaR constraint as a risk management tool in the sense that, all the rest being equal, it always results in the investor choosing a lower volatility portfolio.

The following paragraph is going to describe the CVaR constraint and efficient frontier under normality. The reader may be interested in examining the paper for further information.

Symbols Reminder

n = number of assets

$\mu = \begin{pmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_n \end{pmatrix}$ = Expected rates of return

$\Sigma = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \dots & \sigma_{1n} \\ \sigma_{21} & \ddots & \dots & \sigma_{2n} \\ \vdots & \dots & \ddots & \vdots \\ \sigma_{n1} & \dots & \dots & \sigma_{nn} \end{pmatrix}$ = matrix of covariances of returns

$X \equiv \{\sum_{i=1}^n x_i = 1\}$ = Set of portfolios with defined rate of returns, x_i is the weight of i security in portfolio x

$r = \begin{pmatrix} r_1 \\ r_2 \\ \vdots \\ r_n \end{pmatrix}$ = Rate of return of assets

$F_x(\cdot)$ = Cumulative distribution of r_x

5.2.1 Mean-CVaR Efficient Frontier

Let $E[r_x]$ and $\sigma[r_x]$ denote expected rate of return and its standard deviation for portfolio x . α is the confidence level used to calculate Value at Risk, so that portfolio x 's VaR at $100\alpha\%$ confidence level is $VaR[\alpha, r_x] = -F_x^{-1}(1 - \alpha)$.

Consequently, the portfolio's CVaR, that is the loss it is expected to suffer given that the loss is equal or larger than its VaR is defined as $CVaR[\alpha, r_x] = -E\{r_x | r_x \leq -VaR[\alpha, r_x]\}$.

Assuming the returns have a multivariate normal distribution might cause problems, especially considering the "Fat Tails" issue, but momentarily maintaining this assumption is helpful to explain the calculation of efficient frontier and its implications.

Moreover, some researchers have claimed that fat tails are very important and relevant for a single risk factor, but they are usually less dangerous for a well-diversified portfolio, so we assume $F_x(\cdot)$ to be a multivariate normal distribution, $\Phi(\cdot)$ a standard normal distribution and $\phi(\cdot)$ the correspondent standard normal density function.

Hence, for any confidence level we can define:

$$z_\alpha = -\Phi(\cdot)^{-1}(1 - \alpha)$$

and so,

$$\int_{-\infty}^{-z_\alpha} \phi(x) dx = 1 - \alpha$$

$$VaR[\alpha, r_x] = z_\alpha \sigma[r_x] - E[r_x] \quad \text{and} \quad CVaR[\alpha, r_x] = k_\alpha \sigma[r_x] - E[r_x]$$

$$\text{With } k_\alpha = \frac{-\int_{-\infty}^{-z_\alpha} x \phi(x) dx}{1 - \alpha}$$

Since by definition $k_\alpha > z_\alpha$, we have $CVaR[\alpha, r_x] > VaR[\alpha, r_x]$, and from the previous equations it follows that there is always a confidence level $\alpha' > \alpha$ such that $CVaR[\alpha, r_x] = VaR[\alpha', r_x]$ for every portfolio $x \in X$.

The following definitions will clarify the notions of boundary referred to the cases when CVaR, VaR and variance are used as a risk measurement, as defined by Alexander and Baptista. For any $\bar{E} \in \mathbb{R}$ let $X(\bar{E}) \equiv \{x \in \mathbb{R}^n : E[r_x] = \bar{E}\}$

D1 CVaR: A portfolio $\bar{x} \in X$ belongs to the mean C-VaR boundary at the $100\alpha\%$ confidence level if and only if for some $\bar{E} \in \mathbb{R}$, \bar{x} solves $\min_{x \in X(\bar{E})} k_\alpha \sigma[r_x] - E[r_x]$.

D2 VaR: A portfolio $\bar{x} \in X$ belongs to the mean VaR boundary at the $100\alpha\%$ confidence level if and only if for some $\bar{E} \in \mathbb{R}$, \bar{x} solves $\min_{x \in X(\bar{E})} z_\alpha \sigma[r_x] - E[r_x]$.

D3 Variance: A portfolio $\bar{x} \in X$ belongs to the mean-variance boundary if and only if for some $\bar{E} \in \mathbb{R}$, \bar{x} solves $\min_{x \in X(\bar{E})} \sigma^2[r_x]$.

As long as $\alpha > 0,5$ the set of mean-CVaR boundary portfolio doesn't depend on α , so we can omit the confidence level for mean-CVaR boundary. Since $k_\alpha > 0$ it is possible to state that a portfolio belongs to the mean-CVaR if and only if it belongs in the mean variance boundary.

According to Merton (1972), a portfolio belongs in the mean-variance boundary if and only if:

$$\frac{\sigma^2[r_x]}{1/c} - \frac{(E[r_x] - a/c)^2}{d/c^2} = 1$$

a , b , c and d have already been defined before, with b , c and d being positive by definition. Hence, any portfolio which satisfies this equation also belongs to the mean-CVaR boundary.

The next definitions refer to the notion of efficiency in the three cases:

D4 CVaR: A portfolio $\bar{x} \in X$ belongs to the mean CVaR efficient frontier at the $100\alpha\%$ confidence level if and only if no portfolio $v \in X$ exists such that $E[r_v] \geq E[r_x]$ and $CVaR[\alpha, r_v] \leq CVaR[\alpha, r_x]$, where at least one of the inequalities is strict.

D5 VaR: A portfolio $\bar{x} \in X$ belongs to the mean VaR efficient frontier at the $100\alpha\%$ confidence level if and only if no portfolio $v \in X$ exists such that $E[r_v] \geq E[r_x]$ and $VaR[\alpha, r_v] \leq VaR[\alpha, r_x]$, where at least one of the inequalities is strict.

D6 Variance: A portfolio $\bar{x} \in X$ belongs to the mean variance efficient frontier if and only if no portfolio $v \in X$ exists such that $E[r_v] \geq E[r_x]$ and $\sigma[r_v] \leq \sigma[r_x]$, where at least one of the inequalities is strict.

For a description differences and relationships between CVaR and Mean-Variance please see Appendix C or alternatively Alexander and Baptista “*CVaR as a Measure of Risk: Implications for Portfolio Selection*”.

MatLab is helpful in simplifying mean-CVaR portfolio optimization through the *PortfolioCVaR* object, which receives the data concerning the available assets and elaborates the efficient frontier under the selected constraint, similarly to what the *Portfolio* object does for mean-var optimization.

5.2.2 Montecarlo Simulation of Correlated Asset Returns

Since *PortfolioCVaR* requires number of scenarios in input, the decision is to use a Montecarlo simulation of correlated asset returns starting from the historical data.

Monte Carlo Simulation, also known as the Monte Carlo Method or a multiple probability simulation, is a mathematical technique, which is used to estimate the possible outcomes of an uncertain event. The Monte Carlo Method was invented by John von Neumann and Stanislaw Ulam during World War II to improve decision making under uncertain conditions. It was named after the well-known casino town, since the element of chance is core to the modeling approach, similarly to a game of roulette.

Unlike a normal forecasting model, Monte Carlo Simulation predicts a set of outcomes based on an estimated range of values versus a set of fixed input values. In other words, a Monte Carlo Simulation builds a model of possible results by leveraging a probability distribution, such as a uniform or normal distribution, for any variable that has inherent uncertainty. It, then, recalculates the results over and over, each time using a different set of random numbers between the minimum and maximum values. In a typical Monte Carlo experiment, this exercise can be repeated thousands of times to produce a large number of likely outcomes.

The specific Montecarlo simulation applied in this phase concerns correlated asset returns, aiming to simulate a large number of scenarios starting from the historical data observed in the previous years. Those scenarios are meant to provide the basis for the calculation of the expected returns and expected CVaR eventually used in the optimization phase.

Let S be the asset price, σ the volatility of the asset price and let ε represent a random drawing from a standardized normal distribution. As before, μ represents the expected return of the asset.

The assumption of normality of logarithmic returns and consequently log-normal distribution of asset prices over time is maintained in this phase.

Consistently, securities' price movements are modeled with Geometric Brownian Motion, so that asset returns over a time interval dt are simulated by the following equation:

$$\frac{dS}{S} = \mu dt + \sigma dz = \mu dt + \sigma \varepsilon \sqrt{dt}$$

$\varepsilon \sqrt{dt}$, sometimes also reported as dW_t , is a Brownian motion, or Wiener process, and it is used to simulate the stochastic part of the Stochastic Differential Equation (SDE).

Geometric Brownian Motion is widely used in finance: for instance, it provides the basis for the Black Scholes model, used to forecast derivatives' prices in the future, solving the SDE through the Ito's formula.

A complete discussion of securities' pricing models, their pros and cons and their suitability for each case would certainly require an entire master thesis, so this chapter won't provide a complete demonstration of GBM nor an exhaustive description of each one of its features.

Nonetheless it is a must to mention one of the most important limitations of GMB, that is the assumption of constant volatility, which is also one of Var-Cov VaR approach limits. In this phase we will maintain the assumption, avoiding the application of the several solutions proposed by researchers over the last decades as adjustment for volatility over time.

Montecarlo simulation is run once again through MatLab using the `portsim` function, which requires as input the expected returns and the Variance-Covariance matrix, and then simulates the required number of scenarios considering asset prices follow a univariate Geometric Brownian Motion, and consequently portfolio returns are following a multivariate Geometric Brownian Motion.

In particular, starting from the mean daily return and the daily variance-covariance matrix, we will simulate 10000 scenarios of 260 days each, in order to have a sufficient number of data to perform the Mean-CVaR optimization.

6. EXECUTION AND RESULTS

The first phase of the model implementation takes place in the present, selecting 20 bonds and applying mean-CVaR and mean-variance optimization to obtain optimal portfolios, investigating how the addition of new constraints to the model might influence the optimal portfolio and the expected values.

The second phase is intended as a test on the model itself, evaluating how a bond portfolio selected through optimization at the beginning of 2016 would have performed during the following four years, deliberately excluding the pandemic period.

6.1 Present Optimization

6.1.1 Data Gathering

The selection of the 20 possible bonds is made according to the criteria already mentioned in the fourth chapter, i.e. diversification of geographic markets and industries, availability of historical data and not excessively long maturity. We also selected bonds from issuers of similar ratings, from AA- to BBB-, in order to have potentially similar securities.

Isin	ISSUER	ISSUE_DT	Maturity	Rating S&P
US36966TDL35	GENERAL ELECTRIC CO	14/10/2011	15/10/2025	BBB+
US92343VBR42	VERIZON COMMUNICATIONS	18/09/2013	15/09/2023	BBB+
US023135AN60	AMAZON.COM INC	05/12/2014	05/12/2024	AA-
US023772AB21	AMER AIRLN 13-1 A PASS T	25/07/2014	15/07/2025	BB
US37045VAG59	GENERAL MOTORS CO	12/11/2014	01/04/2025	BBB
US00206RCN08	AT&T INC	04/05/2015	15/05/2025	BBB
US34540TKL51	FORD MOTOR CREDIT CO LLC	17/12/2015	20/12/2025	BB+
US046353AL27	ASTRAZENECA PLC	16/11/2015	16/11/2025	BBB+
XS1292988984	ENI SPA	18/09/2015	18/01/2024	A-
XS1019326641	SNAM SPA	22/01/2014	22/01/2024	BBB+
XS1169832810	TELECOM ITALIA SPA	16/01/2015	16/01/2023	BB+
XS1091654761	ROYAL MAIL PLC	29/07/2014	29/07/2024	BBB
XS1321424670	SKY LTD	17/11/2015	17/11/2025	A-
XS1203941775	METRO AG	19/03/2015	19/03/2025	BBB-
US460599AC74	INTERNATIONAL GAME TECH	13/02/2015	15/02/2025	BB
XS1179916017	CARREFOUR SA	03/02/2015	03/06/2025	BBB
FR0012602761	ENGIE SA	13/03/2015	13/03/2026	BBB
XS1017833242	BASF SE	22/01/2014	22/01/2024	A
XS1014610254	VOLKSWAGEN LEASING GMBH	15/01/2014	15/01/2024	BBB+
XS1084563615	ROBERT BOSCH GMBH	08/07/2014	08/07/2024	A

Table 6.1 List of Securities Available to be chosen in first phase

For each bond the daily price of every day for the last five years was collected, in order to calculate daily logarithmic returns and the variance-covariance matrix.

The securities are either denominated in dollars or in euros, so we translated every price in dollars to exclude, as much as possible, the difference in rates between the two currencies, even though we are aware that doing so we are including the foreign exchange effect in the model. The choice is also not to take coupons into consideration, since they are fixed and the effect they have on prices

is not so relevant to heavily influence the model, and we don't momentarily differentiate between bullet and callable bonds.

Then we calculated the variance-covariance matrix and the daily average logarithmic return, to eventually annualizing them by simply multiplying them by 260, that is the average number of trading days in a year.

	AVG DAILY RETURN	AVG YEARLY RETURN
GENERAL ELECTRIC CO	2,72E-05	0,0071
VERIZON COMMUNICATIONS	1,47E-05	0,0038
AMAZON.COM INC	5,34E-05	0,0139
AMER AIRLN 13-1 A PASS T	-1,83E-04	-0,0475
GENERAL MOTORS CO	1,29E-04	0,0334
AT&T INC	1,08E-04	0,0280
FORD MOTOR CREDIT CO LLC	-2,12E-05	-0,0055
ASTRAZENECA PLC	8,60E-05	0,0224
ENI SPA	1,22E-04	0,0318
SNAM SPA	7,15E-05	0,0186
TELECOM ITALIA SPA	1,18E-04	0,0307
ROYAL MAIL PLC	1,17E-04	0,0304
SKY LTD	1,69E-04	0,0439
METRO AG	1,50E-04	0,0390
INTERNATIONAL GAME TECH	2,26E-04	0,0588
CARREFOUR SA	1,48E-04	0,0386
ENGIE SA	1,72E-04	0,0446
BASF SE	6,90E-05	0,0179
VOLKSWAGEN LEASING GMBH	1,30E-04	0,0338
ROBERT BOSCH GMBH	1,12E-04	0,0291

6.1.2 Execution

Starting from the average returns, along with the variance-covariance matrix, it is possible to apply the optimization algorithms to individuate the efficient frontier.

We are looking at a generic investor, whose utility function is unknown because we don't know his absolute risk aversion, so theoretically there is no clue to determine where he would want to be positioned on the efficient frontier. Therefore, we assume he wants to maximize his risk-return through maximizing its Sharpe ratio choosing the tangency portfolio. For Mean-CVaR optimization the investor will want to maximize the Mean/CVaR ratio.

Each model will be applied three times, changing constraints to force diversification. Short selling is never allowed and we can't invest more money than we have:

1. No additional constraints
2. At most 10% of the portfolio to each security
3. At least 2% of the portfolio to each security

6.1.2.1 No Additional Constraints

Mean-variance

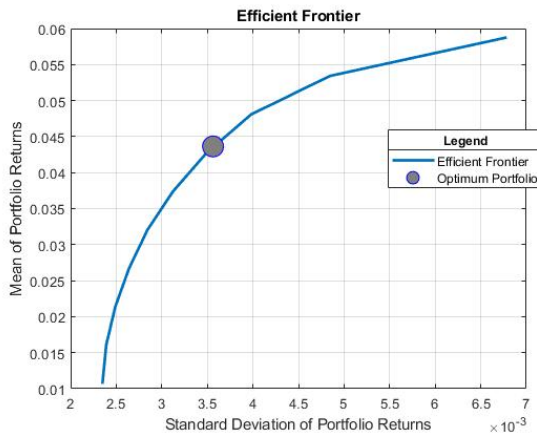


Figure 6.1

Mean-CVaR

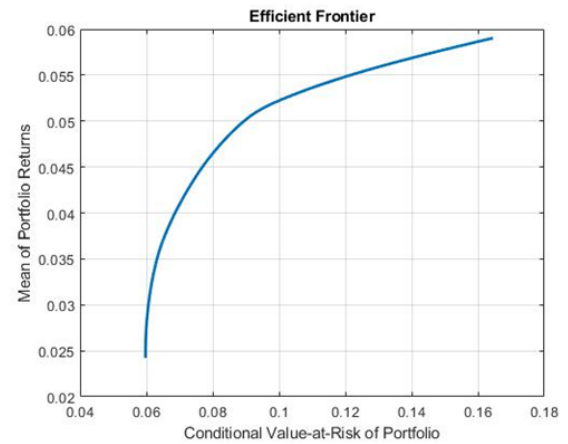


Figure 6.2

Optimal Portfolio Composition

GENERAL ELECTRIC CO	0,0%
VERIZON COMMUNICATIONS	0,0%
AMAZON.COM INC	0,0%
AMER AIRLN 13-1 A PASS T	0,0%
GENERAL MOTORS CO	5,0%
AT&T INC	9,4%
FORD MOTOR CREDIT CO LLC	0,1%
ASTRAZENECA PLC	12,8%
ENI SPA	0,0%
SNAM SPA	0,0%
TELECOM ITALIA SPA	0,0%
ROYAL MAIL PLC	0,0%
SKY LTD	28,9%
METRO AG	0,0%
INTERNATIONAL GAME TECH	29,7%
CARREFOUR SA	0,0%
ENGIE SA	14,1%
BASF SE	0,0%
VOLKSWAGEN LEASING GMBH	0,0%
ROBERT BOSCH GMBH	0,0%

Table 6.2

OPTIMAL PORTFOLIO DATA

Annual Std. Dev	0,0574
Annual Expected Return	0,0436
Sharpe Ratio	0,760

Table 6.3

Optimal Portfolio Composition

GENERAL ELECTRIC CO	0,0%
VERIZON COMMUNICATIONS	0,0%
AMAZON.COM INC	0,6%
AMER AIRLN 13-1 A PASS T	0,0%
GENERAL MOTORS CO	5,5%
AT&T INC	7,7%
FORD MOTOR CREDIT CO LLC	0,0%
ASTRAZENECA PLC	12,8%
ENI SPA	0,0%
SNAM SPA	0,0%
TELECOM ITALIA SPA	0,0%
ROYAL MAIL PLC	0,0%
SKY LTD	24,4%
METRO AG	0,0%
INTERNATIONAL GAME TECH	30,9%
CARREFOUR SA	0,0%
ENGIE SA	18,0%
BASF SE	0,0%
VOLKSWAGEN LEASING GMBH	0,0%
ROBERT BOSCH GMBH	0,0%

Table 6.4

OPTIMAL PORTFOLIO DATA

CVaR	0,074
Annual Expected Return	0,04371
Mean/CVaR	0,596
Annual Std. Dev	0,0578

Table 6.5

6.1.2.2 Not More than 10% for each security

Mean-variance

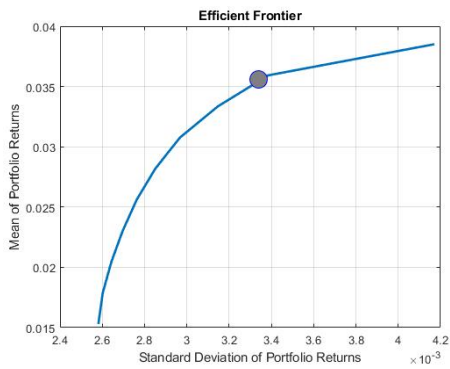


Figure 6.3

Optimal Portfolio Composition

GENERAL ELECTRIC CO	0,0%
VERIZON COMMUNICATIONS	0,2%
AMAZON.COM INC	10,0%
AMER AIRLN 13-1 A PASS T	0,0%
GENERAL MOTORS CO	10,0%
AT&T INC	10,0%
FORD MOTOR CREDIT CO LLC	0,0%
ASTRAZENECA PLC	10,0%
ENI SPA	0,1%
SNAM SPA	0,0%
TELECOM ITALIA SPA	0,0%
ROYAL MAIL PLC	0,5%
SKY LTD	10,0%
METRO AG	9,5%
INTERNATIONAL GAME TECH	10,0%
CARREFOUR SA	10,0%
ENGIE SA	10,0%
BASF SE	0,0%
VOLKSWAGEN LEASING GMBH	10,0%
ROBERT BOSCH GMBH	0,0%

Table 6.6

OPTIMAL PORTFOLIO DATA

Annual Std. Dev	0,05385
Annual Expected Return	0,03556
Sharpe Ratio	0,661
Variation from No Const.	-13%

Table 6.7

Mean-CVaR

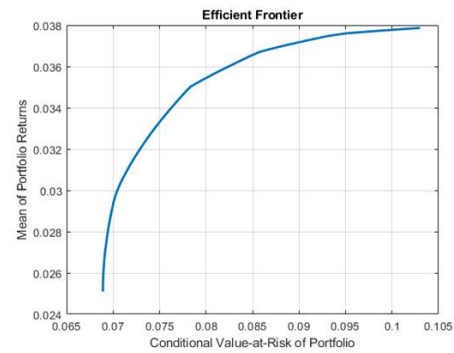


Figure 6.4

Optimal Portfolio Composition

GENERAL ELECTRIC CO	0,0%
VERIZON COMMUNICATIONS	0,0%
AMAZON.COM INC	9,9%
AMER AIRLN 13-1 A PASS T	0,0%
GENERAL MOTORS CO	10,0%
AT&T INC	10,0%
FORD MOTOR CREDIT CO LLC	0,0%
ASTRAZENECA PLC	10,0%
ENI SPA	0,0%
SNAM SPA	0,0%
TELECOM ITALIA SPA	0,0%
ROYAL MAIL PLC	0,1%
SKY LTD	10,0%
METRO AG	10,0%
INTERNATIONAL GAME TECH	10,0%
CARREFOUR SA	10,0%
ENGIE SA	10,0%
BASF SE	0,0%
VOLKSWAGEN LEASING GMBH	10,0%
ROBERT BOSCH GMBH	0,0%

Table 6.8

OPTIMAL PORTFOLIO DATA

CVaR	0,07836
Annual Expected Return	0,03564
Mean/CVaR	0,4549
Annual Std. Dev	0,05394

Table 6.9

6.1.2.3 Not Less than 2% for each security

Mean-variance

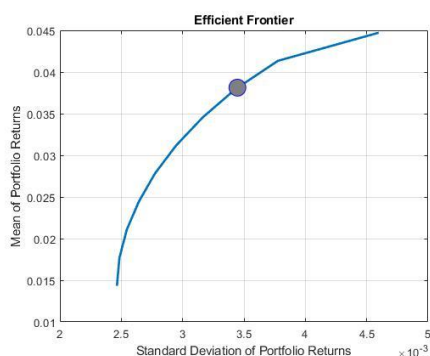


Figure 6.5

Optimal Portfolio Composition

GENERAL ELECTRIC CO	2,0%
VERIZON COMMUNICATIONS	2,0%
AMAZON.COM INC	2,0%
AMER AIRLN 13-1 A PASS T	2,0%
GENERAL MOTORS CO	3,4%
AT&T INC	5,8%
FORD MOTOR CREDIT CO LLC	2,0%
ASTRAZENECA PLC	7,3%
ENI SPA	2,0%
SNAM SPA	2,0%
TELECOM ITALIA SPA	2,0%
ROYAL MAIL PLC	2,0%
SKY LTD	17,3%
METRO AG	2,0%
INTERNATIONAL GAME TECH	30,2%
CARREFOUR SA	2,0%
ENGIE SA	7,9%
BASF SE	2,0%
VOLKSWAGEN LEASING GMBH	2,0%
ROBERT BOSCH GMBH	2,0%

Table 6.10

OPTIMAL PORTFOLIO DATA

Annual Std. Dev	0,0556
Annual Expected Return	0,0381
Sharpe Ratio	0,686
Variation from No Const.	-10%

Table 6.11

Mean-CVaR

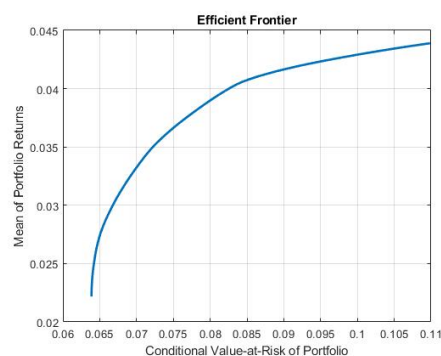


Figure 6.6

Optimal Portfolio Composition

GENERAL ELECTRIC CO	2,0%
VERIZON COMMUNICATIONS	2,0%
AMAZON.COM INC	2,0%
AMER AIRLN 13-1 A PASS T	2,0%
GENERAL MOTORS CO	2,2%
AT&T INC	8,0%
FORD MOTOR CREDIT CO LLC	2,0%
ASTRAZENECA PLC	6,6%
ENI SPA	2,0%
SNAM SPA	2,0%
TELECOM ITALIA SPA	2,0%
ROYAL MAIL PLC	2,0%
SKY LTD	17,0%
METRO AG	2,0%
INTERNATIONAL GAME TECH	28,6%
CARREFOUR SA	2,0%
ENGIE SA	9,5%
BASF SE	2,0%
VOLKSWAGEN LEASING GMBH	2,0%
ROBERT BOSCH GMBH	2,0%

Table 6.12

OPTIMAL PORTFOLIO DATA

CVaR	0,07634
Annual Expected Return	0,03782
Mean/CVaR	0,4954
Annual Std. Dev	0,05519

Table 6.13

The mean-variance graphs report daily average standard deviation on the x-axis, since variance-covariance matrix is expressed in daily values, while return on y-axis is annual. Contrary to what it might seem, this is not a mistake, because we are bound to the assumption of constant volatility and normality of logarithmic returns, so annual standard deviation is nothing else than the daily standard deviation times the square root of the number of trading days in a year.

The optimal portfolios individuated by the two methods are quite similar, in two cases out of three the Mean-CVaR optimization chose a higher expected return accepting a higher risk standard deviation, somehow selecting more “aggressive” portfolios. However, the difference is extremely small, and basing on this particular data set we could say the two methods are approximately equivalent.

The confidence level chosen to calculate CVaR is 95%, in compliance with the rules explained in appendix B concerning the existence of Mean-CVaR efficient portfolios.

As expected, minimum-variance portfolio is never mean-CVaR efficient at this confidence level, and it wouldn't change if we modified it. Please see once again appendix B, proposition 2, for the mathematical explanation and demonstration of the property.

The next chapter investigates the effectiveness of the model through a backtesting operation.

6.2 Backtesting

6.2.1 Description and Data Set

This is the conclusive phase of this paperwork and has one important and specific goal: testing if a portfolio-optimization model based on a risk-return approach could be somehow useful when applied to fixed income securities in a real business situation.

A necessary premise: the results on this phase are not to be considered definitive in any way because the sample is too small and too restrictive from a geographical and sectorial point of view, but they are meant to be seen as a starting point for the firm to apply them to more data sets over different periods of time conducting a more accurate testing work before certifying or denying its effectiveness.

The idea behind the process is extremely simple: pretending we are on January the 1st, 2016, and we are optimizing our bond portfolio choosing between some securities, and then we observe the result our portfolio obtains over the following years compared to universe, which is simply a portfolio containing each security in the same proportion.

This time, every chosen bond is denominated in dollars, to avoid any exchange rate consideration, and they all come from the American market. Moreover, they are all high-yield bonds, with a S&P rating going from B- to BB+, since they usually have a higher volatility and an optimization model could probably be more useful if applied to this kind of securities.

The following tables are going represent the data set.

ISIN	ISSUER	ISSUE_DT	MATURITY	CRNCY	RTG_SP
US345370CA64	FORD MOTOR COMPANY	16/07/1999	16/07/2031	USD	BB+
US912909AD03	UNITED STATES STEEL CORP	21/05/2007	01/06/2037	USD	B-
US626717AA04	MURPHY OIL CORPORATION	04/05/1999	01/05/2029	USD	BB
US780153AG79	ROYAL CARIBBEAN CRUISES	14/10/1997	15/10/2027	USD	B+ *-
US911684AD06	US CELLULAR CORP	08/12/2003	15/12/2033	USD	BB
US530715AJ01	LIBERTY INTERACTIVE LLC	08/06/2000	01/02/2030	USD	B
US654902AC90	NOKIA OYJ	07/05/2009	15/05/2039	USD	BB+
US037411AR61	APACHE CORP	26/01/2007	15/01/2037	USD	BB+
USG5825LAA64	MARKS & SPENCER PLC	06/12/2007	01/12/2037	USD	BB+
US984121CB79	XEROX CORPORATION	04/12/2009	15/12/2039	USD	BB
US197677AG24	HCA INC	30/06/1995	15/06/2025	USD	BB-
US852060AD48	SPRINT CAPITAL CORP	16/11/1998	15/11/2028	USD	BB
US156686AM96	LUMEN TECHNOLOGIES INC	15/01/1998	15/01/2028	USD	BB-
US013817AJ05	HOWMET AEROSPACE INC	25/01/2007	01/02/2027	USD	BB+
US577081AU60	MATTEL INC	28/09/2010	01/10/2040	USD	B-

Table 6.14 List of Securities Available to be chosen in second phase

Daily returns, yearly returns and variance-covariance matrix are all calculated using daily prices between 01/01/2011 and 12/31/2015, the assumptions such as log-normality of prices and constant volatility remain the same as before.

	AVG DAILY RETURN	AVG YEARLY RETURN
FORD MOTOR COMPANY	0,0001	0,0267
UNITED STATES STEEL CORP	-0,0005	-0,1358
MURPHY OIL CORPORATION	-0,0002	-0,0540
ROYAL CARIBBEAN CRUISES	0,0001	0,0291
US CELLULAR CORP	-0,0001	-0,0173
LIBERTY INTERACTIVE LLC	0,0000	0,0073
NOKIA OYJ	0,0000	-0,0060
APACHE CORP	-0,0001	-0,0242
MARKS & SPENCER PLC	0,0001	0,0278
XEROX CORPORATION	-0,0001	-0,0334
HCA INC	0,0001	0,0288
SPRINT CAPITAL CORP	-0,0002	-0,0441
LUMEN TECHNOLOGIES INC	-0,0002	-0,0523
HOWMET AEROSPACE INC	-0,0001	-0,0137
MATTEL INC	0,0001	0,0208

Variance Covariance matrix will not be reported to not excessively burden the dissertation. The reader will find the application of the models to the securities among the following pages.

6.2.2 Execution

6.2.2.1 No Additional Constraints

Mean-Variance

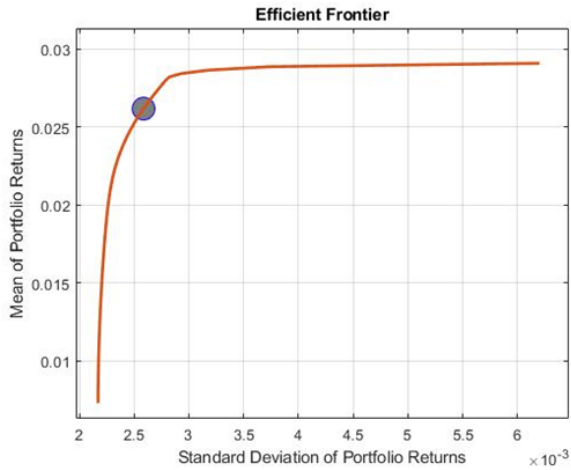


Figure 6.7

Optimal Portfolio Composition

FORD MOTOR COMP	17,43%
UNITED STATES STEEL	0,00%
MURPHY OIL CORP	0,00%
ROYAL CRBN CRUISES	18,59%
US.CELLULAR CORP	0,00%
LIBERTY INTERACTIVE	8,80%
NOKIA CORP	0,00%
APACHE CORP	0,00%
MARKS AND SPENCER	21,65%
XEROX CORPORATION	0,00%
HCA INCORPORATED	31,12%
SPRINT CAP.CORP.	0,00%
LUMEN TECHNOLOGIES	0,00%
HOWMET AEROSPACE	0,00%
MATTEL INCO.	2,40%

Table 6.15

OPTIMAL PORTFOLIO DATA

Annual Std. Dev	0,04171
Annual Expected Return	0,02616
Sharpe Ratio	0,6272

Table 6.16

Mean-CVaR

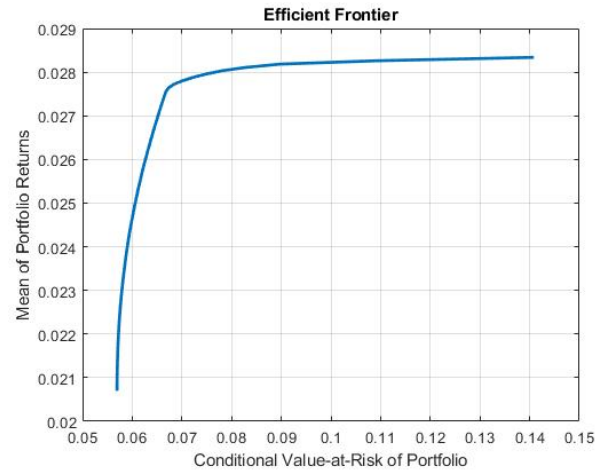


Figure 6.8

Optimal Portfolio Composition

FORD MOTOR COMP	17,06%
UNITED STATES STEEL	0,00%
MURPHY OIL CORP	0,00%
ROYAL CRBN CRUISES	16,78%
US.CELLULAR CORP	0,00%
LIBERTY INTERACTIVE	6,82%
NOKIA CORP	0,00%
APACHE CORP	0,00%
MARKS AND SPENCER	24,21%
XEROX CORPORATION	0,00%
HCA INCORPORATED	33,42%
SPRINT CAP.CORP.	0,00%
LUMEN TECHNOLOGIES	0,00%
HOWMET AEROSPACE	0,00%
MATTEL INCO.	1,72%

Table 6.17

OPTIMAL PORTFOLIO DATA

CVaR	0,06272
Annual Expected Return	0,02662
Mean/CVaR	0,42447
Annual Std. Dev	0,04258

Table 6.18

6.2.2.2 No More than 10% for each security

Mean-Variance

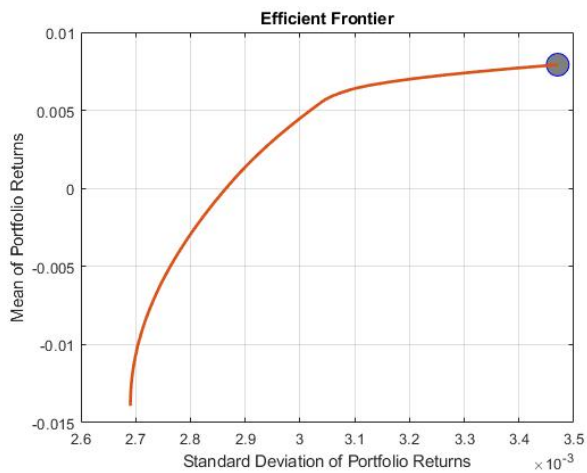


Figure 6.9

Optimal Portfolio Composition

FORD MOTOR COMP	10,00%
UNITED STATES STEEL	0,00%
MURPHY OIL CORP	0,00%
ROYAL CRBN CRUISES	10,00%
US.CELLULAR CORP	10,00%
LIBERTY INTERACTIVE	10,00%
NOKIA CORP	10,00%
APACHE CORP	10,00%
MARKS AND SPENCER	10,00%
XEROX CORPORATION	0,00%
HCA INCORPORATED	10,00%
SPRINT CAP.CORP.	0,00%
LUMEN TECHNOLOGIES	0,00%
HOWMET AEROSPACE	10,00%
MATTEL INCO.	10,00%

Table 6.19

OPTIMAL PORTFOLIO DATA

Annual Std. Dev	0,05596
Annual Expected Return	0,0079
Sharpe Ratio	0,142
Variation from No Const.	-77%

Table 6.20

Mean-CVaR

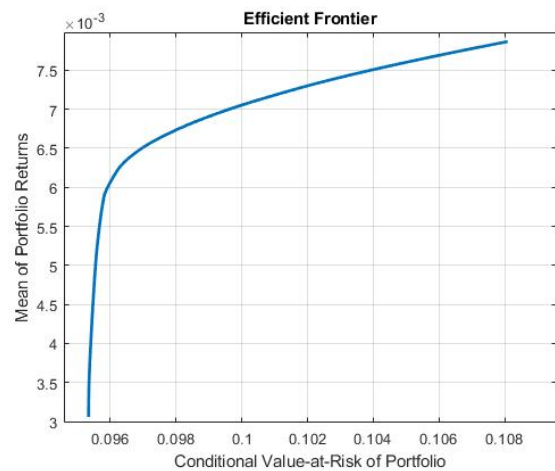


Figure 6.10

Optimal Portfolio Composition

FORD MOTOR COMP	10,0%
UNITED STATES STEEL	0,0%
MURPHY OIL CORP	0,0%
ROYAL CRBN CRUISES	10,0%
US.CELLULAR CORP	10,0%
LIBERTY INTERACTIVE	10,0%
NOKIA CORP	10,0%
APACHE CORP	10,0%
MARKS AND SPENCER	10,0%
XEROX CORPORATION	0,0%
HCA INCORPORATED	10,0%
SPRINT CAP.CORP.	0,0%
LUMEN TECHNOLOGIES	0,0%
HOWMET AEROSPACE	10,0%
MATTEL INCO.	10,0%

Table 6.21

OPTIMAL PORTFOLIO DATA

CVaR	0,1081
Annual Expected Return	0,00792
Mean/CVaR	0,0733
Annual Std. Dev	0,05596

Table 6.22

6.2.2.3 Not Less than 2% for each security

Mean-Variance

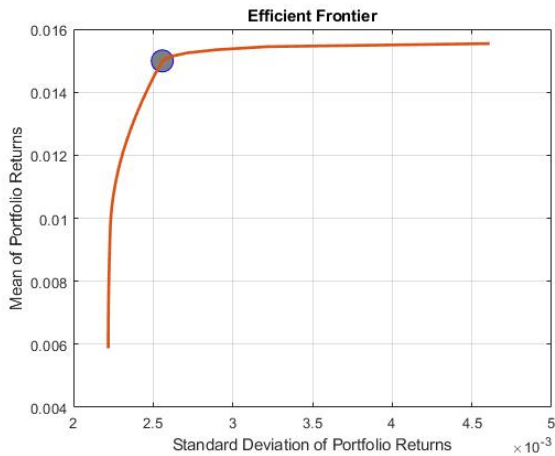


Figure 6.11

Optimal Portfolio Composition

FORD MOTOR COMP	12,24%
UNITED STATES STEEL	2,00%
MURPHY OIL CORP	2,00%
ROYAL CRBN CRUISES	17,64%
US.CELLULAR CORP	2,00%
LIBERTY INTERACTIVE	2,00%
NOKIA CORP	2,00%
APACHE CORP	2,00%
MARKS AND SPENCER	19,24%
XEROX CORPORATION	2,00%
HCA INCORPORATED	28,88%
SPRINT CAP.CORP.	2,00%
LUMEN TECHNOLOGIES	2,00%
HOWMET AEROSPACE	2,00%
MATTEL INCO.	2,00%

Table 6.23

OPTIMAL PORTFOLIO DATA

Annual Std. Dev	0,04124
Annual Expected Return	0,01499
Sharpe Ratio	0,364
Variation from No Const.	-42%

Table 6.24

Mean-CVaR

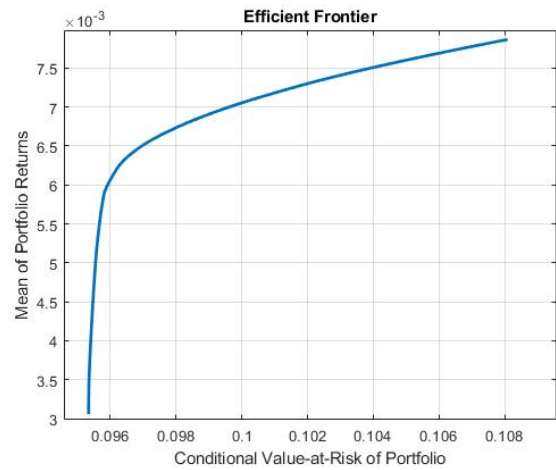


Figure 6.12

Optimal Portfolio Composition

FORD MOTOR COMP	12,21%
UNITED STATES STEEL	2,00%
MURPHY OIL CORP	2,00%
ROYAL CRBN CRUISES	16,49%
US.CELLULAR CORP	2,00%
LIBERTY INTERACTIVE	2,00%
NOKIA CORP	2,00%
APACHE CORP	2,00%
MARKS AND SPENCER	19,52%
XEROX CORPORATION	2,00%
HCA INCORPORATED	29,78%
SPRINT CAP.CORP.	2,00%
LUMEN TECHNOLOGIES	2,00%
HOWMET AEROSPACE	2,00%
MATTEL INCO.	2,00%

Table 6.25

OPTIMAL PORTFOLIO DATA

CVaR	0,069
Annual Expected Return	0,015
Mean/CVaR	0,21576
Annual Std. Dev	0,04125

Table 6.26

6.2.3 Future Data

The second step of backtesting is about observing the future data and evaluating the effect optimization has had on portfolio. The data provided in this section are the ones observed in the years 2016, 2017, 2018, and 2019 confronted with expected value, that is the average value of the five previous years.

Daily Data

	2016	2017	2018	2019
FORD MOTOR COMPANY	7,8E-05	1,3E-04	-8,9E-04	5,2E-04
UNITED STATES STEEL CORP	2,7E-03	4,9E-04	-9,5E-04	2,2E-04
MURPHY OIL CORPORATION	8,2E-04	1,1E-04	-3,9E-04	3,3E-04
ROYAL CARIBBEAN CRUISES	1,4E-04	3,5E-04	-4,8E-04	3,9E-04
US CELLULAR CORP	3,9E-04	2,3E-04	-2,5E-04	4,3E-04
LIBERTY INTERACTIVE LLC	2,1E-04	8,0E-05	-3,8E-04	9,7E-06
NOKIA OYJ	1,3E-04	1,7E-04	-3,2E-04	4,7E-04
APACHE CORP	6,5E-04	1,1E-04	-6,2E-04	3,5E-04
MARKS & SPENCER PLC	-1,4E-05	1,6E-04	-3,1E-04	1,4E-04
XEROX CORPORATION	1,4E-04	2,6E-04	-1,2E-03	1,1E-03
HCA INC	1,8E-05	1,6E-04	-2,3E-04	4,7E-04
SPRINT CAPITAL CORP	1,3E-03	6,7E-05	-2,5E-04	5,1E-04
LUMEN TECHNOLOGIES INC	8,2E-04	-7,4E-05	-9,6E-05	8,7E-04
HOWMET AEROSPACE INC	5,3E-04	2,9E-04	-6,3E-04	6,7E-04
MATTEL INC	4,4E-05	-7,3E-04	-7,8E-04	8,2E-04

Table 6.27 Daily Average Returns in the next four years

Yearly Data

	EXP	2016	2017	2018	2019
FORD MOTOR COMPANY	2,67%	2,02%	3,26%	-23,15%	13,65%
U.S. STEEL CORP	-13,58%	70,92%	12,63%	-24,77%	5,72%
MURPHY OIL COR	-5,40%	21,38%	2,98%	-10,26%	8,64%
ROYAL CARIBBEAN	2,91%	3,76%	9,16%	-12,59%	10,06%
US CELLULAR CORP	-1,73%	10,04%	6,00%	-6,63%	11,16%
LIBERTY INTERACTIVE LLC	0,73%	5,40%	2,08%	-9,85%	0,25%
NOKIA OYJ	-0,60%	3,29%	4,37%	-8,46%	12,21%
APACHE CORP	-2,42%	16,87%	2,99%	-16,26%	9,24%
MARKS & SPENCER PLC	2,78%	-0,36%	4,15%	-8,02%	3,74%
XEROX CORPORATION	-3,34%	3,64%	6,64%	-31,11%	30,01%
HCA INC	2,88%	0,46%	4,14%	-6,10%	12,27%
SPRINT CAPITAL CORP	-4,41%	34,31%	1,75%	-6,40%	13,35%
LUMEN TECHNOLOGIES INC	-5,23%	21,37%	-1,92%	-2,52%	22,71%
HOWMET AEROSPACE INC	-1,37%	13,83%	7,45%	-16,48%	17,47%
MATTEL INC	2,08%	1,16%	-18,99%	-20,40%	21,50%

Table 6.28 Yearly Average Returns in the next four years

6.3 Results

The universe portfolio, where each security has equal weight, is used as a global index of the hypothetical market composed of the examined securities, has the following expected value for volatility and return at 12/31/2015:

Expected Return	-1,60%
Expected Std. Dev.	5,55%

The expected return for the majority of assets is negative, thus the universe portfolio has a negative expected return. However, the observed returns are quite surprising:

Year	Returns
2016	13,87%
2017	3,11%
2018	-13,53%
2019	12,80%
Dev. St	12,69%
Avg Return	4,06%

6.3.1 Optimal Portfolio Results

Optimal Portfolios

P1: No Additional Constraints

P2: Upper Bound 10%

P3: Lower Bound 2%

MEAN-VARIANCE

	P1	P2	P3
2016	1,62%	5,65%	5,02%
2017	4,18%	2,46%	4,53%
2018	-11,37%	-12,79%	-11,42%
2019	9,42%	11,15%	10,75%
Exp Return	2,62%	0,79%	1,50%
Dev. St	8,84%	10,26%	9,52%
Avg Return	0,96%	1,62%	2,22%
Δ vs Universe			
Dev. St	-3,85%	-2,43%	-3,17%
Avg Return	-3,10%	-2,45%	-1,84%

MEAN-CVAR

	P1	P2	P3
2016	1,66%	5,65%	4,98%
2017	3,93%	2,46%	4,47%
2018	-11,31%	-12,79%	-11,35%
2019	9,33%	11,15%	10,75%
Exp Return	2,66%	5,60%	4,12%
Dev. St	8,75%	10,26%	9,48%
Avg Return	0,90%	1,62%	2,21%
Δ vs Universe			
Dev. St	-3,94%	-2,43%	-3,21%
Avg Return	-3,16%	-2,45%	-1,85%

Table 6.29 Final Results

The standard deviation is the standard deviation between years, calculated to evaluate the dispersion of portfolios between positive and negative periods in relation to the market movements.

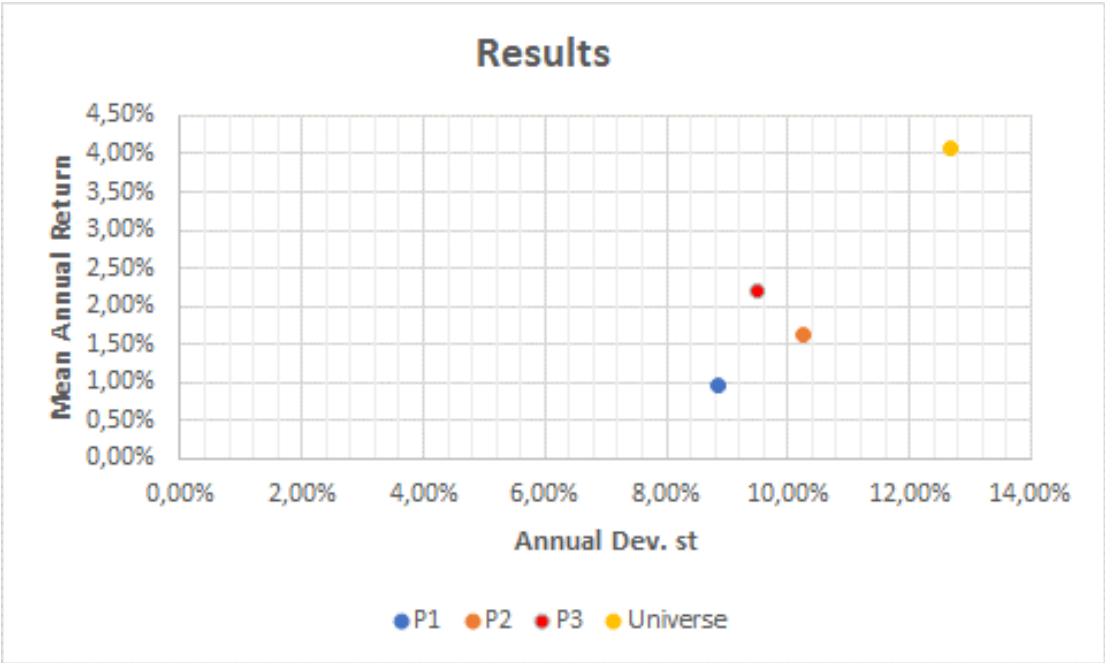


Figure 6.13 Comparison Between Portfolios

6.4 Final Report

Premises

Each security from the chosen sample belongs to the high-yield segment, being more exposed to market fluctuations and volatility. They are all from US markets since the scarce availability of securities with the required characteristics in developed markets, while emerging currencies and markets have not been taken into consideration by now. The sample is thus quite limited and the presented results would need further testing using different data set to lead to statistically robust conclusions. Moreover, transaction costs and eventual limitation to the purchasing of securities, such as bonds for professional investors only, have not been considered, while they can influence the capital allocation in the real world.

Comparison between Optimization Models

As previously indicated, Mean-Variance and Mean-CVaR optimizations return very similar outputs, often almost coincident to each other. This is not much of a surprise since they are based on similar conceptual basis and rely on the same assumptions, such as normality of log-returns and constant volatility. Moreover, the high number of simulations, 10000 yearly scenarios, run for the mean-CVaR model, returns data which tend to approach the average values for the Great Numbers Law. Both the models penalize the most volatile securities, which are generally the ones which are expected to give highest returns. However, the exact relationship between the two models is thoroughly explained in Appendix B.

Optimization Results

The comparison has been made between the optimal portfolios identified by each model, represented by those portfolios maximizing respectively Sharpe Ratio and the ratio between Mean Return and CVaR, and the universe portfolio. Expected results calculated through the average log-return of five years are eventually compared to the yearly log-return of each one of the following four years.

The result is quite surprising, since optimized portfolios heavily underperformed the universal portfolio in two out of the four examined years. In particular, 2016 is the year confirming this tendency, when the optimized portfolio without constraints registers a return of 1,6% against a return of 13,8% by the universal portfolio. This is mainly due to the extremely positive performance of securities with worst expected return, especially the US Steel's bond, which had the worst expected return and had an incredibly positive performance in 2016, 70%.

Those observations seem to exclude the effectiveness of such a model, even suggesting a negative correlation between past returns and future ones. This *Mean Reversion* hypothesis, according to which the worst performers in the past are more likely to overperform in the future, seems to be confirmed noticing all of the securities with return over 10% in 2016 had negative returns in the previous five years.

The mean annual return of the no-constraints portfolio is around 0,9% while the universe portfolio has a mean return of around 4%. The better returns of upper and lower-bounded portfolios are not a surprise since they force the investor to also purchase some negative-expected-return securities, which are the top performers from 2016 to 2019.

The optimized portfolio dramatically underperforms the universe, and it would behave even worse against a “worst-securities portfolio”, sort of a reversely optimized portfolio, during the positive years for the market, 2016 and 2019, while it seems to be a better choice in the downhill periods as 2018, keeping a more regular profile and limiting volatility.

A longer period observation, in fact, evidences the volatility reduction accomplished through optimization, suggesting a quite stable correlation between future volatility and past volatility.

The not-constrained optimized portfolio has a return of 0,9% against an expectation of 2,6%, while conversely the universal portfolio returns exceeds 4%, while it was expected to be -1,6%. This can be due to the presence of 2 extremely positive years in the future sample for the market as a whole, 2016 and 2019, with only one negative year to compensate.

Conclusions

According to the observations, optimization models based on historical data show efficiency in limiting portfolio volatility, untying as much as possible portfolio's performance to global markets' one, giving priority to low-volatility securities to avoid losses even though it might mean accepting a sub-optimal future return in general euphoric periods. This seems to be true for both bonds and equities.

Conversely, for bonds past returns on price are not a good proxy of future ones, but instead they seem to be negatively correlated. This is due to the different kind of security, which is not a property share of a company but a right to receive often fixed cash flows from the company itself.

The oscillations in price mainly depend on the likelihood of insolvency and interest rates and they tend to converge to the par value as it gets closer to maturity date and credit events become less likely.

Unlike equity, whose value can virtually grow unlimitedly and is sometimes influenced from trend logics, fixed income has a natural price cap and tends to return to a certain price, so excluding downgrades and defaults the underperforming bonds in the past are likely to return to the par value and viceversa.

In conclusion, the effectiveness of applying these models to bond portfolios depends on the investors' goals: such an approach is clearly not recommended for that investor who wants to speculate on prices, since he should probably bet on securities which had the worst past performance if he trusts the issuers. However, optimization models might be useful for an investor aiming to hold the securities for a longer period, potentially to maturity, protecting himself from market fluctuations if he had to suddenly liquidate the position following an unexpected event.

Future Adjustments

The possibility to limit volatility is extremely important for bond investors, so an application to real customers is likely to be advantageous, even though, as pointed out multiple times, it requires further testing effort. However, there are some ideas to make those models more suitable for bond investors.

The first one, particularly useful for those who aim to bring the bond to due date, concerns the introduction of a minimum portfolio's yield to maturity or yield to worst constraint. The second one should be even better since it considers any call options often related to bonds. Moreover, such a constraint is linear and consequently very simple to implement.

It is also possible to elaborate further constraints regarding modified duration of securities or coupon rate. In fact, there are some investors who aim to obtain high periodic fixed cash flows from their investments, accepting a higher risk of price fluctuations, which however has to be attentively weighted.

For those investors, a model minimizing volatility granting a certain coupon rate would be extremely useful and it would allow them to choose their investments in a more rational and schematic way. Since those models are based on historical data, the analysts could possibly interfere with the process giving a higher priority to the data coming from the periods that he considers more likely to repeat in the expected holding period of the portfolio.

Elaborating artificial scenarios, even though quite costly and not always profitable, could also be useful to apply the model to those security for which there are not enough historical data. In fact, while equities are potentially eternal, and they often have decades of observations, except for recent IPOs, bonds are more likely to suffer from historical data shortage.

The last possible suggestion for the future could be the elaboration of a customer profiling process, through which advisors would assign them a score basing on specific surveys, and eventually condensing the gathered information to calculate the *Absolute Risk Aversion* parameter.

This parameter would define each customer's utility function in order to individuate his ideal position on the efficient frontier.

APPENDIX A: Quadratic Programming

Quadratic programming is one of the several solution methods for nonlinear programming problems, i.e. those problems which don't respect the linearity condition in either the objective function or the constraint function, or both.

A nonlinear programming problem in its most general form appears as follows:

$$\begin{cases} \max f(x) \\ \text{s.t. } g(x) \leq b_i & \text{for } i = 1, 2, \dots, m \\ x \geq 0 \end{cases}$$

Where $f(x)$ and $g(x)$ are function of the n decision variables. The most appropriate solution technique to solve each problem depends on objective function's and constraints' nature, which can make a problem relatively simple to solve or conversely extremely difficult challenging from the computational point of view.

Since nonlinear programming is a very large field with many different possible problems, this appendix merely describes the techniques useful for the master thesis, deliberately neglecting other methodologies.

Quadratic programming problems have linear constraints and a quadratic objective function, which involves a squared variable or the product of two variables. Those problems are very common in *portfolio selection* and thus this technique is commonly used to solve economic and financial problems. The most common approach to individuate the optimal solution in linear constraint optimization problems consists of the solution of a sequence of quadratic approximations of the original problem.

Karush Kuhn Tucker Conditions

Karush-Kuhn-Tucker conditions are optimality conditions for generic constrained problems, representing a generalization of Lagrange Multipliers Method which allows the inclusion of inequality constraints.

Let Q-Prob be the following nonlinear programming problem:

$$\begin{cases} \max f(x) \\ \text{s.t. } g(x) \leq b_i \\ x \geq 0 \end{cases}$$

Theorem With $f(x)$, $g_1(x)$, $g_2(x)$, ..., $g_m(x)$ being continuously differentiable functions, then the point:

$$x^* = [x_1^*, x_2^*, \dots, x_n^*]^T$$

is a global optimal solution of Q-Prob if and only if there exist m Real numbers u_1, u_2, \dots, u_m such that all of the following conditions, the Karush-Kuhn-Tucker conditions, are satisfied:

$$\begin{aligned}
& \left. \begin{aligned}
1. \quad & \frac{\partial f}{\partial x_j} - \sum_{i=1}^m u_i \frac{\partial g_i}{\partial x_j} \leq 0 \\
2. \quad & x_j^* \left(\frac{\partial f}{\partial x_j} - \sum_{i=1}^m u_i \frac{\partial g_i}{\partial x_j} \right) = 0
\end{aligned} \right\} x = x^*, j = 1, 2, \dots, n \\
& \left. \begin{aligned}
3. \quad & g_i(x^*) - b_i \leq 0 \\
4. \quad & u_i [g_i(x^*) - b_i] = 0
\end{aligned} \right\} i = 1, 2, \dots, m \\
& 5. \quad x_j^* \geq 0 \quad j = 1, 2, \dots, n \\
& 6. \quad u_i \geq 0 \quad i = 1, 2, \dots, m
\end{aligned}$$

The numbers u_1, u_2, \dots, u_m are the Lagrange multipliers in the mathematical derivation. Both conditions 2 and 4 require at least one of the two factors in brackets to be null, so constraint 4 can be combined with constraint 3 to originate:

$$g_i(x^*) - b_i = 0 \text{ for } i = 1, 2, \dots, m.$$

Similarly condition 2 can be combined with condition 1 then:

$$\frac{\partial f}{\partial x_j} - \sum_{i=1}^m u_i \frac{\partial g_i}{\partial x_j} = 0$$

Conditions 3 and 5 grants the solution to be feasible while the others reduce the number of feasible solutions eligible to be the optimal solution.

Application to Quadratic Programming

A quadratic programming problem can be expressed using matrix notation

$$\begin{cases}
\max f(x) = cx - \frac{1}{2}x^T Qx \\
s.t \quad Ax \leq b \\
x \geq 0
\end{cases}$$

Where c is a line vectors, b and x are column vectors, Q and A are matrices. For a generic quadratic programming problem, Karush-Kuhn-Tucker Conditions can be reduced as follows:

$$\begin{cases}
Qx + A^T - y = c^T \\
Ax + v = b \\
x \geq 0, \quad \lambda \geq 0, \quad y \geq 0, \quad v \geq 0 \\
x^T y + \lambda^T v = 0
\end{cases}$$

Where Lagrange multiplier vector λ corresponds to the vector u of the previous form, while y and v are slack variables.

Assuming the objective function to be a concave function and the constraint to be linear functions we can assert x is a global optimal solution of the problem if and only if there exist y , λ and v so that all of the Karush-Kuhn-Tucker conditions are simultaneously satisfied.

APPENDIX B: Relationship between Mean-variance and Mean-CVaR

This section reports and demonstrates some propositions which explain how the two different methodologies relates to one-another, which will be confronted with the results obtained by our bond optimization.

Lemma *If the minimum CVaR portfolio at the $100\alpha\%$ confidence level exists, then it is also mean-variance efficient.*

If there was a minimum CVaR portfolio x which is not variance-efficient, by definition, there is a portfolio v such that $E[r_v] \geq E[r_x]$ and $\sigma[r_v] \leq \sigma[r_x]$, where at least one of the inequalities is strict. But since $CVaR[\alpha, r_x] = k_\alpha \sigma[r_x] - E[r_x]$, we have $CVaR[\alpha, r_v] \leq CVaR[\alpha, r_x]$, implying x is actually variance-efficient.

Let $m_{CVaR(\alpha)} \in X$ be the min-CVaR portfolio at α confidence level, while $m_\sigma \in X$ is the min-variance portfolio. g and h are defined as n -dimensional vectors so that $g = \frac{1}{d}[b(\Sigma^{-1}\bar{1}) - a(\Sigma^{-1}\mu)]$ and $h = \frac{1}{d}[c(\Sigma^{-1}\mu) - a(\Sigma^{-1}\bar{1})]$

Proposition 1 Minimum CVaR Portfolio at the $100\alpha\%$ confidence level only exists if $k_\alpha > \sqrt{d/c}$. If $k_\alpha > \sqrt{d/c}$, then

$$m_{CVaR(\alpha)} = g + h \left(E[r_{m_\sigma}] + \sqrt{\frac{d^2/c^2}{k_\alpha^2 - d/c}} \sigma[r_{m_\sigma}] \right)$$

And,

$$CVaR[\alpha, r_{m_{CVaR(\alpha)}}] = (\sqrt{(k_\alpha^2 - d/c)}) \sigma[r_{m_\sigma}] - E[r_{m_\sigma}]$$

In other words, it is necessary to choose the right confidence level so that CVaR is a realistic objective. If confidence level is low, that means $k_\alpha < \sqrt{d/c}$, the problem of globally minimizing CVaR has no solution. Confidence level is high if $z_\alpha > \sqrt{d/c}$ and moderate if $k_\alpha > \sqrt{d/c} \geq z_\alpha$. The minimum VaR portfolio $m_{VaR(\alpha)}$ only exists if confidence level is high and is always variance-efficient. If min-Var portfolio exists, also min-CVaR does, while the opposite is not granted.

Corollary *If minimum CVaR portfolio at $100\alpha\%$ confidence level exists, then $E[r_{m_{CVaR(\alpha)}}] > E[r_{m_\sigma}]$ and if minimum VaR portfolio at $100\alpha\%$ confidence level exists then the $E[r_{m_{VaR(\alpha)}}] > E[r_{m_{CVaR(\alpha)}}]$.*

It means that the minimum variance portfolio always has a lower expected return and a lower volatility than the minimum CVaR portfolio, which always has a lower expected return and a lower expected volatility than the min-VaR portfolio.

Hence, when both min-VaR and min-CVaR exist, the min-CVaR portfolio lies on the mean-variance efficient frontier between min-variance and min-VaR portfolios.

$E[r_{m_{CVaR(\alpha)}}] > E[r_{m_\sigma}]$ is obtained because we have $\partial\sigma[r_x]/\partial E[r_x]_{x=m_\sigma}$, hence an increase in mean moving upward the mean variance efficient frontier from the min-variance portfolio produces a small increase in standard deviation and hence a decrease in CVaR.

Similarly, we obtain $E[r_{m_{VaR(\alpha)}}] > E[r_{m_{CVaR(\alpha)}}]$ because, since $k_\alpha > z_\alpha$, a decrease in the mean moving downwards along the mean variance efficient frontier away from the min-VaR and toward the min-variance portfolio leads to a decrease in CVaR.

Mean-CVaR Efficiency Characterization

Proposition2 *If $k_\alpha < \sqrt{d/c}$ no mean-CVaR efficient portfolio exists at $100\alpha\%$ confidence level. If $k_\alpha > \sqrt{d/c}$, a certain portfolio w is mean-CVaR efficient at $100\alpha\%$ confidence level if and only if it belongs to the CVaR boundary and $E[r_w] \geq E[r_{m_{CVaR(\alpha)}}]$.*

From this proposition we can infer that the minimum variance portfolio is mean-CVaR inefficient at any confidence level $\alpha < 1$.

APPENDIX C: MatLab Models

Mean-Variance Optimization

```
clc
clear all

%BondList= List of securities' names/codes
%Avg_Rend_Ann= Column vector of annual expected return
%Var_Cov=Variance-Covariance matrix
%YTM= column vector of Yield to Maturity of each bond
%the whole data set has been imported from Excel, code not reported for brevity

%%PORTFOLIO DEFINITION
BondPort=Portfolio;
BondPort.AssetList=BondList(1:20);
BondPort.AssetMean=Avg_Rend_Ann;
BondPort.UpperBound=ones(1,20);
%Set upper bound to vector of 0.10 for the second model
BondPort.LowerBound=zeros(1,20);
%Lower bound at zero doesn't allow short, set lower bound to vector of 0.02 for third model
BondPort.AssetCovar=Var_Cov;

%if you want a min yield to maturity of 1
BondPort.AInequality=YTM';
BondPort.bInequality=[1];

BondPort.AEquality=ones(1,20);
BondPort.bEquality=1;
BondPort=Portfolio(BondPort,'lowerbudget',1,'upperbudget',1);

%Individuate max sharpe ratio
Port_opt=estimateMaxSharpeRatio(BondPort);
screen =[BondPort.AssetList' Port_opt];
disp(screen);
%Check portfolio weights' sum is actually 1
sum=sum(Port_opt);
%calculate optimal port parameters
Rend_opt=Port_opt'*Avg_Rend_Ann;
Dev_Opt=sqrt(Port_opt'*Var_Cov*Port_opt)*sqrt(260);
[Risk1, Ret1]=estimatePortMoments(BondPort,Port_opt);
fprintf('\noptimal portfolio has annual return of %5f with annual volatility %5f\nthe sum of weights is %g', Rend_opt, Dev_Opt, somma);

%Plot efficient frontier
plotFrontier(BondPort);hold on;
plot(Risk1,Ret1,'O','MarkerSize',15, 'MarkerEdgeColor','b','MarkerFaceColor',[0.5 0.5 0.5]);
```

Mean-CVaR Optimization

```
clc
clear all

%BondList= List of securities' names/codes
%Exp_Daily_Returns= Column vector of daily expected return
%Var_Cov=Variance-Covariance matrix
%YTM= column vector of Yield to Maturity of each bond
%Num_Sec= (Int)represents the number of securities available for the portfolio

%the whole data set has been imported from Excel, code not reported for brevity

%% SCENARIOS
A=zeros(1,15);
Num_Scenarios=10000;
Trading_Days=260;

%Simulation of 10000 scenarios of 260 days each starting from daily expected returns
Scenarios = portsim(Exp_Daily_Returns',Var_Cov,Trading_Days,1,Num_Scenarios,'Expected');

%%Calculation of average annual return for each scenario, multiply by 260 to annualize and
%create a vector of scenarios, 15 is the number of securities available for the portfolio

i=1;
j=1;
S=ones(Num_Scenarios,Num_Sec);
for j=1:Num_Scenarios
    for i=1:Num_Sec
        A(1,i)=(mean(Scenarios(:,i,j)))*260;
        i=i+1;
    end
    S(j,:)=A;
    j=j+1;
    i=1;
end
clear i
clear j

for i=1:Num_Sec
    Media(1,i)=mean(S(:,i));
    i=i+1;
end
clear i

%% PORTFOLIO DEFINITION
BondPort=PortfolioCVaR;
BondPort=BondPort.setAssetList(BondList);
BondPort=BondPort.setScenarios(S);
BondPort=BondPort.setDefaultConstraints;

%Setting of min YTM, if needed
```

```

%BondPort.AInequality=YTM';
%BondPort.bInequality=[1];

%Setting of confidence leve
BondPort=BondPort.setProbabilityLevel(0.95);

%Plotting efficient frontier and individuate 100 equally spaced portfolios on the frontier with related
returns and CVaR

[BondPortRisk, BondPortReturns]=BondPort.plotFrontier(100);
[pwgt,BondPortRisk, BondPortReturns]=BondPort.estimateFrontier(100);
Returns=pwgt*(Exp_Daily_Returns*260);
CVars=estimatePortRisk(BondPort,pwgt);

```

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