Thesis

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August 18, 2020

1 A gentle introduction to credit risk

As you might have already inferred from the title, the aim of this section is to give an overview of the topic that is at the hearth of this paper: credit risk. In order to so however, rather than jumping straight into formal definitions, which might create difficulties in grasping with the content, the reader will be first provided with real-life examples characterized by the presence of such risk. Moving on, some formal definitions will be provided along with a description of the agents that usually take upon this risk and how they act to assess it and quantify it with the purpose of taking proper actions to finally mitigate it. Finally, the chapter ends with an introduction to credit risk modelling, as this topic will be

1.1 Introduction

To start off this section, let me provide you with a few examples of situations that occur on a daily basis, which might however serve as a great starting point to understand the topic.

Imagine yourself receving a call from one of your friends that you have not heard for quite a while. You can hear from his voice that he is really upset, and apparently, the reason for this is that he has to pay a fine by the end of the day to avoid an additional charge, but he does not have the money to pay at the moment. He tells you that the reason for this is that he had to cover fo huge expenses lately and he still has not received his monthly salary. He then ask you, whether you would be kind enough to lend him the money, promising to repay you as soon as he receives his paid. What would you do? Would you lend him the money? What if one of your colleague at work asks you the same thing? Would you do it in this case? Would it make a difference if it was someone you knew well? And if your colleague ask you to lend him money for a pizza without mentioning you when and how is going to pay you back?

Usually, the type of questions that you ask yourself before getting into these agreements, which are also a simplified version of what financial istitutions ask themselves before lending, are the following:

1. Who is borrowing?
2. How much they are borrowing?
3. When I will get it back?
4. How much is there for me?

Going back to the last example, imagine your colleague telling you that he will pay you back the week after and in addition, he is willing to take you out for lunch. In this case, he is paying you back more than what you lent him. Would you call this *interest rate*? What if instead he gives you his watch to keep until he pays you back? Now it feels a much more safer lending. Indeed, the watch in this case is usually called *collateral* (or also *security*).

The procedure that has been just introduced is usually referred to as "**credit analysis**", which formally can be defined as the process through which the lender elaborates if he believes the counterparty is going to honor its obligations or not. This ultimately determine whether the agent will enter in that contract, along with the relative risk associated with it, or more precisely, the **credit risk**.

1.1.1 Credit risk

Definition (Credit Risk): the risk that a lender has to take into account due to the uncertainty related to the borrower either failing to repay a loan or to meet its obligations.

In simple terms, this definition suggests that the lender should consider the possibility that a borrower will not be able to pay back the principal and the interest rate according to the initial contractual agreement. He should then quantify this probability and based on the result, charge a coupon rate (i.e. interest rate) to protect against this risk. The methods to derive the aformentioned probability are part of the broad area of **Credit Risk Modelling**, which will be at the heart of the empirical analysis, and for this reason, it will be introduced later.

Ultimately, there are at least 3 additional points that is worth mentioning in the context of credit risk and that should be considered as a key takeaways from this introductory chapter:

1. **Credit risk in every financial transaction**: although most of the times it might come natural to associate this type of risk to transactions that occur between a party and a financial istitution (e.g. mortgages, loans, credit cards, etc...), credit risk has a presence also at the company level, for instance, between companies and clients (e.g. paying invoices, insurance coverage, etc..)

2. **Risk assessment**: before granting new credit, as often it is the case in the business world, the bank undergo an assessment of the borrower that takes into consideration his credit history, the capabilities to repay

back, the capital available, the loan's conditions and associated collateral. Such evaluation has the final goal of providing an accurate prior estimate of the credit risk, which will eventually tell whether the client should get or not the obligations, with an increasing interest rate for those who are perceived as riskier. In the case of bonds, this assessment is done by credit-rating agencies that assign a triple-A (i.e AAA) for low-risk investments, all the way down to C for high-risk investments. Although this process is tied to bonds only, our dataset provides ratings also for loans, perhaps as a result of internal procedures to assess credit risk.

3. **Credit risk vs. other risks**: so far it was assumed that the risk associated to the lending was purely driven by the borrower characteristics. However, in a typical lending transaction, usually other types of risks factor in such as market risks (e.g. economic conditions, FX rates), country-specific risks (e.g. OECD country, emerging-markets country, etc..), operational risk, issuer risk, and so on... To keep things simple, and given the nature of the data for the empirical analysis, although it might represent a far too simplistic assumption, we will stick with it and only deal with a particular type of credit risk: the *CCR (Counterparty Credit Risk)*

1.1.2 CCR - Counterparty Credit Risk

Definition (Counterparty Credit Risk): CCR can be defined as a measure of the **likelihood** that either one of the parties involved in a transaction **might default** on its contractual obligation.

According to the definition of *credit risk* provided above, there is a subtle but fundamental difference between the two type of risk, and in order to make it clear also to the reader, and example on loans is going to be provided. Imagine that a counterparty was able to obtain an incredibly high amount through a loan that was extended for whatever reason from a bank. The latter assessed whether the borrower would be able to pay back the amount also within the date established with the lending contract. This process is also called "credit risk assessment" and takes into account the possibility that the borrower might not be able to fully repay the lender according to the contractual obligations, but do not exclude that the counterparty might cover for the remaining part in the future either. Hence, the bank here is exposed (in terms of risk) only to the portion of the money lended that believes are at risk. What if instead the banks start considering the chance that this counterparty might default on this loan such that he will never be

able to pay back any of the amount received, neither in the present, nor in the future? Here the bank evaluates the risk at the counterparty level also known as "CCR" or "default risk" - the variable we wish to model.

2 Basel Regulatory Framework

The needs for a more comprehensive and better approach to risk management, particularly for counterparty credit risk, has emerged quite significantly after the financial crisis of 2007-2009. Since then, regulators have sharpened their frameworks and applied more stringent controls to the stability of financial istitutions, focusing also on hyphotetical scenarios. On this line of reasoning, this section provides an overview of how regulatory requirements in the context of counterparty credit risk have evolved over time, presenting also reasons for which such rules have been introduced in the first place.

In the aftermath of the well-known and aformentioned financial crisis of the period 2007-2009, there has been an unprecedented revision of the global framework regulating the financial sector, culminating in what is known today with the name of **Basel III** regulatory framework. However, before reaching this result, the banking sector has experienced a relevant number of systemic crisis usually driven by various factors, including the miscalculation of risk represented by inadequate capital levels to carry out their business. Each of this crisis brought some contribution and changes to the previous framework, adding up to the first version, which consisted of 30 pages, more than 1500 pages of guidelines relating to the supervision of daily banking activities. Although it might seem scary at first, the Basel III framework can actually be divided into 7 key modules that are listed here:

1. **Minimum capital requirements**: refers to methodologies for the calculation of operational, market and credit risks
2. **RWA - Risk Weighted Assets**:
3. **Capital buffers**:
4. **Leverage**:
5. **Liquidity**: refers to the amount of capital hold
6. **Supervision**: refers to the periodical capital assessments and supervisory interventions that financial istitutions agree to undertake
7. **Market discipline**: period disclosure of risk exposures by financial istitutions to enable much more informed decisions

Why was the Basel Committee ever needed? In order to answer this question, we have to go back to 1970s, when the Herstatt Bank collapsed and

was put under liquidation due to enormous trades on the foreign exchange market that did not go as planned. The license was withdrawn in the 1974, as losses have reached an amount equal to 10 times the liquidity of the bank. However, there is more to the story: US counterparties engaging in multiple transactions with Hersatt Bank released "Deutschmark" in exchange of dollars. These lenders never see their money, essentially because of time differences: US was still in morning trades when the bank was revoked its license. Although this is purely related to FX activities, and cosequently involves also FX and market risk, this event highlighted the necessity to create a central forum for banking supervision concerning matters related also to other type of risks, such as "credit risk". With the objective of enhancing the financial stability and quality of banking supervision, in 1974 multiple central banks gave raise to a centralized committee which later on took the name of "Basel Committee on Banking Supervision". The latter expanded quite significantly and as of now, it includes 45 central banks worldwide.

The need for a regulatory framework for risk management instead, takes us back to the 70s-80s period, when the surge in debt in the latin american countries combined with the raise of interest rates in US and Europe led the way to a series of critical debt restructuring efforts for many countries worldwide. Hence, the critical needs for a more clear and comprehensive framework to bring overall stability in the banking system led the way for the Basel committee to issue guidelines on weighted approach to risk management. Such need was satisfied with the release of the Basel 1 framework in 1988, when for the first time in history, banks were required to weigh the capital they held against the credit risk they took from lending services.

2.1 Basel 1

The first regulatory framework released by the Banking Committee was denominated "Basel 1". The latter introduced some relevant changes in the financial system:

- Istitutions provide any type of lending services were required to classify assets into 5 different categories based on the risk they bear: from 0% for most secured assets (e.g. cash) to 100% for low-quality assets (e.g. private sector debt). Since then, such assets have been known with the name: "**RWA**" (risk-weighted assets).

- Keep minimum level of capital against the total RWA. This was initially set at 8%, equally spread between most absoring assets (e.g. equity, retained earnings) and the rest, with supplementary assets (e.g. financial

instruments that are more difficult to liquidate). Such threshold was introduced to ensure that financial istitutions had enough standalone capabilities to absord potential losses resulting from defaulting clients.

Despite the major alterations, the first Basel Regulation presented some shortcomings mainly related to the duration of the service, the market risk and, most importantly, the counterparty risk. The complexity introduced by some financial products (Credit default swaps, Complex derivatives, etc..) was drastically incrementing the risk taken by financial istitutions, a situation that required further adjustments with the regulation and shined a light on the ever-increasing importance of accurate methodologies to assess exposures to risk.

2.2 Basel 2

Some of the aformentioned and much needed adjustments have been introduced in the second version of the Basel Framework, today known as: **Basel II**. Major changes are:

- Arrangments of multiple methods to better assess the minimum capital requirements to absorb potential credit losses
- The introduction of a new capital tier: the *Tier-3 capital*. This was meant to cover also for market risk.

Despite the efforts to bring more stability to the financial environment, the paper required substantial time and effort before being released. After this event however, which took place in 2006, most financial istitutions took full advantage of the subprime mortgages - lending money to low credit profile - thank to higher expected returns, but they also started increasing their leverage taking full advantage of the favourable economic conditions after the financial crisis. These events were part of a much broader series of misfunctionality that served as key lessons for the Basel Committee, to bring substantial modification to the current framework and published the latest version as we know it today: The **Basel III**,

2.3 Basel 3

The Basel III framework introduces a very large package of reforms that aims at further strengthen and prevent another financial crisis. Instead of listing the reforms brought and applied, we wish to see how significant changes

over this version of the framework have brought to the attention the ever-increasing need of being able to assess counterparty credit risk (?)

... (leggere Karolina + Online) -¿ collegare a counterparty credit risk e a probability of default! -¿ next chapter!

3 Credit Risk - Empirical Analysis

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4 Blockchain and asymmetric information

5 References

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